

57-3



CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 57-3

LITHIUM DEPOSITS OF MANITOBA,
ONTARIO, AND QUEBEC
1956

By

Robert Mulligan

OTTAWA

1957

Price, 25 cents

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

Paper 57-3

LITHIUM DEPOSITS OF
MANITOBA, ONTARIO, AND QUEBEC
1956

By
Robert Mulligan

OTTAWA
1957

Price, 25 cents



CONTENTS

	Page
Introduction	1
Physical properties, uses, prices	1
Mineralogy	2
Recognition and tests	3
Evaluation	3
Summary of mineralogical data	4
Terminology	6
General geological features	7
Description of districts and properties	9
Preissac-Lacorne district	9
Quebec Lithium Corporation	10
Lithium Corporation of America (Figuary township) ..	11
International Lithium Corporation	11
Canadian Lithium Company	12
Valor Lithium Mines Limited	12
Amos Lithium Corporation	12
Lithium Corporation of America (Lacorne township) ..	12
Other properties	13
Nipigon district	13
Nama Creek Mines Limited	14
Jean Lake Lithium Mines Limited	14
Ontario Lithium (Conwest) and Dunvegan (Newkirk) ..	14
Lun-Echo Gold Mines Limited	15
Aumacho River Mines Limited	15
M. N. W. Group	15
Dryden district	16
Lun-Echo Gold Mines Limited	16
Root Lake Field	16
Capital Lithium Company	16
Lac la Croix district	17
International Lithium Mining Corporation Limited ...	17
Lexindin Gold Mines Limited	17
East Braintree-West Hawk Lake district	17
North American Rare Metals Limited	18
Cat Lake-Winnipeg River district	18
Lithium Mines and Chemicals Limited (Violamac) ...	19
Lithium Corporation of Canada - Cat Lake	20
Lithium Corporation of America - Cat Lake	20
Central Claims - Cat Lake	20
Lithium Corporation of Canada - Bernic Lake East ..	21
Montgary Explorations Limited - Bernic West	22
Papineau property - Shatford Lake	22
Silverleaf and Huron properties - Winnipeg River ...	22
Herb Lake district	23
Green Bay Mining and Exploration Limited	23
Combined Developments Limited	24
Sherritt Gordon Mines Limited	24
Yellowknife-Beaulieu district	25
Bibliography	25

LITHIUM DEPOSITS OF MANITOBA, ONTARIO, AND QUEBEC, 1956

INTRODUCTION

Interest in lithium deposits in Canada remained high in 1956, with one property in production, shaft-sinking begun or in preparation at three more, and diamond drilling and surface work active on numerous others.

Most known deposits are in the Preissac-Lacorne district of Quebec, where Quebec Lithium Corporation is now in production, the Nipigon district of Ontario, the Cat Lake-Winnipeg River and Herb Lake districts of Manitoba, and the Yellowknife-Beaulieu district, Northwest Territories. Other major fields are the Dryden, Lac la Croix, and Root Lake districts of Ontario, and the East Braintree-West Hawk district of southeast Manitoba. More recent discoveries are in the Falcon Lake and O'Sullivan Lake districts of northern Ontario.

Many of the deposits have been described in previous publications of the Geological Survey of Canada, Provincial Mining Departments, and the technical press (see Bibliography). Most of the new developments and discoveries known to the writer have been in Manitoba, Ontario, and Quebec. This paper is a preliminary report, based on one season's field work (1956) in these provinces. It summarizes the presently available information and reviews the main geological features of Canadian lithium deposits. It includes short notes on physical properties, uses and prices of lithium and its compounds, mineralogy, test for minerals, methods of evaluating lithium deposits, and an explanation of the terminology used in the body of the paper.

Special acknowledgment of information and courtesies is made to J. F. Davies of the Manitoba Mines Branch, E. G. Pye of the Ontario Department of Mines, and M. Latulippe of the Quebec Department of Mines.

PHYSICAL PROPERTIES, USES, PRICES (4)*

Lithium (density 0.534) is the lightest of all metals, and one of the lightest materials that is solid at ordinary temperatures. It has a very high specific heat (1.374 at 190°C). The melting point is 186°C and the boiling point 1609°C.

*Numbers in parentheses refer to references in the Bibliography at the end of this report.

The chief industrial applications of lithium compounds are in ceramics and lubricants. Lithium glasses, glazes and enamels have many specialized and superior characteristics. Lithium-based lubricants have highly superior temperature-viscosity characteristics. Other common applications are in electrolytes of alkaline storage batteries, in air conditioning and refrigeration systems, as fluxes in non-ferrous welding and brazing, in paint manufacture, and in special dry-cell batteries.

Lithium metal is used as a scavenger and grain-refining agent in non-ferrous metallurgy, and is a component of certain experimental alloys. Lithium plays a part in some nuclear-energy reactions, and because of its high neutron capture cross-section has been investigated as a possible shielding device for fission reactors. Lithium hydride forms a ready source of hydrogen, and has potential use as a high-energy lightweight fuel.

Nominally quoted prices for lithium concentrates are about \$11 a unit (1%, or 20 lb. of Li_2O per ton) for spodumene, lepidolite, and petalite, and \$75 a short ton for amblygonite. The contract of Quebec Lithium Corporation with Lithium Corporation of America calls for a payment of \$11 a unit for 165 tons a day of concentrate grading not less than 4 1/2% Li_2O .

MINERALOGY

Essentially, all lithium deposits are pegmatite dykes containing one or more lithium mineral. Spodumene is by far the most common and important. Amblygonite is rare except in the Yellowknife-Beaulieu and Cat Lake-Winnipeg River (Bernic East) districts. Lepidolite is of some importance in the Winnipeg River area.

In the Root Lake district of Ontario, assays of 1 per cent or more Li_2O have been reported on some samples of quartz-biotite-amphibole (?) schist. Specimens give a weak positive lithium flame test, but no common lithium minerals have been identified. A purplish colour in amphibolite near dyke contacts has been observed in places in the Preissac-Lacorne district.

The common rock minerals of lithium pegmatites are albite, potash feldspars, quartz, and muscovite mica. Albite, especially in zoned dykes, is commonly in the form of cleavelandite, whose thin wedge-shaped plates give rise to a radiating structure when seen on edge.

Accessory minerals commonly present in lithium pegmatites, especially zoned dykes, are tourmaline, garnet, apatite, and beryl. Tourmaline is black, less commonly blue. Generally it is

opaque, but rarely it is translucent and pink or green. Apatite is common, in small shapeless blue grains. Beryl is green, white, or colourless; it is easily overlooked, but generally shows partly developed hexagonal crystal outlines, and has no cleavage. Fluorite and topaz are rare. Small amounts of columbite-tantalite are common in the Bernic Lake-Winnipeg River area, and other rare-earth minerals as well as cassiterite occur.

