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MEMOIR 253

FIEDMONT MAP-AREA, ABITIBI COUNTY, QUEBEC

BY

L. P. TREMBLAY

GEOLOGICAL SURVEY
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
OTTAWA
1950

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Lacorne mine in August 1945. The two-story building on the left is the office and company's store. (Page 78.)

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

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L. P. Tremblay

OTTAWA
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PREFACE

Fiedmont map-area occupies about 400 square miles of Abitibi county, Quebec, a few miles north of the eastern extension of the Rouyn-Malartic gold belt, and about equal distances from Amos to the northwest, Val d'Or to the south, and Senneterre to the east. It lies within the 'clay belt' of northern Ontario and Quebec, formerly occupied by glacial Lake Barlow-Ojibway, but in the southern half includes a hilly terrain with relatively abundant outcrops. It is underlain by nearly equal amounts of ancient volcanic rocks and later Precambrian intrusions, with minor amounts of pre-batholithic sedimentary material. Originally prospected for gold-bearing deposits, the area has subsequently attracted principal interest because of its abundant pegmatitic rocks carrying molybdenite, spodumene, and rare-element minerals. The only production as yet has come from the Lacorne mine, which commenced operations during the last World War and to date has provided about 4,910,200 pounds of molybdenite and 30,097 pounds of bismuth.

In the present report, the author deals with the geology and mineral deposits of the area, with particular attention to the composite Lacorne batholith, its abundant associated pegmatitic rocks and related mineral occurrences. The account includes a full description of the Lacorne mine, of occurrences of molybdenite-, spodumene-, and beryl-bearing pegmatites, and of three groups of gold-bearing deposits. It is accompanied by a geological map on a scale of 1 inch to 1 mile, which is an entirely revised edition of the Fiedmont sheet issued in 1929.

GEORGE HANSON,
Chief Geologist, Geological Survey of Canada

OTTAWA, March 12, 1949

Fiedmont Map-area, Abitibi County, Quebec

CHAPTER I

INTRODUCTION

GENERAL STATEMENT

Fiedmont map-area occupies an area of some 400 square miles in western Quebec, between latitudes 48°15′ to 48°30′ and longitudes 77°30′ to 78°00′. It had been mapped originally by James and Mawdsley (24)[1] in 1926, when the area was less accessible than now, and the present account is based largely on a re-examination by the writer during the field seasons of 1945 and 1946. Preliminary maps and reports (36, 37, 38) have been issued in advance of the present memoir, which has been prepared from a thesis submitted in 1947 to the University of Toronto in conformity with the requirements for the degree of Doctor of Philosophy.

In recent years about 4,910,200 pounds of molybdenite (MoS_2) and about 30,097 pounds of bismuth have been produced at the Lacorne property of the Molybdenite Corporation of Canada[2], and spodumene (tantalite, beryl, lepidolite) pegmatite dykes have been discovered in several places in Lacorne township. The prospect of commercial production of spodumene from the district, and a need for clarification of the early Precambrian structure and stratigraphy of this part of Abitibi county, because of their importance in connection with the search for gold and base metal deposits, provided the incentives for remapping the area.

Outcrops were mapped in the field on air photographs, which are on a scale of about 1 inch to 1,200 feet.

MEANS OF ACCESS

Most of the map-area is well provided with roads and waterways. The only part that cannot be reached by car or canoe is a belt about 2 miles wide that extends south from the northern limit of Lacorne township to Lake Lacorne, from where it widens to occupy much of the south-central margin of the area. The Val d'Or-Amos highway, following the western boundary of the map-area, gives access to the western part of Lacorne township. Fiedmont township and those parts of Vassan, Landrienne, and Barraute townships in the map-area are traversed at intervals of every mile or two by colonization roads suitable for motor transportation. The northeastern part of the map-area is traversed by the Senneterre-Amos highway and, in a northwesterly direction, by the Quebec-Cochrane branch of the Canadian National Railways. The areas in the vicinity of Lakes

---

[1] Numbers, in parentheses, are to references in the bibliography at the end of this chapter.
[2] Referred to subsequently as Lacorne mine.

Lortie, Roy, and Legendre may be easily reached by the new road following the gravel ridge from Fisher station to Lake Legendre. A motor road following a gravel ridge approximately along the centre line of Carpentier township is useful in providing access to the northeastern corner of the map-area. The parts of Senneville, Pascalis, and Courville townships within the map-area are traversed by Senneville and Courville Rivers, which afford the best means of entry.

ACKNOWLEDGMENTS

The writer wishes to extend his thanks to Professor E. S. Moore, head of the Department of Geological Sciences, University of Toronto, for reading the manuscript; to Dr. W. W. Moorhouse for general criticism and assistance in solving some of the problems encountered during the work; to Dr. M. A. Peacock and Dr. E. W. Nuffield for help in the determination of some of the rare minerals of the pegmatites; and to Professor A. MacLean who critically read the sections on physical features and glaciation. He is indebted to Dr. G. W. H. Norman of the Geological Survey for advice in the field, and to other colleagues for their collaboration. Thanks are also extended to the various mining men who put information at the writer's disposal.

In the field work, the writer was ably assisted by Mr. Donald Bulmer in 1945, and Messrs. Charles E. Keene and Rodney Bradley in 1946.

PHYSICAL FEATURES

PHYSIOGRAPHY

Fiedmont map-area forms part of the so-called 'clay belt' of northwestern Quebec and northeastern Ontario, formerly occupied by a great glacial lake known as Lake Barlow-Ojibway. Within it the common surface features are a clay-covered plain, with swamps and lakes filling present depressions; gravel ridges flanked by aprons of sand; and glacially smoothed rocky hills, surrounded by valleys filled with both morainal material and clay.

Some of these present surface features, however, are more obvious and conspicuous in certain parts of the map-area than in others, and for this reason the area falls naturally into two physiographic divisions: a northern lowland, and a southern hilly area. The imaginary boundary between these divisions passes north of the junction of Senneville and Courville Rivers; from there it runs northwesterly, passing through the centre of Lake Fiedmont, the northwest corner of Fiedmont township, and slightly north of the road in range II, Landrienne and Figuery townships. Figure 4 of this report shows the approximate area occupied by each division.

The northern lowland, covering an area of about 170 square miles, is a clay-covered plain, with a few areas of outcrops and gravel ridges. The outcrops, protruding through the mantle of clay and gravel, are high points of the bedrock, and consist mostly of altered volcanic rocks. The gravel ridges are annual moraines of the same type as those described by Norman in the Chibougamau district (28), and only those located in the highest parts of the lowland have not been covered by the glacial-lake clay. In

general, the outcrops are low and flat, except for the little knobs of granitic rock, which form definite mounds. The plain is about 10 miles wide in Barraute and Fiedmont township on the east, but narrows considerably where it reaches Landrienne township in the centre of the map-area, being limited there to a width of about 3 miles by the Lacorne batholith. Due to its even surface and clay bottom, the plan is a good farming area.

The hilly country in the south is rough and much dissected. It has an area of about 220 square miles, and is one of the most rugged parts of the 'clay belt'. Its relief is as much as 350 feet, but averages about 150 feet. A remarkable feature is the flat top of the hills and their approximate uniform elevation, suggesting remnants of a former plateau, now largely dissected by erosion following slow uplift. The underlying rocks are granitic and volcanic. Granitic intrusions underlie nearly all of the hilly area and constitute what is known as the Lacorne batholith. The volcanic rocks adjacent to this batholith have been transformed to hornblende schists, which are very resistant to weathering and now form the highest hills. The intervening valleys are wide and have been filled in some places with clay, and in others with large granitic boulders of local origin.

DRAINAGE

The drainage of the map-area, particularly its eastern part, has been greatly modified by the glacial deposits, but eventually finds its way into James Bay.

An esker trending about north through the centre of the area divides it into two distinctive drainage zones. The western zone displays a drainage pattern resulting from slow uplift and characteristic of areas of large granitic masses. The drainage is probably antecedent, as all the main streams flow between ridges of rock outcrops, and drain radially from approximately the centre of the batholith in all directions but east, where the gravel ridge (esker) forms a barrier. All the streams are tributaries of the Harricanaw, and the drainage pattern as a whole seems to be better established than in the zone to the east.

Drainage in the eastern zone is of the dendritic type, and here also the main streams seem, on the whole, to have maintained their original courses. Their tributaries, however, are definitely superimposed. The two main rivers, Laflamme and Senneville, are separated by a large, elongated swamp, and many of their tributaries have their source in it. Both the western tributaries of the Laflamme and the eastern tributaries of the Senneville have their source in gravel ridges. It is, consequently, apparent that the glacial features of this eastern zone have had a marked influence on the present drainage pattern.

Despite the fact that most of the rivers of the map-area apparently follow their original courses, all of them flow on soft material representing deposits of the last glaciation, and in general present features of both maturity and youth. Features such as rapids, cascades, gorges, and swift currents are surely characteristic of youth, whereas slow, muddy water, ox-bow lakes, a continuous belt of meanders, and natural levees suggest maturity. All these features have been observed in the field at one place or another.

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CHAPTER II

GENERAL GEOLOGY

GENERAL STATEMENT

All the consolidated rocks of the map-area are of Precambrian age, and consist of volcanic and sedimentary formations that are now folded and invaded by several masses, large and small, of intrusive rocks of various types. Apart from the granitic intrusions the volcanic rocks are the most abundantly exposed, occupying about 85 per cent of the combined area of the volcanic and sedimentary formations. They are mostly of basic to intermediate composition, but are interbanded with minor amounts of rhyolite and trachyte flows and related pyroclastic rocks. All are highly

TABLE OF FORMATIONS

Era	Period	Group	Lithology
Cenozoic	Pleistocene		Gravel, morainal material, sand, clay
	Unconformity		
Proterozoic	Keweenawan(?)		Gabbro, quartz gabbro, olivine gabbro; in part diabase
	Intrusive contact		
Archæan	Post-Timiskaming		Microcline-bearing granitic rocks: amphibolite, hornblende monzonite, biotite-hornblende granodiorite, biotite granodiorite, muscovite granite, pegmatites Albite-bearing granitic rocks: albite granite, porphyritic granite, micrographic granite
	Post-Keewatin		Quartz albitite dykes Quartz-feldspar porphyry Quartz diorite Intrusive amphibolite Peridotite
	Intrusive contact		
	Keewatin and (?) Timiskaming	Kewagama group (?) Kewagama group Malartic group	Greywacke and derived biotite schist; conglomerate Biotite schist Hornblende schist, biotite-hornblende schist; minor greywacke
	Keewatin	Kinojevis group	Basalt; andesite; dacite; minor rhyolite, trachyte, and pyroclastic rocks; some derived hornblende schist

altered: some have been changed to a schistose, chlorite-epidote rock, and some have been entirely recrystallized near intrusive contacts to hornblende schist. Four narrow belts of sedimentary rocks have been recognized They outcrop at the four corners of Lacorne township, are now recrystallized to quartz-biotite schist, and all appear to overlie the volcanic formations conformably. The intrusive rocks underlie about 50 per cent of the map-area and outcrop mainly in Lacorne, Fiedmont, and Courville townships. They vary in composition from peridotite to microcline-bearing granitic rocks, and their relative ages are not everywhere known. Some of the intrusive rocks were probably emplaced before the folding, whereas the albite- and microcline-bearing types are apparently younger. The diabase dykes are the only intrusions of Late Precambrian age; all the others are probably Archæan.

James and Mawdsley (24) mapped all the volcanic rocks of the map-area as Keewatin, and the sedimentary rocks doubtfully as Keewatin or Timiskaming. In this report a more detailed nomenclature has been employed, based on the sequence introduced by Gunning (20), and later used, with some reservations, by Ambrose (2), Gunning and Ambrose (21), and Norman (29), for formations of the southern gold belt in this region. The oldest rocks, which include all of volcanic origin, have been included in either the Malartic or the Kinojevis groups, two groups that may, in fact, represent the same formations repeated by folding and faulting. Overlying these volcanic rocks are the sedimentary strata of the Kewagama group.

VOLCANIC ROCKS

KINOJEVIS GROUP

Definition and Correlation

The Kinojevis group is probably the oldest group of rocks in the map-area. It consists mostly of basic to intermediate volcanic rocks interbanded with minor rhyolite and trachyte flows and pyroclastic material.

Previously (11), all the volcanic rocks of the map-area included in this group had been mapped as Keewatin, because they present most of the features characteristic of the so-called Keewatin greenstone. In La Pause map-area (2) the northern belt of the Blake River group is composed of volcanic rocks similar to those found in Fiedmont map-area. That belt has, however, been traced easterly across La Motte map-area, where Norman (29) referred to the rocks as those of the Kinojevis group, because in La Motte map-area they appeared to underlie the Kewagama sediments, whereas, by definition, the Blake River group overlies the Kewagama. As the relationships indicated by Norman have been observed in Fiedmont map-area, and as these volcanic rocks are there continuous with those of La Motte area, the name Kinojevis has been adopted in this report. On the other hand, by definition, the Malartic group underlies the Kewagama sediments, and it is possible that, due to folding and faulting, the Kinojevis volcanic rocks are the repetition of the Malartic group of Fiedmont map-area. East of the map-area, the Kinojevis group is recognized as Keewatin by L. V. and A. M. Bell (7).

Occurrence

Though outcrops are few and small, they suffice to indicate that the Kinojevis group covers an area of about 160 square miles. Almost all those parts of Landrienne, Barraute, Carpentier, and Senneville townships included in the map-area and most of Fiedmont township are underlain by volcanic rocks of the Kinojevis group.

Basic to Intermediate Lavas

Basic to intermediate lavas are the most widespread volcanic rocks of the Kinojevis group. Of these lavas, basalt is probably the most common type, but its differentiation from the other types has not been attempted, as in almost every place the rock is so altered that no accurate determination of its original mineral composition can be made.

These basic to intermediate volcanic rocks, probably due to their composition, are invariably more altered than the acidic types. On weathered surfaces, the rocks commonly range in colour from light to dark green, display a great variation in granularity, and are sheared to a variable extent. Some of the rocks mapped with this group weather a lighter green, and are probably of intermediate composition. They are fine grained, and display well-formed pillow structures. Three main occurrences of these light green lavas have been noted: on lots 51 and 52, rge. X, Fiedmont tp.; on lot 30, rge. IV, and on lots 6 to 9, rge. 11, Landrienne tp. The grain of the basic to intermediate lavas is quite variable: where these lavas show pillowed and amygdaloidal structures the grain is commonly fine; in other places the grain becomes medium to coarse, and individual outcrops may be difficult to distinguish from intrusive rocks. Examples of such granular types have been seen on the Randall property in Landrienne township, and in the group of outcrops northeast of the Barraute plug in Barraute township.

The basic to intermediate lavas are invariably schistose. The schistosity is not uniform in intensity throughout the area, but appears to be most pronounced along definite belts within which narrow shear zones are common. Commonly, too, the contact of two otherwise massive flows is marked by a schistose zone. Groups of outcrops where the lava appears more massive than schistose are numerous, particularly in rge. III, Barraute tp., northwest of Barraute village, and east of Lake Fiedmont, in rges. VII and VIII, Fiedmont tp.

Pillow structure is the most common feature of these intermediate to basic lavas, and has been observed in almost every outcrop area. It is not always possible to obtain a top determination, but in places pillow structure can be used for this purpose. The pillows are of various shapes and sizes, the balloon-shaped medium (2 feet by 1 foot)-size type being the most common (39, p. 18). Commonly the centres of the pillows weather a light green, which appears to be due to the high epidote content of that part of the pillow. Pillows are generally found at the tops of flows, and amygdules are concentrated within the pillows. Brecciated tops of flows are rare. Those volcanic rocks in contact with the Lacorne batholith have been entirely recrystallized to a hornblende schist, with a sort of gniessic structure apparent at the immediate contact.

From the above description, it is clear that the common volcanic features have been preserved in these basic to intermediate volcanic rocks. Their mineral composition, however, is almost entirely changed, and in most of the thin sections examined it seemed doubtful if any original constituent remains apart from some of the feldspar.

Under the miscroscope these volcanic rocks are fine to medium grained, and are seen to be composed of variable amounts of chlorite, epidote, feldspars, quartz, actinolitic amphibole, carbonates, muscovite, biotite, pyrite, ilmenite, leucoxene, titanite, tourmaline, apatite, and rutile. The most abundant minerals are generally chlorite, epidote, feldspar, and quartz. In places the rock has been so intensely carbonatized that the carbonates become an essential constituent, and most thin sections show at least some carbonate. In the wall-rocks of quartz stringers, biotite and epidote have formed at the expense of chlorite, and the rock is a mixture of biotite, epidote, and feldspar. The lava that has been intensely carbonatized may contain tourmaline as porphyroblasts. Within the contact zone of the Lacorne batholith, the volcanic rocks are entirely recrystallized, and contain hornblende, feldspar, epidote, and probably quartz as essential constituents. Some of the rocks were orginally porphyritic, with phenocrysts of feldspar. Two types of feldspars have been determined as main constituents of these lavas, namely albite and andesine, the latter as basic as An_{45}. In many places the feldspar is lath-shaped, and in general all the minerals are irregularly distributed.

Rhyolite and Trachyte

Rhyolite, rhyolite breccia, and trachyte constitute only a minor part of the rocks of the Kinojevis group. Omitting the highly altered rocks east and southeast of Lake Fiedmont, which will be referred to later and of which a part could probably be included with these acidic rocks, it has been calculated that they occupy about 4 square miles in the east half of the map-area. It is possible that some of these acidic rocks are intrusive, as a few features suggest such an interpretation, but they have not been mapped separately from the volcanic rocks. The quartz-feldspar porphyry of Landrienne, Barraute, and Carpentier townships might be considered by many as of volcanic origin, but for reasons presented later they are here regarded as intrusive rocks. The narrow band of rhyolite and rhyolite breccia outcropping in rge. VIII, Courville tp., is probably the continuation of a similar occurrence farther east in Senneterre map-area (7). This mass of rhyolite is in contact with basic lavas on the north, strikes about 20 degrees south of east, and is definitely extrusive, as the breccia on the south is seen grading into massive rhyolite to the north. The belt of rhyolite trending about 20 degrees south of east and outcropping in rges. II and III, Barraute tp., is possibly intrusive, as inclusions of basic lavas are seen in the rhyolite, and dykes of rhyolite cut the surrounding rocks. However, in spite of such features, this band is probably closely related to the acidic flows and has been mapped with them. Another band of rhyolite outcrops in rge. V, Barraute tp., in the northeast corner of the map-area, but no contacts were observed. Minor bands of similar rock are known to outcrop at several places in the eastern half of the map-area, but are too small to distinguish

from the basic lavas on the accompanying map. Some are included with the pyroclastic rocks of Senneville and Pascalis townships, and some with the basic lavas in Landrienne township.

The rhyolite is a fine-grained, light green to dark rock, white on weathered surfaces, and commonly looks glassy. The trachyte, although quite similar to the rhyolite, contains little quartz, has a less glassy appearance, a slightly coaser grain, and a slightly whiter weathered surface. All these acidic rocks are in places perceptibly porphyritic, with quartz and feldspar as phenocrysts. In thin section, they are seen to be composed mainly of quartz, feldspar, chlorite, and biotite. Apatite, iron ores, and carbonates have been also observed.

In places, the rocks are well jointed (*See* Plate II A). Two main directions of joints, one slightly west of north, the other slightly north or south of east, have been observed.

Pyroclastic Rocks

Three narrow bands of pyroclastic rocks are shown on the east half of the Fiedmont map. They occur in Senneville, Pascalis, and Fiedmont townships, and outcrop in some abundance there only. Together they occupy an area of about 6 square miles. A few other, small occurrences have been indicated on the map, and it is probable that some other bands occur in the altered volcanic rocks described below, and occurring east and southeast of Lake Fiedmont. No pyroclastic rocks have been seen in the west half of the map-area, except the narrow bands found associated with the mass of quartz-feldspar porphyry.

The pyroclastic rocks are fine grained, massive to slightly schistose, and in places finely bedded or fragmental. Where fragmental, the fragments are rounded to subrounded. In composition, they are andesitic, and pass at places to rhyolitic tuffs. In thin section most of them are seen to be composed of quartz, feldspar, chlorite, epidote, pyrite, biotite, and a dark brown, practically opaque substance.

Altered Volcanic Rocks

Some rocks east and southeast of Lake Fiedmont are now so altered that their original character is in doubt, and for this reason they have been mapped separately. They occupy an area in the southeastern corner of Fiedmont township, from ranges I to VI, that extends for about 6 miles in a north and south direction, with a width of 1½ to 3 miles. These rocks are probably volcanic in origin, as they present features suggestive of pillows, have a weathered appearance similar to undoubted volcanic rocks to the north, and are fine grained.

Both acidic and basic types have been recognized. The basic type forms a band that outcrops in ranges III and IV and separates two bands of acidic rocks, represented by the northern and southern groups of outcrops. The rocks of these two acidic groups are alike fundamentally, but differ in several particulars. The northern group appears to be composed of very acidic rock only, and to contain much secondary biotite, whereas the southern group comprises a mixture of both basic and acidic types, with acidic rocks predominating, and also contains much secondary hornblende in addition to biotite.

The band of basic rock is probably slightly more than 2 miles wide, and appears to strike easterly. The rocks of this band weather dark green, contain much hornblende and secondary biotite, and appear to be pillowed. Weathered surfaces expose numerous, small white seams of felsic material that strike in all directions and stand in relief. Narrow masses of flow breccia have been observed interbanded with this basic rock. As a whole, the rocks resemble the basic volcanic rocks, referred to above, that have been metamorphosed to hornblende schist near the contact of the Lacorne batholith, being distinguished only by the high biotite content and a massive appearance. Originally, therefore, the rock was probably an andesite, which has been altered to such a degree that much biotite has formed. It is intruded by small masses of amphibolite and quartz diorite.

The northern band of acidic rocks lies directly east of Lake Fiedmont, in ranges V and VI, where the rock is probably mainly a rhyolite and acidic tuff, interbanded with minor amounts of quartz-feldspar porphyry. These rocks include some narrow interbands of more basic, probably andesitic, material that strike north to northeast. The outcrops in most places are numerous, as the area has been recently burned, but they are so small and so similar that little information can be obtained from them. Flow lines were noted at a few places, striking about north 30 degrees east, and similar trends were observed at what was believed to be the contact between two flows. Most of the rocks weather white to greyish white, and contain much secondary biotite. Although some outcrops carry abundant biotite and others very little, there appears to be a definite sequence in its distribution. From west to east across this series of outcrops, it was observed that the biotite content was quite high near the contact with the granite on the west. Farther from this contact, the biotite content is less, and the biotite occurs in smaller, uniformly distributed grains, but seems to vary slightly in amount from one flow to another. Still farther east, approaching the eastern granite contact, the biotite content increases regularly: at first it is uniformly distributed throughout the rock, but farther east it is concentrated to such an extent as to suggest a faint banding at places, grading finally to a zone where the biotite occurs in large flakes concentrated in lens-like patches associated with garnet. This association of garnet with large flakes of biotite has been seen on several of the eastern outcrops. At places, quartz and feldspar phenocrysts can be seen, indicating that these acidic rocks are partly porphyritic. Some outcrops suggest that a quartz-feldspar porphyry similar to the intrusive type already referred to, and described later, may be present, and the fragmental structure apparent in some outcrops may indicate the presence of pyroclastic material. No bedding was seen.

Quartz veins and stringers have been observed. Two main sets of quartz veins and stringers were recognized, one set, apparently the most common one, striking between 25 degrees west of north and 25 degrees east of north, and the other between north 75 degrees east and south 60 degrees east. The quartz veins and stringers vary in width from a few inches to 3 feet, and, so far as known, are not mineralized. Pyrite or pyrite and sphalerite have, however, been observed at a few places in the altered acidic rocks, and an interesting occurrence of sphalerite carrying some gold, on lot 56, rge. V, will be described later. Joints are

quite common in two principal directions, one about east, the other varying between northwest and north. All the quartz veins and joints dip either west or south depending on the direction of strike.

In thin section, the rock of this northern band has a grain size of about 0·01 mm., and consists mainly of quartz and feldspar, with variable amounts of biotite, chlorite, epidote, garnet, and pyrite as the chief coloured constituents. Away from the granite contacts, chlorite seems to be the main mafic mineral; as the contacts are approached, biotite becomes more abundant, and tends to concentrate in zones or lens-like patches and to increase in grain size. It appears to have formed from chlorite. At the contacts, epidote is its common associated mineral. Pyrite is in minute grains uniformly disseminated throughout the acidic rocks, and carbonate, tourmaline, apatite, and muscovite have been recognized. In all these rocks, the feldspar has indices higher than Canada balsam and lower than quartz, and is probably a calcic oligoclase. The schistose nature of the rocks becomes more apparent in thin sections, as the contacts with the granite are approached.

The southern band of altered volcanic rocks comprises those exposed in rges. I and II, Fiedmont tp. Basic and acidic types appear to be interbanded, and strike about east or slightly south of east. No definite relationship between the two types can be given, as outcrops are scarce and poorly exposed. On weathered surfaces, the acidic type presents a varied appearance: at places it weathers white and much resembles the acidic rocks of the northern band, but where it is porphyritic the rock is similar to the quartz-feldspar porphyry mapped elsewhere in the map-area as intrusive, but the biotite content is much higher. The rocks also have a patchy appearance, a feature particularly characteristic of this southern band. The original rock was probably similar in nature to the rock of the northern outcrops, but it has recrystallized under such intense hydrothermal conditions that not only much biotite but also abundant hornblende crystals have formed. Hornblende crystals have been concentrated irregularly throughout the mass as patches surrounded by areas entirely free of hornblende crystals, or enclosing areas free of hornblende. This blotchy rock appears to have a very irregular distribution, and the amount of material introduced as hornblende seems to vary materially from place to place. Intermixed with it are bands of acidic rock with a high biotite content, bands of quartz-feldspar porphyry, and bands of the basic type. Joints have been observed here also, and strike either north to northeast or about 30 degrees north of west.

Under the microscope these rocks are not different from those of the northern band already described. They are also very fine grained, in places porphyritic, and consist mainly of quartz, feldspar, and a few coloured minerals. Biotite, chlorite, epidote, and pyrite are the principal mafic constituents, except in the patchy-looking rocks, where hornblende is the only mafic mineral of importance. This hornblende is a green mineral with the following absorption formula: X = yellowish green; Y = light bluish green; and Z = dark green. It has an elongated habit, contains many inclusions, and in general is ragged in outline. Its average grain size is about 1·0 by 0·6 mm. Carbonate, tourmaline, apatite, garnet, muscovite, titanite, zircon, and iron ores are the other minerals noted in variable amount. Where the rock is porphyritic, quartz and feldspar generally

form the phenocrysts, reaching a grain size of 2·3 by 1·5 mm., whereas the groundmass may average as little as 0·01 mm. No definite conclusions can be drawn on the results of the metamorphism of the rocks of this southern band, but probably much material has been introduced, as suggested by the hornblende, tourmaline, and carbonate. The rock has been entirely recrystallized. Bedding and fragmental structures are uncommon, but it is possible that some of the rock is tuffaceous, though probably much of it is rhyolite or quartz-feldspar porphyry, as suggested particularly by the way in which it weathers.

Contact with the Kewagama Group

The contact between the Kinojevis group and the overlying Kewagama group is partly exposed in lots 7 to 13, rge. I, Landrienne tp. It is a sharp contact that suggests an abrupt change in conditions from volcanic to sedimentary. North of the contact, the volcanic rocks exhibit features that suggest deformed pillowed structure, whereas the sedimentary rocks present a sort of banding that may represent bedding. Both types are now altered to a schist, due, probably, to the intrusion of the Lacorne batholith. The sedimentary beds are cut by a few dykes of granite and pegmatite, and they contain patches rich in hornblende, suggesting that some mafic material may have been derived from the adjacent volcanic rocks. Pillow structures and bedding appear to be conformable in strike and dip.

MALARTIC GROUP

Occurrence

The Malartic group has been observed only in the western part of the map-area, where it occupies small areas. Its main occurrence is south of the Lacorne mine, where it forms a band contiguous to Harricanaw River and striking southeast. This is the continuation of a belt of rocks of the Malartic group that was traced across the adjoining La Motte map-area by Norman (29). Adjacent to, and west of, Lake Baillairgé, in rges. II, III, IV, and V, Lacorne tp., some rocks included with the Malartic group are exposed for a length of 4 miles and a width of 4,000 feet. This band may be a repetition of the Harricanaw River band by folding, and may extend farther south, where similar rocks outcrop again about 1½ miles due east of the Lacorne mine. About 3 miles due east of Lake Baillairgé, rocks of the Malartic group occupy a small, V-shaped area. There, narrow layers of greywacke are interbanded with the Malartic group, and represent the only place where sedimentary rocks have been mapped with the rocks of this group. Another small body of Malartic rocks is exposed in lots 32 to 40, rge. IX, Lacorne tp., and is cut by numerous pegmatite dykes.

Lithology

The Malartic group of Fiedmont map-area consists mainly of basic volcanic rocks, now completely recrystallized to hornblende schist. These appear to have been almost entirely pillow lavas grading generally into massive andesite. No tuffs, no breccia, and no pyroclastic rocks have been seen. Pillow structure was the only volcanic feature noted, and is not

everywhere in evidence, as in most places the rocks have the weathered appearance and composition typical of massive andesite grading into pillow lava. In general, the rocks of this group resemble that part of the Kinojevis group adjacent to the Lacorne batholith, which has recrystallized to hornblende schist. This suggests for both types of rocks a common origin and age, as under the effects of metamorphism they have reacted in the same way and given rise to the same type of schist. This is a fine-grained, dark green rock, in which hornblende, quartz, and feldspar are recognizable in the hand specimen, and in which the hornblende crystals have a pronounced tendency toward a parallel orientation. In thin section, the rock is seen to be composed almost entirely of hornblende, quartz, and feldspar, and the fresh appearance of the rock suggests complete recrystallization. Some epidote, sphene, apatite, pyrite, biotite, and zircon were also recognized. Chlorite, sericite, and limonite are secondary products, and occur generally in very small amount. The hornblende is a fresh mineral, green in colour and prismatic in habit. It is the most abundant mineral in each slide studied, and in one thin section constitutes at least 90 per cent of the rock. It generally displays a pronounced orientation, which is parallel with the schistosity of the rock, and has a grain size of 0·5 by 0·1 mm. Feldspar is ordinarily fresh or slightly altered to sericite, and most of it appears to be quite calcic. It is not twinned, but as its indices are higher than Canada balsam and lower than quartz it is probably a calcic oligoclase; but some albite is also present. The feldspar has a grain size similar to quartz, about 0·3 by 0·2 mm., and both minerals are intimately mixed. Biotite has been noted where albite was present.

Contact with the Kewagama Group

The contact of the Malartic group with the Kewagama sedimentary rocks was observed at one place only, west of Lake Baillairgé. There Malartic hornblende schist is in sharp, but apparently conformable, contact with Kewagama biotite schist. No structures in the rocks of the Malartic group of this area have been seen that would indicate that they underlie the Kewagama group, but as earlier work (2, 29) has demonstrated this relationship, it is accepted here.

SEDIMENTARY ROCKS

KEWAGAMA GROUP

Distribution and Correlation

The Kewagama group is composed entirely of sedimentary rocks, and overlies both the Malartic and the Kinojevis volcanic groups. No structures, such as grain gradation or crossbedding, have been observed that could be used to indicate the relative age of the Malartic and Kewagama groups, but farther west it has been shown by Ambrose (2) and Norman (29) that the Kewagama group definitely overlies the Malartic volcanic rocks. As the Kinojevis group is possibly the Malartic group repeated by folding and faulting, its stratigraphic relationship to the Kewagama group would be the same as that of the Malartic group. In the Kinojevis volcanic rocks, pillows have been observed facing toward the Kewagama, indicating that the latter is younger.

Two bands of Kewagama sedimentary rocks have been mapped for some distance in the western part of the map-area. They are found at the borders of the Lacorne batholith, partly surrounding it, and are the continuation of the two branches of a Kewagama belt that has been traced across the adjoining La Motte map-area (29). The correlation of these two bands with the Kewagama group is not in doubt, as they can be traced in the field to rocks recognized as being of the Kewagama group. The northern band trends eastward for at least 5 miles in rges. X and I, Lacorne and Landrienne tps., respectively, and varies in width from 1,500 to 3,500 feet. A few inclusions of biotite schist in the granodiorite close to the contact with the Kinojevis volcanic rocks suggest that this Kewagama band may have been continuous at one time all along the borders of this granitic mass, joining the band southeast of Lake Roy. The southern band, due to cross-folding, trends southward along the southwestern corner of the map-area, from Lacorne village to Harricanaw River. It is closely folded with the Malartic group, varies in width from 400 to 6,000 feet, and probably occupies a syncline. Many, small, biotite granodiorite masses are intruded into it, and directly south of Lake Baillairgé it appears to branch, one limb following the zone that serves as a line of separation between the muscovite granite and the biotite granodiorite. About 2 miles directly east of Lake Baillairgé, two small bands of sedimentary rocks, interbedded with some volcanic rocks of the Malartic group, are probably Kewagama, as they are petrographically similar and outcrop close to a recognized Kewagama band. In general, exposures of Kewagama rocks are rare and small, and of rather uniform composition, probably greywacke.

Thickness

The thicknesses of these two bands cannot be estimated accurately. A rough approximation indicates that of the northern band as between 1,200 and 2,500 feet, and the southern band as probably 2,000 feet. For this estimate the average angle of dip has been considered to be 50 degrees, and no allowance has been made for possible duplication of strata.

Lithology

The Kewagama group in Lacorne township consists entirely of quartz-biotite schist. It is highly probable that the original rock was an argillaceous to arenaceous greywacke, which has completely recrystallized under the effects of metamorphism. Good bedding structures are rarely seen, and grain gradation, crossbedding, or other sedimentary structures have been destroyed by metamorphism. Only the mineral composition of the rock now suggests its sedimentary origin. It is a fine- to medium-grained, definitely schistose, grey to bluish grey rock, and weathers reddish brown. In general, the schistosity is parallel with the intrusive contact, and dips at a variable angle away from the intrusive mass. In the northern band, the schistosity strikes about east, and in the southern band about north. Both bands trend about parallel with the schistosity. On fresh surfaces, biotite, quartz, and feldspar are recognizable, and the schistose character is well marked. In thin section, rocks from both bands are seen to be composed chiefly of quartz, feldspars, and biotite. Chlorite, epidote, zircon, muscovite, apatite, iron oxides, sericite, and garnet are also present in variable amounts. Both albite and calcic oligoclase have been recognized.

Twinning is not common, and a little sericite is the principal alteration product. The feldspar grain varies in size from 0·2 by 0·2 to 0·6 by 0·9 mm., and the larger grains are poikiloblastic, containing many inclusions of quartz. Quartz is the most abundant mineral. It has sutured contacts and an undulatory extinction, with grain size quite uniform varying from 0·2 by 0·2 to 0·5 by 0·5 mm. The texture is clastic, and at places a sort of banding is noted. Biotite is reddish brown or greenish, partly altered to chlorite, and occurs in flakes of irregular size and indefinite shape around the grains of feldspar and quartz. The flakes in general lie parallel with the schistosity, and in the same position are a few lenses of quartz composed of many small individuals with sutured contacts.

KEWAGAMA GROUP (?)

Two other bands of sedimentary rocks, both short and narrow, occupy a central position in the map-area. Their relative age and their correlation with the Kewagama group are uncertain.

Southern Band

A southern band, in the southwestern corner of Senneville township, consists entirely of sedimentary rocks, very similar in appearance and composition to those mapped as Kewagama to the west. It trends 30 degrees south of east, varies in width from 500 to 5,000 feet, and has an estimated thickness of 4,800 feet, based on an assumed dip of 80 degrees. As in the case of the Kewagama bands, this band occurs at the border of the Lacorne batholith and has been intensely metamorphosed. The rock is entirely recrystallized to a quartz-biotite schist. This schist weathers reddish brown, is highly schistose, and in thin section is seen to be composed of the same minerals and to present the same characteristic features as those observed in the Kewagama sediments. The band has been seen in contact with the granitic rocks of the Lacorne batholith, and also in contact with the Kinojevis volcanic rocks. Its contacts with the granite are variable, sharp on the northern outcrops but apparently gradational in the south. Where the contacts are sharp, the sediments have been intruded by much granitic material in the form of lenses and patches elongated parallel with the schistosity. In the south the same sediments seem to have been partly assimilated by the granite, and across a zone a few hundred feet wide it is difficult to distinguish the one from the other. This zone is cut by several dykes of porphyritic granite. The contact of this band with the Kinojevis volcanic rocks is partly exposed. It is not a sharp contact but a succession of interbands of volcanic and sedimentary rocks. This relationship suggests a gradual change in the conditions of deposition from volcanic to sedimentary.

Northern Band

A northern band, with an exposed width of about 5,000 feet and a conglomerate at the base in its northern part, has been traced for about 5 miles in the northwestern corner of Fiedmont township. If the average angle of dip is assumed to be 65 degrees, the thickness of the band will be around 4,500 feet. Its relative age is still uncertain, but a few features suggest that it may be pre-Timiskaming. In its extreme northern part

the band trends 25 degrees south of east. Farther south it swings slightly to about 20 degrees east of south, but where it reaches the monzonite mass it resumes its original trend. This deflexion suggests cross-folding, probably due to the intrusion of the Lacorne batholith.

