GEOLOGY OF THE WEST HALF OF LA MOTTE TOWNSHIP, QUEBEC

by

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ABSTRACT

The general geology of an area of 50 square miles comprising the western half of La Motte township, Abitibi County, Quebec, is described.

Peridotites and dunites occur as sills in Early Precambrian volcanic and sedimentary rocks. The belts of rock constitute part of the northern limb of a major anticlinorium. Granitic rocks of the Preissac-La Motte-La Corne batholithic complex probably derived from a common magma chamber occupy about 75 per cent of the map-area. The younger muscovite- and biotite-bearing quartz monzonite masses contain a higher percentage of potash feldspar than the biotite granodiorite masses. All pre-batholithic rocks are metamorphosed to the amphibolite facies.

An ore body of nickeliferous pyrrhotite, pyrite and chalcopyrite is associated with ultrabasic rocks on the Marchant Mines property. Pyritic zones, and small quantities of molybdenite and spodumene have been found.

The formation of periglacial eolian sand dunes is described.

INTRODUCTION

General Statement

This thesis presents the results of a detailed geological survey of the western half of La Motte township, Abitibi County, Quebec, made for the Mineral Deposits Branch of the Quebec Department of Mines. Mineral occurrences, the results of diamond drilling, and geophysical surveys undertaken by private companies were examined, and the data so obtained was compiled on a map on the scale of 1 inch to 1,000 feet. Approximately 50 square miles were mapped. The area had previously been mapped on a smaller scale for the Geological Survey of Canada by James and Mawdsley (1925) in 1925, and Norman (1944) in 1943.

Prospecting in the district has for many years been part of the activity that has developed the Noranda-Senneterre mining belt. The search for spodumene-bearing pegmatites in the northeastern quarter of La Motte township and the discovery of the Marchant Mines nickel deposit in 1957 have focused attention on the area. In response to this increased interest and consequent activity, the remapping of the area was undertaken by the writer during the 1958 field season.

Location

La Motte township lies midway between the towns of Amos and Malartic in Abitibi County in the western part of the Province of Quebec. The map-area is bounded by latitudes 48° 17' and 48° 26' North, and longitudes 78° 00' and 78° 14' West, and comprises approximately 50 square miles. It is bounded on the west by Preissac township and on the south by Malartic township. It lies between Lake Malartic and Lake Kewagama, the biggest lakes in the district.

Means of Access

Quebec highway 61, a good gravel road, crosses the centre of the township. It links the town of Amos to Quebec highway 59, the main road from Rouyn to Montreal. A system of colonization roads suitable for motor transportation has been constructed along the range lines in the southern half of the map-area. The northwestern part of the region is traversed for about 2 miles by a road from St. Michael village in Figuery township. Winter roads, bush tracks, and lines cut for geophysical work provide access to the more isolated parts of the area. No point in the map-area is more than 3 miles from a road.

The nearest railroad stations are at Cadillac and Amos. Lake Malartic is suitable for float-plane landings, but is seldom used. The Harricanaw River is navigable without interruption from Amos to Lake Malartic, but this route has not been used for many years.

Previous Work

The first geological investigation of the area was made in 1901 by J. F. E. Johnston (1902) of the Geological Survey, when he surveyed the geology of the waterways of part of the Abitibi region.

In 1906, W. J. Wilson (1906), also of the Geological Survey, investigated the geology along the waterways and survey lines along the line of the National Transcontinental Railway, which was later named the Canadian National Railway. Part of the La Motte map-area was included in this survey.

In 1914, T. L. Tanton (1919), of the Geological Survey, made a few observations on the rocks of the northern part of the La Motte area.

Following these reconnaissance surveys a programme of geological mapping in western Quebec was begun by the Geological Survey in 1922 when gold-bearing veins were discovered in the vicinity of Rouyn lake. Promising occurrences of gold and copper ore to the east of the Rouyn mining district were investigated, and geological mapping was extended eastward during the years following 1922.

In 1925, W. F. James and J. B. Mawdsley (1925) mapped the La Motte and Fournière areas on the scale of 1 inch to 1 mile and produced a detailed report on the geology and mineral occurrences. At that time the principal road in the area extended from Amos to Lake La Motte.

In 1931, H. C. Cooke, W. F. James, and J. B. Mawdsley (1931) compiled the results of the studies of the previous nine years into a general report on the geology and ore deposits of the Rouyn-Harricanaw region. Their report provides a good summary of all the information that had been accumulated on the La Motte region by earlier workers.

In 1937, W. C. Gussow (1937) included some petrographic details of the granitic rocks in the map-area in his paper on the petrogeny of the major acid intrusives of the Rouyn-Bell River area.

In 1943, G. W. H. Norman (1944) revised the geology of the map-area as part of a war-time investigation of molybdenite, tantalite, beryl and spodumene deposits. He included Preissac and parts of adjoining townships in his investigation. Norman produced a brief preliminary report, and a map on the scale of 2 inches to 1 mile.

In 1952, R. B. Rowe (1953) investigated the pegmatitic beryllium and lithium deposits of the Preissac- La Corne region, and in 1953, K. R. Dawson (1954) reported on the structural features of the Preissac-La Corne batholith for the Geological Survey.

L. B. Halferdahl (1954), and H. Siroonian (1958), have independently investigated the trace elements of the Preissac-La Corne batholith.

During the past few years active prospecting, geophysical surveys, and diamond drilling have added to the knowledge of the area.

Physiography

The map-area is characterized by three distinct types of topography: granite highlands in ranges VIII, IX and X (Fig. 1); sand-covered plains along an esker in the northern part of the area; and in the southern part of the area lowlands underlain by lacustrine clays. The maximum local relief of the hilly country is about 300 feet. Records of the Public Works Department show that Lake Malartic is 965 feet above sea level, and elevations gradually increase toward the batholith area in the north. (Cooke, James, Mawdsley, 1931, p. 21).

The La Motte area is part of the clay belt of northwestern Quebec and northeastern Ontario once covered by the waters of the glacial Lake Barlow-Ojibway. Outcrops project through the blanket of clay and glacial debris. The clay belt has a general altitude of about 1000 feet.

Outcrop ridges in the La Motte area other than those of the granite highlands commonly trend south of east in the direction of strike of the formations.

The southward trending esker in the northern port-

Fig. 1. A view looking north from a granite hill in lot 4, range II, showing a typical farming area with granite highlands in the background.

ion of the area is part of the height of land between the St. Lawrence and James Bay water systems. The height of land in the southern section of the map-area is difficult to follow as there is little slope away from it either to the east or west.

Streams to the east of the height of land flow into Lakes Malartic and La Motte, which are expansions of the Harricanaw River which drains north into James Bay. Streams to the west of the height of land flow into Lake Kewagama or the Kinojevis River. The Cadillac River in the southwestern section of the map-area follows a meandering course across lowlands and drains into Lake Newagama in Cadillac township. Drainage channels have been excavated along parts of the Cadillac River to eliminate many of the meanders. This was done in an effort to improve the drainage conditions of the area.

The few small lakes in the La Motte area can be divided into four types:-

(1) Shallow basins in lacustrine clays. The marshy lake in range II which drains into Lake Malartic is the only example of this type. There are no beaches around the lake and vegetation flourishes in its shallow waters.

(2) Basins whose form is controlled by outcrop distribution and glacial drift. The two lakes on the western boundary of the area are situated near granite ridges and gently sloping glacial material encircles

them.

(3) Kettle depressions on the esker ridge. One small lake in lot 11, range VIII, is impounded in a depression of this type. The lake has a clear sandy bottom and is surrounded by steep ridges of gravel.

(4) Wind deflation hollows. Three shallow lakes to the east of the esker occupy shallow basins which have been scoured from sand plains by wind action. The formation of these depressions is more fully discussed under the heading of Pleistocene Geology. The lakes are seldom more than 10 feet deep. Muskeg occupies many other shallow depressions, evidence of the poor drainage of the low-lying areas.

Settlement

Settlement began in the vicinity of Amos about the time of the construction of the Canadian National Railway and subsequently advanced along the Harricanaw River. The first farmers entered the La Motte area in 1912, and by 1925 clearing of land had extended to the southern boundary of La Motte township. The municipality of La Motte village was incorporated in 1921.

In the western half of the township farms have been established only south of range V. The soil is clayey, and the portions cleared are used to grow hay, or serve as summer pasture for dairy stock. The northern half of the map-area is too rocky and sandy to be suitable for cultivation. An estimated 5 million cubic feet of timber stand in this northern area.

About 450 persons live within the map-area. There are no industries, and farmers needing to supplement their incomes find employment in the mines of the Malartic area or in the towns.

Field Work

Mapping was done on R.C.A.F. aerial photographs printed on a scale of approximately 1 inch to 1,000 feet. In areas of complex geology, outcrops were plotted on graph paper on a scale of 1 inch to 200 feet, and then reduced to the scale of the photographs. A base map was prepared from a survey map of the township and from the aerial photographs.

Pace and compass traverses were spaced along lot lines and in the center of lots, the number of traverses depending on the abundance of outcrops and the complexity of the geology. Granite outcrops are very easily seen on the aerial photographs, so that most of such outcrops in the northern part of the map-area were located without the help of traverses.

Rock exposure is poor, the area of outcrop being not more than 5 per cent of the total area. Outcrop is generally confined to the higher ground and is almost absent along streams.

Acknowledgements

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GENERAL GEOLOGY

General Statement

The oldest rocks in the map-area are fine to medium-grained volcanic rokcs which form two major belts diverging eastward. The northern belt outcrops along the southern border of the La Motte batholith, and the southern belt trends south of east across the southern half of the area. Sedimentary rocks overlying the volcanic rocks are only exposed in a narrow band between the northern belt of volcanic rocks and the La Motte batholith. All that can be seen of this sedimentary belt are a few small outcrops of quartz-biotite schist. These belts of volcanic and sedimentary rocks constitute part of the northern limb of a major anticlinorium.

Intrusive rocks range in composition from the oldest basic and ultrabasic intrusives to granitic rocks of the batholithic complex. The oldest group of intrusives consist of diorite and gabbro, followed by peridotite and dunite. They are mostly conformable with the volcanic structures and form lens-like sills which underlie a large part of the central map-area. They appear little disturbed in some sections, while in others they display strong deformational characteristics.

The second group of intrusives consists of granitic rocks of the Preissac-La Motte-La Corne batholithic complex. Rocks of the La Motte quartz monzonite mass occupy most of the northern part of the area, and the Malartic biotite granodiorite stock underlies most of the southern part of the area. These and other areas of granitic rock occupy about 75 per cent of the entire section which was investigated. Batholithic rocks intruded in more than one stage along the axis of the anticlinorium displacing the formations into their present positions.

The post-batholithic intrusive rocks are three major gabbro dykes which probably fill regional tension fractures. Unconsolidated glacial and post-glacial materials cover most of the area.

Structural features and rock associations of the district indicate that it forms part of a deeply-eroded mountain-built belt.

The geologic history of the area is summarized in the table of formations.

Table of Formations

CENOZOIC	Recent Pleistocene	Stream and swamp deposits Marine and esker material, sand dunes, and lacustrine clays.
Great Unconformity		
LATE PRECAMBRIAN	Keweenawan (?)	Gabbro dykes
Intrusive Contact		
EARLY PRECAMBRIAN	Post-Timiskaming(?)	Epidote-rich aplite granite Pegmatites and aplites Muscovite- and biotite-bearing quartz monzonite Biotite granodiorite
	Intrusive Contact	
	Pre-Timiskaming(?)	Peridotite - Dunite
	Intrusive Contact	
	(?)	Gabbro and diorite
	Intrusive Contact	
	Keewatin (?)	Kewagama Group. Quartz-biotite schist derived from sediments
		Malartic Group. Amphibolitized acid to basic volcanic rocks

Volcanic Rocks

Cooke, James, and Mawdsley (1931), recognized the similarity between the volcanic rocks in this area and the volcanic formations of the type Keewatin area at Lake of the Woods, Ontario. They proposed that the term Keewatin be used in classifications of the Archean lavas in this district. Gunning and Ambrose (1939), used the term Malartic to designate the oldest group of volcanic rocks in the conformable succession of rocks within the Cadillac-Malartic area. Norman (1944), has correlated this Malartic group of volcanic rocks with the oldest group of volcanic rocks in the map-area, which also happens to be the oldest formation in the map-area.

The rocks of the Malartic group may be divided into three loosely defined types: (1) Basic volcanic rocks, or basic greenstones, which are presumed to be metamorphosed basaltic lavas; (2) intermediate volcanic rocks, or typical greenstones of intermediate composition, believed to be metamorphosed andesites; (3) acid to intermediate volcanic rocks which may include metamorphosed rhyolites, tuffs, and agglomerates. These broad terms are used because the widespread metamorphism to the amphibolite facies has destroyed the original mineral assemblages of the volcanic rocks.