RECOGNITION AND TESTS

Spodumene is generally easy to recognize by its colour, crystal habit, and excellent prismatic cleavages. It has a distinctive silky appearance on the ground surface of diamond drill-core. On weathered surfaces, spodumene may be pink or buff-coloured, and alteration to a greenish mica or a brown woody mass is locally conspicuous.

Amblygonite closely resembles albite feldspar and may show similar striations due to polysynthetic twinning. It is noticeably heavier, commonly more chalky in appearance, and its bounding surfaces are locally stained pink by alteration products. Petalite is difficult to distinguish from feldspar, except where its lamellar habit is pronounced. Triphylite-lithiophyllite is characterized by a surface alteration to dark purple or brown purpurite.

Lithium minerals impart a characteristic crimson colour to a sufficiently hot flame. This is usually masked by a pervasive yellow colour due to sodium, but the latter can be filtered out by didymium glass, shade 1.7. Safety spectacles made of this material are available from safety supply dealers. The heat required can be judged from the fusibility of the mineral (see table). Cheap propane or automatic gasoline torches are effective on amblygonite, triphylite-lithiophyllite, and most spodumene, but for petalite and dilute mixtures of fine spodumene with rock minerals, the greater heat of an acetylene torch is needed.

EVALUATION (11)

The standard assay method at present is chemical analysis. Of instrumental methods, the flame photometer gives most promise of reliable quantitative results. Visual estimates of spodumene content by experienced personnel may be fairly reliable under favourable conditions, particularly in diamond drill-cores. Grain-count and grain-intercept-measurement methods are adaptable to dykes containing spodumene. The proportion of spodumene so determined must be corrected for specific gravity in calculating weight percentages.

SUMMARY OF

Lithium Minerals	Ideal Formula	Theoretical or Maximum per cent Li ₂ O
Spodumene	Li ₂ O. Al ₂ O ₃ . 4SiO ₂	8.4
Amblygonite (incl. Montebasite)	2Li($\overset{\text{F}}{\text{OH}}$). Al ₂ O ₃ . P ₂ O ₅	10.1
Lepidolite	(OH, F) ₂ KLiAl ₂ Si ₃ O ₁₀	4.0-6.0
Petalite	Li ₂ O. Al ₂ O ₃ . 8SiO ₂	4.8
Triphyllite -Lithiophyllite	Li ₂ O. 2($\overset{\text{Fe}}{\text{Mn}}$)O. P ₂ O ₅	9.0
Zinnwaldite	Iron-bearing variety of lepidolite	3.3-5
Other lithia micas		Less than 1
Rock Minerals		
Potash feldspar		
Albite		
Albite (variety cleavelandite)		
Quartz		

MINERALOGICAL DATA

Form and Habit	Usual Colour	Hardness	Specific Gravity	Fusi- bility
long prismatic, excellent cleavages parallel to length	green, white	6.5-7	3.17	3.5
sub-crystalline masses, two cleavages at 75°	chalky white	6	3.0-3.1	2
micaceous	lilac	2.5-4	2.8-3.3	2-2.5
massive, pronounced lamellar habit	grey	6.5	2.4	5
cleavable masses	greenish grey to dark purple (purpurite)	4-5	3.5	1.5
curvilammelar micaceous	purplish, brownish, grey			
	pale lilac, yellowish, greenish			
1 good, 1 fair cleavage, at near 90°	usually pink	6-6.5	2.5-2.6	5
	usually white	6-6.5	2.62	4
radiating platy masses	white or pink	6-6.5	2.62	4
massive, - no cleavage	colourless, grey, trans- lucent	7	2.65-2.66	infus.

Where the only minerals present in important amount are quartz, feldspar, and spodumene, specific gravity measurements provide an objective method of determining the weight-percentage of spodumene present in broken pieces of ore. The specific gravity of a specimen is the ratio: weight in air divided by weight in air minus weight in water. If the specific gravity of spodumene is assumed to be 3.17 and that of the quartz and feldspar mixture to be, say, 2.63, the proportion of spodumene by weight is: specific gravity minus 2.63 divided by 3.17 minus 2.63. Small errors in relative weights can cause serious error in calculated specific gravity, and such errors must be within about one part per thousand to give spodumene content within about 3 per cent on medium grades. A good commercial beam of 10-20 lb. capacity just about reaches that order of precision on 10 lb. pieces. Further errors arise from assuming incorrect values for the specific gravity of spodumene and quartz-feldspar gangue, but these tend to cancel out and are not so important. The reliability of the method is, like all other methods, contingent on the number and judicious choice of specimens to provide a representative sample.

TERMINOLOGY (10, 11)

Granitic pegmatites are composed essentially of feldspar, quartz, and mica, in the same general proportions as in granite. They are classified with respect to environment as follows:

1. Interior, i. e. wholly and well within intrusive bodies.
2. Marginal, i. e. close to or athwart contacts with invaded rock.
3. Exterior, i. e. wholly in invaded rock.

Regional Zoning means a progressive spatial distribution of dykes having different mineralogical and/or structural characteristics, with respect to some major geological feature, usually a particular granitic intrusion.

The internal structure units of pegmatites commonly recognized are zones, replacement bodies, and fracture fillings. Of these, only zones are important enough to require definition.

Zoned dykes are complex aggregates of quartz, feldspar, and accessory minerals, in which units of visibly contrasting mineralogy have a fairly consistent systematic arrangement.

If the arrangement is symmetrical, the units form inner or core zones, outer or border and wall zones, and perhaps also intermediate zones.

In the case of lithium-bearing pegmatites, zoned dykes are distinguished from unzoned and imperfectly zoned or 'intermediate' dykes (7), although virtually all lithium pegmatites show some zoning. The basis of distinction is explained under "General Geological Features".

Pegmatite dykes are commonly classified with respect to grain size as follows: fine - less than 1 inch, medium - 1 inch to 4 inches, coarse - 4 inches to 12 inches, very coarse - greater than 12 inches. In this paper, and with special reference to spodumene, the size classification used is: fine - less than 2 inches, medium - 2 inches to 12 inches, coarse - greater than 12 inches.

GENERAL GEOLOGICAL FEATURES

The lithium deposits of Canada are all granite pegmatites. Most are in Precambrian rocks of the Canadian Shield, but a few occurrences in British Columbia and Nova Scotia are related to presumably younger intrusions. Most are exterior or marginal pegmatites, and intrude moderately metamorphosed volcanic and sedimentary rocks or granitic rocks.