This band is composed entirely of sedimentary rocks that appear to be of the same nature as those of the Kewagama group mapped to the west. Where they come in contact with the monzonite mass they have been entirely recrystallized to quartz-biotite schist, and at places are highly sheared and crumpled. They weather reddish brown, and contain much biotite. Drag-folds noted locally near the monzonite mass have an axial trend of north 65 degrees east. Away from the monzonite contact, these rocks are not as metamorphosed, are grey to bluish grey, and exhibit bedding. Nor is their schistose character so pronounced.

The schist that weathers reddish brown is seen in thin section to be composed mainly of quartz, muscovite, and chlorite. Tourmaline, titanite, and iron oxides are also present in variable amount. A good banded structure is noted in thin section and is the result of the segregation of muscovite in bands that alternate with bands rich in quartz and chlorite or tourmaline. The contact between the different bands is sharp, suggesting bedding. The grey schist, the less metamorphosed rock, contains green biotite, quartz, and epidote as the main constituents, and zircon, iron ore, and leucoxene as accessory minerals. Banding and orientation of the elongated minerals are well demonstrated under the microscope.

About a mile north of the place where this band reaches the monzonite mass, the biotite schist is intruded by numerous lenses of porphyritic granite. The lenses are about 2 to 5 feet long by 2 feet wide, and are elongated parallel with the schistosity. The phenocrysts, which are albite, are abundant, forming at least 50 per cent of the granite. The groundmass is made up mainly of albite, but contains some quartz, biotite, and carbonates. Chlorite occurs as a secondary mineral.

A few small layers of grit were observed interbedded with the ordinary sedimentary strata, and in one place a band of more acidic rock, heavily mineralized with pyrite, is believed to have been originally an impure sandstone that had recrystallized to a quartzite under the effects of heat from the nearby monzonite intrusion, with the addition of much sulphide and, probably, some albite. A thin section of this rock shows much quartz, albite, and clinozoisite. Muscovite, sphene, zircon, and pyrite are minor constituents.

The conglomerate (Plate II B) has been observed in only two groups of outcrops in the northern part of this band, where it forms a bed that apparently disappears a short distance southward, with its extension to the west unknown due to the heavy mantle of sand. The more northerly group of outcrops consists entirely of conglomerate. In the southern group, the conglomerate grades upward to bedded greywacke to the east. It carries pebbles and cobbles of greywacke, basic volcanic rocks, granitic rocks, quartz and quartz-feldspar porphyry, chert, flint, quartz and tourmaline-bearing quartz, and a granite with inclusions of basic volcanic rocks. The pebbles amount to about 40 per cent of the rock, and in general are slightly squeezed or sheared. They vary in size from coarse grains to boulders 22 inches in maximum diameter. Most of the pebbles and cobbles of greywacke, chert, and volcanic rocks and some of quartz-

feldspar porphyry are lens-shaped, and are oriented parallel with the schistosity. The granitic cobbles and many of quartz-feldspar porphyry are rounded or oval shaped, and the schistosity seems to swing around rather than across them. Pebbles and cobbles of chert and quartz-feldspar porphyry are the most abundant. Most of the granitic cobbles were noted in the southern group of outcrops, where they reach their maximum diameter of 22 inches, and are well rounded. Some of this granitic detritus has been recognized as from biotite and hornblende granitic and dioritic rocks. The matrix of the conglomerate is biotite-rich, and in thin sections is seen to be composed of variable amounts of biotite, quartz, chlorite, feldspars, epidote, apatite, zircon, and pyrite, of which the first four are the main constituents. This matrix is partly recrystallized; quartz is finely intergrown in places with feldspar, and biotite may be markedly poikilitic.

A few dykes of granite have been seen cutting this band of conglomerate.

Slightly north of the place where the northern sedimentary band reaches the monzonite mass, the sedimentary rocks can be observed in contact with the recrystallized volcanic rocks of the Kinojevis group. The contact is represented by a succession of layers of sedimentary strata interbanded with volcanic rocks, all of which are intensely schistose and drag-folded. The sedimentary layers disappear to the west, but nothing is known of their extent in the opposite direction. This interbanding is not believed to represent transition, but is probably the result of close folding, as suggested by the drag-folds, the flowage folds at the noses of volcanic layers in the sedimentary rocks, and the great variation in the direction of the schistosity in this part of the area. The age of this band is still uncertain, but the close folding suggests that it is pre-Timiskaming.

INTRUSIVE ROCKS

The intrusive rocks of the map-area require only a few comments here, as they will be described in detail in later pages. As a whole, they occupy about half of the map-area. Their main occurrence is that of the Lacorne batholith, which occupies most of Lacorne township and adjacent parts of the adjoining townships. In the remaining part of the map-area, they occur as sills, plugs, and irregular masses. They include a great variety of rocks from peridotite to spodumene-bearing pegmatites, but the granitic varieties (including monzonite and pegmatites) are the most abundant. These granitic rocks vary in mineral composition from albite- to microcline-bearing types and they are typical of the classification proposed by Gussow (22, p. 132) and followed by Norman (30, p. 2). As the microcline-bearing type is the most widespread and the best exposed of the intrusive rocks of the map-area, it will be described in greater detail. As indicated in the table of formations, the intrusive rocks are all assumed to be of Archæan age except the gabbro, which is probably Proterozoic. They may be arranged, according to relative age, beginning with the oldest, as follows:

(1) Peridotite, intrusive amphibolite, quartz diorite, quartz-feldspar porphyry (includes acidic flows and tuffs), quartz-albitite dykes.

(2) Albite granite, micrographic granite, porphyritic granite.

(3) Lacorne intrusions: hornblende monzonite, biotite-hornblende granodiorite, amphibolite, biotite granodiorite, muscovite granite, satellites, and pegmatites.

(4) Gabbro, diabase dykes.

These relative ages are based partly on crosscutting relations and partly on the mineral composition and the degree of alteration of the rocks.

PERIDOTITE

Occurrence

Peridotite occurs as lens-like sills within the Kinojevis volcanic rocks close to the northern contact of the Lacorne batholith. The lens-like sills range in size from a few hundred feet long and a few feet wide to 1 or 2 miles long and 1,000 feet wide. A belt of such peridotite sills was traced west for at least 30 miles in Figuery and Manneville townships by Norman (29) and Ambrose (2). The eastern extension of this belt has not been found in the eastern half of Fiedmont map-area, probably because of the heavy cover of superficial materials, but is possibly near the eastern contact of the Lacorne batholith.

Lithology

The peridotite is generally a massive rock, weathers light brown, mauve, grey, or green, and is softer than the volcanic rocks of the Kinojevis group with which it is commonly associated. It generally outcrops in smooth, rounded mounds with a soft, slippery surface. The rock appears massive, but is cut by many irregular seams of white tremolite. At places these seams are so uniformly distributed that they resemble the outlines of pillows. Commonly, they stand in relief on a weathered surface, and are soft as compared with seams of siliceous material occurring in the volcanic rocks of the Kinojevis group. A characteristic, weathered feature of the peridotite is a sort of platy structure that Norman (29, p. 3) defines as "consisting of fine, radiating, amphibole fibres arranged to form variously oriented groups of parallel thin plates 1 to 2 inches in diameter" (*See* Figure 1).

Fresh surfaces of the peridotite are dark coloured, and the rock appears to be quite fine grained. In thin section, it is composed of variable amounts of tremolite, serpentine, talc, chlorite, calcite, iron oxides, and pyrite. A few skeletons of augite were seen in one slide. In general, tremolite, chlorite, and serpentine or talc are the most abundant constituents. The tremolite is in fibres of various sizes and lengths, and is embedded in a matrix of chlorite and serpentine or talc. Calcite is a minor constituent and may be absent. The distribution of iron oxides suggests that originally olivine was an important constituent of this rock.

So far, no mineral deposits have been found associated with the peridotite.

Age

The relative age of the peridotite has been determined from crosscutting relationship with other rocks. A peridotite mass on lot 18, rge. I, Landrienne tp., is cut by a small dyke of diabase, which is considered to be the youngest intrusive rock of the map-area. West of Lake Lortie, and southeast of

Lake Roy, biotite-hornblende granodiorite and slightly more acidic phases of the Lacorne batholith cut some of the peridotite sills. Therefore, the peridotite is definitely older than this batholith. No field evidence has, however, been found to indicate the age relations of the peridotite to the intrusive amphibolite or the quartz-feldspar porphyry.

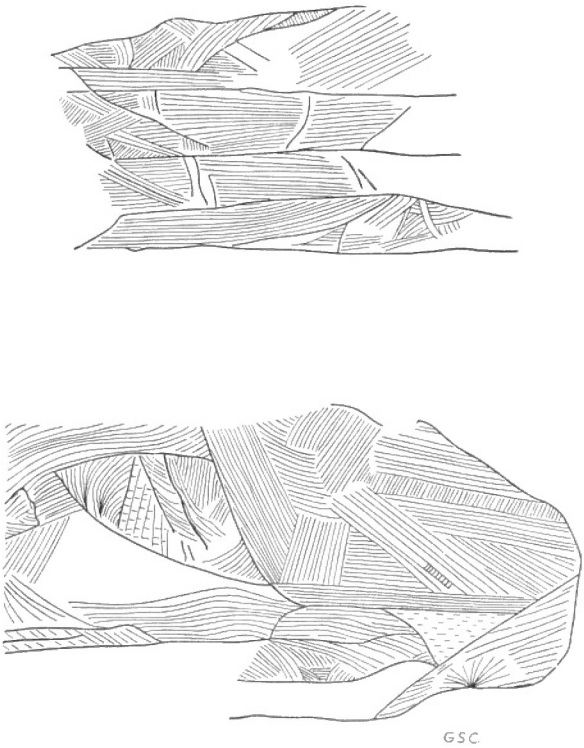


Figure 1. Field drawings of 'platy structure' as seen in places on weathered surfaces of peridotite masses (half natural size).

AMPHIBOLITE

Occurrence

An amphibolite, mapped in the field as an intrusive rock, has been noted only within the Kinojevis volcanic rocks, where it forms a sill and four irregular masses cutting across the trend of the formations. It is possible that there are other such intrusions, but field relations do not reveal their intrusive character. This is especially true of the basic volcanic rocks adjacent to the Lacorne batholith, where the rock is entirely recrystallized to hornblende schist. Bands and small areas of rock very similar in appearance and composition to the intrusive amphibolite are associated with these recrystallized lavas and are almost impossible to distinguish from them.

The amphibolitic mass in lots 7 to 12, rges. IV and V, Landrienne tp., has an area of about 2 square miles. It is broadly V-shaped, with the apex of the V pointing to the east. Its northern contact exhibits typical interbanding of dykes and bands of basic volcanic rocks. Its southern contact appears to be sharp. The two small masses on lots 20-21 and lot 34 respectively of rge. V, Barraute tp., are about 2,000 feet long and a few hundred feet wide. Their field relations suggest that they may be sill-like masses. In both instances the visible contacts are sharp. Southeast of Lake Fiedmont, a small mass of amphibolite occupies an area of ¼ square mile on lots 44, 45, and 46, on the boundary line between rges. III and IV, Fiedmont tp. This mass is roughly Y-shaped, with the Y pointing to the southeast and the long arm slightly bent to the southwest. It has sharp contacts with the adjacent rocks. The largest intrusion of this type is a sill-like mass that strikes about parallel with the trend of the formation, that is, about southeast, in rges. IX and X, and rges. I and II, Senneville and Fiedmont tps., respectively. The sill has been traced at intervals for about 8 miles along its strike, and seems to vary in width from 2,000 feet to 1 mile. The intrusive nature of this mass is demonstrated definitely by its chilled contacts and apophysal dykes.

Lithology

The amphibolite is a coarse-grained rock with an average grain size of 6 mm. It is dark green to black, and weathers dark green, with at places a brownish, dark red cast. The weathered surface appears massive, and is quite smooth. In places a rough banding can be observed, due to different types of rocks occurring in the same mass. This feature was not observed in the masses of Landrienne and Barraute townships, but is very striking in both bodies southeast and southwest of Lake Fiedmont. There, two types of rocks have been recognized in the field, a peridotite-like rock and an amphibolite. The peridotite occurs along the eastern margins of the Y-shaped mass, forming a narrow zone at the borders of the long and the upper right arm of the Y. The peridotite weathers dark brown, and is cut by numerous seams of white tremolite that stand in relief. The rock of the amphibolite zone is more greenish on weathered surfaces, and appears to be much altered. The sill-like mass southwest of Lake Fiedmont presents slightly different features. Here again, it seems that some peridotite has formed along its northern contact, but it is doubtful if the peridotite layer is continuous. Along the south contact, and at a few places within the mass, the amphibolite appears to have been much fractured and brecciated, and subsequently injected by a light reddish, granitic material, which has filled the spaces between the fragments. The amphibolite here much resembles the amphibolite of the masses in Landrienne and Barraute townships, and does not appear as greatly altered as the amphibolite of the Y-shaped mass.

In thin section, all the amphibolite rocks have much in common. The original constituents seem to have been more or less completely altered to some secondary minerals. Amphibole, altered feldspar, and interstitial quartz are the main constituents, but amphibole is by far the most abundant, constituting about 90 per cent of the mineral content. Hornblende is the common amphibole, but tremolite is the amphibole of the small mass on lots 20 and 21, rge. V, Barraute tp. Hornblende occurs

generally in large grains, which have been much bleached and present ragged outlines. They are much altered along their edges to a fibrous material, probably chlorite. Tremolite is fibrous and is variable in grain size. In all the sections examined, the feldspar is highly altered, but may have been a rather calcic plagioclase. The slide in which the amphibole is tremolite contains a feldspar that has been completely altered to zoisite, albite, and sericite. Accessory minerals are sphene, apatite, and iron oxides. Carbonate and pyrite were seen in a slide obtained from a specimen of the large, sill-like mass. Chlorite, epidote, sericite, and leucoxene are the common alteration products. The texture is hypautomorphic granular, and the grain is fine to medium. A thin section obtained from a specimen from the Landrienne mass suggests an ophitic texture, and emphasizes the fact that the original mafic mineral might have been a pyroxene. Some interstitial quartz is present. A Rosiwal analysis of this slide indicated the following mineral composition: amphibole, 77 per cent; feldspar, 15 per cent; epidote, 5 per cent; quartz, 1 per cent; and iron ore, 2 per cent.[1] From this, it seems reasonable to assume that the original rock was a basic gabbro, grading, in places where the feldspar content was low, into pyroxenite. It might be interesting to note that similar masses in Duverny area have been mapped by Weeks as altered pyroxenites (42).

Age

The relative age of these amphibolitic rocks is only known in part. They definitely intrude the kinojevis volcanic rocks, and their sill-like character and extensive alteration suggest that they were emplaced before the folding of that volcanic group. The Y-shaped mass in rge. III, Fiedmont tp., appears to be cut by quartz diorite, as the amphibolite is very schistose where it is in contact with the diorite. The sill-like mass of Senneville and Fiedmont townships is older than the Lacorne batholith, as much monzonitic material cuts across it on lot 11, rge. II, Fiedmont tp. Thus, the amphibolite masses are older than the potassic intrusions of the map-area, and appear also to be older than the quartz diorite. Their age relative to the albite granite is unknown, but they have experienced much greater alteration.

Mineral Association

So far, no significant mineral deposits have been found associated with these amphibolite masses. A few pegmatitic quartz veins containing some molybdenite are associated with the masses southeast and southwest of Lake Fiedmont, but are probably not genetically related to them. Some base-metal deposits have been found associated with a similar amphibolite mass on lots 10 and 11, rge. VII, Barraute tp., beyond this map-area.

QUARTZ DIORITE

Occurrence

Three small masses of quartz diorite are exposed in the map-area. They all occur in Fiedmont township, one on lots 42 to 46, rge. IV, another on lots 32 and 33, rge. IX, and the third on lots 51 and 52, rge. X. The southern mass, on range IV, has been mapped as a granite on the old Fiedmont sheet (24).

[1] According to Johannsen's classification and using volume percentages, this rock is a melatonalite (328).

Description

Although the three masses have been classified and are described here as quartz diorite, the southern mass, on range IV, is somewhat different, being slightly more basic, coarser grained, and more schistose than the other two. As a whole the three bodies are quite massive, medium grained, light grey to dark grey on weathered surfaces and greenish grey on fresh surfaces. Feldspar, hornblende, and quartz can be recognized. Joints strike slightly differently in each mass. On range X they strike 10 degrees and 75 degrees east of north, and 50 degrees west of north, the main set, which is also the latest, striking 75 degrees east of north. This mass has quartz phenocrysts, and its contacts are irregular and sharp. No quartz stringers were seen. The second body, on range IX, is intersected by fractures striking at 15 degrees east of north and at 5 degrees south of east, and has schistose contacts. Quartz is inconspicuous in hand specimens, but a few quartz stringers were observed. The southernmost mass presents features more typical of intrusive rocks. It contains many inclusions of the adjacent rocks, is intersected by fractures and cut by biotite granite dykes, and appears to become more acidic from northwest to southeast. A few narrow shear zones were noted; they strike 55 degrees east of north, dip steeply, and contain veinlets of quartz. Some molybdenite and pyrite have been found in the quartz veinlets. The fractures or joints have three main directions of strike: 10 degrees and 75 degrees west of north, and 40 degrees east of north. The granitic dykes vary in width from 3 to 20 feet and strike in three principal directions, namely, north, 75 degrees east of north, and 35 degrees west of north.

Under the microscope, the rock presents a hypautomorphic granular texture, and has a grain size varying from fine to medium and averaging 0·4 by 0·6 mm. Pale to dark green hornblende, quartz, andesine, and epidote or zoisite are the main constituents. Sphene, iron oxides, and apatite are accessory. Hornblende is the most abundant mineral, constituting more than 50 per cent of the rock. Most crystals are well shaped, but those that have been bleached of iron have a very ragged outline. The feldspar is a much altered plagioclase, and locally is lath-shaped. Due to its alteration, it is difficult to determine its composition, but measurements of the angle of extinction on adjacent albite twins have indicated an andesine at least as basic as An_{36}. Quartz is as abundant as the feldspar, and its grains are clear and rounded.

Age

The age relation of this rock to the quartz-feldspar porphyry is not known. The southern mass is found in contact with an amphibolite mass. At the contact the amphibolite is quite schistose, suggesting that the diorite has intruded it and that the diorite is, therefore, younger than the amphibolite. No crosscutting relations with the albite granite and the Lacorne batholithic rocks have been observed, but the quartz diorite is more altered than any of them.

QUARTZ-FELDSPAR PORPHYRY

Occurrence

Acidic intrusive rocks are known to occur at six different places in the map-area. In rges. II and III, Landrienne tp., they form a belt-like mass 500 to 6,000 feet wide that has been traced from lots 1 to 42, a distance of 7 miles. This mass may be a continuation of acidic volcanic rocks and quartz porphyry that extend northwestward across the Amos map-area (4), which lies directly northwest of, and adjacent to, the Fiedmont map-area. It strikes about east in Landrienne township and seems to reappear in Barraute township, where three different bands were observed striking about 30 degrees south of east. The northern band varies in width from 500 to 1,300 feet, and has been traced for 2 miles, from lots 19 to 26, rges. III and IV. The southern band outcrops on lots 25 to 29, rge. I, has an unknown length, and varies in width from 900 to 1,600 feet. The centre band, on lots 22 to 29, rge. II, and lots 10 to 20, rge. III, varies in width from 400 to 2,500 feet, and is known to be at least 4 miles long. Another small mass, probably the continuation of the centre band, has been noted on rges. X and I, Fiedmont and Barraute tps., respectively. A body of unknown shape, in rges. III, IV, and V, Carpentier tp., is probably the western extension of the acidic intrusion that extends northwesterly across Senneterre map-area (7), which lies directly east of the Fiedmont map-area. It is possible that similar rocks occur in the area of doubtful volcanic rocks that has been mapped separately east and southeast of Lake Fiedmont in the eastern half of Fiedmont map-area. There, rocks with abundant quartz and feldspar phenocrysts and very acidic in composition, were noted at different places, but their intrusive character has not yet been demonstrated. In general, some of the masses mapped as acidic intrusions were classed as granite on the old Fiedmont sheet (24).

Macroscopic Description

The porphyry occurring in rges. III, IV, and V, Carpentier tp., is massive, but in all other places is highly schistose. The massive type weathers white to creamy white, has a glassy appearance and a greyish white colour on fresh surfaces, and contains a small percentage of quartz and feldspar phenocrysts. The schistose rock weathers white, with a yellowish streaky tinge, which in some schistose parts is so regularly distributed that it suggests a pillowed structure. This feature is well represented by some of the outcrops of the Landrienne mass. The yellowish streaks are probably those parts of the rocks that have been altered to a sericite schist. The phenocryst content is commonly very high, but varies slightly from place to place. On fresh surfaces, the schistose porphyry is light yellowish grey to dark grey.

At places, the highly schistose porphyry displays a rough banding that may be mistaken for bedding, but is probably a result of shearing that has been accentuated by differential weathering. Some fragments of massive rhyolite and of andesitic lava were also noted at a few places in this schistose porphyry. A dark grey variety has been recognized in the Landrienne mass, where it occurs as lenses within the schistose porphyry and as a band along the southern border of the belt. This variety has a massive appearance and differs from the other type in

weathering grey or dark grey, in having only occasional phenocrysts, and in being much more chloritized. In the hand specimen, abundant tiny mica flakes can be readily recognized, and it is believed that the dark grey colour of this porphyry is due to this high mica content. Contacts with the schistose porphyry are sharp, and seem to be zones favourable for sulphide mineralization. A few apophyses of the schistose porphyry have been seen in the grey variety. These apophyses, and the occurrence of the grey variety along the south border of the Landrienne mass, where all the pillowed lavas face south, suggest that the grey variety may be an extrusive phase of the schistose quartz-feldspar porphyry. Staining of a few polished sections (17) of the porphyries has revealed interesting features. No potassic feldspar has been recognized either as phenocrysts, or in the groundmass, but seems to have been introduced only along seams filling tiny fractures in the porphyry. In general, the quartz phenocrysts are larger and more abundant than the feldspar phenocrysts; they may be either rounded or angular, with the rounded ones generally the larger. Some of the quartz phenocrysts have been fractured, and the fragments are now separated in the groundmass. Patches of the groundmass are seen enclosed in some of the rounded phenocrysts of quartz. The feldspar phenocrysts are commonly lath-shaped, and some of them have also been fractured.

Two sets of joints were observed in places, one striking north and the other 25 degrees south of east. A few, small quartz veins, varying in width from a fraction of an inch to 6 inches, were noted in the Landrienne mass, some striking between 30 and 70 degrees west of north, a few east, and a few north. No ore minerals were seen in these quartz veins.

Microscopic Description

In thin section, the acidic porphyries are seen to be composed of quartz and feldspar phenocrysts in a groundmass of the same minerals. Chlorite, sericite, iron oxides, epidote, biotite, apatite, zircon, and leucoxene are also present in variable amount. Chlorite and sericite or carbonate are always the most abundant alteration products, sericite being the main secondary mineral of both masses in Carpentier and Landrienne townships, chlorite the most abundant one of the grey variety in Landrienne township, and both plentiful in the mass forming the centre band in Barraute township.

Feldspar occurs as phenocrysts and in the groundmass. The amount of feldspar in the latter is uncertain, owing to the fine grain, but, as revealed by staining, is probably quite high. The phenocrysts in general are well formed. They are commonly lath-shaped, but their common crystal outline is roughly hexagonal. In composition they vary slightly. The feldspar of the Landrienne mass and of the grey porphyry has been determined as a sodic andesine at least as basic as An_{32}, whereas the mass forming the middle belt in Barraute township has albite as the main feldspathic constituent. In general the phenocrysts are slightly altered to sericite, or to sericite and epidote, and are commonly fractured (Plate III A), the fractures being filled with material similar to that of the groundmass. At places the fragments have been moved slightly from their original position, their outlines indicating that they were originally parts of a single crystal. Elsewhere, the fragments are too dispersed to be correlated, and where

abundant in a thin section they suggest a clastic texture, which, however, is probably entirely the result of shearing. Reid (32), supporting a sedimentary origin for the Hardrock porphyry of Little Long Lac area, admits that such a clastic texture may be due to shearing, even though he does not believe it is so of that area. The feldspar phenocrysts have a grain size varying up to 2·5 by 2·0 mm., and the average grain size of the groundmass is 0·02 mm.

Quartz is an important constituent of the quartz-feldspar porphyry rocks. As phenocrysts it is the most common mineral, occurring in all sizes up to 3·2 by 3·0 mm. These quartz phenocrysts are commonly rounded, but many are angular, and some have a good hexagonal outline. They all show features of some kind of regrowth. Many have an irregular rim clear of liquid inclusions, and with numerous tongues pointing toward the groundmass. Some of these tongues have been measured, and in one grain measuring 0·9 by 0·6 mm. one such tongue was 0·1 mm. long. Features similar to those revealed by the staining of some polished sections and described previously have been noted also under the microscope. The angular appearance of some quartz fragments is, as in the case of the feldspar, probably due to shearing. One such fragment was observed to consist of a large remnant of a quartz phenocryst together with some groundmass, suggesting that the original rock was porphyritic and that it had been sheared subsequently to such an extent as to suggest a clastic texture of sedimentary origin.

The quartz phenocrysts of the grey porphyry are not large single crystals, but are rather lens-like patches comprising a mosaic of small individuals with suture lines suggesting that the lenses of quartz may be the result of recrystallization, this emphasizing the porphyritic nature of the rock. The quartz of the groundmass appears intimately and abundantly mixed with feldspar. Chlorite in the grey porphyry occurs mainly in streak-like patches parallel with the quartz lenses, thereby exhibiting a roughly schistose structure. Some of the lath-shaped feldspar phenocrysts, however, lie at right angles to this schistosity. The chlorite content of this porphyry is believed to explain in part its darker colour.

Some evidence of mineralization was observed in the Landrienne mass. A little pyrite is distributed throughout the schistose part, and at places is concentrated in definite zones. Along the contacts of this mass the rocks on either side are in places so strongly carbonatized that they can be mapped as carbonate rock. Near one such occurrence, on lot 9, rge. III, Landrienne tp., sphalerite, chalcopyrite, and pyrite were reported in amounts sufficient to encourage prospecting at depth. Along the southern contact of the middle belt in Barraute township, some quartz veins have been reported to contain a little gold.

Mode of Origin

Field work and microscopic studies substantiate the belief that the quartz-feldspar porphyry masses are intrusive. The presence in them of occasional massive rhyolitic fragments is not an indication of a clastic origin, as similar fragments have been observed in the porphyries of the Porcupine district (15), which are definitely intrusive. In fact, the occurrence of andesitic fragments close to a contact with a mass of andesitic lava demonstrates the intrusive nature of the porphyry of this map-area.

The crosscutting relation of some of these masses in Barraute is well shown, and apophysal dykes have been observed in the basic lavas. Under the microscope, the apparent clastic texture is the result of shearing, as indicated by the fracturing of well-formed feldspar and quartz phenocrysts. The zone of regrowth on most of the quartz grains, and the small areas of groundmass material within some quartz grains, all suggest that recrystallization was an important process in the formation of large quartz individuals, and has been a factor in emphasizing the porphyritic nature of the rock. It is probable, therefore, that some of these phenocrysts are metacrysts, and that the lenses of quartz in the grey variety of quartz-feldspar porphyry represent a stage in the formation of these large quartz metacrysts.

QUARTZ-ALBITITE DYKES

A few quartz-albitite dykes, with an average width of about 4 feet, were noted on the Randall property in rge. IV, Landrienne tp. They cut basic volcanic rocks, and are a very striking feature, as they have a reddish white weathered surface and a very fine-grained appearance. Their contacts are sharp and very irregular. Most of these dykes strike about parallel with the schistosity of the rock.

In thin section, these dyke rocks are seen to be composed mainly of a fine, micrographic intergrowth of quartz and albite, quartz, and chlorite. Some sericite and limonite and a few crystals of sphene and zircon were also seen. The rock, due to its fine-grained texture and its fine, micrographic intergrowth, probably cooled rapidly, though it contains a few, occasional large phenocrysts of quartz.

ALBITE GRANITE

Occurrence

A part of the southeastern corner of the map-area adjacent to Lake Fiedmont is underlain by an albite granite. Farther east, the continuation of this intrusive body has been mapped by Bell (7) as the Pascalis-Tiblemont intrusion. Its dimensions in the Fiedmont area are unknown, as outcrops are not sufficient to determine the positions of the contacts. It has been found in rges. I and II, Courville tp., rges. IX and X, Pascalis tp., and rges. V and VI, Fiedmont and Courville tps. The mass outcropping in rges. VI and VII, Fiedmont tp., around Lake Fiedmont, is probably a large cupola of the Pascalis-Tiblemont mass to the east.

Lithology

The albite granite has in places an amphibolitic border, locally grades into dioritic rock, and contains a few inclusions of basic volcanic rocks. The amphibolite is a coarse-grained, dark green rock, composed of more than 90 per cent hornblende. The granite itself is usually massive and coarse grained, and varies from light grey on fresh surfaces to milky white where weathered. Quartz, some of it opalescent, plagioclase, and biotite are recognizable in hand specimens. Some jointing was seen, in two main sets striking northeast and northwest respectively.

In thin section, the albite granite is composed of variable amounts of quartz, albite, biotite, chlorite, epidote, muscovite, sericite, titanite, calcite,

apatite, iron ores, and zircon. The texture is xenomorphic granular, and the grain size about 3 by 2 mm. Two rosiwal analyses determined the mineral content as follows: quartz, 51 per cent; albite, 42 per cent; biotite, 6 per cent; and accessory minerals, 1 per cent[1]. Albite has an elongated habit and good polysynthetic albite twinning. It is slightly altered to sericite, which in places occurs in flakes as large as normal muscovite. Quartz is in large grains of irregular shape interstitial to the albite, and contains numerous liquid inclusions. Brown biotite occurs in ragged, lath-like grains commonly associated in groups interstitial to the many larger grains of quartz and albite. It is partly altered to chlorite, and contains tiny crystals of zircon. Staining tests (17) have not revealed the presence of any potassic feldspar.

Chemical Analyses

The following are two chemical analyses of the albite granite (7, p. 227):

—	I	II
	Per cent	Per cent
SiO_2	74·61	76·11
Al_2O_3	13·03	12·07
Fe_2O_3	1·50	0·81
FeO	1·51	2·32
MgO	0·30	0·35
CaO	1·42	1·57
Na_2O	4·84	4·40
K_2O	1·56	1·17
H_2O (hygroscopic)	0·04	0·10
H_2O (combined)	0·20	0·41
TiO_2	0·12	0·21
CO_2	0·89	1·01
P_2O_5	trace	trace
$S(FeO_2)$	0·05	trace
MnO	0·02	0·03

I. Siliceous type of soda-granite[2] from Pascalis-Tiblemont mass, northern Tiblemont township. Analyst, M. Archambault, Bureau of Mines, Quebec.

II. Siliceous type of soda-granite from Lake Roquetaillade, Pascalis township. Analyst, M. Archambault.

Age

The age relations of this granite to the other intrusive rocks of the area are not known, but according to Norman's classification (31) it may be older than the Lacorne batholith but younger than the peridotite, amphibolite, quartz diorite, and quartz-feldspar porphyry. Textural and mineralogical features suggest that this albite granite is probably an original differentiate and not the result of alteration.

MICROGRAPHIC GRANITE

A sill-like mass of micrographic granite outcrops on lots 24 to 31, rge. III, Barraute tp. The exposed part of the sill is quite small, varying in width from 200 to 1,700 feet and striking 35 degrees south of east. Due to lack of outcrops its eastern extension is not known.

[1] In Johannsen's classification this rock will be represented by number 214P.

[2] The samples used in these chemical analyses were termed soda-granite; the term is retained here for that reason.

It is a massive rock, of medium grain and dark grey on fresh surfaces. Blue quartz, feldspar, and chlorite are recognizable. The rock weathers light grey, and in general looks fresh. At the western end of the sill-like mass, however, the granite has been mineralized and carbonatized and has a reddish tinge, but the granitic texture is still visible. Two sets of fractures were observed, one striking 60 degrees east of north and the other 26 degrees south of east. The latter is the more significant and is probably the younger.

In thin section, the rock consists mainly of a slightly irregular, plumose, micrographic intergrowth of albite and quartz, albite, and quartz associated with some chlorite. Calcite, muscovite, epidote, leucoxene, pyrite, and probably some biotite were noted, and also a few minute grains of what may be microcline. Albite occurs in well formed crystals, generally surrounded by the graphic intergrowth, which appears to develop outward from the boundaries of the crystals. Quartz is interstitial, filling the spaces at the junctures of many areas of graphic intergrowth. Chlorite is the main mafic mineral, and occurs in irregular patches.

Due to its high albite content, this granite is probably genetically related to the albite granite, and is possibly a satellite of it.

PORPHYRITIC GRANITE

A small mass of porphyritic granite occurs in rge. II, Barraute tp., and occupies approximately all the lots from 40 to 50. Only its eastern boundary is well defined. Its shape as a whole is not known, but is possibly circular, with a diameter of about 1½ miles. It may, consequently, be termed the Barraute plug.

This porphyritic granite forms small hills with rounded tops that stand quite high above the adjacent terrain. Its weathered surface varies in colour from white to pale greenish yellow, and is very rough, as the phenocrysts weather more slowly than the matrix and stand in relief. The porphyritic character of this granite is well marked in almost all the outcrops seen, except close to the border of the plug where the phenocrysts are smaller and less abundant, and the granite becomes dense and resembles a rhyolite. Its granitic texture, however, is always recognizable on fresh surfaces. Most of the phenocrysts are of quartz; a few are of feldspar. In general, they have quite rounded edges, but a few are visibly shattered. Phenocrysts as much as ⅔ inch long were observed, and they may constitute as much as 25 per cent of the rock.

In thin section, the matrix of the porphyritic granite has a uniform grain size of about 2 mm., and is composed mainly of albite (60 per cent), quartz (35 per cent), and biotite (4 per cent). Chlorite, sericite, and epidote are alteration products, and apatite and zircon accessory minerals. Calcite seems to have been introduced, as it occurs in between the grains of quartz.

This granite is intersected by two sets of joints: one is roughly peripheral with the contact of the plug, and the other strikes mainly north. Many quartz stringers and veinlets have been noted in this granite, and may occur more abundantly at some places than at others. In general, they all present similar features. They vary in width from a fraction of an inch to 12 inches, and have a length up to 100 feet but averaging about 20 feet. They strike in two principal directions, and on this basis have been divided into two groups: the veins of one group strike between 20 and 60

degrees east of north, dip northwest, and in places assume an irregular branching form; the others strike between 30 and 55 degrees south of east. Most of the veins of both sets, however, have uniform walls and are lens-shaped. In a few instances these veins have been mineralized with pyrite and chalcopyrite. Some gold is reported to be associated with these sulphides.

The contact zone of this granite with the adjacent rocks shows apophysal dykes in the adjacent rocks, xenoliths in the granite, and a zone mineralized with pyrite, chalcopyrite, and probably also some arsenopyrite. Tourmaline is a common associate. This mineralized zone has been cut by veins of quartz and feldspar containing sparse sulphides.

The high albite content of this granite suggests a genetic relationship to the albite granite of the southeastern part of the map-area rather than to the potassic mass of the Lacorne batholith.

LACORNE INTRUSIONS

General Statement

The Lacorne intrusions are the eastern extension of the Preissac-La Motte intrusive masses (22, 30) and consist of six main rock types: hornblende monzonite, biotite-hornblende granodiorite, amphibolite, biotite granodiorite, muscovite granite, and pegmatitic material. Pegmatites are associated with the muscovite granite, and at a few places carry spodumene or molybdenite. The distribution of the different rock types is shown on the accompanying map. In the field, the hornblende monzonite and the biotite-hornblende granodiorite are readily distinguished from the muscovite granite and the biotite granodiorite by their colour, grain size, and pegmatitic content. The hornblende-bearing rocks are grey, medium grained, and barely cut by pegmatite dykes, whereas the biotite-muscovite rocks are white to reddish white, vary in grain size from fine to coarse, and contain numerous pegmatite dykes. The hornblende monzonite grades into the biotite-hornblende granodiorite and is difficult to distinguish from it in the field. The biotite grandiorite and the muscovite granite differ in their content of biotite and muscovite; the granodiorite is rich in biotite, and is usually finer grained and contains less pegmatite dykes than the muscovite granite. This variation in composition from hornblende monzonite, through biotite granodiorite to muscovite granite, and finally to pegmatites, is a very striking trend of normal differentiation, which is held to have taken place at depth, with subsequent injections, at intervals, of the hornblende monzonite and the muscovite granite. The biotite-hornblende granodiorite is probably an altered phase of the hornblende monzonite, being the result of hydrothermal solutions genetically related to the pegmatites associated with the muscovite granite. The amphibolite is a basic differentiate of the monzonite, probably separated at depth before injection, whereas the biotite granodiorite is believed to have differentiated from the muscovite granite after injection.

Distribution and Form

The Preissac-La Motte-Lacorne masses occupy an area of intrusive rocks about 30 miles long, in an east-west direction, by 14 miles wide. This elongation, about parallel with the axis of the folds of that region, suggests

that these intrusions have risen into strongly folded belts. Only the eastern part of this area of intrusive rocks falls within Fiedmont map-area, where it occupies about 150 square miles, including almost all of Lacorne township and adjacent parts of Vassan, Fiedmont, Senneville, and La Motte townships. This eastern part is here termed the Lacorne batholith, after the township it occupies, and also in conformity with some earlier work (15, p. 99) in this area. The outer contact of this Lacorne mass was observed in only a few places, and provided little direct information on the slope of the walls of the batholith at depth. However, some idea was obtained indirectly on this matter by observing the variations in width of the zone of contact metamorphism, which forms an aureole around the batholith. This zone is narrower along the eastern contact than along the northern one, and, accordingly, it is assumed that the outward slope of the walls is steeper on the eastern than on the northern side, an assumption substantiated by the dip of the schistosity near the contacts, and that the Lacorne mass has the form of a batholith.

