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PEGMATITIC BERYLLIUM AND LITHIUM DEPOSITS, PREISSAC-LACORNE REGION, ABITIBI COUNTY, QUEBEC

By
Robert B. Rowe

OTTAWA
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Price, 50 cents

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PEGMATITIC BERYLLIUM AND LITHIUM DEPOSITS, PREISSAC-LACORNE REGION, QUEBEC

INTRODUCTION

The Preissac-Lacorne region of this report comprises Preissac, La Motte, and Lacorne townships, and adjacent parts of Villemontel, Figuery, Landrienne, Fiedmont, and Vassan townships, Abitibi county, Quebec. Most of the region is well provided with roads (See Figure 1).

Pegmatites containing beryllium, columbium-tantalum, and lithium minerals, molybdenite- and bismuth-bearing veins, and gold and base metal prospects occur in the region. Both molybdenite and bismuth concentrates have been produced. In the past few years considerable interest has been shown in some of the lithium-rich pegmatites.

The pegmatites and veins have been described by Norman (7)[1] and Tremblay (10), and the purpose of the present investigation, which was carried out during the months of June and July 1952, was to examine in detail some of the more important beryllium and lithium deposits.

[1] Numbers in parentheses are those of references in Bibliography at the end of this report.

The writer thanks Mr. C. Bouvier, Amos, Dr. K. R. Dawson, Geological Survey of Canada, Dr. D. R. Derry, Ventures, Limited, Mr. A. S. MacLaren, Geological Survey of Canada, and Mr. P. F. Massicotte, Val d'Or, for information concerning the deposits. Mr. G. Magny, Amos, kindly allowed the writer to use his private road to Lake Lortie. Very capable field assistance was given by Mr. J. R. Nixon.

This report is in three parts. Part I deals with the general geology of the region; Part II discusses the pegmatites of the region; and Part III describes in detail one beryllium and three lithium prospects. An area containing several beryl-bearing pegmatites, and spodumene-bearing pegmatites on two lithium prospects were mapped by plane-table on a scale of 1 inch to 20 feet.

The pegmatite terminology used in the report was developed by the United States Geological Survey as a result of pegmatite investigations conducted during World War II, and is described by Cameron, Johns, McNair, and Page (2). A brief discussion of this terminology is given in the section on internal structure in this report.

PART I

GENERAL GEOLOGY

GENERAL STATEMENT

The consolidated rocks of the region are Precambrian in age, and consist of meta-volcanic rocks, meta-sedimentary rocks, and large and small masses of plutonic rocks, ranging from acidic to ultrabasic in composition. Acidic to intermediate plutonic rocks, which have intruded closely folded, meta-volcanic, meta-sedimentary, and altered ultrabasic rocks, are the most abundant rocks in the region, and include the Preissac-Lacorne batholith and associated pegmatites, aplites, and quartz veins. The pegmatites occur in the acidic to intermediate plutonic rocks, and in the metamorphic rocks near the contact of the plutonic rocks. Descriptions of formations have been taken for the most part from a report by Tremblay (12).

TABLE OF FORMATIONS

Era	Period	Group	Lithology
Cenozoic	Pleistocene		Gravel, morainal material, sand, clay
		Unconformity	
Proterozoic	Keweenawan(?)		Gabbro, quartz gabbro, olivine gabbro; in part diabase
		Intrusive contact	

	Intrusive contact		
Archaean	Post-Timiskaming		Microcline-bearing granitic rocks: amphibolite, hornblende monzonite, biotite-hornblende granodiorite, muscovite granite, pegmatites Albite-bearing granitic rocks: albite granite, porphyritic granite, micrographic granite
	Post-Keewatin		Quartz albitite dykes Quartz-feldspar porphyry Quartz diorite Intrusive amphibolite Peridotite
	Intrusive contact		
	Keewatin and (?) Timiskaming	Kewagama group(?)	Greywacke and derived biotite schist; conglomerate
		Kewagama group	Biotite schist
		Malartic group	Hornblende schist, biotite-hornblende schist; minor greywacke
	Keewatin	Kinojevis group	Basalt; andesite; dacite; minor rhyolite, trachyte, and pyroclastic rocks; some derived hornblende schist

DESCRIPTIONS OF FORMATIONS

The Kinojevis group is apparently the oldest in the region; it consists of meta-volcanic rocks that were originally basic to intermediate lava flows interbanded with minor rhyolite and trachyte flows and pyroclastic material.

The basic to intermediate meta-volcanic rocks weather light to dark green, show pillowed and amygdaloidal structures in places, are variable in texture, and are schistose in most places. At the contact with the Preissac-Lacorne batholith, these rocks have been completely recrystallized to form hornblende schist and amphibolite. Under the microscope, these rocks are seen to be composed of variable amounts of chlorite, epidote, feldspars, quartz, actinolitic amphibole, carbonates, muscovite, biotite, pyrite, ilmenite, leucoxene, titanite, tourmaline, apatite, and rutile, of which the first four are generally the most abundant. In places, the rocks are intensely carbonatized. The recrystallized contact rocks contain hornblende, feldspar, epidote, and quartz as the main constituents.

The acidic meta-volcanic rocks are fine grained, porphyritic in places, and weather white. In thin section, they seem to be composed principally of quartz, feldspar, chlorite, and biotite, with apatite, iron oxides, and carbonates as accessory minerals.

The Malartic group consists of amphibolite, hornblende schist, and biotite-hornblende schist, which were originally basic volcanic rocks, and it is possible that they and the rocks of the Kinojevis group may represent the same formations repeated by folding or faulting. Pillow structure occurs in places. The hornblende schist has been described as a fine-grained, dark green rock, with hornblende, quartz, and feldspar recognizable in the hand specimen. Microscopically, the rock appears very fresh, suggesting complete recrystallization, and consists of hornblende, quartz, and feldspar with minor amounts of epidote, titanite, apatite, pyrite, biotite, zircon, chlorite, sericite, and limonite. Hornblende is the most abundant mineral, and is generally oriented.

The Kewagama group consists of quartz-biotite schist, biotite schist, and staurolite schist, and is believed to have been derived from greywacke. Quartz-biotite schist from Lacorne township is fine to medium grained, schistose, grey to bluish grey, and weathers brown. Biotite, quartz, and feldspar are recognizable in hand specimens, and chlorite, epidote, zircon, muscovite, apatite, iron oxides, sericite, and garnet are seen in thin section.

Considerable altered peridotite occurs in belts in the western part of the region, and as lenses in the Kinojevis meta-volcanic rocks. Norman (9, pp. 2, 3) states that in most outcrops the altered peridotite resembles massive greenstone except that it is softer due to its talc content, and has a characteristic surface caused by "seams" of tremolite, and a generally "platy structure". In places the seams resemble the outlines of pillows. The rock weathers brown, mauve, grey, or green, and is dark coloured on the fresh surface. In thin section, the rock is seen to consist of tremolite fibres in a matrix of chlorite and serpentine or talc. Calcite, iron oxides, and pyrite are minor constituents. Augite was found by Tremblay (12, p. 19) in one thin section, and he believes that the distribution of iron oxides suggests that olivine was an important original constituent.

Plutonic rocks ranging from peridotite to granite intrude the rocks already described, and are discussed in detail by Tremblay (12, pp. 18-63). However, the Preissac-Lacorne batholith will be described here because of its relationship to the pegmatitic mineral deposits.

The Preissac-Lacorne batholith consists chiefly of granitic and syenitic rocks, and occupies most of the area of Preissac, La Motte, and Lacorne townships, and adjacent parts of Vassan, Fiedmont, Villemontel, and Figuery townships (See Figure 1). It extends for more than 30 miles east-west, and averages 12 to 14 miles in width. The batholith is elongated approximately parallel with the fold axes in the region.