In most lithium pegmatites the dominant feldspar is albite, and lithium values tend to decrease with increasing proportion of potassic feldspar. For this reason, most lithium-bearing dykes are conspicuously white, although pink potash feldspar may be present and albite may be coloured pink due to alteration or staining.

In the Winnipeg River and Lacorne districts, some lithium-bearing dykes are associated with peculiar pegmatitic granite bodies. These feature well banded aplite, rectangular crystal-like aggregates of feldspar and quartz in graphic intergrowth, and occasional beryl crystals in quartz-muscovite segregations.

An external structural control by faulting or jointing is suggested in a few areas (Lacorne, Herb Lake) that have been mapped in detail.

In several districts some degree of regional zoning is evident, with spodumene-bearing dykes of simple internal structure lying farther from the central parts of granitic intrusions than complex dykes carrying other rare minerals. Outstanding examples of regional zoning are the Preissac-Lacorne, Nipigon, and Yellowknife-Beaulieu districts.

Many lithium-bearing dykes have recognizable internal structures, of which zoning is the most important. There is little evidence that the spodumene of spodumene-bearing units is of replacement origin, although some albitization of original potash

feldspar is evident. Cleavelandite may have formed at the expense of earlier-formed feldspar, and cleavelandite, quartz, and lepidolite assemblages transgress zone boundaries and commonly vein the spodumene. Only one example of fracture filling was noted; in this case a younger spodumene-bearing dyke cut across an older, the spodumene being oriented perpendicular to the walls in each dyke.

In all the well zoned dykes seen, spodumene is confined to an inner zone generally rich in quartz. In some in the Bernic Lake-Winnipeg River area, however, amblygonite and triphylite are the characteristic accessory minerals of the quartz zone, and spodumene occurs mainly in a marginal part of this inner zone. In some dykes in the Yellowknife-Beaulieu district (8), spodumene occurs in intermediate zones.

The outermost zone is a commonly narrow, discontinuous, aplitic 'chill zone'. Tourmaline generally characterizes the next outer zone, giving way to an intermediate zone that consists chiefly of pink feldspar. Some is in large, well formed crystals and is probably potassium-rich, but pink, purplish, or even dark grey cleavelandite is also common. Muscovite is most abundant in this zone, and beryl is found in quartz-rich segregations associated with muscovite and cleavelandite.

These zones may pinch out or swell, bulge abruptly, or telescope into one another, and core zones are commonly lenticular and discontinuous. All gradations exist from the most complex of zoned dykes to typical unzoned dykes in which spodumene is the only uncommon pegmatite mineral and is distributed essentially from wall to wall. Even in the latter, narrow spodumene-poor outer margins and internal bands, generally of aplite and/or coarse feldspar, are common.

It is obvious that a careful study of the internal structure of dykes is necessary in order to predict the probable lateral and depth extensions of ore-bearing exposures. It also follows that although the exposed section of a dyke may contain no valuable minerals, other parts along the strike or down the dip may be of ore grade.

Spodumene-bearing dykes may be grouped into four types, based on degree of orientation and mode of occurrence of spodumene. They are:

1. Dykes showing consistent parallel orientation of spodumene perpendicular to the walls.

2. Dykes showing parallel cross-orientation of spodumene within patches and lenses, but with the preferred direction varying from patch to patch.
3. Dykes containing radiating or random crystal-like pods of fine quartz-spodumene intergrowth.
4. Dykes containing random-oriented solid spodumene crystals.

There appears to be a statistical interrelationship between degree of crystal orientation, grain size, internal structure, and attitude of dyke. Most steep-dipping exterior or marginal dykes are unzoned, and contain fine- to medium-grained spodumene, essentially from wall to wall. In these the spodumene is characteristically well aligned with the long axes perpendicular to the walls of the dykes. Most flat-lying interior or marginal dykes are zoned, and contain coarse spodumene crystals or crystal-like quartz-spodumene intergrowths in more or less random orientation. However, a tendency to parallel orientation of spodumene perpendicular to the walls is apparent even in the most coarse-grained dykes, and this preferred orientation provides one of the strongest indications of the degree of dip of the dyke.

The steep, medium- or fine-grained, unzoned dykes are generally the most persistent and uniform in grade, and dykes of this general type account for most of the present ore-reserves. As a class these dykes call for a heavy investment in mining and milling plant, especially the latter, as the fine spodumene is intimately intermixed with quartz and, to a lesser extent, with feldspar. On the other hand, large tonnages of spodumene are readily available by surface mining methods and hand-cobbing from flat-lying, coarse, zoned dykes in several districts, and many contain pockets of exceptionally high-grade material.

DESCRIPTION OF DISTRICTS AND PROPERTIES

PREISSAC-LACORNE DISTRICT (6, 9, 17)

This district lies between Amos and Val d'Or, Quebec, and is accessible by Highway Routes 60, 61, and 45. It contains two producing mines, that of Quebec Lithium Corporation, the only Canadian lithium producer, and that of Molybdenite Corporation, besides a number of other lithium, beryl, and molybdenite deposits. The lithium deposits are mainly in Lacorne and adjacent parts of Landrienne, Figuery, and Lamotte townships.

The consolidated rocks, Precambrian in age, are meta-volcanic and meta-sedimentary rocks, intruded by granitic

and other rocks of the Preissac-Lacorne batholith and by younger diabase dykes. The batholith is a composite of several intermediate to acidic types. Of these, a muscovite granite averaging 40 per cent albite and 24 per cent microcline is the youngest, and the most abundant and important. The pegmatites are related to it and cut the other intrusive and invaded rocks.

Those near the contacts strike mainly either parallel with or at right angles to the contact. This and the orientation of pegmatites within the batholith suggest a control by joint systems. Many of the lithium-bearing dykes lie less than 1 1/2 miles southwest of, and approximately parallel with, a large fault zone known as the Manneville fault, which extends west-northwest through northeast Lacorne, southwest Landrienne, and Figuery townships. A molybdenite-bearing pegmatite vein at Lac Roy lies just south of it.

The pegmatites contain variously spodumene, minor lepidolite and other lithia micas, beryl, molybdenite, and small amounts of columbite-tantalite and other minerals.

A rough regional zoning is apparent, with beryl mainly in interior pegmatites, lithium minerals mainly in marginal and exterior pegmatites, and molybdenite in exterior pegmatite veins beyond the lithium zones. There is also a variation in the potash feldspar content of the pegmatites, the typical beryl-bearing dykes having more than the lithium-bearing dykes.