Hornblende Monzonite and Biotite-hornblende Granodiorite

The hornblende monzonite and the biotite-hornblende granodiorite form a distinctive rock mass. They occupy an area of about 100 square miles in Lacorne township and adjacent parts of Fiedmont and Vassan townships, and their areal distribution is shown on the accompanying map. It is believed that the hornblende monzonite is the main rock type, of which the biotite-hornblende granodiorite is probably only an altered phase.

As both rock types are parts of the same intrusive mass, and as the granodiorite is probably only an altered phase of the monzonite, both will be described together. The contact between them is gradational, and the separate rock types can be distinguished properly only by microscopic study. In the field, rocks of both types present a smooth surface, have a massive granitic appearance, and are of uniform medium grain. Weathered surfaces are grey to greyish white, and at places pinkish grey; on the fresh surface, the colour is grey. Marginal porphyritic facies were noted, but were of limited extent. The grain, in general, averages 2 mm. In hand specimens, hornblende and feldspar are easily recognized, and in the granodiorite, quartz and biotite can be observed only in the very marginal zone. Hornblende occurs in elongated, greenish black grains of variable size. A slight increase in the amount of hornblende was noted toward the centre of the mass; in the hornblende monzonite, the amount of hornblende was estimated roughly at 30 per cent of the mineral constituents. The feldspar is white, irregular in shape, and appears to be of one type, but staining (17) reveals that much of it is potassic, and that this potassic feldspar is mainly interstitial and appears to replace both plagioclase feldspar and hornblende. Its quantity appears to decrease towards the granodiorite contact and within the granodiorite zone. The plagioclase feldspars are in elongated grains with irregular borders. Quartz is in part interstitial, and occurs also as veinlets in the other minerals. Only odd grains can be seen in hornblende monzonite, but quartz is quite abundant in the granodiorite zone, especially in the area close to contacts.

An important and typical feature of both rock types is the presence of large, brownish red, well-formed crystals of titanite. These are easily seen in hand specimens, and are rather common in the granodiorite zone, particularly near the contacts.

Hand specimens from the monzonite-granodiorite mass have a monotonous, uniform grain, but thin sections indicate an appreciable variation in the grain size without, however, any tendency toward a porphyritic character. Calcic to sodic oligoclase, microcline, and hornblende are the main constituents. Quartz has been noted in every thin section, and is a major constituent of the granodiorite. Part of it is probably secondary. Several Rosiwal analyses of both types of rock have been made from the thin sections and the stained polished sections, and have indicated the following average mineral content:

	Hornblende monzonite[1]	Biotite-hornblende granodiorite
	Per cent	Per cent
Plagioclase	41·0	52·0
K-feldspar	22·0	10·0
Quartz	2·5	15·0
Hornblende	34·0	15·0
Epidote	0·5	4·0
Biotite	.....	3·5
Chlorite	.....	0·5

[1] According to Johannsen's classification, this hornblende monzonite is a syenodiorite (2211P) or a monzonite (2211P) and the biotite-hornblende granodiorite a granodiorite (227P).

The above composition of the hornblende monzonite has been determined from eight thin sections and thirteen stained, polished sections, and that of the biotite-hornblende granodiorite from eight thin sections and ten stained, polished sections. Magnetite, titanite, apatite, and zircon are accessory. Sericite, epidote, chlorite, and biotite are probably secondary, as a result of alteration of feldspar and hornblende. Locally, the potassic feldspar is perthitic.

In the monzonite, hornblende is everywhere the most prominent mafic mineral, but in the granodiorite its content decreases in approaching the contact with the older rocks to where, at the contact, all the hornblende has been replaced by greenish brown biotite and epidote. These two minerals are believed to have been formed from the hornblende as a result of hydrothermal action after the consolidation of the mass. In the hornblende monzonite the hornblende is quite fresh, the grains show definitely prismatic edges and pyramidal ends, and the crystals commonly have an elongated habit. In the granodiorite, however, the hornblende grains are much corroded and replaced. The absorption formula of the hornblende answers to these determinations: X = light bluish green; Y = dark yellowish green; and Z = dark green. Twinning parallel to 100 is common.

In part of the rock mass the hornblende has been highly altered. This alteration decreases in importance from the contact with the intruded rocks toward the centre of the mass. The main characteristic of this alteration is the transformation of the hornblende to epidote, and to epidote and biotite at the intrusive contact, accompanied by its partial bleaching. This alteration is believed to be the result of the action of late hydrothermal solutions, possibly related in origin and time to the pegmatites of the muscovite granite. As emphasized previously, features of

alteration are gradational, increasing from the centre to the borders of the intrusion. In the centre of the hornblende monzonite mass, the alteration is not obvious, but a slight bleaching and a few grains of epidote, which seem derived from the hornblende, can be recognized. Near the monzonite-granodiorite contact, the bleaching effect is slightly accentuated, but not to the extent of the transformation to epidote. The latter is more abundant, and is intimately associated with the hornblende. It occurs mainly at the periphery of the hornblende crystals, more especially around the hornblende crystals that have been bleached. This epidote is a slightly pleochroic mineral, with colours that pass from pale yellowish to nearly white. It has strong interference colours, and generally shows one direction of cleavage.

Towards the contact with the intruded volcanic and sedimentary rocks, the amount of quartz increases and the alteration becomes more intense. Epidote increases in amount, biotite appears, and both minerals seem to replace hornblende. Very close to the contact, the amphibole has entirely disappeared, and epidote with greenish brown biotite has replaced it and is locally pseudomorphic after it.

Plagioclase feldspar is the most abundant and widespread mineral in this intrusive mass. It appears to be more calcic at the margin than at the centre, and it varies in composition from An_{16} to An_{26}. The average size of the grains is almost 2 by 3 mm., and some grains may measure as much as 10 mm. by 5 mm. The plagioclase grains have an elongated habit, and their crystal outline is generally poor due to corrosion and replacement by microcline and quartz. They are highly altered in comparison with the potassic feldspar. The alteration is most pronounced in the centres of many grains, along definite zones in the zoned grains, and along particular twinned lamellæ. The main products of alteration are sericite and epidote. Sericite is, however, the more abundant, and both minerals occur in very minute grains, epidote being concentrated in patches.

Microcline is apparently the only potassic feldspar of these rocks, and is essentially unaltered. It shows the characteristic twinning, and in places is perthitic. No definite conclusion can be drawn as to the probable origin of these perthites, as some appear to be the result of replacement, others of exsolution, and, in general, perthitic inclusions form only a small part of the mineral. Microcline, including the perthitic intergrowth, was the latest mineral to form in this rock. It is definitely later than plagioclase and hornblende as it replaces both and contains inclusions of them. Replacement by microcline is indicated by tongue-like apophyses invading the hornblende and plagioclase grains. In general, microcline is interstitial and rarely occurs in regular grains like the plagioclases and hornblende. It never contains epidote, rarely sericite, but may hold a few grains of apatite. Microcline is ordinarily earlier than quartz, but in some slides appeared to be later. This later microcline may be a pseudo-effect of the replacement by quartz of plagioclase or hornblende. The writer is not inclined to hold the view that this microcline is hydrothermal, as contended by Gillson (19) for the microcline of the granodiorite in the Pend Oreille district of northern Idaho, but believes that it is pyrogenetic, as maintained by Tolman (35) for the microcline in the Opemiska instrusive of Quebec. The freshness of the microcline is probably due to its state of

equilibrium with the hydrothermal solutions that have acted on this rock, and probably to the fact that it resists alteration more effectively than other feldspar (33).

Quartz, in grains of variable size, is commonly interstitial, but it occurs also in veinlets, as seen in stained polished sections, and in irregular transgressive patches. On the basis of texture and occurrence at the edges of the hornblende monzonite mass, it is believed that most of this quartz is secondary and has been introduced by hydrothermal solutions.

Amphibolite

A few bodies of amphibolitic rocks occur in the hornblende monzonite. They are mostly small, and probably have irregular outlines. Their shapes, however, are not revealed in the field, as their contacts are commonly almost entirely covered with drift and clay material. As these masses have been observed at two different places to grade into the hornblende monzonite, their contacts must be, in general, indefinite within a few hundred feet. An approximate circular outline has been assumed for all these amphibolite bodies, although it is doubtful if this conveys a true picture. Seven different occurrences are shown on the accompanying map, and altogether they cover about 6 square miles. Pegmatite dykes have been seen cutting some of these amphibolite masses.

The amphibolite, as indicated by its name, appears in the field to be composed mainly of one mineral only. In hand specimens it is a coarse- to very coarse-grained, dark to brownish green rock, with a rough appearance on fresh and weathered surfaces. It is readily distinguished from the hornblende monzonite, in which it occurs, by its darker colour, its higher amphibole content, and its rough surface. Hornblende, feldspar, and, at places biotite, are recognized. The hornblende occurs in grains up to 1 inch in diameter, and constitutes in most specimens more than 80 per cent of the rock. The feldspar is interstitial. Biotite has a similar occurrence, but may also have formed in part as an alteration product of the hornblende. The rough surface is due to the coarse-grained nature of the rock, and to the differential weathering of the hornblende crystals.

Thin sections indicate much variation in the grain size and in the abundance of the different minerals present. Hornblende is the main constituent, and was the most abundant mineral in all the slides studied. Its amount varies from 65 to 95 per cent of the rock. It is a green mineral, very similar to the hornblende of the hornblende monzonite and presenting the same characteristic features. It occurs in two principal grain sizes, one varying from 2 mm. by 5 mm. to 1 cm. by 2 cm., and the other, of more uniform size, 0·3 mm. by 0·4 mm. The small grains are fresh and of good crystal shape, whereas the larger ones show the same bleaching effects and the same sort of alteration as the hornblende grains of the hornblende monzonite. The crystal shape may at times be prismatic or elongated, but commonly the large individuals have irregular and ragged outlines. Their main features are: alteration to brown biotite, partial regrowth along the margins of the grains, and probable recrystallization to augite (Plate III B). These large individuals of hornblende are made up of two distinctive parts: a core of altered and bleached hornblende, and an outer zone or rim, entirely fresh and free of alteration products. The central part is dusty due to the presence of the fine grains of iron oxide,

and shows bleached hornblende, alteration to brown biotite, and the presence of a few grains of epidote and titanite. The brown biotite may form irregular patches within the hornblende crystals, or may have a lath-like habit and occur in groups probably replacing the hornblende more completely. The recrystallization to augite, seen in two thin sections, seems to be obvious from the fact that augite occurs in grains of 0·4 to 0·8 mm. distributed around the large grains of hornblende and mixed with the small hornblende crystals. Only odd grains of augite were seen within the large hornblende grains. The augite is fresh and of light colour, shows two directions of cleavage at right angles, and an extinction angle of 51 degrees as determined from a longitudinal section. The plagioclase is a calcic oligoclase, An_{28}, and generally is interstitial to hornblende. It is next to hornblende in abundance, and shows quite good albite polysynthetic twinning. It is commonly slightly altered to sericite and a few grains of epidote, and is commonly moulded against hornblende, and partly replaces it. Its grain size is variable, reaching a maximum of 2·5 by 3·0 mm. A little microcline was noted in nearly all the slides. It is unaltered, definitely later than hornblende and plagioclase, and appears to replace both. Occasional small grains of quartz, apparently later than the other minerals, were seen in two slides.

Some of these amphibolite masses have been described by James, Mawdsley, and Cooke (11, p. 138) in the following terms: "some varieties contain more feldspar, and might properly be classed as basic varieties of the augite syenite, thus suggesting that the amphibolite is merely a basic differentiate of the augite syenite". It is the writer's belief that most of these amphibolite bodies are basic differentiates of the hornblende monzonite. It is possible that they were originally large blocks of basic volcanic rocks, later transformed by metasomatism and recrystallization into these highly hornblende-rich masses, but it is more probable that they are merely basic differentiates. The following facts support this contention:

(a) At two different places, in the masses north of Lacorne village, the amphibolite shows a gradational contact with the hornblende monzonite. Elsewhere no contact is visible. Where large inclusions of volcanic rocks were observed in the monzonite their contacts were sharp and not gradational with the monzonite.

(b) The minerals of these amphibolites are very similar in appearance to those of the hornblende monzonite, and they show the same type of alteration. As might be expected, the plagioclases appear slightly more calcic.

(c) A few large remnants of basic rocks in the hornblende monzonite have entirely recrystallized at places to a sort of amphibolite. It is, however, everywhere possible to recognize the original nature of these remnants from relict volcanic structures. Similar structures have not been seen in those masses mapped as amphibolite.

(d) The habit of the grains, the mineral association and distribution, and the texture of the rock suggest a plutonic origin. Volcanic rocks along the northern and eastern contacts of the hornblende monzonite have recrystallized to a hornblende rock, but nowhere do they present a similar grain habit or have a similar hornblende and quartz content.

Biotite Granodiorite

Two small masses of biotite granodiorite, believed to be genetically a late differentiate of the hornblende monzonite from their close association with it, have been found in the map-area. One mass underlies an area of about 5 square miles in rges. II, III, and IV, east of Lake Baillairgé, Lacorne tp. The other, and probably larger, mass outcrops in rges. VIII and IX, western part of Senneville tp. A few other small masses occur also west and south of Lake Baillairgé in Lacorne township, where they form plugs and sills and are probably cupolas or apophyses of the larger body of biotite granodiorite east of the lake. The granodiorite is believed to be a basic differentiate of the muscovite granite and definitely was intruded at a later stage than the hornblende monzonite, as it contains inclusions of it. This granodiorite weathers white to flesh-white, is of finer grain than the hornblende monzonite and the muscovite granite, and is generally gneissic. Quartz, feldspar, and biotite are recognizable in hand specimens. Polished surfaces when stained (17) have indicated small amounts of potassic feldspar, which, apparently, is in part later than all the other minerals. The biotite is black, and occurs in minute flakes most of them alined in some particular direction, giving to the rock that gneissic structure more apparent in these bodies than in the other masses of intrusive rocks. Quartz also occurs at places in grains elongated parallel with that gneissic structure as determined by the biotite flakes.

Under the microscope the rock is fine to medium grained, and slightly gneissic. The texture is xenomorphic, and only the minor constituents show good crystal outlines. Oligoclase, quartz, microcline, and greenish brown biotite are the main constituents. Muscovite, epidote, titanite, zircon, and iron oxide are accessory, and sericite, epidote, and chlorite secondary minerals. The grain is quite variable in size, but averages around 2 by 3 mm. Five Rosiwal analyses have indicated the following average mineral composition for this grandiorite[1]:

Oligoclase	54.0
Microcline	5.0
Quartz	27.0
Biotite	10.0
Epidote	2.0
Chlorite	1.0
Muscovite	0.5
Sphene-magnetite	0.5

Oligoclase has been determined by index liquids as about An_{18-23}. Some of the grains show zoning. This plagioclase was the first mineral to form, as it shows embayment and replacement by microcline and quartz. Quartz was mobile enough at one stage to replace the plagioclase, as it forms minute, round, scattered inclusions in many of the grains. The oligoclase displays quite different alteration features on the eastern side of the mass than on the west. On the west it is generally only slightly altered to sericite; on the east its alteration is very similar to that of the plagioclase feldspar of the hornblende monzonite and the biotite-hornblende granodiorite. This suggests that the hydrothermal solutions that have circulated along the contact and altered the hornblende monzonite, have also altered this part of the biotite granodiorite close to the contact.

[1] In Johannsen's classification, this rock is termed granodiorite (227P).

Microcline appears to be the only potassic feldspar present. It is commonly interstital, and probably formed later than the quartz, as it has been found veining and partly surrounding grains of quartz. It is a fresh mineral and of very irregular grain size. It may occur in grains as large as 1·5 by 1·6 mm., but is commonly found in smaller grains.

Quartz is a very abundant mineral, and varies in grain from 0·1 by 0·2 mm. to 1·8 by 2·0 mm. It has an undulatory extinction, and contains many liquid inclusions arranged in streaks oriented in every direction. Quartz is found either in large, spindle-like grains and lens-like bands composed of many elongated small individuals, oriented parallel with the schistosity, or in tiny grains scattered through the rocks, or as round particles in the oligoclase, suggesting replacement of the oligoclase by quartz.

The mass east of Lake Baillairgé is cut by a few pegmatites, which, however, nowhere composed more than 5 per cent of the rock. These pegmatites are believed to be genetically related to the muscovite granite.

Muscovite Granite

A large mass of a white granite extends east and northeast of Lacorne village. It underlies about 25 square miles, and forms a mass about 6 miles long, in a northerly direction, by 4 miles wide. In the field, the rock outcrops in high, northerly trending ridges.

On weathered surfaces, this granite is generally white, but in places may be faintly reddish. This red colour has been observed particularly in areas close to the contact with the intruded rocks, where the grain in places, as directly east of Lacorne village, is rather fine and appears to form intergrowths of quartz and feldspar. In general, the grain is coarse and even, averaging about 3 by 6 mm. Quartz, feldspar, micas, and garnet are recognizable in hand specimens. The garnet is reddish, and occurs generally in uniformly scattered, minute, well-formed crystals. Where it is slightly concentrated it gives the granite a deep reddish colour. The micas include both a white and a dark variety, and in general constitute only a small part of the granite. In some areas, particularly in the centre of this granitic mass, the white variety seems to predominate; in others it is subordinate in amount, but both may be well mixed. The feldspar, in hand specimen, is white, and stained, polished surfaces indicate that much of it is potassic. This staining also reveals that none of the minerals have good crystal outline. The order of crystallization is, first, sodic feldspar, followed by potassic feldspar and quartz crystallizing almost simultaneously, with a suggestion in some slides that the quartz might be slightly earlier than the potassic feldspar.

An important feature of this granite is the presence of much intimately associated pegmatitic material, which forms irregular masses, along the north and south contacts, and well-defined dykes in the central part where the granite has a uniform grain. At places the amount of pegmatitic material is so great that the granite could be termed properly a pegmatite-granite. More details on this pegmatitic material will be given later.

Few joints were observed. They are best developed in the central part of the mass, and have three main directions of strike: north, east, and northwest.

In thin section (Plate IV A) the texture of the muscovite granite is xenomorphic. The main constituents are quartz, microcline, and albite. Muscovite and biotite are the characteristic mafic minerals. Garnet, iron oxide, apatite, epidote, titanite, and zircon are accessory. Chlorite, sericite, and some kaolin are secondary. A few grains of spodumene were noted in two slides. Ten Rosiwal analyses of six stained polished sections and of four thin sections indicated the following average mineral composition:

	Per cent[1]
Albite	40.0
Microcline	24.0
Quartz	31.0
Mafic and accessory minerals (mainly muscovite)	5.0

The plagioclase and muscovite were probably the first minerals to crystallize, as both are partly embayed by quartz and microcline. The plagioclase commonly shows very good albite twinning. As determined with the index liquids it is an albite, An_{4-7}. It is only slightly altered to sericite, as compared with the plagioclase of the hornblende monzonite. The grain size is about 2 by 3·5 mm.

Microcline is fresh, and of very irregular shape. It appears to be interstitial with the quartz, and may have crystallized simultaneously with it, or slightly later. Its grain size varies from minute to as large as 2·5 by 3·5 mm. Commonly, the microline is perthitic, the shape and occurrence of the blebs suggesting an exsolution type as most common, but the replacement type, as defined by Alling (1), can be observed in part.

Myrmekites were noted here and there in each thin section. Their occurrence suggests a replacement of microcline and formation at the expense of the albite where in contact with microcline and albite. Veinlets of myrmekite were seen between grains of microcline; crystals of albite in contact with the potassic feldspar show development of myrmekitic intergrowth in the zone close to microcline; and in some instances this myrmekite may reach the core of the albite grain. Quartz inclusions are generally larger away from the microcline contact.

The white mica appears to be ordinary muscovite, with probably a very low content of iron, and an estimated 2V of 40 degrees. Commonly its birefringence colour is deep yellowish cream. It generally exhibits a little alteration to a reddish yellow material.

Under the microscope, the dark mica is the ordinary brown biotite, and is commonly found intergrown with muscovite. Much of it is altered to chlorite, and at places a few crystals of zircon with pleochroic haloes have been noted in it.

The garnet of the muscovite granite has been determined by Gussow (22) as almandine, and is commonly found enclosed in microcline. But the garnet found in the pegmatites, which should be the same, has been determined by H. V. Ellsworth of the Geological Survey of Canada as spessartite.

Quartz has a grain size of about 1·5 by 2·0 mm., and presents an undulatory extinction. It contains abundant liquid inclusions, and appears to be interstitial with, and partly earlier than, the microcline.

[1] According to Johannsen's classification, this rock is a leuco-sodaclase granodiorite (117P).

Satellites

Dykes, plugs, and sills, which are probably satellites of the Lacorne batholith, have been seen in areas adjacent to the Lacorne mass. The plugs and sills of fair size were mapped, but none of the dykes are shown. Only a few dykes, apart from the pegmatites, have been examined, and most of these are, apparently, similar in composition to the hornblende monzonite and the biotite granodiorite. They vary in width from 2 to 27 feet, can be traced for several hundred feet, and are in general porphyritic. The phenocrysts are of feldspar, and the dykes are commonly grey in colour. Some can be seen southeast of and about the Lacorne mine, west of Lake Lortie, and southwest of Lake Fiedmont on the high hills of rge. I, Fiedmont tp.

Small plugs and sills mapped west and southwest of Lake Baillairgé are very similar in appearance and mineralogical composition to the biotite granodiorite. In thin section they are all seen to be composed of oligoclase, quartz, and some microcline, biotite, and epidote. These masses appear to have some importance economically, as quartz veins and pegmatitic quartz veins containing some molybdenite are associated with them. The Lacorne mine is on one of these small bodies.

Along the northern contact of the Lacorne batholith four small plugs are shown on the accompanying map. They are all granitic rocks and in none of them has hornblende been noted; biotite and its alteration product, chlorite, are the characteristic mafic minerals. In all of them albite is the most abundant mineral. Three of these masses have been studied in thin section, and the results of these studies are given below. In the hand specimen, these granites are flesh-white, fine to medium grained, and the two masses north of Lake Roy, in Lacorne and Landrienne townships, have an apparent porphyritic texture. Feldspar, quartz, and a mica are the minerals recognizable in hand specimen.

Plug, on Lot 5, Range I, Landrienne Township. In thin section, the grain of this rock is fine to medium, and the texture xenomorphic. Albite, quartz, and microcline are the main constituents, and green biotite, and epidote are the most important mafic minerals. Sphene, pyrite, apatite, and zircon are accessory. Chlorite, sericite, and a mineral of the epidote-zoisite group are secondary. Albite is the most altered mineral, and is probably earlier than quartz and microcline, as it commonly carries embayments of quartz and microcline. Its grain size averages 1·7 by 1·5 mm. and may be as much as 2·5 by 2·0 mm. In general, albite is the coarsest, and accounts for about 60 per cent of the rock. Quartz is the next most abundant mineral (27 per cent), occurring in grains of irregular size, varying from very small to 0·8 by 0·7 mm., and assembled in patches of varying size and shape. It is in part contemporaneous and in part slightly earlier in crystallization sequence than microcline. Microcline, which forms about 6 per cent of the rock, is a fresh mineral, occurring in minute grains, and interstitial to albite and quartz. Biotite in narrow, lath-shaped grains (3 per cent of the rock), with ragged edges, forms the most characteristic mafic mineral, is closely associated with epidote (4 per cent), and contains a few zircon crystals surrounded by pleochroic haloes.

Plug North of, and Adjacent to, Lake Roy. Under the microscope, the texture of the rocks of this plug is hypautomorphic granular, and the grain is medium, averaging 2·1 by 1·6 mm. Albite-oligoclase, quartz, and biotite are the main mineral constituents. The plagioclase is largely altered to sericite and epidote, and commonly presents a clear rim at the periphery. It forms at least 76 per cent of this rock, and generally shows good crystal outlines. Some of it is zoned, a feature emphasized by differential weathering. Quartz, 18 per cent of the rock, is interstitial to the plagioclase, and is in small grains. Biotite (6 per cent) is the main mafic mineral, and is partly altered to chlorite. Apatite, sphene, and epidote are accessory. No microcline was noted.

Plug on Lot 59, Range I, Landrienne Township. In thin section, the rock from this plug is hypautomorphic granular, with a grain size of about 2·8 by 2·1 mm. Albite, quartz, chlorite, and carbonate are the main mineral constituents. No microcline was seen. Sericite, epidote, and chlorite are secondary. Carbonate is probably an introduced mineral. Albite is the most abundant mineral and is quite fresh. It commonly shows good polysynthetic twinning, and has been intensely crushed. Granulation is intense along the peripheries of the grains, and fractures across twinning lamellæ are common. The fractures and the zone of granulated feldspar are generally cemented and partly filled with carbonate and some quartz. The quartz as a whole occurs in large patches suggesting an original porphyritic texture; each patch is roughly oval, and is composed of many small individuals having suture-like outlines. Albite forms about 48 per cent of the rock, and quartz may amount to as much as 32 per cent. Chlorite and carbonate together account for the other 20 per cent. Apatite, pyrite, and a few grains of biotite are accessory minerals.

Inclusions

In the hornblende-bearing phase of the Lacorne batholith, inclusions of the intruded rocks have been seen in variable amount in every outcrop, but are particularly abundant in the southwestern corner of the hornblende monzonite mass, especially east of Lacorne River and west of Laine River, where they may form as much as 60 per cent of the monzonite. However, no stratigraphic sequence similar to the one found in the adjacent rocks has been suggested in the distribution of the inclusions, probably because they are too small and completely enclosed in the granite.

The inclusions average about 6 inches in length by 2 or 3 inches in width, but vary in size from 1 inch long and a fraction of an inch wide to a quarter of a mile long and 1,000 feet wide. The larger inclusions are rare, and those examined in the field are shown on the map. The inclusions are of various shapes: square, round, lenticular, diamond-shaped, and arrowhead-like. The last are commonly oriented parallel with each other where occurring in the same area, and present a uniform direction of flow. Many strikes have been taken on these small inclusions. In general, they seem to indicate that the inclusions strike parallel with the contact of the monzonite mass or with the trend of the formations near where they occur in the monzonite mass. This would indicate either that the inclusions have not been disturbed by the injection of the magma and have kept their original orientation, or that magma flowage has oriented them parallel with the contact. This last hypothesis seems to be the most probable, as

no stratigraphic sequence has been recognized, there are flow lines, and in the centre of the mass the inclusions strike mainly north or slightly east of north, which probably never was the trend of the formations.

Some of the large inclusions are almost certainly roof pendants, but the small inclusions are entirely enclosed in granitic rock and are widely separated. Inclusions in general are softer than the surrounding granitic rock and weather to form holes or depressions.

The inclusions are of different types: some are composed entirely of biotite, others entirely of hornblende, and still others of a mixture of biotite, hornblende, feldspar, and quartz. Some were originally sediments, others volcanic rocks, and others ultrabasic intrusive rocks, as peridotite. The inclusions are now entirely recrystallized, have sharp contacts, and are coarser in grain near their contacts. The monzonite adjacent to them does not seem to have been transformed or altered; but the inclusions seem to have absorbed much material in the form of quartz and feldspars, and contain minerals similar to those found in the monzonite but in different proportions. All the minerals are fresh and have irregular outlines. Quartz and microcline have definitely been introduced and are later than the other minerals.

The muscovite granite does not contain inclusions except in areas adjacent to the intruded rocks, where a few *schlieren* are present. The biotite granodiorite, too, contains only a very little included material.

Pegmatites and Aplites

Some of the pegmatites of the map-area are possibly of commercial importance as they contain valuable minerals that occur at places in substantial amounts. Landes (26) has classified pegmatites into two main groups, simple and complex, the latter containing minerals such as spodumene, columbite-tantalite, beryl, lepidolite, and other rare minerals. In this area the simple pegmatites are the most common and widespread, whereas the complex types, constituting perhaps less than 1 per cent of all the pegmatites, seem to have been controlled in their distribution by structural features, which will be considered later. The aplites, as in the case of the pegmatites, could be recognized also as simple and complex, but their content of minerals such as spodumene and others is not as high. Aplitic material in the aggregate is abundant, and occurs mainly in dyke form closely associated with the pegmatitic material.

Distribution. Genetically related to, and associated in space with, the muscovite granite are numerous irregular masses and dykes of pegmatitic and aplitic material. They cut the muscovite granite in all directions, and comprise a large part of its present surface area. They are also abundant in a wide zone adjacent to, east and west of, the muscovite granite, where pegmatitic and aplitic material in the form of dykes may constitute in places as much as 50 per cent of the rock. North and south of this granite mass the pegmatite and aplite dykes form a much smaller part of the exposed rock. They occur also in minor amount along and on either side of the contacts of the large mass of hornblende monzonite with the intruded rocks. Pegmatitic and aplitic material forms about 60 per cent of the muscovite granite along the northern edge of this intrusion, 40 per cent at the southern end, and from east to west within the muscovite granite

mass an amount varying from 5 to 23 per cent. The eastern side of this granite mass consequently contains less pegmatitic and aplitic material than in any other part, suggesting that, as exposed, it is farthest from the original top of the granite body.

Strike and Dip. The masses and dykes of pegmatitic and aplitic material striking between north 45 degrees east and east 45 degrees south constitute 80 per cent of all the pegmatitic and aplitic material of the area of muscovite granite, except at the northern and southern edges where they may amount to only 53 per cent. Twenty to fifty per cent of all the pegmatitic and aplitic material of this mass of muscovite granite is represented by dykes and masses striking between east 15 degrees south and east 45 degrees south. Forty per cent of all the pegmatitic and aplitic material of the area of muscovite granite, except at the north and south ends, consists of masses and dykes of pegmatitic and aplitic material striking between north 80 degrees east and south 80 degrees east. About 13 per cent of all the pegmatitic and aplitic material of the muscovite granite body is included in dykes that strike between north 45 degrees east and north 80 degrees east, and have a regular distribution. Pegmatite dykes striking between north and north 40 degrees west are common at the north and south extreme ends of the muscovite granite mass, and form about 40 per cent of all the pegmatitic and aplitic material there. This group of dykes is essentially missing in the eastern part of the muscovite granite body, except in the southeast corner, where some dykes are present and appear to strike mainly north. In the central and western parts of the area of muscovite granite this same group forms about 10 per cent of all pegmatitic and aplitic material. Some other dykes strike beween north and northeast, and have quite a regular distribution; althogether, they amount to about 5 per cent of the pegmatitic and aplitic material.

In the narrow zone adjacent to and surrounding the muscovite granite, where the pegmatite and aplite dykes are abundant, it seems that all the dykes strike either parallel with, or nearly at right angles to, the contact, the latter being probably most common. In the contact zone of the hornblende monzonite with the older rocks, the few dykes noted are rather large and strike either parallel with, or nearly at right angles to, the contact. Those parallel with the contact dip toward the hornblende monzonite at an angle of about 55 degrees, the other group dips at a much steeper angle in either direction. The dykes in the narrow zone surrounding the muscovite granite appear on the surface to dip away from the contact, but at a steeper angle than the schistosity. Some dips have been taken on the pegmatitic material occurring within the muscovite granite mass. In the central area, where the pegmatitic and aplitic material forms dykes rather than irregular masses, it has been noted that the dip is steep, varying from 65 to 90 degrees. In areas close to the contacts, the pegmatitic and aplitic material forms irregular bodies, with variable but, apparently, much flatter dips. Some of these masses may have formed at the time of the intrusion of the muscovite granite, but there is no indication of such masses being intruded by later pegmatite dykes.

Contact and Shape. The contact and shape of the pegmatite and aplite masses vary with their position in and outside of the muscovite granite mass. In the centre of the granite body, the pegmatite and aplite masses form straight dykes that are in sharp contact with the granite. Near the

contacts of the granite with the older rocks, especially at the northern and southern ends of, but within, the granite, the pegmatites and aplites have indefinite and irregular outlines; they form bodies of irregular size and have contacts that grade into the granite, so that it is difficult to distinguish the granite from the pegmatite or the aplite. In between the centre and the marginal zones, all types of pegmatitic and aplitic bodies can be seen. They may be straight for a few feet, then narrow, or branch and eventually disappear; they may form normal dykes, or be lens-like masses, and, in some places, exhibit a sort of *en échelon* pattern. In areas outside the granite itself, the pegmatite and aplite masses form dykes very similar to the dykes found in the central part of the granite.

Size. The size of the irregular pegmatite and aplite masses can be determined only by accurate detailed mapping. One pegmatite mass, for example, was determined to be about 1,000 feet long by 200 feet wide. The pegmatite dykes have widths varying from a fraction of an inch to about 50 feet, and many of them can be traced for several hundred feet. Those in the centre of the granite are generally narrower than those outside the granite mass. In general the aplite masses and dykes are smaller and narrower.

Age Relations. From evidence obtained in the field it appears that most of the pegmatite and aplite masses and dykes striking between north 45 degrees east and east 45 degrees south were formed at about the same time. It seems also that those striking north and slightly east of north represent the youngest group, whereas those with a northwest strike are probably the oldest. But, even if some appear younger or older than others, the interval between each intrusion was probably relatively short. It was probably only a matter of filling first the fractures that extended deeper or were easier to open and finally those that were probably only potential fractures but that opened because of the necessity for more space.

Banding. A banded structure has been noted in many of the pegmatite dykes and masses. It is common in the simple and in many of the complex pegmatites. Where banding was noted in the complex pegmatites, the rare minerals were generally limited to some particular bands or patches in contrast with the unbanded types, in which the rare minerals are uniformly distributed throughout. In general, the banding is parallel with the walls of the pegmatitic bodies, and the contacts between the various bands are sinuous to straight. The different types of banded structures observed in these pegmatitic bodies may be summarized as follows:

(1) The most commonly observed banding, and at the same time the most striking one because of the sharp contrasts between bands, is the one resulting from the alternation of coarse-grained, pegmatitic, and fine-grained, aplitic bands.

(2) The banded structure may result from an alternation of quartz layers with layers of pegmatitic material low in quartz. The contrast between the bands is sharp owing to a difference in colour and type of material.

(3) A banded structure may result from the concentration of a coloured mineral along definite bands. Red garnet, green spodumene, or greenish muscovite, for example, may be concentrated in certain bands, and depending

on the mineral present, the bands will be either red, green, or greenish. In such bands the coloured minerals generally occur in very small but abundant grains. This type of banding was also noted in aplite bodies.

(4) A single band may consist of mixed aplitic and pegmatitic material grading into each other (Plate IV B). Similar bands may be repeated many times in the same mass or dyke and define their banded structure.

(5) In some bodies the mica flakes are concentrated along definite lines or narrow bands, and repetition of such may result in a poor banding.

(6) The crystalline form of some minerals and their distribution in a mass or dyke may impart a rough banding. Lenses of feldspar and lenses of quartz may rest in a groundmass of medium-grained quartz and feldspars. These lenses may be repeated at regular intervals and this repetition gives an apparent banded structure. Mica may also be concentrated in layers and accentuate this banding.

Mixture of Aplite and Pegmatite. A striking feature of the pegmatite dykes, and rarely of the less regular pegmatitic masses, is their close association in the field with true aplite bodies and their intimate mixture in the same mass or dyke with aplitic material. It is this intimate mixture that gives to some of the pegmatite bodies the type of banded structure referred to above. The dykes composed of both aplitic and pegmatitic material afford a series of patterns, which may be listed as follows:

(1) A pegmatite dyke may be bordered on both sides by aplitic material, or vice versa.

(2) An aplite dyke may contain a few pegmatitic stringers irregularly distributed in the dyke and parallel with its strike. The reverse has also been observed in pegmatite dykes.

(3) A dyke of pegmatitic material may contain irregular patches of aplitic material; the reverse is also true.

(4) A pegmatite dyke may grade along its strike into aplite.

(5) Aplitic material in a pegmatite dyke may follow the dyke for a short distance and then cut across the adjoining granite to join another pegmatite or aplite dyke. By this addition of aplitic material, the original pegmatite dyke becomes in part aplitic, or the original aplite dyke becomes larger.

(6) A dyke may show an alternation of aplitic and pegmatitic material repeated as many as three times in zones parallel with the walls.

Analogous occurrences of pegmatitic and aplitic materials, not only as separate dykes but also associated together in the same dyke, have often been described to emphasize their genetic relationship. Derry (14) has studied and discussed the genesis of such a mixed dyke, and has also proposed a sequence that ends with a pegmatitic phase. In the present map-area at least three aplitic phases have been recognized, each separated by a pegmatitic phase, and the whole ending as in the occurrence described by Derry with a pegmatitic phase. This sequence may be explained, as suggested by Derry, by the separation from a water-rich, pegmatite magma of a dry and relatively viscose aplitic phase. This sort of splitting might be possible in the case of one aplitic phase only, but it is difficult to visualize the operation of such a delicate process in instances where more than one aplitic phase is recognized. Consequently, it is proposed here that such

a sequence would form from the same liquid extract, without any further splitting, the difference in the grain size being due only to a difference in pressure along the fractures in which these solutions were circulating. Sudden decreases in pressure, as a result, for example, of the escape of some volatile constituents, would cause a decrease in the solubility of the constituents in solution and would result in the precipitation of an unusually large quantity of material in a relatively short time, forming, thereby, aplitic rocks. Thus, a mere decrease in pressure along the channels of circulation can explain all the textures and structures of these mixed dykes and masses. In other words, a pegmatitic solution circulating along a system of fractures will deposit pegmatitic material if there is no variation in the original conditions of deposition, but if it happens that the conditions of deposition are destroyed by a decrease in pressure at some places along the system of fractures, there will be then precipitation of a larger amount of material from the solution due to a decrease of solubility, and this material on account of the rapidity with which it will precipitate will be aplitic instead of pegmatitic. If this is true, the aplite and pegmatite dykes of this area must be composed of the same minerals, and if there are spodumene-columbite-tantalite-bearing pegmatites there must be also spodumene-columbite-tantalite-bearing aplites. Both such rock types have, in fact, been observed in this area.