The two belts of volcanic rocks diverge eastward across the map-area. The northern belt is exposed only from lots 1 to 8, range VII. The southern belt appears to be composed of a few bands of volcanic rocks separated from each other by sills of ultrabasic rocks. Exposures of this belt occur from lot 3, range V, to lot 31, range II. A third area of volcanic rocks associated with ultrabasic rocks is found between lots 6 and 9, range I. A number of xenoliths and roof pendants of volcanic rocks are present in the Preissac batholith in ranges I, II, and III. These remnants may indicate that the Malartic volcanic rocks once covered most of the southern half of the map-area.

(1) Basic volcanic rocks. There are few truly mafic volcanic rocks in the area. The percentage of secondary quartz and feldspathic constituents in the rocks is high so that no quartz-free basaltic lavas were found. The most basic volcanic rocks appear to be from the northern belt of lavas. The volcanic rocks in range I have a higher proportion of salic constituents than the other basic greenstones, the original lavas were therefore more andestic than basaltic in composition and could be classed as basic to intermediate volcanic rocks. There are a few small areas of the southern belt of lavas which are mafic in composition, but the exact boundaries of these flows cannot be shown. It is difficult to distinguish mafic lavas from bodies of intrusive gabbro and peridotite. This problem is dealt with in the sections on these intrusive rocks.

Weathered surfaces have a darker grey-green colour than the other volcanic rocks, and brown patches of iron oxide staining often discolour the surface of outcrops.

Fresh surfaces are often dark green due to the high percentage of ferromagnesian minerals. The grain sizes vary from fine to medium, and individual minerals are generally difficult to identify in hand specimens. Flow, pillow, and amygdular structures are poorly developed. There are a few relict pillows in the volcanic formations in range I (Fig. 2). All the volcanic rocks are sheared parallel to the general structural trend of the rocks, and this is also the direction of foliation, schistosity, and cleavage.

The basic volcanic rocks consist dominantly of actinolitic hornblende and plagioclase. There are lesser amounts of quartz, epidote, biotite, chlorite, pyrite, magnetite, carbonates, garnet, saussurite, and sericite. The average grain size is less than 1 mm.

The actinolitic hornblende is strongly coloured in shades of green or bluish-green, and is highly pleochroic with Z = bluish-green, and X = pale yellowish-green. The actinolitic varieties of amphibole have extinction angles less than 15^{o}, the deep-green hornblende has extinction angles between 15^{o} and 25^{o}. The amphibole occurs mostly in subhedral prisms with ragged ends. In places the crystals contain abundant inclusions of quartz in a sieve texture. In one thin section plumose hornblende was found (Fig. 3). Actinolitic hornblende is the most abundant mineral constituting between 60 and 75 per cent of the rock. Hornblende crystals are generally aligned in the direction of

Fig. 2. Relict pillow structures in basic volcanic rocks in lot 7, range I. Top determinations could not be made.

Fig. 3. Plumose Amphibole in an inclusion of volcanic rock in peridotite. From lot 31, range VII. x 25

foliation. The mineral has altered to green chlorite in some cases. Chlorite is faintly pleochroic, fibrous, and has a positive birefringence and a small optic angle.

Plagioclase is mostly untwinned, there is some twinning, however, following the Albite and Carlsbad laws. Determinations of the type of plagioclase present were difficult, but the range of plagioclase appears to be between albite and andesine. There are a moderate number of zoned plagioclase crystals with central portions more calcic than the outer shells. Potassic feldspar could not be recognized, and staining techniques were not attempted. It is likely that there are small amounts of orthoclase. Plagioclase shows alteration to both sericite and saussurite. It has a grain size of about 0.4 mm., and is usually mixed with quartz crystals of smaller size. Plagioclase constitutes about 20 per cent of the basic volcanic rocks.

Anhedral quartz, mostly of secondary origin, is found associated with plagioclase in the groundmass of the rock. This plagioclase together with amphibole laths showing a preferred orientation, causes the rock to have a lepidoblastic texture. Quartz forms about 10 per cent of the basic volcanic rocks.

Porphyroblasts of garnet (Fig. 4) often with inclusions of quartz appear to develop mainly near the contact of intrusive rocks. There is less epidote in the basic than in the acid and intermediate volcanic rocks. Magnetite and pyrite occur in small quantities, in fine grains, or large

Fig. 4. Photomicrograph of intermediate volcanic rock. Crystallizing force of garnet porphyroblasts has thrust aside the surrounding amphibole and quartz crystals. Lot 21, range IV. x 25

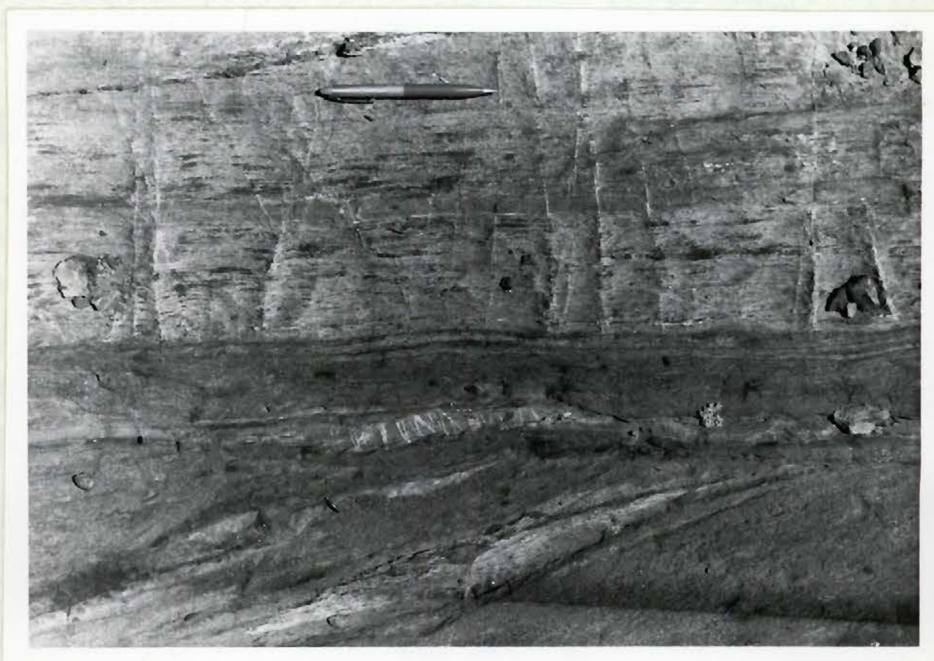


Fig. 5. Colour banding in siliceous volcanic rocks in lot 21, range IV. Variable resistance of fine bands produces a ribbed effect on the weathered surface.

well-formed crystals. Carbonates with no specific crystal outline and small flakes of biotite are sometimes present in small quantities.

(2) Intermediate volcanic rocks. These fine grained massive rocks form about two-thirds of the lavas exposed in the map-area the greatest concentration being in the southern belt. They have the typical buff-green weathered surface of greenstones, while fresh surfaces vary from light grey-green to dark grey. Pink and yellow colours may be developed locally. Most of the pyrite concentrations in the area occur along small shear zones in the intermediate volcanic rocks, and their rusty-brown weathered surfaces are prominent. These rocks are structurally rather featureless. No pillows were seen, and flow and colour banding (Fig. 5) are the most noticeable features. Colour banding is confined to the surface of the rock. Broken surfaces do not reveal textures or colours corresponding to the bands and they must be due to slight differences in the composition of flow layers. Lit-par-lit type of injections of granitic material into lavas were noted in the area north of the Marchant Mines prospect (Figs. 6,7.).

All the minerals found in the basic greenstones are present in the intermediate lavas, and titanite and apatite were noted as well. Actinolitic hornblende may constitute from 30 to 50 per cent of the total mineral content, while plagioclase is equally abundant. Quartz forms up to 20 per

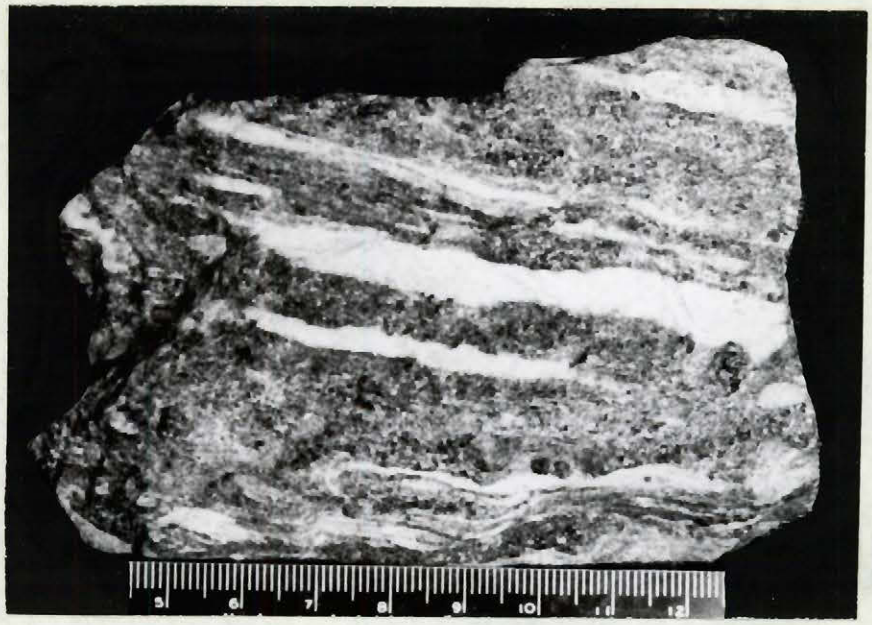


Fig. 6. Lit-par-lit type of injections of granitic material into andesites. Large garnets can be seen. Scale in centimetres. Lot 11, range V.

Fig. 7. Photomicrograph of rock type shown in Fig. 6. The granitic material is fine-grained granoblastic. Crossed nicols. x 25.

cent of some of the thin sections and may be found as inclusions in the larger hornblende and plagioclase crystals. Intergrowths of quartz in large plagioclase phenocrysts were found. The alteration products chlorite, sericite, and saussurite may constitute more than half of certain lavas. The quartz-rich andesites could be called quartz andesites or dacites, but these rocks were not distinguishable in the field.

The development of epidote has been widespread. Large epidote grains with bright, variable polorization colours are found in most thin sections. Epidote can normally be expected to form during the crystallization of the calcic-rich portions of the lavas, and sometimes develops in the more calcic parts of the plagioclase crystals.

(3) Acid to intermediate igneous rocks. There are outcrops in range IV which have light-grey to buff weathered surfaces. These rocks appear to be the most siliceous phase of the volcanic series which is exposed. They may include metamorphosed rhyolites and tuffs of probable dacitic composition, but there are no clastic textures, pillows, or other gross volcanic features which would help to positively identify these rocks. The most prominent feature of these rocks is colour banding on the surface of outcrops.

The size of the grains is about 0.4 mm., which is less than the average grain size of the intermediate or basic volcanic rocks. In thin section the quartz content of these volcanic rocks is found to be less than was estimated from hand specimens, and constitutes between 20 and 40 per cent of the rock. These rocks are more simple mineralogically than the rest of the lavas. They contain quartz, plagioclase, epidote, chlorite, and very little else. Plagioclase is often the dominant mineral found in thin sections, forming an average of 40 per cent of the specimens studied. It is of similar composition to the plagioclase of the basic greenstones. Actinolitic hornblende may be present in minor amounts, or form as much as 20 per cent of the thin section.

The mineral assemblages of these three types of volcanic rocks indicate medium grades of regional and contact metamorphism. There has been a general conversion of pyroxenes to amphiboles. Because of the grade of metamorphism that has been reached most of these rocks could be called amphibolites. The lavas may have been rich in lime as seen from the lime-bearing silicates, green actinolitic hornblende and epidote, which have been formed. The production of porphyroblastic garnets, well-formed crystals of magnetite, and a little titanite, in the volcanic rocks along their contact with ultrabasic rocks in lot 21, range IV is a contact skarn effect. Similar skarn minerals were found with the lit-par-lit granitic intrusions near the Marchant Mines prospect (Fig. 6).

Drag folding (Fig. 8), and flow folding (Fig. 9) in the less incompetent beds, show that high confining pressures and high temperatures existed. This type of deformation

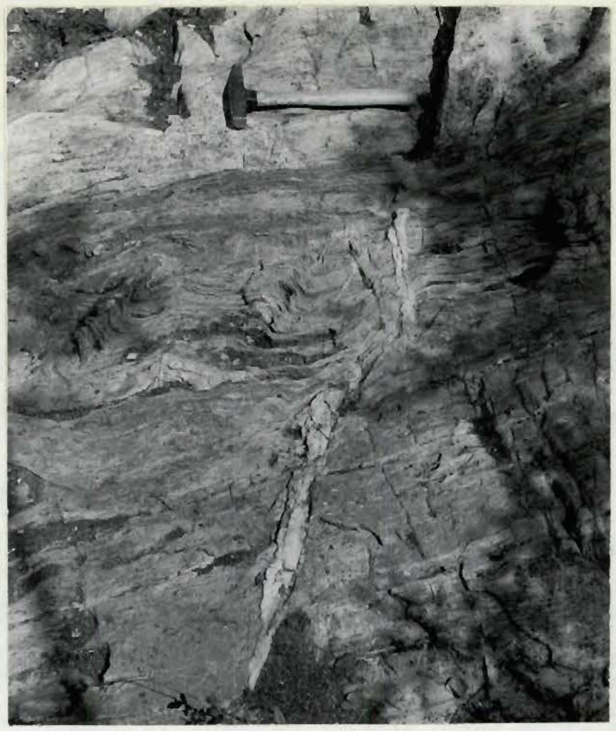


Fig. 8. Quartz-filled fracture in banded volcanic rocks. The incompetent beds show drag folding. Lot 9, range V.