The rocks of the batholith were divided into two distinct types by Gussow (7): hornblende granodiorite, and garnetiferous muscovite leucogranite. Norman (9, p. 3) described these rocks as a diorite-syenite-granodiorite-granite group, which is probably a differentiation series from a common magma. He states (p. 3) that the various members of the group are not of the same age, the siliceous rocks being younger than the others. Six main rock types are recognized by Tremblay (12, p. 30): hornblende monzonite, biotite-hornblende granodiorite, amphibolite, biotite granodiorite, muscovite granite, and pegmatite material. The biotite-hornblende granodiorite is considered to be a hydrothermally altered phase of the hornblende monzonite, and the amphibolite is believed to be a basic differentiate of the monzonite, probably separated at depth before injection. The biotite granodiorite is regarded as having differentiated from the muscovite granite after injection.

The hornblende monzonite and biotite-hornblende granodiorite are grey on fresh surfaces, and grey to greyish white where weathered. In general, the grain size averages 2 mm., but marginal porphyritic facies occur in places. Large, brownish red titanite crystals are typical of these rocks, whose average mineral content has been determined by Tremblay (12, p. 32) as follows:

	Hornblende monzonite	Biotite-hornblende granodiorite
	Per cent	Per cent
Plagioclase	41.0	52.0
K-feldspar	22.0	10.0
Quartz	2.5	15.0
Hornblende	34.0	15.0
Epidote	0.5	4.0
Biotite		3.5
Chlorite		0.5

The biotite granodiorite weathers white, and is finer grained than the hornblende monzonite and muscovite granite. Biotite flakes are generally oriented parallel with one another. In thin section, the rock is seen to have the following mineral composition:

	Per cent
Oligoclase....................	54.0
Microcline....................	5.0
Quartz........................	27.0
Biotite.......................	10.0
Epidote.......................	2.0
Chlorite......................	1.0
Muscovite.....................	0.5
Titanite-magnetite............	0.5

The muscovite granite is generally white, but is reddish in places. Quartz, feldspars, micas, and red garnet are recognizable in the hand specimen, and the grain size averages 3 by 6mm. Garnet, iron oxides, apatite, epidote, titanite, and zircon are accessory minerals, and chlorite, sericite, and kaolin are secondary minerals. The average mineral composition, determined microscopically, is as follows:

	Per cent
Albite........................	40.0
Microcline....................	24.0
Quartz........................	31.0
Mafic and accessory minerals (mainly muscovite).........	5.0

The Preissac-Lacorne batholith is now being studied in detail by K. R. Dawson of the Geological Survey.

PART II

PEGMATITES

GENERAL STATEMENT

Numerous granitic pegmatites occur in the region, and are associated spatially, and perhaps genetically, with the Preissac-Lacorne batholith. Some of the pegmatites contain one or more of the following minerals: beryl, columbite-tantalite, molybdenite, and spodumene. The pegmatites are poorly exposed with the exception of those that are found on granite ridges.

Pegmatites containing the greatest concentrations of beryl and spodumene are internally zoned, with the possible exception of the spodumene pegmatites on the Lacorne Lithium Mines property.

GENERAL FEATURES

Occurrence and Distribution

Granitic pegmatites, lithium-rich granitic pegmatites, feldspathic quartz veins, and quartz veins are associated spatially, and perhaps genetically, with the Preissac-Lacorne batholith. The pegmatites and veins occur both in the rocks of the batholith and in the adjacent metamorphic rocks, and are most abundant near the contact.

Most of the known pegmatites containing beryl, columbite-tantalite, or spodumene occur in two distict belts (See Figure 1). One belt extends along the northern contact of the batholith, and contains several lithium-rich pegmatites, including those described in detail in this report. The second belt extends from the northern contact of the batholith to just south of Lake Lusignan, and lies just east of Lake Okikeska. This belt contains the beryllium prospect described in detail in this report.

Regional Zonation

The regional zonation of pegmatites and veins about the Preissac-Lacorne batholith has been observed by Norman (10) and Tremblay (12).

Norman has described the regional zonation about the western part of the batholith. According to him, beryl- and columbite-tantalite-bearing pegmatites occur more commonly near the border of the batholith, whereas spodumene-bearing pegmatites occur outside the batholith. Molybdenite-bearing quartz veins and feldspathic quartz veins occur near the contact of the batholith with the wall-rocks in both plutonic and metamorphic rocks.

Tremblay (12, p. 72) recognizes a regional zonation about the batholith, particularly the muscovite granite in Lacorne township. Beryl-bearing pegmatites occur in the centre zone, spodumene-bearing pegmatites in the middle zone, and molybdenite-bearing veins in the outer zone.

There are exceptions to the zonations outlined by Norman and Tremblay. Spodumene-bearing pegmatites occurring in lot 12, rge. II, and lot 40, rge. I, Figuery tp., are within the La Motte granite mass. A pegmatite containing spodumene was seen in lot 13, rge. IX, Lacorne tp., and is in the area designated by Tremblay as the beryl zone.

In general, it seems that beryl occurs in greatest concentration in pegmatites within the batholith, and spodumene in pegmatites within the batholith near the contact and in metamorphic rocks adjacent to the contact.

There is also a variation in the potash feldspar content of the pegmatites. The pegmatites containing the greatest concentration of beryl have a higher potash feldspar content than the pegmatites containing the greatest concentrations of spodumene.

The locations of pegmatites and veins containing one or more of the minerals beryl, columbite-tantalite, lithium minerals, and molybdenite are shown in Figure 1. Three regional zones are outlined: a beryl zone with pegmatites containing beryl but no lithium minerals; a lithium mineral zone containing all of the pegmatites having lithium minerals; and a molybdenite zone containing veins that carry molybdenite.

Size and Shape

The pegmatites vary in size to about 1,000 feet in length and 200 feet in width. Many of them are poorly exposed, so that an average size cannot be estimated. The pegmatites examined by the writer were all 20 feet or less in average width. Tremblay (12, pp. 42-43) has observed that pegmatites in the centre of the batholith or in the metamorphic rocks adjacent to it are regular in shape and have sharp wall-rock contacts, whereas those within the batholith, but near the wall-rock contact, are irregular in shape and have gradational contacts. The pegmatites of economic interest are tabular or flatly lenticular in shape, and have sharp contacts.

External Structural Control

A detailed study made by Tremblay (12, p. 42) of the strikes and dips of the pegmatite bodies in Lacorne township has suggested that these bodies are related to structural features associated with the Preissac-Lacorne batholith. Near the contact zones of metamorphic rocks and muscovite granite or hornblende monzonite, the pegmatites strike either parallel with, or at right angles to, the contacts, suggesting that the intrusion of the pegmatites was controlled by longitudinal and cross joints. The orientation of pegmatites within the batholith also suggests a control by joint systems. Tremblay (p. 72) has observed that the more important pegmatitic deposits appear to have formed in areas of intense fracturing close to the batholithic contacts, an observation that seems to be especially applicable to certain spodumene deposits. Diamond drilling has shown that the spodumene-rich pegmatites south of Lake Lortie and Lake Roy dip 40 to 65 degrees south and strike about parallel with the batholithic contacts. It is possible that these pegmatites are structurally controlled by longitudinal joints or by marginal fissures or marginal thrusts.

Internal Structure

General Statement

Granitic pegmatites may be divided into two groups: those that are simple aggregates of quartz, feldspar, and accessory minerals, and that cannot be divided readily into units of contrasting mineralogy or texture or both; and those that are complex aggregates of quartz, feldspar, and accessory minerals, and that can be divided readily into such units.

The primary analysis of a complex pegmatite is made on the basis of internal structure. Three types of structural units are distinguished, and are defined as follows:

(1) Fracture fillings are units that are generally tabular and that fill fractures in previously consolidated pegmatite.

(2) Replacement bodies are units that are formed primarily by the replacement of pre-existing pegmatite, with or without obvious structural control.

(3) Zones are units that are concentric shells, complete or incomplete, that generally reflect the shape or structure of the pegmatite body, and, where ideally developed, are concentric about an innermost zone or core. Some concentric units are not zones, but belong in one of the other two categories. Incompletely developed zones form lenses, trough-like or hood-like bodies, or chains of lenses.

