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Geology and Lithium Deposits of Georgia Lake Area

District of Thunder Bay

By
E. G. PYE

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ABSTRACT

The map-area first came into prominence in 1955, following the discovery by E. W. Hadley, of Auden, of lithium pegmatite forming a small reef in Georgia Lake. This discovery resulted in a staking rush and, ultimately led to the location of over 50 additional occurrences, some of definite economic potential. These occurrences were examined in detail, and the surrounding area was mapped at intervals from 1956 to 1959. The report and accompanying map represent the results of the investigation.

The oldest Precambrian rocks exposed are metasediments, which, as far as could be ascertained from top determinations, form an unrepeated group of east-west to east-northeast, steeply dipping beds along the south flank of a regional syncline. After their formation, the metasediments were invaded by large masses of Algoman granitic rocks and by numerous sills and dikes of genetically related porphyry, pegmatite, and aplite. Also cutting the metasediments are a few small masses and some narrow dikes of basic rocks. Like the metasediments, these too have suffered regional metamorphism, and because in places they are cut by granite and pegmatite, they are considered tentatively to be Pre-Algoman in age.

The peneplained Archean rocks are overlain in places by a thin cover of Proterozoic sedimentary rocks, correlated provisionally with the rocks of the Sibley group, found to the south near the town of Nipigon. Instrusive into these sedimentary rocks, and into the older Archean rocks on which the sedimentary rocks rest, are bodies of diabase. The diabase occurs in two ways; as dikes and as flat-lying or gently dipping sheets (Logan sills), one of which, at Pine Portage, attains a known thickness of 670 feet. The area is intersected by a number of faults, of north-south, north-northeast, northeast, and northwest strikes. All of these faults are younger in age than the granitic rocks, and along several, perhaps most, post-diabase movements occurred.

The pegmatites of the area are thought to be of magmatic origin and to represent late-stage differentiates generated by the progressive crystallization of granitic magma. They appear as crudely tabular dikes and sills, attenuated lenses, and small irregular-shaped bodies. A regional zoning, consequent upon changes in pegmatite characteristics, is evident. Mica-quartz-feldspar pegmatites are found in or close to the main mass of granitic rocks; rare-element pegmatites generally are found at considerable distances from the main mass. The rare-element pegmatites themselves can be divided, mainly on the basis of textural and structural differences, into three groups: one near Cosgrave Lake; one near Georgia Lake and Pine Portage; and one about Postagoni and Downey lakes, and Lake Jean. This division indicates that the rare-element pegmatites are not necessarily arranged about a single petrogenetic centre, but rather may be associated with prominent, westward- and upward-projecting tongues and satellitic bodies of the main granitic mass. The distribution of trace amounts of lithium in the granitic rocks supports this view. Although beryl, cassiterite, and columbite have been recognized, the only economically significant mineral in the rare-element pegmatites is the lithium-bearing mineral spodumene. On the basis of the exploration work done to date, known reserves of lithium pegmatite, in 10 occurrences, are estimated tentatively at 11,700,000 tons having an average grade of 1.14 percent Li_2O.

The spodumene of the lithium deposits is altered in places to either muscovite or to a pseudomorphic matte of very fine-textured sericite. Except in one instance, muscovitization is quantitatively not very important. However, sericitization and attendant darkening of spodumene, with loss of lithia and gain in iron content, has seriously affected the tenor of some deposits. This type of alteration appears to be spatially, and probably also genetically, related to the diabase intrusions in the area.

A low-grade copper deposit is localized along the breccia zone of the Glacier Creek fault in the southeast corner of the map-area, and indicates that base-metal deposits, as well as lithium pegmatites, may occur.

Geology and Lithium Deposits of the Georgia Lake Area

By

E. G. Pye[1]

INTRODUCTION

This report outlines the geology of the Georgia Lake area, which came into prominence in 1955 following the discovery therein of several potentially important deposits of lithium-bearing pegmatite. The report includes the results of a geological survey carried out by the author and his assistants intermittently from 1956 to the fall of 1959. This survey had as its objectives the mapping of the rock formations and their structures, and the study of the nature, distribution, and genesis of the lithium deposits.

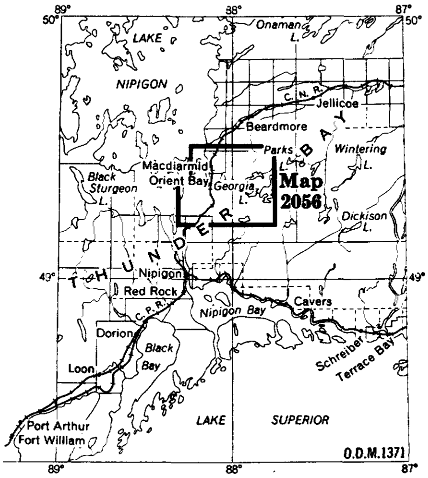

Figure 1—Key map showing the location of the Georgia Lake area. Scale, 1 inch to 50 miles.

The Georgia Lake area lies southeast of Lake Nipigon in the Port Arthur Mining Division, District of Thunder Bay, in the northwestern part of Ontario. It lies between the towns of Beardmore and Nipigon and is about 90 miles northeast of Port Arthur and Fort William. It is bounded by Lat. 49°12′ and 49°30′N. and by Long. 87°45′ and 88°21′W. The principal means of access are: the Port Arthur–Longlac branch line of Canadian National Railways, and highway No. 11, both of which extend northward along the east shore of, or close to, Pijitawabik Bay of Lake Nipigon; and highway No. 585, which connects Pine Portage with highway No. 17-11 near Nipigon. A number of gravel roads, suitable for motor vehicles, have been built by St. Lawrence Corporation Limited from highway No. 11 to nearly all localities in the area. The only parts of the area that must be reached by boat or pontoon-equipped aircraft are the extreme eastern and northwestern parts.

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SCOPE OF MAP AND REPORT

Geological map No. 2056 (in back pocket) presents the results of the survey and shows the distribution and the spatial relationships of the lithium pegmatites to the various rock formations. It was prepared at a scale of 1 inch to 1,320 feet, for reproduction at a scale of 1 inch to 1 mile, using maps of the Forest Resources Inventory as a base, and air photographs supplied by the Silviculture Section, Timber Branch, Ontario Department of Lands and Forests. The locations of the many roads in the area were obtained from maps kindly provided by St. Lawrence Corporation Limited. The pertinent geological features along the roads and the shorelines of the lakes were mapped, and pace-and-compass traverses were run across the area at intervals of 2,000 feet and ½ mile, at or nearly at right-angles to the strike of the formations wherever conveniently possible. The data obtained were plotted according to topography on transparent overlays to the air photographs. Topographic detail was then corrected to scale to conform to the Forest Resources Inventory maps, and the geological information was transferred to the basemaps for eventual publication. To facilitate reproduction, small isolated rock outcrops were indicated by x, whereas areas of numerous outcrops were shown as single outcrop areas. Because of their small dimensions, dikes and sills of pegmatite and some other rocks had to be illustrated by single straight lines.

The geological report supplements the coloured map. Presented in it are: (1) data on the general geology, emphasizing the petrographic features and the relationships of the rock formations; (2) a description of the principal rock structures; (3) a discussion of the characteristics, distribution, and genesis of the lithium pegmatites; and (4) detailed accounts of the mineral deposits discovered to date. The alteration of the lithium-bearing mineral spodumene is of considerable importance because of economic implications, and it is discussed at length.

ACKNOWLEDGMENTS

During the field work the author was assisted by the following: E.H.Chown, K. V. Young, J. J. Cameron, J. R. Garrett, and J. Baillie, in 1956; J. Baillie in 1957; and by V. G. Milne, W. T. Piche, K. G. Fenwick, W. Cruickshanks, and J. Baillie, in 1958 and 1959. Mr. Chown served as senior assistant in 1956 and was responsible for a large part of the field-work in the central part of the map area; Mr. Milne served as senior assistant in 1958 and 1959 and was responsible for much of the mapping in the eastern and southern parts of the area and for the section around Pine Portage. The author also is indebted to Mr. Piche for several of the photographs included in this report; and to Mr. Baillie for the preparation of thin sections, assistance in the preparation of plans and diagrams, and for the determinations of the modes of some rocks by Rosiwal grid analyses.

In 1959, Mr. Milne carried out detailed and painstaking surveys of several lithium deposits. This work, which he used as a basis for his Ph.D. thesis on the genesis of the pegmatites, at the University of Toronto, provided much of the factual information included in this report under Economic Geology.

The author is grateful to the officials and staffs of the mining companies in the area for their co-operation in providing information in the form of maps and records. Those to whom acknowledgment is due are: F. W. Anderson, Conwest Exploration Company Limited (Ontario Lithium Company Limited); J. R.

Bridger, Newkirk Mining Corporation Limited; G. Darling, Lun-Echo Gold Mines Limited; W. Maybank,[1] Kenogamisis Gold Mines Limited; W. J. Salisbury, Dunvegan Mines Limited (Vegan Lithium Mines Limited); and J. P. Walter,[1] Goldale Mines Limited, Jean Lake Lithium Mines Limited, and Towagmac Exploration Company Limited.

The author also takes this opportunity to thank: G. MacKinnon, district forester, and the Geraldton staff of the Ontario Department of Lands and Forests for much assistance in provisioning and transporting the field party; E. A. Smith, woodlands chief forester, St. Lawrence Corporation Limited, for maps showing the locations of company roads; and G. Flatt, foreman, Abitibi Power and Paper Company Limited, for providing accommodation for the field party at Pine Portage during late August and September 1958.

PREVIOUS GEOLOGICAL WORK

The first geological work in the region was by Robert Bell (1870), who investigated the shores of Lake Nipigon and the principal rivers. Supplementing this work, further surveys of the shores were made by William McInnes (1895), and of the islands and some of the larger rivers by D. B. Dowling (1899). Subsequently, W. A. Parks (1902; 1903) completed a reconnaissance survey of a large region, including parts of the Georgia Lake area, southeast of Lake Nipigon; and W. H. Collins (1908) mapped the geology along the Canadian National railway line between Nipigon and the Sturgeon River to the north. In 1908, A. W. G. Wilson (1910) completed a micrometer survey of the Blackwater River from its source near Park Lake a short distance east of the map-area, and this work was incorporated in a geological map and report of the whole of the Nipigon basin. In 1916 the diabase exposed near Orient Bay station was examined by A. G. Burrows (1917, pp. 245–47). The most recent work was carried out in 1917 by T. L. Tanton, who prepared a comparatively detailed compilation map, at a scale of 1 inch to 4 miles, of the southeastern part of the Nipigon basin. This map (No. 312A) was published by the Geological Survey of Canada in 1921 and has until now served as the principal source of information on the Georgia Lake area.

HISTORY AND DEVELOPMENT

One of the topics featured on the program of the annual convention of the Prospectors and Developers Association in the spring of 1955 was the lithium deposits of the Preissac-Lacorne area in Quebec (Latulippe and Ingham 1955). Samples of the lithium-bearing mineral spodumene were on display. Many years ago, E . W. Hadley of Auden had discovered a body of pegmatite forming a reef in Georgia Lake. He noted that the pegmatite contained a prismatic mineral, which he could not identify and which he considered then to be of no value. At the convention, however, he observed that the spodumene on display was very similar to the mineral in the pegmatite at Georgia Lake. He immediately contacted Gordon Miller of Conwest Exploration Company Limited. An examination was made at once, and impressed with the occurrence, Mr. Miller submitted samples to the author for positive identification. The author, in turn, presented the samples to Dr. H. Quackenbush, a Fort William dentist and

[1]Deceased.

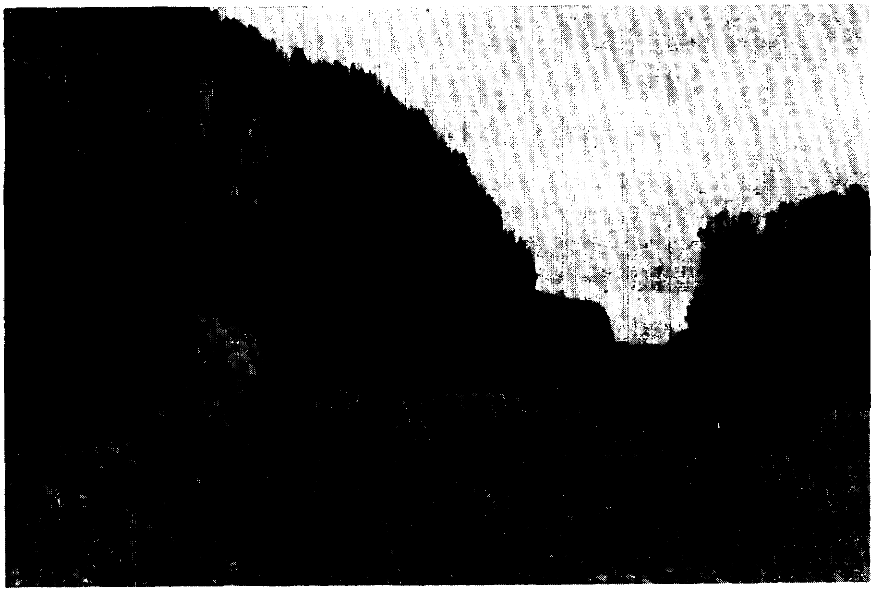
amateur mineralogist, who, as part of his hobby, had built a spectroscope. With this spectroscope, Dr. Quackenbush confirmed that the mineral was spodumene, and immediately Mr. Miller proceeded to stake a large group of claims for his company.

As news of Hadley's discovery was publicized, prospectors entered the area. About 3,200 claims were staked, and within a short time numerous additional lithium deposits were located. Many of these deposits were tested by diamond-drilling in 1955 and 1956. Two of them, on the property of Nama Creek Mines Limited, were found to contain over 4,000,000 tons of ore-grade material; and, in 1956, to initiate underground development of these occurrences, a vertical shaft was sunk to a depth of 503 feet. Several million tons of material suitable for exploitation were also found on other properties (*see* table, p. 26). Due to lack of adequate markets, however, none of these have been developed. Except for some limited diamond-drilling, by the Ontario Lithium Company Limited to test the original discovery in July 1957, and by Leitch Gold Mines Limited to test the E. S. Conway deposits (*see* pp. 66–69) in the late summer of 1958, the area has remained inactive since 1956.

TOPOGRAPHY

The Georgia Lake area is one of topographic contrasts. The parts of the area in which metasediments are exposed are, for the most part, of low relief. In contrast, the parts underlain by granitic rocks are rugged, with rounded hills rising up to about 150 feet above the general level. Most conspicuous, however, are high, imposing vertical or near-vertical cliffs at the boundaries of large exposed sheet-like masses of diabase. These cliffs, along the shores of Pijitawabik Bay and along the Gorge Creek valley, rise in places several hundred feet above Lake Nipigon. Referred to as the Palisades of the Pijitawabik (Pye 1962, p. 42), these cliffs provide northwestern Ontario with some of its most magnificent scenery (Photo 1).

Photo 1



Palisades of the Pijitawabik, near Reflection Lake.

Rock exposures in the area are abundant, and between the outcrops there is a thin mantle of glacial deposits. These glacial deposits consist mainly of stratified accumulations of unconsolidated sand and gravel. Some of them represent a ground moraine sorted by the action of glacial meltwaters; others form prominent terraces along the shores of Lake Nipigon and in the valley occupied by Keemle and Wanogu lakes, and are abandoned beach deposits. Esker ridges also are present but are not high and do not extend for any great distances.

The area lies west and south of the height-of-land between the Hudson Bay and Great Lakes drainage systems. Most of the rivers empty into Lake Nipigon. Cash Creek, by way of Lake Helen, and the Jackfish and East Jackpine rivers, however, flow southward directly to Lake Superior.

NATURAL RESOURCES

Forests

The forest of the Georgia Lake area is a mixed growth of spruce, balsam, jackpine, poplar, birch, and cedar. Good timber stands exist around Lake Jean and Triangle, Barbara, Glacier, and Foam lakes. The remainder of the area has been cut over, however, and little merchantable timber is present. The timber resources are held by St. Lawrence Corporation Limited, who maintain a pulp and paper plant at Red Rock, near Nipigon.

Fish and Game

Commercial fishing, principally for whitefish, yellow pickerel, sturgeon, lake trout, and northern pike, is carried out in the region. The centre of the industry is the village of Macdiarmid on the east shore of Pijitawabik Bay, Lake Nipigon. Game fishing, for pike, pickerel, and trout, is an important tourist attraction.

The most important game animal is the moose. Bear are present, and beaver, as evidenced by their dams, are abundant. Partridge are frequently encountered in the more wooded sections.

Power

Hydro-electric power is generated at Pine Portage on the Nipigon River near the west boundary of the map-area. Here the dam across the river has a length of 3,100 feet and a maximum height of 140 feet and is impressive. The generating station has a peak dependable capacity of 119,200 kilowatts (Ont. Dept. Econ. 1959, p. 28).

Power is available from a transmission line, which extends northeast across the area, through the Gorge Creek valley and along the east side of Postagoni Lake. The power feeding this line is generated partly at Pine Portage and partly at Cameron Falls and Alexander Landing, also on the Nipigon River, and at Aguasabon on the Aguasabon River.

GENERAL GEOLOGY

INTRODUCTION

All the bedrock of the Georgia Lake area is of Precambrian age; and because of the presence of a major angular unconformity, can be separated into two principal divisions, the Archean and Proterozoic. The oldest Archean rocks are metasediments. They strike east-northeast and dip steeply, in general to the north. They are overlain stratigraphically by a group of metavolcanics that are exposed in the Blackwater-Beardmore area to the north. Since they do not appear to be separated from the metavolcanics by a surface of unconformity, they are considered by Peach (1951, pp. 2, 3) to be a part of the same group, customarily referred to by previous workers in the region as Keewatin (Burrows 1917: Tanton 1918: Langford 1928: Bruce 1935; 1936: and Laird 1936). The Archean metasediments also extend (along strike) to the Kenogamisis River area, south of the town of Geraldton, where again they form the lowermost unit of the stratigraphic column. Here, however, they have been classified by R. D. Macdonald (1940, pp. 15, 16, 20, 21) as Coutchiching-type. The problem presented by the two classifications could not be resolved in the map-area. For this reason the terms "Keewatin" or "Coutchiching" are not used.

After their formation, the metasediments were invaded by large masses of Algoman granitic rocks, exposed in the southeastern, southern, and extreme western parts of the area, and by numerous sills and dikes of genetically-related porphyry, pegmatite, and aplite. Also cutting the metasediments are small stock-like masses and narrow dikes of basic rocks. Like the metasediments, these too have suffered from regional metamorphism; and because in places they were found to have been intruded by granite and pegmatite, they are considered to be Pre-Algoman in age. There is no conclusive evidence of this, however, and the possibility that they might rather have formed in early Algoman time cannot be discounted.

The Proterozoic is represented in part by sedimentary rocks. These are flat-lying, and are found in places as a thin cover on the eroded and upturned edges of the Archean formations along and close to Gorge Creek and southwest of Keemle Lake. They have been correlated tentatively with the rocks of the Sibley group, found about 20 miles to the south near the town of Nipigon.

Intrusive into the Proterozoic sedimentary rocks and the older formations are bodies of diabase. The largest occur as flat sheets (Logan sills), up to about 650 feet in thickness; others occur as dikes of vertical or near-vertical attitude. Most of the dikes are no doubt related closely to the sheets and are of Keweenawan age. Some, however, are porphyritic in texture and are quite similar to dikes, exposed near Beardmore to the north, which are cut by diabase sheets and have been classified as pre-Keweenawan in age (Langford 1928, p. 102: Laird 1936, p. 80: Peach 1951, p. 3).

The geological history of the area is summarized in the accompanying Table of Formations.

Table of Formations

CENOZOIC

RECENT AND PLEISTOCENE

Glacial drift, gravel, sand, silt.

Unconformity

PRECAMBRIAN

KEWEENAWAN

Diabase, porphyritic diabase.

Igneous Contact

Sandstone, shale.

Unconformity

ALGOMAN

Pegmatite (dike and sill).
Feldspar porphyry (dike and sill).
Granite, porphyritic granite, pegmatite, migmatite.

Igneous Contact

PRE-ALGOMAN (?)

Metagabbro (dike and sill).
Metagabbro, porphyritic metagabbro.

Igneous Contact

METASEDIMENTS

Biotite-quartz-feldspar gneiss, staurolite gneiss, garnet gneiss, cordierite gneiss, augen gneiss, hornblende schist or gneiss.

METASEDIMENTS

The Archean metasediments form an essentially uninterrupted and, as far as could be ascertained from top determinations, an unrepeated group of beds from south of Cosgrave Lake to the north boundary of the map-area, a horizontal distance of 20 miles. The principal rock making up this succession is a biotite-quartz-feldspar schist or gneiss. It is a grey, rather dark-coloured rock, having a distinct banded appearance due to compositional variations reflecting an original sedimentary stratification, with individual layers from less than an inch to several feet thick. A distinct foliation, due to the parallel or subparallel alignment of biotite crystals, is evident in most places and, except locally in the northern part of the area, appears to be parallel or nearly parallel to the banding. Microscopic examination of typical specimens has shown the rock to be made up of: biotite, 15–40 percent; quartz, 20–35 percent; plagioclase, 25–45 percent; magnetite, 1–3 percent; and small amounts of zircon, which give rise to pleochroic haloes in the biotite, and myrmekite. Green hornblendic amphibole occurs sporadically, and most samples contain small amounts of such secondary minerals as chlorite, sericite, and epidote. Symmetrical extinction of albite twins indicates the plagioclase to have the composition of sodic andesine (Ab_{64-68}).

The most abundant and widespread biotite-quartz-feldspar schist or gneiss is granoblastic in texture. Porphyroblastic rocks are also present, however, and in all but the north-central part of the map-area these are intimately associated with the common variety. They are much the same lithologically, their distinguishing characteristic being the presence of relatively large individuals of one or more of garnet, staurolite, and cordierite. Garnet porphyroblasts are red in colour, and occur as subhedral to euhedral, dodecahedral crystals, from pinhead size to about ½ inch in diameter. Staurolite crystals are brownish red, and are short prismatic in habit, with lengths up to about ½ inch. Microscopic examination shows them to contain numerous, small, rounded to irregular-shaped inclusions of quartz. Cordierite occurs as coarse anhedral grains forming ovoid "spots" or "knots." These range in length from less than 1 inch in most places to a maximum of 4 inches, with the long dimensions oriented roughly parallel to the foliation and layered structure of the rock. They generally contain numerous tiny inclusions of other minerals, notably quartz and a little brown biotite, but also magnetite and, in a few places, small crystals of garnet and staurolite. Both the cordierite and the included brown biotite exhibit small pleochroic haloes about grains of slightly radioactive material, chiefly zircons. Alteration of the cordierite to sericite, and of the biotite to chlorite, is a common feature of the "knots," and in places specimens are found made up almost entirely of quartz grains distributed throughout a matrix of the two secondary minerals. Pyrite occurs as a replacement of magnetite, and no doubt it is responsible for the distinct rusty weathering of the "knots" in some localities. Of special interest is the deflection of the micas in the surrounding rock about the porphyroblasts and, in some instances, the crude alignment of the biotite inclusions, roughly parallel to the strike of the rock's foliation.

The garnet, staurolite, and cordierite porphyroblasts are more resistant to erosion than the matrix containing them, and they stand up in marked relief on outcrop surfaces. Their distribution is erratic—in some outcrops they may occur in most of the exposed strata; in others, they are found only in widely-separated layers; and in still others they are conspicuously absent. They may occur several inches apart in an individual bed, or, conversely, they may be closely spaced and make up several percent of the rock. Of interest is that they generally are found in the more biotite-rich beds of any stratigraphic section, or in the upper, biotite-rich portions of graded beds. Although garnet, staurolite, and cordierite tend to be mutually exclusive, this is not always so, and frequently in the field cordierite-bearing beds are encountered with porphyroblasts of one or both of the other two minerals.

A different porphyroblastic gneiss is exposed in a number of localities in the southeastern part of the area: (1) south of the east end of Cosgrave Lake; (2) between O'Keefe Lake and Glacier Creek; (3) along Glacier Creek about 2½ miles east of Stein Lake; (4) about 1½ miles east-northeast of Stein Lake; (5) along the east shore of Kilgour Lake; and (6) southwest of Berg Lake. It is an augen gneiss, made up of somewhat lenticular "eyes" or porphyroblasts of feldspar (plagioclase and (or) microcline), ¼–¾ inch long, in a medium-grained matrix of quartz, plagioclase, and biotite, in some places with one or both of hornblende and muscovite. It was found to be conformable to the enclosing metasediments and is exposed across widths of up to about 30 feet. It occurs where the metasediments are interrupted by numerous lenses and stringers of pegmatitic material, and is thought to be a product of localized granitization of pre-existing rocks.

Another quantitatively unimportant member of the metasedimentary group is hornblende schist or gneiss. It is found in the southeastern part of the area, intimately associated in places with the augen gneiss, and also in the north-central part near Downey and Parole lakes. It is a dark-coloured, faintly-to well-foliated, fine- to medium-grained rock, which, although locally exposed across widths of 10–20 feet, is generally found as thin layers 12 inches or less in thickness. Whether these layers represent intrusive sills or thin beds of basic tuff or of dolomitic shale (Eckelmann and Poldervaart 1957, p. 1251) has yet to be determined.

Pettijohn (1949, pp. 435–62) recognizes three principal facies of sedimentary rocks deposited in different tectonic environments: (1) the geosynclinal facies; (2) the foreland or "platform" facies; and (3) the terrestrial piedmont facies. The metasediments of the Georgia Lake area have features that correspond most closely to those considered by Pettijohn (1949, pp. 443–49, 455) to be indicative of the geosynclinal facies:

1. The metasediments form a remarkably thick stratigraphic section—the thickness is measurable in miles rather than hundreds of feet.
2. Although the original sedimentary textures have been destroyed by regional metamorphism, the mineralogical compositions of the rocks, made up of large and variable amounts of quartz, feldspar, and biotite, indicate conditions of poor sorting and rapid deposition. No doubt the rocks are the metamorphosed equivalents of greywackes and associated slates; indeed, in the Blackwater–Beardmore area to the north, they have been classified as such (Peach 1951, p. 2).
3. The metasediments commonly exhibit graded bedding, indicated by a concentration of biotite and, in places, also of porphyroblasts of one or more of garnet, staurolite, and cordierite, in the upper parts of individual strata (*see* Shrock 1948, pp. 420–26).
4. Crossbedding has been noted, particularly in the northern part of the area, but occurrences are infrequent, and the structure is on a small scale.
5. Rocks considered typical of the platform facies, such as limestones and quartz sandstones, and red beds of the piedmont facies, are absent.

The metasediments vary somewhat in character across the area. In the south they are generally thin-to medium-bedded (Ingram 1954, pp. 937, 938) and have abundant biotite, reflecting the presence of much original argillaceous material (Harker 1950, p. 49). To the north they become thick-bedded to very thick-bedded, thin biotite-rich layers become increasingly less conspicuous, the section becomes interrupted by strata that are relatively quartzitic and rather massive in appearance, and, as pointed out previously, examples of crossbedding become more numerous. Since tops are to the north, the changes indicate the possibility of uplift toward the close of the sedimentary cycle. This, of course, accords with the appearance, in the Blackwater–Beardmore area, first of tuffaceous deposits interbanded with the metasediments, then of a great thickness of Keewatin-type volcanic rocks (Peach 1951).

PRE-ALGOMAN ?

Metagabbro, Porphyritic Metagabbro

Several bodies of basic rocks, classified as metagabbro and porphyritic metagabbro, were mapped in the southeastern part of the area. They are located (1) between Kilgour and Stein lakes; (2) between Dishpan and Glacier lakes; (3) along the shores and east of Sovereign Lake; and (4) east of Glacier Lake. These bodies are irregular to somewhat oval in shape, and range greatly in size, from small masses a few hundred feet across, to the mass between Kilgour and Stein lakes, which extends for 9,500 feet in a northeast direction. They have intrusive relationships with the Archean metasediments. At the same time, they have been metamorphosed and intruded by Algoman granitic rocks. Their relative age has thus been established, but whether these rocks should be considered as representative of pre-Algoman or of Algoman igneous activity remains to be determined.

The metagabbro is the more abundant of the two rocks. It is dark-coloured (mesocratic), medium- to coarse-grained in fabric, with a brownish weathered surface. Although for the most part quite massive, in some places, notably near its contacts with the metasediments, it is distinctly gneissic, with a foliation that closely parallels the regional trend. Its principal constituents are green hornblende and plagioclase (sodic andesine). Associated with these are small amounts of microcline and biotite and also a little magnetite and apatite. Quartz may be present but is sporadic. Chlorite, epidote, and sericite are ubiquitous alteration products. The dark mineral content of the metagabbro varies considerably, from as little as 30 percent in some specimens to 60–70 percent in others; and in some outcrops thin streaks and irregular patches, made up almost entirely of coarse-grained hornblende, are present as conspicuous segregations in the otherwise more or less homogeneous rock.

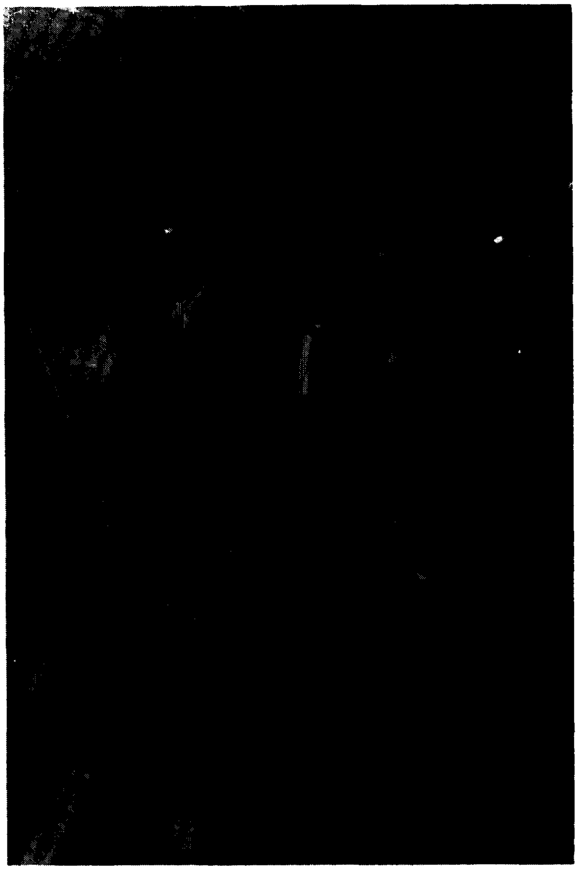
The porphyritic rock associated with the metagabbro grades into the latter and differs from it only in the presence of feldspar phenocrysts. The phenocrysts are pale-pink to red, and for the most part occur as stubby, rectangular, subhedral and euhedral individuals. They range in size from crystals measuring ¼ by ⅛ inch to others measuring ¾ by ⅜ inch, with rare phenocrysts attaining dimensions of 2 by 1 inches. They are harder than the rock as a whole, and they stand up in relief on some exposed surfaces. Microscopic examination indicates them to be microcline rather than plagioclase in composition. The porphyritic metagabbro tends to be best developed near and at the margins of the basic rock masses, particularly where close to Algoman granites. For this reason, and because a few small inclusions of metasediments, at the north end of the Kilgour Lake–Stein Lake mass and in the small body south of Sovereign Lake, were found to exhibit microcline crystals similar to the phenocrysts, it is possible that the porphyry is not strictly an igneous but rather a metamorphic-metasomatic rock, in which the large microcline individuals are metacrysts representing an incipient granitization.

The Kilgour Lake–Stein Lake mass is interrupted by several gently dipping dikes or lenses of granite pegmatite. Because of their attitudes, these dikes or lenses form small cuesta ridges and occur as prominent geological and topographic units. The largest are illustrated on the generalized map of the area (No. 2056, back pocket). They appear to be localized along two joint sets. In one set, the joints strike north or nearly so and dip flatly east; in the other, they strike east and dip 20°–30°N.

Metagabbro Dikes and Sills

Basic dikes and sills were found to interrupt the Archean metasediments near Dump and Pawky lakes in the north-central part of the area and near Blay, Georgia, and Conner lakes in the southeastern part. All are of small dimensions, with thicknesses of 3 feet or less, and are illustrated on the generalized geological map as single black lines. They are thought to be genetically related to the metagabbro—they are made up of a dark-coloured, massive, medium-grained, hornblende-rich rock similar to the metagabbro in composition and, like the metagabbro are cut in a few places by Algoman igneous rocks (*e.g.* pegmatite and feldspar porphyry dikes). Some of them exhibit well-developed boudinage structures (*see* Photo 2). These structures are thought to have resulted from elongation consequent upon lateral compression (Ramberg 1955), and indicate the likely possibility that the basic dikes suffered the same regional deformation and metamorphism as the enclosing sedimentary rocks.

Photo 2



Boudinage structure of basic dike in metasediments, on property of Nama Creek Mines Limited.

ALGOMAN

Granite, Porphyritic Granite

Igneous rocks, mapped in the field as granites, occur as small bosses, dikes, and sills at sporadic intervals throughout the area, and as large masses flanking the metasediments on the west, south, and east. These rocks are quite massive except near the margins of, and close to some inclusions in, the larger bodies, where a foliation may be evident (*see* map No. 2056, back pocket). This foliation reflects a parallel or subparallel alignment of mica flakes and, in some instances, also of mica-rich streaks and schleiren. The granitic rocks are pale-grey or pale-pink in colour, with weathered surfaces that are very pale-pink or white, and are medium- to coarse-grained in fabric. Their essential constituents are: feldspars, 45–65 percent; quartz, up to about 40 percent; one or both of muscovite and biotite; and rarely, a little hornblende. The feldspars are microcline and plagioclase, which are present in ratios that range from about 7:10 to 2:1. Five samples of the granite from widely separated localities were submitted to the Laboratory Branch of the Ontario Department of Mines for the determination of the composition of their plagioclases. Indices of refraction of (001) cleavage fragments and extinction angles indicated the plagioclase of one sample from near Foam Lake to be oligoclase (Ab_{85} An_{15}), that of the remaining four samples to be albite (Ab_{95} An_{5}). The granitic rocks thus appear to range in composition from quartz monzonites to true granites (Moorhouse 1956, p. 256). Minor constituents of the granitic rocks include magnetite, zircon, and such alteration products as chlorite, sericite, and epidote-group minerals. Small red to black garnets, $\frac{1}{16}$–$\frac{1}{3}$ inch in diameter, also occur in places, and make up 1–2 percent of the rocks containing them. They were found to be most conspicuous in the foliated portions of the large granitic mass in the southeast corner of the area, between Hanson and Sovereign lakes.

The granitic rocks are, for the most part, equigranular. However, porphyritic phases also occur. These were found in the principal granitic mass, south of the east end of Cosgrave Lake and southwest of Glacier Lake, and also in the smaller satellitic bodies between Lake Jean and Barbara Lake, at Postagoni Lake, and near the dam at Pine Portage. They are generally poorly defined in that they grade by the gradual disappearance of their phenocrysts into the normal equigranular rock. The phenocrysts are microcline, and occur as well-formed, rectangular-shaped crystals, generally $\frac{1}{2}$–1 inch, occasionally up to 2 inches, in length. In most instances they make up less than 10 percent of the rock containing them and are scattered rather unevenly throughout.

Porphyritic rocks are also found in small bodies in the metasediments southeast of Cosgrave Lake. These, however, differ from the normal porphyritic granite—the phenocrysts are more abundant, forming 25–40 percent of the rocks, and are more uniformly distributed; the groundmass, due to the presence of considerable hornblende as well as biotite, is darker coloured. They are found only near Cosgrave Lake, between granitic rocks on the south and the Kilgour Lake–Stein Lake metagabbro on the north. Where, at the south end of the Kilgour Lake–Stein Lake mass, they are in contact with the basic rocks, their boundaries are gradational. Except for their high content of quartz, they closely resemble the porphyritic metagabbro, and in thin sections the biotite present appears to be intimately associated with, and to replace, original hornblende. In places small lenticular inclusions of metasediments are present. The edges of these inclusions are sharp. But the inclusions commonly exhibit porphyroblasts of feldspar identical to the phenocrysts of the enclosing porphyry. Although the evidence is limited, there is thus reason to suspect that the hornblende-bearing porphyries, unlike the normal varieties, are hybrid rocks resulting from the partial replacement of original metagabbro by granitic constituents.

The contacts between the equigranular granitic rocks and the metasediments were generally found to be abrupt, except along the margins of the main mass south of Cosgrave Lake. Here the contact is represented, not by a single surface, but rather by a wide zone, in places up to 800 feet across, in which the metasediments are interrupted by numerous sills and dikes of granite and pegmatite, from a few inches to 30 feet or more in thickness. This zone was traced intermittently from Jackfish River eastward to the vicinity of Jackpine River. Its south boundary is indicated as a normal geological contact on map No. 2056 (back pocket). This is not a contact in the strict sense of the terminology however, but rather a line joining places along the traverse lines where metasediments were found to first appear, not as small inclusions, but as persistent tabular units in the granitic rocks. The granite and pegmatite sills and dikes are very numerous in the metasediments within 100–200 feet of this line, occasionally making up almost half the rock exposed. Northwards, away from the line, however, they diminish in number per unit area, and generally also in size, until they are found in the metasediments only at widely spaced intervals.

Small inclusions of the metasediments are most abundant in the main granitic mass south of Cosgrave Lake close to the contact zone. The inclusions tend to be lenticular and, in many instances, to be aligned with their long dimentions parallel to the contact zone. Some of them, which are rather sharply separated from the granitic rocks, exhibit thin biotite-rich selvages, whereas others are comparatively ill-defined patches and streaks. These features, the development of a conspicuous foliation in the mass near the contact zone, and the rough parallelism of this foliation to the gneissosity and relict stratification of the metasediments, are all reasons for suggesting that the granitic rocks may be of metasomatic origin. On the other hand, some inclusions, judging from the diverse attitudes of their foliations, must have been rotated. Further, as illustrated on map No. 2056 (back pocket), the metasediments near Lake Jean and Cosgrave, Barbara, and Triangle lakes become distorted, in places rather severely, close to the relatively small, satellitic bodies of granitic rocks. The two features, rotation and distortion, are indicative of magmatism and forcible intrusion. It is thought that the granitic rocks are primarily igneous and of magmatic derivation, the replacement phenomena noted in the field being the results of localized, marginal assimilation.

Pegmatite

One of the outstanding features of the Georgia Lake area is the great abundance of pegmatites close to and within the large masses of granitic rocks, in contrast with their general paucity elsewhere, except for scattered lithium-bearing deposits. A regional zoning (*see* pp. 46–49) is apparent, and a genetic association of pegmatites and granite is indicated. The pegmatites occur in two ways: as irregular-shaped bodies; and as thin dikes, sills, and attenuated lenses.

Irregular bodies of pegmatite are intimately associated with the granite of the principal mass south of Cosgrave Lake. They are found within a few hundred feet of the contact zone and occur as a confused pattern of small, unsymmetrical patches and anastomosing veins. They also occur along the east shore of Barbara Lake; about Reef Bay; and along the shores of and east of Sovereign Lake. Here they are of larger size, and many of them occur as more or less independent masses within areas otherwise underlain by metasediments. The most extensive pegmatite in the area is of this nature, and forms the islands in, and many of the pegmatite outcrops around, Reef Bay and the south bay of Barbara Lake. The fact that most of the inclusions of metasediments are seen, not in the higher points of the pegmatite islands in Reef Bay, but at or near water level indicates the possibility that this body may occur in part as a flat or gently-dipping sheet. The irregular bodies do not differ much in regard to texture and composition. They are typically medium- to coarse-grained, in places very coarse-grained (Cameron *et al.* 1949, p. 16), and are made up of quartz and feldspars (chiefly microcline and perthite), generally with a little muscovite. Biotite is present in a few places, and tourmaline and garnet sometimes occur as accessory constituents. The muscovite generally is present as scattered scales and books. In the large mass at and east of Reef Bay, and in some outcrops near Pine Portage, it also occurs as pale-green, fibrous aggregates, 1–6 inches in length, characterized by a distinct radiating structure. In the latter locality the mineral was identified tentatively in the field as cryophyllite. Subsequent x-ray and microscopic examination by the Laboratory Branch of the Department, however, served to correct this error.

The most prominent dikes, sills, and lenses of pegmatite noted in the field are indicated on map No. 2056 by single red lines and are designated 6. They can be divided conveniently into two types: the economically significant rare-element pegmatites, and the more abundant normal granite pegmatites. The rare-element pegmatites are discussed at length under Economic Geology. They consist essentially of microcline or perthite, albite, quartz, muscovite, and generally spodumene, and occasionally contain small amounts of one or more of beryl, columbite, and cassiterite. The granite pegmatites, except that some contain more abundant plagioclase, are similar in composition to the irregular pegmatite bodies described previously. They are generally narrow, with widths seldom more than 30 feet. On the other hand, they commonly persist for considerable lengths—two sills for example, neither more than 25 feet thick, appear to extend for about a mile along the south shore of Reef Bay. Some of the pegmatites are parallel to the foliation or bedding of the metasediments; others occupy joints in either the metasediments or granite, and where joints of different attitudes intersect, sinuous and zig-zag patterns may be assumed. Contacts are usually sharp and, except where dikes cut granitic rocks, often are found to be marked by thin (¼–¾ inch) border zones of aplitic or granitoid material. A few pegmatites are internally zoned, with mica-rich or tourmaline-rich rock along or close to the walls and, in a few places, quartz cores. The chilled margins and internal-zoned structure, the occurrence in places of rotated inclusions, and the distortion of wallrocks near some contacts, all indicate that the pegmatites, like the granites with which they are associated, are of igneous origin and intrusive.