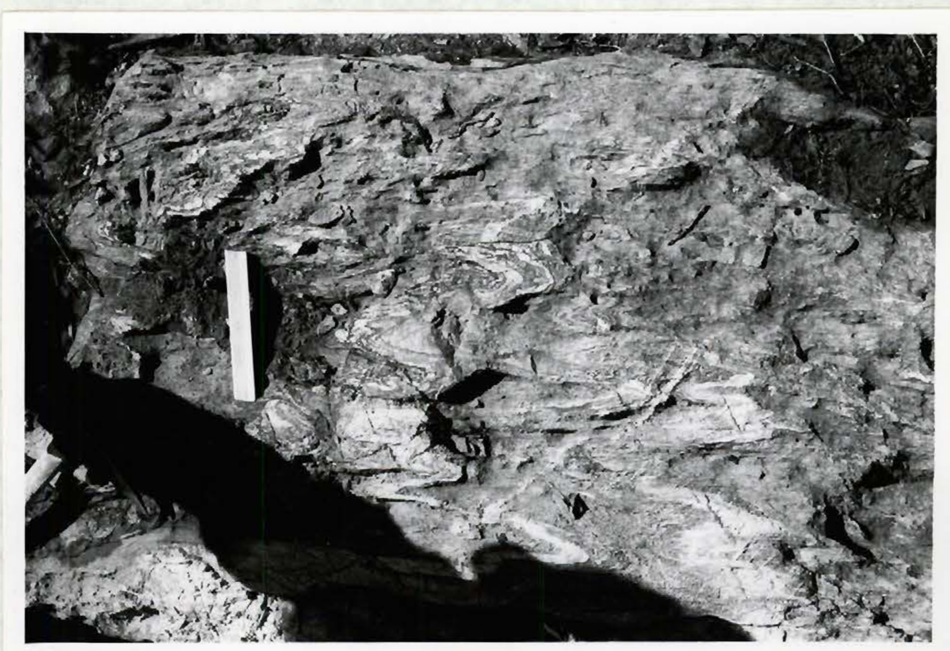


Fig. 9. Flow folding in volcanic rocks from lot 31, range II.

is characteristic of the central parts of orogenic belts. A number of minor shears parallel the general structural trend of the rocks. Concentrations of pyrite found along some of these shears are usually in the vicinity of small granitic intrusions. No major faults were observed.

Sedimentary Rocks

In lots 1 to 5, range V, approximately twelve small outcrops of metamorphosed sedimentary rocks are found along a narrow zone between the La Motte batholith and the Malartic volcanic rocks. In lot 28, range VIII, a few inclusions of sedimentary rocks are found in the granite, and a few small inclusions occur in the central area of the batholith. These are the only exposures of the Kewagama group sedimentary rocks in the map-area. Ambrose (1941), and Norman (1944), have shown that the Kewagama group overlies the Malartic group of volcanic rocks. The sedimentary rocks appear to surround the batholith, but the belt is probably discontinuous, having been disrupted by the batholithic intrusion. Norman has traced this belt westwards along the eastern margin of the batholith, through Preissac township, and into La Pause township. In the northeast quarter of La Motte township the belt is about a mile wide and four miles long, and due to cross-folding it trends northwards parallel to the west shore of Lake La Motte. This area of good exposures was mapped by Jones (1956), who found traces of original sedimentary structures which are not evident in the map-area.

The rocks have been uniformly altered to quartz-biotite schists from silty to argillaceous sediments. The prominent alignment of biotite flakes in a matrix of quartz and feldspar has developed a schistosity which follows the regional structure of the rocks. The strikes of the schistosity of inclusions are haphazard, proving that the schistosity existed before the intrusion of the batholiths. These inclusions usually have sharp contacts with the surrounding granitic material, and there is little evidence of assimilation of the inclusions.

The quartz biotite schist is fine- to medium-grained, weathered surfaces are generally grey with brown patches of iron oxide staining; fresh surfaces are varying shades of grey. Thin sections show the rock is composed of quartz, plagioclase, biotite, sericite, muscovite, garnets, chlorite, and iron oxides. Staurolite, epidote, apatite, and zircon have been noted by previous investigators.

Due to lack of twinning the types of plagioclase were not determined. Albite and oligoclase have been recognized by Tremblay (1950) and Jones (1956) in the Kewagama sediments in their map-areas. Quartz and plagioclase each constitute about 35 per cent of the rock, and they form a granoblastic groundmass across which irregular flakes of the micas and chlorites are aligned (Figs. 10,11). Feldspar can

Fig. 10. Flakes of biotite and chlorite show a preferred orientation in a granoblastic aggregate of quartz and feldspar. Metamorphosed sedimentary rock from lot 6, range VI. x 25.

Fig. 11. The photomicrograph in Fig. 10 shown under crossed nicols. Note garnet porphyroblasts. x 25.

easily be recognized in plane polarized light due to the clouding of crystals by fine grains of sericite. Biotite and chlorite constitute about 20 per cent of the rock. Garnet occurs in prophyroblasts averaging about 3 mm. in diameter.

Drill core from the Ascot Metals Corp. property was examined by Cunningham. His opinion, expressed in company reports, is that there has been widespread assimilation of the biotite schists by the granite masses. He also noted numerous inclusions of schist in peridotite bodies which were intersected by the diamond drill holes. Jones (1956) mapped a migmatite which he considers was formed by the partial assimilation of biotite schists by the Ascot biotite granodiorite mass. The degree of assimilation that has taken place is not evident from the inspection of outcrops in the map-area.

Gabbro and Diorite

These two rock types are grouped together because they appear to be of the same age, and are probably related genetically. There are many examples of diorite-gabbro complexes in western Quebec province.

Gabbro. A number of small occurrences of a quartz-bearing gabbro were observed in the map-area. The rocks are metamorphosed and should be more correctly termed metagabbro. They appear to be intrusive masses occurring as dykes or sills within the volcanic rocks. Bodies of gabbro generally trend parallel to the volcanic formations. The only clearly exposed occurrence of gabbro cutting across lavas was found in lot 9, range V, the grain size of the gabbro diminishes towards the contact indicating a chilled margin. In nearly all the cases these intrusive rocks have been identified by a grain size which is slightly coarser than that of the volcanic rocks, and occasionally by a spotted appearance caused by the alteration of feldspar on the surface of the outcrops. Gabbro and the more basic volcanic rocks are very similar, and it is difficult to differentiate between the two. Only large outcrops exhibiting a coarse grained phase of the gabbro were distinguished in mapping. The conversion of the primary minerals to those of the amphibolite facies has masked the intrusive characteristics of these rocks to the extent where an extrusive origin for most of the occurrences in the map-area cannot be discounted.

The gabbro masses are thin and roughly tabular in shape, tending to occur along the margins of ultrabasic sills. Thicknesses are variable from a few feet to two or more hundred feet. Exact dimensions are not known. Foliation is developed parallel to the regional strike of the rocks.

The gabbro is a medium-grained, massive rock. One occurrence associated with the nickel prospect in lot 20, range IV, is an unusually coarse grained variety (Fig. 12). Weathered surfaces may have a spotted appearance due to greenish-black weathering amphibole with interstitial white-weathering feldspar. Elsewhere outcrop surfaces are a uniform slate-grey to brown colour. Fresh surfaces are grey-black with flecks of light grey felsic minerals aligned parallel to the foliation.

Thin sections indicate that the mineralogy of the gabbro is similar to that of the basic volcanic rocks. Actinolitic hornblende, feldspar, quartz, chlorite, biotite, magnetite, pyrite, saussurite, sericite, apatite, titanite, garnet, and carbonates have been recognized. Amphibole, the main constituent, varies from 50 to 60 per cent of the rock. It is the same variety of blue to green actinolitic hornblende which is characteristic of the volcanic formations of the area. The grain size is variable, averaging about 0.5 mm. Prismatic crystals have ragged terminations, and have been found with sieve structures due to the crowded inclusions of quartz. Crystal edges are sometimes embayed by quartz and plagioclase. The brown biotite, and some of the chlorite, are probably alteration products of the amphibole. Chlorite constitutes as much as 20 per cent of some specimens.

The plagioclase is generally finer grained than the amphibole. It constitutes between 20 and 30 per cent of the rock. Twinning is not well developed, while a number of zoned plagioclase crystals were noted. Plagioclase varying in composition from albite to andesine was observed. No potassic feldspar was recognized. The plagioclase is altered to sericite and saussurite (Fig. 13). A few gabbro specimens,

Fig. 12. Coarse-grained gabbro associated with nickel sulphide mineralization in lot 20, range IV. Large feldspar crystal filling the south-east quarter of the photomicrograph shows faint twinning. Quartz and sericitized feldspar constitute vein-filling. Crossed nicols. x 25.

Fig. 13. Fine-grained gabbro from borehole 11, lot 9, range V. The feldspar has been completely sericitized. A few large quartz phenocrysts are seen, and the strained quartz filling the vein shows uneven extinction. Crossed nicols. x 25.

however, have "fresh" unaltered feldspar.

The gabbro contains between 10 and 20 per cent quartz which is mainly of secondary origin. It appears as inclusions in hornblende, intergrown with plagioclase in the groundmass, as phenocrysts, and as vein-filling.

The close association of the gabbro and ultrabasic masses suggests that the peridotites intruded along the contact areas were zones of weakness and were suitable for the injection of material. In core samples from the Marchant Mines prospect veinlets of peridotite were found cutting the gabbro.

Diorite. Two occurrences of diorite were observed in the map-area, located in lot 31, range III. The distinction between gabbro and diorite is based on the relative proportions of ferromagnesian minerals and plagioclase. The ferromagnesian minerals predominate in gabbro but they are subordinate in diorite. Diorite is intrusive into the volcanic rocks as is indicated by the large numbers of small inclusions of volcanic material scattered through it. The lenticular inclusions are usually less than 1 inch in length, and are aligned parallel to the foliation in the diorite.

The rock is medium-grained, the average diameter of crystals is about 1 mm., while the lengths of crystals vary from approximately 1 to 5 mm. A few scattered feldspar porphyroblasts average 8 mm. in diameter. Diorite shows little difference between weathered and fresh surfaces.

Clusters of greenish-black amphibole needles surround larger, rounded grains of white to pink feldspar and quartz.

In thin section the composition was estimated as 45 per cent hornblende, 30 per cent plagioclase, 10 per cent sericite, 5 per cent quartz, 5 per cent chlorite, 3 per cent epidote, with minor amounts of biotite, sphene, apatite, and sulphides.

Peridotite - Dunite

A series of ultrabasic rocks intrude and are intercalated with lavas, gabbros, and sediments. They occur as sills concordant with the layering in the volcanic rocks. The ultrabasic rocks are massive. They show very little of the schistosity and foliation so prominently developed in the enclosing rocks. These rocks form one of the largest concentrations of ultrabasic rocks in western Quebec province. Two main types were recognized: serpentinized dunite and peridotite. They were mapped as a single unit.

The belts of intrusive ultrabasic rocks diverge eastward in the same way that the volcanic rocks diverge. Scarcity of outcrop prevents the delineation of individual intrusive bodies and the true thickness of any of the sills is not known. Although no specific magnetic intensities shown on aeromagnetic maps can be assumed to represent ultrabasic rocks, two zones of high intensity which diverge eastward are taken to indicate the broad outline of the extent of the ultrabasic rocks (Fig. 14). High magnetic intensities may be due to the presence of magnetite in the peridotite bodies (MacLaren, 1953). The broad area of peridotite south of the La Motte batholith probably persists eastward to where it broadens out along the centre of the township in ranges VI and VII. This belt of ultrabasic rocks will be referred to as the northern belt. The broadening is due to cross-folding which Jones (1956) found occurring in the sediments west of Lake La Motte. The sills in the southern belt are found interlayered with volcanic rocks. A number of sills are due to separate intrusive bodies of ultrabasic material being formed, but tight isoclinal folding may be responsible for the duplication and thickening of some sills.