Mineralogy. All the simple pegmatite and aplite masses and dykes of the map-area consist essentially of the same minerals as those found in the muscovite granite, any difference being rather a matter of grain size than of composition. Albite, quartz, microcline, and microcline-perthite are the main constituents, with muscovite and garnet everywhere present, but in small amount. The complex pegmatite and aplite bodies differ from the simple ones in containing besides the common minerals of the simple pegmatites a few less common minerals such as spodumene, columbite-tantalite, lepidolite, beryl, and others, which in some dykes and masses may be concentrated in amounts sufficient to be recognized as major minerals. Even these complex pegmatite and aplite bodies, however, seem to have a direct compositional relationship to the muscovite granite, as in two thin sections of the muscovite granite there were found few small grains of spodumene.

Quartz is the common glassy type, occurring generally in irregular grains interstitial to albite and microcline or to albite, microcline, and spodumene. It may also form a rough graphic intergrowth with either garnet or muscovite. If fairly abundant, it may occur in large blebs or lenses irregularly scattered in the dykes and masses. Liquid inclusions in it have a regular linear distribution, these lines being oriented in two main directions, one corresponding, in the spodumene-bearing dykes, with the orientation of the spodumene crystals, the other inclined to the first at about 45 degrees. The quartz content may be as much as 35 per cent in the simple pegmatites, and 22 per cent in the complex ones. Two ages of quartz are believed to be represented. The late quartz commonly occurs in veinlets or in grains replacing the other constitutents.

Microcline occurs mainly in fine grains interstitial to quartz and albite, or to quartz, albite, and spodumene. It is a fresh mineral, and at places is perthitic. As perthite, it occurs mainly in lenses that reach a few feet in length and several inches wide, and that have a regular distribution

throughout the pegmatite mass or dyke. Microcline, including its perthitic variety, forms at least 30 per cent of the simple pegmatitic and aplitic bodies, and about 20 per cent of the complex ones.

Albite is the most abundant mineral in all the pegmatites and aplites of the map-area. It occurs mainly as lath-like grains in quartz and microcline of the simple types or in quartz, microcline, and spodumene of the more complex types. Locally a poor graphic intergrowth may result from this mixture. In some thin sections this white albite has a lamellar habit and is known as *cleavelandite*. Two ages of albite are probably represented, an early one (An_{4-6}) and a late one (An_{0-2}). Both types are fresh. The early albite is finely twinned, and is generally lath shaped. The late albite is commonly untwinned, and is interstitial. This late albite is not abundant, but was observed in all the sections examined.

Muscovite is not an abundant constituent although quite widespread. It constitutes at the most a few per cent of the rock, and is commonly so sparingly distributed as to be difficult to detect. In some places, however, it may be concentrated along certain zones and induce a type of banded structure previously described.

Lepidolite mica occurs mainly in fine- to coarse-scaled aggregates in feldspars and spodumene, and is commonly associated with microlite and a pink to purplish, unidentified mineral. It was observed in one pegmatite dyke only, and this occurrence is described in detail in the chapter on Economic Geology.

Spodumene is the most abundant lithium mineral of most of the complex pegmatite and aplite dykes and masses of the area. It occurs mainly as green and buff prismatic grains in a mixture of fine- to coarse-grained quartz and feldspars. These prismatic grains are generally elongated at right angles to the walls of the bodies, and most of them show that they have been partly replaced by quartz and feldspars. Commonly they have ragged outlines. Green spodumene generally occurs in larger and better formed crystals than buff spodumene; it has a specific gravity of 3·141 whereas that of buff spodumene is 3·100. Lustre varies from vitreous to resinous as the colour changes from green to buff. In thin section, the green spodumene contains numerous dust-like particles, which have not been observed in the buff variety. Both types show strong cleavages in at least three principal directions, one parallel with the elongation of the grains, another at right angles, and a third one inclined to the other two. Crystal outlines are rare, for although the general outline of the crystal form may be preserved, the edges of the grains are generally ragged and irregular. These ragged edges are the result of replacement of spodumene by quartz and feldspars, and have the appearance of a fine intergrowth of quartz or feldspars and spodumene (Plate V A). Both green and buff spodumene alter to a lithium-bearing mica, which, apparently, has the optical properties of muscovite, and occurs principally in rosette-like, platy aggregates pseudomorphic after spodumene. Where the alteration is not complete, only the outer margins of the spodumene grains are altered to minute flakes of this mica, or fractures in the grains may be filled with this micaceous material. On weathered surfaces, a powdery, reddish black substance, occurring mainly along fractures and cleavage planes in spodumene or along its contacts with other crystals, is probably derived from the weathering of spodumene.

Beryl, of pale green colour, occurs mainly as prismatic crystals, up to 8 inches in diameter, commonly in quartz or muscovite, less commonly in feldspars. It has not been found in large quantity, but it has been noted in many scattered quartz veins and pegmatite bodies, and may enclose grains of garnet.

Spessartite occurs commonly in minute (up to 1 mm.), bright yellow to orange-yellow grains uniformly distributed throughout the pegmatites. A sample of this garnet from the spodumene-bearing pegmatite south of Lake Lortie is probably similar to the garnet of all the pegmatites and aplites of the map-area and also of the muscovite granite mass. It has a specific gravity of 4·279. A chemical analysis of this sample (I) is given together with one as calculated from the theoretical formula (II):

	I	II
	Per cent	Per cent
SiO_2 (by difference for analysis I)	(38·2)	36·4
Al_2O_3	20·8	20·6
Fe_2O_3 (FeO)	2·2	
MnO	38·0	43·0
CaO	0·4	
MgO	0·4	

I. Analysis made by H. V. Ellsworth of the Geological Survey of Canada.
II. Analysis calculated from $Mn_3Al_2(SiO_4)_3$.

A mineral identified by H. V. Ellsworth of the Geological Survey as mangano-columbite-tantalite occurs commonly in tiny wedge-like grains in albite, more rarely in quartz and spodumene, scattered quite uniformly in very small amount in spodumene- or beryl-bearing pegmatite and aplite dykes. A small sample, analysed microchemically by Ellsworth gave:

	Per cent	
TiO_2	2·5	
$(Cb, Ta)_2O_5$	84·0	(somewhat impure due to incomplete separation of Mn and Fe)

No chemical determinations were made on the columbite-tantalite grains of the other occurrences, but it is probable, as suggested by specific gravity determinations, that everywhere in this area the Ta_2O_5 content is about the same as the one given above. In the occurrence south of Lake Lortie from which the sample was obtained, the mineral was observed intergrown with a brownish mineral that is believed to be microlite. Large crystals (2 by 1·5 cm.) of columbite-tantalite (Ta_2O_5: 28 to 42 per cent) have been noted at one spot in the green, spodumene-bearing dyke southeast of Lake Baillairgé. There, the columbite-tantalite content was quite high in a pocket-like mass about 3 feet in diameter and was associated with bismuthinite and beryl.

Microlite, a resinous, sulphur-yellow to yellow-brown, tantalum-bearing mineral, was found in small, irregular grains commonly in lepidolite, less commonly in albite or quartz, in spodumene- or spodumene-lepidolite-bearing pegmatite dykes. It was also found intergrown with columbite-tantalite south of Lake Lortie.

A single, prismatic crystal of *betafite,* a uranium-bearing mineral, was found in spodumene in the spodumene-bearing pegmatite dykes south of Lake Lortie.

Bismuthinite (Bi_2S_3) occurs in irregular fibrous masses replacing spodumene, albite, quartz, and muscovite in spodumene-bearing pegmatite southeast of Lake Baillairgé. It has been found there is very small amount and at one place only in the main dyke, associated with columbite-tantalite and beryl. This was a pocket-like mass remarkably rich in bismuthinite and columbite-tantalite. At no other place in this dyke or in the map-area has bismuthinite been found, except at the Lacorne mine, where bismuthinite and native bismuth have been reported associated with molybdenite.

A light to deep blue mineral, identified as powellite by S. C. Robinson of the Geological Survey of Canada, occurs in very fine grains in a fault zone on the 250-foot level at Lacorne mine. The mineral either in crystal form or in powder is not fluorescent and occurs commonly associated with quartz, feldspars, muscovite, and some molybdenite. The mineral appears to be a rather pure calcium molybdate and might be secondary. The blue colour is probably due to some impurities in dust-like particles.

Molybdenite (MoS_2) is the most abundant molybdenum mineral in this area. It is a shiny, lead-grey mineral occurring in flake-like grains either in quartz or feldspar, but commonly in aggregates of muscovite flakes and intimately associated with the muscovite. On the weathered surface, it tarnishes black to grey-black. Most of the molybdenite flakes are of medium size, but in some of the veins at the Lacorne mine, which is the main occurrence of molybdenite in this area, the mineral is found in powder form.

Paragenesis. The accompanying paragenesis chart (*See* Figure 2) is the result of field and microscopic work. In the chart, the minerals are arranged in the order presented in Dana's mineralogy with the most abundant in general at the top. The paragenetic relationships could not be determined accurately for all the minerals shown on the chart, because not all the minerals have been noted in a single dyke and many of them occur in too small quantity. The age relationships have been inferred from the mineral association at the place where the minerals were observed. As indicated by the chart, the periods of deposition for the main constituents overlap.

The emplacement of the minerals in these pegmatite masses and dykes involves only two stages, magmatic and hydrothermal. All the pegmatites of the map-area, both simple and complex types, probably formed during the magmatic stage. The minerals deposited during this stage were albite (An_{4-6}), microcline, quartz, muscovite, spessartite, most of the spodumene, beryl, betafite, and probably most of the tantalum-bearing minerals. The hydrothermal stage, which probably followed soon after the magmatic stage, is of relatively slight importance: even though hydrothermal effects have been noted nearly everywhere, the resultant minerals are in very small amount; the principal ones are a late albite (An_{0-2}), a late spodumene, bismuthinite, lepidolite, microlite, and some columbite-tantalite. It is probable that a late quartz has been deposited also, as suggested by its occurrence as veinlets and as minute round grains in other minerals.

The paragenetic relationship of molybdenite in this area is not known with certainty. If the validity of the rough zoning presented by beryl, spodumene, and molybdenite, as described in a later chapter, is accepted, then it would be apparent that molybdenite is also a magmatic mineral.

Origin. All pegmatite and aplite dykes and irregular masses of the map-area are probably late differentiates of the muscovite granite. This view is substantiated by the fact that in general these dykes and masses are

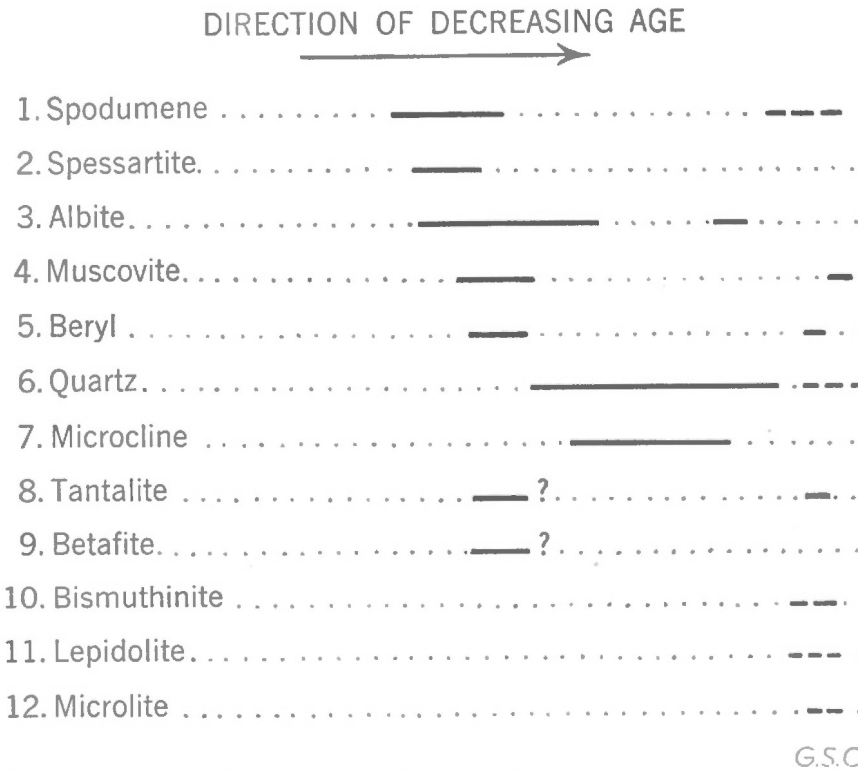


Figure 2. Chart showing the paragenesis of the minerals observed in the pegmatites of Fiedmont map-area.

closely associated in the field with the muscovite granite; that many of them grade into the muscovite granite; and that both the granite and the dykes have the same mineralogical composition. The last extract of this late differentiate gave rise to the complex pegmatite and aplite bodies, and their high spodumene content would be explained by the concentration of the lithium content of the original magma in this last pegmatitic phase. That this lithium was present in the original magma is suggested by the presence of a few grains of spodumene found in two thin sections of the muscovite granite.

Chemical Composition

As chemical analyses of the main rock types of the Lacorne intrusions have already been presented by Gerrie (18) and Gussow (22), no samples were collected by the writer for this purpose. The chemical analyses referred

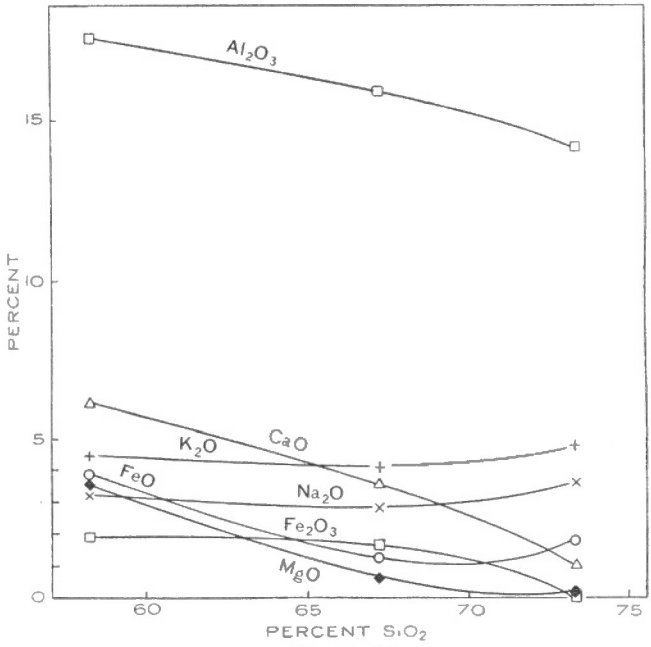


Figure 3A

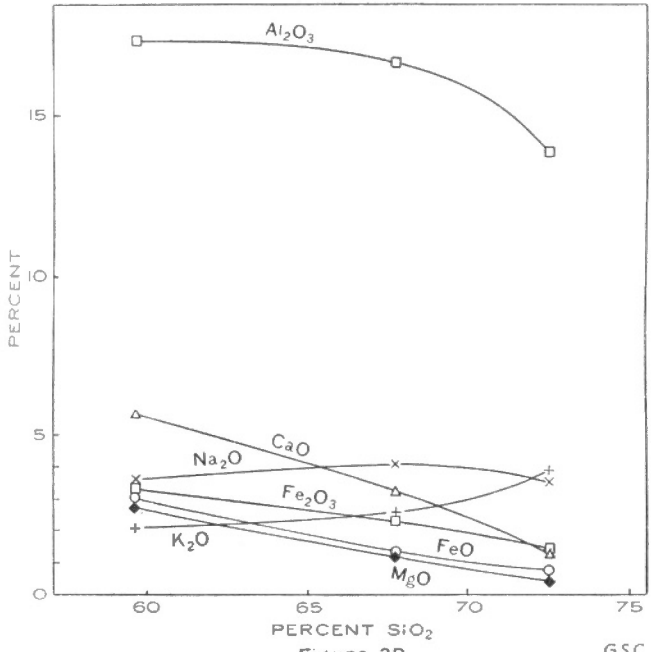


Figure 3B

GSC

Figure 3. Variation diagram for the Lacorne batholithic series, based on the first three analyses of Table I (Figure 3A), and for Daly's average rock types, comprising andesite, dacite, and rhyolite, based on the analyses shown in Table II (Figure 3B).

to are given in Table I. Neither Gerrie nor Gussow, however, presented a magma variation diagram (8, pp. 92-124), so the combining molecules of the rocks analysed are here plotted on Figure 3a, arranged according to the increase of silica content. Only the curves for the variation of the main oxides have been plotted; the minor constituents such as P_2O_5, H_2O, TiO_2, and MnO have not been considered, as most of them have not been determined in the analyses given in Table I. Silica is plotted as abscissæ, and all the other oxides as ordinates. The analyses are few, but they afford a good idea of what took place when the magma was cooling at depth; also they are sufficient to warrant reasonable conclusions. K_2O and Na_2O are quite high in the basic side of the diagram, and remain fairly constant in amount throughout the series. Al_2O_3, CaO, and MgO curves show a gradual decrease in the amount towards the siliceous end. The marked decrease in total iron is noticeable.

Sample No. IV (Table I) is not from the map-area, but its analysis is listed because the description of its microscopic characters and field relations (22) indicates that it is a rock of similar nature to the biotite-hornblende granodiorite of this area, which is considered as an altered phase of the hornblende monzonite mass. The mass of hornblende monzonite extends south of the present map-area for about 3 miles. The sample taken for analysis (No. IV) is from this mass at a place about 2 miles south of the western part of the granodiorite zone and very close to the

TABLE I

Analyses of Rocks of the Lacorne Intrusions

	I	II	III	IV
	Per cent	Per cent	Per cent	Per cent
SiO_2	73·42	67·30	58·30	63·04
Al_2O_3	14·19	15·95	17·65	16·06
Fe_2O_3	0·04	1·75	2·00	1·26
FeO	1·78	1·30	3·98	3·55
MgO	0·18	0·70	3·60	2·68
CaO	1·12	3·68	6·24	5·23
Na_2O	3·63	2·88	3·22	4·07
K_2O	4·81	4·08	4·54	2·31
H_2O	0·50	.....	.....	0·85
CO_2	nil	.....	.....	nil
TiO_2	0·16	.....	.....	0·42
P_2O_5	tr.	.....	.....	0·29
MnO	tr.	.....	.....	0·08
F	tr.	.....	.....	0·05
S	tr.	.....	.....	tr.
	99·83	97·64	99·53	99·92

I. Muscovite granite—lot 12, rge. VI, Lacorne tp., from W. C. Gussow (op. cit.). Analyst: W. H. Herdsman, Chemical and Metallurgical Laboratories, Glasgow, Scotland.

II. Biotite granodiorite—lot 11, rge. II, Lacorne tp., from W. Gerrie (op. cit.). Analyst: W. Gerrie.

III. Hornblende monzonite—lot 44, rge. III, Lacorne tp., from W. Gerrie (op. cit.). Analyst: W. Gerrie.

IV. Biotite-hornblende granodiorite—lot 32, rge. VI, Vassan tp., from W. C. Gussow (op. cit.). Analyst: W. H. Herdsman.

contact with the pre-batholithic rocks. It is believed that this zone of granodiorite extends south to occupy the area from which the sample was collected. Its analysis is used to indicate what substances have been added and what have been removed by the hydrothermal solutions that have altered the hornblende monzonite to a biotite-hornblende granodiorite.

Differentiation

Using Daly's average chemical analyses for andesite, dacite, and rhyolite (Table II), a variation diagram (Figure 3b) has been obtained, which, it is believed, represents the normal liquid line of descent in the differentiation of a magma of basaltic composition. If a comparison is made between this diagram and that of the Lacorne intrusions, many interesting features are noted. The great similarity between them is at once a striking feature. The Al_2O_3 curve in both diagrams is very similar; that of the Lacorne rocks, however, is slightly straighter. The CaO curves are exactly the same in both diagrams. The MgO curve is slightly steeper in the Lacorne diagram, the basic end being higher. A sharp contrast, however, is evident between the two Na_2O curves; in the Lacorne diagram, the curve is concave upward, whereas in the other it is concave downward. The minimum in the Na_2O curve of the Lacorne diagram, between 65 and 70 per cent silica, corresponds to a maximum in the other diagram between the same percentages of silica. The K_2O curves are concave upward in both diagrams, but the line is much flatter in the Lacorne diagram. In general the iron content decreases in both diagrams as the silica content increases, but a few striking contrasts are apparent. The Fe_2O_3 curve for the Lacorne rocks is flat in the basic phase, but lowers quickly as the acidic end is reached, in contrast with the straight line of the same curve in the other diagram. The FeO curves are convex downward in both diagrams, with a maximum between 65 and 70 per cent silica, but the convexity is much more pronounced in the Lacorne diagram than in the other, and there is a marked increase of FeO content in the acidic side of the Lacorne diagram.

If it is assumed that the original magma was basaltic in composition the supposition is that this basaltic magma differentiated in a reservoir at great depth to supply, at successive intervals of injection, the different

TABLE II

Analyses of Daly's Average Rock Types (12)

	Andesite	Dacite	Rhyolite
	Per cent	Per cent	Per cent
SiO_2	59·59	67·67	72·60
TiO_2	0·77	0·33	0·30
Al_2O_3	17·31	16·81	13·88
Fe_2O_3	3·33	2·47	1·43
FeO	3·13	1·35	0·82
MnO	0·18	0·04	0·12
MgO	2·75	1·23	0·38
CaO	5·80	3·31	1·32
Na_2O	3·58	4·18	3·54
K_2O	2·04	2·53	4·03

phases that have been mapped in the field. This differentiation may then be explained by fractional crystallization, which would probably have commenced at depth with the formation of hornblende crystals and some calcic plagioclase, and continued in part where the intrusive masses were emplaced.

All the curves of the Lacorne diagram are smooth, suggesting that the liquid line of descent in the differentiation process was not materially influenced by crystal settling. It is believed, however, that some crystal accumulation took place locally when differentiation was active. The uniformity in composition of the hornblende monzonite suggests an earlier accumulation of the hornblende crystals in the monzonite zone at depth, with concentration of them at places to give the amphibolite masses.

It is generally accepted (8, pp. 92-125) that a variation diagram based on the chemical analyses of rocks related to different magmas presents curves that are ragged rather than smooth. Consequently, as the Lacorne diagram has only smooth curves, it seems that the different phases injected at intervals had a common magmatic source, and that differentiation mainly within the reservoir was essentially complete as indicated by the smoothness of the curves.

The hornblende monzonite mass was probably intruded in a sort of mushy semi-crystalline state, as indicated by the flow lines at the margins, the great abundance of inclusions throughout the mass, and the apparent inability of the mass to digest these inclusions. Crystals present probably included a large amount of hornblende and some of plagioclase feldspars, and the residual associated liquid was probably rich in potash (K_2O) and low in excess silica (SiO_2). This would explain why microcline is everywhere present, even in slight amount in the basic differentiate. The hornblende crystals are now so uniformly distributed throughout the mass of monzonite that it does not seem that much movement took place in it after its emplacement. It is, therefore, probable that when the mass was intruded the hornblende crystals were distributed much as now, and that the concentration of these crystals to form amphibolite probably took place at depth. Any differentiation that may have occurred after the mass was emplaced would have effected only slight compositional variations of this body. The MgO curve showing a maximum in the basic side is, then, the result of the primary accumulation of the hornblende crystals in the monzonite zone when differentiation was effective in the magma at depth. Nearly all the quartz is believed to have been introduced later with the hydrothermal solutions that have altered the marginal zone of the hornblende monzonite to a biotite-hornblende granodiorite. Consequently, this granodiorite, as described before (page 31) is not a differentiate of the monzonite.

The biotite granodiorite, however, and the muscovite granite, which are considered here as parts of the same mass, are probably in part the result of differentiation in place by fractional crystallization. When this mass was intruded, it was partly crystalline, at least that part that formed the biotite granodiorite. At depth some plagioclase and biotite were formed by fractional crystallization. When intruded, these minerals concentrated along the margins where flow lines have developed. After the mass was in place, differentiation continued, as indicated by variations in composition from the margins of the mass toward the central area. Due

to temperature changes, minerals such as biotite and calcic oligoclase that had formed at depth became unstable; biotite, probably due to the low iron content of the magma at that time and its low temperature, was partly resorbed and transformed to muscovite. At the end, muscovite alone was crystallizing out. Similarly, the plagioclase that crystallized out became less and less calcic.

In summary, the Lacorne series of intrusive rocks is characterized by at least two intervals of intrusion, if not three, and by a differentiation that was complete before the emplacement of the intrusive masses except for the core of the muscovite granite. Also, the uniformity in soda and potash contents is very striking, that of the soda content being probably the result of the early concentration of much microcline in the monzonite zone, which left some soda for the more siliceous type.

Alteration

As described previously, the Lacorne batholith appears to illustrate, in its various rock types, the normal line of descent in the differentiation of a magma. The differentiation is thought to have taken place mainly at depth, but also to some extent after emplacement. Differentiation at depth gave rise, through successive intrusions, to the hornblende monzonite mass and the muscovite granite mass. The hornblende monzonite, with its basic differentiate, the amphibolite, probably had a border slightly more basic than the core. Subsequently this slightly more basic outer zone was altered by hydrothermal solutions to a biotite-hornblende granodiorite.

That this alteration is due to hydrothermal solutions can be shown. The plagioclase feldspars have been altered to sericite and epidote, and the hornblende to biotite, epidote, and chlorite. Such alteration processes have often been referred to and described in the literature (9). Many are inclined to consider them as a result of weathering, but a few writers have held, with Gillson (19), that they are the result of post-magmatic hydrothermal solutions. It is the writer's belief, for reasons that follow, that such solutions have been the cause of the alteration of the border zone of the hornblende monzonite to a biotite-hornblende granodiorite.

(1) Schwartz (34) mentions epidote as one of the most common and most distinctive minerals of 'hydrothermal alteration' of igneous rocks.

(2) Glaciation has removed all weathered rock from the surface of this intrusive body. Rocks with freshly exposed surfaces are in abundance, but even in these rocks the alteration can be seen. It is true that the alteration has not the same intensity throughout the mass, but on the other hand it is definitely not concentrated along joint or fracture planes in the intrusive rock, such as could have served as channels for meteoric waters.

(3) The alteration is more intense in a zone near the contacts of the hornblende monzonite with the intruded rocks, and decreases gradually with increasing distance from these contacts, suggesting that the contact zone was the most favourable place for the circulation of the rising solutions. These solutions have thoroughly permeated the rock at the contact and have deposited most of their material there.

(4) The biotite granodiorite along its eastern contact with the mass of hornblende monzonite is similarly altered. Plagioclase feldspars are seen to have been altered to sericite and epidote, and the biotite to chlorite. On the

west, the granodiorite mass is only slightly altered. Similarly, along the eastern border of the muscovite granite, all the biotite has been partly altered to chlorite, and the albite has been partly sericitized. This suggests that the solutions were active in the contact zones of both rocks, the alteration being less pronounced in the muscovite granite and the biotite granodiorite than in the hornblende monzonite, probably because these rocks were still hot when solutions acted on them and more in equilibrium chemically with them.

(5) The older rocks adjacent to the hornblende monzonite, biotite granodiorite, and muscovite granite have entirely recrystallized, the basic lava to a hornblende schist, the greywacke to a biotite schist, and the peridotite to a talc-amphibole-bearing rock. Many of these transformations were probably caused by the circulation of hydrothermal solutions similar to those that permeated the monzonite.

(6) It is probable that the pegmatites have furnished the hydrothermal solutions necessary to cause the alteration, as they are closely related in space to these contact zones.

Differentiation processes are responsible for the hornblende monzonite and its amphibolites, the muscovite granite and its biotite granodiorite, and the pegmatites. Some solutions genetically derived from these pegmatites have been the active agent in the alteration of the monzonite outer zone, in the recrystallization of the adjacent rocks, and in the alteration, in part, of the biotite granodiorite and the muscovite granite. These solutions, the final magmatic residues, were probably very rich in silica and poor in all other mineral constituents. Their main effect has been to precipitate the silica as quartz, and to remove much calcium, magnesium, and iron, mainly from the mafic minerals. The large amount of soda (Na_2O) in the granodiorite is probably of primary, magmatic origin, as no albite is found in the altered zones. Microcline is everywhere fresh, probably because it is much more difficult to alter than plagioclase, and partly because the hydrothermal solutions were in chemical equilibrium with microcline, which is abundant in the pegmatites.

Mechanism of Intrusion

It has been assumed that the hornblende monzonite, with its altered zone of biotite-hornblende granodiorite, and the muscovite granite, with its associated biotite granodiorite, constitute two separate intrusions injected at slightly different times. The structural features characteristic of each of these intrusions will be analysed separately.

The contacts of the hornblende monzonite with the intruded rocks are rarely exposed. Some can be seen west of Lake Lortie, and southeast of Lake Roy and of the Lacorne mine. Where these contacts are observed, they are sharp, and indicate no apparent change in the texture of the intrusive rock. The rock is uniform in grain, and the high quartz content in the marginal zones of the hornblende monzonite is not considered here as a feature of assimilation, but of hydrothermal alteration, which took place regardless of the type of rock with which this mass is now found in contact. If assimilation had been an important process, the contacts would probably not be so sharp, gradational contacts and possibly *lit-par-lit*

injection would be observed, and the composition of the marginal granodiorite zone would vary with the type of rocks found now in contact with the hornblende monzonite.

On account of the many inclusions scattered throughout the monzonite mass, assimilation might be suggested as the process by which this mass was emplaced. But the contacts of those inclusions with the enclosing rock are too sharp and the monzonite mass itself is too homogeneous in appearance throughout to believe that assimilation was the main process. Schistosity is intensified in the intruded rock along the northern and western contacts, and some may consider that the flow lines in the adjacent intrusion are relict of this structure; this, however, cannot be so, as both are not everywhere parallel. A chemical analysis corresponding with the one given above for the hornblende monzonite (page 51) could not be obtained by averaging the chemical analysis of the muscovite granite with that of Daly's average basalt, the average basalt of Porcupine and Kirkland Lake districts, Ontario, the andesite of Dufresnoy township, Abitibi, Quebec, or the andesite of Duverny township, Abitibi, Quebec. These basalts and andesites were considered, as it is believed that they must resemble the basic volcanic rocks of this area. In calculating these averages the silica content was kept constant, and in no case did the results correspond with the chemical analysis of the monzonite mass of the area. To arrive at even an approximate correspondence, the rocks would have to be submitted to a wide series of complex processes, some removing and some carrying in constituents such as Al_2O_3, K_2O, MgO, Fe_2O_3, etc. It appears, therefore, that assimilation cannot have been important as a mode of emplacement for this mass, although it is possible that locally it may have been slightly effective.

Stoping does not modify the structure in older rocks adjacent to intrusive masses, but in this case the schistosity in the intruded rocks adjacent to the monzonite mass has been greatly intensified, and at other places, as east of Lake Roy, the original structure has been modified by the intrusion. As emphasized later, if it is accepted that the present surface is not far from the roof of this batholith, it would be difficult to account for such regular contacts if they were the result of stoping. A few features, however, can hardly be explained by other means than stoping; the monzonite mass, for example, contains many widespread inclusions, and along its eastern contacts cuts across the trend of the formations, suggesting stoping. It is believed, therefore, that stoping has been effective to a certain degree, and probably at the ultimate stage of the intrusion.

These considerations lead to the view that the emplacement of the hornblende monzonite was effected mainly by pushing its walls aside and by lifting its roof. The magma forming this mass was apparently viscous enough to supply the pressure necessary, and at the same time to furnish support from below. When the magma pushed its way up, frictional movement along the walls produced the flow lines, and pressures set up by the rising mass shouldered aside the older intruded rocks, which recrystallized under differential stress but suffered little horizontal displacement. Marginal joints (27) now filled with pegmatites are observed at a few places in the monzonite along its contacts. They dip about 55 degrees toward the intrusive body, and suggest a rising magma, lifting its roof. It is probable, too, that all this took place at great depth, as suggested by the schistosity developed in the intruded rock parallel with the intrusive contacts.

The muscovite granite has been observed at a few places in contact with the intruded rocks, as east of Lake Chaptes and east of Lake Baillairgé. Everywhere the contacts are sharp, and give no evidence of *lit-par-lit* injection. The granite is found in contact with different types of rocks—basic volcanic, sedimentary, and intrusive. Nowhere is there any variation in the composition of the granite as the contact is approached. Consequently, assimilation could not have been any more important for this mass than for the hornblende monzonite. On the other hand, where the muscovite granite is found in contact with older intrusive rocks, as east of Lake Chaptes, schistosity is represented in these hard rocks only in a very narrow zone, possibly because the mode of emplacement, by pushing the walls aside, was less effective here. No inclusions were observed in the muscovite granite, and only a few were seen along the contact zone. Consequently, stoping could not have been an active process. It appears, therefore, that the muscovite granite mass moved mainly by lifting its roof. This is suggested by the flow lines along parts of the contacts, and by the marginal joints now filled with pegmatitic material.

Depth of Erosion

In this region, it has been presumed that erosion has not reached a very low level in the Lacorne batholith. This contention is supported by much field evidence, which may be summarized as follows:

(1) The nature of the metamorphism. No high-grade metamorphic effects have been noted in the rocks adjacent to the Lacorne batholith. The greywacke has not been changed to a sillimanite- or garnet-bearing rock, as would be expected if it were much deeper in the earth's crust where the heat furnished by the batholith would be appreciably greater. It is true that no brecciation was observed along the intrusive contacts, as would be expected if erosion were shallow, but the following features suggest shallow erosion.

(2) The great abundance of acidic rocks.

(3) The abundance of inclusions in the hornblende monzonite. The few roof pendants, and the position of the large inclusions or relicts of roof pendants on the hill slopes suggest an horizon close to the roof of the monzonite. It is probable that the exposed part of the monzonite in the southwestern corner of the map-area was nearer the roof than elsewhere, and has not been eroded as deeply as other parts of the monzonite mass; this is suggested by the greater abundance of inclusions there and the presence of few pegmatites and quartz veins.

(4) The great abundance of pegmatites in the muscovite granite. The western side of this granite mass seems to have been eroded less deeply than the eastern side, as suggested by the relatively greater abundance of pegmatites on the west. This difference in level of erosion in the same mass indicates an inclined mass pitching to the west.

Time of Intrusion

Recently, Norman (31) has proposed a sequence of the major events that have produced the main geological features of the region of which the present map-area forms a part. He summarized these events in the following chronological order:

"(1) Accumulation of Archæan lavas and associated pyroclastic rocks, either alternating with, or essentially followed by, deposition of sedimentary rocks, and interrupted at least once by local and perhaps regional folding and erosion.

"(2) Intrusion of peridotite, pyroxenite, gabbro, anorthosite, diorite, and quartz diorite over a long period, and beginning with diorite intrusion probably before some of the Archæan sediments were deposited.

"(3) Progressive folding and faulting with an east to southeast trend, overlapping in part the period of intrusion and accompanied, at a later stage, first by intrusion of albite granite, later by intrusion of small masses and dykes of pyroxene-hornblende syenite and allied rocks rich in alkalis, and at a still later date by intrusion of granodiorite, granite, and pegmatite, all with microcline as an essential constituent.

"(4) Prolonged erosion.

"(5) Deposition of conglomerate, arkose, and greywacke of the Cobalt and Chibougamau series (Huronian)."

On this analysis, the last group of intrusions to appear was the potassic type, rich in microcline. This is in accordance with the differentiation series of Bowen, and it is reasonable to assume that the potassic intrusions of the Fiedmont area form part of this group.

In this sequence of events, the oldest formations, composed mainly of volcanic rocks with some interbanded sediments, are commonly referred to Keewatin time. The sedimentary rocks, interbanded with some volcanic material, rocks that rest unconformably on the Keewatin formations, are generally considered of Timiskaming age. The period of folding that followed the deposition of the Timiskaming group is probably that referred to by Norman in his third event. On this assumption, the potassic intrusions of this area are of post-Timiskaming and pre-Huronian age. However, no Huronian, and probably no Timiskaming, sedimentary formations have been recognized in the Fiedmont area, but certain structural features there help to support the assumption as to the age of the potassic intrusions. These structural features relate to the schistosity and the flow lines.

The schistosity of, and the banding in, the intruded rocks adjacent to the Lacorne batholith are generally roughly conformable with the intrusive contacts, but in places, as west and southwest of Lake Fiedmont, it can be seen that the intrusions are unrelated to the schistosity. Similarly, it is apparent that the schistose character of the pre-batholithic rocks as a whole is of regional significance, and the result of a general orogeny rather than an effect of the intrusions themselves. Consequently, it may be assumed that the regional cleavage was formed by orogenic forces related to the period of post-Timiskaming folding, and thus pre-dates the emplacement of the Lacorne batholith.