Migmatite

Migmatite was mapped only in the southeastern part of the area and is quantitatively insignificant. It is found: (1) associated with hornblende schist 1e and porphyroblastic gneiss 1f, in a wide zone extending from Berg Lake southwest for about ½ mile; (2) in an outcrop 2,000 feet east of Berg Lake; and (3) along the east side of Glacier Creek north and northwest of Glacier Lake. The migmatite is characterized by a prominent *lit par lit* structure due to the alternation of thin layers of metasediments with parallel, closely-spaced stringers, attenuated lenses, and thin sills of granite or pegmatite. Southwest and 2,000 feet east of Berg Lake, the migmatite occurs in the main mass of granitic rocks, and its boundaries are marked by the disappearance of the metasediments, which occur here as inclusions. Along Glacier Creek, on the other hand, the migmatite is found mainly as narrow zones of *lit par lit* injection within a large area of metasediments, so that here the boundaries are marked by the disappearance of layers and lenses of pegmatite.

Pegmatite Injection Zone

Along the south shore of East Bay of Barbara Lake the normal, massive, medium-grained granite is cut by innumerable pegmatite stringers and dikes. These pegmatite bodies range from less than an inch to a maximum of 10 feet in width, and appear to occupy closely spaced, vertical to steeply dipping joints striking N.15°–65°W. The zone in which they are found is indicated on map No. 2056 by the symbol 4d.

Feldspar Porphyry

The metasediments are interrupted at sporadic intervals by dikes and sills of feldspar porphyry. These bodies, with a few exceptions, are less than 20 feet thick, and like the pegmatite dikes and sills they are represented on map No. 2056 by single black lines, in this case broken to prevent confusion with other symbols. The porphyry is a massive, pale-grey rock characterized by a white weathered surface, which contrasts sharply against the dark-coloured metasediments. It is made up of phenocrysts of plagioclase, $\frac{1}{16}$–$\frac{1}{8}$ inch in diameter, in a fine-grained matrix of quartz and feldspar with accessory biotite and muscovite and, in places, a little hornblende and chlorite. The plagioclase is highly sericitized, and the composition difficult to determine. Microcline is present in some specimens, and in one thin section was found intimately associated with plagioclase as antiperthite.

KEWEENAWAN

Sedimentary Rocks

Thin-bedded, flat-lying sedimentary rocks are found: along Gorge Creek; southwest of Keemle Lake; along the road northwest of Hanson Lake; and along the road near Hausen Lake. They are chiefly sandstones and shales. Except along Gorge Creek, where there are exposures of pale-grey sandstones, these sedimentary rocks are stained red due to the presence of small amounts of finely divided hematite. They attain their maximum thickness, about 40 feet, near McKirdy. They rest with great angular unconformity on the eroded, upturned edges of the Archean metasediments, and in turn are overlain in most places by the thick diabase sheet blanketing most of the west half of the area. They have been correlated tentatively with the Sibley sedimentary rocks about Lake Superior to the south and Lake Nipigon to the northwest (*see* G.S.C. map No. 308A, Lake Nipigon Sheet).

During the field season of 1959 the opportunity was taken to examine the Sibley sedimentary rocks exposed about Cooke Point along the south shore of Lake Nipigon west of The Virgins. These rocks, as pointed out by Wilson (1910, p. 68), are exposed at the base of a diabase sheet for about a mile along the lake shore and rise as much as 20 feet above lake level. They are gently folded, thin-bedded dolomitic limestones, either white or pale-green in colour. Because they are white weathering, they form very conspicuous outcrops. In 1931 these rocks were investigated by the late J. W. Lawrence for a source of building and ornamental stone. Several samples were forwarded to Nicholson Cut Stone Limited, of Leaside; these, according to Lawrence,[1] were found to be acceptable as regards colour, texture, and weathering properties. In 1948 a sample was forwarded to

[1] J. W. Lawrence, personal communication.

Steep Rock Iron Mines Limited for investigation as a source of flux. A chemical analysis, however, indicated the rock to contain over 20 percent silica. The results of the analysis, as reported to the author by Lawrence, are reproduced in the accompanying table.

CHEMICAL ANALYSIS OF COOKE POINT DOLOMITIC LIMESTONE

	percent
SiO_2	20.78
Al_2O_3	3.22
CaO	37.12
MgO	10.80
Fe	1.06
P	0.03
Mn	0.05
S	0.05
Total	73.11
Ignition Loss	22.83

Diabase Dikes

Two types of diabase, one equigranular and the other porphyritic, form prominent dikes. Dikes of equigranular diabase are the more abundant. Some of these, along or close to the contact zone of the large granite mass, in the southern part of the map-area near the Jackfish River, strike easterly; most dikes, in other localities, strike north or within 20 degrees of north. With few exceptions they are vertical or dip steeply. Whether or not these dikes cut the diabase sheets (Logan sills) in the area has not been established, but a genetic relationship is indicated by the close association between one dike and the gently sloping bodies of diabase east of Barbara and Sovereign lakes (*see* map No. 2056).

The porphyritic diabase is a massive, medium-grained, dark-coloured rock characterized by many pale-greenish yellow phenocrysts of highly altered plagioclase, ½–1½ inches in length. Like the equigranular diabase, it is found as north-striking or nearly north-striking dikes in three places: (1) north of the west end of Cosgrave Lake; (2) near the Jackpot lithium deposit southwest of Georgia Lake; and (3) west of Parole Lake. The most outstanding occurrence is the dike west of Parole Lake. This dike has a maximum known thickness of 150 feet. It is exposed at Camp 94 of St. Lawrence Corporation Limited. From Camp 94 it has been traced northwards for 2 miles to Spud Lake. Near Spud Lake it splits into two divergent branches, each of which persists northwards to the limit of the map-area. This dike was also traced southwards from Camp 94 for about 2 miles, and if the porphyritic diabase dike near Claus Lake farther to the south is its continuation, as seems likely, a total length of nearly 14 miles within the area is indicated.

It is reasonable to assume that all the diabase intrusions in the area were formed at about the same time; accordingly they have been grouped together in the map-legend. The relationship of the porphyritic diabase to the other diabase intrusions has not been determined, however, and in the Beardmore–Nezah area to the north a dike of similar rock, older than, and overlain by, a flat sheet of diabase, was classified by Langford (1928, pp. 95, 96, 102) as pre-Keweenawan in age.

Diabase (Logan) Sheets and Sills

Diabase occurs not only as dikes but also as flat or gently dipping sheets, which are exposed throughout and directly underlie about half the map-area. The diabase is dark coloured and is for the most part quite massive, as before. Except within an inch or two of its contacts with older rocks, where in the few cases observed it was found to be very fine-grained, it is medium- to coarse-textured. Although porphyritic phases occur, these are rare, and in general the rock is equigranular, with a characteristic doleritic or ophitic (poikilitic) fabric.

Photo 3

Pancake rock along highway No. 11 near Macdiarmid, showing vertical column of diabase interrupted by closely spaced, flat joints.

No serious petrographic study was attempted. Microscopic examination of a few thin sections, however, showed that, although some of the diabase is olivine-bearing as found by Wilson (1910, pp. 75, 76), much of it is free of this mineral and in places may contain quartz.

The diabase is well-jointed, most of the joints being vertical or steeply dipping. The most prominent ones strike east, west-northwest, and north to north-north-east (*see* Fig. 4). On a small scale the rock is broken into upright, polygonal prisms, which appear on the faces of some outcrops as a poorly-formed columnar structure. Locally, the diabase also is interrupted by flat or gently dipping joints;

where these are closely spaced, the rock may simulate a bedded sedimentary rock (Wilson 1910, p. 76). A fine example of this phenomenon, where crude vertical columns are interrupted by closely spaced, flat and gently dipping joints, can be examined along highway No. 11 near Macdiarmid (Photo 3). On a large scale, vertical or near-vertical joints provide erosion channels, and individual diabase sheets have been dissected into roughly triangular, rectangular, and irregular-shaped hills. Because the slabbing-off of rock fragments from the joint planes as a result of frost action produces steep escarpments, and because the diabase sheets are horizontal or nearly so, many of these hills, in particular the larger ones, stand up as picturesque mesas, with sheer walls in places over 300 feet high (*see* Photo 1).

One of the significant topographic features of the Georgia Lake area is that the many mesas all attain roughly the same elevation. For this reason, and because individual outcrop areas are everywhere closely spaced, it is reasonable to assume that most of the diabase exposed reflects the occurrence of a single horizontal or near-horizontal sheet. Diamond-drilling by Lun-Echo Gold Mines Limited in 1956 indicated that east of Pine Portage this sheet has a true vertical thickness of about 650 feet. It thins eastwards, however, and in the extreme eastern part of the map-area, where the erosional remnants became small and more widely separated, thicknesses do not exceed about 200 feet. Partly because of the general lack of overlying rock, the sheet was described by Wilson (1910, pp. 77–96) as a "capping sheet," and was considered by him to be the basal portion of "a once very extensive flow or series of flows of a very fluid diabase over [a] well dissected topography . . . ." Recent work has discounted this. The sheet is now recognized as an intrusion rather than an extrusive body, for the following reasons:

1. The diamond-drilling near Pine Portage, supplemented by field-mapping, showed that the diabase sheet dips inwards and forms a shallow basin beneath the Archean rocks exposed in this particular locality.
2. The Niemi lithium deposit and the enclosing metasediments appear to overlie the diabase in the large mesa south of Georgia Lake.
3. At Alexander Landing on the Nipigon River, about 12 miles south of Pine Portage, an erosional remnant of the sheet, which here serves as a 60-foot-high spillway at the Hydro-Electric Power Commission generating station, is overlain by an irregular patch of granitic rocks up to 60 feet across and 6 feet thick.

One of the arguments advanced by Wilson (1910, p. 95), in support of his contention that the "capping sheet" is a surface flow, is that the diabase rests on an uneven erosion surface having a considerable local relief. The field-mapping substantiated this evidence, and in several places near Barbara Lake and Reef Bay the diabase was found to be exposed between, and at elevations lower than the tops of, rounded hills of granite. At the extreme west end of Reef Bay, for example, diabase is exposed in a low outcrop but does not appear, or at least could not be found, to cut the granitic rocks of the encircling hills. In this regard it is of considerable interest that, in the west half of the area, near Hausen and Hanson lakes, Sibley sedimentary rocks are present as scattered patches covering Archean rocks. These patches are generally only a few inches thick, and they indicate that the present erosion surface, where remnants of the diabase sheet are absent, must approximate closely the pre-Keweenawan erosion surface. It follows that the diabase sheet was intruded partly parallel to the horizontal or near-horizontal bedding of the Sibley sedimentary rocks, partly along the surface of unconformity separating the Archean and Proterozoic rocks, and to some extent also along gently-dipping fractures in the Archean basement.

The faulted segments of a diabase sheet, not more than 200 feet thick, are present at the south end of and east of Sovereign Lake. The lower contact of this sheet, in the two places where it was observed, strikes in a general northeast direction and dips about 10°NW. The outcrop areas are cuestas, with gentle dip slopes, and along their north and northwest sides diabase is exposed in low ground between relatively high outcrops of Archean rocks. Furthermore, at one point east of the south end of Sovereign Lake, the upper contact of the diabase was found to dip about 50°NW. under granite and pegmatite. Since the diabase of the "capping sheet" in the large mesa, 2 miles west of Sovereign Lake, does not dip east or southeast under the Archean rocks, the "capping sheet" cannot be continuous with that at Sovereign Lake; so the latter must be an independent intrusive body. A second independent sheet is exposed along the boundary of the map-area east of Barbara Lake. It strikes north-northeast, and in the west wall of a deep linear valley it can be seen to dip 20°W. below granitic rocks. Other flat or gently dipping bodies, again apparently independent of the "capping sheet," are found: on the property of Nama Creek Mines Limited near Downey Lake (*see* p. 92); at the base of the large mesa west of Sovereign Lake; and below the Point lithium deposit at the west end of Georgia Lake. The first two of these are no more than about 30 feet in thickness; the one below the Point deposit has a thickness of at least 100 feet.

In general the Archean rocks show little or no evidence of alteration near their contacts with the diabase sheets. In a few places, however, the granites close to these sheets are found to change from pale-pink, medium-grained rocks to brick-red, medium- to coarse-grained rocks. Microscopic study shows this to be due to a gradual transformation of the granite to a micropegmatite made up of intergrown quartz and red alkali feldspar with accessory muscovite. Small irregular bodies of micropegmatite were noted: close to the granite-diabase contact west of the Jackfish River, in the south-central part of the map-area; along, and within about 2 feet of the upper contact of the diabase sheet east of Barbara Lake; in outcrops on the south shore of Rim Lake, where granite is exposed in a "window" in the diabase; and along the edge of the "capping sheet" at a point 2 miles west of Sovereign Lake. The micropegmatite is found intermittently over areas up to several hundred feet across. It is strictly a contact phenomenon, however, and because it is transitional into granite it may simply be a product of local assimilation of the granite by diabase magma.

PLEISTOCENE

Deposits of unconsolidated sand and gravel form a mantle over large sections of the area. Most of these are distinctly crossbedded and are believed to be glaciofluvial deposits. Others, notably in the southwestern part of the area, are of glaciolacustrine origin; they form a number of flat terraces representing successive drops in the level of Lake Nipigon upon the retreat of the Pleistocene ice sheet that once covered the region.

Esker ridges were found at the north end of Parget Lake, and between Lake Jean and Parole Lake, in the northeastern part of the map-area. They are quite sinuous, with an over-all west-southwest trend. Glacial striae, wherever observed, were found to strike southwest.

Large boulders are common. Many of these undoubtedly are glacial erratics. Some of them, however, do not appear to have been transported even a short distance. For example, round boulders of lithium pegmatite, on the property of Nama Creek Mines Limited, rest directly on the deposit from which they were derived; and one angular block of lithium pegmatite, known to have been rotated about 90 degrees, lies directly above the Parole Lake deposit of Jean Lake Lithium Mines Limited. Such boulders probably resulted simply from frost action.

RECENT

The Recent deposits are chiefly talus along the bases of the many high cliffs formed by the diabase sheets, and organic accumulations in open swamps. Fluvial deposits of sand and gravel are being formed, but these are small and inconspicuous.

STRUCTURAL GEOLOGY

FOLDING

Regional Structure

The Archean metasediments have a regional east to east-northeast strike, generally with vertical to steep northerly dips. However, variations in attitude do occur: near Pine Portage, and also near Downey Lake, the metasediments assume a distinct northeast trend; throughout the central section of the map-area, from Pine Portage on the west to Barbara Lake on the east, and from near Palace Lake on the north to Claus Lake on the south, there is a general reversal in the direction of dip; and close to many of the larger masses of granitic rocks considerable distortion is evident. But despite these observations, no large synclinal or anticlinal structures were recognized during the field-mapping. On the contrary, a lack of repetition of the stratigraphy is indicated. The presence in many localities of a well-developed pseudogradational bedding (Shrock 1948, pp. 420–26), in which porphyroblasts of one or more of garnet, staurolite, and cordierite are concentrated in the upper argillaceous portions of original graded strata, and in a few places also occurrences of relict cross-lamination, indicate that the tops consistently face north. The tops of the Archean metasediments also face north in the Blackwater–Beardmore area (Peach 1951, p. 2). It is reasonable to conclude, therefore, that the metasediments merely form a part of the south limb of a huge complex syncline or synclinorium, the axial plane of which extends east through the Little Long Lac–Sturgeon River region to the north of the map-area (Macdonald 1941, p. 9: Pye 1951, pp. 46–51). The deflection in the general strike of the strata near Pine Portage and Downey Lake must reflect the occurrence of either large incipient dragfolds or independent crossfolds. The general reversal in dip in the central section of the area must be due to either a lensing-out of certain formations or possibly a wedging-apart of strata consequent upon the emplacement of granite from below; and the distortion evident near masses of igneous rocks, to the forceful intrusion of granitic magma.

Minor Folds, Dragfolds

Several minor folds were noted at sporadic intervals in the metasediments between Catherine and Parget lakes in the north-central part of the map-area. These are Z-shaped dragfolds or small synclines representing parts of dragfolds.

With one doubtful exception, they plunge flatly to the southwest, in one instance at an angle of 30 degrees. The dragfolds have configurations opposite to those expected along the south limb of a major syncline. This, and the fact that they appear to be localized along an ill-defined but narrow east-trending zone, indicate that possibly they are independent features superimposed on the regional structure.

Small anticlinal folds, plunging 15°–25°NE., occur in the metasediments near the Jackfish River about 8,000 feet west of Cosgrave Lake. These folds also appear to be independent of the regional structure. They are thought to have resulted from compression attending the intrusion of the large oval-shaped mass of granitic rocks in this locality.

Foliation

The Archean metasediments and the Pre-Algoman(?) basic igneous rocks display a distinct foliation in most places, particularly in the south half of the map-area, due to the parallel or subparallel alignment of biotite or hornblende. As a general rule, this foliation is coincident, or nearly coincident, with the relict stratification of the metasediments, and is indicative of a regional deformation contemporaneous with metamorphism (Turner 1948, pp. 240, 278). On the other hand, in the case of the minor folds mentioned previously and small-scale distortions close to pegmatite dikes, the foliation cuts across the relict stratification and appears, in some cases at least, to parallel the axial planes of these structures.

FAULTING

The faults or assumed faults in the map-area strike transversely or at large angles to the regional structure. They belong to four sets: north-south, north-northeast, northeast, and northwest. All are post-granite in age, and along several, perhaps most of them, post-diabase movements occurred. The age relationships have not been established. It is not clear whether the north-south faults terminate against the north-northeast and northeast faults or are cut and offset by them; the single northwest fault, at Kilgour Lake, is not intersected. It is of interest that the north-northeast and northwest faults appear to coincide with the principal joint directions in the metasediments and the granitic rocks (*see* pp. 23–25).

North-South Faults

Partly because the field-mapping indicated some interruption in the continuity of formations and partly because of the presence of linear valleys, three north-south faults were assumed to cut the Archean rocks in the southeastern part of the map-area, between Glacier Creek and Foam Lake and at the east end of Cosgrave Lake. Detailed mapping indicated a left-hand displacement, up to about 200 feet, of the granite-metasediments contacts cut by the fault at the east end of Cosgrave Lake. The directions and magnitudes of the displacements along the assumed faults near Foam Lake, however, were not determined.

A north-south fault may extend through the basins of Pennon and Downey lakes, along a prominent linear valley that can be followed from near the boundary of the map-area to Postagoni Lake and thence southwards to Gorge Creek.

Such a fault would serve to explain the abrupt termination on the southwest of the North Zone lithium deposit of Nama Creek Mines Limited, and the equally abrupt termination on the northeast of the South Zone deposit. The two deposits are quite similar in attitude, composition, and internal structure; they could well be the faulted segments of a single pegmatite. If this is so, a left-hand displacement of about 1,000 feet is indicated. The fault is either post-diabase in age or is a pre-diabase structure that served to localize some post-diabase movement—one diamond-drillhole, bored by Nama Creek Mines Limited through a portion of the fault zone, intersected a fractured and brecciated diabase dike; and the linear valley, marking the location of the fault, in places separates mesas formed by the "capping" diabase sheet (*see* map No. 2056, in back pocket).

North-Northeast Faults

A prominent fault of north-northeast strike is present along the Glacier Creek valley, in the southeast corner of the map-area, and extends through the basin of Sovereign Lake. This fault is indicated by the abrupt termination of a wide band of metasediments striking northeast from O'Keefe Lake, and the presence, where this band is cut by the fault, of a 100-foot-wide breccia zone mineralized with pyrite and a little chalcopyrite (*see* p. 102). The displacement, judging from the distribution of granitic rocks cutting the metasediments about Sovereign Lake, appears to be left-hand. The diabase sheet at the south end of the lake also appears to have been offset, and the dispositions and elevations of outcrops indicate that the left-hand horizontal displacement was possibly accompanied by a vertical one, in which the block of ground west of the fault was slightly uplifted relative to that east of the fault. A second north-northeast fault, roughly parallel to the first, is indicated by a topographic lineament about 4,500 feet east of Sovereign Lake. The relative displacement again appears to have been west side upward and to the south.

According to Wilson (1910, p. 118), the gorge of the Nipigon River was localized by a fault zone of north-northeast strike. He states:

> On the Nipigon river above Lake Jessie the cliffs on the east side stand about 200 feet higher than those on the west. At Island portage, and in that vicinity, there is also exposed from beneath the diabase which forms the cliffs through most of the gorge, a ridge of Archaean rocks. The cliff on the east side here is gneiss; on the west side gneiss occurs on the island and also on the main shore at the base of a granite ridge. This granite ridge is also capped by diabase, but it stands at a much lower elevation than the gneiss on the east. Hence it appears that the gorge of the Nipigon river lies along the locus of a fault zone, and that movement on that zone has brought about the marked difference in elevation between the east and west sides of the gorge.

Northeast Faults

Three northeast-striking faults are believed to extend diagonally across the map-area. These are post-granite in age, and offsets indicate in each case left-hand displacements. One of these faults extends from Hanson Lake to Triangle Lake; the second, from near Claus Lake, through the basin of Lake Jean, to near Snare Creek; and the third, from Keemle Lake, past the west end of Lake Jean, to Snare Lake. The greatest displacement appears to have occurred along the second of these faults—as indicated by the granitic rocks north of Triangle Lake, it was 2,000–3,000 feet. The topographic lineaments reflecting the occurrence of the faults in certain cases extend through areas underlain by diabase, and it is possible that some post-diabase movement occurred. Such movements, however, must have been of small magnitude. As with the north-south faults, the diabase-capped mesas forming the valley walls all have about the same elevation, indicating little or no vertical displacement; and if, as suggested previously, the porphyritic diabase dike exposed at Claus Lake is the southward extension of that west of Parland and Parole lakes, any post-diabase horizontal displacements also must have been negligible.

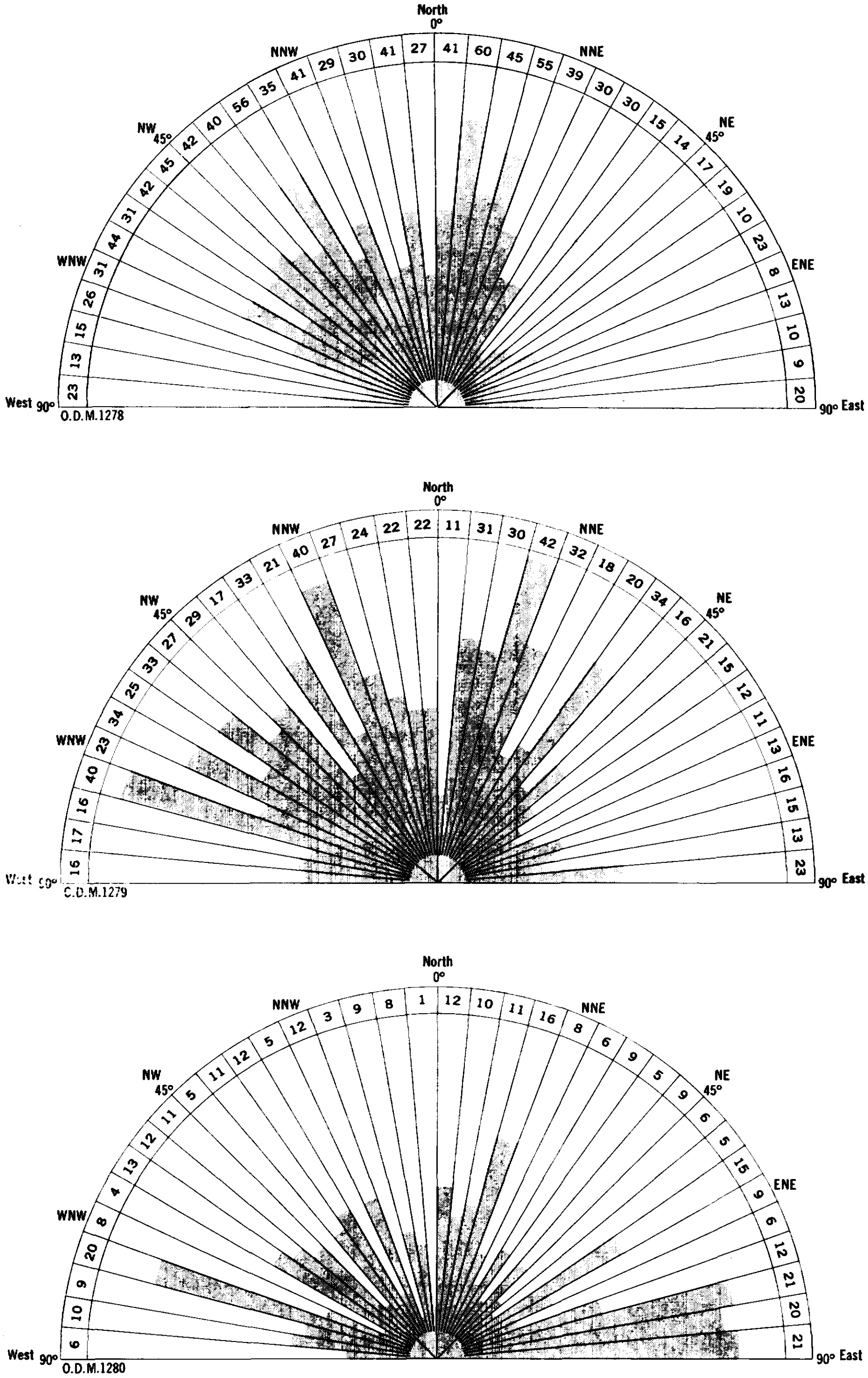
Northwest Faults

Only one northwest-striking fault was recognized. This fault strikes N.30°W. under a prominent linear valley extending from O'Keefe Lake to the north arm of Cosgrave Lake. The principal granite-metasediments contacts were displaced 200–500 feet northward on the east side of this fault. Other contacts, however, have been displaced in the opposite direction. This, and the fact that some rock units have different exposed widths on opposite sides of the fault, indicate that there probably was considerable vertical movement as well as horizontal. Assuming a widening of igneous rock masses with depth, this vertical movement must have been upward on the east side.

JOINTING

During the field-mapping, the attitudes of the prominent joints in most outcrops were determined. The joints were selected impartially, and because of the large number (2,257) of measurements, a representative sampling is thought to have been accomplished. With few exceptions, the joints dip steeply, at angles of 65°–90°, in most cases 75°–85°. Their strikes are indicated by Figures 2, 3, 4. These diagrams show that the joint patterns of the metasediments and the granitic rocks are approximately the same. They differ from that of the diabase, however, and it is reasonable to assume that many of the joints in the metasediments and granitic rocks are postgranite but prediabase in age. The diagrams also show that the joints may have any attitude, but that the principal ones strike: north-northeast, north-northwest, and west-northwest in the granitic rocks; north-northeast and northwest in the metasediments; and north-northeast, east-northeast, and west-northwest in the diabase. North-northeast joints apparently occur in all rocks. Also of interest is that the north-northeast and the northwest joints coincide in strike with two of the principal fault directions.

Most of the joints in the metasediments are occupied by stringers and veinlets of quartz or granitic material. These are generally less than 1 inch, often less than ¼ inch, in thickness. They are more resistant to erosion than the metasediments. They stand up as thin ribs on outcrop surfaces, and where several joints of different attitudes intersect, they commonly form characteristic mesh-like patterns (Photo 4). In places, because of localization along both the joints and the rock foliation, the stringers and veinlets form complex fold-like patterns, with crude S-shaped or Z-shaped configurations. Because of variations in the dip of the joints and the foliation, they plunge, either to the east or to the west, at widely different angles.



Figures 2, 3, 4—Diagrams showing strikes of joints in: Top—Metasediments; Centre—Granitic rocks; Bottom—Diabase.

Photo 4

Metasediments showing mesh-like erosion surface; on property of Nama Creek Mines Limited.

ECONOMIC GEOLOGY

INTRODUCTION

The Georgia Lake area is known principally for its numerous deposits of lithium-bearing pegmatite. Some of these pegmatites are large and have grades comparable with those now being mined in other regions. In several the only lithium mineral, spodumene, has been highly altered. In many, however, this alteration is of little or no significance; and generally the principal deposits are not of present economic importance owing rather to lack of markets than to any deleterious properties of the pegmatites themselves.

To make a reliable estimate of the reserves of commercially-significant lithium-bearing pegmatite is impossible at this time because of inadequate data. However, some deposits have been tested rather thoroughly by diamond-drilling, and tentative estimates of the reserves in each, by company officials, have been published. These estimates are reproduced in the accompanying table. They indicate 11,677,807 tons of material having an average grade of 1.14 percent Li_2O. This figure, 11,677,807 tons, may be considered a minimum. It does not include a certain amount of possibly recoverable "ore" present in: (1) the lithium deposits of Lun-Echo Gold Mines Limited, near Pine Portage; (2) the McVittie deposit east of Postagoni Lake; and (3) the occurrences tested by New Highridge Mining Company Limited (now Combined Metal Mines Limited), and other companies, in the vicinity of Downey Lake.

ESTIMATED RESERVES OF LITHIUM PEGMATITE, GEORGIA LAKE AREA

Company or Owner	Deposit	Estimated Reserves	Average Lithia Content
		tons	percent
Aumacho River Mines Ltd..........	No. 1 (Brink)	(1)759,475	(1)1.65
	No. 2	———	———
	No. 3	(1)96,000	(1)1.50
E. S. Conway....................	Conway	(2)1,830,000	(2)0.96
Jean Lake Lithium Mines Ltd.......	No. 4 (Parole)	(3)1,689,000	(3)1.30
Open for staking.................	McVittie	(4)261,000	(4)1.03
Nama Creek Mines Ltd............	North Zone	(5)2,784,000	(5)1.11
	South Zone	(5)1,508,332	(5)0.96
Ontario Lithium Co. Ltd...........	Jackpot	(6)2,000,000	(6)1.09
Vegan Lithium Mines Ltd..........	No. 2 (Newkirk)	(7)750,000	(7)1.38
Total........................	———	11,677,807	———
Average Grade....................	———	———	1.14

(1)*The Northern Miner*, 13 June 1957, p. 29.
(2)G. A. McKay, Manager, Leitch Gold Mines Ltd.; personal communication.
(3)From Finlay (1956).
(4)Tonnage and grade calculated by author. Source of information: Woolverton (1956).
(5)From Isaacs (1955).
(6)*The Northern Miner*, 22 March 1956, p. 32.
(7)*The Northern Miner*, 26 April 1956, p. 10.

The mineral beryl has been noted in pegmatite deposits west of Cosgrave Lake in the southeastern part of the area; in one of these it is associated with spodumene. Nowhere has it been found in bodies of sufficient size or grade to be mineable. There are, however, no reasons to conclude that deposits of economic importance are absent.

Associated with spodumene and beryl in one deposit (the M.N.W.)[1] west of Cosgrave Lake is a little cassiterite. Small amounts of columbite also have been found in this pegmatite, and some columbite was noted: in one of the lithium deposits near Pine Portage; in the Brink pegmatite at the north end of Blay Lake; and in the No. 1 deposit of Jean Lake Lithium Mines Limited near Parole Lake.

A copper deposit has been discovered in the extreme southeastern part of the area, in brecciated rocks along the Glacier Creek fault. Although this deposit has not been shown to be of economic importance, it serves to indicate the possibility of occurrence of other, perhaps more valuable, base-metal deposits.

Sand and gravel occurrences are widespread and have been used in road and highway construction.

[1]Named from the initials of three men, Moschuk, Neborac, and Wilson, who staked it in May 1955.

LITHIUM AND BERYL DEPOSITS

General Features of the Lithium and Beryl Pegmatites

The lithium and beryl pegmatite deposits of the Georgia Lake area vary considerably in size, form, and attitude.

In size the pegmatite deposits range from thin veins, 6 inches or less in thickness, to bodies 50 feet or more across. They may extend along strike or down dip only for a few feet, or they may continue for distances of ½ mile or more. The largest deposit is the Newkirk (or Vegan-Newkirk), which is exposed about a mile west of Georgia Lake. This pegmatite has been traced in diamond-drillholes for a length of 2,900 feet, and has been found to range up to 25 feet in thickness.

Just as the pegmatites vary in size, they also vary in form. With few exceptions, they exhibit a tendency to pinch and swell. Apart from this, they may be tabular, and, like the Newkirk deposit, persist with widths that vary within fairly narrow limits for considerable distances. Some are lenticular, either short or highly attenuated, thickest at or near their centres and thinning gently, albeit irregularly, outward; a few, or at least their erosional remnants, form cigar-like bodies and irregular-shaped patches at the surface. The pegmatites also differ in the manner in which they terminate. Some, like the Brink deposit at the north end of Blay Lake, wedge-out abruptly; others, like the Parole Lake (No. 4) deposit of Jean Lake Lithium Mines Limited, taper gradually; and yet others, such as the Foster pegmatite near the northeast end of Lake Jean, separate lengthwise into outward-extending, thin, parallel or near-parallel tongues. Branching structures, best studied in the well-exposed North Zone deposit of Nama Creek Mines Limited, also occur. Four have been recognized: (1) a projecting tongue that persists with uniform attitude for an appreciable length, such that it and the parent pegmatite simply bifurcate; (2) a branch that curves and occupies a position a few feet from and parallel to the parent pegmatite; (3) a branch that curves sharply and reunites with the main deposit along strike and down dip, such as to bound a lenticular horse of country rock; and (4) a branch that simply links the pegmatite with a similar, parallel deposit.

In regard to attitude, the pegmatites may conveniently be divided into those having steep dips and those having relatively gentle dips. The steeply dipping pegmatites, with dip angles of 45 degrees (usually 60 degrees) or more, are the more numerous. Many of them parallel or nearly parallel the host rocks in strike or dip, or both, and tend to be sill-like in character. Others strike obliquely or transversely to the host rocks, particularly where the latter are granitic, and are dikes that have been localized along joints or faults. Still others, for example, the No. 1 deposit of Jean Lake Lithium Mines Limited west of Parole Lake, and the West and Harricana deposits northeast of Downey Lake, swing about to some extent. In one or two places these may parallel the host rocks. In general, however, they appear to be localized along intersecting fractures, which cut the host rocks at various angles. Gently dipping pegmatites are common near Georgia Lake. The Brink deposit of Aumacho River Mines Limited at the north end of Blay Lake averages about 15 feet in thickness, and throughout most of the length tested, it strikes N. 45°E. and dips 35°NW. Similarly, the Jackpot No. 2 deposit of Ontario Lithium Company Limited, southwest of Georgia Lake, strikes northeast for several hundred feet and dips 15°–20°NW.; and the Island deposit in Georgia Lake, as indicated by three diamond-drillhole intersections, may strike north-south and dip 35°E. In addition to these pegmatites, and also several minor occurrences between Abner and Marrow lakes, there are flat pegmatites that do not appear to persist for any appreciable distances, either laterally or vertically, beyond their limited exposures. Typical examples are the Jackpot No. 1, Niemi, Salo, and possibly the Carrot Lake deposits. They are thought to be small remnants of originally much more extensive pegmatites now largely removed by erosion. They are of little economic significance.

Mineralogy of the Pegmatites

The lithium-bearing pegmatites are of variable composition. The principal constituents, present in all deposits but in different proportions, in order of decreasing abundance are: feldspars, quartz, spodumene, and muscovite. Both potash feldspar and less plentiful plagioclase occur. In addition, a pegmatite may also contain one or more of apatite, beryl, bityite, cassiterite, cleavelandite, columbite, garnet, hühnerkobelite, molybdenite, purpurite, sericite, talc, and tourmaline. Lepidolite, in small foliated masses, was recognized in drill cores from holes bored to test the Vegan deposit and also in one surface exposure; and a little amblygonite is reported to have been found in the M.N.W. and Brink pegmatites. In general, however, lithium-bearing minerals other than spodumene are absent.

Albite

Albite is ubiquitous and is intimately associated with quartz and some muscovite. It commonly occurs as well-formed crystals, and in some deposits, for example the M.N.W. pegmatite west of Cosgrave Lake where platy individuals tend to form radiating aggregates, it is present as the variety cleavelandite. It frequently occurs as inclusions in the outer portions of large anhedral grains of potash feldspar; it has been found as relatively small crystals along the boundaries between quartz grains. In one sample, from the M.N.W. deposit, it was found to be associated with quartz and sericite along fractures cutting spodumene crystals.

An attempt was made to determine if there was any variation in the composition of the plagioclase in individual deposits. Measurements of extinction angles of the feldspars, in thin sections of samples taken at 24-inch intervals across the Jean Lake No. 1 pegmatite, indicated the composition ($Ab_{97}An_3$) to be constant throughout. A suite of seven samples, also taken at 24-inch intervals, was collected from the McVittie deposit east of Postagoni Lake. These were submitted to the Laboratory Branch of the Ontario Department of Mines, and the indices of refraction of the feldspars were determined by the fusion method outlined by W. R. Foster (1955, pp. 179, 180). The indices, ranging from 1.484 to 1.488, indicated the plagioclase to be albite and, as before, to be of fairly uniform composition.

In the Spruce Pine area of North Carolina, and in the Ross Lake area of the Northwest Territories, C. S. Maurice (1940, pp. 173–79) and R. W. Hutchinson (1955, p. 21), respectively, noted systematic regional variations in the compositions of the pegmatite plagioclase. This is not so in the Georgia Lake area. Samples from most of the lithium deposits were thin-sectioned, and the maximum extinction angles of the albite-twinned crystals were determined. The extinction angles indicated the compositions to range only from $Ab_{95}An_3$ to $Ab_{99}An_1$, a range of little or no significance.

Amblygonite

A little amblygonite was found in the core from a diamond-drillhole (No. 10) bored by Consolidated Mining and Smelting Company of Canada Limited to test the M.N.W. deposit.[1] According to the core logs, the amblygonite is associated with quartz, cleavelandite, and a little muscovite, near the east margin of the deposit. Amblygonite from the Brink deposit of Aumacho River Mines Limited was identified at the University of Toronto by V. G. Milne.[2]

Apatite

Apatite was noted in most lithium pegmatites. It occurs sporadically and is found generally as tiny, bluish, anhedral grains. These grains occur either singly or in aggregates and seldom exceed ¼ inch across. They are moulded upon crystals of plagioclase and spodumene; and in one sample, from the Jean Lake No. 1 deposit west of Parole Lake, a small veinlet of apatite was found to cut across a spodumene-quartz-feldspar aggregate. Similar relationships apparently were noted in lithium pegmatites found elsewhere, by McLaughlin (1940, p. 64), Shaub (1940, p. 683), and Switzer (1938, p. 820); they concur with the conclusion, reached by Moorhouse (1956) for igneous rocks generally, that apatite is typically a late-formed accessory mineral.

Purple-coloured apatite was found in the M.N.W. pegmatite, where it is intimately associated or intergrown with cleavelandite and, in places, beryl. Some well-formed crystals of apatite in this deposit have been altered to purpurite and to a mineral identified tentatively as hühnerkobelite.[3]

Beryl

Beryl has been found in the Island deposit in Georgia Lake (Gilmour 1955) and in the Conway, M.N.W., and Swanson deposits. In the M.N.W. and Swanson pegmatites it occurs as pale-coloured to white crystals intimately associated with cleavelandite, quartz, and muscovite. The crystals are subhedral to euhedral, and in places hexagonal crystal outlines can be recognized. Most of them are less than 4 inches across. However, one exceptionally large crystal, with dimensions of 14 inches by 16 inches (Mulligan 1960, p. 24), is exposed in a trench near the south end of the M.N.W. pegmatite. Some of the beryl, particularly in the Swanson pegmatites, has been altered, along and close to tiny irregular fractures, by small amounts of muscovite, apatite, and hühnerkobelite.

Bityite

A little bityite,[4] as very fine-textured anhedral grains, was found, during the course of microscopic work by V. G. Milne, to be associated with aplite in the Brink deposit of Aumacho River Mines Limited, and also with potash feldspar in the M.N.W. pegmatite.[5]

Cassiterite

A very small amount of cassiterite, intergrown with cleavelandite, was found by V. G. Milne in the M.N.W. deposit and positively identified by him at the University of Toronto.[6]

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[1]Assessment work files, office of the resident geologist, Port Arthur.
[2]Postgraduate student, University of Toronto; personal communication.
[3]V. G. Milne; personal communication.
[4]Bityite: hydrous silicate of calcium and aluminium, with small amounts of the alkalies.
[5]V. G. Milne; personal communication.
[6]Personal communication.

Columbite

Columbite is a rare constituent of the lithium pegmatites. Small amounts associated with albite were identified: in the Brink deposit at the north end of Blay Lake; in the No. 1 deposit of Lun-Echo Gold Mines Limited at Pine Portage; in the M.N.W. pegmatite west of Cosgrave Lake; and in the deposits of Jean Lake Lithium Mines Limited near Parole Lake. In the second locality the mineral was found sporadically as black crystals up to 1½ inches in length. Samples of the crystals were collected and subsequently were identified by x-ray powder photography at the University of Toronto by V. G. Milne.[1]

Garnet

A few crystals of red garnets, nowhere exceeding 3/16 inch in diameter, are associated with quartz, plagioclase, and muscovite in the Giles, Kenogamisis, Island, Nama Creek, and Vegan pegmatites. The garnet crystals are typically euhedral, but in places are highly altered to micaceous material, chiefly sericite and chlorite. Pinhead-size garnets also occur as minor constituents of the aplites in the lithium deposits in the north-central part of the map-area.