Contacts between structural units may be knife-edge sharp or gradational, but few boundaries are so gradational that they cannot be mapped.

Zones are quantatively and economically the most important structural units. In most zoned pegmatites, one or more zones are incomplete, forming pods, lenses, or chains of lenses; pipe-like, trough-like, or hood-like bodies; or more irregular bodies. Two or more zones may merge along their strike or dip to form a single unit corresponding to the bulk mineralogy of the two combined zones: this is referred to as 'telescoping'.

Zones are classified as: (a) border zones; (b) wall zones; (c) intermediate zones; and (d) cores. The outermost zone of a pegmatite is the border zone; the next zone is the wall zone; and the zones between the wall zone and the core are intermediate zones. Not all types of zones are always represented in a zoned pegmatite; for instance, many pegmatites have no intermediate zones, and hence are composed of border zone, wall zone, and core. Nor can a true picture of the internal structure of a granitic pegmatite be obtained from outcrops, because all of the zones may not be represented at that level of erosion.

The principal minerals of each pegmatite unit are included in the name given the unit, and are listed in order of decreasing abundance, as, for example, quartz-cleavelandite-muscovite pegmatite. In general, the accessory minerals are not included in the name unless they are of economic significance.

The term 'pegmatitic' is inadequate for the description of the texture of individual units within pegmatites; hence the following classification has been generally adopted and is used in this report:

Term	Maximum crystal dimension (Inches)
Very fine grained.................	-1/4
Fine grained.....................	1/4 to 1
Medium grained..................	1 to 4
Coarse grained...................	4 to 12
Very coarse grained..............	+12

For a more detailed discussion of internal structure, the reader is referred to a monograph on the subject by Cameron, Jahns, McNair, and Page (2) or to a previous report by the writer (11).

Beryl Pegmatites

Pegmatites in the region containing the greatest concentration of beryl exhibit internal structure. Most of these pegmatites contain a border zone and pods, but some of them consist of a border zone, wall zone, and core. The border zone assemblage consists of perthite, quartz, and plagioclase, with or without muscovite and garnet, and is very fine to medium grained. Pods and wall zones are composed of quartz and perthite, which are medium to very coarse grained. Cores are composed of massive quartz.

Spodumene Pegmatites

All of the spodumene-bearing pegmatites in the region that were examined by the writer feature internal structure, with the possible exception of pegmatites on the Lacorne Lithium Mines property. Several of these pegmatites contain a border zone, wall zone, and apparent core. The border zones are very narrow, are not continuous around the pegmatite bodies, and are composed of very fine-grained feldspar and quartz. The wall zones are also very narrow, discontinuous, and very fine grained. They are composed of feldspar, quartz, and spodumene. Innermost zones or apparent cores consist of plagioclase, quartz, spodumene, and perthite, and comprise the bulk of these pegmatite bodies. Two zonal assemblages are found in the exposures on the Lithium Corporation of America property: an outer assemblage consisting of plagioclase, quartz, perthite, spodumene, and muscovite, and an inner assemblage consisting of quartz, spodumene, and perthite. The outer zone assemblage is mineralogically similar to the apparent cores of the other spodumene-bearing pegmatites. Because the wall-rock contacts are not exposed, it is not possible to classify these assemblages structurally.

Other Features

Several features cannot be properly evaluated because many of the pegmatites are poorly exposed. Where their contacts with the wall-rocks could be seen, the writer was unable to find wall-rock structures that could be related to the formation of the pegmatites, nor any megascopically visible wall-rock alteration. Norman (10, p. 4) suggests that the early phase pegmatites were emplaced partly by segregation and partly by replacement. He bases this suggestion on the following observations: these bodies are of irregular size and shape; are without clearly defined boundaries; and contain numerous inclusions of granite. The orientation of the pegmatites suggest that their emplacement was controlled by fracture systems related to the Preissac-Lacorne batholith, but it is not certain whether the pegmatite-forming material filled open spaces, or replaced other rocks using the fractures as entrance channels.

MINERALOGY

Principal Rock-forming Minerals

Feldspars

Feldspars are the most abundant constituents of the pegmatites associated with the Preissac-Lacorne batholith. A calculation, based on mill tests and allowing for the losses in fines, slimes, and magnetic waste, shows that feldspars constitute 51 per cent of the spodumene-bearing pegmatites south of Lake Lortie (4, p. 99). For the purpose of field mapping, feldspar is designated as microcline if no twin lamellae can be seen in hand specimen, and as perthite if patches or stringers of plagioclase can be seen in the microcline. The feldspars are generally white in colour. Perthite occurs as crystals and aggregates of crystals that reach a maximum of a few feet in length. In places, the perthite crystals and aggregates are oriented at right angles to the walls of the pegmatite body. Tremblay (12, p. 45) reports that microcline occurs mainly as fine grains interstitial to quartz, albite, and spodumene. He estimates that microcline or perthite or both constitute up to 30 per cent or more of the pegmatites. Plagioclase is the most abundant constituent of the pegmatites, and is reported by Tremblay (12, p. 46) as albite (An $_{4-6}$). Plagioclase from the spodumene-bearing pegmatites south of Lake Lortie is albite-oligoclase, with a composition of about An_{10} (4, p. 103). Some of the plagioclase is the platy variety, cleavelandite. In general, the plagioclase is fine to medium grained and anhedral. Cleavelandite and cleavelandite-quartz veinlets transect some spodumene crystals. A partial analysis of the feldspar concentrate obtained during mill tests on spodumene-bearing pegmatites south of Lake Lortie gave the following results (4, p. 103):

	Per cent
Li_2O..............	0.46
Na_2O..............	9.98
K_2O...............	4.06
Al_2O_3............	19.64
SiO_2..............	67.80
Fe_2O_3 and TiO_2.....	0.034

Quartz

Quartz occurs in all of the pegmatites, and is a major constituent of every pegmatite unit. It varies from colourless to milky white to light grey to dark grey, and in grain size from very fine to very coarse. Quartz occurs in all places as anhedral grains. Veinlets of quartz transect crystals of spodumene in places, and small fracture fillings were observed in some pegmatites.

Muscovite

Muscovite is generally present in the pegmatites, but it is not an important constituent except in places at the outer contact of quartz-perthite pegmatite and massive quartz. It varies in grain size from very fine to medium, and is pale green or greyish green in colour. In some of the spodumene-rich pegmatites, muscovite is present in amounts less than 1 per cent.

Economic Minerals

Beryl

Beryl occurs in many of the pegmatites of the region, and the relationship of beryl-bearing pegmatites to the Lacorne batholith has been discussed previously. Although a few beryl crystals have been found in the spodumene-rich pegmatites, apparently beryl is present in significant amounts only in some of the pegmatites that occur in the granite phases of the batholith. The crystals are euhedral, pale green, pale blue, blue-green, or green in colour, and range from very fine grained to as much as 84 square inches in exposed area, but most of the crystals seen are under hand-cobbing size. The beryl is easily identified by its colour and euhedral crystals, but pale green or blue crystals may be difficult to distinguish from other minerals in bright sunlight. In the pegmatites examined by the writer, beryl is found most abundantly in zones or pods of quartz-perthite pegmatite, especially along the outer margins of the zones or pods (See Figure 2). Beryl is also found in perthite-plagioclase-muscovite-quartz pegmatite, especially near the contact with quartz-perthite pegmatite, and at the outer contact of massive quartz in one pegmatite. Norman (10, p. 9) states that in the western part of the area beryl is particularly common in pegmatites containing central bands of quartz margined by muscovite, and is associated with the muscovite bands. The 'central bands' of quartz are presumably quartz cores.