Quebec Lithium Corporation

The mine of the Quebec Lithium Corporation is about 6 miles south by road from a point 17 miles east of Amos on Highway 45. The holdings cover the eastern and central lots of ranges VIII and IX and parts of range X, Lacorne township. The mine and mill plants are about 1/4 mile south of Lac Lortie.

A zone of dykes extends through the shaft area for more than 8,000 feet in a direction south 76 degrees east. The tonnage in the shaft area alone is reported to be 15.0 million tons. The grade of the ore so far has been over 1.25 per cent lithia.

In the shaft zone, 10 or 12 subparallel or overlapping dykes strike mainly about north 76 degrees west and dip 50 to 75 degrees south, cutting the greenstone-granodiorite contact which slopes about 35 degrees northward. Dykes are known to extend as much as 1,100 feet into granodiorite with good width and grade.

Spodumene is the only important accessory mineral, though beryl, fluorite, columbite-tantalite, molybdenite, and bismuth are

occasionally found. It occurs essentially from wall to wall, mainly with quartz, in bands separated by aplite and feldspar-rich stringers. The spodumene of the shaft zone is white, fine to medium grained, and oriented perpendicular to the local attitudes of walls and bands. The few coarse crystals tend to a more random orientation. That of the exposures in the east zone is pale green, medium grained, and strongly oriented perpendicular to the granodiorite contacts. Some spodumene is locally altered to dark green especially near a watercourse underground, and leached spodumene and feldspar occur in the fissure.

Quebec Lithium uses a flotation process and produces spodumene, feldspar, and mica concentrates. Production in late 1956 was at the rate of about 1,000 tons of ore a day. The spodumene concentrate is exported to the United States, under a contract with Lithium Corporation of America which calls for 165 tons a day grading 4 1/2 per cent or better at \$11.00 a unit Li_2O .

Lithium Corporation of America (Figury township)

At the showing on lot 36, range II, Figury township, a dyke is partly exposed at intervals for about 300 feet by stripping and trenching. The dyke contacts are not exposed, but the steep northerly plunge of most spodumene crystals suggests a gentle southerly dip, parallel with an ill-defined zone boundary. The dyke is roughly zoned. An inner zone consists chiefly of quartz with medium- to coarse-grained green spodumene and long white perthite crystals in subparallel orientation. An outer zone consists of white cleavelandite, with quartz, coarse white feldspar, muscovite, and green spodumene. The spodumene is veined by quartz and cleavelandite. Garnet and tourmaline are present in small amounts, and rare rusty black equidimensional grains were identified as sphalerite.

International Lithium Corporation

The showing on lot 39, range II, Figury township, is on the tip of a peninsula on Hurricanaw River. A very small incomplete exposure shows distinct unsymmetrically banded pegmatite across an exposed width of 14 feet. A low-grade cleavelandite-spodumene-quartz-muscovite band on the south side is succeeded in turn by a coarse, random-oriented, spodumene-quartz band, a finer grained band in which spodumene crystals plunge 15 degrees north, a barren blue-striped quartz band, and an aplite-pegmatite band that is in contact with schist. The spodumene is mostly green and is broken and veined in two directions by fine cleavelandite and mica. Quartz biotite schist, dipping gently northward, is exposed on the south side of the point.

Canadian Lithium Company

Several dyke-like masses composed of interbanded pegmatite and aplite near the southern border of lots 25 and 26, Landrienne township, contain spodumene in small pockets. On lot 25 a small pit reveals coarse, random-oriented, white and green spodumene, lepidolite, and a little beryl, associated with quartz, white cleavelandite, and coarse massive white feldspar. The spodumene crystals are distorted and are veined and partly replaced by cleavelandite and lepidolite.

Valor Lithium Mines Limited

At the main showing on lot 22, range VIII, Lacorne township, aplite and pegmatite form irregular masses and stringers in granitic rocks of the Preissac-Lacorne batholith. This occurrence is well within the batholith and is anomalous to the general regional zoning of the district. In an irregular core zone about 125 feet by 75 feet, pale green to white spodumene crystals up to 4 feet long, in random orientation, are embedded in cleavelandite-quartz-lepidolite aggregates that vein the broken and distorted spodumene crystals. These aggregates make up about half the core area and contain about 50 per cent spodumene. Coarse muscovite masses and fine-grained tourmaline, with occasional pale green beryl crystals, occur at contacts of the aggregates with aplite, which contains scattered garnets. A few similar aggregates lie outside the core area.

Amos Lithium Corporation

The deposit, on lot 8, range III, Lacorne township, is a network of longitudinal and cross dykes in granite with inclusions of altered wall-rock. Beryl occurs commonly with quartz and pale mica in the longitudinal stringers and also in an irregular core that contains all the visible spodumene. The spodumene is green, coarse, and in random orientation, and is associated chiefly with large masses of white feldspar.

Lithium Corporation of America (Lacorne township)

This deposit is on lot 11, range II, Lacorne township. According to a published account (17), one of several spodumene-bearing dykes that cut biotite granodiorite is traceable on the surface for 1,000 feet and varies from 5 to 18 feet in width. The dyke dips steeply. Uniformly distributed spodumene in large crystals, oriented about normal to the walls, makes up an estimated 20 per cent of the exposed surface. The dykes also contain a little beryl,

columbite-tantalite, and bismuthinite. Preliminary drilling indicated lower values at depth.

Other Properties

Among other properties that have been drilled are the Ventures, Vallee, Lithuanium, and North American Rare Metals.

NIPIGON DISTRICT (7)

All the deposits of this district, except the Lun-Echo dyke, lie east of Highway 11, in the vicinity of Orient Bay, Ontario. They are contained within a belt that extends from a point west of Cosgrave Lake, through the Georgia Lake and Jean Lake areas, to a point about 10 miles south of Beardmore. The dykes intrude Archaean meta-sedimentary rocks comprising biotitic quartzite and quartz biotite schist, and granitic rocks that underlie large areas to the south and east of the district. Large masses of diabase that outcrop extensively are parts of a thick, flat-lying intrusive sheet and associated steeply dipping dykes. The diabase is younger than the pegmatites, and cuts a number of them off at depth.

A rough regional zoning is apparent in the district. The Nama Creek and Jean Lake dykes, which are farthest from the granite, are mainly steep-dipping and unzoned. They contain medium-grained spodumene in parallel orientation from wall to wall. Those farther south, in the vicinity of Georgia Lake, are commonly flat-lying and imperfectly zoned, with coarse spodumene in random orientation mostly confined to ill-defined core zones. The M. N. W., the southernmost property, is wholly in granite, and is a typical zoned dyke. An analogous increase in grade of metamorphism of the country rocks, from north to south, has been noted.