Hühnerkobelite

A small amount of the mineral hühnerkobelite,[2] identified by spectrographic analysis and x-ray powder photography by the Laboratory Branch of the Ontario Department of Mines, was found in the Swanson beryl pegmatites west of Cosgrave Lake. The mineral is very fine-grained and dark green, and occurs as small, irregular-shaped, allotriomorphic aggregates either intimately intergrown with feldspar and quartz or associated with beryl. A mineral tentatively identified as hühnerkobelite by V. G. Milne[3] occurs in the M.N.W. deposit, where it appears to replace pre-existing apatite.

Lepidolite

A small amount of lepidolite in foliated masses is said to be present at the south end of the exposed portion of the Vegan pegmatite northwest of Georgia Lake,[4] and lepidolite, associated with quartz, feldspar, and other micas, was reported in the log of a diamond-drillhole bored by Dunvegan Mines Limited to test this deposit.

Flame Photometric Analyses of Muscovites From Lithium Pegmatites, Georgia Lake Area
(Analyses by Laboratory Branch, Ontario Department of Mines)

Lithium Deposit	K_2O	Na_2O
	percent	percent
No. 1: Jean Lake Lithium Mines Limited	9.52	0.57
M.N.W.	10.48	0.62
Brink; Aumacho River Mines Limited	9.97	0.65
Salo; Ontario Lithium Company Limited	9.73	0.70
North Zone; Nama Creek Mines Limited	10.12	0.65

[1]Personal communication.
[2]Hühnerkobelite: a phosphate of sodium, calcium, iron, and manganese, essentially (Na, Ca) (Fe, Mn)$_2$(PO$_4$)$_2$
[3]Personal communication.
[4]W. J. Salisbury, geologist, Vegan Lithium Mines Ltd.; personal communication.

Molybdenite

A little molybdenite was found associated with transverse quartz veins cutting the lithium pegmatites in the northeastern part of the area. It is a rare constituent.

Muscovite

A ubiquitous constituent of the lithium pegmatites, less abundant than albite, is a colourless to pale yellowish green mica. It seldom occurs as plates exceeding 1 inch in diameter, and in most places it is found as flakes ¼ inch or less across. Flame photometric analyses of typical samples were carried out by the Laboratory Branch of the Ontario Department of Mines to determine the contents of potash and soda; these indicated the latter to be low and the mica to be a muscovite (*see* table). The muscovite occurs in several ways:

1. In most of the deposits examined, it is disseminated, generally more or less regularly, throughout. It occurs along and transects the boundaries between individuals of quartz or plagioclase or both; and it is found as flakes within large crystals of spodumene and potash feldspar.

2. In most pegmatites it is a prominent constituent of thin "chill" or border zones, where it sometimes occurs as crystals oriented roughly normal to the pegmatite contacts, in a few places widening inward.

3. In a number of pegmatites, for example, the Giles, Kenogamisis, McVittie, Nama Creek, Newkirk, and Vegan deposits, some of the muscovite occurs as elongated, granular-textured aggregates that, in part at least, appear to have replaced, and to be pseudomorphic after, prismatic spodumene crystals.

4. In the Brink deposit at the north end of Blay Lake, particularly near the centre of the pegmatite, there are scattered pods and small rounded masses, made up largely of muscovite, which appear to have replaced large crystals of spodumene and feldspar.

5. In the lithium deposits near Lake Jean and Pawky Lake, muscovite is associated with quartz in, and replaces pegmatite minerals outward from, narrow transverse quartz veins. In a few places it has been found also to replace metasediments, both in inclusions and along and immediately adjacent to pegmatite margins. Wallrock replacement appears to have been particularly intense where the pegmatites are cut by the transverse muscovite-quartz veins.

Myrmekite

Myrmekite is an intergrowth of vermicular quartz in plagioclase (Howell 1957, p. 195). A little myrmekite was noted in thin sections of the groundmass of the Giles pegmatite on Treasure Island in Lake Jean, and was found in border zones from ¼ to ½ inch wide, along the margins of the North Zone deposit of Nama Creek Mines Limited.

Potash Feldspar (Perthite)

A very prominent mineral of the lithium pegmatites is potash feldspar. This is white, except near the south end of the Harricana and West pegmatites and at the north end of the McVittie deposit, where it is pale pink. Because of this, when the lithium deposits were first located and before any petrographic work had been attempted, the potash feldspar was mistaken for plagioclase, and the deposits were considered to be albite pegmatites (Pye 1956, p. 74).

The potash feldspar occurs in two principal forms: (1) as large phenocrysts in a coarse-textured pegmatite groundmass; and (2) as tiny individuals forming a part of the groundmass itself. The phenocrysts may be more or less equant or, where there is a tendency to preferred orientation, strikingly elongated, either crudely rectangular or lens-shaped. At first glance they appear to be well-formed; but when they are examined carefully it becomes apparent that, around their edges, they are intergrown with other pegmatite minerals, and their boundaries are irregular. Microscopic examination indicates that, except near the centres of some large crystals, the potash feldspars are characteristically poikilitic and contain inclusions of euhedral albite and, in some samples, of quartz also. Similarly, in the Brink, Salo, and Vegan deposits, large crystals of poikilitic feldspar contain numerous rounded grains of quartz, up to ½ inch in diameter, in appearance much like raisins in a pudding. The potash feldspar of the pegmatite groundmass is present only as anhedral grains, which occupy spaces interstitial to, and in general moulded upon, individuals of plagioclase and quartz.

Thin sections were made of the potash feldspars from a number of pegmatites across the area, and these were studied in detail for the author by V. G. Milne. According to Milne,[1] the potash feldspars everywhere have cross-hatch twinning and extinction angles that indicate them to have the composition of microcline. They are all more or less perthitic, with intergrown plagioclase existing as: (1) fine needles and films or strings parallel to the (100) direction and oriented at an angle of 74 degrees to the (001) cleavage; (2) less abundant, irregular-shaped patches having no apparent preferred orientation; and (3) in one beryllium-bearing pegmatite west of Cosgrave Lake, ragged and branching bands forming a typical braid perthite. The plagioclase in these intergrowths is optically continuous, and the individual films, patches, or braids have uniform extinction. The plagioclase exhibits polysynthetic twinning, and the extinction angles indicate the feldspar to be sodic albite.[2] Rosiwal grid analyses of the perthitic intergrowths showed the plagioclase content to range from 6.7 to 24.5 percent. Although the greatest amount of plagioclase was found in the potash feldspars from beryl pegmatites on the Swanson property west of Cosgrave Lake, no systematic regional variation was noted.

Purpurite

Purpurite[3] was reported in logs of diamond-drillholes bored to test the M.N.W. pegmatite.[4] The mineral was also identified in this deposit by V. G. Milne, who found it to occur sporadically as an alteration product of apatite.[5] It is a minor constituent.

Sericite

A little sericite replaces the feldspars of the lithium pegmatites. It also occurs as the principal alteration product of spodumene, which it replaces inward from the latter's crystal boundaries, and along and outward from cleavage planes and oblique and transverse fractures. This alteration greatly influences the lithia content of the spodumene in several pegmatites, and is of considerable economic importance (*see* pp. 54–60).

[1]Personal communication, V. G. Milne.
[2]The exact compositions of the albites were not determined because in each case the plagioclase is oriented in the microcline host, and the exact plane of section is not known.
[3]Purpurite: a phosphate of iron and manganese, (Fe, Mn) (PO_4).
[4]Assessment work files, office of the resident geologist, Port Arthur.
[5]V. G. Milne; personal communication.

Spodumene

Spodumene, like potash feldspar, occurs in the Georgia Lake pegmatites principally as large isolated crystals in a relatively fine-textured groundmass of other minerals, and to a lesser extent as a part of the groundmass itself. In most places it is of prismatic habit, and individual crystals have length: width ratios that range from 3:1 to a maximum of about 10:1. Locally, in some of the deposits in the vicinity of Georgia Lake (e.g. the Carrot Lake, Jackpot, and Salo pegmatites), it also occurs as irregular-shaped, poikilitic grains, with rounded blebs of quartz and included subhedral and anhedral feldspars. These grains attain large sizes, one in the Salo deposit having a length of about 5 feet. The most unusual occurrence, however, is in the M.N.W. pegmatite. Here spodumene is found as both thin, tabular or platy crystals, several inches across, and tiny acicular crystals that form unique lamellar and, in places, fibrous intergrowths with quartz.

CHEMICAL ANALYSES OF SPODUMENES

(Analyses of Nos. 1 and 2 by Laboratory Branch, Ontario Department of Mines).

	No. 1	No. 2	No. 3[1]	No. 4[1]	No. 5[1]	No. 6[1]
	percent	percent	percent	percent	percent	percent
SiO_2	60.85	62.07	61.7	60.2	60.2	60.2
Al_2O_3	27.60	28.17	28.6	28.9	29.5	26.6
Fe_2O_3	0.29	1.38	0.62	1.05	0.52	2.05
FeO	0.44	0.32	——	——	——	——
MgO	0.32	0.19	——	——	——	——
CaO	0.00	0.31	——	——	——	——
Na	——	——	0.85	1.01	1.17	1.83
Na_2O	0.24	0.15	——	——	——	——
K	——	——	0.05	0.07	0.09	0.09
K_2O	0.23	0.25	——	——	——	——
Li_2O	6.62	5.48	7.76	7.70	7.62	7.96
L.O.I.	1.20	0.68	——	——	——	——
Totals	97.79	98.48	(2)	(2)	(2)	(2)

No. 1—No. 1 deposit, Jean Lake Lithium Mines Ltd.
No. 2—North Zone, Nama Creek Mines Ltd. (average of 2 analyses).
No. 3—Kings Mountain, North Carolina. (Browning 1958, p. 4).
No. 4—Beaver Dam Creek (near Lincolnton, N.C.) (Browning, *idem*).
No. 5—Hill City, S. Dak. (Browning, *idem*).
No. 6—Quebec, Canada. (Browning, *idem*).

(1)Analysis of hand-picked crystal, crushed and separated at 2.94 sp. gr. to remove free quartz.
(2)Not reported.

Typical unaltered spodumene from the map-area varies somewhat in colour, from chalk-white in the M.N.W. pegmatite to pale grey and greenish elsewhere. Although the white and pale-grey varieties are frequently found to be harder and to have somewhat higher lithia contents than greenish-coloured specimens, this can in no way be considered axiomatic. The results of complete chemical analyses of two samples of spodumene are presented in the accompanying table. Also included in the table are analyses of spodumene samples found in other regions. It is apparent that, with regard to impurities, particularly iron oxides, the spodumenes of the Georgia Lake area compare favourably. They have relatively low lithia contents; but these are well above the 4.5 percent minimum specified by most consumers (Schreck 1961, p. 3). Furthermore, these two samples are not necessarily representative, for in the map-area there are spodumenes with lithia contents that, according to analytical work on samples by the Laboratory Branch, are higher and range up to a known maximum of 7.4 percent (in the Jackpot deposit).

The spodumene in the Georgia Lake area exhibits several interesting textural relationships:

1. As pointed out already, tabular and most prismatic crystals occur as large individuals in a relatively fine-grained groundmass, giving rise to a distinct porphyritic texture.

2. The spodumene often is intergrown along its crystal boundaries with quartz, as small rounded or irregular blebs, or with both quartz and feldspar. This is particularly noticeable at and near the extremities of prismatic crystals, so that the spodumene often occurs as well-formed individuals with straight, parallel sides but with rather irregular terminations. A similar phenomenon has been noted by Rowe (1954, p. 503), who remarked that, in Canadian pegmatites generally, elongate spodumene crystals "are euhedral with ragged ends."

3. Prismatic spodumene crystals often are found to be fractured transversely. These fractures do not extend into the enclosing groundmass minerals. On the contrary, they are often healed by groundmass quartz to form thin, cross-cutting veinlets.

4. In rare instances, when spodumene and potash feldspar are found in contact, the feldspar conforms to the crystal outlines of the spodumene; and occasionally large phenocrysts of potash feldspar are found to exhibit, near their margins, small euhedral inclusions of spodumene. Small inclusions in large-sized crystals might be relicts of early-formed minerals, largely replaced by the enveloping host. If, however, the pegmatites are of magmatic crystallization (*see* pp. 49–54), the inclusions might also be regarded as small growing crystals enveloped by a more rapidly growing host material (Jahns 1953a, p. 589). That the spodumene inclusions in the potash feldspar are euhedral certainly favours the second possibility.

Talc

A little talc, associated with quartz and albite, was noted by the Laboratory Branch in a sample from the North Zone deposit of Nama Creek Mines Limited. It is assumed to be rare and of sporadic occurrence.

Tourmaline

Black tourmaline, as small prismatic crystals, has been found in several lithium or beryl deposits: the Brink, Giles, Jackpot, M.N.W., and Swanson deposits. In these deposits it occurs as a minor accessory mineral associated with quartz, plagioclase, and muscovite. It is found in the country rocks intermittently along, and within an inch or two of, the boundaries of the Brink and M.N.W. deposits (*see* pages 62–64); in the case of the Brink deposit it also occurs as a constituent of thin (½–1 inch) quartz veins in the country rocks near the pegmatite, in the pegmatite itself, and in a few places along the pegmatite contacts.

Internal Features of the Pegmatites

Zoning

Internal zones are described by Cameron *et al.* (1949, p. 14) as "successive shells, complete or incomplete, that reflect to varying degrees the shape or structure of the pegmatite body. Where ideally developed they are concentric about an innermost zone or core," and from this core outward may be classified as intermediate, wall, and border zones, the last being thin, fine-textured selvages along the pegmatite margins. They do not include fracture fillings or recognizable replacement bodies formed at the expense of pre-existing pegmatite.

The lithium pegmatites of the Georgia Lake area are usually separated from the country rocks by thin (¼–½ inch), well-defined border zones of granitoid material made up of quartz with one or both of albite and muscovite. Apart from this, most of them exhibit no internal zoning. The essential minerals—potash and soda feldspars, quartz, spodumene, and muscovite—are found distributed from wall to wall, either irregularly or, in some cases, surprisingly uniformly. Typical examples are: the Brink deposit of Aumacho River Mines Limited; Nos. 1 and 4 deposits of Jean Lake Lithium Mines Limited; the Pine Portage deposits of Lun-Echo Gold Mines Limited; the North and South zones of Nama Creek Mines Limited; and the Georgia Lake pegmatites of Ontario Lithium Company Limited. Others are the Caral, Foster, Harricana, Lew, Line 60, and West pegmatites in the northern part of the map-area.

The M.N.W. pegmatite west of Cosgrave Lake, in contrast to those mentioned, is a remarkably fine example of a zoned pegmatite. It lies in a granite host rock, strikes northerly, and dips 75°–80°W. It has been traced on the surface, and in diamond-drillholes bored in 1956 by Consolidated Mining and Smelting Company of Canada Limited, for a length of 1,400 feet; it has been found to range in thickness up to 45 feet. Detailed mapping, and the diamond-drilling, showed the deposit to be made up of four distinct zones (Fig. 12):

1. A well-defined core, about 400 feet long and up to 30 feet in width, of spodumene and quartz.
2. An inner intermediate zone, extending below and outward from the core, of quartz with some muscovite and feldspar, and accessory tourmaline.
3. Outer intermediate zones, 2–6 feet wide, flanking the inner intermediate zone and the core, composed of cleavelandite with quartz, muscovite, beryl, and accessory tourmaline.
4. Wall zones of feldspar, quartz, muscovite, and accessory tourmaline.

In the wall zones, there is a regular decrease in granularity toward the pegmatite margins, but typical granitoid "chill" or border zones are not evident.

There are, in addition to the unzoned lithium deposits and the well-zoned M.N.W. dike, a few pegmatites that exhibit a rather ill-defined zonal structure, consequent upon variations in the distribution of spodumene and muscovite, in some respects similar to that of the Etta pegmatite described by Schwartz (1925, pp. 652, 653). In these pegmatites, a central section made up of feldspar, quartz, spodumene, and subordinate muscovite is enclosed by thin, mostly continuous, shells made up of feldspar, quartz, and abundant muscovite with little or no spodumene. The most outstanding example is the Newkirk pegmatite northwest of Georgia Lake. This pegmatite strikes N.65°–75°W. for a known length of 2,900 feet. Throughout most of this length, a central section rich in spodumene, 10–11 feet thick, is flanked on each side by 1–3 feet of muscovite-rich material;

and at its northwest extremity, over a distance of 200–300 feet, the pegmatite decreases to a total width of only about 5 feet, the central spodumene-rich section disappears, and the two muscovite-rich portions unite.[1] Other examples of lithium deposits showing a similar internal structure, with muscovite-rich portions enclosing spodumene-bearing pegmatite, are: the Camp, Giles, Kenogamisis, and Vegan No. 1 deposits. In these deposits it is of interest that much, but not all, of the muscovite forms elongate granular aggregates or streaks, having about the same size and the same orientation as nearby spodumene crystals. On account of this, and because similar muscovite aggregates and streaks found elsewhere are known to be pseudomorphic after original spodumene (*see* p. 54), and also because the boundaries between the spodumene-rich and muscovite-rich materials are generally not sharply defined, the muscovite in the outer parts of the pegmatites may be due, at least in part, to selective replacement. If this is true, of course, the muscovite-rich portions of these pegmatites would not constitute zones in the strict sense of the terminology.

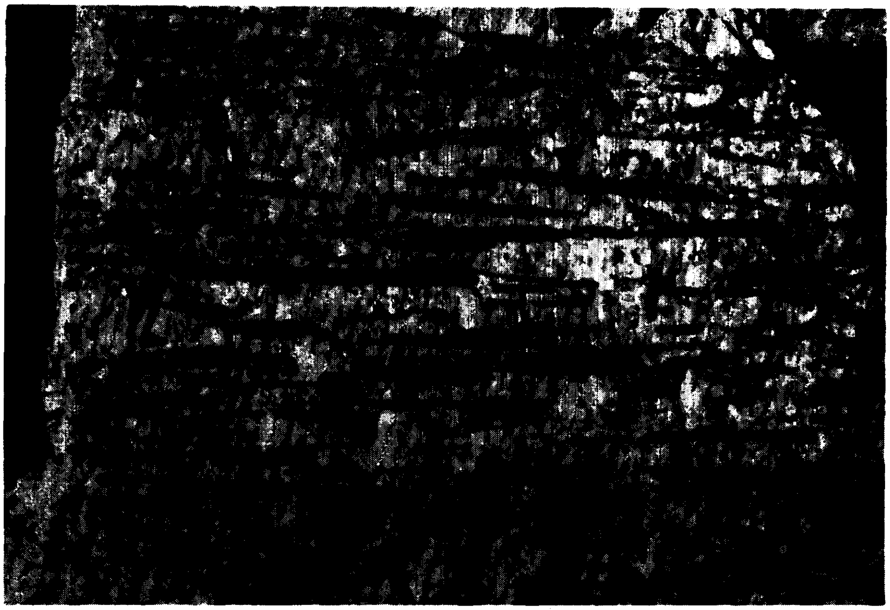
Orientation of Potash Feldspar and Spodumene Crystals

One of the outstanding features of the lithium deposits of the area is that, except in the unique M.N.W. dike (*see* p. 33), the larger individuals of potash feldspar and the prismatic crystals of spodumene tend to be oriented with their long dimensions normal, or nearly so, to the pegmatite contacts. In some pegmatites, such as the Carrot Lake and Island deposits and those at Pine Portage, this preferred orientation is scarcely evident; in others, such as the Brink, Newkirk, and Vegan deposits, it is only poorly developed, and the crystals are more or less subparallel to one another; and in still others, particularly those in the northern part of the area, it is remarkably well-developed, and the feldspar and spodumene crystals are in strong parallel alignment (*see* Photo 5). In general the potash feldspar crystals are better oriented than the spodumene crystals. Because in places the large feldspar and spodumene crystals are wedge-shaped, widening from the pegmatite contacts inwards (*see* Photo 6), it is quite possible that the orientation may reflect an original comb structure, resulting from growth initiated at or close to the walls (Jahns 1953a, p. 584).

In most pegmatites the orientation of the feldspar and spodumene crystals is constant throughout. However, in the Giles pegmatite, and in the No. 1 deposit of Jean Lake Lithium Mines Limited, the orientation is variable. Along the margins of these deposits, the crystals are, as elsewhere, roughly perpendicular to the walls. However, in several places they change direction inwards, so that about midway between the contacts they tend to be oriented somewhat obliquely (*see* Photo 7). They may also change in pitch; detailed mapping of the No. 1 deposit, for example, showed that, along one cross-section near the centre of the pegmatite, the pitch ranged from 5° to 25°N., and that, along a second cross-section near the east end of the pegmatite, the crystals pitched inward from both contacts, at angles of 5–15 degrees. The change in orientation is accentuated in places by curved or bent but unbroken crystals (*see* Photo 8). It is also of interest that in the two deposits there are narrow zones, a few inches wide and roughly parallel to the pegmatite contacts, in which spodumene crystals tend to be oriented longitudinally, at large angles to the crystals in the main mass of the pegmatite (*see* Photo 9). Such zones, of abrupt change of orientation, merge with

[1]W. J. Salisbury, geologist, Vegan Lithium Mines Limited; personal communication.

Photo 5



Oriented spodumene crystals; No. 1 deposit, Jean Lake Lithium Mines Limited.

Photo 6

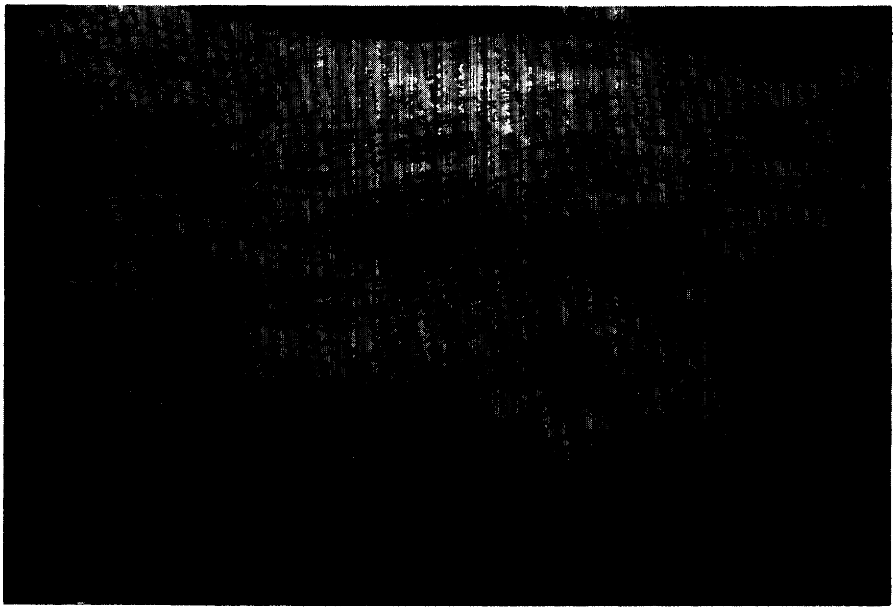
Large oriented crystals of potash feldspar; Camp pegmatite, Lake Jean.

the adjoining rock. Because there is again no evidence of fracturing or granulation, it is inferred that the deposits suffered some plastic deformation during the final stages of pegmatite formation.

Inclusions

Wallrock inclusions occur in all the known pegmatites. They are small and widely separated, however, and appear to be of little or no importance economically. Only rarely do they have ill-defined margins and grade into the enclosing pegmatite. The boundaries most often are "knife-sharp," and along them the enclosing pegmatite may in some cases exhibit thin granitoid selvages, similar

Photo 7



Oriented feldspar and spodumene crystals; No. 1 deposit, Jean Lake Lithium Mines Limited.

in every way to typical "chill" or border zones. There is little evidence that the inclusions have been transported any distance; rather, because they invariably are identical to the immediately adjacent country rocks, and because in a few places they have shapes that match exactly those of nearby pegmatite contacts (*see* Photo 10), they appear to be strictly of local derivation.

Wallrock inclusions are of either lenticular or irregular shape. Lenticular inclusions are the more common. Generally their long dimensions are oriented parallel or nearly parallel to the margins of the enclosing pegmatite. Irregular-shaped inclusions tend to be angular or subangular. They may occur singly or, more commonly, in groups; and in the latter case they may have matching shapes, indicating that they are the separated fragments of a single original body (*see* Photo 19). Rotated inclusions are not common in the known lithium deposits but have been found in the Brink and M.N.W. pegmatites and in the North and South zones of Nama Creek Mines Limited.

Photo 8

Curved feldspar crystals; No. 1 deposit, Jean Lake Lithium Mines Limited.

Photo 9

Zone of change of orientation of spodumene crystals; No. 1 deposit, Jean Lake Lithium Mines Limited.

Aplites

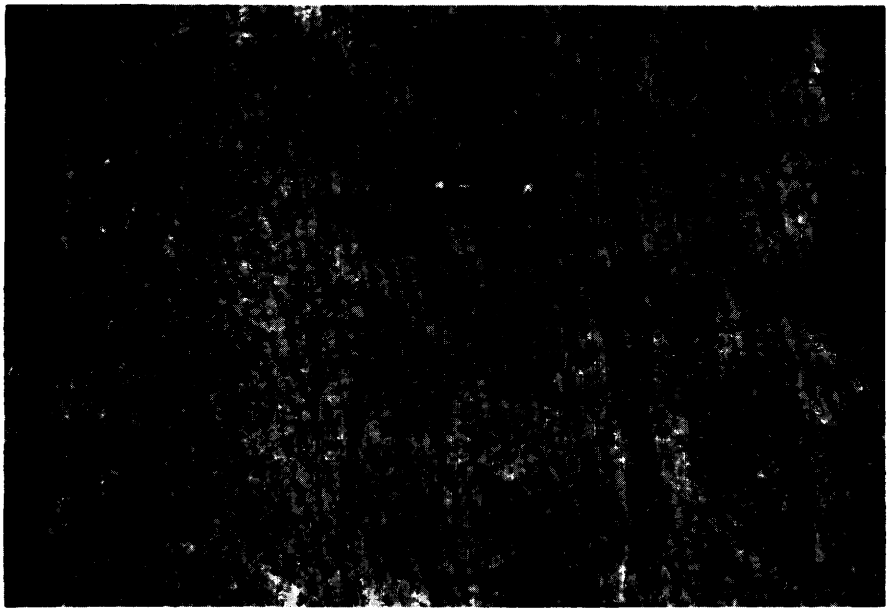
Occurring within many of the lithium pegmatites of the Georgia Lake area are thin veins of sugary-textured, pale-coloured granitic material or aplite. These veins commonly pinch and swell. They range from a fraction of an inch to several inches in thickness, and in a few rare cases, as in the Giles and McVittie pegmatites, attain thicknesses of up to 18 inches. Although the aplite veins may curve somewhat and locally split and bifurcate, typically they tend to be conformable in attitude to the enclosing pegmatites; and often, where several are

Photo 10

Inclusions of metasediments in North Zone pegmatite; Nama Creek Mines Limited.

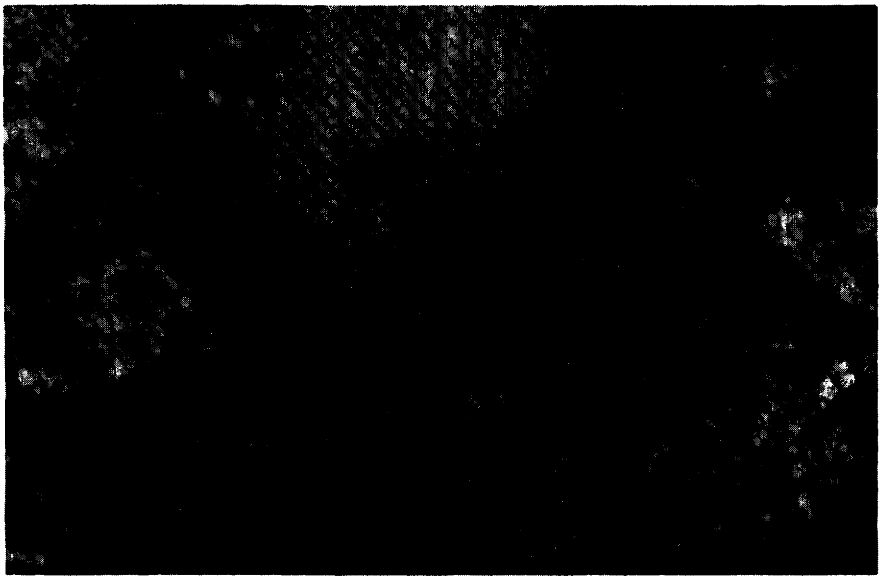
found in a single pegmatite, they occur as roughly parallel sometimes closely spaced layers, and as such impart to the pegmatite a distinct banded appearance (*see* Photo 11). The aplite veins or layers, despite their narrow widths, are found in good exposures to be remarkably persistent—in the North Zone pegmatite of Nama Creek Mines Limited, for example, aplite veins no more than 6 inches thick have been traced intermittently in surface outcrops for distances of up to 90 feet. They are similar to the enclosing pegmatites in composition. Most are made up of a granulitic aggregate of albite, quartz, and muscovite; some contain, in addition, one or both of microcline and euhedral spodumene;

Photo 11



Layered structure of Camp pegmatite, Lake Jean, due to longitudinal or vein aplites.

Photo 12



Vein aplite in main South Zone pegmatite; Nama Creek Mines Limited.

and in places very small amounts of apatite and occasionally a little garnet are found. Most aplites are thought to be of replacement origin for the following reasons:

1. The walls of a given aplite vein or layer seldom if ever match, as might be expected in the case of simple fracture filling.
2. In numerous places the contacts between an aplite and its enclosing pegmatite are irregular and gradational; and contacts, which in the hand specimen appear at first glance to be sharp, are often found when examined microscopically to be poorly defined.
3. It is common to find aplites cutting through crystals of potash feldspar and spodumene without evidence of dilation.
4. Occasionally included large-size crystals (or parts of crystals) of spodumene have the same orientation as similar crystals in the adjoining pegmatite; there is no evidence of rotation.

An interesting feature of some vein aplites, notably those in the Camp and Giles deposits, is that along their margins the adjoining pegmatite may be enriched in muscovite (*see* Photo 11). The muscovite-enriched zones are narrow, generally ¾ inch or less in width. They may or may not be sharply separated from the aplites, but their boundaries with the normal, muscovite-poor pegmatite are generally ill-defined and somewhat gradational. They are thought to be selvages formed during the development of the vein aplites, the muscovite being a replacement of pegmatite feldspars consequent upon the release of potash resulting from substitution of original microcline by aplite minerals.

In addition to, or in place of the aplite veins, some pegmatites, for example the Brink, Jackpot, Jean Lake No. 1, M.N.W., Pine Portage, and Vegan deposits, exhibit irregular-shaped patches of sugary-textured, aplite-like material. These patches generally are large, up to several feet across. They are made up principally of very fine-grained sodic albite (Ab_{97-100}) with, locally, a little apatite. In places their boundaries are somewhat rounded and fairly sharply defined, and the pegmatite immediately adjoining may be enriched in muscovite as in the case of some vein aplites. Generally, however, the boundaries are somewhat gradational, and the aplites merge with the pegmatite, particularly with the groundmass of the pegmatite. In the Brink and Jean Lake No. 1 deposits, occurrences were observed in which aplite-like patches truncated and obviously replaced crystals of potash feldspar. In the Salo pegmatite there is a large aplite-like patch about 6 feet in diameter, and close to its periphery, this patch contains crystals of spodumene, some fractured and veined by the sugary-textured feldspar. The relationships here are such as to indicate the possibility that the aplite selectively replaced the quartz, feldspars, and muscovite of the original pegmatite.

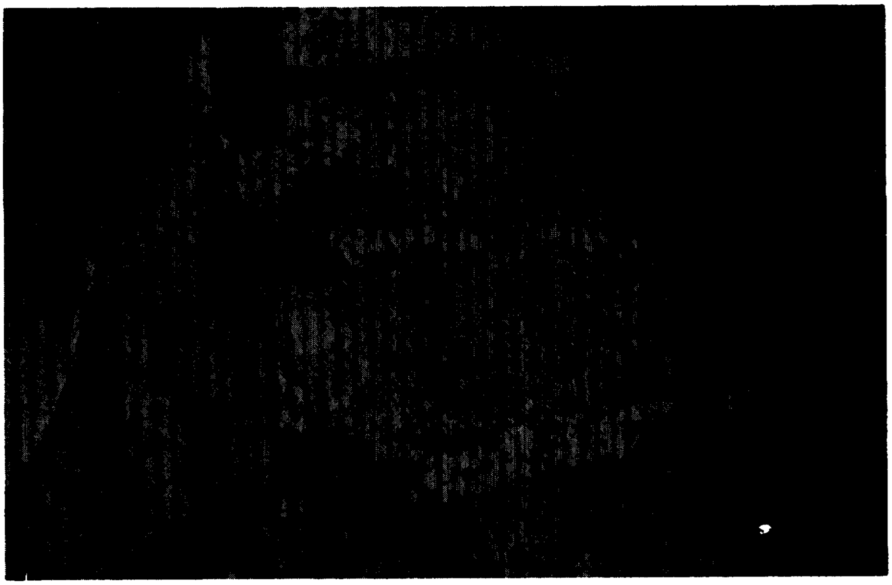
Quartz Veins

A common feature of the lithium pegmatites in the northern part of the map-area is the presence within them of narrow quartz and muscovite-quartz veins. These veins interrupt the pegmatites at wide and irregular intervals. As illustrated in Figure 15, they commonly are found along transverse or, locally, oblique, post-aplite fractures; and they may extend across the pegmatite from contact to contact, project into the pegmatite to terminate in the latter's interior, or, in rare cases, occur across the pegmatite as attenuated lenses in *en échelon* arrangement (*see* Photo 13). They seldom exceed 12 inches in thick-

Photo 13

En échelon muscovite-quartz veins; No. 1 deposit, Jean Lake Lithium Mines Limited.

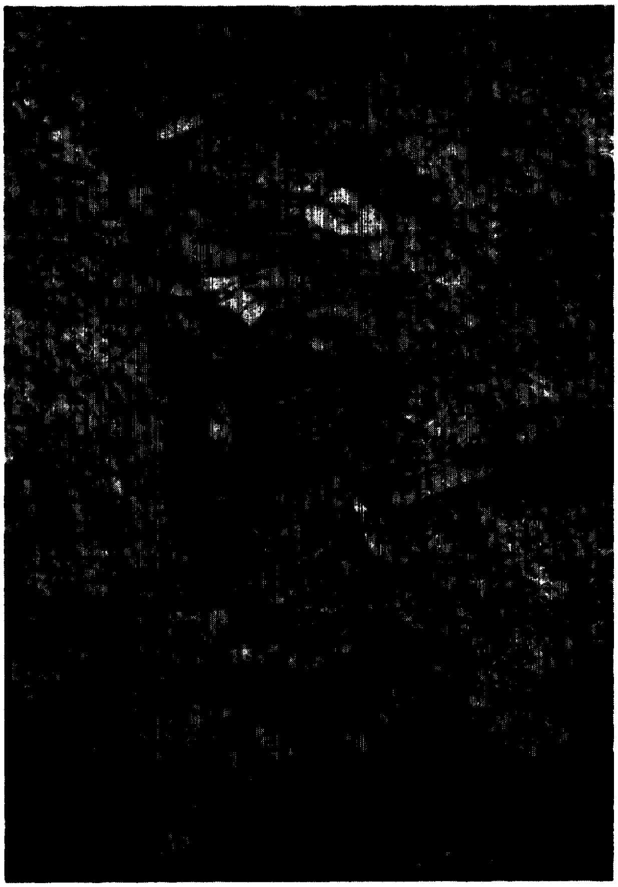
Photo 14



Transverse muscovite-quartz veins; North Zone deposit, Nama Creek Mines Limited.

ness, and most are 6 inches or less. Where present, muscovite tends to be concentrated along the contacts, and may be oriented roughly normal to them. In general the veins have straight contacts, fairly uniform widths, and matching walls, and appear to be essentially open-space fillings. Because of this, and because in several instances the wallrocks have been deformed so as to protrude into the pegmatite along the transverse fractures for an inch or two to meet the veins (*see* Photo 14), the veins no doubt occupy extension fractures. Such fractures formed possibly as a result of lateral compression of the pegmatite, and thus may reflect an incipient boudinage structure (Ramberg 1955, pp. 512–26).

Photo 15



Transverse spodumene-quartz-vein; No. 1 deposit, Jean Lake Lithium Mines Limited.

Tourmaline-bearing quartz veins, without muscovite, are found associated with the Brink deposit at the north end of Blay Lake. These veins range from about ½ inch to 1 inch in thickness. They are found occupying fractures: (1) in one or two places along the contacts between the pegmatite and its granite host rock; (2) in the granite near the pegmatite; and (3) within, and roughly conformable to and dividing, thin apophyses of the pegmatite in the granite.

Quartz-Spodumene Veins

A short distance west of its centre, the No. 1 pegmatite of Jean Lake Lithium

Mines Limited is interrupted by a transverse vein, about 2 feet wide, of quartz and spodumene with a little feldspar. This vein extends completely across the pegmatite without, as far as is known, projecting into the adjoining country rocks. It is crudely zoned, with quartz-spodumene core grading into and enclosed by quartz-spodumene-feldspar wall zones. In the core the spodumene crystals are oriented normal to the vein; in the wall zones in places they are oriented obliquely and tend to parallel the spodumene crystals of the main pegmatite. Although the transverse vein is distinct, its contacts with the pegmatite are gradational, and some spodumene crystals extend without interruption across the boundaries.

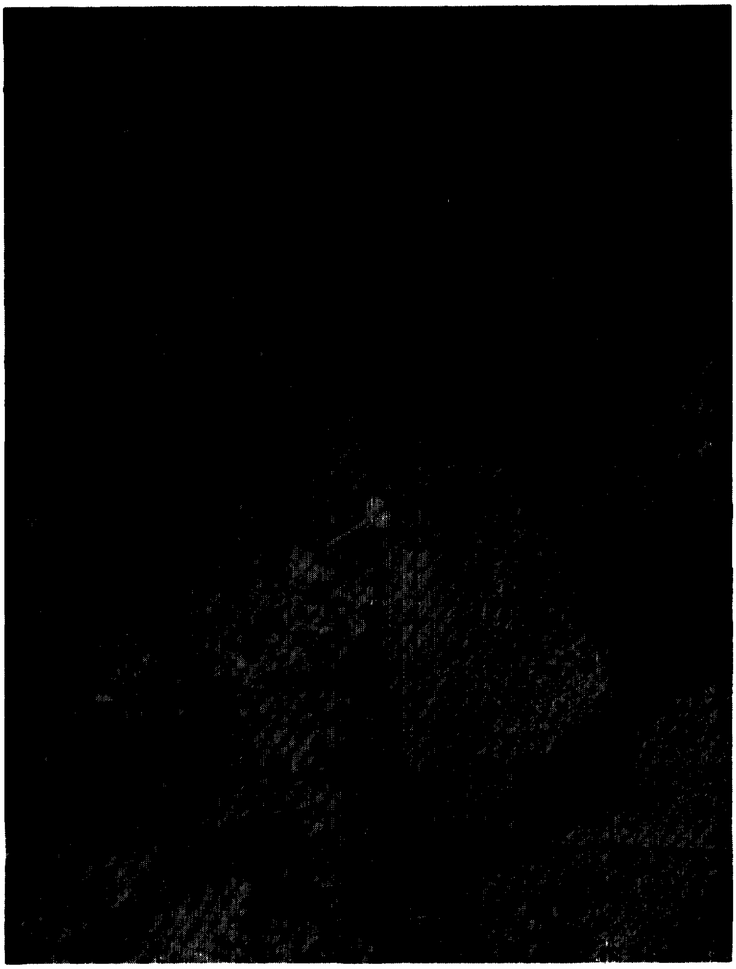
To the east the No. 1 pegmatite curves abruptly, from a strike of N.75°E. to one of N.30°E. Here are several additional quartz-spodumene veins, 3–12 inches thick. They project inward from the south contact, in some places pinching out within the pegmatite, in others extending across it to the opposite contact. As shown in the photograph (Photo 15) the vein boundaries are again somewhat gradational, and the spodumene crystals tend to be oriented roughly perpendicular to the vein walls. Like the transverse quartz and muscovite-quartz veins described previously, they appear to occupy extension fractures. Possibly the main pegmatite was deformed, and the quartz-spodumene veins heal tension cracks formed on the convex side of the bend in the pegmatite.

Wallrock Alteration

In the Georgia Lake area, the wallrocks adjacent to the rare-element pegmatites as a general rule have not been altered. It is true that in a few places along the contacts of the McVittie pegmatite, the North Zone deposit of Nama Creek Mines Limited, and the No. 1 pegmatite of Jean Lake Lithium Mines Limited, and in occasional inclusions, the country rocks have been enriched in muscovite. Tourmaline also has been developed along the margins of the Brink deposit of Aumacho River Mines Limited where, at its north extremity, the dike cuts mica schist. However, this alteration is sporadic and unimportant. Wide zones of distinct mineralogical changes, such as those associated with the famous Etta pegmatite (Schwartz and Leonard 1927, pp. 655–63), are conspicuously absent.