The surfaces of outcrops are smooth and rounded (Fig. 17). The best examples of glacial striations were found on these outcrops because the rocks are generally soft and easy to scratch. Weathered surfaces are shades of greenish-grey, buff, or light grey. Fresh surfaces may be blue-black or dark grey; dunites are black with greenish-yellow flecks. They are usually so fine grained that individual minerals cannot be recognized except for concentrations of magnetite, pyrite, pyrrhotite (with pentlandite), and chalcopyrite.

Petrographic examination of the ultrabasic rocks shows that antigorite is the chief serpentine mineral, replacing practically all the original constituents of the

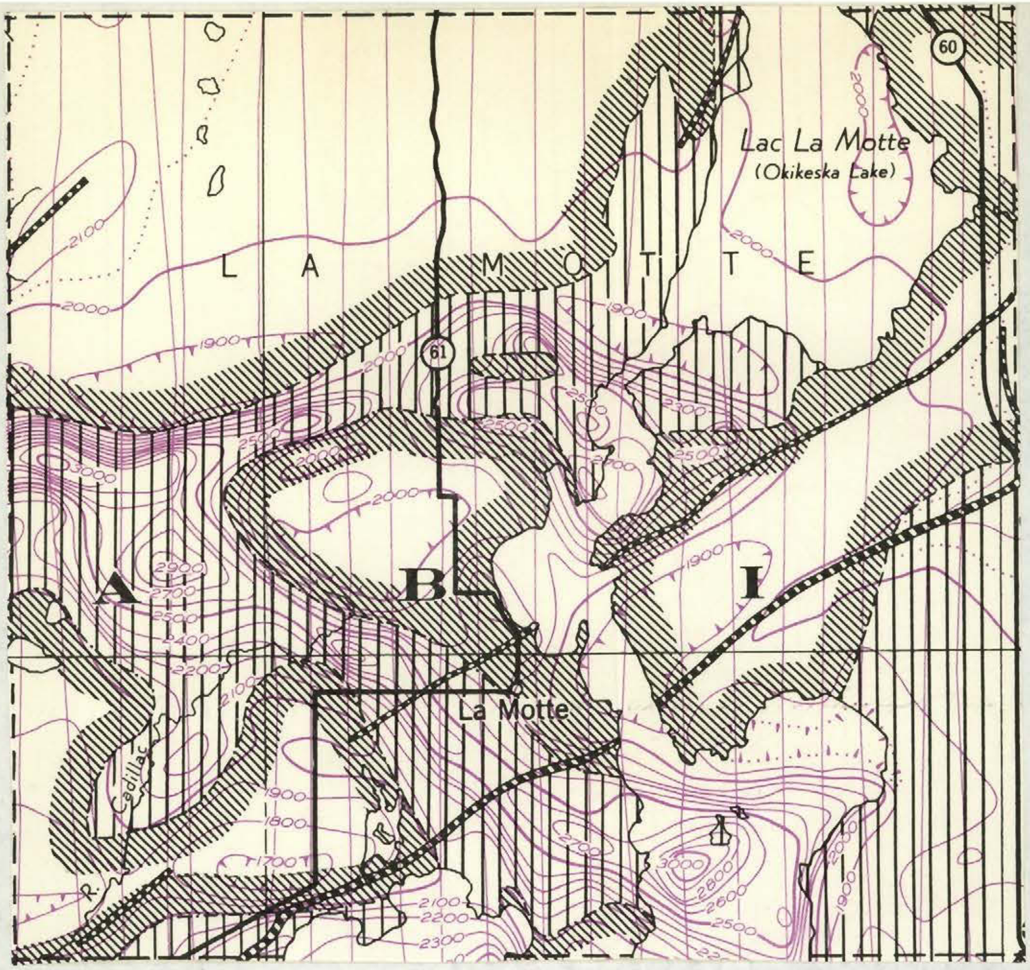
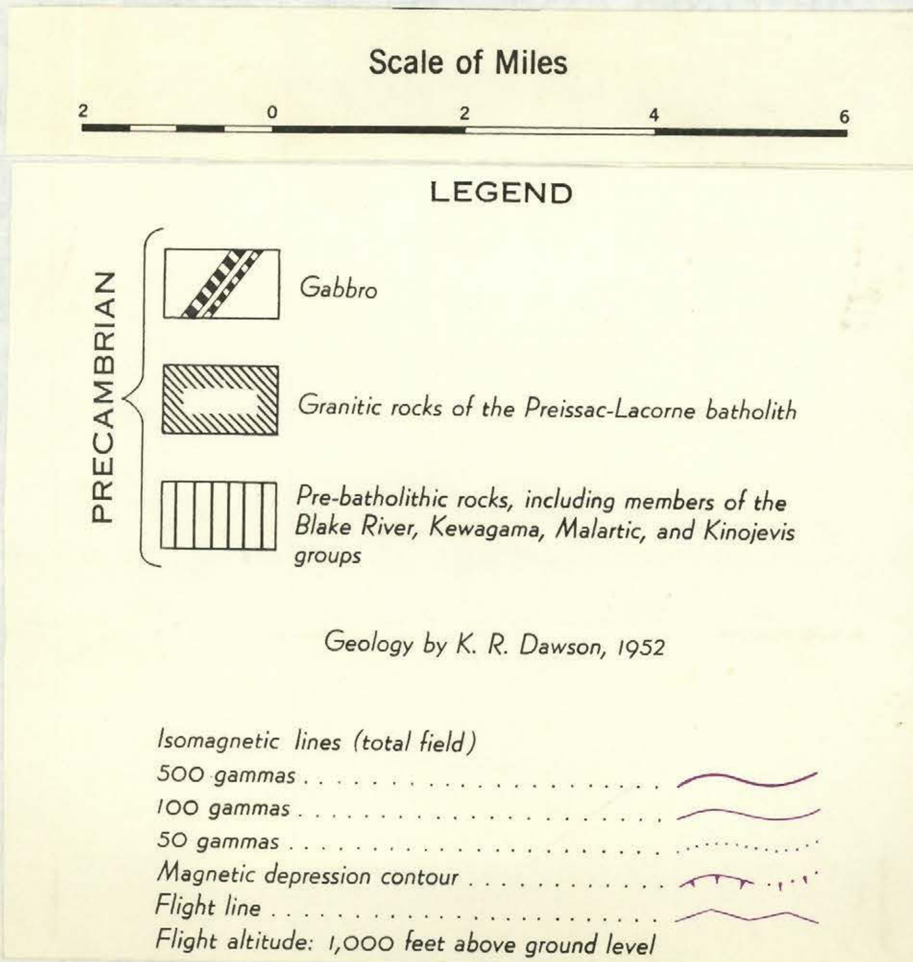


Fig. 14. Aeromagnetic map of La Motte township, Quebec. (From K. R. Dawson, G.S.C. Paper 53-4, (1954)



rock (Fig. 16). It occurs in lath-like plates, often bent, showing no directional tendencies in an interlaced arrangement. In the field the terms "peridotite" and "serpentinized peridotite" were used depending on the degree of serpentinization that was evident. In actual fact all peridotites and dunites are serpentinized to a greater or lesser degree. Thin sections examined failed to reveal easily recognizable pyroxene, or pseudomorphs after pyroxene, and therefore it is likely that most of the outcrops mapped as peridotite are actually dunite.

Serpentinized dunites have pseudomorphs after olivine, usually rounded rather than euhedral in outline (Fig. 15). They are composed of antigorite showing characteristic radial extinction, and low bluish-white interference colours. Serpophite, the compact variety of serpentine, was noted in small quantities. Serpentine alters to chlorite and probably more than one variety of chlorite is present.

Primary and secondary serpentine minerals cannot be separately identified. Most of the serpentine is assumed to be an alteration product formed by the metamorphism of primary olivines, and to a lesser extent, pyroxenes. "Serpentinite" would perhaps be the more appropriate term to use when describing the many occurrences of ultrabasic rocks where it is impossible to determine whether the original rock was a dunite or peridotite.

Magnetite is found in small grains outlining olivine pseudomorphs, or strung out in lines in what appears to

Fig. 15. Rounded pseudomorphs after olivine in a serpentinized dunite from lot 9, range V. Note grains of magnetite surrounding the pseudomorphs. x 25.

Fig. 16. Same specimen as above under crossed nicols, showing the original crystals have been replaced by a felty mass of antigorite. Crossed nicols. x 25.

have been interstitial material. Large, well-formed magnetite octahedra are found in the same specimens with small grains of magnetite, and have had a different mode of origin. Some magnetite was released during the original serpentinization process, and the granitic intrusions also caused the precipitation of magnetite in skarns zones. Varying amounts of talc are found concentrated along fractures. Anhedral carbonate material is of widespread occurrence, and calcite crystals are found in some fractures. Chrysotile of the cross-fibre type occurs in a few veinlets. Tremolite in acicular felty masses was identified in hand specimens.

Minute amounts of a violet coloured mineral were found in small fractures in serpentinized dunite specimens from the Marchant Mines prospect. Using refractive index liquids the mineral was identified as paucilithionite, a variety of lepidolite.

Pyrite is of fairly widespread occurrence. Chalcopyrite was only found in limited amounts at the nickel prospects in lot 9, range V, and lot 20, range IV. Pyrrhotite is easily recognized in the massive sulphide bodies; but the nickel mineral pentlandite cannot be macroscopically identified, and is probably enclosed in small grains in the pyrrhotite. Nickel could have been released from olivines or pyroxenes during the serpentinization process and then deposited in shears.

Contact effects are rarely found in the ultrabasic rocks, and alteration of the host rock by the intrusion of the peridotites and dunites is slight. In a few instances, for example in lot 21, range V, metamorphic effects on the enclosing rocks are seen. A skarn contact effect has resulted in the production of large euhedral pink garnets and coarse clusters of magnetite crystals in the volcanic rocks.

Two principal mechanisms have been generally proposed for the formation of serpentine minerals in ultrabasic rocks: serpentinization by hydrothermal processes, and serpentinization by autometamorphic processes. Turner and Verhoogen (1951) have summarized the various arguments on the subject. They admit both processes may take place, but they favour the hydrothermal process. Solutions from outside sources would thus form the serpentine minerals by reaction with the olivine and pyroxene present in the ultrabasic rocks. Talc is a common constituent, and the steatization process, which is the formation of secondary talc or soapstone in the ultrabasic rocks, may have occurred at the same time as the serpentinization process (Turner and Verhoogen), or may be due to solutions from the batholithic intrusions (Hess, 1933).

All pre-batholithic rocks in the area have been metamorphosed to the amphibolite facies with the result that very dark, fine grained basic volcanic rocks are similar in appearance to peridotites. The two rock types in the large outcrop west of Highway 61, range I, were difficult to outline, as was the area of outcrops between lots 25 and 29, range III. The most difficult task of all was distinguishing basic volcanic rocks from peridotites in the diamond

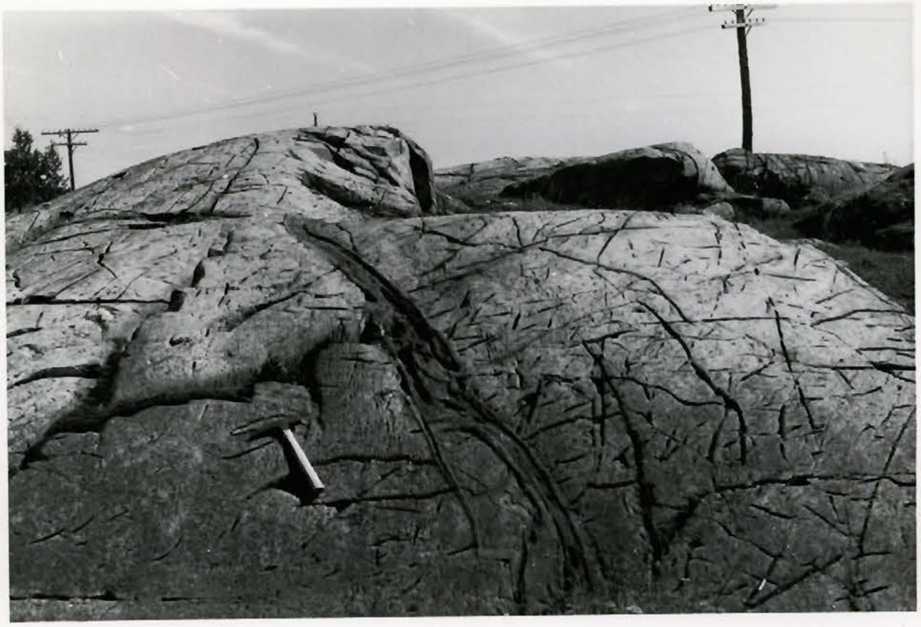


Fig. 17. Smooth, rounded surface of peridotite outcrop in lot 24, range IV. Fracture patterns are typical of peridotites in the La Motte area.

Fig. 18. Polygonal fractures in peridotite in lot 30, range II.

drill cores from the Marchant Mines nickel prospect in range V. Here all the core was originally logged as varieties of ultrabasic rocks, the term "silicified peridotite" being applied to a rock type which is more likely an altered basic volcanic rock. A few contacts between ultrabasic and volcanic rocks were seen, but in many instances the rocks appear to grade into one another. This uniform appearance is due to the widespread alteration the rocks have undergone.