Spodumene

The spodumene found in the region is white, buff, or green in colour, and varies in size from very fine grained to crystals 18 inches long, but is generally fine to medium grained. It occurs as elongated plates and laths or as prismatic crystals. The plates and laths occur in pegmatite consisting of plagioclase, quartz, and perthite, with or without muscovite, whereas the shorter, prismatic crystals are found in pegmatite containing quartz and perthite. In the spodumene-rich pegmatites examined by the writer, the spodumene has a preferred orientation throughout the pegmatite body as exposed, or at places within the body (See Figures 3 and 4). Diamond drilling on two of the spodumene prospects indicates that the spodumene is oriented with its long axis approximately perpendicular to the walls of the pegmatite body. This preferred orientation has been previously reported by Tremblay (12, p. 46). In places, spodumene is altered to a dark green material, or may be coated with a brown substance, but in general it is very fresh in appearance. Tremblay (12, p. 46) reports that both buff and green spodumene alter to a lithium-mica, which occurs in rosette-like, platy aggregates pseudomorphic after spodumene. In thin section, the green spodumene is seen to contain dust-like particles, whereas the buff spodumene does not (12, p. 46). Tremblay has observed that the ragged terminations of the spodumene crystals are the result of replacement of spodumene by quartz and feldspars. A few grains of spodumene were found by Tremblay (12, p. 49) in two thin sections of muscovite granite.

Other Minerals

Many other minerals have been reported as occurring in pegmatites in the region and include: lepidolite, spessartite, columbite-tantalite, microlite, betafite, bismuthinite, hematite, powellite, phenacite, molybdenite, and lithiophyllite (1, 10, 12). None of these minerals has been found in sufficient abundance in the pegmatites to be of economic significance, and all are regarded as accessory minerals.

ORIGIN

Norman (810, p. 16) proposes that the pegmatites and quartz veins represent successive stages of differentiation, and are closely associated with biotite-muscovite granite masses in the Preissac-Lacorne region. The earliest phase produced pegmatites, some of which are irregular in outline and without a clearly defined structural control. These pegmatites consist of quartz, perthite, muscovite, and small amounts of garnet. The second phase is represented by pegmatites containing albite, columbite-tantalite, beryl, spodumene, molybdenite, chrome spinel, and, rarely, phenacite. Quartz lenses and vein-like masses selvedged by muscovite occur at the centres of some of these pegmatites, and are believed by Norman to represent a residual siliceous fraction that was the last phase of differentiation. Norman proposes that the quartz and feldspathic quartz veins represent the siliceous fraction dissociated from the normal pegmatites.

Tremblay (12, p. 49) suggests that the pegmatite and aplite bodies are late differentiates of the muscovite granite. He states several features to support this suggestion: the pegmatites and aplites are closely associated spatially with the muscovite granite; many of them grade into muscovite granite; and they are similar in mineralogical composition. A few grains of spodumene were found in two thin sections of muscovite granite, which Tremblay interprets as suggesting that lithium was present in the original magma.

Tremblay (12, pp. 44-45) observed that pegmatites and aplites are closely associated in the field, and may be intimately mixed in the same body. Both rock types are mineralogically similar, and he suggests that the difference in grain size is due to pressure differences along the fractures in which the mother liquors were circulating. Changes in pressure at places in the fracture or along the entire fracture could explain the intimate mixture of pegmatite and aplite.

Derry (4, p. 104) writes as follows concerning the spodumene-bearing pegmatites on the Lacorne Lithium Mines property:

> "The spodumene crystals, far from showing evidence of replacing the albite-oligoclase, have been partially resorbed at their terminations before or during the crystallization of the latter. Instead of occurring in patchy concentrations the spodumene crystals are rather evenly distributed throughout the dykes, and show a parallel orientation relative to the dyke walls. From the above evidence it would appear that the mineral assemblage crystallized directly from the melt, first the spodumene, then the feldspar followed by quartz. If replacement played any part in the formation of these dykes, its role appears to have been relatively insignificant."

Several features are pertinent when considering the origin of the pegmatites:

(1) The pegmatites, aplites, and quartz veins occur within the batholith or in metamorphic rocks within 1.5 miles of the contact.

(2) Most of the pegmatites, aplites, and veins are controlled by structural features that are systematically related to the batholith.

(3) There is a regional zonation in places of pegmatites about the batholith.

(4) The pegmatites and aplites are mineralogically similar. One or more of the following minerals are found in these rocks: beryl, columbite-tantalite, molybdenite, and spodumene.

(5) Microcline, beryl, columbite-tantalite, and molybdenite occur in some of the quartz veins. Norman (10, p. 5) reports that the veins vary in composition from pure quartz to quartz veins

with a high proportion of microcline.

The first two of the above listed features suggest that the pegmatites, aplites, and quartz veins are related in time to the formation of the batholith, and the last three suggest that the pegmatites, aplites, and veins are genetically related. It is possible that the batholithic rocks, pegmatites, aplites, and veins are differentiates of a single magma.

PART III

DESCRIPTION OF PROPERTIES

GENERAL STATEMENT

Three lithium properties and one beryllium property are described in detail in this section. All three lithium properties have been recently diamond drilled, and concentration tests have been made on spodumene-bearing pegmatite from two of them. So far as is known, the beryllium property contains the most important concentrations of beryl in the region. Tremblay (12) has described other lithium and beryllium properties and deposits in the region, and that information is not repeated here.

BERYLLIUM

Heroux-Gamache-Massicotte Property (8, 12)

The claims comprising the Heroux-Gamache-Massicotte property include the south halves of lots 14 to 19, rge. VIII, Lacorne tp., and are held by Messrs. G. P. Heroux of Montreal and R. Gamache and P. F. Massicotte of Val d'Or.

Three large, and several small, beryl-bearing, granitic pegmatites occur in the south halves of lots 15 and 16. Forest fires have removed much of the growth and soil in the area, and the three large pegmatites are well exposed in a clearing on the side of a granite ridge. These deposits may be reached by a trail beginning at the farm of Mr. W. St-Louis, which is 0.9 mile east and 1.9 miles north of the village of St. Benoit (See Figure 1).

An area about 1,000 feet long and 500 feet wide, containing the three main pegmatites, was mapped (See Figure 5), and beryl counts were made on these pegmatites.

Granitic pegmatites, many of which are beryl bearing, intrude granite in many places on this property. In general, the beryl-bearing pegmatites are similar to those that do not contain beryl except that they have well-developed quartz-perthite assemblages. The granite-pegmatite contacts are generally sharp, but are gradational in a few places.

Although the strikes and exposed widths of the three main pegmatites are apparent, the dips are uncertain. The north pegmatite body strikes north 80 degrees west, and averages about 20 feet in exposed width. It is exposed over a distance of 880 feet. The dip is measurable only at one place, where it is 65 degrees northeast. The south pegmatite body strikes east-west, is exposed over a distance of 760 feet, and also averages about 20 feet in exposed width. At no place is the dip apparent. The central pegmatite body is traceable for 130 feet, strikes north 70 degrees east, and averages about 10 feet in exposed width. At one place the dip was measured as vertical. Outcrops indicate that the south and central pegmatites meet, but it is not certain whether the central and north pegmatites do.

The three main pegmatite bodies exhibit internal structure, and three mineral assemblages were recognized and mapped. In all three pegmatites, the outer zone consists of perthite, quartz, plagioclase, and muscovite, and contains beryl in places, generally in greater abundance near the inner contact. The bulk of the beryl in this zone is too small for hand-cobbing. The perthite is usually medium grained, and the other minerals are very fine to fine grained. This zone is irregular in texture and in the proportion of constituent minerals, especially near the outer contact, and is apparently the border zone of these pegmatites. Coarse- to very coarse-grained quartz-perthite pegmatite occurs as pods in all three pegmatite bodies and apparently represents discontinuous wall zones. Beryl crystals, ranging up to 84 square inches in exposed area, occur in places within this assemblage or at the outer contact. In places, the outer contact is marked by a concentration of medium-sized muscovite books. The feldspars of both assemblages are white, and the beryl varies from pale blue to blue-green to green. Massive quartz is exposed only in the most northerly of these pegmatite bodies, and is the apparent core. The outer margin of the massive quartz is marked in places by a concentration of medium-grained muscovite books, and a few crystals of beryl.