The north-trending M.N.W. pegmatite west of Cosgrave Lake has conspicuous, fairly continuous border zones. Each is made up of two parts: an inner part of pale-grey to pale-pink, muscovite-bearing, granitic rock rich in tourmaline; and an outer part of similar material with little or no tourmaline. In the west border zone, the tourmaline-rich layer is ½–1 inch thick and contains in places as much as 90 percent dark mineral; in the east border zone it is 3–6 inches thick and contains 25–30 percent disseminated tourmaline. The outer layers of the border zones are 1–2 inches thick. Megascopically they appear to be sharply defined from the tourmaline-rich layers, and from the granitic host rock. Close examination, however, reveals that the rock minerals interlock across the boundaries, which thus, on a microscopic scale at least, are gradational. Because the border zones are texturally similar to the host rock, and because they contrast markedly with the adjoining relatively coarse-textured pegmatite, it is quite possible that they resulted along the pegmatite contacts by reaction involving the destruction of host-rock biotite, the formation of muscovite, and the combination of original oxides with introduced materials to yield black tourmaline. It is of some interest in this regard that two spectrographic analyses of border-zone material, conducted by the Laboratory Branch, Ontario Department of Mines, indicated a lithium content of 0.0008 percent in contrast to 0.015 percent for host-rock samples taken at points from 2 inches to 10 feet outward from the west contact of the pegmatite.

Photo 16



East border zone; south end of the M.N.W. pegmatite.

Regional Zoning

In many pegmatite areas investigators have recognized a regional zoning consequent upon systematic changes in pegmatite characteristics at distances from large granitic masses (Brögger 1890: Gevers 1936: Cameron *et al.* 1949, pp. 7–8: Heinrich 1953: Rowe 1952; 1953; 1954: Hutchinson 1955). In the Georgia Lake area also the pegmatites differ. Within and close to the main mass of granitic rocks, particularly in the eastern and southeastern parts of the map-area, there are numerous mica-quartz-feldspar pegmatites without, except in one isolated occurrence, valuable rare-element minerals. Occurring within the metasediments and to a lesser extent in small granitic sills and stocks, there are a relatively small number of pegmatites containing appreciable amounts of one or both of lithium and beryl (*see* Fig. 5). In addition to this major zoning, the lithium-beryl pegmatites themselves can readily be subdivided into three distinct groups, each with its own characteristics. The first group is represented by deposits near Cosgrave Lake in the southeastern part of the map-area; the second, by the deposits near Georgia Lake and Pine Portage; and the third, by the deposits near Postagoni and Downey lakes and Lake Jean in the northeastern part of the area. The differences, although to a small extent mineralogical, are chiefly textural and structural and may be due, in part at least, to different physical conditions of formation. Significantly the Cosgrave Lake pegmatites occur close to the main granitic mass and in a locality where the Archean sedimentary rocks have been most highly metamorphosed; the Pine Portage–Georgia Lake pegmatites lie at much greater distances from the main granite mass; the Postagoni Lake–Downey Lake–Lake Jean pegmatites are found farthest from the main granitic mass (not its small outward-projecting tongues), where in general the Archean sedimentary rocks have been least metamorphosed. The different characteristics of the pegmatites of the three groups are as described in the following paragraphs.

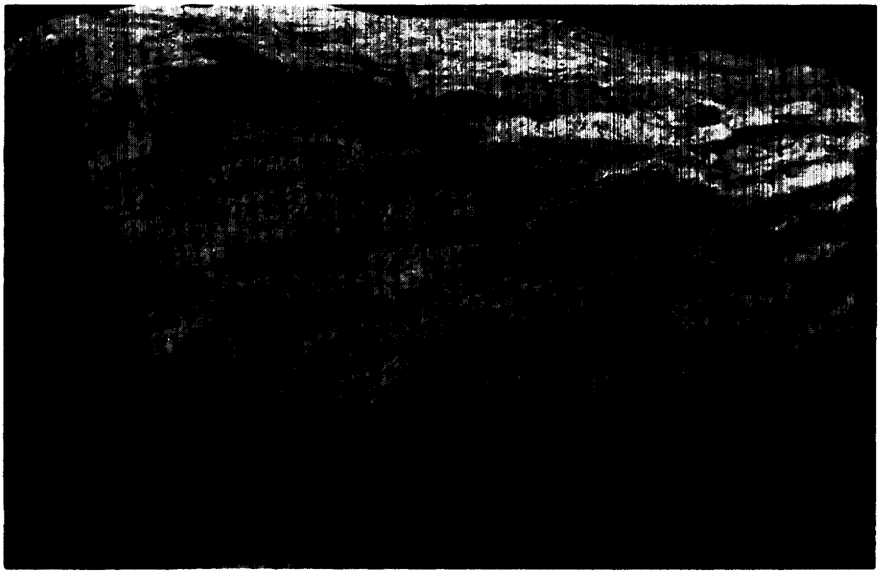
Cosgrave Lake Pegmatites

The pegmatites near Cosgrave Lake are represented by the unique M.N.W. dike and the Swanson beryl deposit (*see* p. 103). Except for large scattered crystals of feldspar and spodumene in the M.N.W. dike, these pegmatites are non-porphyritic in fabric, their constituent minerals exhibiting no apparent tendency to be oriented normal to their contacts. Both potash feldspar and albite are present, the latter occurring largely as the platy variety, cleavelandite. In the terminology of Cameron *et al.* (1949, p. 16), the feldspars, quartz, and beryl are typically medium-grained, in a few instances coarse-grained; ubiquitous muscovite generally is fine-grained. The M.N.W. and Swanson deposits contain black tourmaline as an accessory constituent, and this mineral is particularly abundant along the pegmatite margins, either in the pegmatite itself or in the immediately adjacent country rock. An unusual mineral present in these deposits is hühnerkobelite; in addition, the M.N.W. pegmatite contains a little bityite, cassiterite, columbite, and purpurite. Irregular-shaped patches of sugary-textured albite or "aplite" occur in places, but vein-like aplites are not evident. As pointed out previously the M.N.W. deposit is internally zoned, with a well-defined spodumene-quartz core. The Swanson deposits are not zoned, however, and any theory that internal zoning may be characteristic of the Cosgrave Lake pegmatites is untenable.

Georgia Lake—Pine Portage Pegmatites

Except for a small amount in the Island deposit (Gilmour 1955), beryl does not appear to be present in the Georgia Lake–Pine Portage pegmatites; tourmaline, although associated with the Brink and Jackpot deposits, is not a common accessory constituent. Columbite was noted in two deposits: the Brink deposit, and the No. 1 pegmatite of Lun-Echo Gold Mines Limited near Pine Portage. Unlike the Cosgrave Lake pegmatites, the Georgia Lake–Pine Portage deposits are characteristically porphyritic, with large crystals of potash feldspar and spodumene in a relatively fine-textured groundmass; these crystals tend to be oriented with their long dimensions roughly perpendicular to pegmatite contacts. In regard to size, the large potash feldspar and spodumene crystals are typically coarse to very coarse-grained, whereas the minerals of the groundmass are fine- to medium-grained. As in the Cosgrave Lake deposits, the pegmatites in places are interrupted by large, irregular-shaped patches of sugary-textured albite; and roughly conformable, vein-like aplites, although present in the Salo, Newkirk, and Vegan deposits, are again generally lacking. Only the Newkirk and Vegan deposits have an internal-zoned structure, with spodumene-rich pegmatite enclosed in muscovite-rich material having little or no spodumene. Thin tourmaline-quartz veins are associated with the Brink deposit, but in general, quartz veins are conspicuously absent in surface exposures.

Photo 17



Crudely banded lithium pegmatite; No. 4 deposit, Jean Lake Lithium Mines Limited.

Postagoni Lake—Downey Lake—Lake Jean Pegmatites

In the Postagoni Lake–Downey Lake–Lake Jean pegmatites, beryl is again either absent or present in very small amounts; and tourmaline and columbite are rare. In texture the deposits are again porphyritic; and the large feldspar and spodumene crystals, oriented as before roughly normal to pegmatite contacts, are in strong parallel alignment. The large potash feldspar crystals vary greatly in size, from medium-grained to very coarse-grained, often in the same pegmatite. Some individuals are several feet long, and in places, such as in the Parole Lake deposit, they may impart to the pegmatite a crudely-banded appearance at right-angles, or nearly so, to the walls (*see* Photo 17). The large spodumene crystals are less variable in size, being medium- to coarse-grained. They seldom exceed 6 inches in length. The groundmass minerals are typically either fine-grained or, according to Rowe's terminology (Rowe 1954, p. 504), very fine-grained. Patch-like "aplites" were noted only in the No. 1 deposit of Jean Lake Lithium Mines Limited.

Conformable vein-like aplites, on the other hand, are found in most of the Postagoni Lake–Downey Lake–Lake Jean pegmatites and may be considerea characteristic. Several of the lithium deposits (*e.g.* the Camp, Conway, Kenogamisis, and McVittie) are much like the Newkirk and Vegan dikes in that they are crudely zoned, with spodumene pegmatite enclosed by muscovite-rich, spodumene-poor pegmatite. Quartz veins and muscovite-quartz veins are common and are generally found healing transverse or oblique fractures (*see* pp. 42–44). A little molybdenite is associated with these veins in places.

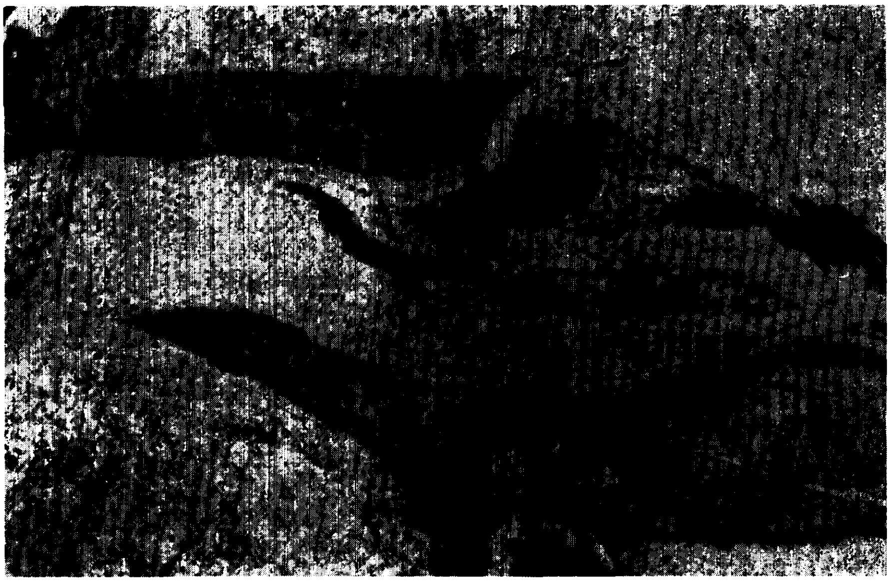
Petrogenesis of the Pegmatites

The problem of pegmatite formation is complex and is a subject of considerable controversy. There are two principal schools of thought. According to one school, the pegmatites are of magmatic derivation and resulted from fluid emplacement with or without concurrent metasomatism; the other school, championed by Ramberg (1949; 1952; 1956) and Barth (1952, pp. 222–24, 315–18), maintains that some pegmatites at least are of metamorphic origin. The pegmatites are thought to have resulted from the diffusional transfer of the elements of pegmatite minerals toward low-pressure loci (*e.g.* joints and faults) during regional metamorphism, and to have grown by volume-for-volume replacement, concretion, or secretion processes.

Chadwick (1958) recently delimited and classified the possible mechanisms of pegmatite emplacement and reviewed the criteria by which these two mechanisms can be recognized. He recognizes two principal emplacement mechanisms: displacement and non-displacement (Chadwick 1958, pp. 806, 807). In the case of displacement, the rock formerly occupying the site of a given pegmatite was moved bodily outward, either forcefully or permissively, to make room for the pegmatite; in the case of non-displacement, the rock material either became bodily mobile during pegmatite emplacement or "was dissolved and recrystallized or replaced by an increment-by-increment process." In so far as the Georgia Lake area deposits are concerned, the available evidence indicates that the host rocks were displaced as a result of a mobile type of pegmatite emplacement consistent with a magmatic derivation. This evidence is as follows:

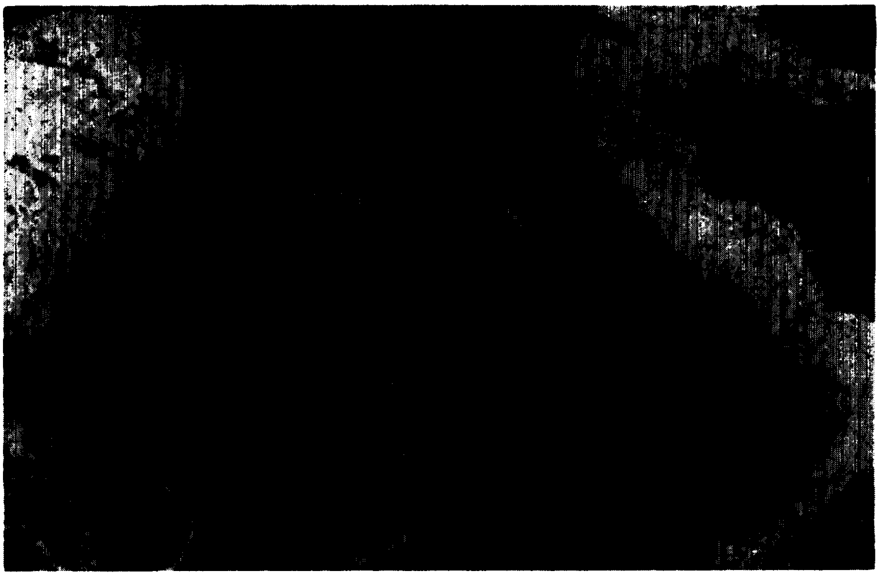
1. The lithium and beryl pegmatites, in general, have fairly straight contacts; and where the contacts of thin pegmatites are irregular, the walls commonly have crudely matching shapes.
2. In several instances obliquely transected structural units have been offset directly across the pegmatites. A quartz vein, 6–12 inches wide, which strikes N.30°W., has been displaced in this way by the north-striking Brink deposit (Fig. 9); at least two small porphyry dikes appear to have been offset by and displaced perpendicularly to the McVittie pegmatite (Fig. 13).
3. Original large host-rock inclusions in several pegmatites near Downey Lake have been broken, and the fragments, which have matching shapes, have obviously been displaced and dilated by the younger, enclosing pegmatite (*see* Photo 18).
4. The metasediments along and close to the margins of some pegmatites, and a few inclusions in these pegmatites, are highly distorted (*see* Photo 19), whereas the host rocks several feet from the pegmatites show little or no evidence of having been folded. Excellent examples

Photo 18



Dilated inclusions of metasediments; main South Zone deposit, Nama Creek Mines Limited.

Photo 19



Inclusions of folded metasediments; Vegan No. 1 deposit, Vegan Lithium Mines Limited.

were found associated with the Line 20, Vegan, and McVittie deposits; in the case of the McVittie pegmatite the foliation of the metasediments on opposite sides of the dike is bent in the same direction, indicating possible forceful injection.

5. A few rare-element pegmatites, notably the Brink deposit and the North Zone and South Zone deposits of Nama Creek Mines Limited, contain inclusions obviously rotated. These rotated inclusions are generally angular in shape, show little or no evidence of replacement by pegmatite minerals, and in places have shapes that can be matched with indentations in the main pegmatite contacts (*see* Photo 20).

Photo 20

Rotated inclusion; main South Zone deposit, Nama Creek Mines Limited.

6. The rare-element pegmatites have in most instances fairly regular, knife-sharp contacts, and all except the M.N.W. deposit are characterized by thin (¼–½ inch), well-defined border zones. These border zones are very fine-grained aggregates of quartz, muscovite, and feldspar. They are most satisfactorily explained as zones of fluid-emplaced pegmatitic material, which was rapidly chilled against the country rocks.
7. The Pine Portage–Georgia Lake and Postagoni Lake–Downey Lake–Lake Jean pegmatites have distinct porphyritic textures—potash feldspar and spodumene crystals characteristically occur as phenocrysts in relatively fine-grained groundmasses (*see* Photos 5–9). It is true, of course, that large crystals in a rock may be of metamorphic origin (Turner 1948, pp. 116–17, 138–39), but here many large spodumene crystals, instead of having replaced the minerals of the pegmatite matrix, have in fact been fractured and obviously veined by groundmass quartz.
8. The large feldspar and spodumene crystals in some deposits are oriented normal to the pegmatite contacts and in places widen inward from them

(*see* Photo 6). This feature, according to Chadwick (1958, p. 819), is best interpreted as the result of "crystallization inward into a chamber filled with pegmatitic fluid or into an open cavity . . . and . . . is considered evidence of mobility."

9. The Jean Lake No. 1 deposit west of Parole Lake is interrupted at irregular intervals by thin, transverse, quartz-spodumene veins. Because these veins do not extend into the country rocks and thus appear to occupy extension fractures, and because, like the main pegmatite, their spodumene crystals tend to be oriented perpendicularly, it is difficult to visualize their formation by any process other than fluid emplacement.
10. As with deposits near Ross Lake in the Northwest Territories (Hutchinson 1955, p. 13), apophyses intersect their parent pegmatites with sharp corners, and junctions are not enlarged. This would not likely be the case if any metasomatism had occurred.
11. At least one pegmatite, the M.N.W., has a primary internal zonal structure. Such a structure is claimed by some authors to be indicative of crystallization in a fluid-filled chamber (Cameron *et al.* 1949, p. 105: Flawn 1951, pp. 183–90: Jahns 1953b, pp. 1078–1112); it is considered by Chadwick (1958, pp. 818, 819), who disagrees with the metamorphic metasomatic thesis of Ramberg (1956, p.211), to be diagnostic evidence of mobile emplacement.

Because the rare-element pegmatites and the granitic rocks (*see* p. 13) both appear to be fluid-emplaced and of magmatic origin, it is logical to assume that they are genetically related, and that the pegmatites crystallized from late-stage differentiates generated by the progressive crystallization of the granitic magma. Certainly the regional zoning previously described supports this view. But the regional zoning also indicates that the spatial relationships of the pegmatites to the granitic rocks are not necessarily simple. It is true that the rare-element deposits in the northeastern part of the map-area differ from those near Georgia Lake and Pine Portage, and that the Georgia Lake–Pine Portage deposits differ from those near Cosgrave Lake. The changes in the mineralogy, texture, and internal structure of the rare-element pegmatites across the area, however, are abrupt rather than progressive. Nor do the changes accord in a strict directional sense with the distribution of the rare-element pegmatites relative to that of the more numerous, simple, interior and marginal pegmatites. Although all the pegmatites are without doubt consanguineous, it is questionable that they are spatially related about a single petrogenetic centre.

Examination of the map of the area shows that the rare-element pegmatites may occur in a special geological environment. It shows that, with few exceptions, these pegmatites are found either in the metasediments beyond and roughly in line with prominent, westward- and upward-projecting tongues of the main granitic mass, or within or close to isolated sills and small stocks, some of which, in turn, lie roughly off the ends of such tongues. Of special interest in this regard is the distribution of lithium in the granitic rocks. During the field-mapping, samples of the granitic rocks were collected from all parts of the map-area. These samples, totalling 143 in number, were submitted to the Laboratory Branch for quantitative spectrographic determination of their contents of lithium, rubidium, and cesium. Cesium was not detected; the rubidium content was found to be more or less constant, ranging from 0.02 to 0.07 percent and averaging

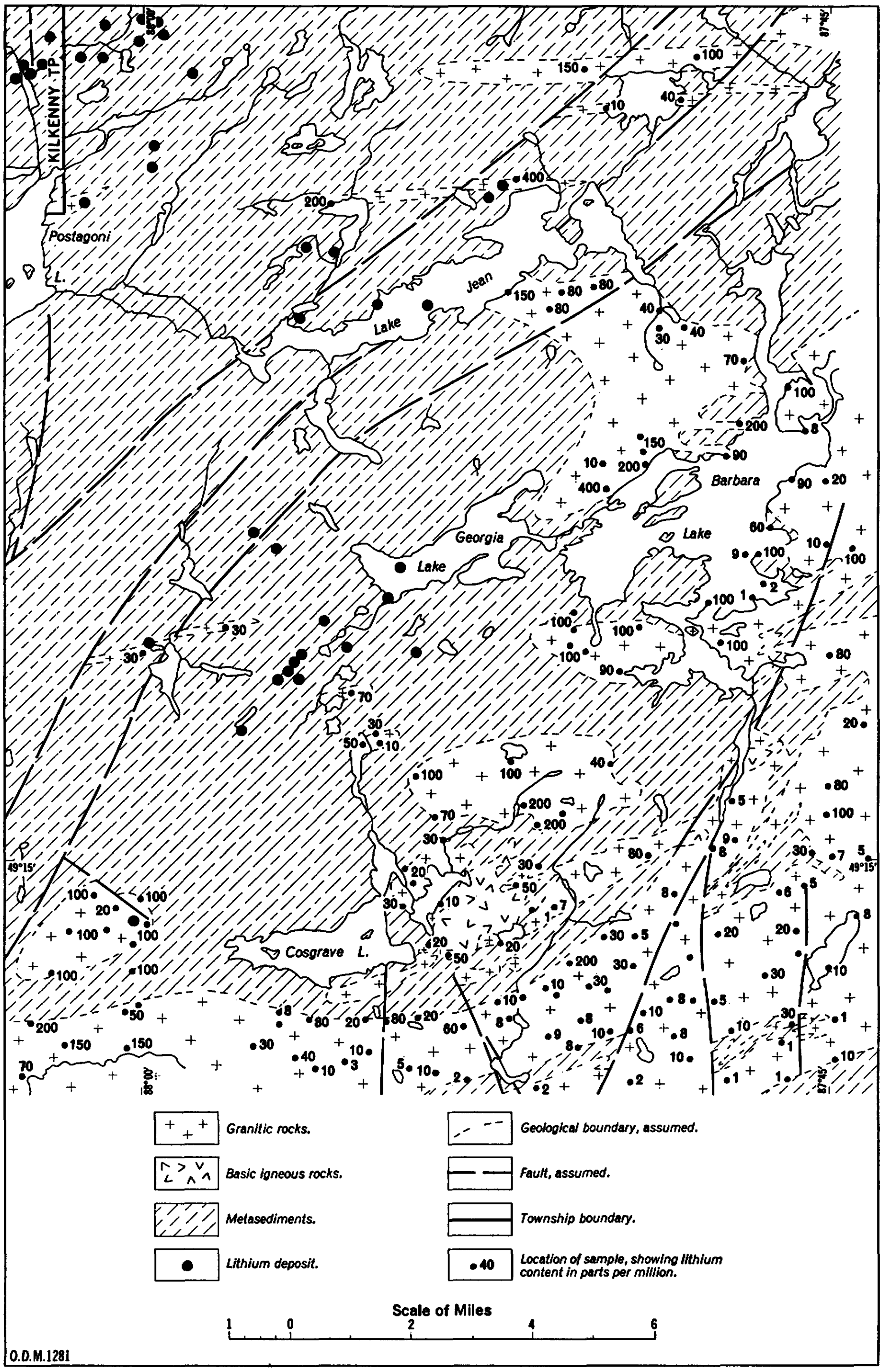


Figure 5—Simplified geological map showing distribution of lithium in granitic rocks.

about 0.04 percent; the lithium content was found to vary considerably, from a low of 0.0001 percent to a high of 0.04 percent. The locations of the samples and their lithium contents are indicated on the simplified geological map shown in Figure 5. This map shows that the distribution of the lithium in the granitic rocks is not erratic. On the contrary, the main granitic mass, in the extreme eastern and southern parts of the map-area, has a lithium content of from 0.0001 to 0.005 percent, whereas the tongues and some of the isolated sills and small stocks have lithium contents of from 0.01 to 0.04 percent, in most places about 0.01 percent.

In his study of the gold deposits of the world, W. H. Emmons (1937) noted that a large number of important lodes occur in fractures within the outer margins, along the flanks, and off the ends of small elongated bodies or stocks of acid igneous rocks. He suggested that the elongated stocks are satellites, which represent the uppermost parts of large batholithic masses, and that they are cupolas within which late-stage differentiates, which ultimately gave rise to the ore deposits, were concentrated. A similar theory may well be applicable to the rare-element pegmatites of the Georgia Lake area.

Alteration of the Spodumene

Altered spodumene, in amounts that vary within wide limits, has been found in many of the lithium-bearing pegmatites. Two principal types have been recognized: in one the spodumene has been replaced, either in whole or in part, by a granular-textured aggregate of pale-yellow or pale-greenish yellow muscovite; in the other, it has been altered to an exceedingly fine-grained (cryptocrystalline to microcrystalline) material, which generally causes the mineral to become dark, in places almost black, in colour. Both types of altered spodumene commonly are found in a single outcrop. Detailed study, however, indicates that they occur in somewhat different structural environments; contrary to what might be expected, they do not appear to be manifestations of a single geological process. They differ in importance. In general, spodumene altered to granular-textured muscovite has a fairly restricted distribution within individual deposits and is quantitatively not very significant. Dark-coloured spodumene, on the other hand, is present in some pegmatites in rather large amounts. It may contain less than 1 percent lithia and several percent of iron oxides; and since commercial spodumene must contain at least 4.5 percent lithia (Shreck 1961, p. 3) and a minimum of iron (Gabriel *et al.* 1942, p. 117), this may detract appreciably from the potential value of the deposits.

Nature of the Alteration

The alteration of the spodumene to granular-textured muscovite may be either partial or complete. Incipient alteration is indicated by the presence, within prismatic crystals of spodumene, of tiny scattered flakes of colourless or pale-yellow mica. With moderate alteration, the mica content of the spodumene increases, particularly towards one or both ends of the crystals or along the sides of them. A spodumene individual with scattered flakes of muscovite, for example, may grade along its length into a granular aggregate of mica. Such a granular aggregate is often confined to the outline of the original crystal. More commonly, adjoining feldspars also have been affected, and where the muscovite content of the spodumene increases, the prismatic shape of the crystal becomes somewhat ill-defined. This is also true in the case of complete alteration—the only indication of the original spodumene may be an aggregate of granular-textured muscovite elongated roughly parallel to nearby crystals of unaltered spodumene, where the latter has a recognizable preferred orientation.

In the second type of alteration, as mentioned above, the spodumene usually is darkened. With advancing alteration it changes from pale-grey to pale-green to, first, a yellowish or brownish green, then to a dark-greenish brown, and ultimately to a dull-greenish black. Again some spodumene crystals have been affected differently from others. A few are altered either uniformly or irregularly throughout; others are changed toward their extremities; still others have been affected only in their outermost parts, so that when broken they are found to be made up of fresh or only slightly altered spodumene enclosed in a thin, continuous or discontinuous, dark-coloured "shell" of alteration products. Microscopic examination by V. G. Milne of dark, highly altered spodumenes showed them to be made up largely of a pseudomorphic matte of a very fine-grained, pale-greenish yellow to colourless mica, in places dusted with dirty greenish black, pleochroic material, believed to be a variety of chlorite.[1] In a few thin sections, some of the mica could be recognized as muscovite. Most of it, however, is too fine-grained for the usual optical tests and could not be identified with any degree of certainty. Samples of typical fresh spodumene and of the dull-black, highly altered spodumene were submitted to the Laboratory Branch for complete quantitative chemical analyses. These analyses, and an x-ray powder photograph of dull black material, indicated the principal alteration product to have a composition that corresponds well with that of muscovite (*see* table, below) and, because of its fineness and matte-like character, to be perhaps best described as sericite.

Chemical Analyses of Spodumene Crystals, Georgia Lake Area

(Analyses Nos. 1-5 by the Laboratory Branch, Ontario Department of Mines)

	Samples						
	Unaltered Spodumenes			Altered Spodumenes		Muscovites	
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
	percent	percent	percent	percent	percent	percent	percent
SiO_2	60.85	62.70	61.44	48.84	49.57	45.21	48.76
Al_2O_3	27.60	27.27	29.06	29.78	28.23	33.40	29.91
Fe_2O_3	0.29	1.53	1.22	1.50	4.59	2.78	4.24
FeO	0.44	0.31	0.33	2.19	1.36	2.00	0.41
CaO	——	0.34	0.28	——	0.40	——	0.33
MgO	0.32	0.22	0.16	3.00	2.73	1.58	2.63
Li_2O_3	6.62	5.33	5.63	0.43	0.15	——	——
K_2O	0.23	0.16	0.33	8.99	6.50	10.71	6.83
Na_2O	0.24	0.17	0.12	0.20	0.16	0.42	2.31
H_2O	——	——	——	——	——	3.95	4.60
F	——	——	——	——	——	0.94	——
L.O.I.	1.20	0.65	0.70	5.73	5.26	——	——
Totals	97.79	98.68	99.27	100.66	98.95	100.99	100.02

No. 1—No. 1 deposit, Jean Lake Lithium Mines Ltd.
No. 2—North Zone, Nama Creek Mines Ltd.
No. 3—North Zone, Nama Creek Mines Ltd.
No. 4—No. 1 deposit, Jean Lake Lithium Mines Ltd.
No. 5—North Zone, Nama Creek Mines Ltd.
No. 6—Muscovite No. 11 (Dana 1909).
No. 7—Muscovite No. 16 (Dana 1909).

[1]V. G. Milne, personal communication.

Occurrence of Altered Spodumene

Spodumene that has been altered partly or wholly to granular-textured muscovite is found:

1. Adjacent to, and within a few inches of, muscovite-quartz veins filling transverse and oblique fractures cutting pegmatites in the northern part of the map-area.
2. Along the margins of some aplites thought to be of replacement origin, for example in the Camp and Giles pegmatites (*see* p. 42).
3. As small scattered pods and patches that occur throughout some pegmatites, but appear to be more abundant in the central rather than the outer portions of them, for example the Brink deposit.

Because the muscovite-quartz veins fill post-aplite fractures that do not extend from the pegmatites into the country rocks, and because the scattered pods in the Brink deposit show no obvious relationship to fractures or veins, the alteration of spodumene to granular-textured muscovite is interpreted to be the result of the action of late-stage solutions genetically associated with the pegmatites themselves. It is not considered to be the manifestation of an unrelated, post-pegmatite mineralization.

As mentioned on page 35, a few pegmatites in the map-area exhibit a rather ill-defined zonal structure, with muscovite-quartz-feldspar pegmatite enclosing spodumene-bearing pegmatite. In the outer, spodumene-poor or spodumene-free pegmatite, the muscovite occurs in elongate granular aggregates having about the same size and the same orientation as the spodumene crystals in the inner zone. These granular aggregates are much the same as those resulting from the selective replacement of spodumene and could have a similar origin, at least in part.

Dark-green or black, highly sericitized spodumene is found in small amounts in most deposits in the area; in a few places it is sufficiently abundant to render the pegmatites, or large parts of them, valueless. The detailed mapping showed that it occurs sporadically and has no obvious spatial relationship to muscovite-quartz veins, aplites, or pegmatite contacts. Rather, it commonly occurs close to, and thus is intimately associated with, thin white "veins" up to about ⅛ inch in thickness, which cut sharply across the pegmatites (*see* Photo 21). Material from some of these veins, examined microscopically by Milne,[1] was found to consist largely of albite with a little quartz and mica. Some of the albite may have been introduced, but in general the minerals are highly fractured and brecciated and mostly represent comminuted pegmatite material. Because the fractures were observed to cut aplites and muscovite-quartz veins and in places to coincide in attitude with joints in the country rocks, the sericitic alteration is believed to be a post-consolidation feature of the pegmatites.

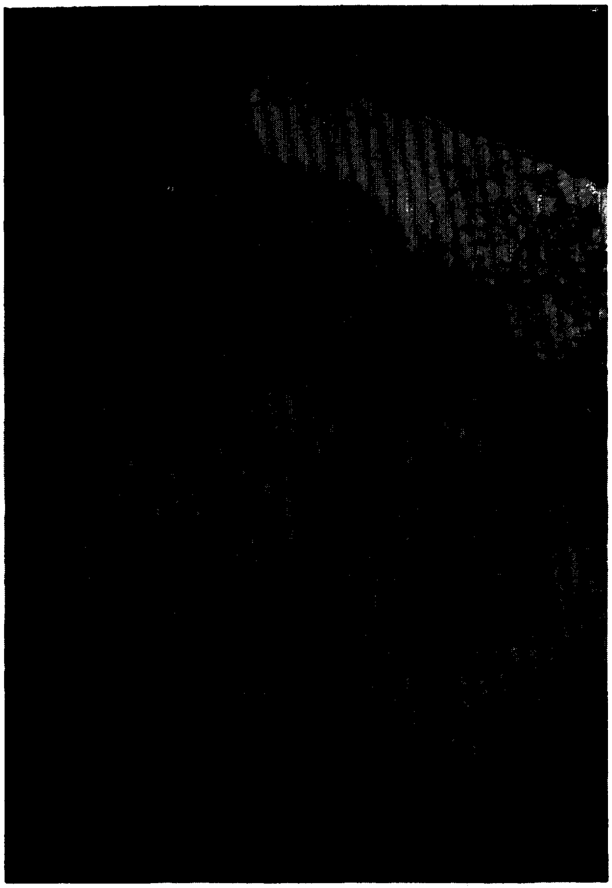
The post-pegmatite alteration of the spodumene appears to be due to hydrothermal effects associated with the formation of the Logan sills and associated dikes in Proterozoic time. This is indicated by the following evidence:

1. On the property of Lun-Echo Gold Mines Limited, near Pine Portage, there are several northeast-trending, steeply-dipping lithium pegmatites. Diamond-drilling of these deposits showed them to be truncated, at depths below the present erosion surface of from 85 feet on the north to

[1]V. G. Milne, personal communication.

250 feet on the south, by a diabase sheet having a thickness of about 650 feet. At the surface these deposits are rich in lithia, and one of them, the No. 1 deposit, has the highest average tenor of all the pegmatites of the Georgia Lake area. As the diabase sheet is approached, however, the spodumene progressively becomes highly altered, and the lithia content decreases accordingly. The effect of the alteration of the spodumene on

Photo 21



Altered spodumene adjacent to an oblique fracture; main South Zone pegmatite, Nama Creek Mines Limited.

the grade of the No. 1 deposit, as the diabase sheet is approached, is well-illustrated in the vertical cross-section reproduced in Figure 6.

2. On the property of Ontario Lithium Company Limited, the Point deposit was found by drilling to be cut by diabase at vertical depths of 100–115 feet. In one diamond-drillhole, which intersected the pegmatite 15–25 feet below the surface, the spodumene was found to be unaltered. In a second hole, bored from the same set-up to intersect the pegmatite 65–100 feet below the surface, the spodumene was found to be highly sericitized. The core from the second hole was estimated visually to contain 10–15 percent altered spodumene; the lithia content was found by analysis to be 0.01–0.04 percent.

3. The Jackpot deposit of Ontario Lithium Company Limited is cut by a thin diabase dike that strikes N.10°–20°W. and dips 70°W. In diamond-drillholes that intersected the pegmatite close to this dike, the spodumene, as in the instances previously mentioned, was found to be highly sericitized.

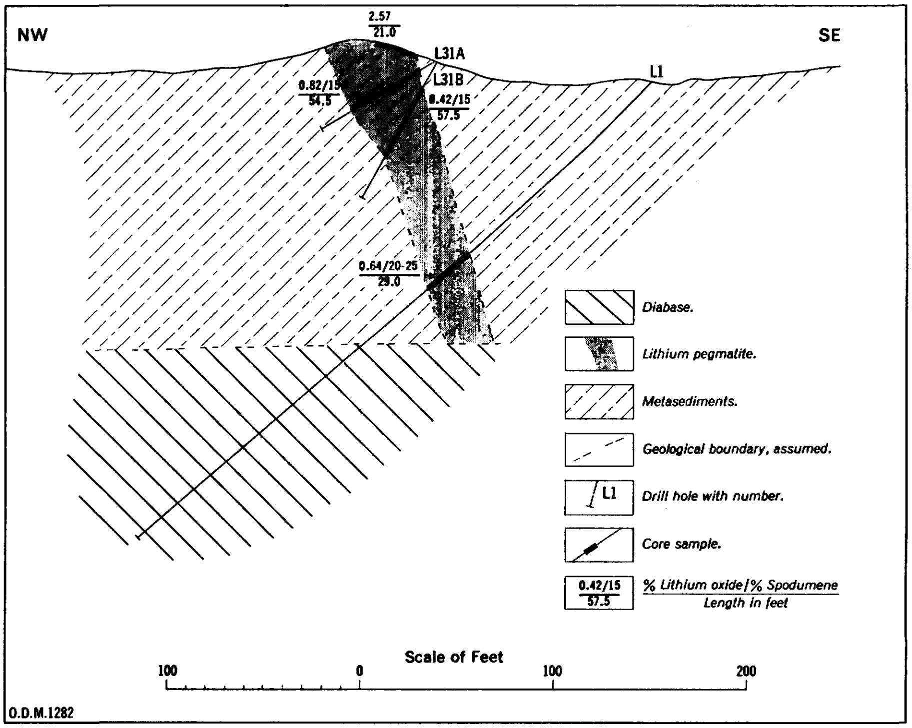


Figure 6—Vertical section, No. 1 deposit, Lun-Echo Gold Mines Limited.

4. The North Zone deposit of Nama Creek Mines Limited, towards its northeast extremity and at a vertical depth of 600 feet, is cut by a flat sheet of diabase about 30 feet thick. As illustrated in Figure 7, the pegmatite close to this sheet, even though it contains 15–20 percent spodumene, has a grade of only 0.14 percent lithia because of alteration.
5. The West, Line 60, and Caral pegmatites east of Downey Lake contain highly altered spodumene. This altered spodumene becomes increasingly more conspicuous towards the south as the diabase sheet in that locality is approached.

The fact that the post-pegmatite alteration of the spodumene appears to be related to the intrusion of diabase magma is of value in exploration. It indicates that the discovery of highly altered spodumene may lead to the location of a substantially richer deposit by tracing the pegmatite away from outcrops of diabase. Furthermore, a pegmatite, of low grade at the surface because of alteration, may increase in grade with depth and become valuable. Such appears to be true of the North Zone deposit of Nama Creek Mines Limited. As illustrated in Figure 8 this deposit has a lower tenor near the surface than at depth,

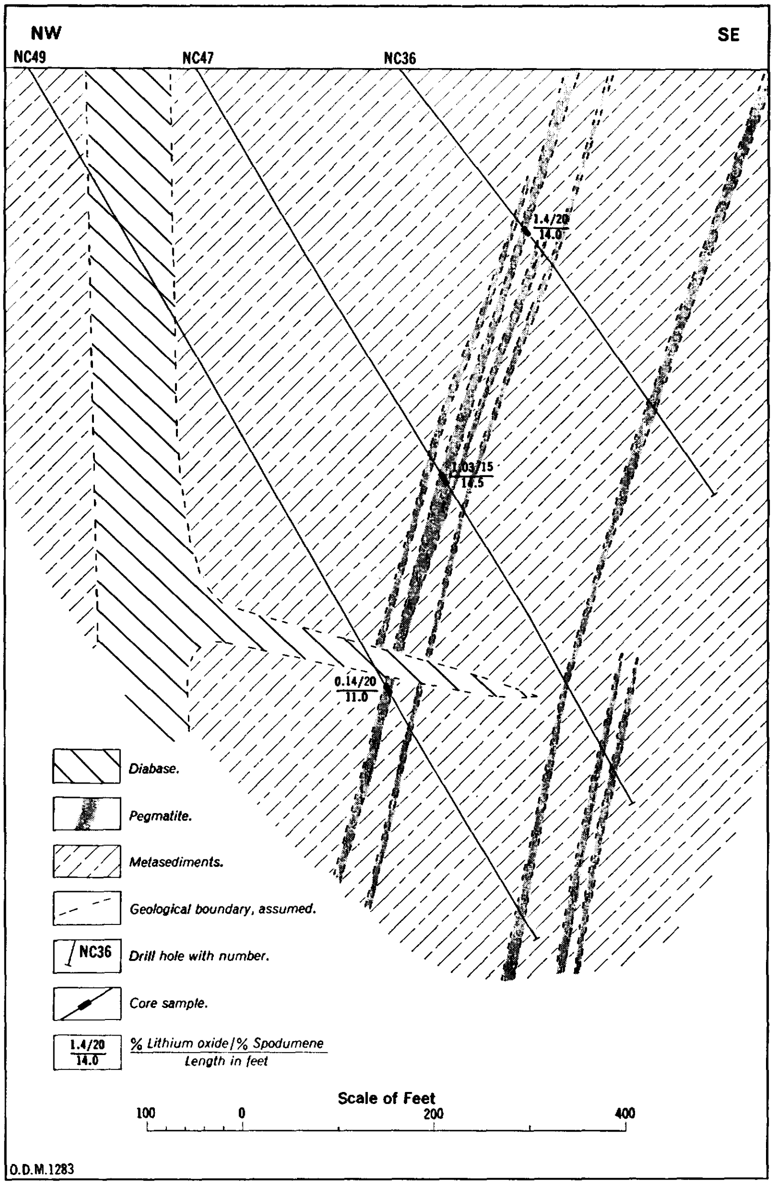


Figure 7—Vertical section, 44+00 NE. co-ordinate, North Zone deposit, Nama Creek Mines Limited.

not because of variations in spodumene content, but largely because of alteration. This alteration may be attributed to the fact that, a short distance to the west, a thick diabase sheet caps a mesa-like hill. Originally, this sheet extended across the area of the deposit, only a short vertical height above the present erosion surface.