The dykes are composed essentially of quartz, white albite and minor potash feldspar, and varying small amounts of muscovite. A little blue apatite in small grains is common but tourmaline, beryl, and cleavelandite are conspicuous only in the M. N. W. dyke. Spodumene is the only lithium mineral worth mention.

Alteration of spodumene to a dark green or brown soft, woody mass is especially severe in proximity to large masses of diabase. Spodumene and feldspar are locally leached and altered to deep red.

Nama Creek Mines Limited

The property lies 4.5 miles by truck road east of a point 12.3 miles south of Beardmore on Highway 11. A number of spodumene-quartz-feldspar dykes cut biotitic quartzite and schist. The north zone is a series of dykes arranged more or less en échelon and totalling some 2,800 feet in length. The dykes average 60 feet in width. The south zone is a dyke about 800 feet long and 60 feet wide.

The dykes are banded to some extent, but essentially spodumene-bearing from wall to wall. The spodumene is in lath-shaped crystals averaging about 6 inches in length oriented perpendicular to the dyke walls. Most of the spodumene is light green, but part is altered to dark green and brown, and this alteration is thought to be related to the proximity of younger diabase bodies. Pale yellowish mica is conspicuous along oblique fractures in the dykes.

The company estimates the ore-reserves in the north and south zones at 4.3 million tons assaying 1.06 per cent Li_2O . A headframe, surface buildings and a power line are in place and preparations for shaft sinking under way.

Jean Lake Lithium Mines Limited

A road about 4 miles long extends from Postagoni Lake eastward to the property. The dykes on the Jean Lake and adjoining Towagmac properties are similar, in the main, to those of Nama Creek.

No. 4 zone, which crosses Parole Creek about 1 1/2 miles north of Jean Lake, was closely drilled, and showed substantial improvement in dimensions and grade with depth. According to company reports, results indicate 1.7 million tons containing 1.3 per cent lithia to a depth of 1,095 feet. An unusual feature of this dyke is a cross-banding, due to regularly spaced stringers of coarse white feldspar.

No. 1 zone, about 1/2 mile west of No. 4, is not so cross-banded, but is unique in that the main dyke is cut by a narrow cross dyke. The dykes dip steeply, and contain medium-grained spodumene oriented perpendicular to the walls of each dyke.

Ontario Lithium (Conwest) and Dunvegan (Newkirk)

These properties are near the west end of Georgia Lake. The most important showing of Ontario Lithium Company consists

of pegmatite bodies that outcrop over a considerable area. Parts are very rich in coarse green spodumene. The crystals locally show a pronounced parallelism, plunging steeply southeast, and suggest that the bodies are parts of a nearly flat-lying sheet. The spodumene is mostly concentrated towards the hanging-wall of the dyke. Another gently dipping zone, which does not outcrop, is reported from drilling.

Lun-Echo Gold Mines Limited

A dyke on this property, at Pine Portage on Nipigon River, is also rich in coarse green spodumene, although barren banded aplite is abundant in parts. There is locally a tendency for the spodumene crystals to be oriented perpendicular to the walls of the dyke, which dip steeply. Diabase appears to limit the dyke on the north, and a thick sheet cuts it off at depth. Alteration is pronounced near the diabase.

Aumacho River Mines Limited

The showing on this property is at the north tip of Blay Lake, about 4 miles southwest of Georgia Lake. As exposed for about 150 feet the dyke is in granite and pinches and splits irregularly. Coarse green spodumene in random orientation forms clusters within the dyke. Fairly well defined aplitic 'chill-zones' at the contacts contain blue apatite in small, scattered grains, and a little tourmaline, with rather abundant muscovite. The dyke extends into schist, and ore reserves indicated by drilling are reported to be 0.7 million tons carrying 1.63 per cent Li_2O .

M. N. W. Group

This property lies about 1 1/2 miles west of Cosgrave Lake. It is owned by Murray Wilson of Nipigon, and associates, and was drilled under option by Consolidated Mining and Smelting Company. The well zoned dyke is in granite, probably near a contact with schist, and dips steeply. Pure white spodumene in random-oriented large crystals, and fine quartz-spodumene crystal-like aggregates are embedded in quartz that forms a lenticular core zone 400 feet long, up to 35 feet wide, and 150 feet deep. An intermediate zone consists chiefly of pink cleavelandite and some coarse white feldspar, with quartz, coarse muscovite, and scattered white beryl crystals. The outer zones are marked by aplite with narrow bands rich in tourmaline. A little amblygonite and purpurite are reported in drill-logs.

DRYDEN DISTRICT

Lun-Echo Gold Mines Limited

The lithium deposit of Lun-Echo Gold Mines, in this field, is 10 miles northeast of Dryden, Ontario, and is accessible by a side road from a point 6 miles east of Dryden on Highway 17. The main zone is traceable at intervals for some 3,000 feet, and is roughly parallel to the strike of chloritic mica schist and amphibolite that form the country rock. Stripping and drilling on the western part have disclosed an irregular branching dyke structure that appears to have a rather gentle northward dip.

Coarse and fine, green and white spodumene in random orientation, associated with very coarse white feldspar and quartz, occurs in irregular lenses and masses within the dyke. These are exposed here and there through about 2,200 feet along the general strike of the zone, and some parts are very rich. Other parts of the dyke, especially along contacts, are low grade or barren, consisting mainly of aplite with locally abundant black tourmaline and small grains of blue apatite. These contrasting assemblages constitute a general but rough form of internal zoning.

Some of the spodumene is altered to dark green and buff, and some pale greenish mica appears to be pseudomorphous after spodumene. Both spodumene and feldspar are locally stained pink by alteration processes.

ROOT LAKE FIELD (7)

Capital Lithium Company

The property of Capital Lithium Company described here lies athwart Roadhouse River about 3 miles by tractor road northwest of Root Lake, which is about 60 air-miles north of Sioux Lookout, Ontario. The country rock is pillow lava and quartz-biotite-chlorite schist. The known lithium-bearing bodies lie in an inward dipping arcuate zone about 1,800 feet long and may represent two or more dykes or faulted sections of dykes. The dykes are not sharply zoned but commonly have a banded structure, with aplite or pegmatite wall zones.

Spodumene occurs as random-oriented fine white laths with dark grey quartz and scattered white feldspar crystals, in lenticular bands and patches. Lithia assays up to 1 per cent have been obtained from schist near dyke contacts. This schist contains

biotite and an unidentified fine acicular mineral visible in hand specimen, but apparently no spodumene or lepidolite.

Ore reserves according to company estimates are 2.3 million tons containing 1.3 per cent Li_2O .