A few grains of molybdenite were found in quartz-perthite pegmatite, and several fine-grained crystals of red garnet occur in places in perthite-quartz-plagioclase-muscovite pegmatite. Narrow fractures containing hematite were found in perthite at one place. The occurrence of columbite-tantalite was reported by Tremblay (12, p. 89).

Complete beryl counts were made on each of the three large pegmatite bodies. Separate calculations were made for each pegmatite, for the various mineral assemblages within each pegmatite, and for three beryl-rich areas. The results of the beryl counts are given in the following table.

A complete evaluation of the property cannot be made because it is not certain that the existing exposures truly represent the pegmatite bodies, and nothing is known about their nature at depth. It is possible that stripping of the shallow overburden would reveal additional beryl-rich areas or extensions of the known areas. There is a possibility that the pods of quartz-perthite pegmatite connect at depth to form continuous zones. Although the bulk of the exposed beryl occurs in the quartz-perthite pods, not all of the pods contain beryl, so it is unlikely that a continuous wall zone would contain uniformly distributed beryl. This feature is to be expected in beryl-bearing pegmatite.

BERYL COUNTS ON PEGMATITE BODIES

Pegmatite	Parts covered by crystal measurements	Area of exposures covered by measurements (Square inches)	Number of beryl crystals in exposures covered	Total area of beryl in exposures covered (Square inches)	Per cent beryl in pegmatite measured
South body	Entire exposure	301,968	136	458.99	0.15
	Perthite-quartz-plagioclase-muscovite pegmatite	277,344	65	11.48	0.004
	Quartz-perthite pegmatite	24,624	71	447.51	1.82
	Beryl-rich area No. 1	13,824	55	426.94	3.09

(continue page 18)

Central body	Entire exposure	102,960	17	107.76	0.10
	Beryl-rich area No. 2	16,704	12	104.50	0.63
North body	Entire exposure	613,152	400	183.23	0.03
	Perthite-quartz plagioclase-muscovite pegmatite	528,768	327	39.72	0.008
	Quartz-perthite pegmatite	41,760	66	139.60	0.33
	Massive quartz	42,624	7	3.91	0.009
	Beryl-rich area No. 3	14,400	49	124.62	0.87

NOTE. The Beryl-rich areas all consist of quartz-perthite pegmatite.

LITHIUM

Lacorne Lithium Property (3, 4, 12)

The spodumene-bearing pegmatites on the Lacorne Lithium property are very poorly exposed, so that most of the information on the deposits has been obtained by diamond drilling and subsequent separation tests on spodumene-bearing diamond-drill core. Dr. D. R. Derry, Ventures Limited, has very kindly made available to the writer a detailed report on the property (3), from which much of the following information was obtained.

The original claims included lots 45 to 54, rge. IX, Lacorne tp., but subsequent claims were staked to include lots 37 to 44, rge. IX, and options were taken on properties to the north and west of these claims. The claims were held jointly by Nepheline Products Limited and Great Lakes Carbon Corporation. At present the property is owned by Lacorne Lithium Mines Limited, 712, 320 Bay St., Toronto, and consists of lots 45 to 54, rge. IX, the north halves of lots 37 to 44, rge. IX, and the south halves of lots 52 and 53, rge. X, Lacorne township.

The principal showings occur on lots 52 and 53, rge. IX, Lacorne tp., about 1,500 feet south of Lake Lortie (See Figure 1). A private road to Lake Lortie meets highway 45, 2 miles west of Fisher. The road is blocked about 4 miles from the highway, by a locked gate, the key to which is in charge of Mr. G. Magny, Amos. This road is in excellent condition to the southwest corner of Lake Lortie, but from there to the showings it has been almost obliterated by new vegetation.

The outcrops of spodumene-bearing pegmatites on the original claims were discovered by Mr. F. Chubb, and were examined by Dr. D. R. Derry in the autumn of 1945. On the basis of preliminary sampling, separation tests were made on a bulk sample of several hundred pounds. The results of the tests were encouraging, and a limited diamond drilling program was undertaken. Six holes were drilled, totalling 2,088 feet; and three, large, spodumene-bearing, pegmatite dykes, A, B, and C, and several smaller ones intersected. The cores at each intersection of the three main dykes were colour-photographed, and the cores sent to the laboratories of Nepheline Products Limited at Lakefield, Ontario, for separation tests. Intersections of small, discontinuous, or low-grade spodumene pegmatite were filed for possible future tests.

The spodumene-bearing pegmatite dykes intersected by drilling occur at the contact of granite and meta-volcanic rocks, and the three large dykes cut rocks of both types. In the vicinity of the granite, the meta-volcanic rocks have recrystallized to form hornblendite. The granite-meta-volcanic rock contact apparently dips flatly to the north.

Outcrops of the spodumene-bearing pegmatites occur on a hill that rises abruptly from a gently rising slope. The highest point on the hill is 110 feet above the base, which has been given an arbitrary elevation of 1,000 feet. The 900-foot elevation is near the deepest point at which the dykes were intersected.

By drilling, dyke A has been traced for 600 feet laterally, and varies from 11 to 48 feet in true width; it is open to the east, but narrowing, and is open and of good width to the west. Dyke B was intersected with certainty by only one hole, and is regarded as a lens 100 feet in length extending to elevation 1,000 feet. The true width of this dyke at the diamond-drill intersection is 22 feet. Dyke C has been followed for 350 feet horizontally, and has an average width of 10 feet. It narrows to less than economic width to the east, but is open to the west. The three main dykes strike about north 70 degrees west, and dip southwesterly at angles of from 40 to 60 degrees. In section, the dykes are approximately perpendicular to the granite-metavolcanic rock contact.

The dykes apparently carry spodumene from wall to wall, so that the entire dykes are considered in tonnage estimates. Because it would be possible to drive an adit at the 1,000-foot level, two tonnage estimates were made, one for the pegmatite above the 1,000 foot level, and the other for the pegmatite above 900 feet. These estimates are given below.

Dyke	Tonnage, surface to 1,000 feet elev.	Tonnage, surface to 900 feet elev.
A	88,660	234,000
B	18,330	18,330
C	23,330	56,870
Total	130,320	309,200

No internal structure has been recognized, and the dykes are apparently consistent in composition and texture from wall to wall. Calculations based on the separation tests, with allowances for losses in slimes, fines, and magnetic waste, show that the average mineral content of the three dykes is as follows: feldspars, 51 per cent; spodumene, 25 per cent; quartz, 23 per cent; and accessory minerals, including muscovite, magnetite, and columbite-tantalite, 1 per cent or less. Medium- to coarse-grained, white, potash feldspar and fine- to medium-grained, white spodumene occur in a groundmass of fine-grained, grey quartz and white plagioclase (An_{10}). The ratio of potash feldspar (mostly orthoclase, with some microcline) to plagioclase was determined as about 5 to 1. The spodumene is white where fresh, and buff to brown where weathered. In outcrops examined by the writer, the spodumene crystals range up to more than 4 inches in length, parallel with the long axis, and up to 1/3 inch normal to this axis, though most of them are less than 1/4 inch wide. The crystals are oriented approximately perpendicular to the walls of the dykes in most places (See Figure 3). The lithia content of the pure spodumene has been determined by calculation as 6.74 per cent.

Separation tests were made on the bulk sample and on each diamond-drill intersection of the three main dykes, and spodumene, feldspar, and quartz concentrates were obtained in each case. The milling procedure was as follows:

(1) Sample was crushed to minus 3/8 inch and weighed.

(2) Three-stage crushing through rolls reduced the material to minus 35 mesh.

(3) The minus 200 mesh material was removed by screening.

(4) The plus 200 mesh material was passed over a Dings High Intensity Magnetic Separator twice; the magnetic waste was then passed over the separator, and all of the non-magnetic material was combined.

(5) The non-magnetic material was conditioned in a caustic solution, and classified to remove the slime.

(6) Oleic acid and emulsol X-20 were added to the sand, which was transferred to a Fahrengren flotation machine where a rougher spodumene concentrate was obtained.