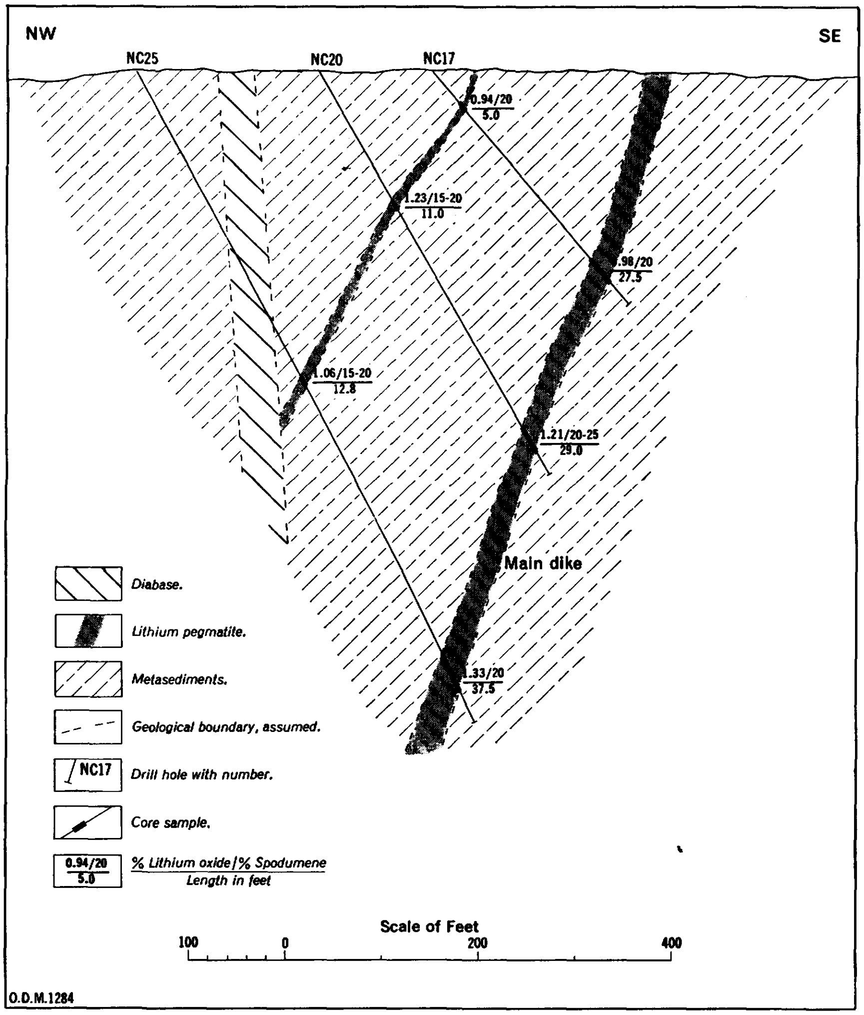


Figure 8—Vertical section, 24+00 NE. co-ordinate, North Zone deposit, Nama Creek Mines Limited.

BASE-METAL DEPOSITS

Only one base-metal deposit, known as the Potter, has been discovered in the map-area. This deposit was discovered in the southeastern part of the area along the Glacier Creek fault, where the fault, at a location about 2 miles east-northeast of O'Keefe Lake, cuts and displaces a narrow band of metasediments in granitic rocks. It is essentially a breccia zone, mineralized with disseminated pyrite and chalcopyrite across widths up to about 100 feet. It strikes N.20°E. and has been traced in diamond-drillholes for a length of 2,400 feet. One of the drillholes is reported to have cored material averaging about 0.05 percent copper over a width of 104 feet.

Although the Potter deposit may be of too low a grade to be of any economic significance at the present time, the possibility that other, more valuable base-metal deposits may occur under similar conditions elsewhere in the area should not be discounted.

SUMMARY AND CONCLUSIONS

1. The rare-element pegmatites are variable in attitude. Most are steep-dipping; some dip gently at angles of 45 degrees or less; others are flat. The steep-dipping pegmatites lie parallel or nearly so to the foliation of the metasediments, or occupy north-trending fractures that cut metasediments or intrusive granitic rocks either transversely or obliquely. The gently dipping pegmatites also appear to be localized along transverse or oblique fractures. The flat pegmatites occur near Georgia Lake, as thin irregular patches at the surface. They are erosional remnants of once-larger bodies and are too small to be of any economic value at the present time.

2. The only mineral that occurs in the rare-element pegmatites in sufficient concentrations and in sufficiently large bodies to be economically significant is the lithium-bearing mineral spodumene. However, the presence of beryl and traces of cassiterite in the Cosgrave Lake pegmatites, and of columbite in the M.N.W., Brink, and Pine Portage deposits, indicates that important bodies of valuable minerals other than spodumene may occur.

3. Most of the rare-element pegmatites are not internally zoned. A few, however, are made up of spodumene-bearing pegmatite enclosed by narrow, ill-defined wall zones rich in muscovite but containing little or no spodumene; one deposit, the M.N.W., is made up of several concentrically disposed zones, of different compositions, enclosing a rich spodumene-quartz core.

4. Except in the Cosgrave Lake deposits, the potash feldspar and spodumene crystals tend to be oriented perpendicular to the pegmatite contacts; and in some instances, where exposures are poor, they facilitate determining attitudes and so aid in exploration.

5. Wallrock inclusions, aplites, and quartz veins are not abundant and do not detract appreciably from the values of the lithium deposits containing them.

6. Wide zones of wallrock alteration adjacent to pegmatite margins are conspicuously absent.

7. A regional zoning, consequent upon changes in pegmatite characteristics, is a feature of the area. Mica-quartz-feldspar pegmatites occur in or close to the principal mass of granitic rocks; rare-element pegmatites occur at considerable distances from this mass. The rare-element pegmatites can be divided, on the basis of textural and structural differences, into three groups: one near Cosgrave Lake; one near Georgia Lake and Pine Portage; and one around Postagoni and Downey lakes and Lake Jean. The pegmatites of all three groups contain spodumene; only those near Cosgrave Lake contain traces of cassiterite and any appreciable amount of beryl. The regional zoning, therefore, should be given serious consideration in prospecting.

8. The pegmatites are of magmatic origin and are thought to represent late-stage differentiates generated by the progressive crystallization of granitic magma.

9. The rare-element pegmatites are not necessarily grouped about a single petrogenetic centre, but rather seem to occur off the ends of prominent, westward- and upward-projecting tongues and satellitic bodies of the main granitic mass.

10. The spodumene of the lithium deposits is altered in places to either a granular-textured muscovite or to a pseudomorphic matte of very fine-textured sericite. Except possibly in the Vegan deposit, muscovitization is quantitatively not very important. However, sericitization and attendant darkening of spodumene, with loss of lithia and gain in iron content, may seriously affect the tenor of a deposit. This type of alteration appears to be spatially related to the Keweenawan diabase intrusion.

11. The occurrence of chalcopyrite in brecciated rocks along the Glacier Creek fault indicates that valuable base-metal deposits may occur in the area. A locality worthy of investigation in this regard is the area about Sovereign Lake, where the Glacier Creek fault cuts not only metasediments and granitic rocks, but also metagabbro and porphyritic metagabbro.

DESCRIPTIONS OF MINING PROPERTIES

The bracketted figure after the name indicates its location on map No. 2056 in back pocket.

AUMACHO RIVER MINES LIMITED (1)

In 1961, Aumacho River Mines Limited held a group of 11 claims (T.B. 67010–16, inclusive; 67026, 67029, 67030, and 67033) at the north end of Blay Lake in the east-central part of the map-area. This property is underlain by metasediments, which are interrupted by a sill-like body of massive to faintly foliated, grey to pinkish grey, white-weathering granitic rock. This sill-like body strikes east and dips 75°–80°N., and ranges up to about 500 feet in horizontal width. It serves as the host rock for at least three lithium-bearing pegmatites, known as the Brink (or No. 1), the No. 2, and the No. 5 deposits.

The Brink (or No. 1) deposit is exposed along the north shore of Blay Lake. It has an average exposed width of 13 feet, and can be followed for 215 feet continuously in a direction of N.20°W. At its north extremity, where it extends across the contact from the granitic host rock into metasediments, it wedges out sharply (Fig. 9). To the south, under the lake, it curves rapidly to assume a strike of S.40°W. and has been traced in this direction by diamond-drilling for about 500 feet. Where the dike strikes N.20°W. it dips 65°W. to a depth of about 100 feet, then flattens and assumes a dip of 40°W.; where it strikes S.40°W. it dips 35°NW. As the dike curves and assumes a southwesterly strike, it increases gradually in thickness to about 20 feet. Drillhole data indicate it to be essentially tabular in shape.

The Brink deposit contains about 25 percent spodumene, as coarse- to very coarse-grained prismatic crystals having lengths up to a measured maximum of 42 inches. The spodumene crystals (and accompanying feldspars) exhibit a distinct tendency to be oriented perpendicular to the pegmatite contacts. For the most part they are unaltered; a typical specimen, taken by Simard and

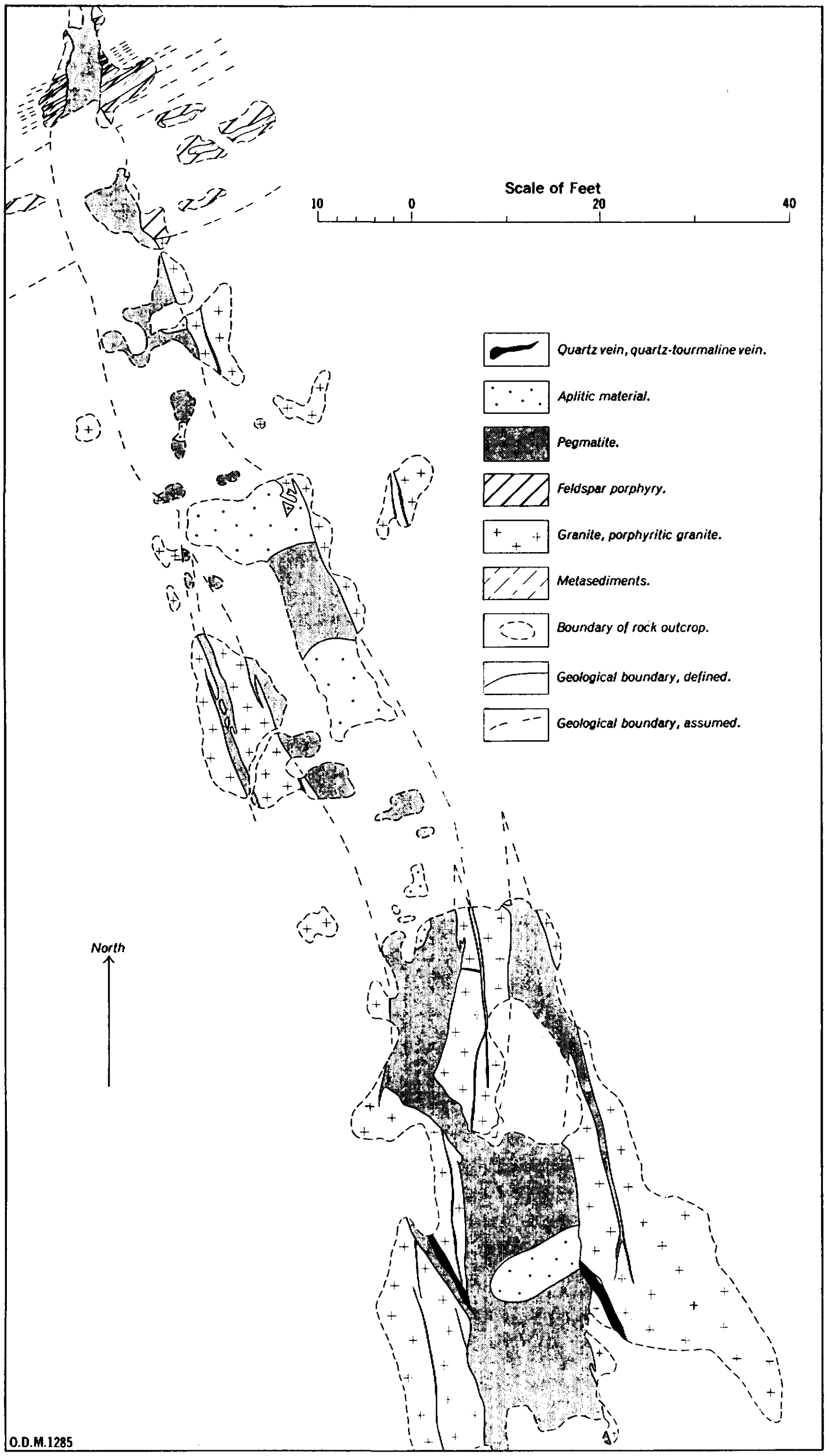


Figure 9—Detailed surface plan, Brink deposit; Aumacho River Mines Limited.

Knight,[1] was found on analysis to contain 7.14 percent lithia. In the surface exposure some of the spodumene (and feldspar) has been replaced by very fine-grained yellowish and pale-greenish mica, which occurs as small pods and irregular-shaped masses at irregular intervals throughout the deposit, but mostly along or near the central part of it.[2] This alteration, however, is quantitatively and hence economically of little significance. Except for the occurrence of narrow (½–1 inch wide) "chill" or border zones of quartz, muscovite, and feldspar, the Brink deposit does not exhibit any mineralogical or textural zoning, and spodumene occurs from wall to wall. The distribution of spodumene within the dike, nevertheless, is erratic, and in the drill cores lithia-rich and lithia-poor sections of variable proportions were found to alternate. Examination of the surface exposure indicates that this erratic distribution may reflect the occurrence of large, irregular-shaped patches of sugary-textured albite or "aplite."

The No. 2 deposit lies 20–25 feet below the flatter portions of the No. 1 dike. It strikes N.40°–45°E. and dips flatly northwest; where the No. 1 dike curves to strike N.20°W., the No. 2 maintains its attitude so that, to the northeast, the two deposits diverge. On the other hand, to the southwest and at depth, they converge gradually.[3] According to F. C. Knight,[4] the No. 2 pegmatite decreases in thickness downward and, in places, appears to wedge-out at a vertical depth of about 200 feet. It is persistent along strike and has been traced in the drillholes for a length of about 600 feet. Its character is not known, because drillhole cores were not split for record purposes, but it is believed to be similar to the No. 1 deposit.

The No. 5 dike was located in diamond-drillholes about 900 feet east of the surface exposure of the Brink deposit. Its dimensions and attitude have not been reported.

The lithium deposits were tested by diamond-drilling, from October 1955 to April 1956, and some additional drilling was done in 1957. This work indicated the No. 1 and No. 2 deposits to contain, according to company officials, an estimated 759,475 tons of pegmatite having an average grade of 1.65 percent lithia.[5] On the basis of three diamond-drillholes, it is estimated the No. 5 deposit possibly contains an additional 96,000 tons having an average grade of 1.5 percent lithia.[6]

A mill test of typical pegmatite by the Department of Mines and Technical Surveys, Ottawa, indicated that heavy-media separation would yield a concentrate containing 6.27 percent lithia with a recovery of about 90 percent;[7] a second test indicated that flotation would yield a concentrate containing 5.93 percent lithia, also with a 90 percent recovery.[8] Because of the establishment by diamond-drilling of the presence of an appreciable tonnage of ore-grade material, undergound development was proposed.[9] Markets for lithium concentrates, however, have not been forthcoming, and work at the property has been suspended.

[1]F. C. Knight, consulting geologist; personal communication.
[2]V. G. Milne, post-graduate student, University of Toronto; personal communication.
[3]*The Northern Miner*, 19 Jan. 1956, p. 22.
[4]F. C. Knight; personal communication.
[5]*The Northern Miner*, 13 June 1957, p. 29.
[6]*Idem.*
[7]*The Northern Miner*, 8 March 1956, p. 26.
[8]*The Northern Miner*, 27 Sept. 1956, p. 4.
[9]*The Northern Miner*, 3 May 1956, p. 25.

CAMP LITHIUM DEPOSIT (2)

The Camp lithium deposit occurs in metasediments, on the south shore of the small pond along the river connecting the west end of Lake Jean with Parole Lake. It was staked by Lewis E. Giles on 9 July 1955, and on 17 October was acquired by Jean Lake Lithium Mines Limited. Some stripping and surface sampling were done. Largely because of the small size of the deposit, however, the company permitted the claims to be cancelled on 12 September 1960.

The Camp pegmatite strikes N.50°W. obliquely across the metasediments as a dike and, as far as can be ascertained, dips vertically. It is exposed in two outcrops over a length of 125 feet, and is 7–12 feet in thickness. Medium- to coarse-grained crystals of potash feldspar, and fine–to medium-grained prismatic crystals of spodumene, well oriented normal to the strike of the dike, occur in a matrix of very fine- to fine-grained quartz, feldspar, and muscovite. A crude mineralogical zoning is apparent. A central zone rich in spodumene is bordered on the northeast by a one-foot-wide wall zone rich in muscovite but with little or no spodumene or potash feldspar, and on the southwest by a similar zone 2–3 feet wide. These wall zones change in granularity to sugary-textured, aplitic material as the dike contacts are approached, but no distinct "chill" or border zones were noted in the surface exposures. Although the contacts with the metasediments are knife-sharp, a little wallrock alteration is evident in a few places along the contacts; within 1–2 inches of them, the metasediments have been enriched in muscovite and are speckled in appearance.

The Camp pegmatite is interrupted by a large number of thin (⅛–4 inches) vein aplites. The aplites occur in three groups, each 2–2½ feet wide. One group lies within the dike, 6–8 inches from the southwest contact, and is made up of five distinct aplite veins separated by intervening strips of pegmatite. These aplites split and bifurcate along their lengths, and at one point in the outcrop eleven aplitic bands can be recognized across a width of 2 feet. The second group, made up of three aplite veins, lies about 2½ feet from the first, near the centre of the pegmatite. The third group, made up of four aplite veins, lies 1½–2 feet from the second group, close to the northeast contact of the dike.

The central section of the Camp dike, in the surface exposures at least, averages 25–30 percent unaltered spodumene, indicating a lithia content of 1½ percent or better. In a few places, close to the outer aplite zones, some spodumene crystals near oblique fractures are highly sericitized. Alteration of spodumene, however, does not appear to be quantitatively significant.

CARAL LITHIUM DEPOSIT (3)

The Caral lithium pegmatite is located in metasediments in the northeastern part of the map-area, about a mile north of Palace Lake, close to and west of Piper Lake. It was found and staked originally by Rudy Pifko on 26 May 1955. Subsequently, in August, the claims were transferred to the Caral Mining Company Limited. Geological mapping of the property by E. T. Spencer was carried out, and early in 1956, under the direction of Rene Maloney, a program of diamond-drilling was completed. The pegmatite was tested over a strike length of 600 feet by 13 diamond-drillholes having an aggregate length of 2,681 feet. The drilling failed to locate anything of economic value, however, and work at the property was suspended. The claims were cancelled on 8 June 1960.

The Caral pegmatite strikes about N.35°E. and dips 80°NW. It has been traced in outcrops and in the drillholes for a length of about 700 feet. At or near its southwest extremity it is only about 2 feet wide; but it increases gradually in thickness to the northeast, where it averages about 10 feet in width over a length of 400 feet. Spodumene can be observed in the surface exposures, where it occurs as fine-grained prismatic crystals, ½–1 inch in length, crudely oriented roughly normal to the strike. Midway along the dike this spodumene is unaltered, but to the southwest, as a large sheet-like body of diabase is approached, it becomes highly sericitized. It is not abundant. One diamond-drillhole, bored S.45°E. at 47 degrees under a spodumene-bearing outcrop, about midway along the length of the deposit, cut 27.5 feet of pegmatite which, on analysis, was found to average less than 0.5 percent lithia. The best sample, 5 feet in core length, from the centre of the intersection, was found to contain 0.67 percent lithia.[1]

An interesting feature of the Caral pegmatite is that in one exposure, where spodumene is particularly conspicuous, the pegmatite is veined by aplite. Here the aplite was noted to make up more than half of the outcrop, and to occur as layers alternating with thin bands, not over 4 inches thick, of spodumene-bearing pegmatite. The aplite is thought to have replaced the pegmatite along longitudinal fractures (*see* pp. 40–42); it may account in part for the low over-all grade of the deposit. This theory cannot be checked, however, because the dike material was not described in the drillhole logs, and the drill cores are not available for inspection.

CARROT LAKE LITHIUM DEPOSIT (4)

The Carrot Lake deposit is exposed along the west shore of Carrot Lake, about a mile west-southwest of Georgia Lake. It was staked in May 1955, by Conwest Exploration Company Limited; in the spring of 1956, it was transferred to Ontario Lithium Company Limited. The Carrot Lake pegmatite occurs in metasediments as a dike that strikes east for a known length of about 200 feet and is exposed across an average width of about 50 feet. It contains about 20 percent unaltered spodumene, as prismatic crystals up to 18 inches long by 4 inches wide. According to Gilmour (1955), there is evidence to indicate that the pegmatite is merely the erosional remnant of a flat dike, 30–40 feet thick. The deposit was not tested by diamond-drilling. The claim on which it occurs was cancelled on 20 July 1960.

E. S. CONWAY (5)

Introduction

E. S. Conway of Beardmore holds a group of seventeen claims in the northeastern part of the map-area, east of and adjoining the property of Nama Creek Mines Limited. The property originally was staked in the spring of 1955 and acquired by United Montauban Mines Limited; a program of diamond-drilling was carried out to test a lithium deposit located about 1,500 feet east of Camp 83 of St. Lawrence Corporation Limited. This work failed to indicate anything of commercial value. On 14 July 1958, the claims were allowed to lapse. The ground was immediately restaked by E. S. Conway. Subsequently, on 22 July it was optioned to Leitch Gold Mines Limited, and, between 27 August and

[1]Assessment work files, resident geologist's office, Port Arthur.

2 October 1958, a second program of diamond-drilling was undertaken. In all, four lithium deposits were investigated: (1) the No. 1 occurrence tested by United Montauban Mines Limited about 1,500 feet east of Camp 83; (2) the Conway; (3) the Norland; and (4) the No. 4 pegmatite exposed southeast of the Norland deposit. All these occur as dikes cutting metasediments.

Lithium Deposits

No. 1 Deposit

The No. 1 deposit strikes N. 20°–25° E. and dips 55°–65° NW. It is exposed in three outcrops over a distance of 115 feet and ranges in horizontal width from 3 to 8.5 feet. The pegmatite is strikingly banded in appearance owing to its interruption at closely spaced intervals by vein aplites (*see* Economic Geology, pp. 40–42). The aplites are conformable to the dike or nearly so; they are 1–5 inches in thickness, and in one place make up about one quarter of the deposit. The pegmatite itself consists of medium-grained crystals of potash feldspar and fine-grained crystals of spodumene in a very-fine-grained (granitoid) groundmass. The larger crystals are subparallel and are poorly oriented, roughly perpendicular to the strike of the deposit. Most of the spodumene is unaltered. Some of it has been highly sericitized, however, and about 50 feet from the southwest end of the dike the spodumene, within 20 inches of the contacts, has been largely replaced by granular-textured muscovite.

In May 1957, five diamond-drillholes, aggregating 1,447 feet, were bored by United Montauban Mines Limited. Only two of these holes, Nos. 121-1 and 121-2, intersected pegmatite containing any appreciable amount of spodumene. Diamond-drillhole No. 121-1 was drilled east at an angle of 45 degrees from a point about 250 feet west of the dike, and at a depth of 205.0–224.0 feet cut 19 feet of pegmatite having an average grade of 0.58 percent Li_2O.[1] Diamond-drillhole No. 121-2, collared 220 feet north of hole No. 121-1, was also drilled east at an angle of 45 degrees. At a depth of 256.5–279.0 feet, it intersected 22.5 feet of pegmatite having an average grade of 0.56 percent Li_2O.[2] Because this intersection was obtained almost due north of that in hole No. 121-1, it either indicates an abrupt change in attitude to the north (a more northerly strike or a flatter dip, or both), or, in contradistinction, it represents a different pegmatite that is not exposed.

A 4-foot-wide pegmatite dike is exposed 110 feet N. 55° E. from the northernmost outcrop of the No. 1 deposit. This dike strikes N. 15° E. for 35 feet and dips 50° W. It is similar to the No. 1 deposit, but has much lower spodumene content. Whether it is a branch of the No. 1 deposit or a separate occurrence is not known.

Conway Deposit

The Conway deposit is exposed 1,000 feet north-northeast of the No. 1 deposit, and about 1,500 feet east of Little Postagoni River. It occurs roughly along the line of strike of the No. 1 deposit, and since it has a similar attitude (N.30°E.; 70°NW.), it may represent the latter's extension. The Conway deposit has a known length of 1,400 feet and ranges in thickness from about

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[1]Average calculated by author from data in assessment work files, resident geologist's office, Port Arthur.

[2]*Idem.*

10 feet at its extremities to a maximum of 37 feet near its centre. In September 1958 it was tested by diamond-drilling by Leitch Gold Mines Limited. A total of 15 holes, aggregating 3,200 feet, were bored at intervals of 65–130 feet. From this work it was estimated that the dike contains, to a depth of 1,000 feet, 1,830,000 tons of pegmatite having an average grade of 0.96 percent Li_2O.[1]

The Conway deposit, like others in the area, is made up largely of feldspars, spodumene, and quartz with relatively small amounts of muscovite. Red garnet occurs sporadically as an accessory constituent. Small amounts of an unidentified black mineral, possibly tourmaline, were found in cores from the diamond-drillholes.[2] Of special interest is that, in the southwestern portion of the deposit, there also is a little fine-grained beryl. Samples from several diamond-drillholes indicated, in places, beryllium contents of 0.02–0.05 percent over core lengths up to 12.5 feet.[2] The Conway deposit is similar to the No. 1 in texture and internal structure. As before, large crystals of potash feldspar, here 3–18 inches in length, and of spodumene, 1½–6 inches in length, occur as phenocrysts in a relatively fine-grained groundmass of quartz, feldspar, and muscovite; these characteristically are arranged in subparallel alignment and are oriented roughly normal to the strike of the dike. Vein aplites, up to several inches in thickness, also occur. In general they are less numerous and more widely separated than in the No. 1 pegmatite. They increase in abundance to the northeast, however, and in one outcrop they were found to make up over 90 percent of the west half of the dike. Their presence accounts, at least in part, for the somewhat lower grade of the northeastern portion of the dike—the diamond-drilling showed the northeastern portion, over a strike length of about 500 feet, to have Li_2O contents ranging from 0.49 percent over 9.3 feet of core in hole No. 5, to 0.91 percent over 14.5 feet of core in hole No. 1; the southwestern portion, from 0.73 percent over 10.3 feet of core in hole No. 13, to 1.30 percent over 35 feet of core in hole No. 8.[2]

RESULTS OF SOME DIAMOND-DRILLING BY LEITCH GOLD MINES LIMITED, SEPTEMBER 1958

(Information from assessment work files, resident geologist's office, Port Arthur)

Diamond-Drillhole No.	Angle of Hole	Footage From	Footage To	Core Length	Li_2O Content
		feet	feet	feet	percent
12	50°	45.8	48.0	2.2	0.03
		48.0	52.4	4.4	1.32
13	50°	92.5	105.0	12.5	0.23
14	45°	165.0	170.0	5.0	0.03
		170.0	177.5	7.5	0.50
15	50°	108.0	115.0	7.0	0.88
		115.0	125.7	10.7	0.31

From 100 to 200 feet west of the southwest end of the Conway deposit, a second lithium-bearing dike has been located. This dike swings about but has a general northerly strike and dips 65°–70° W. It has been traced in outcrops and in four diamond-drillholes, bored primarily to test the Conway

[1]G. A. McKay, manager, Leitch Gold Mines Limited; personal communication.
[2]Assessment work files, resident geologist's office, Port Arthur.

deposit, over a length of 450 feet. It ranges from 6 to 11 feet in thickness. Its grade, and the distribution of the spodumene within it, are indicated by the diamond-drillhole intersections reproduced in the accompanying table. Because this dike is very similar to the Conway in composition, even to the extent that it contains small amounts of beryl, and since the two deposits appear to converge southward, it is reasonable to suggest that they are branching structures.

Norland Deposit

The Norland deposit is exposed 1,700 feet east of the No. 1 occurence. It strikes north and dips 65°–80°W. It is exposed across widths up to about 12 feet, and has been traced intermittently on the surface over a distance of about 1,200 feet. The lithia content is highest at the south end of the dike. Here, over a length of about 300 feet, spodumene is abundant, and selected surface samples were found to contain up to 1.87 percent Li_2O.[1] In September 1958, the lithia-rich section was tested by diamond-drilling by Leitch Gold Mines Limited. Four holes, aggregating 1,050 feet, were bored at 100-foot intervals. The best core intersection, at a footage of 89.2–99.4 in hole No. 19, drilled easterly at 45 degrees at the south end of the dike, was found on analysis to contain 0.81 percent Li_2O.[2]

The Norland deposit is similar to the No. 1 and Conway pegmatites, the principal difference being a relatively fine granularity—potash feldspar crystals range in length from 1½ to 12 inches, spodumene crystals, ½ to 1½ inches. Longitudinal aplite veins, up to 4 inches thick, interrupt the deposit at closely-spaced intervals as before. They constitute much of the surface exposure and no doubt are largely responsible for the low average grade of the deposit. In the southernmost exposure, the dike splits and bifurcates. One branch, 3 feet wide, trends S.10°W., and it is of interest to note that along its strike, at distances of 400–450 feet and 550 feet, exposures of lithium-bearing pegmatite again occur. These are also narrow, however, and of little economic significance.

No. 4 Deposit

The No. 4 deposit is exposed 650 feet east of the south end of the Norland dike, and from this point it has been traced intermittently on the surface in a direction of S.30°E. for a distance of 600 feet. It ranges up to 6 feet in horizontal width and dips 70°–75°SW. Selected surface samples were found on analysis to contain up to 2.28 percent Li_2O.[3]

In 1958 the No. 4 deposit was tested by two diamond-drillholes, totalling 270 feet, bored by Leitch Gold Mines Limited. These were collared 200 feet apart to test the dike roughly midway along its length. They intersected nothing of commercial value.

DUNNING LITHIUM DEPOSITS (6)

Several lithium deposits are exposed along or close to the motor road, about 3,000 feet south of the east end of Palace Lake in the northeastern part of the map-area. They occur as dikes cutting metasediments in a zone that, according to R. S. Woolverton (1956) was found to extend over a distance of about 2,000 feet. Two of the dikes were examined by the author and are shown on map No.

[1]Information from a plan provided by G. A. McKay, manager, Leitch Gold Mines Limited.
[2]Assessment work files, resident geologist's office, Port Arthur.
[3]Information from a plan provided by G. A. McKay, manager, Leich Gold Mines Limited.

2056 (back pocket). These dikes are 4–5 feet wide. One strikes N.5°E., roughly along the line of strike of the Norland dike located on claims held by E. S. Conway north of Palace Lake (see p. 69); the other strikes N.45°E. Both are fine-grained, with spodumene crystals up to ½ inch in length. Their lithia contents are low and are of no present economic importance.

FOSTER LITHIUM DEPOSIT (7)

The Foster lithium deposit lies within a small, sill-like body of massive, pink, biotite granite in metasediments, and occurs near the northeast end of Lake Jean and about 2 miles east of Parole Lake. It was discovered in the summer of 1956 on ground staked the previous November by W. W. Kembel. This ground was acquired by Towagmac Exploration Company Limited, and from 19 September to 6 October 1956, the deposit was tested by five diamond-drillholes, having a total length of 2,003 feet. However, this work indicated the deposit to be of low grade, and eventually, in February 1961, the claims making up the company's property were allowed to lapse.

The Foster dike strikes N.80°–85°E. and dips 80°–85°S. To the east it is exposed continuously for 250 feet. Over this length it averages about 30 feet in thickness. To the west, it splits into a number of thin, parallel tongues, and where intersected in the most westerly diamond-drillhole (T-10), it was found to be represented by seven strips of pegmatite, 1–8 feet wide, separated by bands of granite from a few inches to 3 feet wide. The deposit contains 10–15 percent spodumene, which here is typically fine-grained to medium-grained in size and for the most part unaltered. As in other deposits in the northeastern part of the area, its crystals are prismatic and oriented normal, or nearly so, to the strike and, except for narrow "chill" or border zones, extend from wall to wall. The pegmatite was intersected in four of the five diamond-drillholes bored in 1956, over a length of 400 feet, and was found to average less than 1 percent lithia. The intersections were as given in the accompanying table.

FOSTER LITHIUM DEPOSIT; RESULTS OF DIAMOND-DRILLING BY TOWAGMAC EXPLORATION COMPANY LIMITED

(From Walter 1957a)

Hole No.	Location	Core Length	Lithia Content
		feet	percent
7	3 + 50W	29.0	0.26
6	4 + 50W	30.0	0.55
9	5 + 50W	31.3	1.04
		20.0	0.58
10	7 + 50W	32.7	0.58

The fifth diamond-drillhole, collared 300 feet east of hole T-7, failed to intersect spodumene-bearing pegmatite.

GEORGIA LITHIUM DEPOSIT (8)

During the staking rush following E. W. Hadley's discovery of a small reef of spodumene-bearing pegmatite in Georgia Lake, a group of 39 claims, east of the south end of Blay Lake, was staked in May 1955 for H. E. Martin. These claims subsequently were mapped geologically for Georgia Lake Lithium Mines Limited, on a scale of 1 inch to 200 feet, by S. S. Szetu, a geologist of Geo-Technical Development Company Limited. The mapping resulted in the location of a group of eleven glacial erratics, scattered over an area of 250 feet by 60 feet, about a mile east of the south end of Blay Lake and a mile south of the east end of Abner Lake. These erratics have been described by S. S. Szetu (1955) as follows:

> These erratics have sizes ranging from about 3 × 3 × 3 to 15 × 15 × 10 cubic feet, and appear not [to have been] carried by glaciers from a far distance. Trenches dug immediately north and northeast of the group [of boulders] did not uncover any pegmatite dike. The erratics have a similar appearance to the pegmatite of the showings at the property of . . . [Ontario Lithium Company Limited], the nearest of which is a little more than a mile to the northeast. No similar erratics have been found in between. Further exploration to the northeast of the erratics by means of trenching is thus desirable.

In 1956, sixteen diamond-drillholes, aggregating 9,589 feet, were bored to investigate the ground near the boulders. These holes completed a section extending S.17°E. from the east end of Abner Lake for about 4,000 feet. Two of the holes tested the ground about 1,500 feet northeast of the boulders, in a location where the erratics may have originated. The deposit was not located, however, and eventually, on 20 July 1960, the claims were allowed to lapse.

GILES LITHIUM DEPOSIT (9)

The Giles deposit is exposed on Treasure Island about midway along the south shore of Lake Jean. It was staked by Daniel Kirpatrick on 16 September 1955. In June 1956 it was acquired by Towagmac Exploration Company Limited, and a program of trenching and diamond-drilling was carried out. The drilling failed to disclose a mineable lithium deposit, however, and in February 1959 the claims protecting the discovery were allowed to lapse.

The country rock underlying Treasure Island is a biotite schist or gneiss, which strikes N.80°–85°E. and dips 50°–65°S. The Giles pegmatite parallels the schist in strike, but dips 70°–80°S., at a steeper angle, and hence is a dike rather than a sill as might be concluded from a surface examination. It has been traced intermittently across the island, in surface exposures and diamond-drillholes for 600 feet, and has been found to range in width from about 13 to 50 feet.

The spodumene crystals found in the Giles pegmatite are of slender prismatic habit, and are fine- to coarse-grained; the largest, up to 6 inches in length and ¼–½ inch in width, occur near the centre of the pegmatite. These crystals, together with medium- to coarse-grained individuals of pale grey to pinkish potash feldspar, occur as phenocrysts in a matrix of fine-grained quartz and feldspar with accessory muscovite and, in places, a little black tourmaline. They exhibit a well-developed, subparallel to parallel alignment, normal to the strike near the margins of the pegmatite but oblique to the strike in the interior portions. Alteration of spodumene is evident in several places in surface exposures but quantitatively is not significant.

Surface sampling is reported to have indicated the 600-foot length of the deposit to average 1.25 percent lithia across an average width of 25 feet (Walter 1957a). The pegmatite was tested by and intersected in five diamond-drillholes, aggregating 2,406 feet, spaced at intervals of 100–200 feet. Of the five holes, only two, T-4 and T-5, cut spodumene-bearing material. Diamond-drillhole T-4, drilled S.25°E. at 45 degrees, intersected 30 feet of pegmatite, of which 5 feet near the footwall was found on analysis to contain 0.21 percent Li_2O (Walter 1957a). Diamond-drillhole T-5, drilled S.25°E. at 76 degrees down the dip of the deposit, from a set-up at about the centre of the deposit, cored pegmatite to a depth of 289 feet, the bottom of the hole. From a depth in the hole of 3 feet to a depth of 80 feet 5 inches, the pegmatite averages 1.06 percent Li_2O;[1] from 80 feet 5 inches to the bottom of the hole, however, the spodumene content was found to be negligible, the average grade throughout this core length being 0.08 percent Li_2O (Walter 1957a).

It is evident from the drilling that the Giles deposit is zoned, with a spodumene-rich section enclosed by low-grade muscovite-quartz-feldspar pegmatite. It is of interest that the only indication of this zoned structure at the surface is found at the east end of the deposit. Here, on the shore of the island, the pegmatite is exposed over a width of 20 feet and is found to be made up of a 16-foot-wide central section, rich in spodumene, flanked by two 2-foot-wide wall zones of tourmaline-bearing rock, relatively rich in muscovite but containing little or no spodumene.

HARRICANA LITHIUM DEPOSIT (10)

The Harricana lithium deposit occurs as a prominent dike cutting metasediments northeast of Downey Lake in the northeastern part of the map-area; it is partly on the property of Nama Creek Mines Limited and partly on open ground to the south. The occurrence was staked in the late spring of 1955 and subsequently was investigated by trenching and sampling, and by a diamond-drilling program conducted jointly by New Highridge Mining Company Limited, New Harricana Mines Limited, and Nama Creek Mines Limited. A total of 15 diamond-drillholes, aggregating 7,136.8 feet, were bored at 200-foot intervals over a strike length of 1,600 feet. This work, however, failed to indicate anything of commercial interest, largely because of severe alteration of the spodumene of the pegmatite. In June 1957 the claims of New Harricana Mines Limited at the south end of the deposit were allowed to lapse; in June 1959 those held by New Highridge Mining Company Limited were allowed to lapse.

The Harricana dike has been traced in the diamond-drillholes and in outcrops for a total length of 1,850 feet. Throughout most of this length, the dike strikes N.30°E. To the northeast, however, it curves and assumes a strike of N.45°E., roughly parallel to the metasediments. It dips 70°–80°NW., and is 10–45 feet thick, the thicker portions occurring where, over a length of 1,300 feet, the strike is N.30°E. The dike is crudely tabular in shape and, as far as can be ascertained from the outcrops and the diamond-drillhole intersections, does not appear to split and branch.

The principal constituents of the Harricana dike are potash feldspar, spodumene, quartz, plagioclase, and muscovite. The potash feldspar forms elongate individuals up to 8 inches in length; the spodumene is found as prismatic crystals up to 4 inches, in most places 1–2 inches, in length. They occur in a relatively fine-grained matrix of pegmatite minerals, and are arranged in subparallel alignment, roughly perpendicular to the walls of the dike. In a few places the spodumene is pale greenish and unaltered. Much of it, however, has been replaced by granular-textured muscovite, and considerable black spodumene, changed largely to "sericite," is evident. In a few places the altered spodumene appears to be more abundant closer to the walls of the pegmatite than in the interior portions, but in general its distribution is irregular throughout the full

[1]Average calculated by author from data included in Walter (1957a).

length of the deposit. The dike is interrupted in places by conformable vein aplites up to 12 inches thick. However, these are not numerous and would not reduce significantly any value the deposit might have.

The average grade of the Harricana dike is less than 0.5 percent Li_2O, and it cannot be considered of any economic importance at the present time. The best intersection was obtained in diamond-drillhole HM-14. This hole, drilled S.40°E. at 55 degrees to intersect the dike near its south end, cut 39.5 feet of pegmatite. One 10.0-foot section, 9.0 feet from the hanging wall, was found on analysis to average 0.97 percent Li_2O.[1]

JEAN LAKE LITHIUM MINES LIMITED (11)

Following the discovery of lithium pegmatite at Georgia Lake, a large block of claims north of and at the west end of Lake Jean was staked in June–July, 1955, by Lewis E. Giles and August Rentz. Subsequently in October 1955 the claims were acquired by Jean Lake Lithium Mines Limited; in the spring and summer of 1956 the known lithium occurrences were investigated by surface work and diamond-drilling under the direction of the late J. P. Walter. The five principal deposits all occur in metasediments; one of them, the Parole Lake or No. 4 deposit, was found to contain an appreciable tonnage of ore-grade material.

No. 1 Deposit

No. 1 deposit is exposed on leased claim T.B.71944, along a poorly marked winter road between Lake Jean and Camp 94 of St. Lawrence Corporation, about ½ mile west of the south arm of Parole Lake. Here it can be traced intermittently on the surface for a length of 315 feet. Its central section strikes N.75°E. for 150 feet and dips 65°–85°S., the dip angle increasing westward. Towards its east extremity, it curves sharply to strike N.30°E. for 75 feet and to dip 60°SE. Similarly, to the west it bends sharply, to strike S.20°–30°W. for 90 feet and to dip from 85°SE. to vertically. Although it attains widths of up to 21 feet, the average exposed width is 12.5 feet, and the average width indicated in diamond-drillholes is 16 feet.