LAC LA CROIX DISTRICT (7)

International Lithium Mining Corporation Limited

This property is on the south shore of Lac la Croix near its east end. Air service is available from Fort Frances, Ontario, or Crane Lake, Minn. At the main surface showing, a dyke forms a small island 200 by 55 feet near the drill camp, and another lies about 650 feet south of the lake shore about 3,400 feet east of it. Both strike about east parallel with the meta-sedimentary country rocks, dip steeply, and line up roughly along strike. They are similar in mineralogy and structure.

The dykes are irregularly banded longitudinally. Spodumene-bearing quartz-feldspar bands alternate with barren ones composed of aplite and coarse white feldspar. The spodumene is light to dark green, in places brownish and woody. Crystals range up to 1 foot in length and are mainly oriented perpendicular to the dyke but their attitude varies somewhat from band to band. The bands are interrupted by a few transverse quartz-filled fractures. A closely drilled section 1,600 feet long of the main zone is estimated by the company to contain 1.5 million tons grading 1.20 per cent Li_2O to a depth of 500 feet. A few other spodumene-bearing dykes outcrop in the vicinity.

Lexindin Gold Mines Limited

This property lies south of Wisa Lake, about 4 miles north of Lac la Croix. Several spodumene-bearing dykes that cut meta-sedimentary rocks appear to be similar to those of International Lithium. Alteration of spodumene to yellowish brittle mica on the surface of dykes is marked. Drilling was in progress during the summer.

EAST BRAINTREE-WEST HAWK LAKE DISTRICT (12, 14, 15)

Several spodumene-bearing pegmatites have been found in an east-west band of meta-volcanic rocks that extends about 20 miles from East Braintree to West Hawk Lake. A regional zoning of pegmatites near West Hawk Lake has been noted. The only deposits

of note are on the Lucy and Artdon claims, which lie about 1/2 mile north of the new Trans-Canada Highway at a point 6.6 miles east of the East Braintree turnoff.

North American Rare Metals Limited

The main showing of this company is on the Lucy No. 1 claim, where a pegmatite body outcrops for 63 feet along the face of a low cliff. An upper or hanging-wall zone contains abundant coarse black tourmaline, pink feldspar, quartz, and muscovite. Very coarse green spodumene crystals in random orientation are embedded in quartz in a lower lenticular zone exposed for 20 feet, with a maximum width of 5 feet. The dyke appears to dip gently into the hill and is partly surrounded by patchy pink and white aplite containing nests and stringers of bright blue tourmaline. A large mass of gabbro lies to the south and contains an abandoned quarry. The area has been extensively drilled recently.

Pieces of spodumene, white amblygonite, pale lilac mica, and beryl are scattered near a small water-filled pit about 300 feet farther north.

CAT LAKE-WINNIPEG RIVER DISTRICT (1, 2, 12, 13, 15)

This district lies east of Lac du Bonnet and is about 80 miles northeast of Winnipeg. It is served by a railway line, a highway and newly constructed secondary roads, and a power line. The district is noted for the large number and diversity of pegmatite mineral deposits. These include beryl, tin, and rare-earths as well as all the more common lithium minerals. Many have been known and intensively studied since 1925. Some development work was done and small shipments made in earlier years but it is only recently that the exploration and development of lithium deposits on a large scale has been undertaken. This has resulted in the blocking out of several large deposits in the Cat Lake and Bernic Lake areas and in renewed exploration of deposits in the vicinity of Winnipeg River.

The consolidated rocks of the district are Precambrian in age, and comprise meta-volcanic and meta-sedimentary rocks invaded by various granitic and some basic intrusions. Lithium-bearing pegmatites occur chiefly in meta-volcanic rocks close to their contacts with large granitic bodies, and to a lesser extent in marginal parts of the intrusions.

The youngest intrusions are of pegmatitic albite granite. One of the most prominent outcrops of this rock lies south of

Winnipeg River. It is characterized by intricately contorted banding, by large rectangular crystal-like aggregates of quartz and feldspar in graphic intergrowth, and by the occasional occurrence of beryl crystals in quartz-rich segregations. The banding is marked by thin layers of aplite, rich in muscovite mica and, less commonly, red garnet. Thus the albite pegmatite and pegmatite dykes have many mutual peculiarities and probably a common origin as offshoots of the large widespread granite masses.

The complex, mainly flat-lying dykes of Winnipeg River and Bernic Lake are much closer to the granite masses than are the simple mainly steep-dipping spodumene pegmatites of the Cat Lake area. Otherwise no well defined regional zoning pattern is apparent.

Lithium Mines and Chemicals Limited (Violamac)

This property is 5 miles west of Cat Lake and 1 1/2 miles northwest of the lake used for aircraft. It is not accessible by road but is crossed by the power line to Cat Lake. Two major pegmatite dykes cut volcanic greenstones that are intruded by very coarse porphyritic gabbro.

The main or south dyke is exposed intermittently for 1,800 feet and drilling has established its continuation for a further 1,400 feet to its western termination in a body of granite. In its central portion, the dyke is broken up and apparently offset. It averages 12 feet in width and dips steeply. The dyke is essentially unzoned. Spodumene is distributed more or less uniformly throughout, but is locally segregated into bands with quartz and bluish white feldspar, separated by aplite bands from others in which it is associated with similar feldspar and little quartz. Local narrow aplite wall zones contain a little fine garnet and apatite. The spodumene is white and mostly in fine laths. These show a tendency to parallelism, but their orientation varies from place to place. According to published reports, drilling on the south dyke indicated 2.5 million tons grading 1.3 per cent Li_2O to a depth of 1,000 feet.

The 'north dyke' is about a mile farther northwest. It is exposed for a length of about 750 feet and averages 15 feet in thickness. The dip is nearly vertical. Spodumene is mainly in the form of fine needles intergrown with quartz to form elongated pods and lenses, in which the spodumene is oriented perpendicular to the long directions of the pods. These aggregates are interstitial to coarse feldspar masses and have random orientation. They weather to buff or pink, contrasting with the white feldspar and grey quartz-mica-feldspar components that make up the bulk of the dyke. Drilling indicated a reported 1.5 million tons at 1.25 per cent Li_2O to 450 feet depth.

Lithium Corporation of Canada - Cat Lake

The property, known as the Irgon claim, is 1,700 feet north of Cat Lake, and is accessible by gravelled road. It consists of a dyke that intrudes a band of meta-volcanic greenstone, about 600 feet north of the contact of the latter with a large body of granite. It is about 1,200 feet long, up to 60 feet wide, and dips steeply.

Spodumene occurs in bands and long lenses composed of quartz, with some white feldspar and muscovite. Intervening bands consist mainly of white and pink feldspar, in part microcline, and of aplite in which are trains of fine red garnet and blue apatite. The spodumene is in fine white or pale green laths, without marked parallelism.