(7) The rougher spodumene concentrate was cleaned three times to produce a final concentrate.

(8) The rougher and cleaner tailings were then combined, Armour AMAC 118.5 C, pine oil, and hydrofluoric acid were added, and a rougher feldspar concentrate was floated.

(9) The rougher feldspar concentrate was cleaned twice, producing a final feldspar concentrate. The tailing from the feldspar-flotation was quartz concentrate. This procedure was developed by Messrs. B. D. Weaver and E. O. Foster.

The result of the milling tests are given in the following tables:

Test Results - Bulk Sample

Product	Weight	Lithia	Distribution of lithia
	%	%	%
Feed	100.00	1.64	100.00
Spodumene concentrate..	18.15	5.86	64.90
Feldspar concentrate....	44.28	0.46	12.40
Quartz concentrate.....	19.96	----	-----
Magnetic waste and slime	17.61	2.11	22.70

Test Results - Diamond-drill Intersections

Dyke	Number of intersections	Per cent weights of test products		
		Spodumene concentrate	Feldspar concentrate	Quartz concentrate
A	6	19.60	34.51	20.65
B	2	18.80	31.80	20.45
C	6	22.31	34.06	19.38
Over-all average		20.46	33.91	20.06

Partial Analyses - Bulk Sample and Bulk Sample Concentrates

Material	Li_2O	Na_2O	K_2O	Al_2O_3	SiO_2	Fe_2O_3 TiO_2	CaO	MgO	Mn
	%	%	%	%	%	%	%	%	%
Total pegmatite	1.64	5.02	1.47	17.21	73.05	0.23	1.29	0.48	
Spodumene concentrate	5.86	2.98	0.79	25.34	64.92	0.30	0.23	0.029	0.08
Feldspar concentrate	0.46	9.98	4.06	19.64	67.80	0.034			
Quartz concentrate				2.49	95.12	0.01			
Magnetic waste and slimes	2.11			19.42					

Mineral Count - Bulk Sample Concentrates

Product	Spodumene	Feldspar	Quartz
	%	%	%
Spodumene concentrate	84.2	11.4	4.4
Feldspar concentrate	Trace	90.8	9.2
Quartz concentrate	Trace	1.7	98.3
Magnetic waste and slime	40.0	45.0	15.0

Diamond drilling on the property has blocked out 309,200 tons of spodumene-bearing pegmatite, and milling tests have shown that a spodumene concentrate can be obtained that would consist of 20.46 per cent of the pegmatite, contain 64.9 per cent of the total lithia, and assay 5.86 per cent lithia. In practice, the minus 200 mesh fines, magnetic waste, and cleaner tailings would be re-treated.

Lithium Corporation Property (1, 13)

The Lithium Corporation property consists of lots 31 to 38, rge. II, Figuery tp., and is owned by Lithium Corporation of America, Incorporated, Rand Tower, Minneapolis, Minnesota. The exposures of spodumene-bearing pegmatite occur in lot 36, and are 11.6 miles by road from the town of Amos (See Figure 1).

A small outcrop containing spodumene was discovered by Mr. J. Cyr, Amos, in 1947, and the spodumene was identified by Mr. C. Bouvier, Amos. Claims were staked by a group of people from Amos, including Messrs. Cyr and Bouvier.

Removal of overburden by bulldozer exposed spodumene-bearing pegmatite in five places (See Figure 6). The exposures were washed, and nine shallow pits were blasted. A bulk sample of several hundred pounds was sent to the Bureau of Mines, Ottawa, for concentration tests by Mr. L. Almond, Amos, in 1949. The exposures were briefly described by Weber, Quebec Department of Mines, and named the Bouvier spodumene deposit (13).

The property was subsequently acquired and drilled by Lithium Corporation of America, Incorporated. Drilling information has not been made available to the writer, but the site of one drill-hole was discovered south of the exposures (See Figure 6).

According to Norman (9), the wall-rocks are biotite and staurolite schists derived from greywacke. There are no outcrops of wall-rock in the vicinity of the exposures.

Although spodumene-bearing pegmatite has been exposed in five places over a distance of 250 feet, it is not certain whether the exposures represent one or more pegmatite bodies. No wall-rock contact is exposed, and the extent, shape, and attitude of the body, or bodies, are unknown.

Two pegmatite zones were readily mapped: an outer zone consisting of plagioclase (commonly the variety cleavelandite), quartz, perthite, muscovite, and spodumene; and an inner zone of quartz, spodumene, and perthite (See Figures 6 and 7). The zonal contact is generally sharp, and is marked in places by narrow, muscovite-rich bands or muscovite aggregates.

The most abundant constituent of the outer zone is fine-grained, white plagioclase, commonly occurring as the variety cleavelandite. The quartz is grey, and the muscovite is silvery green; both are fine grained. White perthite occurs as coarse to very coarse crystals ranging to more than 30 inches in maximum dimension. In one of the pits, the long axes of the perthite crystals plunge north. Several white patches that appeared to be perthite crystals were found on closer examination to be aggregates of fine-grained plagioclase. The spodumene of this zone is pale green in colour, platy in habit in most places, and is present in variable amounts. A few crystals are altered in part or entirely to a dark green material. The surfaces of exposed spodumene crystals are weathered brown. Some of the spodumene is veined by quartz or cleavelandite, or by both. The grain size of the spodumene ranges from less than 1/8 inch in maximum dimension to more than 18 inches, but most of the crystals are less than 1 inch long. Larger spodumene crystals as well as fine-grained spodumene occur near the inner zone contact, and, in general, the spodumene content increases towards this contact. In places in this zone, the spodumene crystals have a preferred orientation, and the long axes plunge 60 to 65 degrees north. Reddish brown, very fine-grained lithiophyllite is a common accessory mineral. Very fine-grained tourmaline occurs in places, and a few grains of molybdenite were found.

Grey quartz is the most abundant constituent of the inner zone of this deposit, and forms a groundmass for green spodumene and white perthite crystals. Although the spodumene ranges up to 12 inches in length and 3 inches in width, most of the crystals are about 3 inches by $\frac{1}{2}$ inch. These of the inner zone are usually prismatic rather than platy, and are generally striated on the crystal faces, parallel with the long axis. In places they have a preferred orientation, with the long axes plunging about 60 degrees north. The spodumene is brown where weathered, and some of the crystals are veined by quartz. The perthite is generally euhedral and medium grained, but crystals up to 17 inches long were seen. A few grains of lithiophyllite were found in this zone, but it is not as abundant as in the outer zone. Black, metallic grains of unknown composition were observed in the inner zone, and at the zonal contact near a muscovite aggregate.

Measurements were made on the inner zone to determine the amount of spodumene present. Corrections being allowed for specific gravity, the weight percentage of spodumene in each outcrop of the inner zone was calculated, and a final average was determined for the zone as a whole. The specific gravity of spodumene was taken as 3.10, and that of the remainder of the pegmatite as 2.62. The following table gives the results of the measurements.

Exposure	Area (Square feet)	Average per cent of spodumene	Area x per cent
1	80	20.51	1,640.80
2	46	15.00	690.00
3	358	21.46	7,682.68
Totals	484		10,013.48

Average spodumene content of inner zone = $\frac{10,013.48}{484}$ = 20.69 per cent.

Flotation, decrepitation, and sink-float tests were made on a bulk sample of spodumene-bearing pegmatite from this property by the Bureau of Mines, Ottawa (1). The sample contained quartz, spodumene, and feldspar, with minor amounts of muscovite and lithiophyllite. Spodumene crystals, ranging from $\frac{1}{2}$ inch to 3 inches in length, constituted 17 per cent of the sample, and assayed 6.03 per cent lithia. A representative portion of the sample assayed 1.39 per cent lithia.

Several flotation tests were made on this material. The procedure and results of the test that gave the best grade concentrate were as follows:

Preparation treatment. The ore was ground to minus 20 mesh, then reground in a pebble mill, at a 1 to 1 dilution, and deslimed.