No. 1 deposit is made up of about 30 percent each of potash feldspar and spodumene, 20–25 percent quartz, 10–15 percent plagioclase, and 5 percent muscovite. A porphyritic fabric is conspicuous, with large individuals of potash feldspar and spodumene in a groundmass of fine-grained to very fine-grained quartz, feldspar, and muscovite. The potash feldspars occur as elongated crystals, up to 4 feet in length and 9 inches in width; the spodumene crystals, as thin prisms 1–6 inches in length and not more than ½ inch or so in width. The potash feldspars are characteristically white; the spodumene, except where it is altered close to some transverse and oblique fractures, is pale greenish or greenish grey. Both are well oriented, roughly normal to the strike of the pegmatite. The orientation, however, is not uniform. At the walls, in the central segment of the deposit, the crystals are perpendicular or nearly perpendicular to the contacts; but they change direction inward, so that about midway between the contacts they are oriented obliquely, as if the pegmatite had been deformed plastically by a movement of the footwall westward relative to the hanging-wall. Except for chilled margins, ¼–½ inch wide, the deposit is not zoned, and the composition is remarkably uniform from contact to contact.

[1]Assessment work files, resident geologist's office, Port Arthur.

In its central segment, and near the junction of the central and northeast segments, the pegmatite is interrupted by thin transverse quartz-spodumene veins. These are described in the section Economic Geology (pp. 44, 45). The pegmatite also is interrupted at irregular intervals by narrow quartz and muscovite-bearing quartz veins and, in the northeast segment, by small bodies of aplite. These are quantitatively of little significance and detract little from the average grade of the deposit.

Most of the quartz and muscovite-bearing quartz veins fill transverse fractures and extend across the pegmatite from contact to contact; a few, generally of relatively short lengths, cut the pegmatite obliquely. They do not penetrate the enclosing metasediments where the country rock is exposed. They range from less than 1 inch to about 6 inches in thickness. Where present, the muscovite generally occurs within the veins and is concentrated along and oriented roughly normal to the contacts; in one 6-inch-wide vein, it was found to coat the surfaces of the quartz-filled fracture and to occur as an alteration product of adjoining pegmatite minerals, in particular the spodumene. The transverse veins dip from 45°W. to vertically. Their attitudes, their generally straight contacts, their fairly uniform widths, and their comb-like structures where they are rich in muscovite, indicate that they are simple fillings along extension fractures confined to the pegmatite.

The aplites in the northeast segment of the deposit are elongated bodies having irregular shapes. They range in length from a few inches to 3 feet and have maximum exposed widths of up to 8 inches. With few exceptions they are oriented with their long dimensions roughly perpendicular to the strike; and in one place four of them are "lined up" across the pegmatite. Their boundaries are characteristically accentuated by ill-defined, muscovite-rich zones, ¼–½ inch thick. The aplite itself is made up almost entirely of plagioclase. There is justification, therefore, for assuming that the marginal concentrations of mica represent materials expelled during the formation of the aplite, and that the aplite developed, at least in part, by replacement of original, oriented, pegmatite minerals, for example potash feldspars.[1]

Alteration of the spodumene is not a conspicuous or significant feature of the No. 1 deposit. Altered spodumene, however, does occur close to some transverse and oblique fractures. In most cases the spodumene was sericitized and darkened without loss of idiomorphism; in a few instances, it has been largely replaced by granular-textured aggregates of muscovite. Within the southwest segment of the pegmatite, 6–12 inches from the hanging-wall contact, there is an ill-defined zone rich in muscovite that, because of its occurrence in small elongated oriented aggregates, may also be pseudomorphic after original spodumene crystals.

Between 15 March and 6 June 1956, the No. 1 deposit was tested at 35- to 40-foot intervals by ten diamond-drillholes having an aggregate length of 3,605 feet. Of these holes, only six cut spodumene-bearing pegmatite. In diamond-drillhole A-6, bored to cut the southwest segment at a depth of 60–70 feet, the pegmatite was found to average 0.15 percent Li_2O over a core length of 9 feet 10 inches.[2] Except for this low-grade intersection, however, the lithia content in the other holes was found to range from 1.07 percent, over a core length of 10 feet in hole A-2 through the northeast segment, to 1.29 percent, over a core length of 34 feet in hole A-4 through the central segment.[2] Holes A-3, A-4, and

[1]V. G. Milne, post-graduate student, University of Toronto; personal communication.
[2]Information from assessment work files, resident geologist's office, Port Arthur.

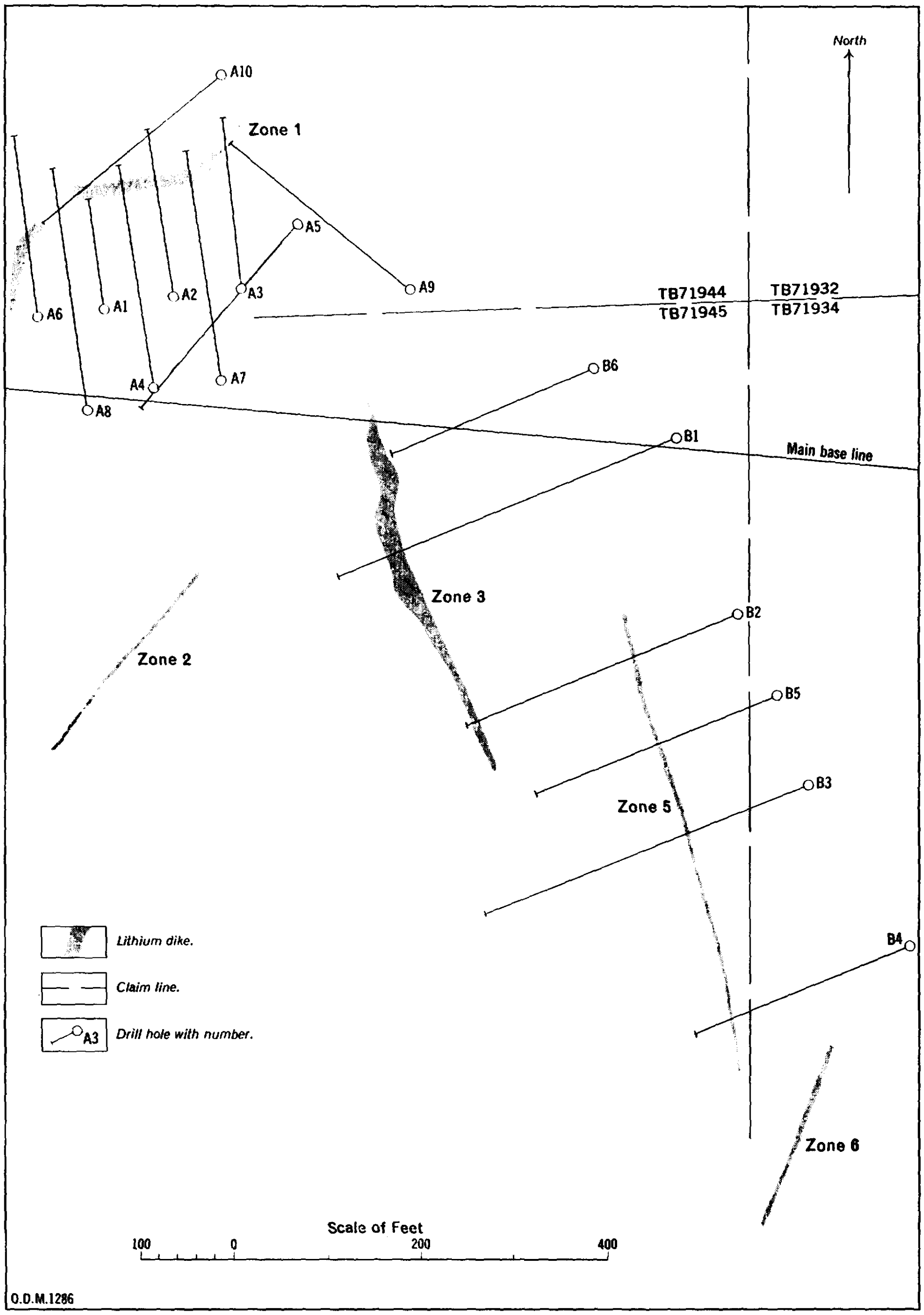

Figure 10—Surface plan showing Nos. 1, 2, 3, 5, and 6 deposits; Jean Lake Lithium Mines Limited.

A-6 were bored at a dip angle of 50 degrees. The failure of two deep holes, A-2 and A-9, to intersect the pegmatite below the southeast and northeast segments at approximate vertical depths of 250 and 200 feet, respectively, indicates that the deposit may be a small lens, whose ends rake flatly inward.

No. 2 Deposit

No. 2 deposit is exposed about 350 feet S.40°E. of the southwest extremity of the No. 1 deposit (*see* Fig. 10), and from this point it is exposed intermittently over a length of 210 feet along a strike of N.30°E. It dips vertically and averages about 4 feet in width. Like the No. 1 deposit, it is made up of large crystals of potash feldspar and spodumene in a fine-grained to very fine-grained matrix of quartz, feldspar, and muscovite. The larger crystals, although they tend as before to be aligned roughly normal to the contacts, are poorly oriented. Large, rounded to irregular-shaped patches of aplite, 2–3 feet across, occur. The spodumene content is low, and the deposit was not tested by diamond-drilling.

No. 3 Deposit

No. 3 deposit appears to be an attenuated lens. It is found 330 feet S.30°E. from the northeast extremity of the No. 1 deposit (*see* Fig. 10), thence extending irregularly to the southeast for 300 feet. It dips 85°NE. In surface exposures it averages about 5 feet in width. It is similar to the No. 2 deposit in structure and composition, but tends to be coarser-grained, with potash feldspars up to 18 inches, and spodumene crystals up to 8 inches, in length.

The No. 3 deposit was tested by three diamond-drillholes.[1] Hole B-1, drilled at 45 degrees near the centre of the deposit, cut 13.5 feet of pegmatite having an average grade of 1.20 percent Li_2O. Hole B-2, also drilled at 45 degrees from a point 200 feet southeast of hole B-1, intersected 11.9 feet of pegmatite, 5 feet of which near the lower contact yielded 1.26 percent Li_2O. Hole B-6, drilled at 60 degrees from a set-up 100 feet northwest of B-1, cut 12.5 feet of pegmatite, of which the upper 5 feet was found to contain 0.83 percent Li_2O. The intersection in hole B-6 was found about 100 feet east of where anticipated. It either indicates a flattening of the dip to about 60°NE. at the northwest end of the dike, or it represents a parallel occurrence.

No. 4 (Parole Lake) Deposit

The Parole Lake pegmatite is exposed about 50 feet west of the shore of Parole Lake. It strikes easterly, and dips 80°–85°S. The most conspicuous feature of the deposit is a crude-layered structure perpendicular to the strike. This structure is due to the occurrence of lenses and irregular-shaped bands of white potash feldspar, with small amounts of fine-grained quartz and a little muscovite. The lenses and bands make up almost half the deposit. Separating them is a matrix consisting of: spodumene, 50 percent; quartz, 25; feldspar, 15–20; and muscovite, 5–10 percent. The spodumene is pale green and occurs as slender, well oriented, prismatic crystals, averaging 2 inches or less in length; the quartz, plagioclase, and muscovite form a fine-grained groundmass. Although in places the spodumene content decreases, and the amounts of feldspar and muscovite increase towards the margins of the pegmatite, there is no internal-zoned structure.

[1]Information from assessment work files, resident geologist's office, Port Arthur.

At one place on the surface, the Parole Lake deposit is represented by a group of angular boulders. These boulders have not been shifted laterally and have been simply detached through frost action. Of particular interest is that one boulder, although remaining directly over the dike, has been rotated 90 degrees. In this boulder the spodumene and layered structure are oriented parallel rather than at right-angles to the strike of the pegmatite.

The deposit was tested by 28 diamond-drillholes, aggregating 16,053 feet, drilled between 10 November 1955 and 23 May 1956, under the direction of the late J. P. Walter. Sixteen holes, drilled to intersect the pegmatite at vertical depths of 100–250 feet, indicated a horizontal length at these levels of about 525 feet and an average width of 14.1 feet. The deposit becomes longer and thicker with depth, however, and nine drillholes, put down to intersect it at the 500-foot horizon, indicated a length of 1,100 feet and an average width of 17.2 feet. The remaining three holes, 600 feet apart, were bored at 50 degrees to cut the deposit at about the 1,000-foot horizon. The most easterly hole cut 25 feet of pegmatite at a vertical depth of 850 feet; the second deep hole, put down 600 feet west of the first, cut 32 feet of pegmatite at a vertical depth of 1,100 feet; the third and most westerly hole failed to intersect the deposit.

According to an estimate by J. P. Walter, the Parole Lake pegmatite contains, to a vertical depth of about 1,100 feet, 1,689,000 tons of material having an average grade of 1.30 percent Li_2O (Finlay 1956). It is possible that there is with depth an improvement in grade as well as width. The shallow holes indicated an average grade of 1.06 percent Li_2O; the nine holes drilled to cut the deposit at the 500-foot horizon, an average of 1.25 percent Li_2O; and the two deep holes, grades of 1.23–1.34 percent Li_2O (Finlay 1956).

No. 5 Deposit

No. 5 deposit is exposed 200 feet east of the southeast end of No. 3 deposit, and has been traced along a strike of S.30°E. for 200 feet. It dips from about 85°NE. to vertical and is up to about 12 feet in width. It is quite similar to No. 2 deposit in texture and composition. In surface outcrops near its northwest extremity, a sharp right-hand deflection in strike is apparent. This deflection, however, is small and local and does not significantly affect the general attitude of the pegmatite.

No. 5 deposit was intersected in two diamond-drillholes. Hole B-3, drilled S.62°W. at 45 degrees, cut 12.0 feet of pegmatite averaging 1.00 percent Li_2O; hole B-5, collared 100 feet to the northwest and drilled S.62°W. at 35 degrees, cut 7.5 feet of pegmatite averaging 1.16 percent Li_2O.[1] Two other holes (B-2 collared 100 feet northwest of B-5, and B-4 collared 200 feet southeast of B-3) failed to intersect the deposit.

KENOGAMISIS LITHIUM DEPOSIT (12)

The Kenogamisis deposit, located in Kilkenny township at the north end of Downey Lake, was staked by Alfred Vallee and Laurier Grenier of Beardmore in May 1955, and was acquired by Kenogamisis Gold Mines Limited on 9 June 1955. The following December, three diamond-drillholes, totalling 1,015 feet, were bored at 200-foot intervals to test the deposit; but they did not locate anything of commercial interest. No additional work has been attempted, to the author's knowledge, and in July 1959 the claims were cancelled.

[1]Information from assessment work files, resident geologist's office, Port Arthur.

The Kenogamisis pegmatite is a tabular-shaped body in metasediments. It strikes N.60°E. and dips 70°NW., and has been traced intermittently in outcrops for about 650 feet distant from the shore of Downey Lake. Exposed widths range from about 6 feet in the most southwesterly exposure, to 13 feet at the northeast end at the lakeshore. The deposit is made up of medium-grained, pink to bluish grey, potash feldspar crystals and fine- to medium-grained spodumene crystals. These occur in a fine-grained matrix of quartz, feldspar, and muscovite, and, like other deposits near Downey Lake, they exhibit a well-developed subparallel to parallel alignment normal to the pegmatite contacts. The spodumene content appears to be highest in the central portion of the pegmatite, and the muscovite content highest near the walls. The muscovite occurs as granular-textured aggregates, and since these are elongated and about the same general size as the spodumene crystals and exhibit the same preferred orientation, the muscovite may have replaced original spodumene. Aside from this, much of the spodumene in the central portion of the pegmatite is black and highly sericitized. This may be due to the proximity of a large, thick sheet of diabase to the west and southwest.

Surface samples of the Kenogamisis pegmatite were taken at the lakeshore, and at 100 feet and 200 feet from the lakeshore. These samples were found on analysis to indicate 0.49 percent lithia over a width of 10.0 feet; 1.31 percent lithia over a width of 9.0 feet; and 0.55 percent lithia over a width of 7.0 feet respectively.[1] In the diamond-drillholes, the deposit was found to range from 0.21 percent lithia over a core length of 7.6 feet in hole K-2, drilled at 60 degrees, to 0.78 percent lithia over a core length of 12.3 feet in hole K-3, drilled at 70 degrees from the same set-up, 450 feet from the lakeshore.[2] The spodumene content of the deposit decreases away from Downey Lake, and in the most southwesterly exposures it is negligible.

Three narrow dikes of pegmatite, spaced at intervals of 10 and 40 feet, occur on the east shore of Downey Lake. They strike N.60°E. The largest, averaging 40 inches wide, contains about 10 percent spodumene. It lies roughly along the line of strike and may represent the northeast extension of the Kenogamisis pegmatite.

At the southwest end of the Kenogamisis deposit and 50 feet to the northwest, a parallel lithium pegmatite about 5 feet wide is exposed. It can be followed on the surface for about 75 feet, and was intersected in the diamond-drillholes 100 feet and 300 feet northeast of its outcrop. Where exposed, it averages about 5 percent fine-grained spodumene. In diamond-drillhole K-3, it was found to contain 0.57 percent lithia over a core length of 11.5 feet; in hole K-1, drilled at 45 degrees from a set-up 200 feet northeast of K-3, 0.29 percent lithia over a core length of 5.0 feet.[2] Much of the spodumene is highly sericitized.

LEW LITHIUM DEPOSIT (13)

The Lew deposit occurs in metasediments about 1,500 feet southwest of the Foster dike (*see* p. 70), near the northeast end of Lake Jean. Like the Foster dike, it was acquired by Towagmac Exploration Company Limited in 1956.

[1]Walter Maybank, exploration manager, Kenogamisis Gold Mines Limited; personal communication.

[2]Assessment work files, resident geologist's office, Port Arthur.

Except for some stripping, little or no work was done, and the claims protecting the discovery were cancelled on 1 February 1961.

The Lew deposit strikes northeast, obliquely across the metasediments, and dips steeply south. It has been traced on the surface for 108 feet, and over this length is 8–10 feet in width. It is cut by several transverse, east-dipping faults, with right-hand displacements of 1 inch or less in most places, but in one instance of 5.5 feet. The spodumene occurs from wall to wall as medium-grained, slender, prismatic crystals, oriented for the most part perpendicular to the strike. It is pale green in colour, unaltered, and makes up 15–20 percent of the deposit.

LINE 60 LITHIUM DEPOSIT (14)

The Line 60 deposit is exposed about 1,600 feet east of the Harricana pegmatite, northeast of Downey Lake, partly on the property of Nama Creek Mines Limited and partly on open ground formerly held by New Highridge Mining Company Limited. It was staked in the late spring of 1955 and subsequently was investigated by trenching and sampling, and by a diamond-drilling program conducted jointly by the two companies. A total of 15 diamond-drillholes, aggregating 7,817 feet, were bored at intervals of 80–220 feet over a strike length of 1,700 feet. This work, as in the case of the Harricana dike (pp. 72, 73), failed to indicate anything of commercial interest, and in June 1959 the claims held by New Highridge Mining Company Limited were allowed to lapse.

The Line 60 dike was so named from the fact that it is exposed on picket line L60 of Nama Creek Mines Limited. It strikes about N.15°E. At its south end, the dip is vertical to steeply west. The dip decreases to the north, however, and near the north end of the dike it is 50°–70°W. The width attains a maximum of about 70 feet in diamond-drillhole No. 28, collared about midway along the length tested, and from here it decreases more or less gradually outward, to about 10 feet at the north end of the dike, and about 25 feet at the south end.

The Line 60 dike is similar to the Harricana in composition. It is made up of medium- to coarse-grained crystals of potash feldspar, and of fine- to medium-grained crystals of spodumene, occurring as phenocrysts in a matrix of quartz, feldspar, and muscovite. The phenocrysts, as before, are arranged in subparallel alignment, and are oriented at right-angles, or nearly so, to the strike of the dike. The Line 60 dike also resembles the Harricana in internal structure—it is not zoned, and it is interrupted at closely spaced intervals by prominent longitudinal or vein aplites (*see* Economic Geology, pp. 40–42). The aplites are thicker, with widths up to 36 inches, and in places, about midway along the length of the dike, they are nearly as prominent in outcrops as the pegmatite itself. Altered spodumene is abundant and tends to be concentrated close to the contacts, particularly to the footwall contact. It increases in amount, and the lithia content of the pegmatite decreases southward towards the large sheet-like mass of diabase that is exposed about Palace Lake.

Because of alteration, the lithia content of the Line 60 dike as a whole is low. In the northern part of the deposit, however, one section was found to average better than 1 percent Li_2O. This section occurs in the interior of the pegmatite, at or within 15 feet of the hanging wall, and ranges in thickness from less than 10 feet near its extremities to a maximum of about 25 feet. It was cut in eight diamond-drillholes over a strike length of 1,150 feet. The diamond-drillhole intersections are indicated in the accompanying table.

LINE 60 DIKE; RESULTS OF DIAMOND-DRILLING BY
NEW HIGHRIDGE MINING COMPANY LIMITED AND NAMA CREEK MINES LIMITED

(Information from assessment work files, resident geologist's office, Port Arthur.)

Hole No.	Strike Distance from Hole 23	Angle of Hole	Pegmatite		Lithia-Rich Section		Core Length	Average Grade Li_2O
			From	To	From	To		
	feet		feet	feet	feet	feet	feet	percent
23......	0	50°	229.0	310.0	235.0	245.0	10.0	0.95
19......	240	50°	138.7	201.5	145.0	175.0	30.0	1.29
28......	340	50°	355.0	446.5	360.0	370.0	10.0	1.16
			182.0	200.5	182.0	200.5	18.5	1.21
20......	515	50°	214.0	230.0	214.0	230.0	16.0	1.00
			249.0	260.0	—	—	—	—
21......	740	50°	136.0	153.0	136.0	153.0	17.0	1.00
			163.4	170.0	—	—	—	—
22......	960	50°	76.5	100.5	85.0	95.0	10.0	0.92
24......	1,150	50°	71.5	103.0	80.0	85.0	5.0	1.44

LUN-ECHO GOLD MINES LIMITED (15)

Introduction

In early 1961, Lun-Echo Gold Mines Limited held a group of 37 claims, located east of Forgan Lake, about 2 miles northeast of the Pine Portage dam of the Hydro-Electric Power Commission of Ontario on the Nipigon River. These claims were staked in August 1955, following the discovery of lithium pegmatite, along an old logging road, by prospectors Fred Bergkvist and Onni Niemi. Careful examination of the ground indicated the presence of additional occurrences; these appeared to have sufficient promise that an intensive exploration program was initiated. A geological survey of the property, on a scale of 1 inch to 100 feet, was made by N. H. Black of Bartley, Greer and Associates, between September 26 and December 1955, when the various deposits were tested by diamond-drilling; a total of 39 holes, aggregating 10,561 feet, were bored. However, because the lithium deposits are truncated at shallow depths by diabase, and because the spodumene close to this diabase is highly altered, the work done failed to indicate the presence of any substantial tonnage of ore-grade material.

General Geology

The rocks exposed on the property are chiefly metasediments, which strike N.40°–45°E. and dip 55°–70°SE These are cut by two prominent diabase dikes. One diabase dike, 75 feet in width, is exposed along the west shore of Lucky Lake, the small pond ¾ mile east of Forgan Lake. It strikes N.5°–10°W. and has been traced intermittently for a distance of about 3 miles. The second dike occurs ½ mile southwest of the first and is roughly parallel to it; where exposed along the old logging road, it has a width of 100 feet. The metasediments are terminated ½ mile west and ¼ mile north of Lucky Lake by the diabase sheet mentioned previously. The sheet dips under the metasediments and was intersected in the diamond-drillholes at vertical depths of 80–230 feet. Analysis of outcrop and drillhole data indicates the sheet has a warped or gently undulating upper contact. In two diamond-drillholes it was found to have vertical thicknesses of 640 and 670 feet.

Lithium Deposits

Six spodumene-bearing pegmatites have been sampled. For the most part they parallel the metasediments in attitude and thus are sills.

No. 1 Deposit

The No. 1 pegmatite is exposed 450 feet west of the south end of Lucky Lake, and from here it has been traced on the surface in a direction of S.40°W. for about 900 feet. It dips 65°–70°SE. It ranges from about 15 feet to 46.5 feet in width; the average width is about 30 feet. The principal constituents are feldspar, spodumene, and quartz, with small amounts of muscovite and a little accessory apatite and columbite. The potash feldspar is white or pale pink and is coarse-grained to very coarse-grained, with individuals in places exceeding 12 inches in length. The spodumene is pale grey and prismatic, generally occurring as medium- to coarse-grained crystals. Both this and the potash feldspar are found as rather poorly oriented phenocrysts in a relatively fine-grained matrix of feldspar, quartz, and muscovite. The black columbite occurs sporadically in crystals up to 1½ inches long; it is not considered to be of any commercial importance. The pegmatite is not zoned. Of some interest, however, is the fact that near the centre of the pegmatite, the continuity is broken in a few places by large irregular patches of sugary-textured feldspar or "aplite." One of these is 5 feet wide and 15 feet long.

The No. 1 pegmatite, as indicated by a study of surface outcrops, contains about 30 percent spodumene. Several channel samples were taken by Lun-Echo Gold Mines Limited. Three samples, from about midway along the known length of the deposit, were found to average 2.57 percent Li_2O over a width of 21.0 feet; two samples, from 80 feet southwest of the first three, averaged 4.23 percent Li_20 over 24.5 feet; and an additional two, from 225 feet farther southwest, 1.98 percent Li_2O over 25.0 feet.[1] The deposit, however, is truncated at vertical depths of 140–165 feet by the diabase sheet mentioned previously. As this sheet is approached, the spodumene becomes highly altered, with concomitant lowering of its lithia content, and the grade of the pegmatite falls below acceptable limits a short distance below the surface. (*See* Economic Geology, pp. 54–60.)

The No. 1 deposit was tested by nine diamond-drillholes, aggregating 3,379 feet, bored at intervals of 100–200 feet along the strike. One of these holes (L-33), 1,803 feet in length, was drilled to cut the pegmatite below the diabase sheet. It is of interest that it intersected 7.1 feet of pegmatite made up of quartz, muscovite, and a greenish mineral (possibly altered spodumene), exactly where anticipated.

No. 2 Deposit

The No. 2 pegmatite is exposed about 100 feet northwest of the southwestern part of the No. 1 deposit. Because of its proximity to the No. 1 deposit, and because it parallels the latter in strike, it is not shown on the map of the area. The No. 2 pegmatite has been traced in outcrops for 150 feet. It has an exposed width of 45 feet, with a 15-foot-thick parting of metasediments 10 feet from its southeast contact. One diamond-drillhole (L-7), bored N.49°W. at 30 degrees, failed to intersect the deposit. The No. 2 pegmatite is similar in composition to the No. 1. Its grade has not been established.

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[1]Information from company plan provided by G. B. Darling, exploration manager, Lun-Echo Gold Mines Limited.

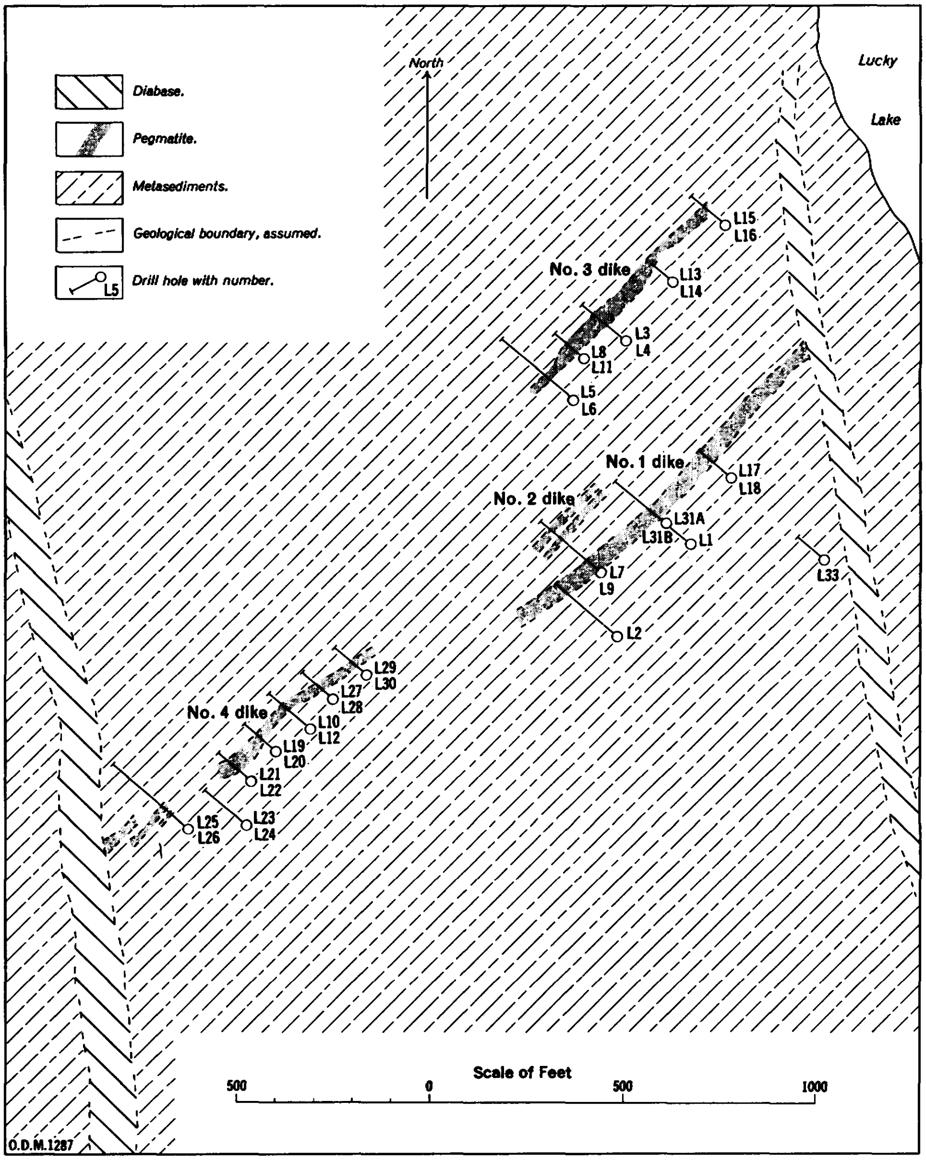

Figure 11—Surface plan showing Pine Portage lithium deposits; Lun-Echo Gold Mines Limited.

No. 3 Deposit

The No. 3 deposit parallels the No. 1 in attitude. It occurs 400 feet northwest of the No. 1 and has been traced from Lucky Lake southwest for 1,050 feet. In the surface exposures it averages about 20 feet and ranges up to 30 feet in width. The No. 3 pegmatite contains about 25 percent spodumene. As in the No. 1 occurrence, however, much of this is highly altered, and the grade of the deposit is low.

The No. 3 deposit was tested by 10 diamond-drillholes, aggregating 2,730 feet, bored at intervals of 100–200 feet. The best intersection was obtained in hole L-3. This hole, drilled N.49°W. at 40 degrees, cut 29.5 feet of pegmatite having an average grade of 0.80 percent Li_2O, including one 5-foot section, 8.0–13.0 feet from the hanging-wall contact, containing 1.78 percent Li_2O.[1] One diamond-drillhole (L-8) was drilled 1,112.7 feet to intersect the No. 3 pegmatite below the truncating diabase sheet. It cut 55.4 feet of pegmatite, containing an unidentified green mineral (possibly altered spodumene), 170 feet northwest of where the deposit should occur, had the formations suffered displacement normal to the contacts of the diabase sheet during the latter's intrusion.

No. 4 Deposit

The No. 4 deposit is exposed 600 feet S.55°W. from the No. 2, and from here it has been traced southwest for about 800 feet. It swings about in strike, ranging from N.40°E. to N.50°E.; therefore it is uncertain whether it is an extension of the No. 2 or a separate pegmatite. It ranges up to 20 feet, averaging about 15 feet, in thickness. The dip, as before, is 65°–70°SE. The pegmatite contains 10–15 percent fine- to medium-grained spodumene. However, the spodumene has been highly altered as before, and the lithia content is low. The No. 4 deposit was tested by 15 diamond-drillholes, totalling 2,949 feet, bored at 100-foot intervals along the line of strike.

No. 5 Deposit

Like the No. 2, the No. 5 pegmatite is not shown on the map of the area. It is located 4,000 feet, S.45°W. from the south end of Lucky Lake, and has been traced in two outcrops and four diamond-drillholes for 550 feet. It strikes N.55°E. and dips 50°–60°SE. In the diamond-drillholes it was found to range from about 5 to 15 feet in thickness. It contains about 20 percent spodumene, but the grade is low because of intense alteration in the proximity of the underlying and truncating diabase sheet.

No. 6 Deposit

The No. 6 deposit is found 100 feet northwest of the No. 5, and 3,100 feet southwest of and roughly along the line of strike of the No. 1.[2] It has been traced in outcrops for a length of 2,050 feet, and it is exposed across widths of up to about 30 feet. Throughout most of its length it strikes N.45°E., but to the southwest it curves to assume a strike of N.20°–25°E., and thus is arcuate in shape. It dips 50°–60°SE.

Some fine-grained spodumene was noted in outcrops. The deposit was tested by two diamond-drillholes, totalling 650 feet, spaced 400 feet apart. The spodumene content of the drill intersections was found to be negligible.

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[1]Assessment work files, resident geologist's office, Port Arthur.

[2]On the map of the area (No. 2056, in back pocket) the Nos, 1, 4, and 6 pegmatites are illustrated by a single red line because of scale limitations. The No. 1 and No. 6 pegmatites lie 3,100 feet apart on the same line of strike; the No. 4 occurs about midway between the other two and about 200 feet to the northwest of them.

M.N.W. LITHIUM DEPOSIT (16)

The M.N.W. lithium deposit is named from the initials of the three men, John Moschuk, T. Neborac, and Murray Wilson, who discovered and staked it in May 1955. It occurs in massive, medium-grained, pink granite and is localized along a fracture, which strikes north and dips 75°–80°W. It ranges up to 45 feet in thickness and has been traced in outcrops and trenches intermittently for a distance of 1,400 feet. Although it pinches and swells, the M.N.W. dike is essentially tabular in shape; towards its extremities it splits into two, and in one place three, narrow units separated by 5–15 feet of intervening wallrock. It is unique in the area in that it is characterized by an exceptionally well-developed, internal-zonal structure. It is made up of five distinct petrographic units: (1) a quartz-spodumene core; (2) a feldspar-muscovite-quartz intermediate zone; (3) cleavelandite-rich intermediate zones; (4) muscovite-quartz-feldspar wall zones; and (5) tourmaline-rich border zones (*see* Fig. 12).

The core of the M.N.W. dike has a length of about 400 feet and widths of up to 30 feet. It is made up largely of fine-to medium-grained, acicular spodumene crystals and quartz, together forming unusual lamellar and fibrous intergrowths. These peculiar intergrowths range up to several feet across. They adjoin and merge with other intergrowths, similar in every way but having different directions of preferred orientation of the spodumene crystals. The spodumene-quartz intergrowths in places enclose scattered, medium- to coarse-grained, tabular crystals of spodumene; they are interrupted at widely-spaced intervals by large, irregular-shaped masses of quartz, from several inches to 7 feet across, and large individuals of potash feldspar up to 4 feet in length. A little amblygonite is associated with the quartz of the irregular-shaped masses, and very small amounts of colourless beryl occur in the spodumene-quartz intergrowths. The spodumene of the core is largely white and unaltered. Some altered spodumene, however, occurs in the southernmost outcrop. Here, on either side and within 6–8 inches of an oblique fracture striking N.20°–30°W., the spodumene is pale red to deep brick-red in colour. The altered spodumene was examined microscopically by V. G. Milne,[1] who found it to be made up largely of a fibrous, colourless mica and a little red hematite, the latter occurring as tiny patches in the mica and as grains and films along irregular fractures.

The inner intermediate zone was not observed in the surface exposures. It extends downward and lengthwise, outward from the core. It is represented by material made up largely of medium-grained quartz with abundant muscovite, some feldspar, and accessory amounts of black tourmaline. The proportions of the major constituents vary considerably, but in general the quartz makes up 50–70 percent by volume; the muscovite, 10–30 percent. In places the pegmatite minerals are interrupted by small, irregular masses of sugary-textured albite. The outer intermediate zones are discontinuous units, 2–6 feet thick, that flank the core and the inner intermediate zone. Unlike the latter, they are made up largely of cleavelandite, as crystals up to 6 inches in length, associated with quartz, muscovite, and some beryl. Minor amounts of tourmaline, columbite, cassiterite, apatite, and purpurite also occur.[1] The cleavelandite-rich unit grades sharply, over an inch or two, into the inner intermediate zone and the adjoining wall zones.

[1]V. G. Milne, post-graduate student, University of Toronto; personal communication.

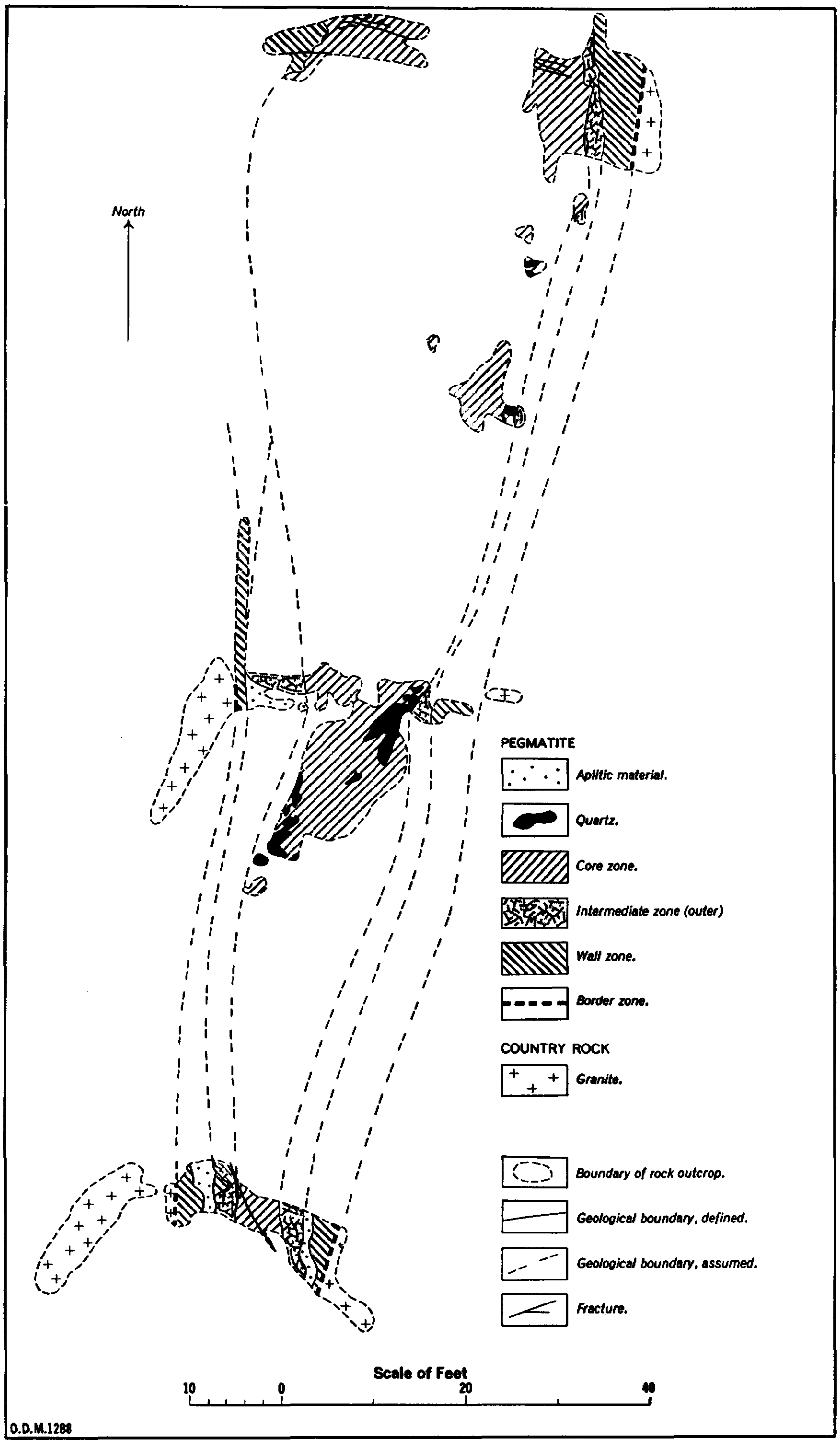

Figure 12—Detailed surface plan of part of the M.N.W. pegmatite.

The wall zones are continuous units, 2–12 feet thick, which lie between the intermediate zone and the border zones. They are made up of quartz with potash and plagioclase feldspars and, in places, a little tourmaline, apatite, and beryl. Adjacent to the cleavelandite zones, the quartz and potash feldspars are medium-grained, with individuals 1–4 inches across. But the granularity decreases outward, so that at the border zones these minerals are typically fine-grained, with individuals ¼–½ inch across. Along and close to the cleavelandite-rich pegmatite, the muscovite-quartz-feldspar material of the wall zones is interrupted at irregular but frequent intervals by large individuals of potash feldspar, many of them 12 inches or more in length. These crystals may represent still another intermediate unit, which, because the central part of the outcrop at the north end of the exposed portion of the dike consists largely of potash feldspar, possibly occurs as a north-plunging "hood."[1] The wall zones are also interrupted in places by irregular-shaped masses of "aplite," from a few inches to several feet across, which appears to replace and is intimately intergrown with the pegmatite minerals. It consists almost entirely of sugary-textured albite ($Ab_{97}An_3$) with a little black tourmaline and blue apatite.[1] It is similar to, but more abundant and conspicuous than, the sugary-textured feldspar of the inner intermediate zone.