Two well-developed features help to identify the ultrabasic rocks in the field: (1) hachured structures; (2) fracture patterns.

(1) Groups of parallel thin plates of antigorite, tremolite, and magnetite alternating with equally thin bands of clinochlore (MacLaren, 1954) are oriented to produce a patterned effect, termed "hachured structure" by Jones (1956). In Fig. 19 the manner in which the groups of plates truncate each other can be clearly seen. The groups of parallel plates are not more than one or two inches long, and usually less than one inch wide. A satisfactory explanation of their formation has yet to be given. MacLaren (1954) believes they are the result of movement, but their haphazard orientation rules out shearing along directions of weakness. They may be flowage phenomena, or the result of an original pattern of crystallization of the minerals.

(2) Another distinctive structural characteristic is of more widespread occurrence; fracture patterns form

ing crude polygonal shapes (Fig. 18). The fractures may have been formed across the width of ultrabasic sills in the same way as columnar jointing froms in basalts. The fractures have been filled with talc, carbonate, serpentine, and other secondary minerals, and when deformed, the polygonal shapes are similar to pillows in appearance.

In drill core some joint and fracture surfaces showed evidence of slickensides, and zones of talc schist prove that far more deformation has taken place than is evident from surface exposures (Fig. 20). The contacts between ultrabasic rocks and lavas are marked by talc schists in some cases. Examination of drill cores shows granite dykes of varying widths cutting the ultrabasic sills. Alteration due to the batholithic intrusions may have caused precipitation of secondary magnetite in the ultrabasic rocks.

Peridotite bodies are characteristic early-stage intrusions in an orogenic cycle, and are emplaced along the axial regions of geosynclines. They have been found in the central regions of most mountain chains in the world and are usually associated with large batholithic masses which are common to the later stages of an orogenic cycle. The La Motte rock type associations of ultrabasic rocks and granites suggests that the remnants of an old mountain chain are centred over the La Motte area.

Fig. 19. Hachured structure in peridotite from lot 12, range I. Dark bands are composed of antigorite, tremolite and magnetite. The colourless mineral in the light bands is clinochlore. Crossed nicols. x 25.

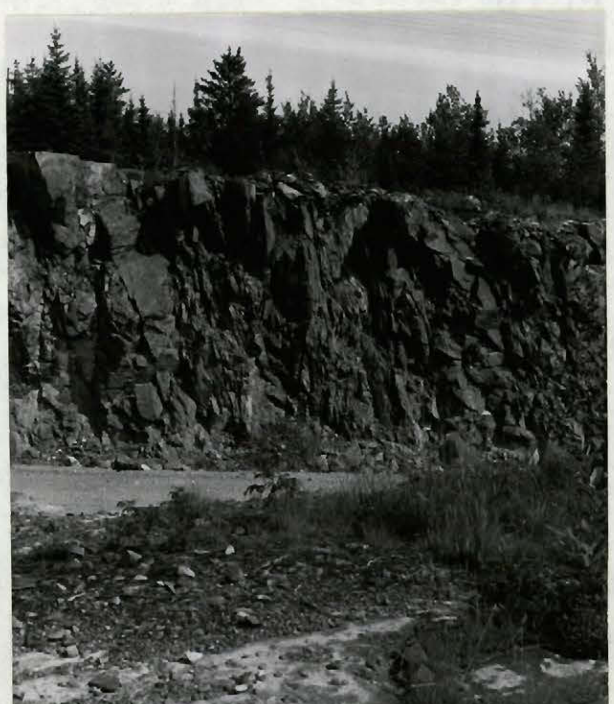


Fig. 20. Wide shear zone in ultrabasic rocks exposed in a road-cut in lot 28, range VI. Note absence of indications of the shear on surface of outcrop in foreground.

BATHOLITHIC ROCKS

General Statement

The granitic rocks which occupy about 75 per cent of the map-area, are part of the Preissac-La Motte-La Corne batholithic and satellitic masses; their distribution is shown on the accompanying map No. 2 compiled by the Geological Survey of Canada. In the northern part of the map-area muscovite- and biotite-bearing quartz monzonite rocks of the La Motte batholith underlie most of four ranges. Biotite granodiorite rocks of the Malartic stock fill most of the central part of ranges I, II, and III. The area west of the Cadillac River, in the southern half of the map-area, is occupied by rocks of the Preissac batholith which are very similar to those of the La Motte batholith. A small mass of biotite granodiorite west of the main highway in range VII will be referred to as the Ascot Stock as it underlies claims once owned by Ascot Metals Corp. A small body of epidote-rich aplite granite is situated east of the centre of the map-area.

Norman (1942), Tremblay (1950), Dawson (1954), Rowe (1953), and Halferdahl (1954), have all concluded that the three main batholithic masses, along with associated pegmatites, aplites, and quartz veins are derived from a common magma at depth. In the field two main rock types are recognized: biotite granodiorite, and garnetiferous muscovite-and biotite-bearing quartz monzonite. Through contamination of the acid granitic magma by digestion of more basic country rocks a series of hybrid rocks have been formed. Mafic schlieren and inclusions, and migmatitic rocks are found, but scarcity of outcrops has prevented the delineation of these hybrid members of the granitic complex. Aplites and pegmatites which developed from the residual solutions of the magmas cut the granodiorite and monzonite. The granodiorite was intruded before the monzonite. The granodiorite is finer grained, gneissose, rich in biotite and contains fewer aplites and pegmatites than the monzonite. Aplite bodies in the monzonite are similar to the pegmatites in mineralogy; they often grade into pegmatites and differ only in grain size.

Map No. 2 is the tectonic map of the Preissac-La Corne batholith area compiled by Dawson (1954). This map shows the strikes and dips of all structural features including joints, lineations, and dykes; a general picture of the structure of the batholithic rocks can be gained by its study.

Biotite Granodiorite

The granodiorite mass underlying ranges I, II, III and a small portion of IV is part of the Malartic stock which lies astride the La Motte-Malartic township boundary. The stock has been described by Dawson (1954) as a satellitic mass genetically related to the main batholiths in the area. A second smaller mass of biotite granodiorite in lots 29 and 30, range VII is the western extension of a granodiorite body centered in ranges VI and VII in the east half of the township. For the sake of convenience this mass will be called the Ascot stock as it underlies claims once owned by Ascot Metals Corporation. To differentiate between offshoots from these two granodiorite masses and the younger Preissac and La Motte monzonite batholiths, classification based on their plagioclase content was made. The younger intrusives were found to contain a higher percentage of potash feldspar whereas older intrusives have more than twice as much plagioclase as potash feldapar.

Biotite granodiorite outcrops are generally small and isolated and occupy low-lying ground, whereas the monzonite masses commonly form prominent hills. Selvages of granodiorite are found along the margins of harder weathering gabbro dykes and peridotite outcrops. Contacts are sharp, and varying degrees of alteration in the invaded rocks are commonly found. These granodiorites weather light greyish-white and are fine to medium grained. Biotite flakes are generally aligned parallel to the regional strike of the formations and develop a gneissose appearance in the granodiorite. The rock is composed of quartz, biotite and feldspar. The feldspar is generally white and is difficult to identify, and staining techniques had to be used to indicate the amounts of potassic feldspar present. Staining showed that there is usually more than twice as much plagioclase as orthoclase. The orthoclase is generally concentrated in the fine grained interstitial material.

In thin section the texture of the rock is allotriomorphic; mineral boundaries of most crystals are determined by their neighbours, and accessory minerals are well developed (Fig. 21). No coarse grained granodiorite was found. The larger grains of plagioclase are seldom more than 3 or 4 mm. in size and the minerals in the matrix are too small to be determined macroscopically. Oligoclase is the normal plagioclase and invariably constitutes 50 per cent or more of the rock. Tremblay (1950, p. 36) determined the composition of the oligoclase by index liquids to be about An_{18-23}. Jones (1956), studying the Ascot stock, found zoned grains of plagioclase with "...cores ranging in composition from calcic oligoclase (Ab_{75} An_{25}) to labradorite (Ab_{60} An_{40}), progressively changing in composition to outer zones of oligoclase ranging from (Ab_{82} An_{18}) to (Ab_{75} An_{25}), the more calcic cores having more calcic outer zones." Zoned plagioclases were found only in specimens from the eastern edge of range VII, and it must therefore be concluded that the Ascot granodiorite mass has a slightly different cooling history from that of the Malartic stock. It was also noted that plagioclase in the Ascot granodiorite mass is rarely twinned whereas twinning is commonly seen in plagioclase from the Malartic

Fig. 21. Photomicrograph of biotite granodiorite showing allotriomorphic texture and development of the mafic minerals. Lot 13, range I. x 25.

Fig. 22. Contact of granodiorite and peridotite in Lot 7, range III, showing broken fragments of granodiorite in the peridotite. This is indicative of forceful intrusion of the granitic magma into a partially mobile ultrabasic body.

stock.

Halferdahl (1954, p. 30) gives the composition of the granodiorite of the Malartic stock as: (point count in weight per cent)

Quartz	33.2
Microcline	0.6
Plagioclase	56.8
Biotite	6.3
Titanite	0.2
Epidote	2.5
Chlorite	0.4

Similar compositions were noted in the present study, but up to 10 per cent orthoclase was found in some sections, and quartz usually varied between 20 and 30 per cent in quantity. Small amounts of hornblende were noted in a few cases. A specimen from range II, lot 27 has oligoclase phenocrysts with an unusual reddish colour. The high proportion of hornblende, constituting 15 per cent of this rock, might indicate local contamination. Almost 2 per cent of this specimen was found to be titanite.

Microcline, found interstitially, appears less altered than the plagioclase. Sericite is the usual alteration product of feldspars, and flakes of biotite show alteration to chlorite. Epidote is an alteration product of hornblende and is believed to be found mainly near the contacts with the intruded rocks. Pleochroic haloes around zircon inclusions in biotite are a common feature. Apatite and magnetite are the other accessory minerals.

Quartz in grains of variable size is mostly interstitial and is sometimes seen as small inclusions in feldspar crystals. It may replace plagioclase in places indicating that plagioclase crystallized before the quartz; some of the quartz may be secondary.

Tremblay (1950, p. 36) describes two small masses of granodiorite in La Corne and Senneville townships which appear to be very similar in mineralogical composition and mode of occurrence to the biotite granodiorite in the La Motte area. Tremblay believes the granodiorite to have differentiated from the muscovite granite phase of the La Corne batholith. In the writer's opinion the Malartic granodiorite stock was injected before the La Motte batholith intrusion. This problem is discussed in the next sub-section. There are no field relations to establish the relative ages of the La Corne and La Motte masses, and therefore the relative ages of the various granodiorite masses cannot be established.

Granitic intrusions are rarely seen to transect peridotite outcrops, but in diamond drill core many granitic dykes and veins cut the ultrabasic rocks. Fragments of biotite granodiorite in peridotite (Fig. 22) were found along one contact, which indicates that there may have been partial mobilization of the metamorphosed and altered ultrabasic mass during the intrusion of the granodiorite body.

Muscovite- and Biotite-bearing Quartz Monzonite

This rock type forms the major part of the La Motte and Preissac batholith masses in the map-area. Pegmatites in irregular masses or dykes and aplitic material constitute almost half the mass of the batholith in places. They are fully described in the next sub-section.

Although the boundary of the La Motte batholith appears to be in the vicinity of the belt of pre-batholithic rocks in range VI, it is evident that La Motte and Preissac granitic masses are linked at depth because of the similarity of their appearance, and mineral and chemical compositions. Dawson (1958, p. 232) states, "The mineralogical homogeneity of the quartz monzonite supports the hypothesis that it has been derived from a single magma source at depth".

Various names have been given to the rock type:-

Gussow	- garnetiferous muscovite-leucogranodiorite
Norman	- muscovite granite, biotite granite, pegmatite.
Dawson	- quartz monzonite.
Jones	- muscovite quartz monzonite.
Halferdahl	- biotite muscovite granite.

The rock is best termed a quartz monzonite because of the high oligoclase content of the granites which is approximately equal to the alkali-feldspar content.

The monzonite outcrops are the most prominent physiographic features in the area. Generally the rock is almost pure white, and white weathered surfaces are visible from long distances when they are scantily covered by vegetation. In places concentrations of biotite give the rock a greyish colour, elsewhere pinkish feldspars and concentrations of red garnets give the rock a reddish appearance. The high content of garnets is a distinctive feature of the quartz monzonite. The rock is mostly massive and coarse grained. Quartz, feldspar, muscovite, biotite, and garnet are recognizable in hand specimens. In addition, epidote concentrations, a distinctive light greenish - yellow mica, and very occasionally pyrite is seen.