Reagent	Pounds per ton of feed					
	Prim. grind	Sec. grind	Rougher No. 1	Rougher No. 2	Cleaner No. 1	Cleaner No. 2
Sodium hydroxide	2.0	2.0	-	-	-	-
Oleic acid	-	-	0.3	0.15	-	-
Reagent No. 708	-	-	0.3	0.15	-	-
Emulsol X-1	-	-	0.05	0.03	-	-
Sodium silicate	-	-	-	-	0.75	0.35

Notes. Sodium hydroxide was added to control the acidity (pH) and to clean the weathered spodumene. The grind was 69.5 per cent minus 200 mesh, and the pH of the flotation was 10.2. Desliming was necessary to remove fine ground spodumene, which coats the gangue minerals and causes them to float. Oleic acid and reagent No. 708 were used as collectors. The tailings from the No. 1 rougher cell were reground, deslimed, and sent to the No. 2 rougher. The two rougher concentrates were then cleaned twice. The cost of reagents was estimated as $0.25 a ton of feed, and the combined cost of mining and milling was estimated as $5 to $6 a ton.

Results of Concentration Test

	Weight	Lithia	Distribution of lithia
	%	%	%
Feed	100.0	1.69 (calc.)	100.0
Flotation concentrate	20.84	5.06	62.3
Flotation middling	16.13	1.29	12.3
Flotation tailing	47.12	0.60	16.7
Slimes	15.91	0.93	8.7

Notes. The over-all recovery of spodumene would be 68.4 per cent, assuming that one-half of the spodumene in the middlings can be recovered.

Three decrepitation tests were made on this material; the procedure and results of the best test were as follows:

Procedure

(1) The ore was crushed to minus 1.5 inches.

(2) The minus 65 mesh material was discarded.

(3) The plus 65 mesh material was heated for 1.5 hours at a constant temperature of 1,185 degrees centigrade.

(4) The material was then put in a jar mill with 50 per cent of its weight in rubber balls, and ground for 1 hour.

(5) The ground material was then passed over a 65 mesh screen.

Results

Product	Weight	Lithia	Distribution of lithia
	%	%	%
Feed	100.0	1.61	100.0
- 65 mesh unroasted	0.3	-	-
+ 65 mesh roasted	77.1	0.86	41.1
- 65 mesh roasted	22.6	4.20	58.9

Sink-float tests were made varying the size of the particles and the density of the separating medium. The procedure and results of the test on minus 1 inch-plus 4 mesh material, using a separating medium with a density of 2.70, were as follows:

Procedure

(1) The material was crushed to minus 1 inch.

(2) The material was screened and the minus 4 mesh material was discarded.

(3) The material was subjected to sink-float concentration; using a medium of 2.70 density.

Results

Product	Weight	Lithia	Distribution of lithia
	%	%	%
- 4 mesh fines	17.36	2.05	17.05
Sink at 2.70	53.65	2.91	74.68
Sink and fines	71.01	2.70	91.73
Float at 2.70	28.99	0.60	8.27
Ore (calculated)	100.00	2.09	100.00

A complete evaluation of this property is not possible because of lack of information. Data concerning the grade and methods of concentration of the inner zone material have been presented. It is the writer's opinion that a successful mining operation for lithium alone under existing economic conditions would probably depend upon proving the availability of a substantial tonnage of inner zone material. Because most of the spodumene in the outer zone is fine grained, bulk sampling methods are probably necessary to determine the grade of this material. Exposures indicate that the spodumene content of the outer zone is variable, but, because this zone generally contains much spodumene near the contact with the inner zone, it is possible that a considerable amount of outer zone material could be mined in conjunction with the inner zone.

Lithium Exploration Property (12)

The Lithium Exploration property consists of lots 56 to 62, rge. IX, Lacorne township. Spodumene-bearing pegmatite is located on lots 59 and 60, and can be reached by private road from highway 45 or by road from Barraute (See Figure 1).

Lots 55 to 62 were originally staked by Mr. G. Dumont of Val d'Or, for molybdenite. The property was optioned to Sullivan Consolidated Mines, Limited, and the molybdenite deposits were stripped, trenched, and diamond drilled in 1942 and 1943. Since then the property has been acquired by Lithium Exploration Company Limited, 1604 Aldred Building, Place d'Armes, Montreal, spodumene-bearing pegmatite has been stripped and trenched in places, and five holes were diamond drilled (See Figure 8). The writer made a cursory examination of the drill core, and copies of the drill logs and the results of assays on spodumene-bearing core have been made available by the company.

It is not certain whether the exposures represent one or more pegmatite bodies, but the writer believes that one pegmatite body can be traced for a distance of 250 feet. Diamond drilling indicates that this pegmatite body probably dips about 65 degrees south.

Three zones occur at the surface, a south border zone, a wall zone, and an inner zone. Because the border and wall zones are narrow, and occur only in places, they were not mapped as individual units. The inner zone is spodumene-bearing from contact to contact.

The border zone is generally less than 1 inch wide, and occurs only in a few places. It is very fine grained in texture, and is composed of white feldspar and colourless to grey quartz.

The wall zone also occurs only in a few places. It is very fine grained, and is usually less than 1 foot in width. This zone is composed of white or pink plagioclase, mostly cleavelandite, colourless to grey quartz, and green spodumene.

Plagioclase, quartz, spodumene, and perthite comprise the bulk of the inner zone, which forms most of the pegmatite body both in the outcrops and diamond-drill core and is apparently the core of the pegmatite. A few small beryl crystals were seen in this zone by the writer, and both beryl and columbite-tantalite were reported by Tremblay (12, p. 75). The plagioclase is white, and the quartz is grey; both are fine grained. Spodumene occurs as highly elongate, lath-like crystals that are generally of medium grain, but may range up to more than 8 inches in length (See Figure 4). The spodumene is normally pale green, but many of the crystals are coated with a brown substance, and in places in the most easterly trench they are altered to a dark green material. Perthite occurs as white, elongate crystals and crystal aggregates that are generally coarse grained, but may range up to more than 24 inches in length. Both the spodumene and the perthite crystals are oriented so that their long axes are about normal to the walls of the pegmatite.

An attempt was made to estimate the spodumene content of the pegmatite by measuring the spodumene crystals exposed across sections of outcrop. Most of the measurements were made normal to the long axes of the crystals in a plane parallel with the long axes. In addition, measurements in a plane normal to the long axes of the crystals were made on a large dome-shaped outcrop. The results of the measurements on seven exposures are tabulated as follows:

Exposure[1]	Per cent spodumene by weight, average measurements		Area of exposure (square feet)	Per cent area
	In plane normal to long axes of crystals	In plane parallel with long axes of crystals		
1	17.50			
		19.99	1,100	21,989
2		22.84	72	1,644
3		15.68	68	1,066
4		15.28	64	978
5		21.75	80	1,740
6		15.84	50	792
7		20.32	100	2,032
Totals			1,534	30,241

$$\text{Average spodumene content} = \frac{30,241}{1,534} = 19.71 \text{ per cent}$$

[1]For purposes of calculation, the specific gravity of spodumene was taken as 3.10 and that of the remainder of the pegmatite as 2.62.

On the basis of diamond-drill core data and assays, the average amount of spodumene in the pegmatite sampled by the four drill-holes that were put down on or near the exposures of pegmatite was calculated as 20.32 per cent. The lithium oxide content of the spodumene crystals is not known, but for purposes of calculation 6.94 per cent, which is an average for spodumene, was used.

The spodumene-bearing pegmatite on this property is similar to that on the Lacorne Lithium property. Four of the diamond-drill holes were shallow holes put down on or near exposures for sampling purposes. The fifth hole intersected spodumene-bearing pegmatite at depth, and the pegmatite was similar in all respects to that intersected by the shallow holes. More drilling is necessary to outline the pegmatite body or bodies, before a tonnage estimate can be made, and the writer believes that a substantial tonnage can be proved.

ECONOMIC OUTLOOK

Further diamond drilling should increase substantially the known tonnage of spodumene-bearing pegmatite containing from 15 to 20 per cent recoverable spodumene, and pegmatites that contain spodumene practically from wall to wall are particularly worth further exploration, should economic conditions be favourable.