Drilling results, according to company estimates, indicates 1.0 million tons containing 1.5 per cent Li_2O , to a depth of 700 feet. A power line and surface buildings are complete and shaft sinking is in progress.

Lithium Corporation of America - Cat Lake

This property, known as the Eagle Group, lies northwest of Cat Lake. A zone of lenticular pegmatite dykes extends nearly 1/2 mile west from a granite bluff near the northwest end of the lake. The dykes are partly in greenstone and partly in granite, and dip steeply. Fine- to medium-grained, white and light green, spodumene is confined mainly to narrow quartz-rich stringers and pods that are interstitial to coarse white and pink feldspar masses and aplite bands. The spodumene laths are normally in parallel orientation perpendicular to the stringers but this preferred direction varies from one small area to another.

Beyond a broad bushy gully, a bright red pegmatite body appears to be part of a cross dyke, cutting off the western extremity from the rest of the zone. This body contains quartz in large crystal-like grains, abundant coarse pale to green mica, black and blue tourmaline, smoky quartz grains, and small white beryl crystals.

A considerable amount of surface trenching and drilling have been done on the property.

Central Claims - Cat Lake

This property is owned by H. Johnson of Bird River. The main dyke is 1,000 feet south of Cat Lake and is accessible by a branch road. It lies in granite and appears to dip gently southward

into a cliff face. The dyke has been exposed for nearly 300 feet and is distinctly zoned.

Spodumene occurs mainly as random-oriented white to pale green crystals up to 24 inches long, embedded in coarse quartz-feldspar pegmatite. In part it occurs as parallel needles intergrown with quartz in aggregates that are interstitial to feldspar masses. It is mainly confined to a zone generally separated by aplite from a hanging-wall zone. The latter consists chiefly of coarse feldspar, with coarse pale mica, pale beryl, and blue apatite prominent at the southern limit of exposure. A substantial amount of coarse spodumene could easily be recovered by hand-cobbing.

Lithium Corporation of Canada - Bernic Lake East

The dykes near the east end of Bernic Lake are outstanding in complexity of zoning and variety of minerals. Locally more prominent than spodumene are the uncommon lithium silicates, petalite and lepidolite, and the phosphates, amblygonite or mon-tebrasite and triphyllite or lithiophyllite, commonly altered to purpurite. Lithium minerals where present, are confined essentially to cores or inner zones composed chiefly of quartz, and the dominant lithium minerals vary from dyke to dyke or from place to place in the same dyke.

The dykes dip gently and probably do not all outcrop, and the relationship of certain isolated exposures to one another is in doubt. The country rock is recrystallized andesite.

Typically complex zoning is well displayed in a large pit on the Buck claim about 1,500 feet east of Bernic Lake. There the lowest exposed zone consists chiefly of massive grey quartz in which are embedded a few irregular masses up to 2 feet long of white, locally pink-stained amblygonite, and of triphyllite-lithiophyllite-purpurite. At the top of this quartz zone fine spodumene intergrown with quartz forms a few crystal-like masses embedded in a thin lenticular zone of quartz and cleavelandite. Above this, reddish feldspar, in part cleavelandite, characterizes several subzones made up of feldspar, quartz, and coarse pale mica, in varying proportion, and carrying scattered beryl crystals. This merges with a zone 1 foot to 2 feet thick in which coarse black tourmaline, set mostly perpendicular to the hanging-wall, forms the dominant constituent. This is locally separated from the green-stone hanging-wall by a 'chill-zone' 1 inch to 2 inches thick, consisting chiefly of fine-grained feldspar, quartz, and tourmaline. A considerable amount of material has been hand sorted and stock-piled in bins.

About 700 feet southwest of the pit the upper part of a similarly zoned dyke is exposed at the edge of a swamp. Grey lamellar petalite forms most of a large irregular mass exposed in a small pit near the cabins on the Coe Claim. Several diamond drill-cores on the property reveal symmetrically zoned dykes in which the lithium minerals are variously, spodumene, amblygonite, lepidolite, and petalite.

Montgary Explorations Limited - Bernic West

This property, on the north shore of Bernic Lake, includes the old Jack Nutt tin mine. The outcropping dykes contain abundant black tourmaline, excepting one beryl-rich dyke, but no lithium minerals. The original lithium-bearing dyke was encountered in drilling for tin concentrations.

A number of subparallel, gently dipping lithium-bearing dykes have been discovered by recent drilling and contain a reported 7.8 million tons at 1.85 per cent Li_2O . The dykes are in andesite near a contact with granite. Spodumene laths and fine needles occur in quartz-rich bands with intervening white and pink pegmatite and aplite.

Papineau Property - Shatford Lake

Shatford Lake is the site of the original tin discovery of the district and other dykes along the south shore contain beryl and other unusual minerals. The only lithium-bearing dyke of note is about 4,000 feet west of the east end of the lake. It carries spectacular conical crystal aggregates of greyish curvillammellar zinnwaldite as much as 4 feet across, intimately mixed with and embedded in coarse pink feldspar and quartz. Beryl occurs in scattered crystals, and columbite-tantalite and other rare-earth minerals are found in cavities that are lined with black alteration material. The dyke has been exposed by stripping and trenching over a length of 400 feet and a width of 80 feet. The ground is held by J. J. Papineau of Winnipeg.

Silverleaf and Huron Properties - Winnipeg River

Two outstanding pegmatite bodies are situated 1 mile southwest of Winnipeg River at a point about 4 miles east of Lamprey Falls. They lie in altered pillow lavas just south of an albite pegmatite stock.

The Huron dyke is noted as the source of uraninite which first established the great age of Canadian Archaean rocks. The

dyke also contains tantalite-columbite and large green beryl crystals, but no lithium minerals of importance have been found.

The Silverleaf claim, also called Bear or Bob, adjoins the Huron on the west. It contains the only lepidolite body that has been worked. Zinnwaldite and other lithium micas are also present and spodumene occurs as fine parallel needles in quartz-spodumene crystal aggregates in a restricted zone. The common rock minerals are pink feldspar, in large part cleavelandite, quartz, and muscovite. Very minor amblygonite, beryl, topaz, and rare-earth minerals have been identified. The body is small but features extremely complex internal structures involving zoning and replacement. It has been the subject of intensive studies and several technical papers. Some drilling was done several years ago on the property, which is now held by Lithium Corporation of Canada.

HERB LAKE DISTRICT (3, 12, 16)

Spodumene-bearing dykes have been found in three areas in the vicinity of Crowduck Bay, north of the settlement of Herb Lake, which is situated on the east shore of Wekusko Lake, Manitoba.