Study of thin sections reveal that the texture of the rock is allotriomorphic. Large, well-formed crystals of feldspar, which are not zoned, and mica are partly embayed by round, clear quartz grains, as well as by microcline and orthoclase. In order to distinguish the types of feldspars present, polished sections were stained and approximately half, or more than half of the feldspar was found to be potassic. Epidote, chlorite, and sericite are secondary minerals. Apatite, titanite, garnet, and zircon are accessory. Tremblay (1950, p. 38) found that the garnet in the pegmatites of the muscovite granite in La Corne township is spessartite, whereas Gussow determined that the garnet in the granite itself is almandine. Interstitial feldspars and quartz occur in small amounts between the larger grains. Myrmekites were noted by Jones and Gussow, and some graphic intergrowths of quartz and feldspar were noted in the field.

Inclusions vary in size from minute patches of mafic material to roof pendants hundreds of feet in length which are found in lot 4, range II. The smaller inclusions are generally highly schistose and completely altered so that their original compositions cannot be ascertained. Although granitic material appears to have been added to the inclusions producing secondary quartz and feldspar, nevertheless contacts are sharp and the surrounding monzonite appears uncontaminated. The volcanic roof pendants have shallow dips to the east, while regional dips are to the northeast (Fig. 23). This change in attitude of the volcanic beds may be suggestive of the forceful intrusion of the batholith.

The La Motte quartz monzonite is very similar to the La Corne muscovite granite (Tremblay, 1950, p. 37) in many details. The main difference appears to be the type of plagioclase in the granites - the La Motte monzonite has mainly oligoclase and some albite, whereas the La Corne granite has albite as the only plagioclase. Another basic difference is the biotite content of the La Motte monzonite; this mineral is not found in the La Corne granite. Jones (1956, p. 50) found aplite dykes similar in composition and texture to the muscovite quartz monzonite cutting biotite granodiorite, therefore the monzonite probably intrudes the granodiorite and is younger than the granodiorite. He also noted complex interfingering between granodiorite and monzonite in some outcrops; contacts are sharp, and the monzonite shows some evidence of having a chilled margin against the granodiorite. Dawson (1958, p. 225) states "The lack of linear anomalies parallel with the strike of the enclosing

Fig. 23. Part of a roof pendant exposed in lot 4, range II. The banded volcanic rocks, locally intruded by granite, are resting on top of the hill of granite shown in Fig. 1.

Fig. 24. Epidote (dark grey), sericitized feldspar (light grey), quartz (white), and wedges of titanite (black) in epidote-rich aplite granite. Lot 23, range V.
x 25.

rocks and the low content of mafic materials make it unlikely that the quartz monzonite is a granitization product of the enclosing biotite schist, greenstone, and serpentinite."

Pegmatites and Aplites

Pegmatites and aplites which stem from the granitic masses are found in the form of irregular masses and dykes cutting the batholiths and the surrounding older rocks. Pegmatites occur in two forms, complex or simple. More than 90 per cent of the pegmatites are simple, and do not contain the rare elements found in the complex types. In addition simple pegmatites show no internal zoning of their minerals. A regular distribution of complex pegmatites about the batholiths has been noted by earlier investigators. In the inner portions of the granite masses pegmatitic material is in the form of dykes and veins, whereas around the edges of the batholiths pegmatites occur mainly as irregular masses. Pegmatitic solutions were thus concentrated in the border zones of the intrusives, possibly because the outward migration of the solutions was restrained by the enclosing prebatholithic rocks. In a road-cut in lot 28, range VI, massive pegmatitic material of the border zone can be seen truncating volcanic beds (Fig. 25), and veins of quartz and pegmatite are injected along bedding planes. Fewer pegmatites were seen in the Malartic and Ascot biotite granodiorite stocks.

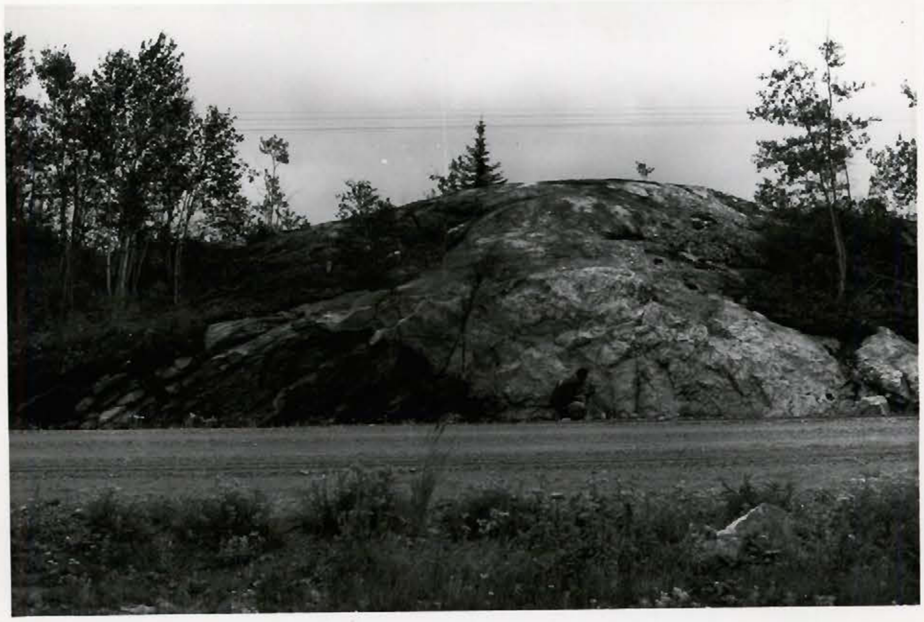


Fig. 25. Intrusive contact between northerly dipping volcanic beds and the northern edge of the La Motte batholith. Road-cut on main road to Amos in Figuery township.

Fig. 26. Concentrations of garnet and mica produce banded structure in pegmatite granite exposed in road-cut shown in Fig. 25.

Jones (1956, p. 58) found the major strike directions of pegmatites west of Lake La Motte to be between N. 70° W. and N. 80° W., or east-west. Widths vary from less than an inch to tens of feet, lengths being also very variable. The pegmatites are believed to fill fractures developed during the cooling stages of the batholith.

Macroscopically the pegmatites are either white, or pinkish, due to concentrations of red garnets or pink feldspar. Quartz, feldspar, muscovite, and smaller quantities of garnet and biotite are easily recognizable. Coarse textures and zonal structures which develop are shown in Fig. 26. Spodumene was found in clusters of small white crystals in lot 7, Range VI. Molybdenite in scattered flakes or pockets was found in lot 4, range VII, and lot 4, range II. The latter occurrence is in a wide quartz vein which grades into the surrounding pegmatite granite and has inclusions of pegmatitic material. A few large crystals of bismuthinite are associated with the molybdenite in this occurrence. Beryl and columbite-tantalite was not found in the map-area. Garnets occur in well-formed, red crystals and are of widespread occurrence.

Economic deposits of spodumene and molybdenite as well as scattered occurrences of beryl, columbite-tantalite, and lepidolite have been found in complex pegmatites of the Preissac-La Corne batholith. Consequently they have been fully described by previous investigators*.

* For detailed descriptions see Tremblay (1950), and Rowe (1953).

The commercial deposits are all associated with the La Corne granite mass. Halferdahl (1955, p. 47) explains this difference by showing that the La Corne granite contains twice as much lithium as the La Motte granite. During crystallization the micas, especially biotite, in the La Motte mass retained more lithium than the hornblende of the La Corne mass, therefore the residual solutions of the La Corne mass contained a greater proportion of lithium. Siroonian (1958) recognizes that "...the last major differentiate of the batholiths was parental to the lithium-bearing pegmatites found in the area." He also proved that the granite contains three times as much lithium as the granodiorite. Beryl-bearing pegmatites occur in zones within the batholiths, spodumene, and molybdenite pegmatites near the contact or in pre-batholithic rock near the contact of the batholiths. Aplites are similar to pegmatites in mineralogy and are found grading into pegmatites. Quartz veins, and pegmatitic quartz veins are genetically related to the other late intrusives and are included in this section.

Epidote-rich Aplite Granite

A small group of outcrops occurs between lots 22 and 26, near the road between ranges V and VI. Norman (1944) mapped these rocks as hornblende syenite. The rock is fine to medium grained, slightly pinkish in colour with green flecks which were identified as hornblende in the field. In thin section and using staining techniques the rock was seen to be composed of about 55 per cent plagioclase (albite to oligoclase), 15 per cent orthoclase and microcline, and 15 per cent quartz. Epidote, chlorite, biotite, and small quantities of titanite, and sericite are the remaining constituents (Fig. 24). The texture is allotriomorphic-granular with interlocking anhedral grains of feldspar. The writer concluded that the rock is an epidote-rich aplite granite representing the last water-rich phase of a batholithic intrusion. A very strong lineation strikes about S. 75° E. and may indicate that this aplite granite is part of the earlier biotite granodiorite intrusions. The low percentage of potassic material also shows that its composition is closer to that of the granodiorite than the monzonite.

A peridotite-aplite contact is exposed, and there is ample evidence of assimilation of basic material by the aplite, and silicification of pendotite near the contact.

GABBRO DYKES

Three major dykes of gabbro are present in the area. They shall be referred to as the southern, middle and northern dykes. The northern dyke crops out to the west of the esker in range IX. The southern and middle dykes are found outcropping in the southern third of the map-area. Their mineralogy, attitude, and other characteristics are similar to those of dykes occurring elsewhere throughout the Rouyn-Bell River area. Their strike averages N. 55° E, the major direction of strike of such dykes in the region. A second direction of strike of approximately N. 25° E has been reported for dykes of this type in the general area. Local variations of strike produce rather sinuous forms. The southern dyke is the widest, averaging 200 feet. The other two vary in width from 100 to 150 feet. The dykes are not continuous in outcrop.

Contacts with the invaded rocks are always sharp. The gabbro is chilled to a fine-grained texture for a width averaging 18 inches along contacts, but chilled margins up to 3 feet in width have been found. Grain size gradually increases towards the centre of the dyke. Contacts vary markedly in attitude. At some places contacts are straight and follow the general strike of the dyke; in others they follow irregularly scalloped outlines. The thicknesses of the dykes thus vary by as much as 20 feet within short distances along strike length. Scalloped contacts and variable thicknesses are particularly noticeable in range 1, lots 8 and 9, where the dyke cuts the older gabbro of the peridotite-gabbro complex.

The rough weathered surface of the dykes is brown due to the break-down of ferromagnesian minerals to form iron oxides. The fresh unweathered surface is a dark greenish grey, and breaks with an angular fracture. Macroscopically the dykes are aggregates of feldspar of lath-like habit, pyroxene and minor epidote and pyrite.

Offshoots of the major dykes form stringers a few inches wide having any attitude and small subsidiary dykes up to 15 feet wide paralleling the parent dyke in strike in some places (Fig. 27). Three such subsidiary dykes occur along the southern side of the northern dyke. In range 1, lots 13 and 14, and in range 11, lot 15 subsidiary dykes strike N. 25° E. The outcrops show a total thickness of dyke rock of 25 to 30 feet. These dykes may be individual offshoots from the main dyke, or more likely, they may be part of a smaller dyke whose strike corresponds to the second main direction of strike reported by numerous authors. A small gabbro outcrop in range 1, lot 9, is surrounded by peridotite and granite. Its relation to the rest of the dykes in the area is unknown.

In range IV, lot 28, the middle dyke is interrupted across strike by peridotite. The dyke has a chilled contact against the peridotite and it appears that the dyke failed to reach the present surface. This type of occurrence is probably common, but is obscured by alluvium and glacial material. Where outcrops of dyke rock are found, however, they are high and prominent and have rounded tops. A selvage of the invaded rock is often found on the side of the outcrop.

Strong joints with nearly vertical dips are common. The two main directions of joints in the dykes average N. 45° E. and S. 40° E. paralleling and cutting at right angles across the dykes respectively. This system is likely due to contraction on cooling. The joints in weathered outcrop often stand out as ridges up to 1.5 cm above the weathered gabbro surface due to alteration along a narrow zone. A band of iron staining on either side of the joint is due to the concentration of magnetite around the joint (Fig. 28). Epidote and chloritic material are also present in joints and cracks.

Xenoliths of volcanics, some containing appreciable pyrite, are included in the southern dyke in range 11, lot 30.