On the other hand, flow lines have been observed in the intrusive rocks. These occur along the contacts but never within the interior of the mass, where the rock is uniform and massive. In strike, these flow lines commonly follow the contacts of the intrusive mass. As they are not present in the centre of the mass, but occur only along the contacts, they merely indicate the direction of the magma movement, and are not a result of later regional orogenic disturbances.

GABBRO AND ASSOCIATED ROCKS

Occurrence and Field Description

Seven dykes of gabbro are known in the map-area, and are shown on the accompanying map. Five of these dykes outcrop in the northwestern part of the map-area. The other two are in the eastern half of this area.

The small dyke on lots 15 and 16, rge. I, Landrienne tp., is about 20 feet wide. It has been traced for about 100 feet, and strikes about 55 degrees east of north. The rock is of fine to medium grain, and has a readily recognizable ophitic texture. It cuts sharply across Kinojevis volcanic rocks and a lens-like peridotite mass.

A second dyke outcrops on rges. X and I of Lacorne and Landrienne tps. respectively. Two small outcrops, one on lot 54, rge. VII, La Motte tp., the other one on lot 57, rge. V, Landrienne tp., may form part of the same dyke, but its continuity beneath the drift in the intervening areas is not proved. This dyke has an average width of about 100 feet, strikes about 55 degrees east of north, and displays a good ophitic texture. It has sharp contacts with the Kinojevis volcanic rocks, the Kewagama sedimentary rocks, the muscovite granite, and the hornblende monzonite.

A third, and largest, gabbro dyke, varying in width from 100 to 250 feet, and standing vertically, has been traced for 7 miles northeast from Lacorne village, passing ½ mile north of Lake Chaptes, to a point on lot 36, rge. X, Lacorne tp., where the dyke is much narrower, suggesting that it may not continue much farther north. It seems, however, to reappear about ½ mile farther west, and has been traced for 4 miles in ranges I and II, Landrienne tp. Small outcrops on lot 62, rge. V, Landrienne tp., and on lot 4, rge. V, Barraute tp., are probably parts of this dyke, but this continuity cannot be demonstrated. One small subsidiary dyke branches from this dyke on lot 32, rge. I, Landrienne tp., striking about north. This large dyke, as a whole, displays a wide variation in granularity from very coarse at the centre to dense at the margins, where an ophitic texture is visible. It cuts hornblende monzonite, muscovite granite, and Kinojevis volcanic rocks. Where the contacts are well exposed, they are sharp, and appear slightly irregular in detail. A few xenoliths of the older volcanic rocks have been observed in the dyke, but do not appear to have recrystallized as a result of the intrusion. A few aplite dykes are associated with this gabbro dyke. They vary in width from a fraction of an inch to 5 inches, and have been found only where the dyke cuts the muscovite granite. The aplite dykelets cut the diabase dyke at right angles to its strike, and generally extend from wall to wall. They are in sharp contact with the gabbro and can be readily distinguished from it as they are reddish and fine grained as compared with the basic dyke, which is dark brown and coarse grained. Another feature of the diabase is the presence of basic to acidic patches where it cuts the muscovite granite. These patches seem to occur in the same part of the dyke where the aplites were seen, and are of two types: some have gradational contacts with the diabase and appear to be composed of the same minerals as, but in amount different from, the diabase; others are in sharp contact with the surrounding diabase. Their genesis as well as that of the aplite dykelets will be referred to on a later page. The large dyke is porphyritic in places; the phenocrysts are feldspar crystals, about an inch long, and are sparsely scattered through the dyke.

A fourth dyke cuts an amphibolite mass on lot 64, rge. VI, La Motte tp. It strikes 50 degrees west of north, has been traced for half a mile, and is about 30 feet wide. It is a fine-grained rock with sharp contacts and a clear ophitic texture.

The fifth dyke of the group in the northwest corner of the map-area is exposed on lots 11 and 12, rge. V., and is probably also represented by outcrops on lots 29, 30, and 31, rges. VIII and IX, Lacorne tp. It is a fine-grained, 22-foot wide dyke, striking about 55 degrees east of north, and cutting muscovite granite, some amphibolite, and volcanic rocks.

Of the two dykes known in the eastern part of the map-area, one strikes about 15 degrees east of north, and may be continuous from lot 44, rge. V, Barraute tp., to lot 27, rge. VI, Fiedmont tp. The width of the dyke is not known, but is probably about 80 feet. The dyke is fine to medium grained, and its contacts are sharp. The second dyke is much larger and displays a considerable variation in granularity. Four outcrops appear to show its continuity for about 5 miles. These outcrops occur in ranges VIII, IX, and X, Senneville tp., and in range 1, Courville tp. The dyke strikes about 60 degrees east of north, and varies in width from 150 to 250 feet. It has sharp contacts with acidic tuffs, rhyolite, pyroclastic rocks, and albite granite.

From the above descriptions it is apparent that all the dykes are in sharp contact with adjacent rocks, are continuous for long distances, are for the most part of fairly constant width, and are relatively straight. Most of them strike about 55 degrees east of north, which is probably a principal direction of tensional stress. On the weathered surface, the rock is dark to brownish black, with at places a dark reddish cast. The surface is quite rough, and commonly displays some variation in granularity. All have dark, chilled borders. Their exposures form small outcrops of quite high relief with rounded smooth tops. Two sets of joints are commonly present, striking generally at an angle of 60 degrees with the walls of the dykes.

Petrographic Description

In thin section, two main types of rocks have been recognized; a quartz gabbro and an olivine gabbro. Quartz gabbro composes six of the seven dykes, the only olivine gabbro dyke being the large one in the southeastern part of the map-area. Under the microscope, all these dykes have much in common. All are composed of plagioclase feldspar, pyroxenes, and a few accessory and secondary minerals. Their only difference is the presence of interstitial quartz in the quartz gabbro and of olivine in the olivine gabbro, and neither mineral is sufficiently abundant to be recognized in the hand specimen. Plagioclase varies slightly in composition, from about An_{46} to An_{54}; crystals have everywhere a general lath-shaped habit, and vary in length from 0·1 to 3·0 mm. They are partly altered to sericite and epidote. Carlsbad and albite twins are common and well developed. The pyroxene is principally augite, but includes some pigeonite. It is light grey, and of good crystal shape where it occurs in greater quantity than the feldspar. The pyroxene of the olivine gabbro, as it has a violet tinge, appears rich in titanium. All the pyroxenes alter to uralite and chlorite, but the intensity of alteration is variable. Apatite, iron ores, and titanite are accessory. Chlorite, sericite, epidote, and uralite are secondary. A few flakes of biotite

were noted. Only one grain of olivine was seen in the slide from the olivine gabbro. A characteristic feature of the quartz gabbro is the presence of some interstitial quartz and feldspar in micrographic intergrowth.

Origin of the Acidic Phases

Eight thin sections from the quartz-gabbro dykes of this area have been studied, and their mineral contents as measured by the Rosiwal method is given in Table III. The grain size as measured from the thin sections is also given. These values suggest that the amount of quartz-feldspar intergrowth is a function of the plagioclase feldspar content, the amount of quartz-feldspar intergrowth increasing with increasing feldspar content. The intruded rocks adjacent to the place where the samples were obtained are also given, with the purpose of showing that they do not appear to influence the content of this intergrowth. Collins (8) proposed differentiation as a process to explain the granophyre, the aplites, and all the other analogous features associated with the Keweenawan diabase. The quartz-feldspar intergrowth in this instance is probably also a result of differentiation from the gabbroic magma that supplied the dyke, and not the result of assimilation of granitic rocks.

The large dyke in the northwestern corner of the map-area, described above as the third one, presents features that were not observed in the other dykes of the map-area, due perhaps to the fact that it is better exposed than the others, is larger, and cuts an area of muscovite granite and pegmatitic material. As mentioned before, this dyke contains patches of more acidic and more basic material. Some of these have a gradational contact with the gabbro, and may be either more basic or more acidic than the gabbro itself; they must consequently have a common origin. These patches are probably due to segregation of the mineral constituents in place, while the gabbroic magma was cooling, and differ from the gabbro itself only by a greater concentration of one or other minerals. Other patches are in sharp contact with the diabase. These are always more acidic, and it has been found that they are composed of the same minerals as those found in the aplite dykes. Consequently, these patches and the aplites have probably the same origin, being formed from the same solutions. A Rosiwal analysis of a thin section from one of these aplite dykes revealed the following mineral composition: albite, 61·5 per cent; microcline, 10·7 per cent; quartz, 10·3 per cent; intergrowth of quartz and feldspar, 9·0 per cent; and mafic minerals, 8·5 per cent. The mafic minerals were mainly green hornblende and titanite, but included some epidote. The rock is very fresh. Another section contained more than 80 per cent albite, with garnet, titanite, and biotite as the principal mafic minerals. As these aplites show no gradational contacts with the gabbro in which they occur, and as they have a mineral composition entirely different from that of the gabbro, it is believed that neither they nor the irregular patches related to the aplites are differentiates of the gabbroic mass. Their mineral composition suggests that the solutions from which they formed were rich in soda, such as might emanate from a deep-seated gabbroic mass during a late stage in its consolidation. Such solutions may have circulated in this case along the contact zones of the dyke with the intruded, granitic rock and have digested some material

Table III

Percentage Modes of Quartz Gabbro of Fiedmont Map-area

Specimen	1	2	3	4	5	6	7	8
Plagioclase	48·0	45·5	43·0	44·0	43·0	39·0	35·0	30·0
Pyroxene	42·0	44·0	49·0	45·0	49·0	53·0	62·0	62·0
Quartz-feldspar	8·0	7·5	4·0	3·0	3·0	2·0	Tr.	Tr.
Iron ore	2·0	3·0	4·0	8·0	5·0	6·0	3·0	8·0
Intruded rocks	Basic volcanic	Basic volcanic	Basic volcanic	Muscovite granite	Hornblende monzonite	Muscovite granite	Hornblende monzonite	Amphibolite
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Feldspar	0·2 x 0·4 to 3·0 x 1·5	0·2 x 0·2 to 1·7 x 0·7	0·8 x 0·3 to 2·0 x 0·4	0·6 x 0·2 to 1·8 x 0·4	0·2 x 0·3 to 1·7 x 0·9	0·2 x 0·2 to 1·1 x 0·3	0·2 x 0·5 to 3·0 x 0·6	0·1 x 0·1 to 0·2 x 0·3
Pyroxene	0·2 x 0·3 to 2·2 x 0·6	0·2 x 0·2 to 1·4 x 0·5	0·6 x 0·4 to 1·2 x 0·6	0·2 x 0·6 to 1·7 x 0·4	0·3 x 0·4 to 2·2 x 0·8	0·2 x 0·2 to 0·9 x 0·7	0·3 x 0·3 to 2·4 x 0·9	0·2 x 0·2 to 2·1 x 0·6

1. Lot 62, rge. V, Landrienne tp.
2. Lot 32, rge. VII, Fiedmont tp.
3. Lot 44, rge. V, Barraute tp.
4. Lot 7, rge. VIII, Lacorne tp.
5. Lot 2, rge. VII, Lacorne tp.
6. Lot 14, rge. VII, Lacorne tp.
7. Lot 64, rge. VII, La Motte tp.
8. Lot 64, rge. VI, La Motte tp

from this rock. As the diabase dyke cooled, fractures would develop in it and be potential openings for the deposition of the aplites and the irregular aplitic patches.

Age

The gabbro dykes are the youngest consolidated rocks of the map-area; they intrude all other formations, but their precise age is unknown.

CARBONATE ZONES

Carbonates replace to a varying degree most of the rocks of Fiedmont map-area. Where the replacement is nearly complete, the rock becomes a carbonate rock and has been mapped as such. Fresh surfaces are white to creamy white, and the rock appears to be very massive. The weathered rock, on the other hand, is porous; is reddish brown, due to a heavy coating of iron oxide; and is speckled with rust to a depth of a few inches. These rocks are composed of carbonates and quartz, and are fine grained. Where only part of the rock has been carbonatized, it has a spotted appearance, and the weathered rock is slightly rusty, dark green, and porous to a depth of a few inches.

Carbonatization has been most effective in lavas of the Kinojevis group, where it can be observed in all types, varying in intensity from place to place. The sedimentary rocks, in general, and the lavas that have been recrystallized to a hornblende schist show very little carbonatization, and the rocks of the Lacorne batholith are not carbonatized. The process seems to have been the most effective in zones of intense shearing, and in rocks that have developed a pronounced schistosity. These areas of intense carbonatization are commonly cut by numerous tiny quartz stringers, which may or may not be mineralized, and which also contain variable amounts of carbonate minerals.

Four separate carbonate zones have been mapped. They vary in width from a few hundred to a thousand feet; have all been slightly prospected; and in all of them gold has been reported, but so far no commercial ore deposits have been found.

PLEISTOCENE DEPOSITS

The deposits and the other effects of Pleistocene glaciation are widespread and conspicuous in this map-area. They have some importance as they are distinctive enough to indicate the direction of ice movement, the approximate shape of the ice front while receding, and, roughly, the periodicity of the retreat of the ice-sheet.

The glacial features described below were observed by the writer in the process of mapping the underlying formations.

The main features of interest noted in the field (Figure 4) are glacial striæ, eskers, annual moraines, and deposits of glacial Lake Barlow-Ojibway.

GLACIAL STRIÆ AND BOULDER TRAINS

The direction of the ice movement is well indicated by glacial striæ and boulder trains. The striæ have been observed in every part of the map-area, and in general seem to indicate two main directions of ice

movement. A large, north-trending esker divides the area into two almost equal parts. West of this esker, the striæ strike east of south; east of it, they strike west of south; and in general the angle east or west of south appears to increase slightly with the distance from the esker.

In his remarks on the removal of the ice from this area, Antevs (3) notes: "The last ice-sheets during their disappearance were nourished, and the ice moved constantly forward, so that the retreat represented the excess of disintegration over growth". In other words, the ice continued to move forward even while the ice front was receding; hence the glacial striæ must represent the last movement of the ice before its disappearance in this area. A. MacLean suggests (15, p. 495) that "the line of junction noted between Harricana and Bell Rivers may mark, not the contact of the Keewatin and Labrador sheets, but rather the line of fusion of two lobes of the Labrador sheet, one of which came directly overland from the southern end of the ridge of dispersion and the other of which flowed westerly from the central or northern parts of the dispersion ridge and then southward down the low ground of the Hudson-James Bay basins to debouch from the latter depression and advance to meet its neighbour in the region of the Harricana and Bell River valleys". Similarly, it is believed that when the ice was retreating, the topography, as at the first advance of the ice, was the main controlling factor for the direction of ice movement. As the highest hills lie along the zone of the central esker, it is possible that they constituted the main topographic feature that favoured the development of the englacial river that provided the esker. By the nature of the deposit that occurs along that zone, it can be assumed that it was formed where the ice was retreating and definitely by running water. If a river could flow along that zone the ice-mass must have been separated into two lobes along it, and because more net melting, due to the presence of the river, would occur there than elsewhere, the ice front must have been concave toward the south at that time in the map-area.

In the hilly country of Lacorne township, some hills carry boulder trains that trend southeast, indicating the same direction of ice movement as the glacial striæ (*See* Figure 3).

ESKERS

Some fluvioglacial deposits, probably eskers or esker-delta ridges, were observed in the map-area. All show good crossbedding and seem to have been formed by streams flowing in tunnels beneath the ice, some depositing deltas at their mouths. They are composed mostly of coarse gravel, and near their borders have been washed and sorted by the waves of glacial Lake Barlow-Ojibway. Subsequently, when the lake was completely drained into Hudson Bay, the fine-grained, loose washed materials were much disturbed and modified by wind action, giving rise to many sand dunes (Plate V B), most of them of the U-shape or related types. They all indicate a prevalent westerly wind.

The eskers are flanked by lakes and swamps, and contain some kettle-holes on their tops. At least two sets of eskers were observed. One, trending about north or slightly west of north, comprises the large esker in the centre of the map-area and the small one west of it. The other two, small eskers, trend about 15 degrees east of north and constitute the second set.

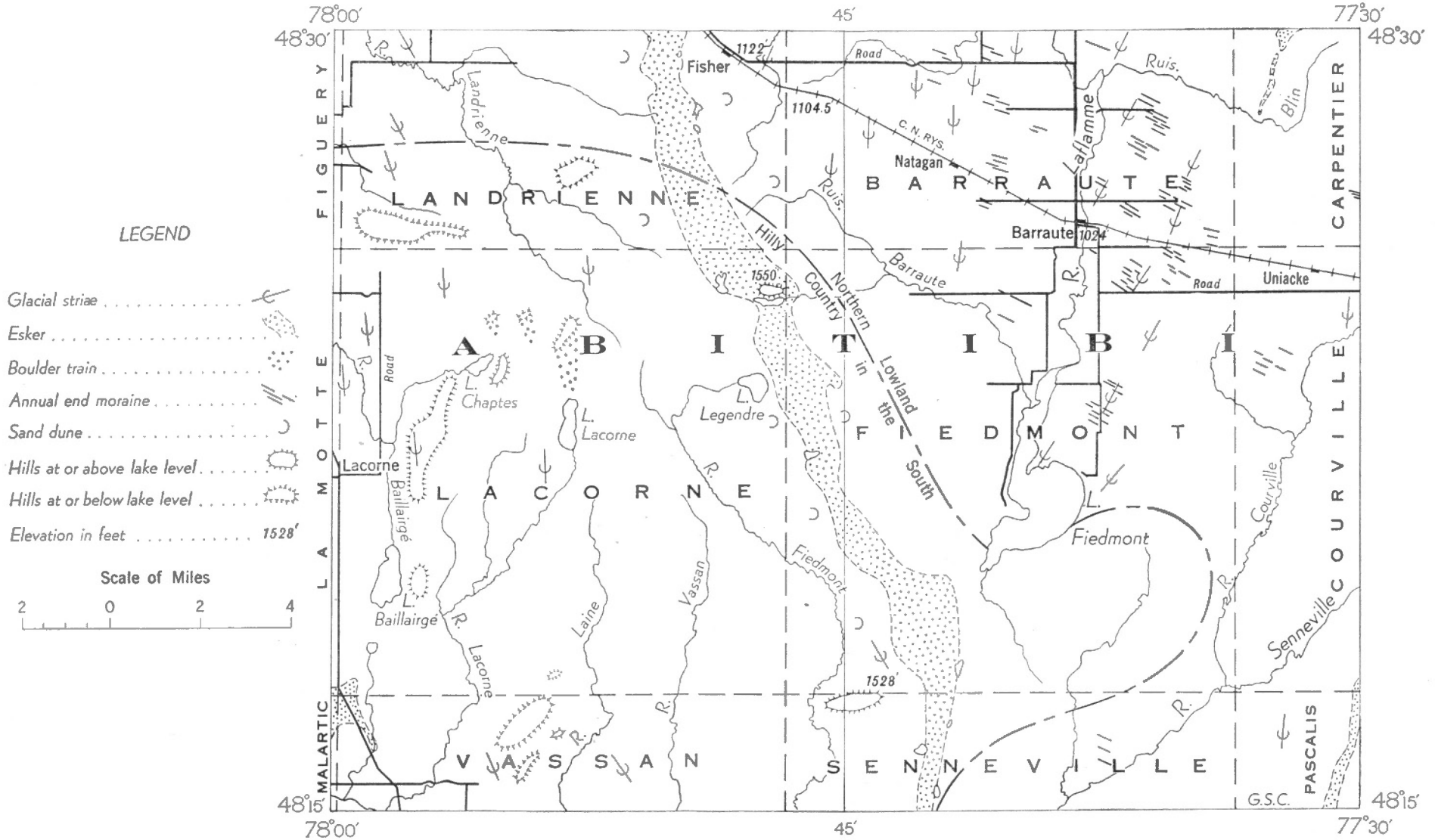


Figure 4. Fiedmont map-area, showing the main features of Pleistocene glaciation, and the approximate position of the boundary between the two physiographic divisions.

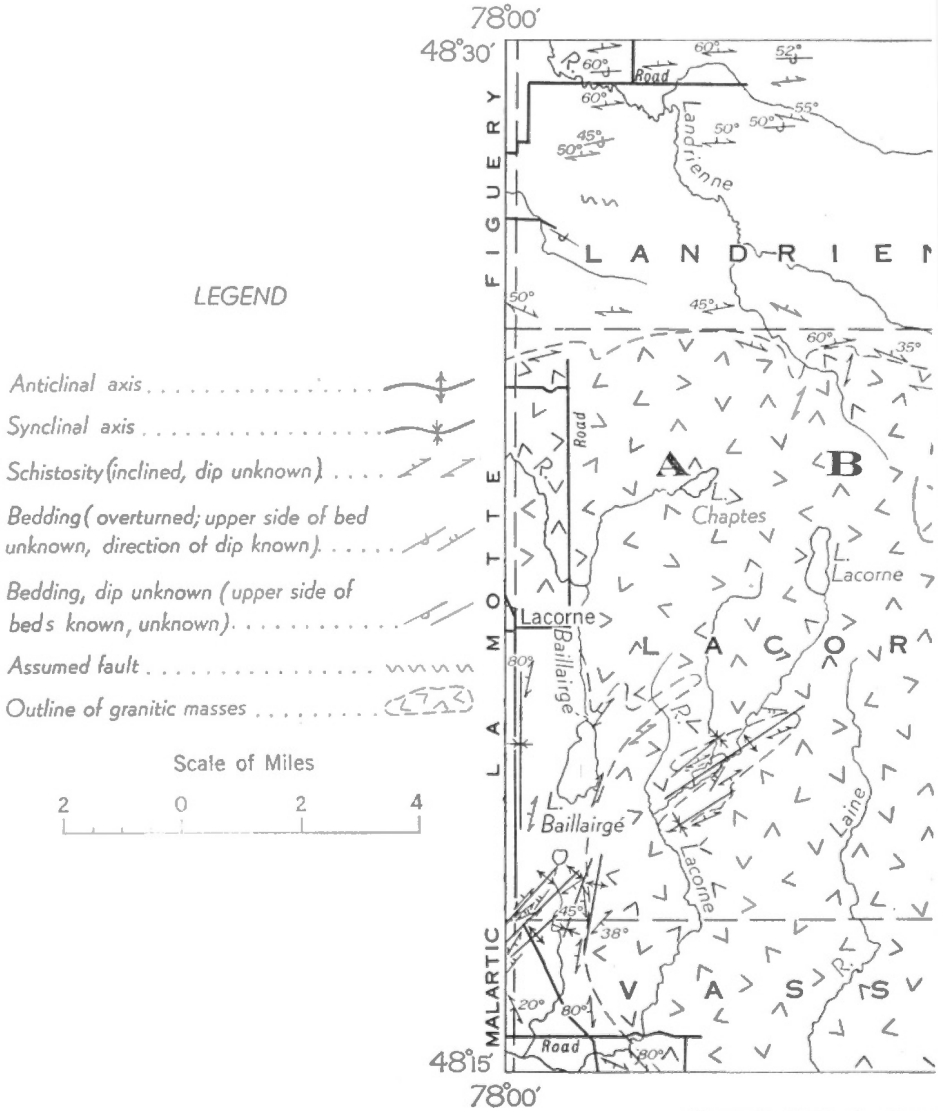
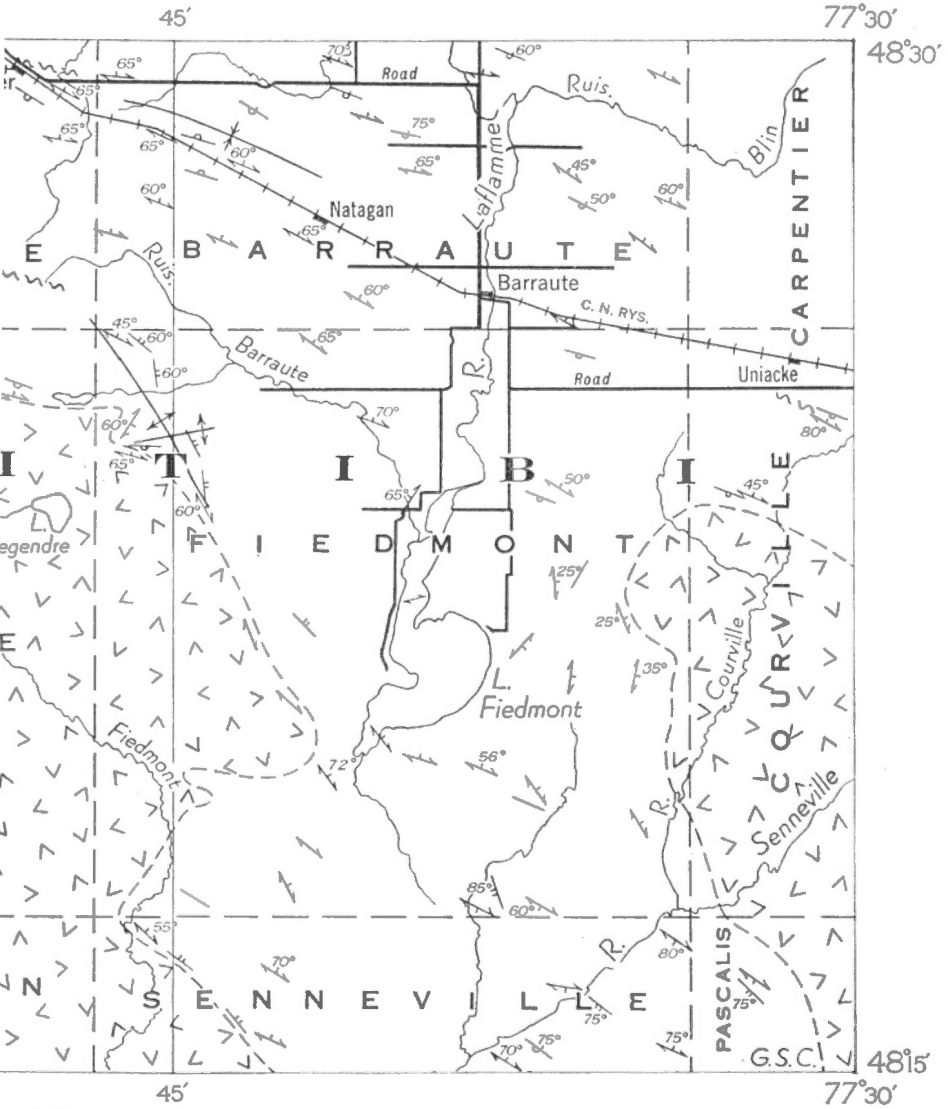


Figure 5. Main structura



es of Fiedmont map-area.

The relations of these eskers to the glacial striæ suggest a similar outline for the ice front. Eskers are generally deposits formed at right angles to the ice front. As their size depends on the size of the streams that controlled their formation, it is probable that the main esker in this map-area has been formed by the largest stream. Further, because this stream was large, it is probable that the ice melted faster there than at any other place to the east or west in this map-area, and that the ice front was, therefore, concave toward the south, as already suggested by the glacial striæ.

MORAINES

The moraines of Fiedmont map-area are low ridges, 6 to 8 feet high and about 15 feet wide, and traceable in the field for a few thousand feet. They are composed of till, and carry boulders of local origin on their tops. Distances between them vary from 100 to 800 feet, but are commonly 400 to 600 feet. These moraines are most common in the low plain area, and seem to be rare or missing in the rugged hilly area of Lacorne township.

Norman (28) has described annual moraines in the Chibougamau district of Quebec. From their periodicity, as indicated by the intervals between two successive moraines, he has calculated the annual retreat of the ice-sheets. He obtained the figure of about 600 feet, which corresponds with the one given by Antevs (3)—454 to 820 feet—as calculated from the yearly accumulation of varved clays. Some annual moraines of similar type have been mapped by the writer in Fiedmont map-area, and are shown on Figure 4. They strike slightly north of west in Fiedmont and Barraute townships, but in Landrienne township, a few small ridges, suspected from air photographs to be moraines of the same type but not mapped, trend slightly north of east. The trend of these moraines confirms the idea of a concave ice front in this area, and also, even if they have not been found in large number, they suggest a figure similar to Norman's for the periodicity of the retreat of the ice-sheet.

GLACIAL LAKE BARLOW-OJIBWAY

Fiedmont map-area occupies a position within the limits of glacial Lake Barlow-Ojibway as traced by Antevs (3). The existence of this lake in the map-area has been marked by the formation of beaches; by the erosion, due to wave action, of material from the slopes of the hills; and by the deposition of lake sediments in the valleys.

In the map-area, the surface of Lake Barlow-Ojibway reached a level as high as 1,450 feet and as low as 1,100 feet above sea-level. In the northwestern corner of Senneville township, a high hill, with a triangulation station on it, has an elevation of 1,528 feet. The top of this hill is covered with dense vegetation, but the slopes, to an elevation of about 1,475 feet, are of bare rock, suggesting their erosion by wave action. On the other hand, a beach on the western side of the gravel ridge not far from the Fisher station has an approximate elevation of 1,100 feet, and probably indicates a low level of the glacial lake.

The beaches are composed of rounded boulders, most of them 8 inches in diameter or smaller. These are mainly granitic rocks, but some of volcanic origin were noted. Only at a few places have remnants of more than one beach in succession been observed. These are preserved mainly in re-entrant areas where they were protected from destruction by the waves of contemporaneous big storms.

Bare slopes on the sides of hills, particularly granitic hills, are a striking feature in the hilly country. These bare slopes are most conspicuous on the western sides of the hills, and may be partly due to glacial erosion, as the ice moved from the northwest in this part of the area; but it is probable that they are due mainly to wave action by Lake Barlow-Ojibway, which covered the entire area. The bare, western slopes would, in this instance, suggest a predominant wind from the west or northwest. That wind would have been the cause of the waves that have washed bare the western slopes of the hills. Some of the hills presumably lay at or beneath the level of the lake, as their tops are now completely bare of morainic material, which appears to have been removed by wave action; in other instances, some hilltops are still covered with drift and vegetation, suggesting that they were not so submerged.

Varved clay has been found in almost all the valleys of the map-area. In general, the clay rests on boulder clay or till-like material. Wells dug by the settlers of the area for water have all encountered gravel beneath the clay, the thickness of the clay varying from one place to another. Most of the clay examined is well laminated at the bottom, but is more massive and shows only faint traces of lamination near the present surface.

CHAPTER III

STRUCTURAL GEOLOGY

Two types of structural features have been recognized in the map-area (Figure 5): those resulting from folding of the volcanic and sedimentary rocks, and those related to a later period of shearing and fracturing. In general, however, structural data are so scanty, due to lack of suitable exposures, that only indefinite conclusions can be drawn.

FOLDS

The volcanic and sedimentary rocks of the map-area have been closely folded into synclines and anticlines, the normal trend of which is indicated by the strike of the formations and the schistosity developed in them.

The normal trend of the formations in the northern parts of the map-area appears to vary only slightly. Pillow structures and bands of acidic rocks indicate a strike that changes gradually from 75 degrees east of north in the western part of Landrienne township to about 25 degrees south of east in Courville and Carpentier townships. This gradual change in strike follows approximately a symmetrical curved line concave to the south, with an east-west direction somewhere near the boundary line between Landrienne and Barraute townships. In the southeastern part of the map-area, in Senneville and Pascalis townships, the formations also trend about 25 degrees south of east, but in other parts, particularly in zones adjacent to or between intrusive masses, the trend of the formations has varied materially from the normal. On a narrow zone adjacent to the northern contact of the Lacorne batholith with the Kinojevis volcanic rocks, the formations have been slightly deflected from the normal trend, which is still broadly preserved. Due east of Lake Fiedmont, however, southeast of Lake Roy, and in the southwestern corner of the map-area, the formations trend abruptly north, probably as a result of cross-folding induced by the intrusive masses between which the formations lie. West of Lake Fiedmont or along the eastern contact of the Lacorne batholith, the formations do not appear to have been deflected by the intrusion, as in places the intrusive rocks cut abruptly across them.

Schistosity is well developed in the rocks of the map-area and commonly strikes about parallel with the trend of the formations, even in areas where the formations trend northerly. The trend of schistosity is locally disrupted by intrusive masses, but elsewhere, as along the eastern contact of the Lacorne batholith, the schistosity seems to have been uninfluenced by the intrusions.

The normal dip of the schistosity in this map-area, as in adjoining areas, is steeply to the north, but some deviation from this may be observed in zones adjacent to the intrusive masses where the latter are apparently of batholithic shape. A curious southerly dip in the schistosity

has, for example, been noted about 4 miles south of Lake Fiedmont, where the schistosity seems to strike and dip away from, as though conforming with, a hidden intrusive body.

L. V. Bell and A. M. Bell (7) have recognized an anticlinal axis passing by Lake Courville and striking about 50 degrees west of north in Senneterre map-area. This anticlinal axis probably reaches Barraute township near range VII in Duverny map-area, from where it appears to strike due west for a short distance and then to swing southwest to enter the Amos map-area in rge. VI, Figuery tp. As top determinations on pillows in Fiedmont map-area have indicated overturning to the south, it is believed that the area is on the overturned southern limb of a broad anticline that has its axis to the north of the map-area.

An exception to the general attitude has been noted in rge. III, Barraute tp., northwest of Barraute village. At two different places there, north and south of the Canadian National Railways track, pillows have been observed to face north. Farther north, in range IV, and east and west along the strike of the formations, all the pillows indicate tops facing south. It is probable that this discordance indicates the presence of a small syncline, the axis of which strikes about 25 degrees south of east and passes between the two northern belts of quartz-feldspar porphyry of Barraute township, each belt being on one limb of the syncline.

The band of sedimentary rocks east and southeast of Lake Roy presents bedded structure on its most eastern outcrops only, where the dip is to the east or northeast. On the west the rocks have been metamorphosed and deformed so much that all original structures are destroyed. In its northern part, the band grades to the west into a conglomerate. If it is assumed that the conglomerate marks the base of the section, it is probable that this band would represent the eastern limb of an anticline striking north-northwest. At the northern tip of this band the bedding swings in strike from north to northwest, suggesting that the anticline pitches in that direction. In the metamorphosed and deformed sedimentary rocks, and in the vicinity of the contact with the Lacorne batholith, the sedimentary rocks are closely interbanded with the Kinojevis volcanic rocks. Drag-folding in the sedimentary rocks near where the interbands occur suggest cross-folding in a northeast direction as a result of the intrusion of the Lacorne batholith. This cross-folding resulted in an anticline that strikes about 20 degrees north of east, is slightly overturned to the southeast, and, apparently, pitches at a low angle to the northeast.

The band of sedimentary rocks in the southwestern corner of the map-area has also been closely folded. If the age attributed to the hornblende schist directly west of Lake Baillairgé is correct, it would appear that the sedimentary strata overlie the volcanic rocks and that a synclinal axis follows approximately along the road from the Lacorne mine to Lacorne village. About 5,000 feet northeast of the mine, or slightly south and southeast of Lake Lusignan, a large sill of biotite granite has been carefully mapped, and has indicated the presence of an asymmetric syncline, with the western limb steeper, pitching to the southwest at an angle of 28 degrees, and striking about north 20 degrees east. The other axes shown on Figure 5

in that part of the map-area have been inferred from observations on bedding, drag-folds, and fracture cleavage, and also from the small plugs of granitic rocks that seem to outcrop along anticlinal axes.

The roof pendant outcropping about 2 miles due east of Lake Baillairgé on rges. II and III, Lacorne tp., consists of rocks of the Malartic group in the centre with two small bands of Kewagama sedimentary rocks on either side. If, as is supposed, the Malartic rocks are the older, the structure here suggests an anticlinal axis striking approximately 55 degrees east of north and pitching to the northeast.

FRACTURES

Joints observed at various localities in the map-area, especially in outcrops of massive rocks, commonly strike either north-northeast or east-southeast (Figure 6). At places, other joints have been seen striking either south-southeast or east-northeast. All joints dip steeply. In places they contain quartz veins and quartz stringers, especially those striking south-southeast. On the assumption that compressive stresses were from the north-northeast and south-southwest, as suggested by the trends of fold and the schistosity, the set of veins and joints striking north-northeast probably represent tension fractures, and fractures in the other two

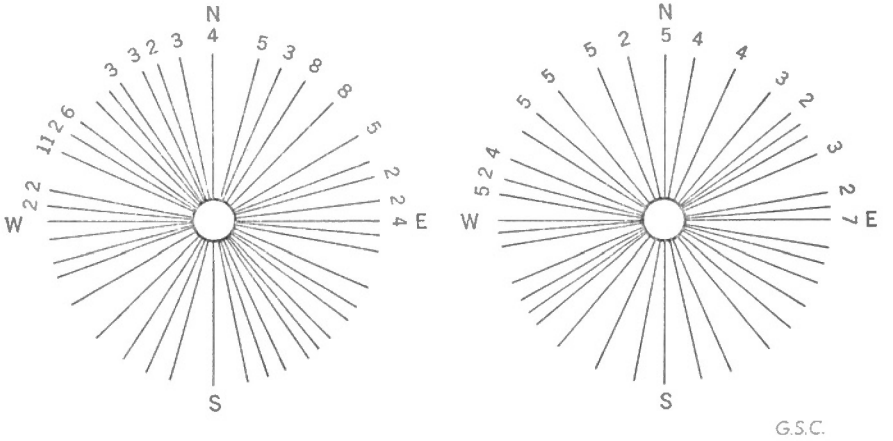


Figure 6. Chart showing strikes of joints (left) and of quartz veins (right) intersecting all types of rocks in Fiedmont map-area. Numbers at the ends of lines in the upper half of each large circle indicate the number of groups of outcrops from which the particular directions were obtained.

directions would be due to some sort of shearing. This view is supported by the fact that the quartz veins striking east-southeast are in small shear zones. These shear zones cannot, in general, be traced far along strike, but where they are wide they have been strongly carbonatized. A few small shear zones have been seen striking about east-northeast. Figure 6 shows the strikes of joints and quartz veins plotted through a single point. The number at the upper end of each line represents the number of groups of outcrops that have joints or quartz veins striking in that direction. Never more than three different sets of fractures have been observed in one locality; commonly there are only two, in other places only one set.