Green Bay Mining and Exploration Limited

This property is about 2 1/2 miles southeast of Crowduck Bay, and is accessible by road from a point about 2 1/2 miles north of the narrows. Seven known dykes strike west of north, obliquely across a zone that trends about north 55 degrees east. The zone lies east of a mapped northerly striking fault, and about 1/2 mile northwest of, and parallel with, another mapped fault. The country rocks are greenstones, apparently derived from intermediate lavas, with some interbedded clastic rocks resembling greywacke.

The dykes contain abundant coarse feldspar, characteristically pink, with which spodumene is intimately intergrown, and relatively small amounts of quartz. The spodumene is mostly coarse and random in orientation. It is mainly confined to a crudely-defined core zone. Outer zones consisting mainly of pink aplite and coarse feldspar, contain most of the mica, tourmaline, and scattered beryl crystals, as well as some spodumene. Tourmaline and mica are also scattered through the core-zones. Thus the zones are telescoped. Some dark, biotite-like mica is present as well as a pale greenish variety. Spodumene is locally altered, and both spodumene and feldspar are commonly stained pink by alteration products.

The main or most westerly dyke is exposed for about 600 feet, varies up to 90 feet in width, and is nearly vertical in attitude. It has been closely drilled and is reported to contain 1.9 million tons at 1.3 per cent or 3.0 million tons at 1.0 per cent Li_2O .

Combined Developments Limited

The main dyke on this property is 300 feet east of Crowduck Bay, and about 1/2 mile north of the narrows. It is well exposed for about 415 feet and is upwards of 60 feet wide. It cuts schist and fragmental rocks, and is nearly vertical. Throughout its exposed length the dyke carries uniformly distributed medium-grained green spodumene, with quartz and some white feldspar. The spodumene crystals lie consistently perpendicular to the dyke walls, and make up an estimated 20 per cent of the surface.

The dyke is typically unzoned, but at one point an outer band about 2 feet thick contains abundant pink feldspar and tourmaline. It is in contact with tourmalinized schistose wall-rock and, towards the inner part of the dyke, the bordering spodumene and feldspar are conspicuously altered and stained.

Indicated tonnage in this dyke, according to figures supplied by the company, is 3.3 million tons at 1.2 per cent Li_2O to the drilled depth.

Sheritt Gordon Mines Limited

This property is 1/2 mile west of the narrows of Crowduck Bay. Two dykes cut a quartz diorite body near its contact with biotite granite. The most northerly dyke consists of intermittent pink pegmatite stringers carrying coarse, random-oriented green spodumene in small concentrations. The southern dyke, which appears white, is the important one.

According to a published description (12) it dips steeply, and carries coarse green spodumene from wall to wall. The spodumene is oriented mainly perpendicular to the dyke walls. The essential rock minerals are coarse white and pink perthite, cleavelandite, and quartz. Some tourmaline, garnet, and a little beryl are present. Drilling indicated a spodumene content of 13.76 per cent over a width of 18.6 feet for a length of 900 feet.

YELLOWKNIFE-BEAULIEU DISTRICT (5, 8, 10)

The writer was unable to visit this area, and the following generalizations are inferred from the references cited above:

1. Lithium-bearing pegmatites lie within a belt that extends some 60 miles northwest from Hearne Channel to a point about 35 miles northeast of Yellowknife.
2. The belt lies in meta-sedimentary rocks cut by large granitic batholiths.
3. Younger muscovite granite bodies intrude the meta-sedimentary rocks, and zones of relatively high metamorphism ('hot sediments') are chiefly associated with these.
4. The rare-element pegmatites of the district are chiefly in these zones, and are presumably related to the younger granite.
5. Regional zoning is marked in the Ross Lake-Redout Lake area. Lithium-bearing dykes lie farther from a granite contact than others carrying beryl, columbite-tantalite, and graphic granite.
6. Spodumene is the predominant lithium mineral, with amblygonite of secondary importance.
7. The dykes are internally zoned. Lithium minerals occur in intermediate zones rather than quartz cores.

BIBLIOGRAPHY

- (1) Davies, J. F.: Geology and Mineral Deposits of the Bird Lake Area, Manitoba; Man. Mines Br., Pub. 54-1, 1955.
- (2) ——— Manitoba Lithium Deposits; Can. Min. Jour., vol. 77, No. 4, Apr. 1956.
- (3) Frarey, M. J.: Crowduck Bay, Manitoba; Geol. Surv., Canada; Map 987A, 1950.
- (4) Haw, V. A.: Lithium Minerals, 1955 (Preliminary) in the Canadian Mineral Industry in 1955; Mines Branch, Dept. Mines and Tech. Surv.

- (5) Jolliffe, A. W.: Rare Element Minerals in Pegmatites, Yellowknife-Beaulieu Area, N.W.T.; Geol. Surv., Canada, Paper 44-12, 1944.
- (6) Latulippe, Maurice: Lithium Search in Lacorne Area; Northern Miner, Mar. 10, 1955.
- (7) Pye, E. J.: Lithium In Northern Ontario; Can. Min. Jour., vol. 77, No. 4, Apr. 1956.
- (8) Rowe, R. B.: Pegmatitic Mineral Deposits of the Yellowknife-Beaulieu Region, N.W.T.; Geol. Surv., Canada, Paper 52-8, 1952.
- (9) ——— Pegmatitic Beryllium and Lithium Deposits, Preissac-Lacorne Region, Abitibi County, Que.; Geol. Surv., Canada, Paper 53-3, 1953.
- (10) ——— Pegmatitic Lithium Deposits in Canada; Ec. Geol., vol. 49, No. 5, Aug. 1954.
- (11) ——— Evaluation of Pegmatitic Mineral Deposits; Can. Inst. Min. Met. Bull., Nov. 1953.
- (12) ——— Lithium Deposits of Manitoba; Geol. Surv., Canada, Paper 55-26, 1956.
- (13) Springer, G. D.: Mineral Deposits of the Cat Lake-Winnipeg River Area, Manitoba; Man. Mines Br., Pub. 49-7, 1950.
- (14) ——— Geology of the Rennie-West Hawk Lake Area, Manitoba; Man. Mines Br., Pub. 50-6, 1952.
- (15) Stockwell, C. H.: In Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169, 1938.
- (16) ——— Gold Deposits of Herb Lake Area, Northern Manitoba; Geol. Surv., Canada, Mem. 208, 1937.
- (17) Tremblay, L. P.: Fiedmont Map-Area, Abitibi County, Quebec; Geol. Surv., Canada, Mem. 253, 1950.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1957