In range 11, lot 30, contacts on opposite sides of the dyke appear to have been displaced perpendicularly across the width of the dyke. This would indicate that the dykes were forcefully emplaced, pushing aside the country rock. Little or no replacement of the wall-rock took place. Ambrose (1941) suggests that the dykes fill tension cracks, the above

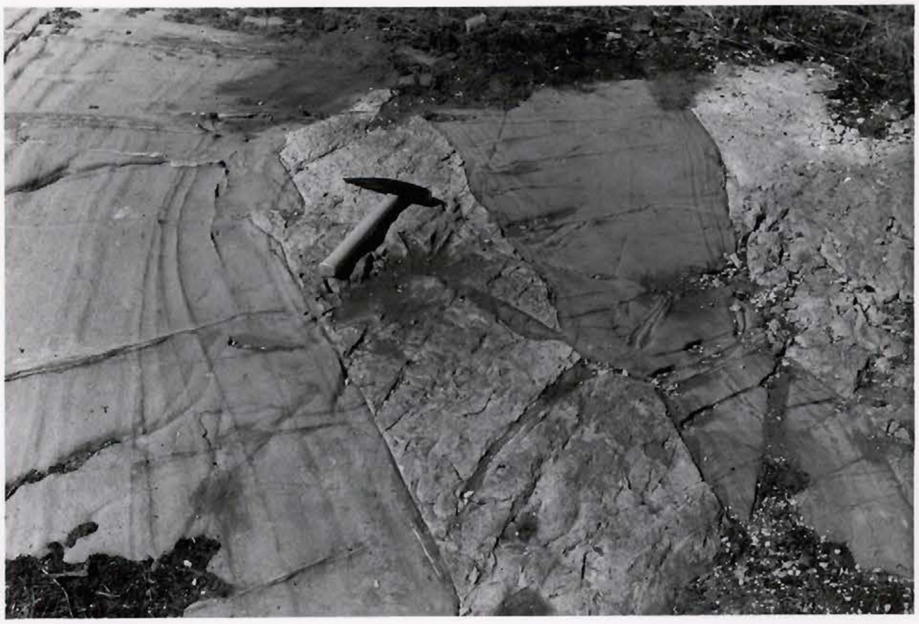


Fig. 27. Offshoot from a gabbro dyke encompassing an angular block of granite. Well defined "flow lines" parallel the sharp contacts of the dyke. Lot 13, range I.

Fig. 28. Fluted structure in gabbro dyke, probably a type of 'flow banding'. Iron staining is seen on either side of the joint. Lot 13, range I.

evidence does not disagree with this. The dykes cut across all the formations found in the area, and are the youngest consolidated rocks in the area. All that may be said regarding the actual age of the dykes is that they are younger than the youngest granite and are probably Precambrian in age. L'Esperance (1951) found this to be the case in the area he mapped.

PLEISTOCENE GEOLOGY AND PERIGLACIAL EOLIAN FEATURES

General Statement

Glacial Lake Barlow-Ojibway covered all of the present surface of the area with the possible exception of part of the granite uplands; clays and silts deposited in this lake obscure most of the pre-Pleistocene geology. Other deposits related to the ice-retreat are an esker, sand plains (some of which are wind-blown, and some of which are beach deposits), and glacial erratics.

Freeman (1957), p. 184) has drawn attention to the fact that the formation of eolian sand-dunes has not been thoroughly investigated by previous observers of Pleistocene geology in western Quebec. He describes an area of U-shaped eolian dunes in which the convexities all face south of east. Cooke, James, and Mawdsley (1931, p. 157) note that "Airplane photographs of the sand areas in Quebec show great numbers of dunes, with a convexity very beautifully developed and in all cases facing almost due east." Thus eolian features may be of wide-spread occurrence, and the present description of dune features noted in the map-area supplements the data presented by Freeman (1957, pp. 184-223).

Eskers

The south-trending esker which crosses the four northern ranges of the map-area and appears to terminate in range IV, is shown by Wilson (1938) to be part of a major esker which is over 100 miles long. The esker is not continuous along its whole length, and is variable in its appearance.

A stereoscopic study of the aerial photographs (Figs. 29, 30) of the area shows the esker as a small sinuous ridge in the middle of a wide plain of sand. The vegetation growing on this sand plain and sand ridge is limited almost exclusively to jack pine, with the result that it can be easily distinguished from the clay belts where spruce and alders grown on the poorly drained soil.

Wilson (1938, pp. 52-53) describing the origin of this type of esker states:

> When a glacial stream enters a large lake its load of coarse sediments is deposited as a delta at the edge of the ice-front, while the finer sediment is carried further out. Each year, over a wide area, one fan-shaped layer is deposited, and the layer is thickest at the centre, where it is of sand or gravel, becoming thinner where it is silt or clay.
> Each year the ice-front recedes by melting, and thus the annual layers overlap. The overlapping of many annual delta deposits along the old course of the stream produces a sand ridge, or esker, which grades gently on each side to areas underlain by varved clays. It is clear that eskers made in this way will be large features with indeterminate boundaries.

These overlapping delta deposits may be called retrogressive deltas.

Wilson says that the central ridge due to the de-

Fig. 29. Aerial photograph, approximate scale 1 inch to 1,000 feet, showing central sinuous ridge of the esker on the extreme left. Flanking the eastern margin of the esker are clusters of U-shaped eolian sand dunes.

Fig. 30. Aerial photograph, approximate scale 1 inch to 1,000 feet, showing old shorelines on the west side of the esker. Note distinctive drainage pattern.

position of material along the course of a sub-glacial stream was later buried beneath the delta deposits.

In his studies of the last Pleistocene ice front in the Chibougamau district Norman (1938, p. 80), considers that large eskers and sand plains whose width is greater than the annual retreat of the ice front, estimated to be between 500 to 700 feet, are retrogressive deltas formed along a receding ice shoreline.

Along the esker there are a number of small depressions, one of which is filled with water. These are thought to be kettle holes formed by the melting of ice blocks trapped in the delta sands. The small lakes along the eastern edge of the esker sand plain, on the other hand, were probably formed in wind-scoured deflation hollows. These lakes have been described in the section on Physiography.

During the lowering of the waters of Lake Barlow-Ojibway the esker became a shore feature. Old shorelines on the west side of the esker can be clearly seen on the aerial photograph (Fig. 30).

Sand Dunes

Flanking the eastern margin of the esker in ranges VII, IX, and X, is an area about 1 mile wide which is covered with sand dunes of distinctive shapes and sizes. The dunes are either parallel, slightly curved ridges, or nested clusters of U-shaped ridges with convexities pointing south of east in all cases (Fig. 29). Parallel ridges are generally between 100 and 500 feet apart, and seldom more than 30 feet high; lengths are variable. U-shaped ridges are of the same size with the inner side of the curve steeper than the convex side in most cases. The number of dunes in the area cannot be estimated because in some cases dunes overlap, form clusters tying onto one another, are incompletely formed, or are partially destroyed by wind action. Bedding was not observed because of the cover of unbedded sand, but bedding has been observed in road cuts through similar types of dunes.

The manner in which the dunes were formed will be discussed later. The dunes have characteristics identical to those of eolian sand dunes and have been classified according to Melton's classification (1940, pp. 113-145) of this type of dune. There are three basic types of dunes;-

(1) Parabolic dunes, formed by gentle winds of constant direction which scour an oval basin forming a U-shaped sand dune on the downwind side of the basin with horns pointing upwind.

(2) Elongate-blowout dunes, formed by moderate winds, are simply parabolic dunes which have been drawn out by wind action into a more elongate form.

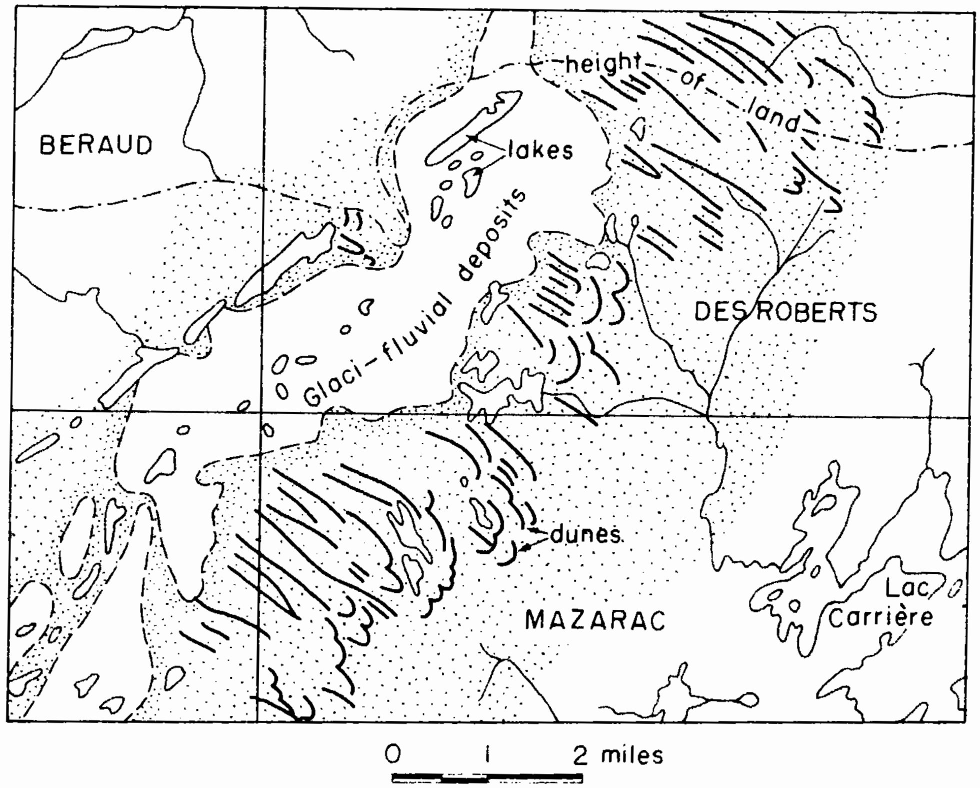
(3) Windrift dunes result when strong winds of constant direction break thorugh the U-shaped ridge leaving paired ridges with a trough in between them.

Elongate-blowout dunes and windrift dunes are the two types commonly found in the map-area. Similar types of dunes were recognized by Freeman (1957, p. 187) in the Beraud-Mazerac area, and by L'Esperance (1951, p. 30) in the Duprat area (Fig. 31).

Observers have noted that the dunes are restricted to the eastern margins of the source areas of sand, which in most cases are eskers, sand and beach ridges, moraines, and outwash plains of sand and gravel. The convexities of the U-shaped dunes always face due east or slightly south of east. The prevailing wind must have been westerly. Authors, for example Cooke, James and Mawdsley (1931, pp. 156-157) must have wrongly identified the dunes as barchans, because they maintained that the wind direction was from the east instead of from the west.

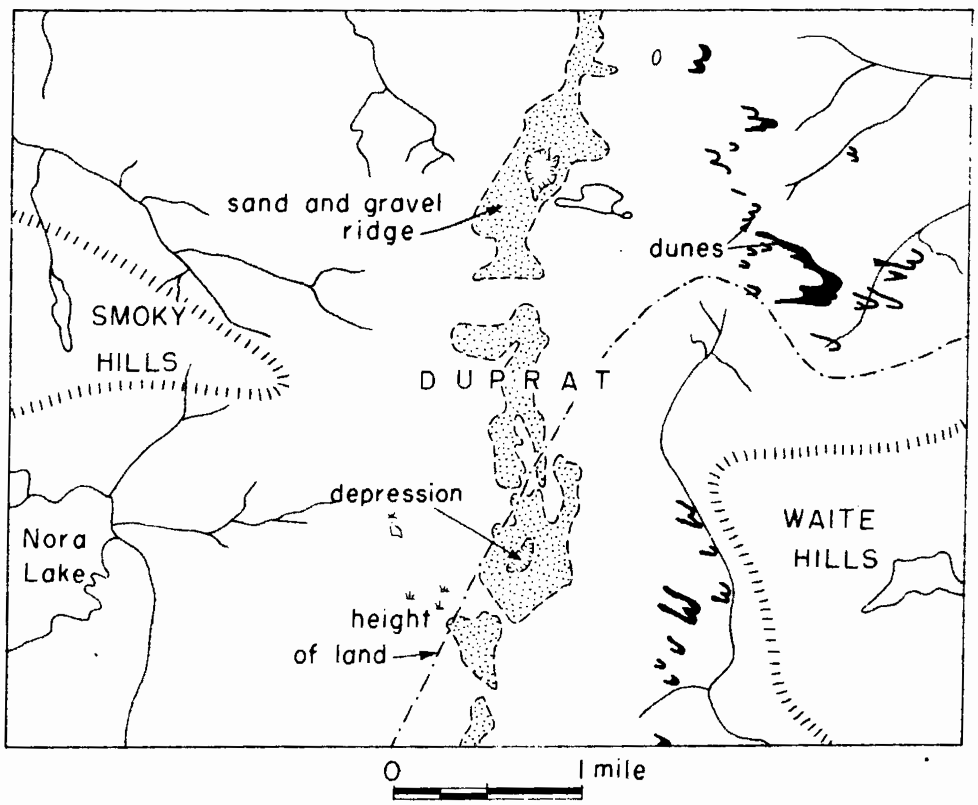
Shallow lakes along the east margin of the esker (Fig. 29) occupy hollows scooped out by wind, and dunes formed from the transported sand are found east of the lakes.