Faults may be present in the map-area, but the available field data do not indicate that they are important structural features. A crushed granite has been observed on lot 59, rge. I, Landrienne tp., and may mark the eastward extension of the Manneville fault observed in Figuery township south of Lake Figuery (7), but the scarcity of outcrops, due to the thick cover of sand in that part of the area, does not permit any definite conclusions. Farther east, the rocks that outcrop in line with the possible extension of the Manneville fault do not appear to have suffered faulting, but are so few that no definite conclusion is possible.

A shear zone was observed in the north-central part of the map-area, on the old Fisher property. It is now so highly carbonatized that it has been mapped as a separate rock-unit. The carbonatized zone contains a few quartz stringers, and the association of shearing, carbonatization, and quartz stringers suggests faulting. This zone, however, is not believed to be a feature of major importance, but may extend south to include the zone of carbonate rock on the Venus showing, and the carbonate zone south of Uniacke station. East and southeast of Barraute village, a good section of rocks is exposed, but no evidence of faulting was noted.

Adjacent to and north of Lake Roy there are probably many sharp-cut fault fissures striking about north and northeast. A few field features, such as sharp cliffs, suggest their presence.

CHAPTER IV

ECONOMIC GEOLOGY

Molybdenite is the only mineral that has been found so far in commercial quantity in the map-area. Recently, spodumene has been discovered at various places in the western part of the area, and exploratory drilling on an occurrence south of Lake Lortie has revealed a tonnage large enough to encourage mining operations. No gold deposits of commercial value have yet been found, but a little work has been done on many prospects. The map-area, however, lies southeast of the Amos area and northwest of the Pascalis-Tiblemont area, where there are many interesting prospects, and about 10 miles north of the highly productive Bourlamaque-Dubuisson region.

Fiedmont map-area is crossed by the main line of the Canadian National Railways, and being easy of access was prospected early in the development of the region. At first, gold attracted the attention of most of the prospectors, and about 1925 much preliminary work was done on many gold discoveries. At no place, however, was gold found in commercial quantity. The Mine d'Or Abitibi, the Fisher-Quebec Prospecting Syndicate, Limited, and La Mine d'Or Vénus Ltée, are some of the prospects on which preliminary work was done about that time. Today, there is no active prospecting for gold. The discovery of molybdenite on the operating property of Lacorne township dates back to 1915, and much exploratory work was done on this deposit before its value was proved. Only recently (1942) did mine operations commence. The demand for strategic minerals during World War II intensified prospecting in this area, and resulted in the discovery of interesting occurrences of spodumene, with minor amounts of tantalite-columbite, beryl, and a few other rare minerals.

CHARACTERISTICS OF MINERAL OCCURRENCES

The mineral occurrences of the map-area comprise two distinct groups. One group is characterized by the presence of molybdenite, spodumene, beryl, and other rare minerals, and is exemplified by the deposits of molybdenite and spodumene of Lacorne township. The other group comprises those occurrences where gold has been reported, and which contain variable amounts of sulphides other than molybdenite. Both groups are represented by a variety of ores.

The first group is the more important one, as it is the only one that so far has provided mineral deposits of economic value. In these deposits, molybdenite and spodumene are by far the most abundant ore minerals; others include some beryl, tantalite-columbite, and lepidolite, but at present it is not known if these occur anywhere in commercial quantity. However, as beryl and tantalite-columbite are generally found in limited amounts in the most important deposits of spodumene, it is possible that their concentration as a by-product may be of some interest. All these minerals are

found in pegmatite dykes and masses, pegmatitic quartz veins, or quartz veins, and commonly in close association with the Lacorne batholith. The pegmatites are believed to be a late differentiate of the muscovite granite, and the occurrence of the ore-bearing pegmatites or quartz-pegmatitic veins in incomplete concentric zones around the Lacorne batholith, and particularly the muscovite granite, suggests a zoning with beryl in the centre, molybdenite at the outside, and spodumene in between (Figure 7). Molybdenite occurs in three belts in the map-area. A northwest-trending belt near the south-central border lies near the western contacts of the biotite and muscovite granites with the biotite and hornblende schists, but mainly within the biotite schist. This band appears to be the eastern extension of the belt described by Norman (29) as occurring along the southern margin of the granitic mass in Preissac and La Motte townships, and contains workable deposits of molybdenite at the Lacorne mine. The molybdenite-bearing veins in this belt are found either in the schist or in the small granitic masses, but always in close relation with these masses of granitic rocks, suggesting that the fractures within or near them were the loci for the circulation and deposition of the ore from the ore-bearing pegmatitic solutions. South and southwest of Lake Fiedmont, molybdenite occurs at various places in a northeast-trending belt that lies about parallel with the southern contact of the extension of the Lacorne batholith in Fiedmont township. It is possible that this belt is the continuation of the northwest-trending belt in the southwestern corner of Lacorne township. In this belt, the molybdenite-bearing veins are very similar to some of the veins of the Lacorne property, but occur in volcanic rocks or in basic intrusive masses, such as quartz diorite and amphibolite, rather than in granodiorite masses. The third belt trends easterly along the northern contact of the Lacorne batholith with the volcanic rocks of the Kinojevis group. There the veins are found in the volcanic rocks. In the three belts molybdenite occurs generally in small amount except at the Lacorne mine and a few other interesting occurrences, which will be described.

Between, adjacent to, and striking parallel with, the northwesterly and the easterly trending molybdenite belts are two belts of spodumene-bearing pegmatites. Pegmatites in the northwest-trending belt are mainly within biotite granite and hornblende monzonite along the western contact of the muscovite granite. In the easterly trending belt, they are found in recrystallized lava, biotite schist, and granodiorite. In these two belts, spodumene at places is highly concentrated; south of Lake Lortie, for example, the occurrence has been proved by drilling to be a possible workable deposit. Beryl-bearing pegmatites are widespread in the area enclosed within the spodumene-bearing belts. At no place, however, has beryl been found in valuable concentration, but it has been noted in many pegmatites within the muscovite granite and in some outside of, and adjacent to, this granitic mass.

The zoning presents a picture of the mineral succession from the muscovite granite outward, but it does not explain why most of the higher grade ore-bearing pegmatites are concentrated at certain places. The occurrences of more important deposits seem to be related to some structural control. They appear to have formed in areas of intense fracturing close to contacts of granitic masses with volcanic or sedimentary rocks, and more especially where embayments of granite occur in the older rocks.

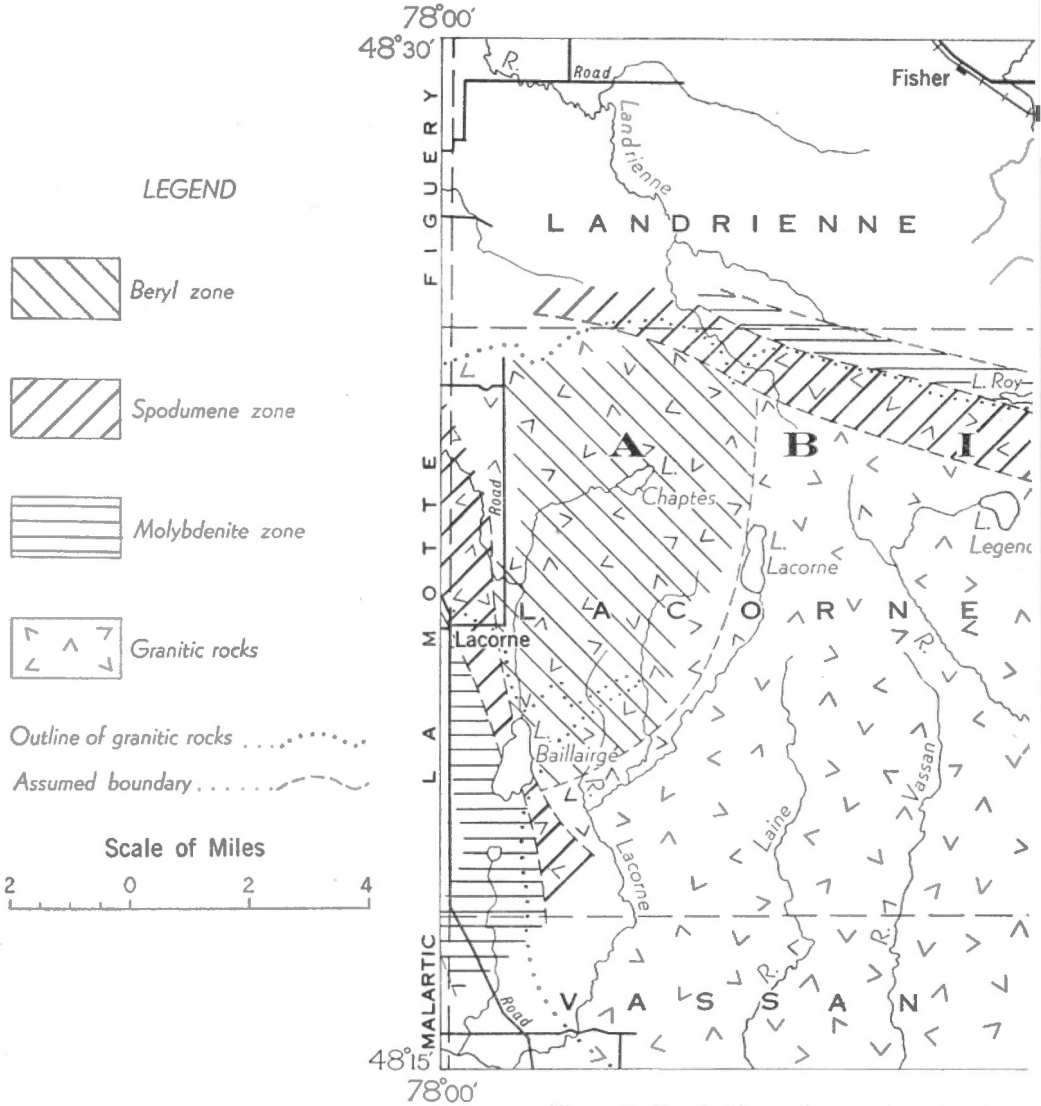
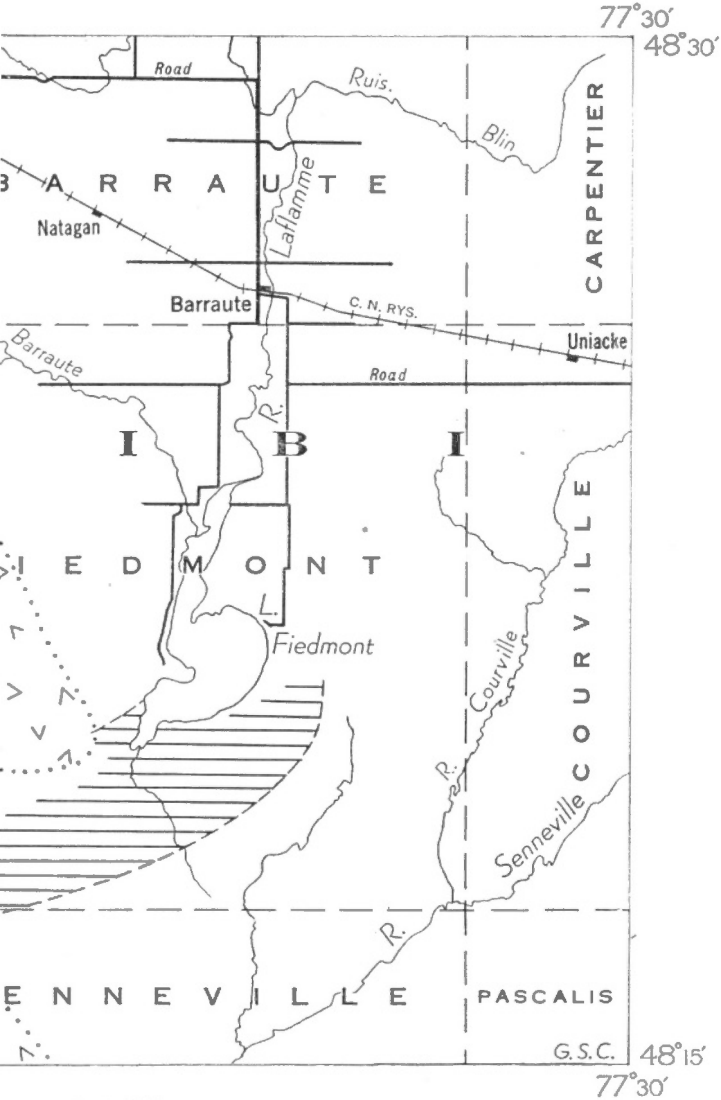


Figure 7. Sketch illustrating rough zoning in ar



acorne batholith.

Molybdenite has generally a flaky habit, and occurs in normal quartz veins, in pegmatitic quartz veins, and in banded pegmatite dykes or masses. In the banded pegmatites, as in the normal quartz veins, molybdenite is commonly found in small amount and generally in the more siliceous parts. Only the pegmatitic quartz veins contain molybdenite in appreciable amount, and at the Lacorne property such veins are the richest and constitute the orebodies.

Spodumene occurs generally in small crystals of uniform size in pegmatite dykes and masses, where it is distributed either uniformly throughout the pegmatitic body, in bands parallel with the walls of the body, or in irregular patches scattered in the dykes and masses. Everywhere the spodumene appears to occur as an ordinary rock-forming mineral, and its uniform distribution in some dykes suggests an early crystallization, to which reference has already been made in discussing the mineralogy of the pegmatites. Only dykes and masses that are large enough, and in which spodumene is uniformly distributed, contain a tonnage of ore sufficient to be of economic interest. Spodumene crystals are always elongated at right angles to the walls of the dyke.

Beryl occurs in crystals of variable size, and nowhere is sufficiently concentrated to encourage mining operation. Its main occurrence is in pegmatite dykes, especially in the quartz and muscovite segregations of the pegmatites.

In the second group of mineral deposits, gold is the principal metal, and has been reported in a variety of occurrences but nowhere in deposits rich or large enough to pay to mine. Most of the occurrences are in volcanic rocks of the Kinojevis group, and some are in the small granitic masses that cut this group, but none has been found in, or is believed to be genetically related to, the Lacorne batholith.

Those occurrences in which gold has been reported could be grouped tentatively under the following heads:

Group 1. *Quartz veinlets and stringers,* consisting mainly of glassy to milky quartz, and sparsely mineralized with a few sulphides, mainly pyrite and chalcopyrite. The adjacent rocks are commonly partly carbonatized. The quartz bodies are found both in the volcanic rocks and in the intrusive masses, most of those observed in the Barraute plug being of this type.

Group 2. *Carbonate zones.* These are zones of intense carbonatization, where the original volcanic rock has been almost entirely replaced by ferruginous carbonates, with some sulphides. They may or may not contain quartz stringers and grade into Group 1. To date these carbonatized zones have seemed to be the best gold-bearing occurrences of the map-area; an example is the carbonate zone south of Uniacke station.

Group 3. *Lenses of massive to disseminated sulphides* such as sphalerite and pyrite in acidic volcanic rocks or sheared quartz-feldspar porphyry. One occurrence has been observed on lot 56, rge. V, Fiedmont tp. It is a lens of massive sphalerite containing tiny specks of gold, silver, and chalcopyrite, and found in altered tuffs or rhyolite not far from the contact with the albite granite of the Pascalis-Tiblemont intrusion. It is believed

that this is a replacement deposit genetically related to the granite. Carbonatization is not intense. In addition to this massive body of sphalerite, there are areas where pyrite is finely disseminated or concentrated along bands.

DESCRIPTION OF PROPERTIES

SPODUMENE DEPOSITS

An important spodumene-bearing dyke has been trenched at seven different places on lot 11, rge. II, Lacorne tp. This dyke is one of several cutting a small mass of biotite granodiorite that is here about a mile wide, in an easterly direction, and is bordered by a band of biotite schist on the west and by a large mass of hornblende monzonite on the east. At least four dykes of some importance, in addition to several smaller ones, have been observed. They all strike between north and north 50 degrees west, and dip steeply in either direction. The most important dyke, known as dyke A, traceable for about 1,000 feet, has a width varying from 5 to 18 feet, contains on surface an average of about 20 per cent spodumene, and is of remarkably uniform mineral composition throughout. At its most southern exposure the dyke has a width of 18 feet, but is then lost for a distance of 300 feet. When noted again it appears to have split into two branches, each 5 feet wide and converging southward. The eastern branch seems to be the more important, as it can be traced for almost 650 feet farther north. This branch reaches a width of 18 feet at its northern end. The western branch appears to pinch out as it is followed north. Three hundred feet east of dyke A, a 3-foot dyke was observed, and 100 feet west of it a dyke, known as dyke B, varying in width from 4 to 6 feet, has been traced, and seems to be of some importance as it carries an average of about 15 per cent spodumene. All these dykes consist of quartz, feldspar (microcline, microcline-perthite, albite), and green spodumene, with some lithium-bearing muscovite, beryl, columbite-tantalite (Ta_2O_5, 28 to 42 per cent), and bismuthinite. In all of them the amount of spodumene is persistent along the strike, and the spodumene itself occurs in large crystals, mainly concentrated in areas of quartz-feldspar intergrowth and oriented about normal to the walls of the dyke. Large lenses of microcline-perthite interrupt the uniformity of the intergrowth. From a point about 450 feet west of the place where dyke A splits into two branches, another dyke, dyke C, has been traced for about 750 feet southward. At its northern end it is about 4 feet wide, but 500 feet farther south the width has increased to 18 feet. Beyond this point no contacts were exposed. The concentration of spodumene in this dyke is much more variable along the strike than it is in the other dykes, and the grain is also finer.

This showing was found by the prospector, Mr. F. W. Shubb, in 1944, and the seven trenches mentioned above were excavated under his supervision. Now the claims are the property of Great Lakes Carbon Corporation, and in 1947 this company put down eight short diamond drill-holes aggregating 1,975 feet. Seven holes were put down to intersect dykes A and B—dyke A at a depth of about 300 feet and dyke B near the surface. These seven holes dip 45 degrees east. No. 8 hole intersects dyke C; it dips 41 degrees west.

The drilling has revealed that dykes A and B do not carry as much spodumene at depth as at the surface. The spodumene content below surface seems to be rather low in the north parts of both dykes, somewhat less than 5 per cent, whereas towards the south it averages about 15 per cent of the dyke, or more nearly what it appears to contain at the surface. The width of the dykes is quite constant, and both dip steeply east. In its northern part dyke C probably dips steeply west, and at a depth of 300 feet appears to split into a group of narrow dykes with an average spodumene content of 5 per cent.

Two spodumene-bearing dykes are exposed on lot 59, rge. IX, Lacorne tp., about half a mile south of Lake Roy. They are in contact partly with a biotite-hornblende granodiorite, and partly with large inclusions of biotite schist. One of these dykes strikes south 75 degrees east, dips about 60 degrees south, and has a width varying from 19 feet at the east end to 12 feet at the west end. The contacts are sharp, and the dyke is bordered on both sides by a thin layer of white feldspar. No banding was noted. An important feature is the presence of long (at least 3 feet long in some places) lenses of microcline-perthite forming large crystals in a groundmass of finely intergrown quartz and feldspar. Green spodumene, columbite-tantalite, and beryl are the economic minerals noted, with spodumene by far the most abundant. It occurs mainly as crystals as much as 4 inches long, all oriented about normal to the strike of the dyke, uniformly distributed in the quartz-feldspar intergrowth. Beryl and columbite-tantalite are in very small amount, whereas spodumene may represent as much as 28 per cent of the dyke, but at places forms as little as 15 per cent. The other dyke strikes north, stands nearly vertically, and is about 18 feet wide. Its mineral composition is not uniform throughout. This dyke is much finer grained than the other, and spodumene is concentrated in patches.

An interesting and very promising occurrence of spodumene occurs on lots 52 and 53, rge. IX, Lacorne tp., about 1,400 feet south of the south shore of Lake Lortie. Not much is known from the exposed surface, as the area where this showing occurs is almost entirely covered by a thick growth of timber and a light mantle of sand and gravel. Outcrops, although very scarce and small, indicate the presence of much spodumene, and most of them occur on the top of a ridge that rises to an elevation of about 150 feet above Lake Lortie. This ridge can be traced for about 2,000 feet in an east and west direction. Most of the information on this deposit has been obtained from the 2,000 feet of exploratory drilling that has been done by Nepheline Products, Limited, and Great Lakes Carbon Corporation, who hold the deposit jointly. Spodumene occurs, as in the other deposits, in pegmatite dykes. The dykes strike about 35 degrees south of east, dip between 40 and 60 degrees south, and occur close to the northern contact of the Lacorne monzonite mass with Kinojevis volcanic rocks recrystallized now to a coarse-grained hornblende schist. The dykes occur either in the schist or in the granodiorite phase of the monzonite. At least three large dykes and many small ones, all containing some spodumene, have been intersected by drilling. They vary in width from a few to 45 feet, and are separated from each other by granitic or volcanic rocks.

So far, they have been traced for several hundred feet and the drilling has revealed 300,000 tons of ore with a possible average spodumene recovery of 20 per cent. Of the three large dykes cut by drilling, the northeast one is the largest. The one of next importance occurs about 50 feet south of the first. So far, both dykes have been traced for 200 feet down the dip, and the first one for 600 feet and the second for 350 feet horizontally. Further drilling should reveal the lateral and vertical extensions of both dykes. Not much is known about the third dyke, which lies about 50 feet south of the second dyke.

The spodumene of these dykes is generally buff coloured, instead of green, is fine grained to ½ inch, and appears to be partly replaced by albite and quartz. Spodumene, quartz, albite (An_{0-6}), microcline, and microcline-perthite are the main constituents, and their distribution throughout the dykes is quite uniform. Beryl, mangano-columbite-tantalite (Ta_2O_5, 32 to 53 per cent), spessartite, microlite, and betafite are accessory minerals. The grain is uniform, and rather fine compared with many pegmatites in the area.

Small dykes of pegmatite cut hornblende monzonite in a small outcrop on lot 64, rge. IX, La Motte tp. Within a distance of 100 feet in a north-south direction, at least six dykes, varying in width from 2 to 4 feet, were observed to contain spodumene and some beryl and columbite-tantalite. They strike between west and 30 degrees west of north. Spodumene occurs in small grains, generally concentrated in an intergrowth of quartz and feldspars. Its content appears to be small, but the fine grain may give an incorrect impression.

A small outcrop of biotite-hornblende granodiorite is cut by a fine-grained, spodumene-bearing pegmatite dyke, on lot 58, rge. X, Lacorne tp. The dyke can be traced for 300 feet on the western side of the outcrop, where it forms the edge of a cliff as high as 60 feet, strikes about 30 degrees west of north, and dips 60 degrees northeast. A measure of its width cannot be given, as its western contact is not exposed. In addition, this dyke contains so many irregularly disposed large inclusions of the adjacent rock that an apparent width of 65 feet is equivalent to about 40 feet of pegmatitic material and 25 feet of granitic inclusions. But as a whole, the dyke has an exposed width varying from 20 to 65 feet. Quartz and albite are the main constituents. Green spodumene, muscovite, garnet (probably spessartite), columbite-tantalite, beryl, pyrite, and a later albite are present in variable amount. The grain is fine to medium. Spodumene is the most abundant economic mineral, and its content along the dyke is quite variable. It appears to be concentrated in patches or in bands where it may constitute at least 30 per cent of the rock. It occurs always in grains varying from a fraction of an inch to 1½ inches long. Yellowish red garnet occurs also in small grains concentrated in bands or in patches, and generally where there is no green spodumene. This distinction in colour between spodumene and garnet and the fact that they occur in bands give the dyke a roughly banded appearance, the bands being parallel with the

walls of the dyke. Columbite-tantalite is in very small, uniformly distributed grains, and its amount is apparently low. Large patches of microcline-perthite may be observed.

Along the northern edge of a small outcrop of quartz-biotite schist, adjoining a muskeg in lot 25, rge. I, Landrienne tp., is a 5-foot lepidolite-spodumene-bearing pegmatite dyke that strikes 10 degrees north of east and is exposed for about 50 feet. Quartz, feldspar, spodumene, lepidolite, and muscovite are the main constituents. Beryl, microlite, columbite-tantalite, and garnet have also been recognized. Spodumene and lepidolite are the most abundant economic minerals. Spodumene, as in the other dykes, occurs in crystals of elongated habit, varies slightly in amount, and is of buff to green colour. No rough estimate of its content can be given. Lepidolite is the most conspicuous mineral; it occurs as flakes up to 1 cm. square, and is of a deep purple colour. Its main occurrence is in irregular patches and in vein-like masses that seem to cut across all the other minerals. It also seems to replace these minerals, especially spodumene and feldspar, as it occurs in them in small, dot-like patches.

A large mass of coarse-grained pegmatitic material outcrops on lot 26, rge. I, Landrienne tp., cutting across quartz-biotite schist. This mass has been traced for 900 feet in a north 70 degrees west direction, and has an exposed width of 250 feet. It is not known whether this mass is a large dyke or a sill. The pegmatite consists mainly of quartz, feldspar, and muscovite, but contains also small amounts of green to buff spodumene, beryl, columbite-tantalite, and garnet. Spodumene is the only interesting economic mineral as it is the most abundant one. It occurs in irregular masses, or pockets, where it may compose as much as 23 per cent of the rock. The crystals appear to stand vertically, suggesting that the mass is a flat-lying body. No accurate estimate of the total amount of spodumene present can be given owing to its irregular distribution.

Narrow pegmatite dykes cut biotite-hornblende granodiorite near its contact with volcanic rocks, on lot 46, rge. X, Lacorne tp. One of these dykes was observed to carry a little green spodumene. The dyke is about 3 feet wide, strikes 60 degrees west of north, dips steeply southwest, and was traced for 20 feet. Spodumene occurs in small grains mixed with quartz, feldspars, and muscovite, concentrated in the centre of the dyke, and oriented at right angles to the walls of the dyke.

On lot 22, rge. I, Landrienne tp., two pegmatite dykes were seen cutting across basic volcanic rocks now recrystallized to hornblende schists or hornblende-feldspar gneisses. These pegmatite dykes vary in width from 3 to 6 feet, strike 20 degrees west of north, and appear to contain some spodumene now completely altered to a micaceous material, which is believed to be a lithium-bearing muscovite, as on weathered surfaces a tinge of red was noted in those areas of altered spodumene. Quartz, feldspars, muscovite, and this altered spodumene are the main constituents. Large crystals of microcline-perthite and quartz lenses are also present.

A dyke similar in all respects to the above two, but 15 feet wide, was noted on lot 19, rge. I, Landrienne tp.

MOLYBDENITE DEPOSITS

Lacorne Mine

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Introduction. The Lacorne property lies at the intersections of Lacorne, La Motte, Malartic, and Vassan townships, and occupies an area of 1,647 acres. It includes the following ground: lots 1 to 4, rge. I, Lacorne tp.; lots 61 to 64, rge. I, La Motte tp.; the southern half of lots 58 to 60 and lots 61 to 64, rge. X, and the northern half of lots 58 to 60, rge. IX, Malartic tp.; and lots 1 and 2 and the northern half of lots 3, 4, and 5, rge. X, Vassan tp.

The property can be reached easily by motor car either from Val d'Or or Amos, as the mine lies about halfway between these towns on the Val d'Or-Amos highway.

All the geological underground plans of the mine were placed at the writer's disposal by the company officials, and the description that follows has been prepared mainly from these plans. The writer spent only a limited time underground to check and verify a few features characteristic of the veins. Thanks are extended to Gus Shartner, manager in 1945, and to B. W. Marcotte, resident manager in 1948, for their willing co-operation in pointing out the main underground geological features.

History and Development. An Indian was the first man to notice molybdenite on this property, and as a result of his discovery Hugh Gilligan of Cobalt, in 1915, staked the southern half of lots 1 and 2, rge. I, Lacorne tp. In the following year, L. N. Benjamin of Montreal and associates bought the property from Mr. Gilligan and held it until November 1921, when Molybdenite Reduction Company was incorporated to take over and operate the claims. In the following years, this company increased the number of its claims to include most of the property held today. In Abitibi, this showing was then known as the Eureka mine or Benjamin claims.

In 1917, L. N. Benjamin and associates did some 1,000 feet of stripping and trenching, blasted twelve to fifteen test pits, and sank a shaft, on the site of the present shaft, on one of the largest veins of the deposit to a

depth of 30 feet at an angle of 60 degrees south. In 1923, about 200 tons of ore were sent to Ottawa for mill tests, and C. S. Parsons reported on this ore as one readily amenable to concentration by flotation. In 1927, Molybdenite Reduction Company deepened the shaft to 80 feet, and by April 1, 1928, had reached a depth of 150 feet. Some lateral work was also done on the 100- and 150-foot levels. During the winter of 1928, a 30- to 50-ton mill was erected, and in the spring of 1929 commenced operation. About 17 tons of concentrate were then produced, of which only 9·5 tons (approximately 16,000 pounds MoS_2) were sold.

Early in January 1930, Hollinger Consolidated Gold Mines, Limited, took an option on the property and immediately began extensive exploration work. The shaft was deepened to 275 feet, and lateral work was concentrated on the 250-foot level. The results were not encouraging, and at the end of June the company ceased operations and abandoned its option. At the end of 1930, total stripping and trenching at the surface amounted to about 3,500 feet, of which 1,500 feet in the vicinity of the shaft uncovered ten veins.

No further work was done on the property until the summer of 1937, when Molybdenite Reduction Company, Limited, then incorporated as Molybdenite Corporation of Canada, did some diamond drilling and assessment work. The concentrator operated for a time in 1939 and about 2,240 pounds of molybdenite were shipped. The property was inactive from 1940 to the middle of 1942, but in July of that year, due to a great increase in the demand for molybdenum, Wartime Metals Corporation took over the property and got it into production. The property was designated as the Lacorne Molybdenum Project, and was under the management of Siscoe Gold Mines acting for Wartime Metals Corporation. As the old mill was unsatisfactory for efficient production, a new 200-ton mill was installed and commenced operations on May 17, 1943. In July 1945, the property was returned by Wartime Metals Corporation to its former owners, and since then has been under the management of Molybdenite Corporation of Canada. During the period from May 1943 to July 1945, about 2,663,000 pounds of molybdenite were produced.

In July 1945, the mill concentrate carried a fair percentage of molybdenite, but contained impurities that made it undesirable and almost unsaleable. These impurities were bismuth and copper. Accordingly, the mill was remodelled, and a new milling procedure established in May 1946. Bismuth was recovered separately, and a molybdenite concentrate answering market requirements was obtained. The following figures give the percentages of the main constituents in the different concentrates:

—	MoS_2	Bi	Cu
Old concentrate	88	2·5	0·5
New MoS_2 concentrate	94	0·4	0·1
Bismuth concentrate	12	30·0	.....

The production for the period 1942-1947 is as follows:

—	Quantity	MoS_2	Bi
	Pounds	Per cent	Per cent
Molybdenite concentrate—			
1942 to July 15, 1945	3,066,800	86·85	.....
July 15, 1945, to May 1946	1,424,600	85·41	.....
May 1946 to Dec. 31, 1946	837,500[1]	94·44	0·44
Jan. 1, 1947, to Nov. 20, 1947	798,426	93·84	.....
Bismuth concentrate—			
May 1946 to Dec. 31, 1946	76,000	.....	27·36
Jan. 1, 1947, to Nov. 20, 1947	13,740·5	.....	96·67

[1] Produced in part from ore and in part by re-treating 640,000 pounds of concentrates (85 per cent MoS_2) produced prior to May 1946.

As the company was operating at a loss, it resumed underground operations late in November 1947. The mill ran, however, until the end of April 1948. No production has been reported since that time. In 1946, there was an operating loss of about $44,839 on sales amounting to $300,531. In May 1948, ore reserves were estimated at 130,983 tons grading 0·51 per cent MoS_2 and 0·09 per cent bismuth. In 1944, the operating cost per ton milled amounted to $3.75, exclusive of overhead charges.

Previous Work. The principal geological reports on this property are those of Adhemar Mailhot, W. Gerrie, J. E. Hawley, and G. W. H. Norman. Mailhot was the first to examine the property, in 1919, and in a report to the Quebec Department of Colonization, Mines and Fisheries, he briefly described the geology of the property and the individual veins. W. Gerrie, working under W. F. James, studied the property in detail, and provided valuable geological information on the mineral vein sequence and the close association of molybdenite with granitic sills and dykes. J. E. Hawley re-examined the property in 1929 for the Quebec Bureau of Mines. His report contains a complete account of the geology in the vicinity of the mine as well as a definition and description of the main vein types of the deposit, their important structural features, their age relations, and their possible origin. G. W. H. Norman described the two principal types of veins and dealt briefly with the main geological features of the deposit.

Physical Features. The area in the vicinity of the Lacorne mine is so covered with sand and gravel that bedrock exposures are rare. Only four small areas of outcrops have been found on the property, and from them alone it is impossible to outline the area underlain by the different rock types. Of these four areas of outcrops, the most southern one is an exposure of biotite schist; the three others are exposures of granitic rocks with a little schist, cut by numerous dykes of quartz-pegmatitic material, and quartz veins. Of these three small areas of outcrops, the one with the largest dykes and veins has been prospected more thoroughly than the others; within it is the Lacorne mine, and all the molybdenite produced so far has come from dykes and veins in this outcrop area.

Geology. Highly foliated biotite schists and minor amounts of hornblende schists comprise the oldest rocks in the vicinity of, and at, the Lacorne mine. The biotite schists are fine- to medium-grained, dark grey

to brown rocks consisting mainly of biotite, quartz, and feldspars. Traces of bedding were seen in places, but in general are poor, and no top determination is possible. In thin section, biotite is the most abundant constituent and may be either green or brown. Commonly the biotite flakes are oriented in one direction. Quartz and feldspar are about equally abundant. Near the mine two cleavages can be seen in the biotite schist: an older one conforming closely with and generally obscuring the bedding structures and a later cleavage superimposed on the other and probably parallel with the axial directions of the main intrusive bodies or folds of the area. Some bedding structure and these two cleavages can be seen in a small trench between the shaft and the main highway, and in another outcrop 3,500 feet southwest of the mine shaft.

The hornblende schist is more massive than the biotite schist, and is a medium-grained, green rock, composed entirely of fresh minerals. Bluish green hornblende, quartz, and feldspars are the main constituents. This schist occurs in narrow bands interbedded with the biotite schist, and because of this conformity, these bands have probably an origin similar to that of the biotite schist. As the biotite schist is generally accepted as of sedimentary origin, it is then probable that the hornblende schist is also sedimentary and not an alteration product of old basic sills or dykes, or volcanic rocks.

A schistose, biotitic rock found in the granodiorite at some distance from the schist-granodiorite contact has been mapped at two different places in the underground workings of the Lacorne mine. One exposure is found on the 250-foot level, and appears to be part of a mass that does not conform in strike with the main body of schist in contact with the granitic rock. For this reason, and because this mass cuts across the veins, it may be regarded as a young biotitized intrusion. The other exposure, however, found on the 375-foot level, appears to be part of a wedge-shaped mass cutting across the veins and with the tip of the wedge ending apparently in the granodiorite a short distance beyond the veins. The suggestion here is that this mass may be a large inclusion of biotite schist in the granodiorite. Also, because there are small inclusions of similar rocks close to this large inclusion in the granodiorite, and because small veins in the main schist-granodiorite contact zone cut across the dykes of granitic rock and end at the bands of schist, it is believed that these masses of biotitic rock are only inclusions of biotite schist, altered by recrystallization and by the addition of some material from the granodiorite. Their apparent cross-cutting relationships are, therefore, only accidental, and have no genetic significance. A thin section of the mass on the 375-foot level close to the granodiorite indicates that much material, in the form of quartz and feldspar, has been added, and microscopically much resembles the ordinary biotite schist outcropping at the surface.

Granitic rocks in the immediate vicinity of the mine occur as irregular masses of unknown shape and size; as sills varying from a few feet to about 200 feet in width; or as irregular dykes in the schists. Chemical analyses of these various forms of granitic rocks have shown that they are all similar in composition and are identical with what has been described before as the biotite granodiorite. Microscopic work has also revealed their

striking similarity, as they are formed of the same minerals and present a similar texture. A complete description of this biotite granodiorite is given on page 36.

Chemical Analyses[1] *of Granitic Rocks in the vicinity of Lacorne Mine*

—	1	2	3	4
SiO_2	69·10	69·00	69·15	67·30
Al_2O_3	17·90	17·35	16·10	15·95
Fe_2O_3	0·72	1·28	1·30	1·25
FeO	1·38	1·22	1·50	1·30
CaO	3·44	3·40	2·95	3·68
MgO	1·14	0·75	1·18	0·70
Na_2O	1·16	1·33	1·88	2·88
K_2O	5·00	5·48	5·10	4·08
Total	99·84	99·81	99·16	97·64

[1] Gerrie, W., analyst.

1. Representative of small sills on surface (Group B veins).
2. Representative of large mass on outcrop 1,000 feet north of mine (Group C veins).
3. Representative of large mass to southwest of mine (Group A veins).
4. Granite, 2 miles northeast of property.