The border zones occur as fairly continuous, sharply-defined units, up to about 8 inches thick, along the margins of the dike. Each border zone is made up of two parts, an inner part of pale-grey or pink granite rich in black tourmaline, and an outer part of similar granite in which tourmaline is absent or nearly absent. In the west border zone, the tourmaline-rich layer is ½–1 inch thick and contains in places as much as 90 percent dark mineral. In the east border zone, it is 3–6 inches thick, and contains 25–30 percent tourmaline, which is disseminated irregularly throughout but is particularly abundant, over a width of about ½ inch, adjacent to the outer part of the zone. As pointed out under Economic Geology (p. 45) the border zones are thought to be a part of the granite host rock and to have resulted along the pegmatite contacts by reaction involving the destruction of host-rock biotite, the formation of muscovite, and the combination of original oxides with introduced materials to yield black tourmaline.

In early 1956 the M.N.W. property was optioned to Consolidated Mining and Smelting Company of Canada Limited. The core of the deposit was sampled and was found to average better than 1.5 percent Li_2O,[2] and a program of diamond-drilling was initiated. Fourteen holes, aggregating 2,499 feet, were drilled at intervals of 50–200 feet, over a strike length of 1,400 feet, to cut the dike at vertical depths of 70–90 feet. Nothing of economic value was indicated. Most of the holes failed to cut the spodumene-bearing material of the core, and in those few holes in which spodumene was found, the intersections were narrow or of low grade or both. The property was returned to the vendors on 27 August 1956; the claims were cancelled in June and July, 1957. Subsequently, the M.N.W. dike was sampled for its beryl content,[3] and in July 1960 it was staked by Frederick Koosel as a cesium prospect; but both ventures proved unsuccessful in locating anything of present economic importance.

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[1]V. G. Milne, personal communication.
[2]W. Little, geologist, Consolidated Mining and Smelting Company of Canada Limited; personal communication.
[3]Walter Maybank, Little Long Lac Gold Mines Limited; personal communication.

McVITTIE LITHIUM DEPOSIT (17)

The McVittie lithium deposit is exposed along the north shore of Dive Lake, the small lake about 3,000 feet east of Postagoni Lake, in the northeastern part of the map-area. This deposit was discovered and staked by Jack McVittie, James Cryderman, and E. W. Hadley in the late spring of 1955. On 29 July 1955, Noranda Mines Limited, Anglo-Huronian Limited, and Mining Corporation of Canada Limited jointly secured an option on the property, and from that date until 22 January 1956, a program of trenching and diamond-drilling was undertaken. A total of 12 diamond-drillholes, aggregating 3,587 feet, were bored at intervals of 100–300 feet over a strike length of 1,100 feet. This work, done under the supervision of Noranda Exploration Company Limited, indicated the presence of a substantial tonnage of ore-grade material. A market for the sale of lithia concentrates was not established, however, and on 24 September 1958, the property was returned to the vendors. Subsequently, on 20 July 1960, the claims were cancelled.

North from Dive Lake, for 500 feet, the McVittie pegmatite strikes N.25°W., and then curves to strike N.10°W. It dips 80°E. to vertical and ranges up to 26.5 feet in width. Except for within about 50 feet of the shore of Dive Lake, where it wedges out southward into metasediments, it cuts a small boss of biotite granite and porphyritic biotite granite. It is not coarse-textured—the potash feldspar crystals rarely exceed 4 inches in length; the spodumene crystals, 2 inches. Both these minerals occur in a very fine-grained groundmass of quartz, feldspar, muscovite, and accessory apatite. In places, particularly in the interior portions of the dike, they show little tendency to any preferred orientation. In other places, in general near the walls, they are conspicuously parallel or subparallel and are oriented with their long dimensions perpendicular or nearly perpendicular to the strike. A border or "chill" zone, ¼–½ inch thick, separates the main mass of the pegmatite from its host rocks, and the granularity of the pegmatite itself increases gradually inwards. Just as the granularity increases inwards, so also does the spodumene content; and in the southern part of the dike, over a length of about 300 feet, there are ill-defined wall zones, up to 18 inches wide, which have little or no spodumene but are proportionately rich in muscovite. Much of this muscovite occurs in small, elongated aggregates, which as pointed out under Economic Geology (p. 54), may have replaced original oriented spodumene crystals. Some black, highly sericitized spodumene also occurs, close to oblique fractures; in places, particularly in narrow portions of the deposit, it has significantly affected the latter's tenor (Woolverton 1956). The McVittie pegmatite is interrupted by several longitudinal aplite veins, for the most part 6–24 inches thick. They occur both along and close to the contacts and to some extent in the interior portions of the dike. They are widely separated and unimportant.

The McVittie pegmatite can be divided into three parts on the basis of its lithia content. One section lies 50–650 feet north of Dive Lake; the central section, 650–850 feet north of the lake; and the third section, 850–1,250 feet north of the lake. The first section, 600 feet in length, ranges from 8 to 26.5 feet and averages 17 feet in width. It is estimated to contain, per vertical foot of depth, 770 tons of pegmatite having an average grade of 1.00 percent Li_2O (Woolverton 1956). In the central section, the pegmatite splits into two parallel bodies, each averaging about 5 feet in width. These lie up to 15 feet apart and average 0.68 percent Li_2O (Woolverton 1956). From 1,050 to 1,250 feet north of

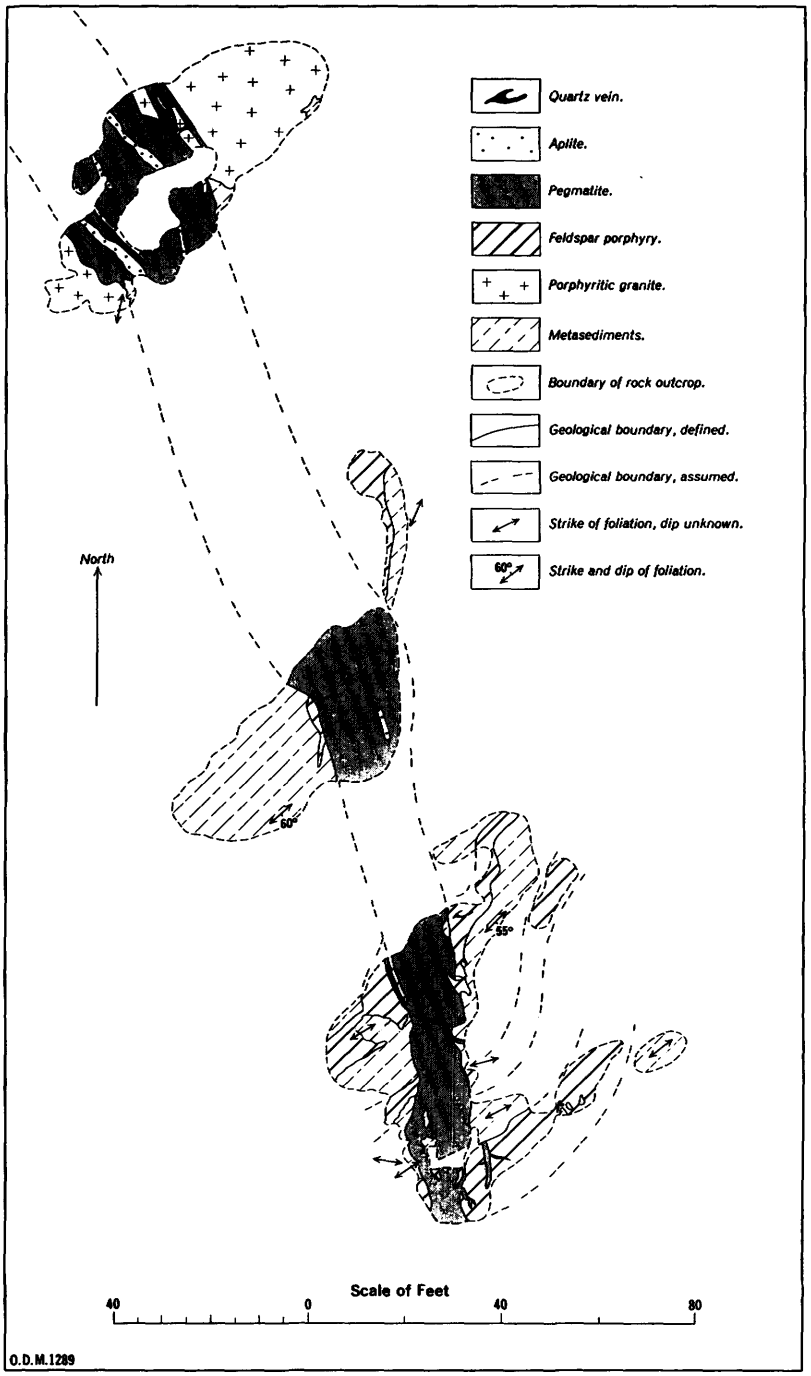

Figure 13—Detailed surface plan of part of the McVittie pegmatite.

Dive Lake, only a single body is present as before. This section averages 7 feet in width. It is estimated to contain, per vertical foot of depth, about 100 tons of pegmatite having an average grade of 1.25 percent Li_2O (Woolverton 1956). To the depth of diamond-drilling (300 feet), the north and south sections of the deposit would contain 261,000 tons of material having an average grade of 1.03 percent Li_2O.[1]

In his report, R. S. Woolverton (1956) mentioned that, 450–1,050 feet north of Dive Lake and 30–75 feet east of the main dike, there is a parallel lithia-bearing pegmatite. This pegmatite has an average width of 6 feet and an average grade of 1.04 percent Li_2O.

NAMA CREEK MINES LIMITED (18)

Introduction

Nama Creek Mines Limited holds a group of 54 claims (T.B. 67132–67185, inclusive) east of Dump and Pawky lakes and north of Downey Lake, in the northeastern part of the map-area. These claims, staked by R. Grenier and associates following the discovery of what appeared to be several promising lithium deposits, were purchased in the late spring of 1955. The deposits were trenched and sampled, and from 17 June 1955 to 21 February 1956, an intensive program of diamond-drilling was carried out. This work indicated the presence to a depth of 1,000 feet in two occurrences (the North and South zones) of 4,292,332 tons of material estimated to have an average grade of 1.06 percent Li_2O (Isaacs 1955).[2] Underground development was planned, and in late 1956 and 1957 a vertical four-compartment shaft was sunk to a depth of 503 feet; stations were cut and levels established at depths of 150, 300, and 450 feet. Markets for the sale of lithium concentrates were not forthcoming, so underground lateral development of the deposits was not initiated. Operations at the property were suspended in mid-1957.

General Geology

The property of Nama Creek Mines Limited is underlain chiefly by thick-bedded biotite gneisses and quartz-rich biotite gneisses. In places these are folded on a small scale, forming synclinal structures pitching 30°–35°SW. and, close to intrusive bodies of lithium pegmatite, minor crenulations and dragfolds. As a general rule, however, the metasediments strike rather uniformly northeast, and dip 50°–85°NW. They are interrupted at widely-spaced intervals by a few tabular bodies of hornblende schist, representing either beds of tuff or basic intrusive sills. These rarely exceed 12 inches in thickness and exhibit a remarkably well-developed boudinage structure. Several diabase dikes, with widths up to 100 feet, cut sharply across the metasediments and the pegmatites; in the extreme southwest corner of the property, along the west shore of Downey Lake, the metasediments are overlain by an intrusive diabase sheet that stands up to form high, east-facing cliffs.

A wide fault zone is thought to exist under a linear valley extending north from Downey Lake. Two diamond-drillholes, bored to test the ground under the valley, intersected intensely fractured metasediments and diabase, showing

[1]Calculated by the author.
[2]*The Northern Miner*, 8 Nov. 1956, p. 17.

calcite and some quartz stringers, and numerous chloritic partings and slickensided slip surfaces. Although the relative displacement is not known, it is apparent that the fault has cut several of the lithium-bearing pegmatites and is responsible for the abrupt terminations of them.

Lithium Deposits

The principal lithium deposits discovered on the property of Nama Creek Mines Limited are: (1) the North Zone; (2) the South Zone; (3) the Boundary; (4) the Line 20; (5) the Camp 37; and (6) the Camp-38 Road pegmatites.

North Zone Deposits

The North Zone deposits occur about 2,500 feet north-northeast of Downey Lake and have been traced northeastward in outcrops and trenches for 2,800 feet. They also have been tested by diamond-drilling over this length—45 diamond-drillholes, aggregating 29,698 feet, were bored to intersect the deposits at 200-foot intervals along strike and at vertical depths of about 100–200, 300–400, and 500–600 feet. From this work, the deposits were estimated to contain, to a depth of 1,000 feet, 2,784,000 tons of pegmatite having an average grade of 1.11 percent Li_2O (Isaacs 1955).

The principal occurrences are two lenses, which overlap along strike and thus are arranged *en échelon* (Fig. 14). The Southwest lens strikes N.50°–55°E. and dips 70°–80°NW. It has a known length of 1,400 feet, and its southwest portion is exposed in outcrops and nine trenches over a distance of 820 feet Where exposed it maintains a fairly uniform thickness of 20–30 feet. To the northeast, however, the width diminishes, and the northeast section of the dike, 600 feet in length, averages only about 10 feet in thickness. The Northeast lens lies 70–125 feet southeast of this section. It strikes N.55°–60°E. and dips 60°–70°NW. It has been traced in the diamond-drillholes for about 2,000 feet, and its central portion is exposed intermittently in outcrops and trenches over a length of 1,100 feet. It ranges from less than 10 feet in thickness at its extremities to a maximum, at a point about 500 feet from its southwest end, of about 60 feet.

The Southwest lens is essentially a single, continuous unit with few wall-rock inclusions and fairly straight contacts, whereas the Northeast lens in several places either splits and bifurcates or separates into roughly parallel units; otherwise both lenses are quite identical in composition and internal structure. In both, the pegmatite is made up of large crystals of potash feldspar and spodumene in a fine-grained matrix of quartz, feldspar, subordinate muscovite, and accessory apatite and garnet. The potash feldspar crystals are characteristically elongated, with lengths of 3–30 inches; the spodumene crystals are prismatic, with lengths up to 24 inches, for the most part 8 inches or less. Both minerals are arranged such that their long dimensions are parallel or nearly parallel, and they are oriented normal to the walls of the pegmatite. Except for chilled margins, ¼–½ inch wide, of quartz, feldspar, and muscovite, and the sporadic occurrence of muscovite-rich, spodumene-poor material across widths up to 2½ feet inward from these margins, the lenses do not exhibit any internal-zoned structure. On the contrary, the composition, or at least the spodumene content, is remarkably uniform from wall to wall (*see* accompanying table). Interrupting the pegmatite lenses at irregular but fairly closely spaced intervals there are transverse muscovite-quartz veins, 2–12 inches thick, and thin but remarkably persistent vein aplites. These are described under Economic Geology (*see* pp.

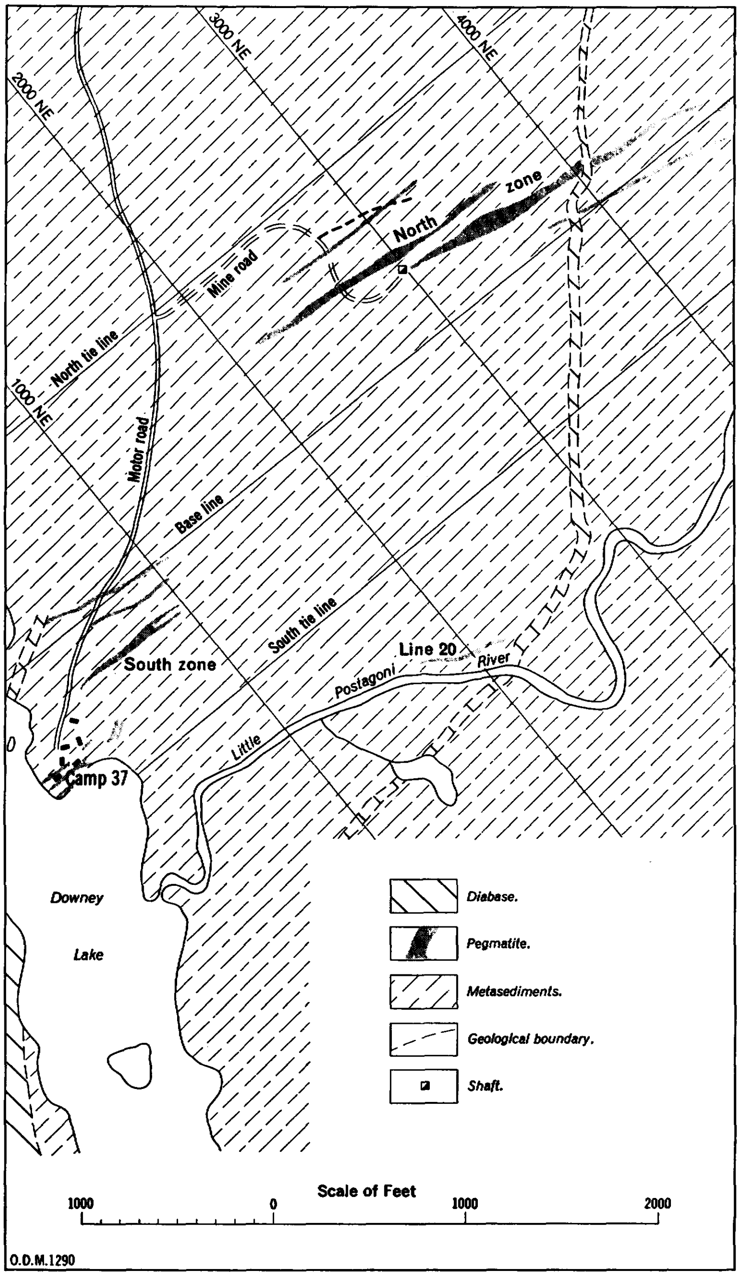

Figure 14—Surface plan showing North and South Zone deposits; Nama Creek Mines Limited.

NORTH ZONE DEPOSITS; RESULTS OF SOME DIAMOND-DRILLING BY NAMA CREEK MINES LIMITED, SHOWING THE DISTRIBUTION OF Li_2O

(Information from assessment work files, resident geologist's office, Port Arthur.)

Hole No.	Footage		Core Length	Lithia Content
	From	To		
			feet	percent
5	550.0	555.0	5.0	0.80
	555.0	560.0	5.0	1.30
	560.0	565.0	5.0	1.35
	565.0	570.0	5.0	1.11
	570.0	575.0	5.0	1.55
	575.0	580.0	5.0	1.97
	580.0	585.0	5.0	1.09
Total or Average	550.0	585.0	35.0	1.31
20	430.0	435.0	5.0	1.14
	435.0	440.0	5.0	1.42
	440.0	445.0	5.0	1.57
	445.0	450.0	5.0	1.66
	450.0	455.0	5.0	1.06
	455.0	459.0	4.0	0.27
Total or Average	430.0	459.0	29.0	1.21
25	702.5	707.5	5.0	1.62
	707.5	712.5	5.0	1.46
	712.5	717.5	5.0	1.38
	717.5	722.5	5.0	1.18
	722.5	727.5	5.0	1.40
	727.5	732.5	5.0	1.26
	732.5	740.0	7.5	1.14
Total or Average	702.5	740.0	37.5	1.33
38	494.5	498.5	4.0	1.70
	501.0	505.0	4.0	1.49
	505.0	510.0	5.0	1.77
	510.0	515.0	5.0	1.64
	515.0	520.0	5.0	1.89
	520.0	525.0	5.0	1.58
	525.0	529.5	4.5	1.93
Total or Average	494.5	529.5	35.0	1.60

40–42). Small inclusions of metasediments also occur. A few of these have been rotated; many have been fractured and veined and dilated by pegmatite material (*see* Photo 19). They are not of any quantitative or economic significance.

Most of the spodumene in the two lenses is unaltered. Some of it, however, is highly sericitized, with a low lithia content and an abnormally high iron content. The altered spodumene is found to some extent throughout the pegmatite, but in general appears to increase in amount towards the contacts, particularly the footwall contact. Significantly, as pointed out on page 58, it decreases in importance with depth except where it is close to a flat sheet of diabase, 30 feet thick, which is found in the diamond-drillholes cutting the northeastern part of the Northeast lens at a vertical depth of about 600 feet. A vertical north-striking diabase dike also cuts the Northeast lens, but here the amount of altered spodumene close to its contacts is small and unimportant.

Figure 15—Detailed surface plan of part of the Southwest lens, North Zone deposit; Nama Creek Mines Limited.

Because the altered spodumene has a high content of iron, which is considered a deleterious impurity, several composite samples of diamond-drillhole cores were analyzed. These were found to average 0.2 percent iron (Isaacs 1955).

In addition to the two large lenses of the North zone, two smaller, more or less parallel dikes are exposed. One of these is exposed 200–250 feet northwest of the Southwest lens. It strikes N.45°E. for a known distance of 950 feet and dips 60°–65°NW. It is 4–10 feet thick and contains 15–20 percent spodumene. It was intersected in nine diamond-drillholes at 200-foot intervals over a strike length of 800 feet. The best intersections were obtained at its southwest end. Diamond-drillhole No. 20, bored S.40°E. at 60 degrees, cut 11.0 feet of pegmatite, which was found on analysis to contain 1.23 percent Li_2O; hole No. 25, also bored S.40°E. at 60 degrees, such as to test the dike 200 feet below the intersection in hole No. 20, cut 12.8 feet of material having an average grade of 1.07 percent Li_2O.[1] The second minor dike is exposed about 200 feet southeast of the Northeast lens. This dike parallels the Northeast lens in both strike and dip. It has been traced in outcrops and diamond-drillholes for a length of about 1,000 feet. It ranges from 2 to about 15 feet in thickness and contains 15–20 percent spodumene as before. The best intersection was obtained in diamond-drillhole No. 36. This hole, drilled S.40°E. at 52 degrees about midway along the length of the dike, cut 14.5 feet of pegmatite having an average Li_2O content of 0.89 percent.[1]

South Zone Deposits

The main South Zone pegmatite is exposed about 500 feet north of Downey Lake. It is similar to the two principal occurrences of the North Zone in mineralogy, texture, and structure, and it is possible that it represents the faulted extension of the latter's Southwest lens. It strikes N.45°E. for a known length of 800 feet, and dips 70°–75°NW. It has been tested by 12 diamond-drillholes, totalling 5,793.0 feet, at 200-foot intervals along the strike, and at vertical depths of about 200, 400, and 500–600 feet. The drilling, together with the surface mapping, showed it to be a crudely tabular dike or attenuated lens, with widths up to about 35 feet and an average thickness of about 25 feet. This dike has been estimated to contain 1,508,332 tons of pegmatite having an average grade of 0.95 percent Li_2O (Isaacs 1955). Like the North Zone deposits, the dike exhibits much altered spodumene. As before, however, the ratio of altered to unaltered spodumene tends to decrease inward from the contacts and, except possibly near the northeast end of the dike, with depth also, therefore selective mining should prove feasible.

A second dike or lens lies 5–25 feet to the southeast and roughly parallels the main pegmatite. This dike has been traced in outcrops and in the diamond-drillholes for about 650 feet. Throughout most of the length tested, it ranges from 10 to 20 feet in thickness. Surface mapping shows that, at its southwest end, it splits and fingers-out into the enclosing metasediments. In general, the spodumene content is lower than in the main dike, and the ratio of altered to unaltered spodumene is higher. The richest material was found in diamond-drillhole NC-16, bored S.40°E. at 50 degrees. At depths in the hole of 305.0–309.4, 310.2–317.3, and 322.0–326.3 it cut 4.4, 7.1, and 4.0 feet of pegmatite,

[1]Assessment work files, resident geologist's office, Port Arthur.

which was found on analysis to contain 1.34, 1.40, and 1.10 percent Li_2O, respectively.[1]

Additional lithium-bearing dikes occur in the South Zone, 150–200 feet and 250–350 feet northwest of the main dike. They strike N.55°–60°E. and dip 70°–80°NW. The pegmatite located 150–200 feet northwest of the main dike has been traced in diamond-drillholes and outcrops over a distance of about 450 feet; the second pegmatite, for about 650 feet. Both are narrow, averaging less than 10 feet in width, and their spodumene contents are low. At its southwest end, the second pegmatite is cut by a diabase dike that strikes N.15°–20°E. and dips 65°–70°E.

Boundary Deposits

The Boundary lithium pegmatites are exposed in the southeastern part of the property, south of Little Postagoni River, on claims T.B. 67174, 67175, and 67176. They have been described elsewhere in this report as the West, Harricana, and Line 60 deposits (*see* pp. 72, 73, 79, 80, 105, 106).

Line 20 Deposit

The Line 20 dike cuts metasediments exposed along the north bank of Little Postagoni River, about 2,000 feet east-northeast of Camp 37 of St. Lawrence Corporation Limited at the north end of Downey Lake. This dike strikes N.85°E. and dips 70°–75°N., and has been traced in outcrops for a distance of about 450 feet. At its west end, over a length of 250 feet, the dike is 7–8 feet wide; to the east, over the remaining length, it tapers to a width of about 3 feet. The Line 20 dike is similar to the North Zone and South Zone deposits in composition, with potash feldspar crystals, 6–30 inches in length, and spodumene crystals, 1–6 inches in length, occurring as phenocrysts in a fine-grained matrix of feldspar, quartz, and muscovite. The Line 20 dike is also similar to the other deposits in internal structure. It is separated from the enclosing metasediments by thin (⅛–¼ inch) "chill" zones; it tends to be richer in muscovite and poorer in spodumene within a few inches of its contacts; and it is interrupted in places by thin vein aplites and transverse quartz veins. Where the dike is 7–8 feet wide, it is estimated visually to contain 15–20 percent spodumene; where it is 3–5 feet wide, about 10 percent. While some of the spodumene has been highly sericitized, most of it is pale greenish grey and unaltered, and has a high lithia content.

The Line 20 dike was tested by one diamond-drillhole (N.C.-42) 480 feet long. This hole was drilled S.40°E. at 50 degrees. Spodumene-bearing pegmatite was intersected at depths in the hole of 208.3–210.5, 212.5–215.0, 271.5–274.0, and 411.0–415.5 feet. The cores were found to contain 10–15 percent spodumene, but this has been highly altered, and the lithia content accordingly is low.[1]

Camp 37 Deposits

Three pegmatite dikes are exposed at the end of the road at the abandoned Camp 37 of St. Lawrence Corporation Limited, at the north end of Downey Lake. One dike, which strikes N.60°E. and dips steeply northwest, can be traced in outcrops for 90 feet. It averages about 12 inches in width, ranging from 6 inches at its northeast end to 30 inches at its southwest end. It contains a little fine-grained spodumene, but the amount does not exceed about 5 percent of the pegmatite. The second dike is exposed 40 feet northwest of the first and parallels

[1]Assessment work files, resident geologist's office, Port Arthur.

it. It is tabular, and extends for a length of 90 feet with an average width of 40 inches. At its northeast extremity it splits, with one branch, 27–30 inches wide, extending N.40°E. for 55 feet, and the other branch, 17–24 inches wide, extending N.55°E. for 60 feet. Its spodumene content is estimated visually to be 5–10 percent. The third dike at Camp 37 is exposed 50 feet northwest of the second, and strikes N.70°E. for 125 feet. It ranges from 5 to 27 inches in width, averaging 20 inches. Its spodumene content is low.

Camp-38 Road Deposit

This deposit is exposed about a mile from the shaft, along the road to Camp 38 on Little Postagoni River. It strikes N.40°E. and dips 70°NW. It is exposed over a length of 20 feet and across a width of 15 feet, and is made up of spodumene-bearing pegmatite interrupted at closely spaced intervals by several conformable veins of aplite, each about 2 inches thick. The spodumene crystals are unaltered and make up about 10 percent of the deposit. It is of interest that the deposit appears to lie along the projected northeast strike of the Harricana pegmatite (*see* pp. 72, 73).

NEWKIRK LITHIUM DEPOSIT (19)

The Newkirk lithium pegmatite occurs in metasediments near Slush Lake, a small pond about a mile west of Georgia Lake in the east-central part of the map-area. It was staked on 14–15 May 1955, by P. St. Amand and F. Loisel; on 1 June it was transferred to H. E. Martin. Subsequently it was acquired by Newkirk Mining Corporation Limited. From 17 August to 8 September 1955 the ground was mapped on a scale of 1 inch to 200 feet by S. S. Szetu of Geo-Technical Development Company Limited; between 18 September and 29 October the deposit was tested by diamond-drilling under the direction of John R. Bridger. Eight holes, totalling 2,525 feet, were bored at intervals of 100–300 feet along strike and 55–290 feet down dip. Nothing of commercial importance was discovered, however, and ultimately, on 20 July 1960, the claims were allowed to lapse.

The metasediments in the vicinity of the Newkirk pegmatite strike easterly and dip 60°–65°S. The pegmatite, in contradistinction, strikes N.65°–70°W. and dips about 30°N. and is a dike. It is exposed over a length of 60 feet and across widths up to 20 feet, and from the outcrop it has been traced easterly in the diamond-drillholes for about 500 feet. It is made up partly of medium- to coarse-grained crystals of white potash feldspar and fine- to medium-grained crystals of spodumene. These occur as phenocrysts, crudely oriented with their long dimensions roughly perpendicular to the walls of the dike, in a matrix of fine-grained feldspar, quartz, subordinate muscovite, and accessory amounts of greenish blue apatite. Some of the spodumene has been highly sericitized, but this occurs sporadically and does not appear to be quantitatively significant. In the outcrop, the dike is interrupted by a typical aplite, 3 inches thick. Other aplites, found in the drillhole intersections, occur in places along the contacts and range from ½ inch to 6 inches in width.

A crude zonal structure, with spodumene-rich pegmatite enclosed by ill-defined wall zones rich in muscovite but relatively poor in spodumene, is evident in the cores from the diamond-drillholes. The spodumene-rich central section ranges up to about 8 feet thick; the muscovite-rich, spodumene-poor wall zones, up to about 4 feet. Because of this zonal structure the grade of the deposit is low.

The best intersection was obtained in hole No. 8, drilled 60°S. from a point 400 feet east and 665 feet north of the outcrop. It was obtained at a depth in the hole of 346.7–351.9 feet and was found on analysis to contain 1.71 percent Li_2O. Enclosing this material are two muscovite-rich wall zones, each about 3 feet thick. The upper one was found to contain only 0.07 percent Li_2O; the lower one, 0.12 percent Li_2O.[1]

NIEMI LITHIUM DEPOSIT (20)

In May 1955, a lithium deposit about a mile south of the west end of Georgia Lake was staked by Onni Niemi. The deposit was acquired by Lun-Echo Gold Mines Limited in August 1955, and from 13 October to 19 November, it was investigated by 35 short, vertical x-ray diamond-drillholes, aggregating 1,330 feet. These holes were spaced at intervals of 20 feet across and 50 feet along strike. They failed to indicate any mineable orebodies, and on 12 August 1958 the claims were allowed to lapse.

The Niemi deposit occurs in metasediments that strike N.75°E. and dip vertically. It was traced in surface outcrops and in the drillholes for a length of 420 feet parallel to the strike of the metasediments, and was found to be a thin, flat erosional remnant, up to 30.5 feet thick and not more than about 100 feet in horizontal width. The spodumene appears to be confined to the eastern 300-foot section of the deposit. In the most easterly 100-foot section, it is found across the full 100-foot width of the pegmatite. To the west, however, it appears to occur only in narrow zones along the north and south contacts. Thus, in plan, the spodumene-bearing section is roughly U-shaped, with the arms of the U, 20–30 feet apart, projecting westward.

The spodumene-bearing portion has an average grade of 0.51 percent lithia.[2] It ranges from 4.1 to 20.3 feet in thickness and averages 15.7 feet. Of interest is that the lithia content is highest, over vertical thicknesses of 3–10 feet, near the centre of the flat deposit. Diamond-drillhole G-7, for example, intersected 15.5 feet of pegmatite averaging 1.02 percent lithia; and the central section, 5 feet in core length, was found on analysis to contain 2.0 percent lithia.[1]

ONTARIO LITHIUM COMPANY LIMITED (21)

Introduction

The property of Ontario Lithium Company Limited, is made up of 27 leased claims (T.B. 66243–66246, inclusive; T.B. 66248–66249; T.B. 66251; T.B. 66255–66257, inclusive; T.B. 66264–66271, inclusive; T.B. 66282–66283; T.B. 66289–66290; T.B. 66304; and T.B. 66306–66309, inclusive) located at the west end of Georgia Lake in the east-central part of the map-area. These claims were staked in May 1955 for Conwest Exploration Company Limited, subsequent to the discovery of lithium pegmatite making up a small island in Georgia Lake by E. W. Hadley of Auden (*see* pp. 3, 4). During the staking and initial prospecting of the claims, several additional deposits were located, and from 24 July to

[1]Assessment work files, resident geologist's office, Port Arthur.
[2]Average grade calculated by the author from data filed in resident geologist's office, Port Arthur.

28 November 1955, these were tested by diamond-drilling. Fifty diamond-drillholes, aggregating 13,555 feet, were bored; one deposit, the Jackpot, was found to contain 2,000,000 tons of pegmatite having an average estimated grade of 1.09 percent Li_2O.[1] The property was transferred to Ontario Lithium Company Limited in the spring of 1956. Markets for the sale of lithia concentrates were not established, however, and except for some diamond-drilling done in July 1957 to further test the original discovery, no more work has been undertaken.

General Geology

The property is underlain chiefly by metasediments, which strike N.70°E. to east. For the most part they dip steeply north, but in a few localities, they dip vertically or steeply south. They are interrupted in several places by thin dikes and sills of white-weathering, pale-grey feldspar porphyry. Also cutting them are a prominent dike, striking N.10°–20°E., of porphyritic diabase, and two flat-lying sheets of equigranular diabase. One diabase sheet overlies the metasediments, and its erosional remnants form prominent hills about the end of Georgia Lake. The second sheet of equigranular diabase, at least 100 feet thick, cuts the metasediments 100–115 feet below the surface. It was found in diamond-drillholes bored to test the Point lithium deposit, at the west end of and along the south shore of Georgia Lake.

Lithium Deposits

The lithium deposits discovered on the property of Ontario Lithium Company Limited are: (1) the Island; (2) the Jackpot; (3) the Point; (4) the Salo; and (5) the Southwest. Of these only the Jackpot occurrence has been shown to contain any appreciable amount of lithia-rich pegmatite.

Island Deposit

The reef in Georgia Lake, which is the Island deposit discovered by Eric Hadley, is crudely circular with a diameter of about 75 feet. Except for a few small inclusions of metasediments, it consists entirely of coarse-textured pegmatite made up of potash and plagioclase feldspars, quartz, spodumene, and subordinate muscovite with a little apatite and red garnet. Beryl also is reported to be present (Gilmour 1955). The spodumene crystals, mostly less than 12 inches in length, occasionally attain lengths of 14–18 inches. On the horizontal surface of the reef, they exhibit no preferred orientation. In a few places along the north and south sides of the reef, however, a crude vertical orientation, indicative of a small angle of dip, is apparent.

The Island deposit was trenched at intervals of 15–20 feet in the early summer of 1955. Sixty-six samples, each weighing 4.4 pounds, were taken across 3-foot widths. These indicated an average grade of 1.2 percent Li_2O. A bulk sample weighing 470 pounds was also taken, which was found on analysis to yield 1.4 percent Li_2O.[2] Between 10 July and 28 July 1957, the Island deposit was tested by diamond-drilling. Three diamond-drillholes, spaced about 50 feet apart at the corners of a near-equilateral triangle, and aggregating 225.0 feet, were drilled

[1] *The Northern Miner*, 22 March 1956, p. 32.
[2] F. W. Anderson, geologist, Conwest Exploration Company Limited; personal communication.

vertically through the pegmatite. These showed the pegmatite to have vertical thicknesses of 17.8–49.5 feet, and its lower surface to strike north-south and dip about 35°E. The grade of the deposit, as indicated by the diamond-drillholes, has not been reported.

Jackpot Deposits

The Jackpot deposits are located about 6,000 feet southwest of Georgia Lake and about 2,000 feet north of Marrow Lake. They are named for the size of the area, about 1,000 feet across, throughout which outcrops of lithium-bearing pegmatite are numerous and closely spaced. The occurrences were tested by diamond-drilling between 24 July and 28 November 1955; during this period 32 holes, totalling 10,648.8 feet, were bored. The drilling showed the outcrops to be merely erosional remnants, 20–30 feet thick, of a flat sheet of pegmatite (the No. 1 deposit) at the level of the present surface, and hence to be of little significance. But a second dike (the No. 2 deposit), which is not exposed, was located below the first in the diamond-drillholes. As mentioned previously this dike was found to contain 2,000,000 tons of material estimated to have an average grade of 1.09 percent Li_2O.[1] It is the most important occurrence discovered on the property to date.

The No. 2 pegmatite dike, which was discovered by diamond-drilling, strikes about N.65°E. and dips 15°–25°NW. It was intersected in the holes at intervals of 100–300 feet over a strike length of 700 feet and at intervals of 100–200 feet over a distance of 1,200 feet across the strike. It ranges from 13 to 65 feet, averaging approximately 36 feet, in vertical thickness. It is somewhat irregular in attitude, as indicated by vertical cross-sections (Fig. 16), and to the northeast, along its strike, it appears to split into two bifurcating branches. The spodumene present is medium- to coarse-grained for the most part; it appears to be concentrated near the centre of the dike, such that the lithia content of the pegmatite decreases outward, more rapidly towards the lower contact than the upper one. In several diamond-drillholes, the decrease in spodumene content towards the contacts was found to be accentuated by an increase in the muscovite content.

In general, the spodumene present in the Jackpot deposits is unaltered. In diamond-drillhole No. 424, however, a thin diabase dike was located at a vertical depth of 229.5–300.0 feet. This dike appears to strike N.10°–20°W. and to dip about 70°W. In the pegmatite intersections close to it, in holes Nos. 417, 418, and 421, the spodumene present was found to be dark coloured and hence highly sericitized.[2]

Point Deposit

The Point pegmatite is exposed in an outcrop, measuring 25 feet by 35 feet, along the shore at the southwest end of Georgia Lake. It is made up of medium- to coarse-grained crystals of potash feldspar and spodumene in a matrix of feldspar, quartz, subordinate muscovite, and accessory apatite. The spodumene content is 5–10 percent, and between 28 August and 3 October 1955, the deposit was tested at intervals of 100–200 feet by eight diamond-drillholes aggregating 1,793.0 feet. From the outcrop, the pegmatite was traced irregularly westward for about 600 feet. Throughout this length it was found to dip 60°–70°N. and

[1]*The Northern Miner*, 22 March 1956, p. 32.
[2]Information from assessment work files, resident geologist's office, Port Arthur.

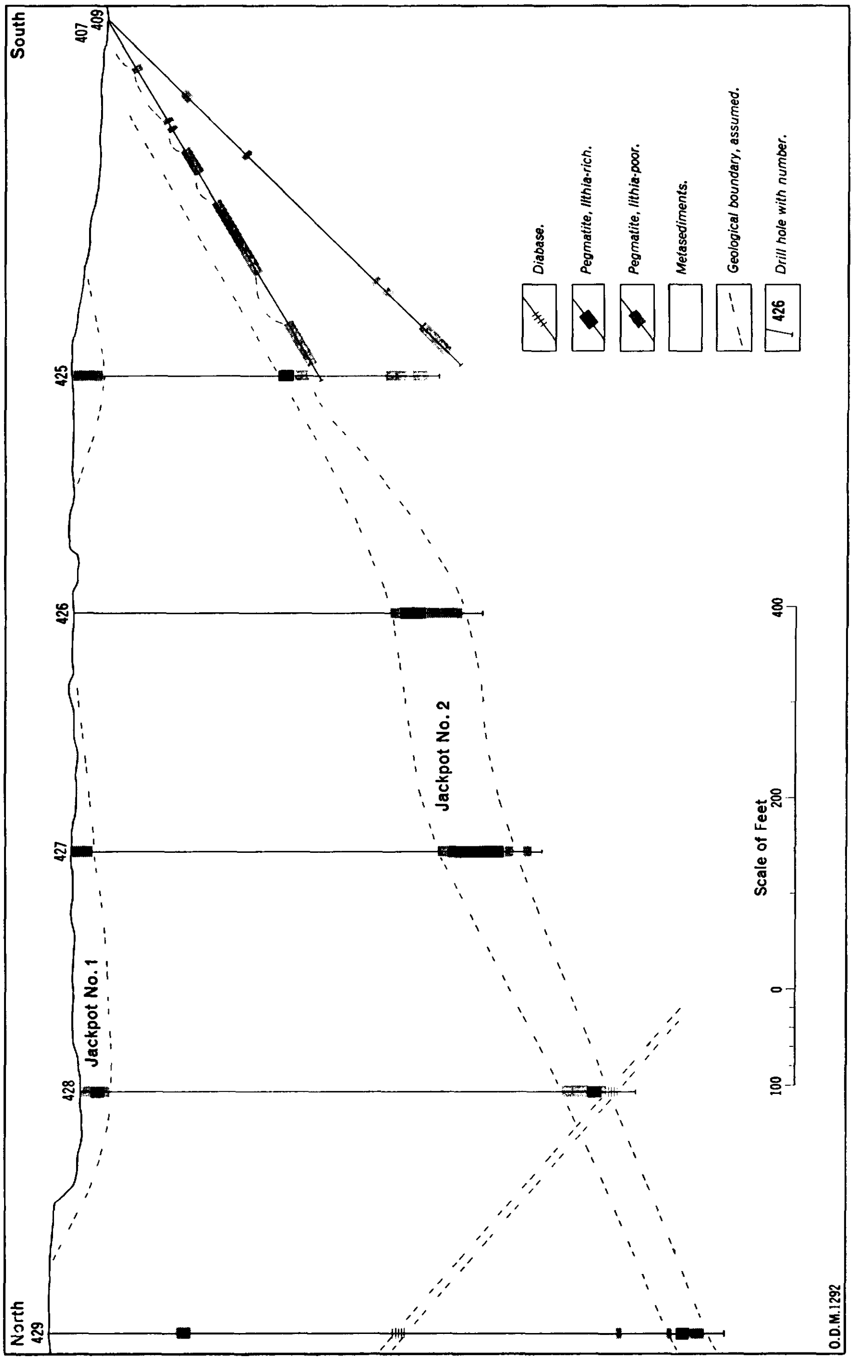

Figure 16—Vertical section, deposits; Ontario Lithium Company Limited.

to range from 25 to 60 feet in thickness. The average lithia content is low (Gilmour 1955). The best material was located in diamond-drillhole No. 201, bored S.45°E. at 30 degrees to test the dike about 200 feet west of the outcrop. This hole cut 23.7 feet of pegmatite, of which the upper 15 feet was found on analysis to average 0.96 percent Li_2O (Gilmour 1955).