Preliminary concentration tests indicate that a spodumene concentrate could be produced that would meet market specifications[1]. If flotation procedures were used, feldspar and quartz con-

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[1]Prices for spodumene are quoted on a basis of 6 per cent lithium oxide content.

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centrates could also be produced. If the decrepitation technique were employed, lithium metal could be made using an acid leaching treatment[2] as part of the process (5). Both decrepitation and acid

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[2]Application for a Canadian patent covering the process was made on December 8, 1950.

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leaching are believed to be relatively inexpensive processes.

Markets are a prime factor in considering the economic outlook. An increasing commercial demand for lithium and its compounds is reflected in the announcement by the United States Defence Production Administration of an expansion goal for the production of lithium compounds (6). No information is available concerning the Canadian market for lithium and lithium compounds. Feldspar concentrate from spodumene-bearing pegmatite in this region would be white in colour, exceptionally low in iron oxides, and high in soda. Such feldspar could be used in making glass and cleansers, and in special mixtures requiring a very low iron content.

The Preissac-Lacorne region is a considerable distance from markets. Freight rates for pulverized rock, bagged, and in carload lots are as follows: Amos, Quebec to Toronto, Ontario, $0.44 per 100 pounds; and Amos to Montreal, Quebec, $0.33 per 100 pounds. These rates would be subject to agreement based upon the value and amount of the material to be shipped.

Very little information is available concerning the cost of mining and milling spodumene ore. The combined cost of mining and beneficiation by flotation of spodumene-bearing pegmatite from the Lithium Corporation property was estimated as $5 to $6 per ton of pegmatite treated (1). It is believed that the production of spodumene concentrate by decrepitation would be relatively cheap. Consequently, if spodumene-bearing pegmatite is mined in the region, consideration should be given to producing lithium and lithium compounds on the spot using decrepitation and acid leaching treatment.

Unless larger, higher grade deposits of beryl are found, the writer believes that they would have to be mined in conjunction with feldspar to support any appreciable mining venture. The bulk of the beryl in the region occurs in perthite-quartz pegmatite in which the perthite is medium to very coarse grained and generally white.

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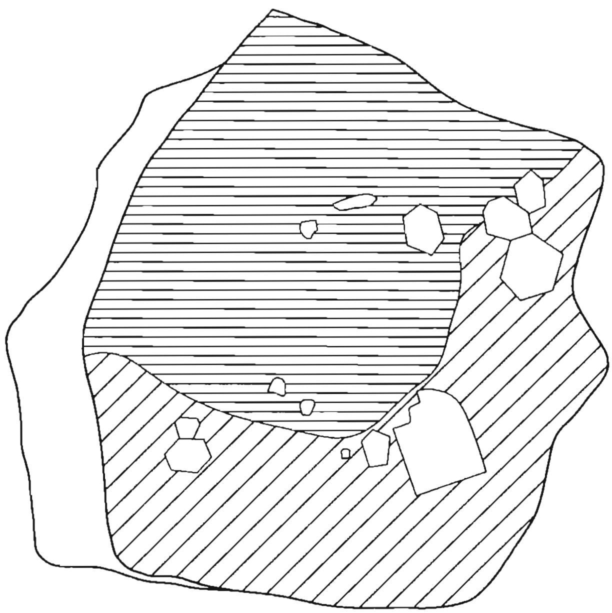

Figure 2

Sketch of specimen of pegmatite from lot 28, rge. 1, Figuery tp., showing occurrence of beryl crystals at contact between cleavelandite - quartz pegmatite (horizontal ruling) and perthite - quartz pegmatite (diagonal ruling). Note that most of the large beryl crystals occur in the perthite-quartz pegmatite. X$\frac{1}{9}$ natural size

Figure 3

Sketch of specimen of spodumene – bearing pegmatite from the Lacorne Lithium property. Note the parallel orientation of spodumene crystals in a groundmass of feldspar and quartz. X$\frac{2}{3}$ natural size

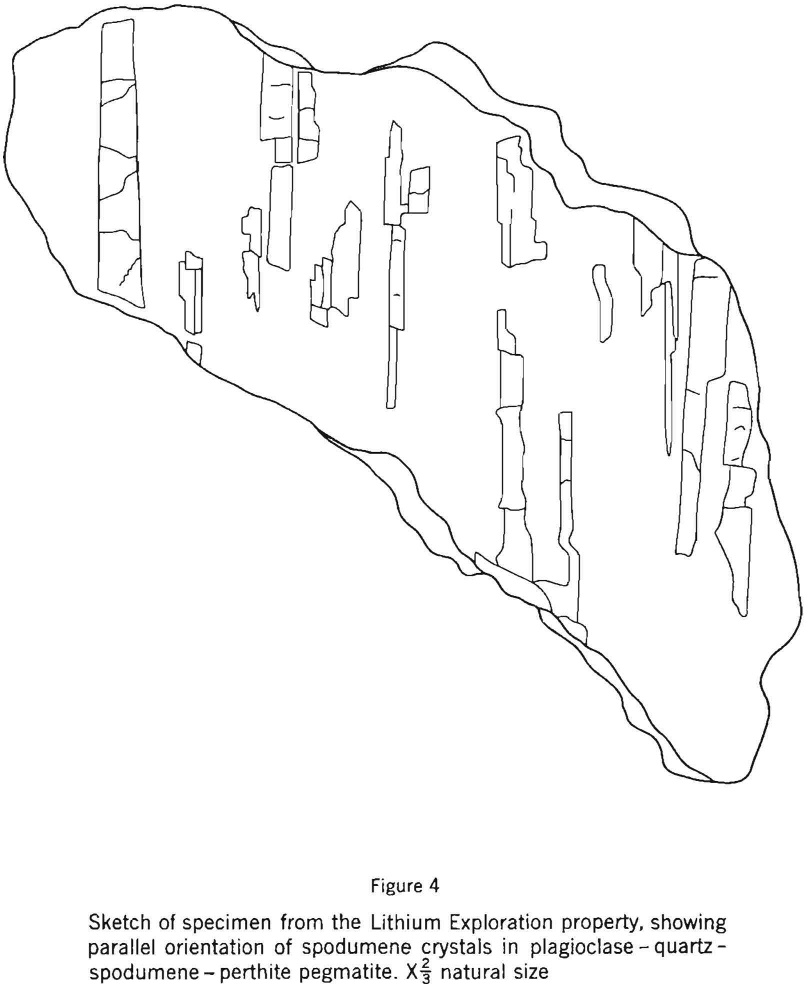

Figure 4

Sketch of specimen from the Lithium Exploration property, showing parallel orientation of spodumene crystals in plagioclase - quartz - spodumene - perthite pegmatite. X$\frac{2}{3}$ natural size

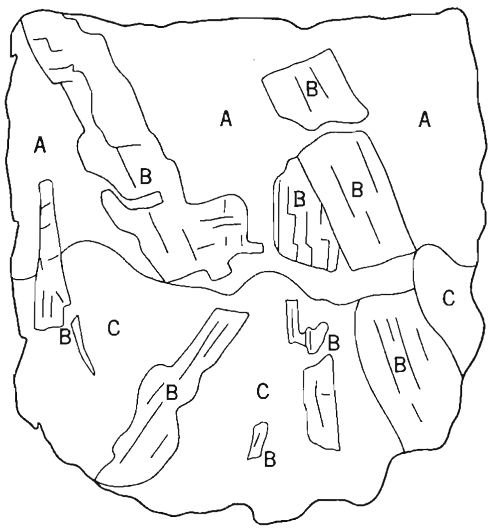

Figure 7

Sketch of specimen from the Lithium Corporation property, showing cleavelandite (A)–spodumene (B) pegmatite in contact with quartz (C)–spodumene (B) pegmatite. The contact is sharp, and two of the spodumene crystals are shared by both of the assemblages. X$\frac{2}{3}$ natural size

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