The youngest rocks in the vicinity of, and at, the mine are pegmatite dykes, pegmatitic quartz veins, and quartz veins. These dykes and veins resemble the dykes and veins within the main mass of muscovite granite of the Lacorne intrusions, and for this reason are believed to be genetically related to them and to have a similar origin. It is in these pegmatitic quartz veins and quartz veins that molybdenite occurs. Only one area of outcrop, the one in the vicinity of the mine, appears to contain veins rich and large enough to be of economic interest, and for this reason has been actively explored and mined during the past 4½ years.

Structural Features. As previously mentioned (page 68) the biotite schist in the vicinity of Lacorne mine has been closely folded along axes that strike about 20 degrees east of north and pitch to the southwest at an angle of 28 degrees. It is probable that these folds are minor features on a broad synclinal structure that extends from Lacorne village due south to the mine. From there it swings, and probably pitches, to the southwest.

The granitic mass in which all the Lacorne mine workings are concentrated is of unknown shape and size. Only a small part of its northern contact with the schist is known, striking 45 degrees east of north and dipping from 60 to 80 degrees to the northwest. From the surface down to a depth of about 300 feet, this northern contact is not a sharp feature, but is represented by an alternating succession of schist bands and granitic dykes. As many as fourteen dykes have been counted in such a succession on the 150-foot level within a distance of 200 feet. On the 500-foot level (Figure 8), however, the contact zone appears to be narrower. From the surface down to the 250-foot level the granodiorite is intensely faulted, whereas on the 500-foot level faulting is not as prevalent. The veins, too, at this depth appear in general to be more uniform and regular in width than they are

nearer the surface. If these observations are correct, they would suggest that the present surface is near the roof of the granitic body. Also, the observations that the fractures disappear and the veins become more uniform in width at depth would suggest a position on the 500-foot level nearer the centre of the mass than its contact. For all these reasons, it is believed that the granitic mass may be a plug.

Description of Veins. The veins of *Group A,* situated about 2,500 feet southwest of the Lacorne mine shaft, occur entirely in biotite granodiorite. Although most of these veins can be traced for 200 to 300 feet, only a little surface stripping and rock trenching has been done on them, as economically they do not appear to be important. They are composed almost entirely of quartz; only a few of them contain minor amounts of muscovite and feldspar, and in these a little molybdenite is also present. Muscovite is the most abundant minor constituent, and is concentrated at the margins of the veins in zones 1 inch to 2 inches thick. It is also found rarely in pocket-like patches in some of the veins. Feldspar where present is associated with muscovite in zone-like masses. Molybdenite occurs with muscovite or with muscovite and feldspar, and in general where the veins have a pegmatitic appearance. All the veins of this group vary in width from 1 inch to 4 feet, and in general are narrow. The largest appear to be the only veins to be pegmatitic here and there along their margins. Three sets of veins have been recognized. One set strikes between 45 and 65 degrees east of north and dips steeply either to the southeast or northwest. A second set strikes from 10 to 30 degrees north of west and dips steeply southwest. Some of the veins of this set appear to be younger than all the other veins. A third set strikes about 35 degrees west of north and dips steeply southwest.

Veins of *Group C* outcrop about 1,000 feet northeast of the mine shaft, and economically are not important, as they vary in width from only a few inches to 1 foot. They occur either in granodiorite or in quartz biotite schist, and, as noted by Gerrie, are muscovite-quartz rich where in the granodiorite and carry little molybdenite, whereas those in the schist contain much feldspar and are rich in molybdenite. Some of the veins in the schist carry pyrite and radiating clusters of needle-like tourmaline. Two main sets have been recognized: one strikes 60 degrees east of north and dips 50 degrees southeast; the other strikes north and dips west.

Veins of *Group B* lie between the other two groups and are found either in quartz-biotite schist or granitic rocks. Some of these veins are quite large in comparison with the veins of Groups A and C, and for this reason have been prospected more intensely. In recent years, due to the great demand for molybdenum, they have been mined to a depth of 500 feet (Figure 9). The veins of this group outcrop in the vicinity of the mine shaft, but when the property was visited by the writer the area of outcrops was so covered with buildings, muck, and debris that it was impossible to obtain a clear picture of the vein system from what could be seen at the surface. For this reason, most of the details that follow are based on underground workings and mine plans.

Hawley notes that although only two sets of contemporaneous veins can be recognized at the surface, four different ages of veins can be distinguished underground. The writer suggests a modified classification, which, though similar to Hawley's, differs from it in distinguishing only

three ages of veins underground. These, from oldest to youngest, are: (1) quartz veins with a little muscovite and molybdenite; (2) quartz-feldspar-muscovite-molybdenite-bearing veins; and (3) quartz-feldspar-fluorite-bearing veins.

The oldest veins (1) are few in number and are unimportant economically. They are mainly narrow, small veins composed almost entirely of quartz but carry a little muscovite and molybdenite. The veins of the intermediate group (2) are of principal economic importance. They constitute two sets, similar in appearance, but one set is slightly more quartzose and contains more of the rare minerals commonly found in pegmatites and less molybdenite. Some veins at least of this quartzose set definitely cut some of the veins of the other set. The veins of the youngest group (3) carry hematite, molybdenite, and sulphides.

The two sets of veins of the intermediate group (2) are of principal importance at Lacorne mine; they constitute not only the most abundant veins, but are also the only veins that have been explored underground and mined.

The veins of one set trend 20 to 40 degrees west of north, have been termed 'northerly veins' by Norman, and occur only in the granodiorite mass, where they appear to be wider than the veins of the other set. These northerly trending veins end at the schist-granodiorite contact, and appear in some instances to be arranged *en échelon*, stepped eastward to the northeast. They vary in width from a few feet to 15 feet, and are very irregular in shape, but are commonly lens-like bodies dipping vertically or steeply to the east. Some of the veins of this set are probably older than a few veins of the other set, but most of the veins of both sets are believed to be contemporaneous. These northerly veins widen where a vein of the other set passes laterally into them.

The veins of the other set strike between 60 and 80 degrees east of north, dip about 50 degrees southeast, and are arranged *en échelon* stepped northward to the northeast. They have been designated by Norman as 'easterly veins'. They are found either in the granodiorite or in the biotite schist, and cut across the schist-granodiorite contact at a small angle. They vary in width from 1 foot to 7 feet, and generally maintain a regular width, but in passing from schist to granodiorite, or vice versa, they generally follow a curved line, and commonly vary considerably in width. Thus, an 'easterly vein' may vary from wide to narrow in passing from granodiorite to biotite schist, and vice versa. These veins do not seem to maintain their width at depth, as on the 500-foot level, in the contact zone, they contain numerous inclusions of the intruded rocks, which have changed their widths appreciably. In general, they exhibit a more irregular contact in schist than in granodiorite, but where entirely enclosed in granite they are narrower and straighter than the northerly veins, and are also more fractured.

Veins of both sets are of the fissure-filled type, but differ appreciably in composition. The 'northerly veins' consist of quartz, red (microcline and albite) and white (albite-oligoclase, about An_{10}) feldspars, light green muscovite, and molybdenite. Quartz is the most abundant constituent, but in these veins it is not as abundant as in most of the 'easterly veins'. It occurs in individual lenses or irregular patches elongated parallel with

the strike and dip of the vein, and also in irregular grains well mixed with feldspars and muscovite. Some parts of the quartz lenses or patches show fractures filled with feldspar. In some veins, only the red feldspar seems to occur; in others, both are present. The feldspars generally form irregular patches with muscovite or occur as minute streaks in or between quartz masses, and in some veins are abundant. The white feldspar commonly forms a narrow zone that may be continuous at the granite contact. Light yellowish green muscovite is found in patches and streaks mixed with feldspars in or in between the quartz masses, and it is in such muscovite occurrences that molybdenite is concentrated in abundance. In places a strong concentration and development of muscovite can be seen in the granodiorite at the contact with the veins. Most of these 'northerly veins' are, in fact, more pegmatitic than the easterly ones and could readily be regarded as pegmatitic quartz veins. The agglomerations of feldspar and mica have been intensely sheared due to a later movement probably parallel with the veins, and show slickensided surfaces that formed later than the molybdenite, which occurs in fine powder along these surfaces.

The 'easterly veins' differ from the 'northerly veins' in the fact that they contain much more quartz. A few of them, however, particularly those entirely enclosed in granodiorite, contain much less quartz, and for this reason resemble the 'northerly veins'. Feldspar is present, but is not abundant. Its main occurrence is as a marginal zone at the contact with the intruded rocks. Where the intruded rock is a schist, it shows a strong development of biotite at the contact, with the addition of some feldspar and quartz, but where it is granodiorite, muscovite is concentrated at the contact in the granodiorite and the granodiorite has, in places, been highly altered and is definitely reddish. This colour has probably a similar origin to that which distinguishes some of the feldspars in both sets of veins. In the 'easterly veins', most of the feldspar is white; some red feldspar is present, but in small amount, and mainly in the veins entirely enclosed in the granite. Little patches or streaks of white feldspar are also found in the main bodies of quartz, but are not common. In general, the veins that contain red feldspar and that occur entirely in granite and contain less quartz than the ordinary 'easterly veins' are similar in mineral distribution and texture to the 'northerly veins'. Muscovite is in very small amount, and occurs in the same fashion as in the northerly veins. Molybdenite ordinarily accompanies muscovite, and is found also in small quantity in grains irregularly scattered in the feldspar, in the bodies of quartz, and at the contact between the intruded rocks and the veins. In general the 'easterly veins' appear to have a lower MoS_2 content than the 'northerly ones'. Small quantities of pyrite, chalcopyrite, bismuthinite, native bismuth, fluorite, tourmaline, apatite, beryl, and scheelite have been seen in these 'easterly veins', and some of these minerals have been also noted in the 'northerly veins', but appear to be less abundant there.

The third and youngest group of veins (3) is, as in the case of the oldest group (1), of little economic significance. In general, the veins vary in width from few inches to a foot, carry very little molybdenite, and contain appreciable amounts of fluorite, finely crystalline hematite, and a variety of sulphide minerals. They cut across the other veins on a strike ranging from due east to 30 degrees north of east, and have been observed

so far only in the granodiorite mass. Fluorite and hematite are the main constituents; the former is usually deep violet, but in places may be almost white to pink. Muscovite, quartz, and feldspar are generally present in small amounts that vary along the strike and the dip of the veins. Pyrite, chalcopyrite, molybdenite, calcite, and powellite are also present in variable amount.

Faulting. Fractures and faults are common features in the underground workings at Lacorne mine, and most of them are now filled with vein matter. Most of the veins occupied fault fissures, as evidenced by the fact that the older veins are displaced by faults occupied by veins of the younger types. Some late faults may or may not be filled with vein matter. In general, however, the displacement along all the veins amounts to only a few inches or feet, though one of the later faults has an apparent horizontal displacement of as much as 30 feet.

No general direction of movement along the faults has been determined, though in plan it appears that most of the faults are of the left-hand type. Most of the faults strike about parallel with the two main sets of veins, either 15 or 25 degrees north of east or at right angles to this direction. The easterly striking faults vary in dip from southeast to 75 degrees northwest, whereas those striking northerly are vertical or dip steeply to the northeast.

In some parts of the mine, especially on the 250-foot level, and to a minor degree on the 375-foot level, the faults are so numerous and so closely spaced that where they intersect a vein the vein is sliced into so many small fragments that it is of little mineable value. This is particularly true of some 'easterly veins' not far from the shaft on the 250-foot level. There, in one place, the vein has been sliced into a group of small lenticular veins arranged *en échelon* and separated from each other by barren granite.

Most of the faults are small features; only two of consequence have been encountered underground. The most conspicuous one lies about 120 feet southeast of the shaft, strikes 15 degrees north of east, and dips 45 degrees southeast. It is a very pronounced feature on the 150- and 250-foot levels. It was also noticed on the 375-foot level, but appears to end at greater depth, as it was not seen on the 500-foot level. This fault is marked by several small mud seams, and in places the fault zone is at least a foot wide. It is filled with vein matter of composition similar to the 'easterly veins' entirely in granite, and on the 250-foot level much blue powellite, powdery hematite, and fluorite were found in it. Molybdenite is also present in powder-like form in this fault zone. The fault has a probable horizontal displacement of 30 feet.

The other fault, known only on the 375-foot level, occurs at the end of the long drift in the southeast section of the mine. It appears to be a sharp-cut fracture, with a horizontal displacement of about 60 feet. The fault strikes southeast, and movement along it is apparently right-hand.

Faulting is an important feature in some parts of the mine, particularly in the northeast section on the 150- and 250-foot levels. It seems less significant on the 375-foot level, although faults are common there too, but on the 500-foot level the faults have decreased in number and appear only as relatively minor fractures. This decrease with depth suggests a plug-like granitic mass, whose present surface lies close to the original, more easily fractured roof. If this is so, the larger veins only may be expected to extend to great depth.

Origin. As the molybdenite-bearing veins of the Lacorne mine vary in composition from pegmatitic quartz veins to true quartz veins, as they are closely related in space to the Lacorne intrusion, and as they are high in quartz, they are believed to be genetically related to the pegmatites of the muscovite granite and to be probably, as previously suggested, the 'distal parts' of those pegmatites.

Hawley (p. 119) has described the origin of the fractures and faults in which the veins occur as follows: "As indicated above, fracturing and faulting continued throughout the intrusive granite over some period of time. This is best related to the cooling down of the intrusive and was accompanied by the injection of the quartz and pegmatitic veins, with molybdenite. The process was probably a continuous one, but the material introduced changed, as probably did conditions of temperature and pressure. Still later faulting occurred after the veins were formed, rendering some of them of little value".

Future of the Mine. The molybdenite-bearing veins of mineable size are in fair abundance and not too far apart to make the deposit uninteresting. The abundance of vein matter does not seem to decrease with depth, although small seams and veinlets are not as common on the lowest levels. The tenor of the veins in molybdenite varies from place to place, and in general appears to average less than 1 per cent and to decrease somewhat with depth. On the 500-foot level the average percentage of molybdenite in the ore is 0·51. The veins occur both in granitic rocks and in schist, and in general have a higher molybdenite content in granitic rocks than in schists. Consequently, if the mass of granodiorite is in the form of a plug, as appears probable, the possiblities of further extension of the vein system either laterally or vertically are good. On the other hand, if the tenor of the veins continues to decrease with depth, the chances for future profit on this scale of mining are poor, though the recovery of bismuth as a by-product, even if the amount is small, may serve to lend some encouragement to further mining operations.

Dumont Claims

References: The Mining Industry of the Province of Quebec; Quebec Dept. of Mines, p. 106 (1943) and p. 65 (1944).

The Dumont claims cover lots 55 to 62, rge. IX, Lacorne tp., and were staked for molybdenite. In 1942, they were optioned to Sullivan Consolidated Mines, Limited, and by the end of the year 1,205 feet of stripping and trenching had been done to explore the molybdenite occurrences at the surface and 1,634 feet of diamond drilling had tested the mineral deposit at depth. In 1943, 1,960 feet were drilled to get additional information at depth. As the results were not satisfactory the drilling program was discontinued on February 15, 1943.

The molybdenite-bearing dykes and veins are found mainly on lot 58 at the southwestern end of Lake Roy, and the main showing can be seen at the lake shore. There a molybdenite-bearing dyke occurs in a narrow band of volcanic rock, now transformed to a hornblende schist, separating two lens-like sills of peridiotite that trend east. The band of schist appears to

be cut on the east by a small mass of granitic rock. The pegmatite dyke cuts across the schistosity of the hornblende schist, and varies in width from 4 to 13 feet. It has been traced for about 200 feet on a strike of about 35 degrees east, and dips steeply. The dyke is narrow at its eastern end, but gradually widens towards the west to where it reaches the southern contact of the northern peridotite sill, where it seems to disappear or to divide into many small, unimportant stringers that follow the contact. This dyke consists of quartz, microline, albite (An_{0-6}), mica, molybdenite, and pyrite. A banding is noted at places, and is defined by a centre core of quartz bordered by a mixture of fine-grained albite and quartz. Molybdenite occurs as well-formed hexagonal crystals, either concentrated in book-like patches or disseminated in individual flakes in the feldspathic areas. The amount of molybdenite is not constant along the strike, but the minerals appear to be concentrated mainly in the banded parts of the dyke.

Le Roy-Fiedmont Mining Company, Limited

Reference: Quebec Bur. of Mines, Mining Operations 1929, p. 146.

The Le Roy-Fiedmont Mining Company was incorporated in 1928 to operate the claims on lots 40 to 46, rge. IV, Fiedmont tp., where an occurrence of molybdenite-bearing pegmatitic quartz veins is found on lots 41 to 44, about a mile southeast of Lake Fiedmont. The claims were staked for the molybdenite-bearing veins, and exploration work, commenced in November 1928 and continued through the first half of 1929, was suspended in the summer of 1929. Much stripping and trenching were done along and across the veins, and a few test pits were also sunk.

Most of the veins occur along fractures and shear zones in a small quartz diorite mass that cuts a highly altered basic to intermediate lava. The veins appear to occur more abundantly in zones close to the contact of this diorite mass with the invaded rocks, and can be found either on the eastern or the western sides of this mass. On the east, within a distance of 1,000 feet in a south 25 degrees west direction, at least ten small quartz veins, varying in width from a few inches to 8 inches and traceable for short distances, have been noted and are associated with numerous small quartz stringers. All the veins strike about 20 degrees east of south and dip steeply northeast to vertically; and most of them contain some molybdenite, apparently in very small amount. These eastern veins carry a few small pegmatitic patches only, and some occupy definite shear zones. On the west, in the area close to the small mass of amphibolite and within 1,000 feet in a north-south direction, ten veins varying in width from a few inches to 10 feet have been counted. All but two strike between north and north 30 degrees west, and dip about 50 degrees east. They are definitely pegmatitic, and contain much molybdenite in places. Molybdenite is commonly concentrated in the pegmatitic areas. The veins are lens-like, and near where they pinch out they become strongly pegmatitic and highly mineralized with molybdenite. The other two veins strike about east, and also contain some molybdenite. They are small, and dip south. Quartz, feldspar, and muscovite are the common minerals. Fluorite and beryl were also observed at one place.

BERYL DEPOSIT[1]

A group of claims, covering lots 14 to 19, rge. VIII, Lacorne tp., was staked for beryl in June 1948 by Mr. Massicotte and associates. The claims are deeply drift covered on the east, but exposures are abundant on lots 14, 15, and 16. The rocks are muscovite granite or muscovite-biotite granite intruded by dykes of pegmatites and aplite, quartz veins, and younger dykes of diabase. They form large hills with smooth tops and gently dipping flanks thinly covered with drift.

The main showing is on the south half of lots 15 and 16, about 1,200 feet north of range line VII-VIII, and consists of a group of beryl-bearing pegmatite dykes. Three main dykes, designated here as dykes A, B, and C, have been observed in the field. Dykes A and B strike north 80 degrees west, and are about 100 feet apart. Dyke A is about 17 feet wide, whereas dyke B varies in width from 8 to 15 feet. Both are crossed by dyke C, which strikes north 80 degrees east and is 10 feet wide. The three dykes were traced by outcrops a distance of about 550 feet, and were lost at both ends beneath drift. Several smaller dykes occur in the vicinity. All these dykes are composed of coarse feldspar and muscovite clusters, and large aggregates of quartz, which in places seem to constitute as much as 30 per cent of the dykes. A few crystals of molybdenite, tantalite, and red garnet were noted. Hexagonal crystals of bluish to apple-green beryl were also observed embedded in the other minerals, and particularly in close association with the muscovite clusters. The beryl crystals vary in size from ¼ inch in diameter to 8 inches; the best concentrations of beryl appear to be at the intersections of dyke C with dykes A and B.

A few hundred feet south and east of the main showing are other beryl-bearing dykes. One of them, 15 feet wide, is directly south of the western end of the main showing, and was traced on a strike of 20 degrees south of east for a few hundred feet to where it pinches out. Directly east of the main showing and a few hundred feet from the exposed rocks, abundant beryl-bearing boulders were noted.

In December 1948, the claims were taken up by The Simard Industries of Sorel, and exploration is planned.

GOLD DEPOSITS (Group 1)

The gold deposits of this group are, as previously noted (page 73), chiefly mineralized quartz veinlets and stringers occurring both in volcanic rocks and intrusive masses.

Randall Mines Corporation, Limited (4)[2]

References: Quebec Bureau of Mines, Ann. Repts., pt. A: 1932, p. 90; 1933, p. 111; 1934, p. 104; 1935, p. 63; 1936, p. 80; 1937, p. 98; Quebec Bureau of Mines, Mining Properties: 1936, p. 72; 1937, p. 26; 1938, pp. 37-38. James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 63 (1927).

The Randall mine is about a mile southeast of Fisher station, on the Senneterre-Cochrane branch of the Canadian National Railways, and a good motor road a short distance southeast of Fisher station leads to it from the Senneterre-Amos provincial highway.

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[1] Thanks are extended to W. N. Inghan, resident geologist in Val d'Or for the Quebec Government of Mines, for placing at the disposal of the writer all his information regarding this beryl occurrence.

[2] Numbers in parentheses are those that give the location of the property on the accompanying map (map in pocket).

The property is entirely in Landrienne township, and in 1938, when it closed, comprised lots 52 to 55, south half lots 56 to 58, and north half lots 59 to 62, rge. III; lots 51 to 57 and lots 61 and 62, rge. IV; and lots 51 to 54 and south half lots 49 and 50, rge. V. The property was staked by E. M. Loring, prospected intensely in 1926 by Fisher-Quebec Prospecting Syndicate, Limited, and later was sold to Mines Development Corporation, which, in December 1932, was incorporated to operate the property. Development work, commenced in the spring of 1931, was abandoned for the winter and resumed in the spring of 1932. During the following summer much trenching and stripping was done on several quartz veins, one of which, then designated as the 'quartz dome', was found to carry some visible gold. Most of the later work has been concentrated in the vicinity of this deposit, on north half lots 55 and 56, rge. IV, Landrienne tp. A diamond drilling and shaft sinking program, commenced in January 1933, was completed during the summer of that year, a shaft being sunk to a depth of 215 feet and 2,024 feet of diamond drilling done. Lateral work was also done on the 100- and 200-foot levels, but mainly on the latter level. Due to a fire, operations were suspended at the end of August. In the late summer of 1934, underground work was continued by Mine Development Corporation, Limited, who had a 70 per cent interest in the company. The property closed briefly in 1935, was reopened in the late autumn of that year, and underground work continued. The construction of a 50-ton mill was started, the shaft was deepened to 345 feet, and the 325-foot level was established. In 1936, the mill was completed and operated intermittently. By the end of 1937, the shaft was 600 feet deep and two new levels, the 450- and 575-foot, had been added. Some lateral work had also been done on them, averaging 500 feet of crosscut to the northeast on each level. Altogether, 3,000 feet of lateral work has been done on the four levels of this property (Figure 10). The mine was closed early in 1938, and in 1945 the property was limited to north half lots 54 to 56, lot 57, and south half lots 58 and 59, rge. IV.

The rocks exposed at the surface near the shaft and by underground workings are mainly basic to intermediate volcanic rocks, now in part intensely altered to chloritic and sericitic schists, in part carrying numerous, minute, scattered crystals of magnetite, and, in general, much carbonatized. Pillow structure was observed on several areas of outcrop, but top determination was possible only in one place. There the structure indicates a strike of north 55 degrees west and a steep northeasterly dip; pillow tops face southwest, showing that the formations are overturned. These volcanic rocks are in places intensely sheared in a north 65 degrees west direction, with a dip of 50 degrees northeast, and they are intruded by small dykes of dioritic rocks, and porphyritic quartz albitite, striking about parallel with the formations.

Many quartz stringers and veins of various size and generally lenticular shape cut the rocks near the shaft, particularly where they are sheared. These veins are composed mainly of quartz, with minor amounts of chlorite, carbonate, and dark tourmaline. They are slightly mineralized with coarse pyrite, which is believed to be of high temperature origin and carries some chalcopyrite and native gold. The veins strike parallel with the dykes, and in general dip from about 65 degrees northeast to vertically. The wall-rock is most carbonatized where sheared and cut by quartz stringers.

Two parallel veins, 2 to 3 feet wide, have been traced in test pits and excavated trenches for 800 feet south of the shaft. They cut carbonatized, sheared rocks, strike parallel with a quartz albitite dyke, about 65 degrees west of north, and are scantly mineralized with pyrite. A sample from them is reported to have assayed 0·17 ounce in gold a ton.

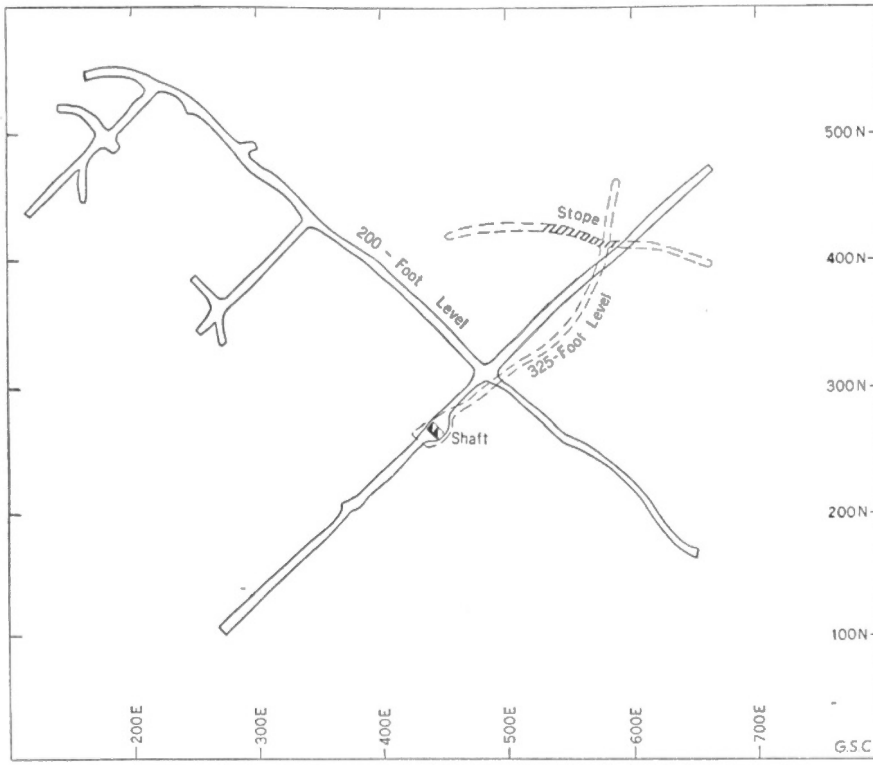


Figure 10. Composite plan of the 200- and 325-foot levels of the Randall mine; altogether 1,600 feet of drift and crosscut have been run on the 200-foot level, and 490 feet on the 325-foot level.

The main vein outcropping at the shaft, and known there as the 'quartz dome', was traced underground to a depth of a little more than 325 feet. It varies in width from 2 to 6 feet, and is mineralized with scattered pyrite. It cuts massive, siliceous and carbonatized rocks and chlorite schist, which are everywhere mineralized with pyrite. The vein has been explored on the 200- and 325-foot levels by raises and stopes. In the northwest drift of the 200-foot level, it was reported to carry $6 in gold a ton across 20 inches for a distance of 100 feet. Several other quartz veins and stringers, all slightly mineralized with pyrite, have been encountered in the underground workings, but the gold content is reported low in all of them.

A dioritic rock, partly quartzose and underlying the altered basic volcanic rocks of the surface exposures, is reported to have been encountered in the shaft below a depth of 360 feet. Its contact with the other rocks is sharp, and dips about 30 degrees northeast. Most of the rocks exposed on

the 450- and 575-foot levels are reported to be of dioritic composition. This dioritic rock is intersected by shear zones, quartz veins and stringers, and quartz albitite dykes, and should outcrop at the surface along the west edge of an outcrop about 500 feet west of the shaft.

Vallée Claims (15)

Reference: Quebec Bureau of Mines, Mining Operations 1933, p. 112.

The Vallée claims occupy north half lots 42 to 45, and lots 46 to 51, rge. II, Barraute tp., and were explored in 1933 by Damara Mines, Limited, who stripped and trenched across a few quartz veins and stringers here and there on the property. Most of the surface work was concentrated on lots 47 to 49. In December 1933, the property was optioned to Noranda Mines, Limited, who drilled seven holes aggregating 628 feet. The option was abandoned soon after the drilling program was completed, and apparently no work has since been done on the claims.

The rocks are basaltic to andesitic flows interbanded with some massive rhyolite and intruded on the west by the Barraute plug. This plug of porphyritic granite is cut at a few places by several narrow quartz veins and stringers, which may be divided into two sets, one striking between 20 and 60 degrees east of north and dipping steeply northwest, and the other striking 35 to 60 degrees west of north. The veins of both sets have uniform walls and are lens-shaped and generally short, averaging 20 feet in length. Most of the veins consist of barren glassy quartz, but some of them are composed of well fractured, milky quartz slightly mineralized along fracture planes with pyrite and chalcopyrite. Tourmaline, carbonates, and a little black quartz were noted in these veins, and gold is reported to have been found with the sulphides. Such a mineralized vein has been traced by trenching for 150 feet on lot 48.

Trenches excavated in north half lot 49 cross a mineralized zone in volcanic rocks at their contact with the prophyritic granite. This mineralized zone is 6 feet wide, strikes about north 40 degrees east, is strongly carbonatized, and is cut by feldspathic quartz veins. Minerals present, in order of abundance, are pyrite, chalcopyrite, and probably arsenopyrite. These occur either in large individual grains or in fine-grained aggregates, and mainly in the intruded rocks. Tourmaline is also quite abundant. Gold is reported from this zone, although none was observed by the writer.

Carchy Malartic Mining Company (17)

Most of the ground held by the Carchy Malartic Mining Company in Courville township is covered with clay and gravel. Only rare and small areas of outcrops protrude through this mantle, and are concentrated on lots 6 and 7, rge. VIII, where also exploratory work, consisting of stripping and trenching, has been done. A good trail leads due south to the workings from the Senneterre-Amos provincial highway, a distance of about 1½ miles. The rocks are rhyolite, rhyolite breccia, agglomerate, and basic to intermediate volcanic rocks. The most northerly outcrops in these areas are of basic volcanic rocks. Farther south, these rocks pass into agglomerate and thence into massive rhyolite grading in places to rhyolite breccia, suggesting that tops face in this direction. Pillows in the basic volcanic

rocks also face southerly, striking north 75 degrees west and dipping 60 degrees northeast. Most of the rocks are only slightly carbonatized, and a little sheared in a direction almost parallel in strike with the pillows but dipping at an angle of 45 instead of 60 degrees. The outcrops of some areas, however, are heavily fractured in a north 65 degrees west direction, with a dip of 60 degrees northeast, and are cut by several quartz veins.

Three principal sets of quartz veins were noted: one strikes north 40 degrees east and dips steeply northwest; a second dips vertically and strikes due north; and a third set strikes north 70 to 80 degrees east and dips northerly at 60 degrees. The veins are 8 inches wide at the most, were traced for only short distances, and are of the quartz-tourmaline type with some carbonate and pyrite. No free gold was observed.

Claims of the Consolidated Mining and Smelting Company of Canada, Limited (9)

Reference: Quebec Bur. of Mines, Mining Operations 1942, p. 62.

A group of claims on lots 21 to 25, rges. III and IV, Barraute tp., was held in 1942 by the Consolidated Mining and Smelting Company of Canada, Limited. Much stripping and trenching done before 1942 on south half lots 23 and 24, rge. IV, a short distance north of range line III-IV, was supplemented in the spring of 1942 by a drilling program, during which four holes, aggregating 658 feet, were put down on south half lot 25, rge. IV.

The north and west parts of these claims are almost entirely covered with clay and morainal deposits, and rock outcrops are rare and small, but in the remaining parts of the claims outcrops are abundant. They vary from massive basaltic and andesitic flows, through pyroclastic and rhyolitic rocks, to intrusive quartz-feldspar porphyry and micrographic granite. All the formations trend about north 60 degrees west, and are interbanded as shown on the map. The intrusive rocks occur as sills. The micrographic granite body narrows greatly when reaching this property, and where it outcrops has been intensely carbonatized, mineralized, and cut by several quartz stringers. Several trenches excavated across this zone have shown that pyrite is common although not abundant. Some chalcopyrite and carbonates are associated with the pyrite in the quartz stringers. Gold was not observed by the writer, but its presence was probably the reason for this exploratory work.

Lot 9, Range III, Barraute Township (7)

References: Quebec Bur. of Mines, Mining Operations: 1927, p. 156; 1933, p. 112. James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 62 (1927).

Fisher-Quebec Prospecting Syndicate, Limited, did considerable exploration work on north half lot 9, rge, III, Barraute tp., during the summer of 1926. This work, done for Fisher-Quebec Gold Mines, Limited, and consisting of stripping, trenching, and excavating small test pits across and on quartz veins and carbonatized rocks, was suspended in 1927, when the property was returned to the owners. In 1933, Randall Mines Corporation, Limited, took over the property and did some more surface work and 424 feet of diamond drilling.

Not much can now be seen on the ground, as most of the surface workings are either filled with water or covered with a thick growth of alders. The exposed rocks suggest that the area of the workings is underlain by highly sheared basic to intermediate volcanic rocks. The shear zone trends north 70 degrees west and dips 60 degrees northeast. Carbonatization is intense where the shearing is strong. Quartz lenses and stringers have been exposed at several places in the sheared, carbonatized volcanic rocks. Most of them strike and dip parallel with the shear zone, are narrow, and consist of milky to glassy quartz, which carries some pyrite, tourmaline, chloritic material, and in places chalcopyrite. Gold is reported. Pyrite is also common in the wall-rocks of these veins and in the carbonatized rocks as a whole. A few stringers were observed to strike about north and to have a rather flat dip.

Lots 58 and 59, Range IV, Landrienne Township (5)

References: Quebec Dept. of Colonization and Mines, Mining Operations: 1925, p. 148; 1926, p. 142.

Seven trenches have been excavated across a strong shear zone, along the northern edge of an easterly trending ridge, on south half of lots 58 and 59, rge. IV, Landrienne tp. The property can be reached by a good trail leading due south from the railway. As the ridge is heavily covered with gravel and a thick forest growth, the rocks are poorly exposed; outcrops consist mainly of basic volcanic rocks, now slightly altered to hornblende schist and in part a little carbonatized, but in general of quite massive appearance and showing only a few pillows. Along the northern edge of the ridge, however, the rocks have been strongly sheared along a definite zone trending north 75 degrees west and dipping 70 degrees northeast, and are now altered to chlorite schist. This sheared zone, 15 feet wide, has been traced for 700 feet, and carries much pyrite. It is also highly carbonatized and contains numerous quartz lenses. The trenches, some of them reaching a depth of 10 feet, reveal that these quartz lenses strike and dip parallel with the shear zone, and carry pyrite, chalcopyrite, tourmaline, carbonates, and chloritic patches. The quartz of these lenses is milky; no gold was observed although it has been reported.

Lots 22 and 23, Ranges III and IV, Landrienne Township (3)

A few small quartz veins have been explored by trenches on lots 22 and 23, a short distance north and south of range line III-IV, Landrienne tp.

The exposed rocks are altered basic to intermediate volcanic rocks, now in places intensely sheared and heavily carbonatized. Pillows formed of a rock rich in epidote, and for this reason weathering lighter than the enclosing volcanic material, are common in the less sheared rocks, and amygdules composed mainly of quartz are abundant in the pillows. In places the rock has developed a slaty structure. Three narrow shear zones striking about east and only a few feet wide were noted, and are, from north to south, respectively, 300 and 175 feet apart. Pyrite was noted in all of them, but only the centre shear zone seems to be of some importance as the shearing there is more intense, sulphides more abundant, and quartz veins are present.

Six quartz veins, at most 2 feet wide, strike in two main directions: north 45 degrees east and north 25 degrees west. The first set dips 70 degrees southeast, and the other between 55 degrees northeast and vertically. Of the six veins, only one represents the first set. All the veins are of the quartz-tourmaline type, with the tourmaline in needles oriented at right angles to the walls. Pyrite occurs in single crystals, in aggregates, or in seams, either in the veins or in the wall-rocks. Quartz stringers and irregular quartz patches were noted at several other places in this area, particularly in the pillowed parts of the volcanic rocks.

Gillies Claims, Barraute Township (8)

References: Quebec Bureau of Mines, Mining Operations 1927, p. 157. James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 66 (1927).

Some work was done in 1926 on north half lot 10, rge. III, Barraute tp., by the Gillies interests, and consisted of about 350 feet of stripping and trenching to uncover quartz lenses and carbonatized, sheared rocks. Most of these workings are now caved or filled with water.

The rocks are slightly sheared and carbonatized, basic to intermediate volcanic flows, and in places show good pillow structure striking north 30 degrees west and dipping 55 degrees northeast. The shears trend about parallel with the formations, the strike being north 70 degrees west and the dip 60 degrees northeast. Most of the quartz veins and stringers in the area strike and dip parallel with the shears, but a few strike about north 80 degrees east and others appear to be flat-lying. Most of them are barren, but some carry a little pyrite, chalcopyrite, and carbonates, and the intruded rocks adjoining these veins are invariably highly carbonatized and carry abundantly disseminated pyrite cubes. Gold has been reported from some of the mineralized veins. At least three veins, all very narrow, slightly mineralized and carrying tourmaline and chloritic patches, were uncovered by the workings.

Natagan Gold Mines Syndicate, Limited (14)

Reference: Quebec Bureau of Mines, Mining Operations 1928, p. 130.