As pointed out previously, a flat sheet of diabase at least 100 feet thick was located in three diamond-drillholes at vertical depths of 100–115 feet. Near this sheet, in diamond-drillholes Nos. 202 and 204, the spodumene of the pegmatite was found to be highly altered. The spodumene content of the pegmatite cut in hole No. 202, for example, was visually estimated to be 10–15 percent, whereas the lithia content was found on analysis to be only 0.01–0.04 percent.[1]

Salo Deposit

The Salo deposit is exposed along the motor road about 1½ miles southwest of Georgia Lake. It has been traced on the surface in a direction of N.80°E. for 350 feet. It is exposed across horizontal widths of up to 30 feet and forms a north-facing escarpment, 10–15 feet high, along the valley of an east-flowing creek. The Salo pegmatite is made up of elongated crystals of potash feldspar, up to 3 feet in length, and prismatic crystals of spodumene, up to 2 feet in length, in a matrix of feldspar, quartz, subordinate muscovite, and a little accessory apatite. Its spodumene content is about 25 percent, and from 28 July to 3 August 1955, it was tested by eight diamond-drillholes, totalling 503.5 feet. This work, however, showed the pegmatite to be roughly cylindrical in shape, terminating against metasediments 23–28 feet below the surface, and hence to be merely an erosional remnant of little economic importance. According to Gilmour (1955), the deposit contains only about 3,000 tons of spodumene-bearing pegmatite.

Southwest Deposits

The Southwest deposits were found on claims T.B. 66270 and 66271, in the southwestern part of the property, east of Abner Lake. They occur in four localities and have been referred to as the Nos. 6A, 6B, 6C, and 7 deposits.

The No. 6A deposit lies about 1,200 feet S.27°W. from the west end of the Salo pegmatite. It is exposed only in one outcrop, across a horizontal width of 13 feet. It strikes N.65°–75°E. It contains abundant coarse-grained spodumene, which makes up about 30 percent of a central zone, 4–5 feet wide, flanked on the north by barren pegmatite and on the south by aplite.

There are two dikes in the No. 6B area, about 400 feet S.45°W. from the No. 6A outcrop. These dikes strike N.65°E. and dip 20°NW. One is exposed in two outcrops about 100 feet apart and has horizontal widths up to 30 feet; the other dike, 150 feet southeast of the first, is also exposed in two outcrops, in this case about 65 feet apart, and has widths up to 40 feet. Both dikes contain an appreciable amount of spodumene and were tested by diamond-drilling. Diamond-drillhole 601B was drilled south at 45 degrees to test the occurrences, but failed to indicate anything of commercial importance.

The No. 6C pegmatite is exposed on claim T.B. 66271, about 1,700 feet S.45°W. from the No. 6A outcrop. It has been traced N.75°E. in outcrops spaced at intervals of 30–150 feet, for a length of 440 feet. It dips 30°N., with horizontal widths of up to about 30 feet. At the surface, the No. 6C pegmatite averages

[1]Assessment work files, resident geologist's office, Port Arthur.

10–15 percent spodumene. It was tested by diamond-drillhole No. 601C, which was drilled south at 45 degrees. At a depth of 139.0–147.0 feet, the hole intersected 8.0 feet of pegmatite containing an estimated 10 percent spodumene, in part highly sericitized.

The No. 7 deposit cuts metasediments in the eastern part of claim T.B.66270, about midway between the Salo and No. 6A deposits. It has been traced on the surface for 360 feet in a direction of N.75°E. and ranges up to 30 feet in horizontal width. Spodumene occurs only at the east end of the dike, in amounts too small to be of any economic importance.

POTTER COPPER DEPOSIT (22)

The Potter copper deposit occurs along the Glacier Creek fault, about 8,500 feet east-northeast of O'Keefe Lake in the extreme southeastern part of the map-area. It occurs where the fault cuts and truncates a band of metasediments, 1,000–2,400 feet wide, which occurs as an east-northeast-trending inclusion in granitic rocks. It is essentially a wide zone of brecciation, in which highly fractured biotite and augen gneisses, and some granitic rocks, are cut by narrow veins of quartz and calcite and mineralized with disseminated pyrite and chalcopyrite. The mineralized zone has been traced N.20°E. in diamond-drillholes for 2,400 feet. It dips vertically, and ranges up to about 100 feet in width.

The copper deposit was staked in the summer of 1955 by Reino O. Kotanen, John W. Price, and P. Forsgren; on 12 July 1957, it was acquired by Ray Potter and associates of Port Arthur–Fort William. From 13 December 1957 to 30 January 1958, the deposit was tested by diamond-drilling. Five holes, totalling 1,444 feet, were drilled over a length of about 1,500 feet. A copper-bearing zone was indicated, up to 50 feet wide, including a narrow section, 3–14 feet wide, averaging over 1 percent copper. In the spring of 1956, the property was optioned to Frobisher Limited, and from 23 May to 16 June a geological survey, on a scale of 1 inch to 600 feet, was made by H. G. Rushton; magnetometer and electromagnetic surveys were carried out by McPhar Geophysics Limited (Rushton 1956). This work failed to indicate anything of interest, however, and the option was not exercised. Subsequently, the property was acquired under a new option agreement by MacLeod-Cockshutt Gold Mines Limited. A second program of diamond-drilling, under the direction of Walter Maybank, was initiated, and seven holes, aggregating 2,218 feet, were drilled along the fault. This work extended the known length of the mineralized zone to 2,400 feet. It showed the zone to have a low average grade across minimum mining widths, however, and work at the property was terminated. The claims protecting the deposit were cancelled in the sprıng of 1961.

POWER LINE LITHIUM DEPOSIT (23)

The Power Line deposit is a dike cutting metasediments, located along the transmission line of the Hydro-Electric Power Commission of Ontario, about 7,500 feet east of the north end of Postagoni Lake. This dike was investigated by Noranda Exploration Company Limited in 1955, and was traced by stripping for a length of 250 feet (Woolverton 1956). It is a highly irregular deposit, with numerous inclusions of metasediments, but has an average strike of N.40°–45°E. and a mean width of about 5 feet. Spodumene is present as pale-grey to black crystals, ½–1½ inches in length, arranged in subparallel alignment roughly perpendicular to the walls of the dike. The crystals are not abundant, however, and the lithia content of the deposit accordingly is low.

SWANSON BERYL DEPOSIT (24)

Several small, beryl-bearing pegmatite deposits occur in metasediments south of Jackfish River and west of Cosgrave Lake in the southern part of the map-area. These were found by F. Swanson of Dorion, who staked them on 5 June 1957. The discovery pegmatite is exposed along the west side of a shallow, north-trending valley. It is a sill that strikes N.60°E. and dips vertically to steeply northwest. It is exposed for a length of about 40 feet. It is 35 feet wide at one point; northeast of this point it splits into two parallel branches, one 10 feet wide, the other 3–5 feet wide, separated by about 20 feet of metasediments. The sill is made up of potash and plagioclase feldspars, quartz, muscovite, beryl, and accessory tourmaline, forming an equigranular, fine- to coarse-grained rock devoid of any apparent preferred orientation. The beryl present occurs as greenish yellow, well-formed, hexagonal crystals up to 7 inches in length. It is not abundant, and some of it has been altered to hühnerkobelite and small amounts of muscovite and apatite. In 1957, Goldale Mines Limited optioned the property. A channel sample, 15 feet in length and weighing 225 pounds, was taken across the southeast side of the discovery dike. This sample was found on analysis to contain 2.58 percent BeO.[1] No additional work has been reported, and Swanson's claims were cancelled on 17 June 1959.

TRANS LITHIUM DEPOSIT (25)

The Trans lithium deposit[2] is a spodumene-bearing dike cutting metasediments exposed along the north shore of Lake Jean in the northeastern part of the map-area (*see* Map No. 2056, in back pocket). This dike was discovered in 1956 by Goldale Mines Limited, during an investigation of a property acquired through an option agreement from Jack Martin and Chester Campbell. It strikes N.50°W. and dips vertically to steeply east. It is exposed about 800 feet from the lakeshore along its line of strike, and has been traced intermittently on the surface for 500 feet. The width ranges from a few inches at the northwest end to about 7 feet near the southeast end. The deposit was not examined by the author, and its grade has not been reported. According to J. P. Walter (1957b) the spodumene content is highest at the southeast end, where the dike attains its greatest width.

VEGAN LITHIUM MINES LIMITED (26)

The property of Vegan Lithium Mines Limited consists of 27 claims (T.B. 66614–66640, inclusive), located northeast of Claus Lake and about a mile west of Georgia Lake in the east-central part of the map-area. These claims were staked 13–16 May 1955, by E. Assad, C. J. Kirk, and A. Swanson, during the staking rush initiated by the original lithium discovery at Georgia Lake. At the time of staking, a spodumene-bearing pegmatite dike was located in metasediments underlying claim T.B. 66621, and because of the possibilities indicated, the property was optioned to Dunvegan Mines Limited. The pegmatite outcrops were sampled, and from 30 August 1955 to 22 March 1956, a program of diamond-drilling was undertaken to investigate the deposit and also the extension of the dike tested by Newkirk Mining Corporation Limited on the adjoining

[1]J. P. Walter, Goldale Syndicate Limited; personal communication.
[2]*See* Walter (1957b)

claim group. Forty-eight diamond-drillholes, aggregating 8,226.6 feet, were bored. This work was successful in indicating the presence, in the extension of the Newkirk dike, of 750,000 tons of pegmatite estimated to have an average grade of 1.38 percent Li_2O.[1] Dunvegan Mines Limited exercised its option, and on 17 September 1956, the claims were transferred to the present company, newly incorporated to take over the property.

Vegan No. 1 Deposit

The Vegan No. 1 deposit has been traced in outcrops and in 19 diamond-drillholes, aggregating 2,423.3 feet, over a length of about 700 feet. It ranges from 2 to 30 feet in thickness and averages about 15 feet. Throughout 500 feet of its length, it strikes S.35°–40°W. and dips 35°E.; to the southwest, limited outcrop data indicate that it may curve sharply and assume a strike of S.5°–10°E, for about 200 feet. It is made up of coarse-grained to very coarse-grained. elongated crystals of white potash feldspar and prismatic crystals of spodumene, 2–8 inches in length, in a groundmass of quartz, feldspar, and muscovite. At the south end of the dike, a little red garnet and black tourmaline also are present; lepidolite, in small foliated masses, was recognized in the drill-cores and in one outcrop.[2] The granularity of the pegmatite appears to be coarser, and the spodumene, although sporadically distributed, most abundant about midway along the dike. Although in places the large crystals of potash feldspar are arranged with their long dimensions roughly normal to the strike, the pegmatite minerals, including the spodumene crystals, in general exhibit no marked preferred orientation in the surface exposures. Irregular masses and lenses of aplitic material occur at intervals along the footwall, and in outcrops near the north end of the deposit the pegmatite is interrupted by a few longitudinal aplite veins, up to 4 inches in width and 6 feet in length.

The spodumene in the centre of the dike is pale greenish grey in colour and is virtually unaltered. But as the walls are approached, it becomes dark greenish to black as a result of sericitization. Muscovite, occurring in elongated aggregates that may in part have replaced original spodumene, also becomes abundant close to the contacts of the dike. This has given rise to an ill-defined, internal-zoned structure, such that wall zones rich in mica grade into and enclose an interior section with abundant spodumene. The mica-rich zones widen and unite down the dip of the dike and to the northeast. Because of this, the central lithia-rich section of the deposit, reported on the basis of surface sampling to average 1.5 percent Li_2O over a length of about 200 feet,[2] is of small dimensions and of no present economic significance.

Vegan No. 2 (Newkirk) Deposit

The Vegan No. 2 deposit was located at the east boundary of the property, along the projected strike of the Newkirk dike (pp. 96, 97), by diamond-drilling. From here it was traced in the diamond-drillholes, in a direction of N.75°W., for about 2,000 feet. Throughout this length it averages 16 feet and ranges up to 18.5 feet in width, and is essentially a tabular body that dips 35°–45°NE. It is not exposed on the property, and representative drill cores were not stored, so an examination by the author was not possible. According to logs of the diamond-

[1] *The Northern Miner*, 26 April 1956, p. 10.
[2] W. J. Salisbury, geologist, Dunvegan Mines Limited; personal communication.

drillholes, however, the No. 2 deposit is similar in character to the No. 1. It possesses a crude internal-zoned structure—a central section rich in spodumene is enclosed by ill-defined wall zones having little or no spodumene but rich in muscovite. From the property boundary west-northwest for about 1,100 feet, the muscovite-rich wall zones are 1.5–2.5 feet wide and enclose a spodumene-rich interior section that, according to W. J. Salisbury,[1] averages 10.5 feet wide. Farther along strike, the dike diminishes in width to about 5 feet; and over a distance of 200–300 feet, the central spodumene-rich section narrows and disappears, and the two muscovite-rich border zones unite. Throughout the remainder of the 2,000-foot length tested, the dike is made up of a fine-grained assemblage of feldspar, quartz, and muscovite—in the drill cores only a few scattered crystals of highly altered spodumene were recognized.

As pointed out previously, the diamond-drilling indicated, in the southeast section of the dike, 750,000 tons of pegmatite having an average grade of 1.38 percent Li_2O. This tonnage was indicated over a length of 1,350 feet, to a depth down dip of 450 feet.[1]

WEST LITHIUM DEPOSIT (27)

The West lithium deposit is a dike that cuts metasediments northeast of Downey Lake in the northeastern part of the map-area, on claim T.B. 67176 of Nama Creek Mines Limited and on open ground to the south. It was staked in the late spring of 1955, and was investigated jointly by New Highridge Mining Company Limited, New Harricana Mines Limited, and Nama Creek Mines Limited. Some trenching was done, and from 12 October to 18 November 1955, 13 diamond-drillholes, aggregating 6,674.8 feet, were bored over a strike length of 1,950 feet, partly to test the West dike and partly to test the nearby Harricana dike (pp. 72, 73). This work, however, failed to indicate anything of commercial interest. The claims held by New Harricana Mines Limited were cancelled in June 1957; those held by New Highridge Mining Company Limited, in June 1959.

The West dike has been traced N.45°E. in outcrops and in the diamond-drillholes for about 900 feet; N.5°–10°W. for 450 feet; and N.25°–30°W. for an additional 600 feet. Where the dike strikes N.45°E. it dips 65°–75°NW. As the dike curves, however, the dip flattens, so that where the strike is N.30°W. the dip is only about 50°SW. The pegmatite ranges in thickness from about 10 feet at its extremities to a maximum of 40 feet where, about midway along its length, the strike changes from N.45°E. to N.5°–10°W.

The West pegmatite is similar to the Harricana dike in composition and internal structure. Potash feldspar crystals up to 8 inches in length and spodumene crystals up to 4 inches in length occur in a relatively fine-grained groundmass of quartz, feldspar, and yellowish green muscovite, and are arranged in subparallel alignment, roughly normal to the walls of the dike. As before, much of the spodumene is altered and has a low lithia content. The altered spodumene appears in many instances to be more apparent near the contacts than in the interior portions of the dike, and to be particularly abundant along the footwall side of the deposit; the ratio of altered to unaltered spodumene tends to increase southward, as outcrops of a diabase sheet are approached. The West deposit is interrupted in places by vein aplites (*see* Economic Geology, pp. 40–42). These, however, are thin and widely separated and are of little importance.

[1]W. J. Salisbury, personal communication.

WEST LITHIUM DEPOSIT; RESULTS OF DIAMOND-DRILLING BY NEW HIGHRIDGE MINING COMPANY LIMITED, NEW HARRICANA MINES LIMITED, AND NAMA CREEK MINES LIMITED

(Information from assessment work files, resident geologist's office, Port Arthur.)

Hole No.(1)	Location		Angle of Hole	Footage		Core Length	Average Li_2O Content
	Lat.	Dep.		From	To		
	feet SW.	feet NW.		feet	feet	feet	percent
6	200	658	50°	139.0	191.3	26.0	1.00
8	200	880	50°	98.0	113.9	15.1	1.13
				123.8	129.8	6.0	1.21
9	200	990	50°	119.0	125.0	6.0	1.32
14	400	300	55°	80.0	95.0	15.0	1.22
				80.0	120.0	40.0	0.84
5	600	220	50°	182.6	215.3	32.7	1.18
7	600	590	60°	589.6	596.3	6.7	(2)
10	800	70	50°	31.0	41.9	10.9	0.85
12	800	340	50°	306.5	318.0	11.5	0.94
11	1,000	100	50°	42.5	50.5	8.0	0.78
16	1,000	270	50°	245.0	255.0	9.7	1.10
2	1,170	275	50°	234.0	250.0	16.0	0.41
3	1,170	500	52°	460.0	465.0	15.3	0.16
17	1,400	150	50°	39.8	49.0	9.2	0.43

(1)All holes drilled S. 40° E. (mag.), except hole No. 9, which was drilled N. 45° E. (mag.).
(2)Li_2O not detected.

Although the average grade of the West dike has not been reported, the diamond-drillhole intersections indicate the occurrence of an appreciable tonnage of material containing about 1 percent Li_2O.[1] The results of the diamond-drilling are reproduced in the accompanying table.

[1]Assessment work files, resident geologist's office, Port Arthur.

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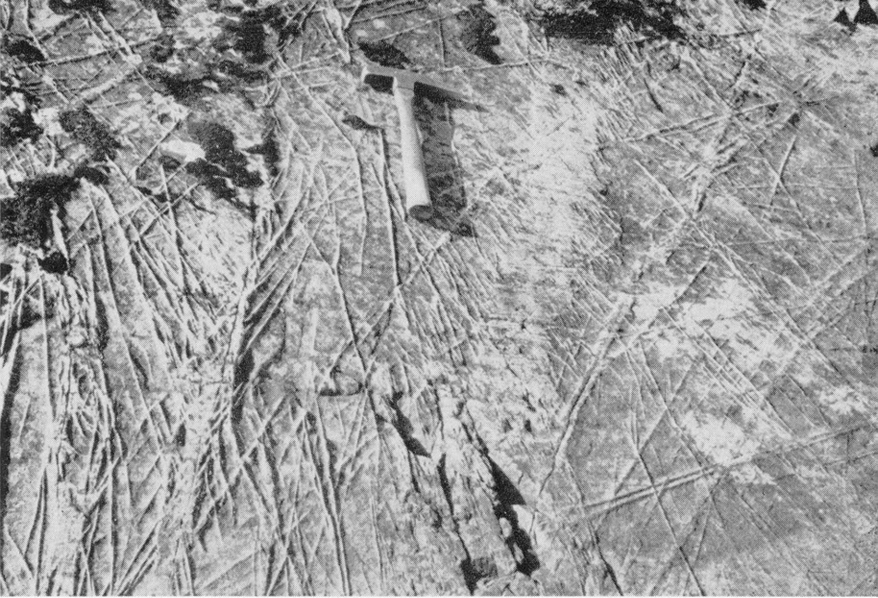
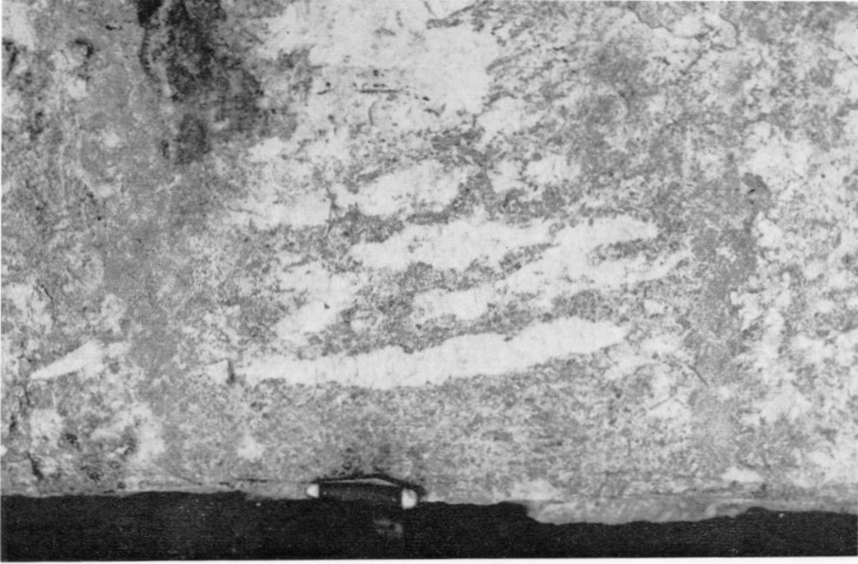
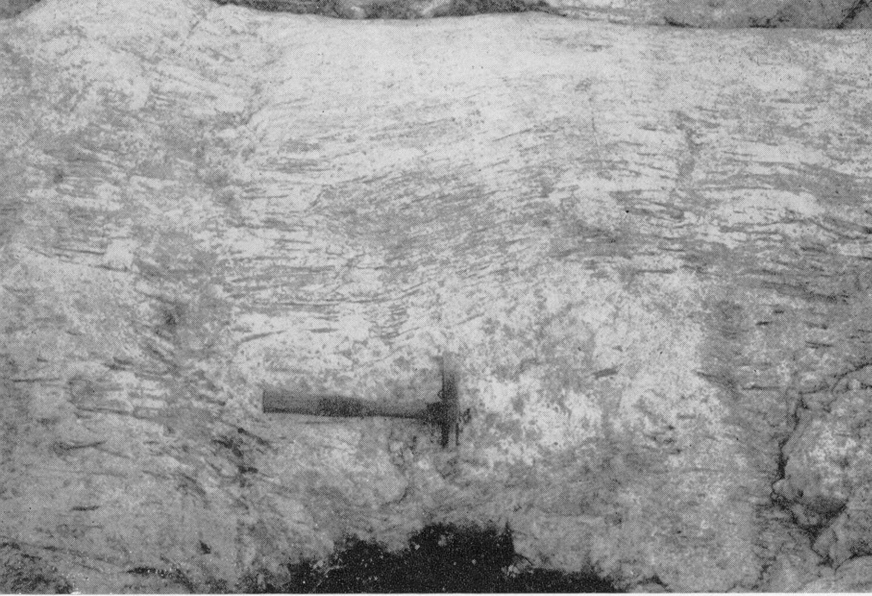
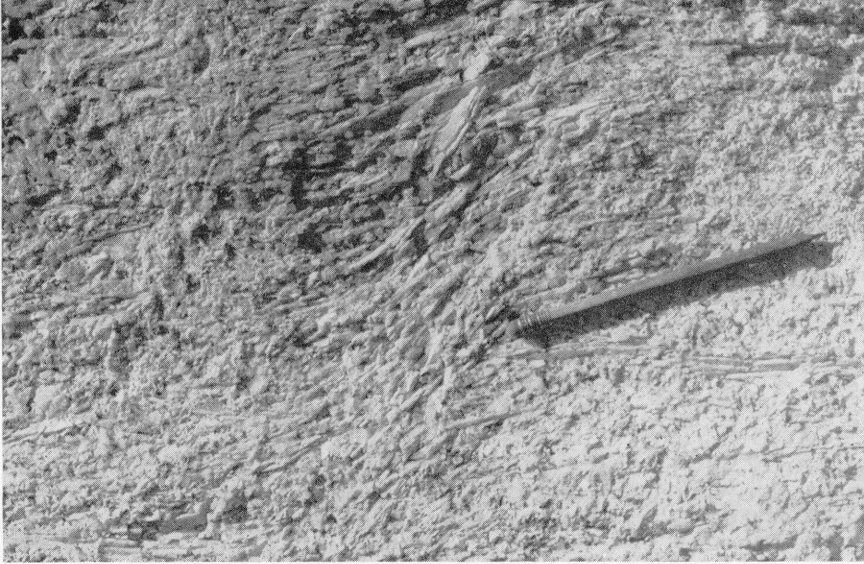
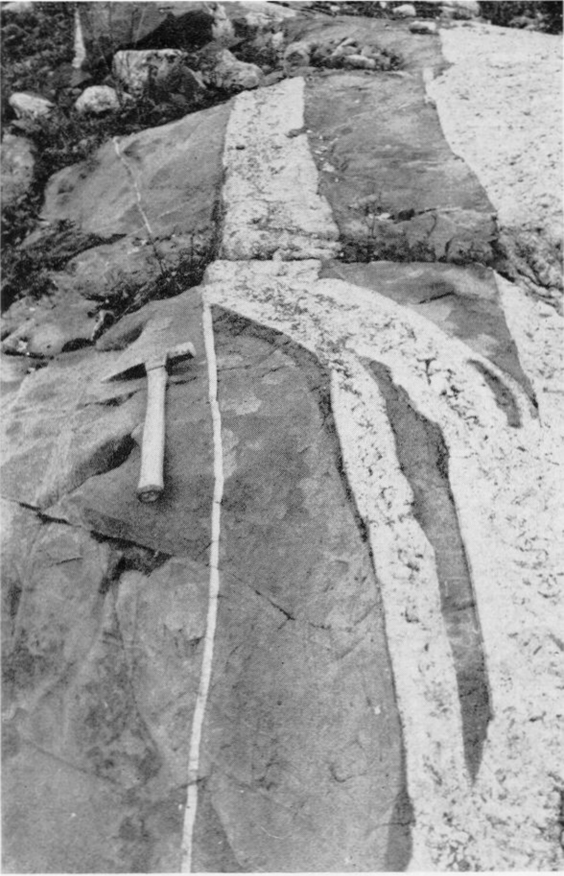
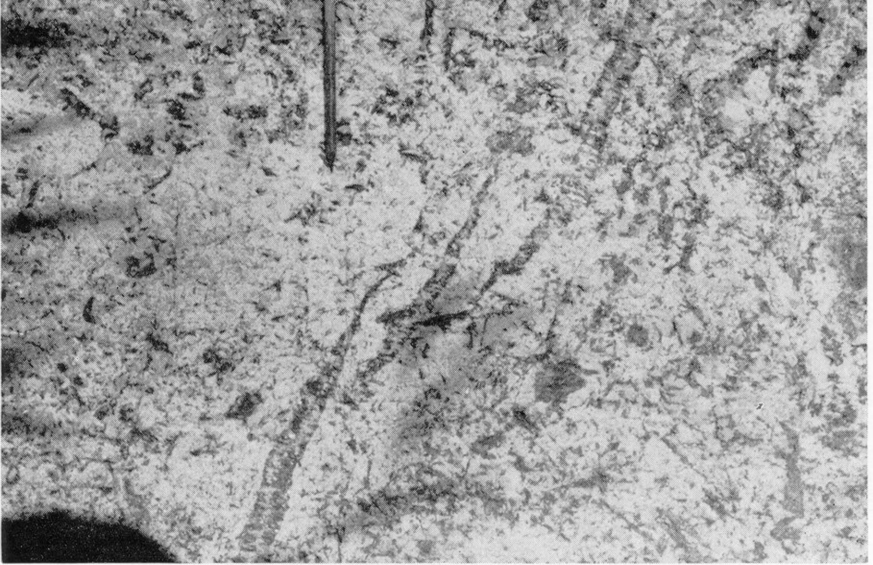


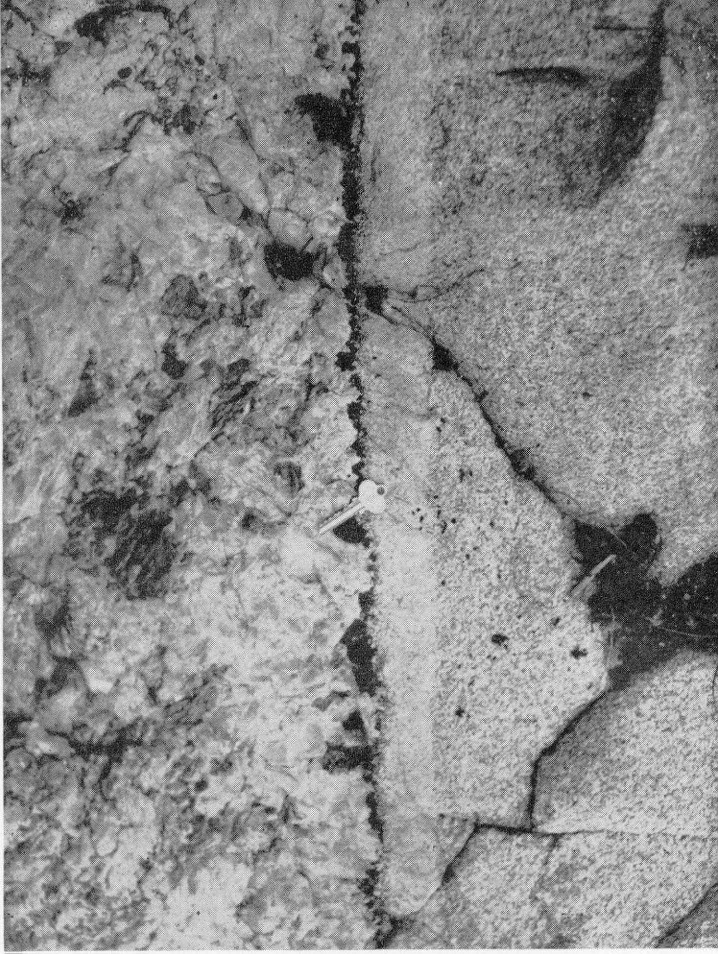


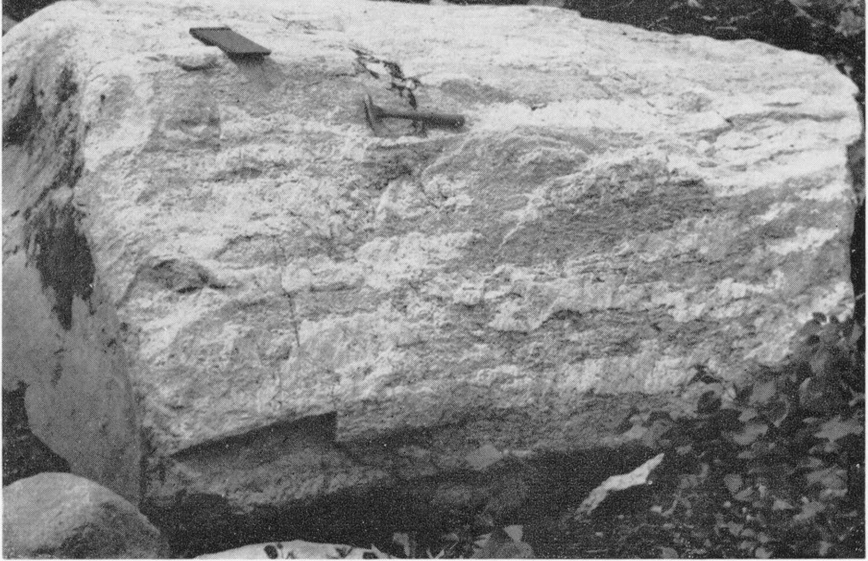












SYMBOLS

- Glacial striae.
- Esker.
- Small rock outcrop.
- Boundary of outcrop area.
- Geological boundary, defined.
- Geological boundary, approximate.
- Geological boundary, assumed.
- 45° Strike and dip; direction of top unknown.
- Strike and vertical dip; direction of top unknown.
- 60° Direction (arrow) in which inclined beds face as indicated by gradation in grain size.
- Direction (arrow) in which inclined beds face as indicated by cross bedding.
- Direction in which vertical beds face as indicated by cross bedding.
- 65° Strike and dip; top in direction of arrow (from metamorphic grain gradation).
- Strike and vertical dip; top in direction of arrow (from metamorphic grain gradation).
- 70° Strike and dip of overturned bedding; beds face in direction of arrow and dip in direction of loop (from metamorphic grain gradation).
- Synclinal axis.
- Anticlinal axis.
- 75° Strike and dip of foliation.
- Strike of vertical foliation.
- Strike of foliation, dip unknown.
- 15° Lineation (plunge known, plunge unknown).
- Jointing, horizontal.
- 30° Jointing, inclined.
- 40° Drag-folds. (Arrow indicates direction of plunge).
- Fault, defined.
- Fault, assumed.
- Higher ground.
- 855′ Altitude in feet above sea level.
- Muskeg or swamp.
- Highway 11 Highway with number.
- No. 585 Motor road, with provincial secondary road number.
- Wagon road.
- Trail, portage, winter road.
- Building.
- CS28 Campsite with number, St. Lawrence Corporation Limited.
- Shaft.
- IV Surveyed line with milepost; township boundary, approximate position only.
- (15) Location of mining property.

LIST OF PROPERTIES

1. Aumacho River Mines Ltd.
2. Camp lithium deposit
3. Caral lithium deposit
4. Carrot Lake lithium deposit
5. E. S. Conway
6. Dunning lithium deposits
7. Foster lithium deposit
8. Georgia lithium deposit
9. Giles lithium deposit
10. Harricana lithium deposit
11. Jean Lake Lithium Mines Ltd.
12. Kenogamisis lithium deposit
13. Lew lithium deposit
14. Line 60 lithium deposit
15. Lun-Echo Gold Mines Ltd.
16. M.N.W. lithium deposit
17. McVittie lithium deposit
18. Nama Creek Mines Ltd.
19. Newkirk lithium deposit
20. Niemi lithium deposit
21. Ontario Lithium Co. Ltd.
22. Potter copper deposit
23. Power Line lithium deposit
24. Swanson beryl deposit
25. Trans lithium deposit
26. Vegan Lithium Mines Ltd.
27. West lithium deposit

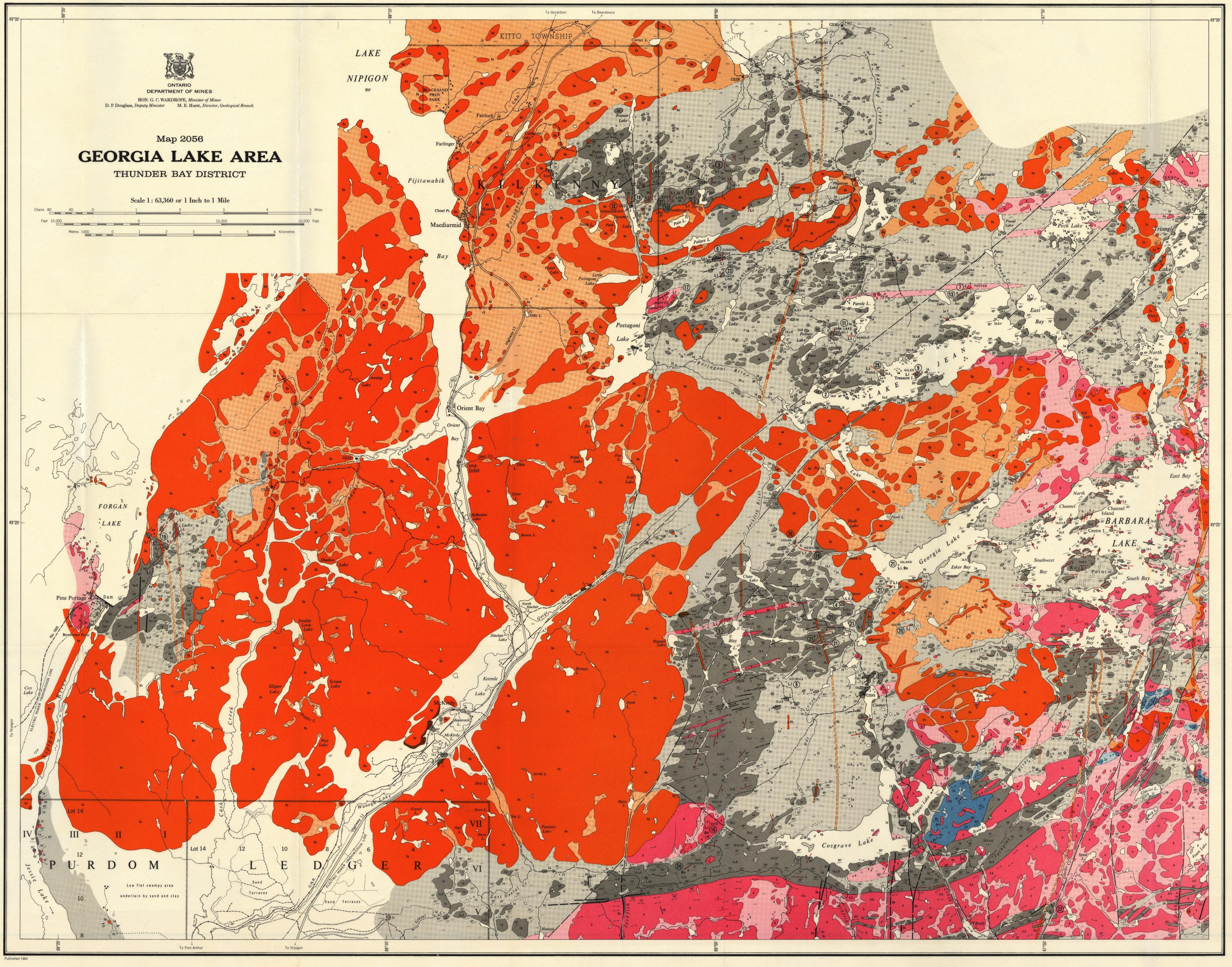
ONTARIO
DEPARTMENT OF MINES
HON. G. C. WARDROPE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* M. E. Hurst, *Director, Geological Branch*

Map 2056

GEORGIA LAKE AREA

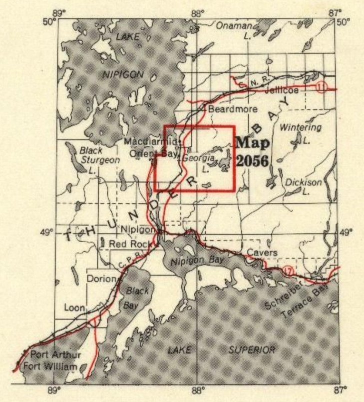
THUNDER BAY DISTRICT

Scale 1 : 63,360 or 1 Inch to 1 Mile



Published 1964

Map 2056
Georgia Lake Area



Scale, 1 inch to 50 miles

N.T.S. reference 42E/4, 42E/5, 52H/1, 52H/8

LEGEND

CENOZOIC*

RECENT AND PLEISTOCENE
Glacial drift; gravel, sand, silt.

UNCONFORMITY

PRECAMBRIAN**

KEWEENAWAN

- 8a Diabase (sheet).
- 8b Diabase (dike).
- 8c Porphyritic diabase (dike).***

IGNEOUS CONTACT

- 7 Sandstone, shale.

UNCONFORMITY

ALGOMAN

- 6 Pegmatite (dike, sill).
- 5 Feldspar porphyry (dike).
- 4 Granite.
- 4a Porphyritic granite.
- 4b Pegmatite.
- 4c Migmatite.
- 4d Pegmatite (injection zone).

IGNEOUS CONTACT

PRE-ALGOMAN (?)

- 3 Metagabbro (dike, sill).
- 2 Metagabbro.
- 2a Porphyritic metagabbro.

IGNEOUS CONTACT

METASEDIMENTS

- 1a Biotite-quartz-feldspar gneiss.
- 1b Staurolite gneiss.
- 1c Garnet gneiss.
- 1d Cordierite gneiss.
- 1e Hornblende schist or gneiss.
- 1f Augen gneiss.

- Be Beryllium (Beryl).
- Li Lithium (Spodumene).
- S Sulphide mineralization.

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*Unconsolidated deposits. Cenozoic deposits are represented by the lighter and uncoloured parts of the map.

**Bedrock geology. Outcrop and inferred extensions of each rock map unit are shown in deep and light tones of the same colour.

***Some or all of the porphyritic diabase may be of pre-Keweenawan age.

SOURCES OF INFORMATION

Geology by E. G. Pye and assistants, 1956, 1958, 1959.

Map No. 312A, Sturgeon River Area, Geological Survey of Canada, 1934.

Maps and plans of mining companies.

Cartography by J. Stankiewicz, Ontario Department of Mines, 1964.

Base map derived from Forest Resources Inventory maps, Ontario Department of Lands and Forests, with additional information by E. G. Pye.

Magnetic declination approximately 1°W., 1963.