Natagan Gold Mines Syndicate, Limited, was incorporated in 1928 to operate the claims on lots 17 to 23, rge. II, and south half lots 20 to 23, rge. III, Barraute tp. Preliminary work, consisting of stripping and trenching, was commenced in May 1928 to explore a mineralized zone reported to have been found on the property. The operations were soon abandoned.

Batège Mines, Limited (6)

Batège Mines, Limited, holds the claims on lots 60 to 62, and north half lots 58 and 59, rge. IV, and north half lots 61 and 62, rge. V, Landrienne tp., and lots 1 to 3, rge. V, and lot 1, rge. IV, Barraute tp. Some geological mapping was done and a magnetometer survey made on this property during the summer of 1947.

Other Occurrences

In Fiedmont map-area are many occurrences of metalliferous deposits on which little work has been done and little information is available. Most of these occurrences carry a little gold, and consist of narrow veins and stringers of glassy to white milky quartz, mineralized with pyrite and tourmaline. Workings on a few of such occurrences may be summarized briefly: (1) a few trenches excavated across a mineralized highly siliceous rock on north half lot 12, rge. VII, Fiedmont tp.; (2) much stripping and trenching done on lots 48 and 49, rge. VIII, and on north half lots 48 and 49, rge. VII, Fiedmont tp.; and (3) some trenches noted on north half lot 54, rge. X, Fiedmont tp., on lots 60 and 61, rge. II, Barraute tp., on north half lot 29, rge. II, Barraute tp., on south half lot 12, rge. III, Landrienne tp., and on south half lot 29, rge. V, Landrienne tp.

GOLD DEPOSITS (Group 2)

The gold deposits of this group are, as previously noted (page 73), intensely carbonatized zones in volcanic rocks. They are usually sparsely mineralized with pyrite and chalcopyrite, and may or may not be cut by quartz stringers. They grade into gold deposits of group 1.

Bar-Lan Gold Mines, Limited (13)

References: Quebec Dept. of Colonization and Mines, Mining Operations 1925, p. 149. Quebec Bur. of Mines: pt. A, 1927, pp. 158-160; pt. A, 1928, p. 131; pt. A, 1929, p. 146; pt. A, 1931, p. 105; pt. A, 1932, p. 91; pt. A, 1934, p. 105; pt. A, 1930, p. 97; pt. B, 1930, pp. 41-51. James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, pp. 64-65 (1927).

The property of Bar-Lan Gold Mines, Limited, formerly known as La Mine d'Or Vénus, Consolidée, lies about 2 miles west-northwest of the old Natagan station, on the Senneterre-Cochrane branch of Canadian National Railways, and occupies lots 11 to 16, rge. II, and lots 14 to 17, rge. III, Barraute tp. A wagon road following lot line 13-14 leads to the mine due south from the Seneterre-Amos provincial highway, a distance of a little more than 2 miles. The property was prospected at two different places by extensive workings, first within a small area on lot 14, about 1,500 feet south of range line II-III, Barraute tp., and later, just south of the railway line on lots 16 and 17, rge. III. These two places are known as the Big Venus, or southern, zone and the small Venus, or northern, zone respectively.

The original discovery, consisting of several, narrow, gold-bearing quartz veins on lot 13, rge. II, was made early in 1925 by the prospector, E. Foisie. The original property comprised lots 13 and 14, rge. II, and lots 12 to 15, rge. III, Barraute tp., and was transferred to La Mine d'Or Vénus, Limitée, which was incorporated as a company in October 1927. Development work, consisting of stripping, trenching, and test-pit excavation, was done in 1925, 1926, and 1927. Several quartz veins were exposed and explored, and before the end of January 1928, four diamond drill-holes had been put down to a depth of about 300 feet to explore the veins exposed at the surface. Further operations were continued throughout 1928, and comprised about 9,260 feet of diamond drilling, two test pits—one 18 feet

deep on lot 17, rge. III, north of the railway, and the other 20 feet deep, south of the track on the same lot—and several trenches on lots 12 to 14, rge. II. Early in 1929, a shaft was commenced on lot 14, rge. II, and was continued to a depth of 230 feet. From this shaft the 200-foot level was opened, and about 2,000 feet of crosscutting and drifting done. In 1930, La Mine d'Or Vénus, Limitée, was reorganized to La Mine d'Or Vénus, Consolidée. The construction of a 25-ton test mill, commenced in 1930, was completed in 1931, and operated only for a time. By the end of 1931 a new shaft had been sunk on lot 17, rge. III, south of the railway line, to a depth of 225 feet, and lateral work comprising about 1,500 feet of drifting and crosscutting had been done on the 200-foot level. Operations were suspended in January 1932, but were resumed again in June, when some surface exploration and underground drilling were carried out at different places on the property. In August, all development work was suspended. More exploratory work was done during the summer of 1934, since when the mine has been closed except for a time in 1946-47 when, apparently, some further diamond drilling was done.

Much of the property is thickly covered with glacial deposits, but in some sections outcrops are common. Most of the rocks exposed are altered basic to intermediate volcanic flows, intruded near the railway by numerous sill-like bodies of quartz-feldspar porphyry and interbanded with minor amounts of rhyolite and tuffs. Pillow structures are recognizable in places. Along some zones the rocks are intensely sheared, mineralized with pyrite, cut by quartz stringers and veins, and so carbonatized that one has been mapped separately as a carbonate shear zone. Such are the southern and part of the northern zones, referred to above, where most of the exploratory and development work has been done.

The southern zone occurs in and close to the northern contact of a wide area of carbonatized basic to intermediate volcanic rocks, where shearing, mineralization, and silicification are intense. This contact is neither a sharp feature nor of the gradational type, but it is an alternating succession of sheared, carbonatized, quartz stringer-bearing bands and massive flows of slightly carbonatized pillow lava. As gold was found in the quartz stringers and in the adjoining rocks, these mineralized shear bands were carefully prospected. The volcanic rocks strike 60 to 70 degrees west of north and dip steeply northeast. A few top determinations on pillows slightly north of these workings suggest tops to the northeast, which would indicate that these workings are on the southwestern limb of a synclinal structure. The rocks have been sheared along definite planes in a direction parallel with their strike, but the shear planes dip in two main directions, the more striking one 55 degrees northeast, the other, rather weak and resembling joints, 50 degrees southwest. Quartz veins and stringers form lens-like masses a few inches to 3 feet thick in these shear planes, but in general are narrow and, apparently, of small dimensions vertically and laterally. So the veins instead of being continuous for long distances appear to be a succession of small lenses along these planes of shearing. These two sets of veins are of two main types: the northeasterly dipping set seems to be of little economic importance, as most of the veins are very narrow, are only slightly mineralized, and do not appear to carry any gold; their quartz is of the milky type. The southwesterly dipping veins are the largest, and in places are partly bent into saddle-like forms. They

carry gold, are mineralized with pyrite, and are composed of glassy quartz. Tourmaline, some chalcopyrite and carbonates, and chloritic patches are the most common accessories. Only three veins of this set have been noticed on the surface, but others have been encountered underground, and according to Bell they are younger than the veins of the northeasterly dipping set. Of the three outcropping veins, one is exposed at the shaft and, according to James, could be traced for 60 feet; the second vein, about 400 feet farther south, was not picked up underground; the third vein, about 700 feet south of the shaft, is exposed for 150 feet.

The veins of this southern zone are in general narrow, and apparently carry very little gold, so that they do not encourage further development.

The northern zone differs from the southern in not being located in or at the edge of what is mapped as a carbonate zone. Most of the northern workings, as of those of the southern zone, have been concentrated on quartz veins and stringers found in strongly sheared rocks. But the rocks of the northern zone are not as carbonatized as the rocks of the southern zone, the carbonatization being concentrated only in the vicinity of the quartz veins and stringers. The area of the northern zone as a whole is underlain by basic to intermediate volcanic rocks and minor amounts of rhyolite, intruded in places by numerous, sill-like masses of quartz-feldspar porphyry. All the rocks are now sheared, some more highly than others, along certain subzones. Shearing was observed in two main directions, which correspond in strike and dip to those of the southern zone, and it is along the subzones that quartz veins and stringers have accumulated. Two main quartz vein-bearing subzones have been located, one north of the railway line, the other south of it. They have been closely prospected, and the shaft of the small Venus has been put down on the southern one. A third and minor direction of shearing was noted in one of these subzones, striking 50 to 70 degrees east of north and dipping steeply northwest. Minute quartz stringers were noted along planes parallel with it. The quartz veins in the two main vein-bearing subzones strike parallel with these subzones and appear to dip gently in either direction, although a few dip northerly at about 60 degrees. All these veins are lenticular bodies of small lateral and vertical extent, so that these subzones are properly belts of quartz lenses and not definite quartz veins. In strike and dip the formations correspond with those of the southern zone, but in general they appear to be here more sheared and more fractured, and are cut by more irregular quartz lenses. These facts, with the occurrence of two belts of quartz-feldspar porphyry, suggest that this northern zone may be situated on a fold axis, probably a synclinal axis.

The two main subzones of quartz lenses of the northern workings strike 68 degrees west of north, dip about 70 degrees northeast, and are 250 feet apart. The one north of the railway line has been traced on surface for 140 feet, and was picked up on the 200-foot level. This subzone is, apparently, about 10 feet wide, whereas the other subzone south of the railway is in places 40 feet wide. Quartz lenses are concentrated in masses in the sheared rocks, and amount to about 25 per cent of the rocks in the subzones. They are composed mainly of vitreous quartz, but also carry tourmaline, pyrite, some chalcopyrite, carbonates, and chlorite. In some of them gold has been found with the pyrite, and gold in fair amount has also been found with pyrite in the wall-rocks at the contacts of the quartz

lenses. But not all pyrite has gold associated with it, and in general where gold is present it occurs only across narrow widths of vein matter. Gold appears to be later than the sulphides, as it is found as a coating on pyrite crystals.

Fisher-Quebec Gold Mines, Limited (1)

References: James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 61 (1927). Quebec Bur. of Mines, Mining Operations: 1928, p. 130; 1927, pp. 153-154. Quebec, Dept. of Colonization and Mines, Mining Operations 1926, p. 142.

The Fisher mine lies a little more than a mile due east from Fisher station, on the Senneterre-Cochrane branch of the Canadian National Railways, and is about 600 feet north of the Senneterre-Amos provincial highway on lot 59, rge. V, Landrienne tp.

The claims held by Fisher-Quebec Gold Mines, Limited, in September 1926 included lot 54, rge. III, Landrienne tp., eastward to lot 9, Barraute tp.; lot 48, rge. IV, Landrienne tp., eastward to lot 12, Barraute tp.; lot 48, rge. V, Landrienne tp., eastward to lot 6, Barraute tp.; and lot 56, rge. VI, Landrienne tp., eastward to lot 2, Barraute tp. Now they apparently include only south half lots 54 to 61, rge. V, Landrienne tp.

In 1924, large quartz boulders carrying free gold were found on this property, and resulted in the area being intensely prospected. The claims were staked in 1925, and exploratory work, commenced the same year and continued through 1926, was concentrated on lots 59 and 60, rge. V, Landrienne tp., and consisted in stripping, trenching, shaft sinking, and diamond drilling. In September 1926, the shaft had reached a depth of 25 feet, and 2,122 feet of diamond drilling had been done in seven holes to a maximum vertical depth of 250 feet. In 1927, the shaft was deepened to 215 feet, and the 200-foot level was opened. Lateral work on this level, commenced in February 1928, included about 600 feet of drifting and cross-cutting (Figure 11). Toward the end of 1928, the property was optioned to some other interests, and an aggregate of about 2,000 feet more of diamond drilling was done in ten short holes. The option was relinquished at the end of the drilling, and since then the property has been closed.

This property is in large part thickly covered with drift and sand, and the area of exposed rock, where most of the work was done, is about 1,000 feet square. The exposed rocks are altered, basic to intermediate volcanic rocks interbanded with a few small bands of rhyolite, chert, agglomerate, and probably intrusive rhyolite porphyry. The basic to intermediate volcanic rocks are now much altered to chloritic and sericitic material, and in general show the development of numerous tiny crystals of magnetite. Determinations on grain gradation in the less altered flows, passing from fine on the south to coarse on the north, and on the strike of the rhyolitic and cherty bands, seem to indicate that the formations strike about 65 degrees west of north and dip steeply northeast. Shearing in a direction parallel with the strike and dip of the formations has strongly affected these rocks in places, and associated with it is commonly intense carbonatization of the sheared and adjoining rocks. Quartz stringers and irregular masses are also found in these shear zones, and they are reported to carry some gold.

Two zones of carbonatized rocks, identified here as the north zone and the south zone, have been traced across the area of exposed rocks. The north zone, of apparently narrow width, and occurring at the northeastern tip of the exposed area of outcrops, can be traced for only a few feet, being lost at both ends beneath drift. The rock of this zone, which is now carbonatized, intensely sheared, and well mineralized with pyrite, contains quartz phenocrysts in a fine acidic groundmass, and is believed to be an altered intrusive rhyolite porphyry. South of this zone, and extending

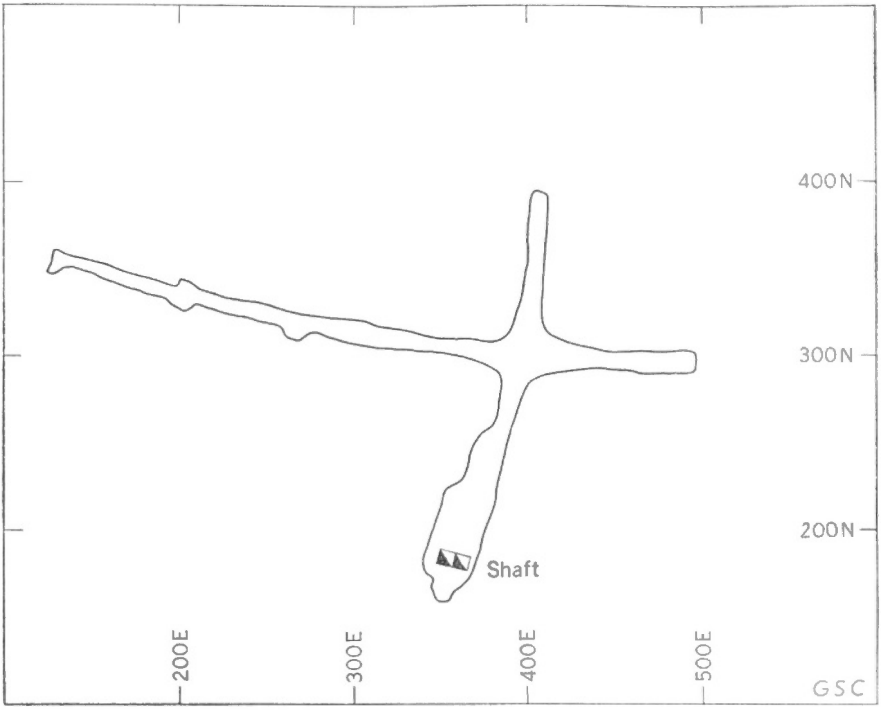


Figure 11. Plan of underground workings (200-foot level) of the Fisher mine.

to the south zone, are about 300 feet of agglomerate and massive, slightly altered, basic to intermediate volcanic rocks, cut by a few small shear zones believed to occur between flows. The south zone, which is at least 500 feet wide, is in part intensely sheared and trends about parallel with the direction of shearing. In places, particularly in the sheared parts, are numerous quartz stringers and irregular masses of quartz carrying chalcopyrite, pyrite, carbonate, and chlorite. Gold is reported from these quartz masses and stringers. The main occurrence of these quartz masses is along a shear zone about 8 feet wide that passes slightly south of the shaft, striking about parallel with the trend of the formations. The quartz masses have been trenched at several places and traced at depth without significant results. The sheared rocks adjacent to these quartz masses are reported to carry appreciable gold, and assays as high as $14.46 a ton across a width of 3·0 feet have been reported by the operators.

Heva Cadillac Gold Mines, Limited (16)

References: Quebec Bur. of Mines, Mining Industry of the Province of Quebec: 1937, p. 98; 1938, p 72; Mining Properties, 1937, p. 21.

The property of Heva Cadillac Gold Mines, Limited, comprising lots 11 to 22, rge. IX, Courville tp., is situated about a mile south of Uniacke station. It lies in a flat area, almost entirely covered with clay and gravel, but includes two areas of outcrops termed here the 'west group' and 'east group'. The west group, on lot line 11-12, consists mainly of basic volcanic rocks interbanded with a few small rhyolite flows and cut by dykes of granitic rocks. No indications of mineralization were found on this group of outcrops, and all work on this property was concentrated on the east group, where in places gold has been reported. The east group is exposed on lots 15 and 16, and consists of rocks similar to the rocks of the west group, striking north 70 degrees west and dipping steeply northeast. In places, however, the basic volcanic rocks have been intensely carbonatized, and these parts have been mapped separately as a carbonate rock. Most of this rock is markedly schistose, and in places is mineralized, and contains quartz stringers, which in most instances strike about north 30 degrees west and dip steeply northeast. Some are nearly flat. Pyrite is not only scattered throughout the carbonate rock but is also concentrated along fractures and quartz stringers and is associated with a green mica and some talc.

As a result of the discovery of native gold in some of the quartz stringers at the surface, much stripping and trenching was done in 1937 on that part of the property, and diamond drilling, amounting to 4,086 feet, was carried out in 1937 and 1938 to investigate conditions at depth. Encouraging gold assays had been obtained from surface samples, but as the drilling results were unsatisfactory, operations were suspended early in 1938.

Continental Gold Mines Syndicate (12)

References: Quebec Dept. of Colonization and Mines, Mining Operations 1926, p. 143. Quebec Bur. of Mines, Mining Operations: 1927, p. 155; 1932, p. 91. James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 63.

Continental Gold Mines Syndicate was incorporated to operate the claims on lots 8, 9, and 10, rge. II, Barraute tp. During the summer of 1926, about 2,000 feet of stripping, trenching, and some excavation, were done on north half lot 9. In 1927, the claims were sold to Dorval Mining Company, Limited, who later on transferred them to Cummings-Trudel Mining and Development Company, Limited. This last company did some more surface stripping and trenching during the summer of 1932. Some diamond drilling is also reported to have been done at one time on the property. The area of the workings can be reached easily following a wagon road due south along lot line 13-14 for 2 miles from Amos-Senneterre provincial highway and then by going due west on range line II-III for a distance of a mile.

The property is in an area of low relief in which outcrops occur only in the north part of lot 9, where the mantle of drift and sand is not as thick as in the other parts of the property and where most of the development work has been concentrated. The rocks are basic to intermediate volcanic

flows interbanded with siliceous rocks that may be partly flows and partly dykes. Some agglomerate and pillowed lava was noted at places. All these rocks are now sheared in a north 60 to 70 degrees west direction with a dip of 60 degrees northeast, but the intensity of shearing varies from place to place and is concentrated along definite zones. These zones are commonly highly carbonatized, and the larger ones are cut by numerous, narrow, short, quartz lenses. One such zone, traced for about 1,000 feet, lies 300 feet south of the end of the trail, and is mineralized with pyrite. The quartz lenses noted in it consist mainly of glassy milky quartz with minor amounts of tourmaline, chlorite, carbonates, and pyrite, and vary in width from few inches to 2 feet. Pyrite is abundant in the wall-rock and in the intruded rocks as a whole, and in some outcrops is associated with much magnetite. Chalcopyrite occurs with some of the pyrite in the quartz lenses, and although gold was reported from the property none was observed in the field. All the quartz lenses strike parallel with the shear zone, but appear to dip to the southwest. Some of them branch into stringers of glassy, barren quartz. Several other narrow quartz-tourmaline veins have been noted in the area, but have been traced for only short distances, and are all associated with carbonatized rocks.

Mine d'Or Abitibi (2)

Reference: James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 59 (1927).

The Mine d'Or Abitibi property, held in 1926 in the name of Sinaï Rousseau, occupies south half lots 8 and 9, rge. IV, and north half lots 8 and 9, rge. III, Landrienne tp. A motor road from Landrienne south to St. Marc de Figuery runs close to the property, which can be reached easily by following a cleared roadway along range line III-IV from a point on that motor road. The property is in an area of low relief exposing a few small areas of outcrops.

The exposed rocks are of basaltic to andesitic composition, and although relatively fresh looking in places, large parts of them are intensely carbonatized. Pillows can be observed in the fresh rocks; these indicate a strike of 85 degrees east of north, a northerly dip, and overturned strata facing south. The carbonatized rocks are slightly sheared in a north 80 degrees east direction, with a northerly dip of 60 degrees, and form carbonatized zones that appear to trend north 60 degrees west. These zones of carbonatized rocks are commonly mineralized with pyrite, the degree of mineralization varying with the intensity of carbonatization, and are cut by quartz-tourmaline veins and stringers themselves slightly mineralized, and amounting in places to as much as 15 per cent of the outcrop areas. Three such carbonatized zones have been recognized on this property and trend as indicated above. The first one, extending from the northeastern end of the large outcrop on lot 8, is 160 feet wide in a southeast direction. It is adjoined on the southeast by 40 feet of fresh looking volcanic rocks, which pass into the middle carbonatized zone, 80 feet wide, and thence to a zone belt of dark green basic volcanic rocks, about 520 feet wide. Southeast of this belt is the third and southernmost zone of carbonatized rocks.

In the northernmost carbonatized zone, pyrite is uniformly widespread, but quartz veins are most irregularly distributed, forming about 15 per cent

of the total rock in the eastern part of the zone but less than 1 per cent in the western part. At least three sets of these quartz veins have been recognized; one set strikes uniformly between 20 and 40 degrees west of north, dips steeply southwest or vertically, and carries patches of carbonates, aggregates of pyrite and chalcopyrite, and chlorite clusters. These veins are narrow, lenticular masses, varying from 1 inch to 8 inches in width and overlapping each other; they form the most abundant group and are believed to be among the oldest veins. A second set strikes east and dips about 75 degrees north. These veins are few and about 2 inches wide at most; they are apparently contemporaneous with the set described above, and remarkable only for their relatively great length. Other veins, striking between 55 and 73 degrees east of north and dipping 80 degrees northwest, constitute a third set and are probably the youngest. They are at most 3 inches wide, and may reach a length of 100 feet; as they are lens-shaped, they appear to overlap each other, and have undulatory contacts with the wall-rocks. Two test pits were excavated in the eastern part of this northern carbonatized section, and some stripping was done. All the veins are of the quartz-tourmaline type.

The middle carbonatized zone is only slightly carbonatized, and as pyrite is not widespread and quartz stringers are few, it has not been prospected.

In the southern carbonatized zone pyrite is not as uniformly distributed as in the northern zone, and the quartz veins are not as numerous, but the few present are larger. The three sets of quartz veins observed in the northern zone were also found here. The easterly striking set is more important here, as it includes veins 1½ and 2½ feet wide respectively, both of which carry carbonates and chloritic patches. The most important set is, however, as in the northern section, the one consisting of veins striking about 30 degrees west of north. These veins are short and lenticular, and are arranged *en échelon*. The youngest set is represented in this section by only a few, narrow veins, apparently unmineralized. Several trenches have been excavated across the veins of this southern zone and much stripping was done. No gold has been reported from any part of the property.

Bacon Claims (10)

Reference: Quebec Dept. of Mines, The Mining Industry of the Province of Quebec, 1942, p. 62.

The claims covering north half lots 8 and 9, rge. II, Landrienne tp., were known in 1942 as the Bacon claims, and during that year were optioned to Inspiration Mining and Development Company, Limited, who put down four inclined diamond drill-holes totalling 402 feet. This drilling was done to explore a strongly mineralized and carbonatized zone at the contact of sheared rhyolite prophyry with basic volcanic rocks. The results are not known. Pyrite is an important and abundant constituent of this zone, and gold, copper, and lead have been reported.

GOLD DEPOSITS (Group 3)

The gold deposits of this group are, as previously noted (page 73), lenses of massive to disseminated sulphides such as sphalerite and pyrite in acidic volcanic rocks or sheared quartz-feldspar porphyry.

Jarvis Mine (formerly Swanson claims) (18)

References: Quebec Bur. of Mines, Mining Operations: 1934, p. 94; 1941, p. 52; and Division of Mineral Deposits, 1939, p. 30.

The Jarvis mine, situated about 2 miles due east of the eastern shore of Lake Fiedmont, comprises eighteen claims, including lots 54 to 62, rges. IV and V, Fiedmont tp. A rough, winding wagon road leads to the showing from a motor road on lot line 43-44, rge. VI. Most of the work has been concentrated on lots 56 and 57, north of range line IV-V.

The area outlined by this property is of low relief and covered by a thick, second growth of trees. Rock outcrops are generally small, as most of the bedrock is covered with a thick mantle of gravel and clay.

The exposed rocks suggest that most of the area is underlain by highly altered, sheared, siliceous volcanic rocks, which are believed to have been originally rhyolite, tuffs, and feldspar porphyry, now partly recrystallized to a mica-rich acidic rock. This rock is probably separated from the Pascalis-Tiblemont intrusive mass to the east by a narrow band of intensely altered basic volcanic rocks. The approximate positions of the contacts between the different formations are shown on the map.

The area was staked for zinc and gold. The main mineral occurrence is a lens, 6 feet long, 2 feet wide, and only a few inches thick, of massive sphalerite with minor amounts of pyrite, chalcopyrite, quartz, and gold. The lens strikes and dips parallel with the schistosity of the altered acidic volcanic rocks, which near the lens are mineralized with disseminated pyrite and sphalerite, and intruded by minute, lens-shaped masses of the same ore minerals. Mineralization is also represented by several quartz stringers, which may or may not carry small amounts of the same ore minerals. Pyrite is concentrated in places along the joint planes. A grab sample from the main lens, consisting mainly of sphalerite and pyrite, assayed $105.18 a ton in gold and 45·8 per cent zinc, and a polished section of the ore indicated that sphalerite was the most abundant constituent and carried disseminated minute grains of gold, silver, and chalcopyrite. A little pyrite is also associated with the sphalerite.

Joint planes in the acidic rocks strike 25 to 45 degrees west of north and 65 degrees east of north and dip steeply to the southeast and southwest. Quartz stringers, varying in width from a few inches to a foot, strike and dip in similar directions to the joint planes, but in general their dips are less steep, or about 40 degrees. Schistosity, striking 10 degrees east of north and dipping easterly at about 35 degrees, varies in intensity from place to place, and in some places definite shear zones have formed, along which pyrite is abundant and in which gold has been reported.

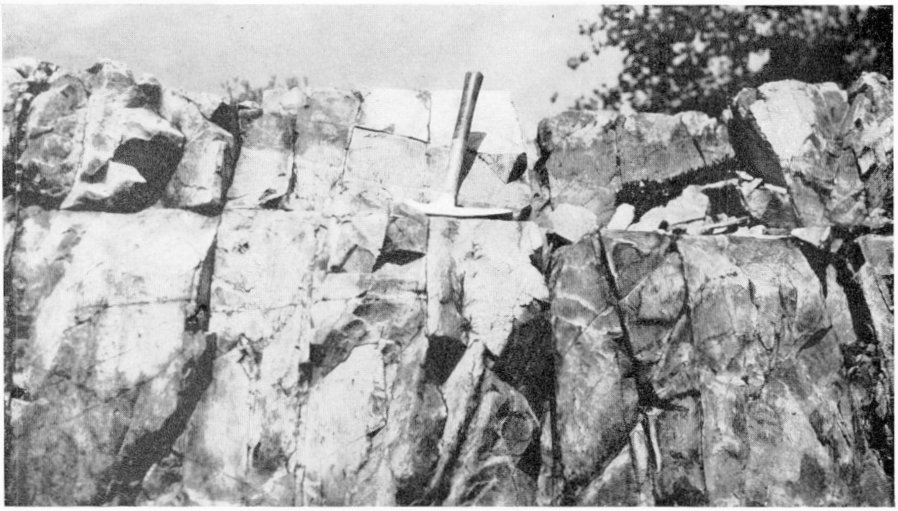
Much trenching and stripping have been done on these mineralized zones, and in 1939 Dome Exploration, Limited, which had taken an option on this property, did some 3,500 feet of diamond drilling in eight holes to explore the surface indications at depth. Results were not satisfactory, and the option was abandoned at the end of the drilling program. This property, now known as the Jarvis mine, is reported to have been explored further by diamond drilling in the autumn of 1948.

Sulphide Zones (11)

Reference: James, W. F., and Mawdsley, J. B.: Fiedmont and Dubuisson Map-areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pt. C, p. 60 (1927).

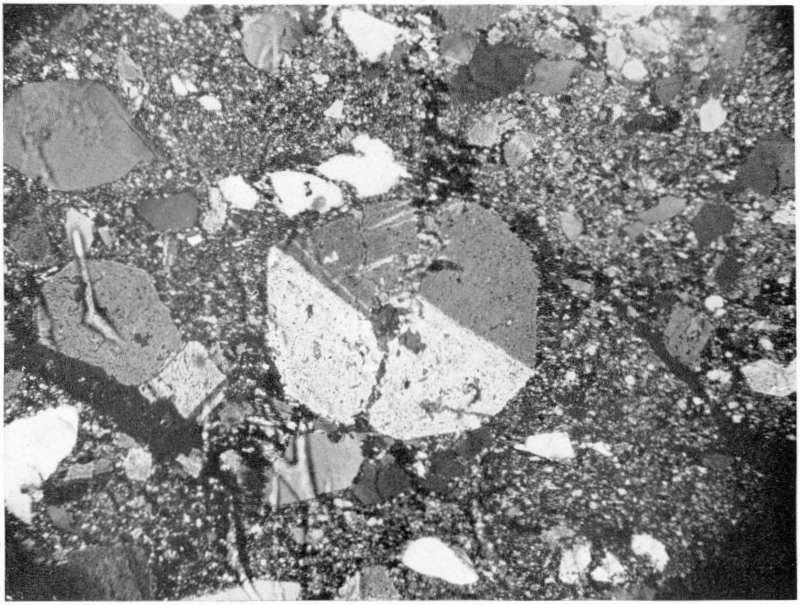
In north half lots 32 to 35, rge. II, Landrienne tp., is an outcrop, about half a mile in diameter, of sheared quartz-feldspar porphyry mixed with some massive grey porphyry. This outcrop protrudes through a thick mantle of glacial deposits, and in places rises about 50 feet above the surrounding swamp and sand plains. The grey porphyry forms lens-shaped masses trending about 65 degrees west of north and, apparently, dipping steeply northeast. The quartz-feldspar porphyry is heavily sheared in a north 65 degrees west direction and on a dip of 45 to 60 degrees northeast.

Mineralized zones were noted at a few places in the quartz-feldspar porphyry parallel with the schistosity of the rock. They were also seen along contacts between both types of porphyry, and between either of the porphyries and the large inclusions of basic volcanic rocks. Fine-grained, pale yellow pyrite was the only sulphide mineral observed in the field, and is believed to have formed at high temperatures, though not as high as that of the pyrite of the Fisher, Randall, and Venus showings. Two main zones and many small ones were examined in the field. The northernmost main zone, along the northern margin of the outcrop on lots 33 to 35, is about 250 feet wide and can be traced for several hundred feet. Trenches have been excavated across parts of this zone on lot 35, and show that the pyrite crystals are concentrated along the planes of schistosity either in scattered grains or sizable aggregates. The second main zone, about 1,100 feet farther south, is about 100 feet wide in places. Like the other, it lies parallel with the schistosity, and was traced for at least 1,200 feet. No quartz veins or stringers were seen in these two zones, but a few small veins were seen nearby. It is not known whether gold was found in these mineralized zones.

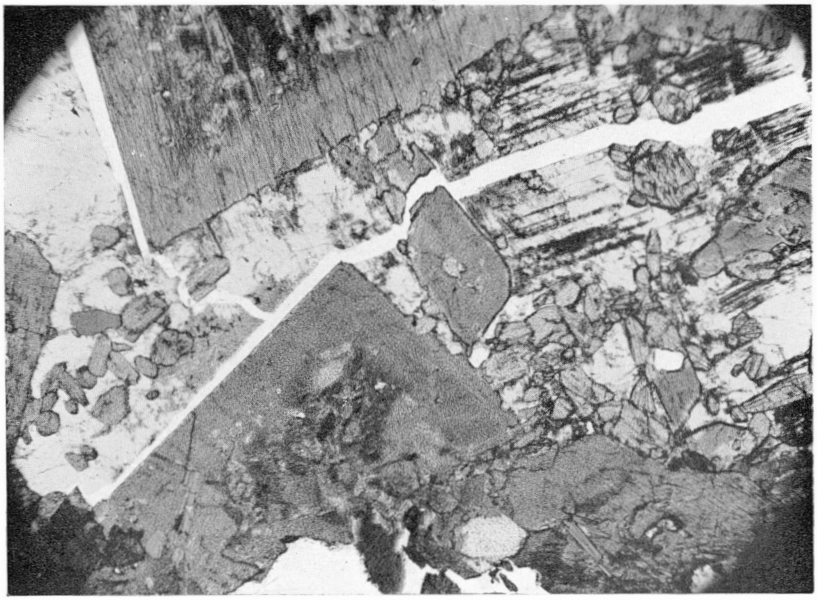


A. Northeasterly trending joints in the band of massive rhyolite southeast of the Barraute plug. (Page 10.)

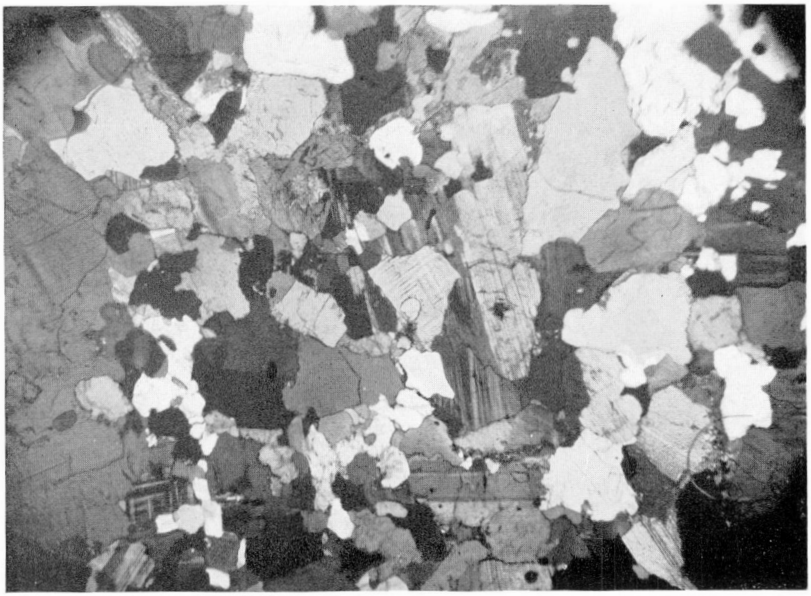
B. Conglomerate northeast of Lake Roy, showing the elliptical character of the cobbles and pebbles. Cherty cobbles can be seen on the left, and granitic cobbles on the right. (Page 17.)



A. Typical quartz-feldspar porphyry. Note fractured feldspar phenocrysts in the centre, and slightly to the southeast of it three white fragments of quartz, parts of the same grain, separated by groundmass material. Crossed nicols, X 20. (Page 25.)



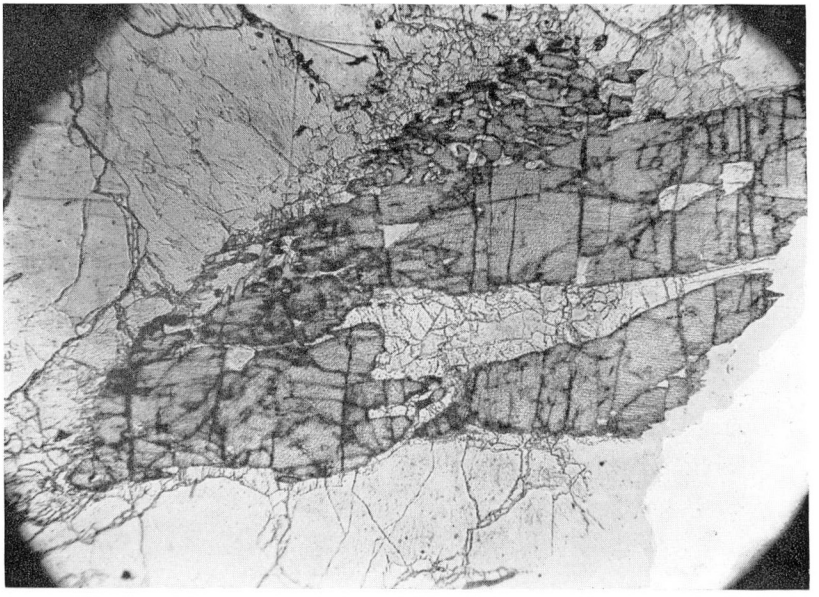
B. Amphibolite. Large hornblende crystals, showing a clear zone at their margins and an altered core, are surrounded by many small grains of pyroxene. X 20. (Page 34.)



A. Typical muscovite granite. Quartz, microcline, plagioclase, and mica can be seen. Crossed nicols, X 20. (Page 38.)

B. Banded structure in pegmatites, resulting from an irregular sequence of pegmatitic and aplitic materials. (Page 44.)

PLATE V



A. Spodumene in complex pegmatites. The ragged nature of the spodumene, as a result of its replacement by other minerals, is a conspicuous feature of the slide. X 20. (Page 46.)

B. Fine lamination in sand dunes, producing crossbedding. The sand is very fine and of uniform grain and composition. (Page 64.)

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