Flint (1942, p. 265) describes the formation of Lake Barlow to the south of the Great Lakes - Hudson Bay divide or height of land. Further north a large lake, Lake Ojibway, was formed between the waning ice sheet and the divide. Flint states, "With continued deglaciation this lake and Lake Barlow enlarged until they merged into a single vast water body which has been called Lake Ojibway - Barlow". Now Freeman (1957, p. 229) in discussing the formation of wide sand plains and great dune areas specifically in the Lake



BERAUD—MAZARAC AREA (after P.V. Freeman)

Fig. 31



DUPRAT AREA (after R.L.L'Esperance)

SKETCH MAPS SHOWING THE DISTRIBUTION OF GLACI—FLUVIAL DEPOSITS AND SAND DUNES

Barlow area in Quebec states:

> The large areas occupied by dunes and their height seem to point to their origin on more extensive tracts of loose material than that occupied by a shore on a large lake. The problem is how these large areas of sand became available for drying in a short time, before vegetation had time to establish itself. The only solution appears to be that the very large tracts were exposed from an aqueous environment by a very sudden elimination of the glacial lake.

Freeman then suggests ways in which the glacial Lake Barlow may have suddenly been drained. He also says "The dunes built on the sand deposits of Lake Ojibway to the north may no doubt have a different origin,but this is not discussed here" (p. 230).

It is possible that the height of land was many miles south of its present position during the time the lakes were formed, and the uplift of the land subsequent to the ice retreat has moved the divide northwards to its present position. For this reason it is doubtful whether Freeman can distinguish between the Lake Barlow and Lake Ojibway deposits, and be correct in suggesting conditions which only prevailed in the Lake Barlow area. In addition Freeman has overlooked the important point that vegetation initiates and regulates dune growth. Olson (1958, July, p. 345) states emphatically that plants are necessary for parabolic dune formation. Parabolic dunes must have the same origin whether formed in the Lake Barlow or Lake Ojibway areas - a supply of sand, suitable winds, and the right type of vegetation are all necessary for dune growth. Dresser and Denis (1944, p. 29) states that "Creseentic dune-like ridges on the surface of some of these sand plains show that the sand was wind-blown before it became covered with vegetation." This assumption is incorrect, because vegetation covered the sand areas (except for the blowout holes) during all the phases of dune growth. In addition, Olson (1958, July, p. 350) says, "Hydrostatic factors of the water level strongly influence seedling germination and survival around beach and blowout pond margins." Thus local fluctuations of the water table would affect the extent of the vegetation cover, and would be a controlling factor in dune formation.

Freeman (1957, p. 231) is certain that no terracing of Lake Barlow deposits has been seen. This fact would strengthen his argument for the sudden disappearance of Lake Barlow. Now Olson has illustrated (Fig. 32) how beach and dune ridges form during the lowering of a lake level. I suggest, therefore, that beach ridges too low to be easily noticed may form on a widening beach if a lake level were being lowered fairly rapidly. Terracing would then not be seen, and the gradual accumulation of beach sand is also the most plausible means of explaining the formation of the material needed for the sand dunes.

A controversial point in Freeman's discussion (1957, p. 222) is his assigning of two different ages to the parabolic dunes and the linear windrift dunes. He locates parabolic dunes on the downwind side of the linear dunes, and he tabulates five main reasons for the different age

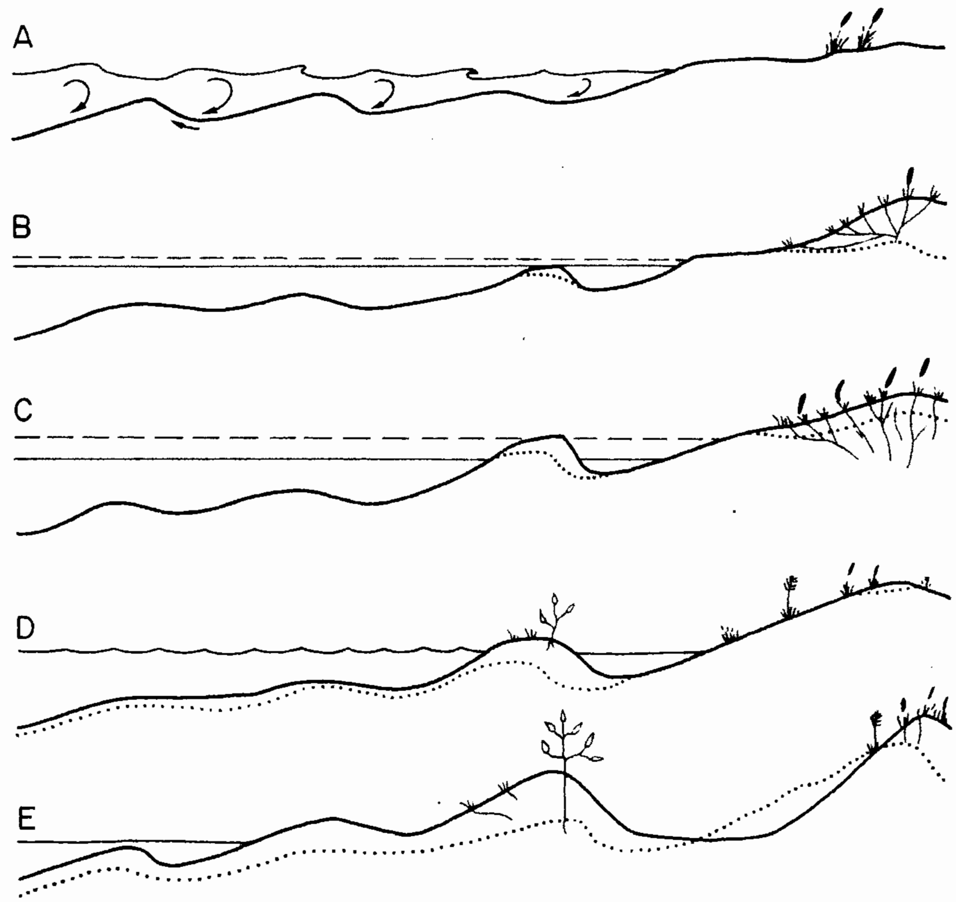


Fig. 32 <u>Schematic development of beach and dune ridges</u>

A. Water completing its orbit back toward the lake scours sand along with it, forming a ridge on the lakeward side.

B. Under conditions of lowering lake level, there may be a "subaqueous dune" mode of landward migration of these ridges.

C. The newly emerged barrier is built up further by breaking waves.

D. A rising lake level will not destroy this barrier.

E. A whole sequence of ridges are formed when the lake level is consistently being lowered over the years.

(After J. S. Olson, Sept 1958, p.478)

relationships. It is my contention that the dunes are not of different ages, but that the distribution of the vegetation caused the formation of differing sets of dunes. As Olson (1958, July, p. 350) states, "In the course of time, an area which was receiving active deposition from either the beach or an adjacent bare blow-out erosion area may later be cut off from this sand supply by virtue of interception by vegetation which has meanwhile grown out into the bare area." An additional explanation for the two sets of dunes is given by Olson's (1958, May, p. 261) reconstruction of the effect of the single dune (in the La Motte area the esker functions as Olson's dune) on the wind profiles far to the leeward. The effect is analogous to ripples downstream from a barely submerged rock in a brook. After the wind has dropped its load in the lee of a ridge it is capable of scouring sand further to the leeward, possibly with less force, thus accounting for the more moderate wind forms further to the leeward.

A final reason for the occurrence of parabolic dunes down-wind from linear dunes is suggested by Olson's (1958, July, p. 351) statement that "a typical blowout dune often reaches down to the water table where erosion rates are slowed." During successive years when lake levels drop, the beaches at higher elevations may be more deeply eroded, whereas deflation hollow development close to the waters edge is arrested because sand cannot be scoured below the water table.

Because of the close association of beach and dune forms and the lake level, it is more than likely that the dunes were formed during the years when the glacial Lake Barlow-Ojibway was finally drained when ice melting allowed the water to escape northward to Hudson Bay.

Varved Clays and Concretions

The best exposures of varved clays are along the shores of Lakes Malartic and La Motte. The total thickness of the formation is unknown; exposed thicknesses of about 30 feet were found. Silty, light grey summer layers, and clayey, medium grey winter layers are uniform in size and continuity (Fig. 33). The winter layers are usually thinner than the summer layers. Contacts between winter layers and overlying summer layers are sharp.

Calcareous concretions in a great variety of forms occur in the silt layers of the varves, and great numbers have been eroded from the varves and washed onto the beaches. Concretions are generally rounded aggregates modified into forms which have been classified by Tarr (1935, p. 1509). The original materials of the enclosing beds have been cemented into the form of the concretions. This cementing material is the only addition to the original composition of the varves found in analysis of the concretions.

Tarr (1935, p. 1514) found no evidence of a nucleus which is commonly regarded as essential to the formation

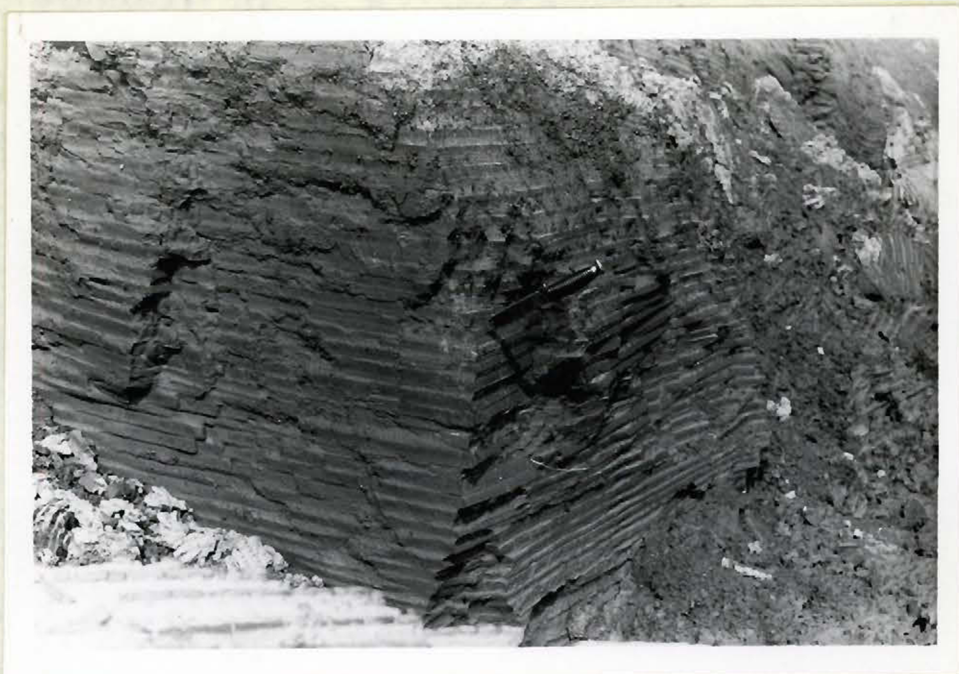


Fig. 33. Varved clays along the shore of Lake Malartic. Range II.

Fig. 34. Rare specimen of a bilaterally symmetrical concretion cemented on a pebble. Scale in centimetres. From a Lake Malartic beach.

of the concretions. He notes, "A few specimens contained small pebbles, but the growth was not centered around them." A specimen (Fig. 34) found on a beach of the Lake Malartic is a rare example of a bilaterally symmetrical concretion cemented on a pebble. The pebble must have been rafted out by the ice and dropped to the lake bottom. The curvature of the bedding planes of the silt which once surrounded the pebble is preserved in the concretion. This is so because bedding planes always continue uninterruptedly through concretions.

STRUCTURAL GEOLOGY

The belts of rock which cross the map-area are part of a regional structural feature which has been interpreted by earlier investigators as a major anticline or anticlinorium. The southern limb is to the south of the map-area, and the northern limb extends into Figuery township to the north of the La Motte batholith. The map-area probably lies for the greater part along the northern limb of this structure, although the axis of the fold may cross the southern part of the area. No field evidence was obtained to indicate the presence of this major axis. The axial trend is east to south of east, and the fold plunges to the west. The major axis of the Preissac-La Corne batholith also strikes east.

Schistosity, foliation and cleavage are generally well-developed and their strikes parallel the general structural trend of the rocks. Practically all strike measurements are from 5° to 20° south of east with dips generally between 50° and 80° to the northeast. The regional strike changes progressively with the result that the northern belt of volcanic and sedimentary rocks curves to the northeast following the contour of the La Motte batholith. The central belt on the other hand curves to the southeast. Due to scarcity of outcrops very little is known of the structure of the rocks between these two diverging belts.

A series of ultrabasic bodies are intercalated with the volcanic beds. The repetition of the volcanic-ultrabasic rock series may be due to a number of separate peridotite sills having been injected into the folded volcanic rocks, or to the isoclinal folding of both volcanic and ultrabasic rocks during the period of mountain building. This tight folding would agree with the theory that the major structure is anticlinorial. Drag folds and minor folds with axes which strike in varying directions indicate that the folding is far more complex than indicated by the relatively simple regional trend of the formations. Jones (1956) found proof of cross-folding in the northeast quarter of La Motte township which helps to account for the divergence of the belts of older rocks. There is a regretable lack of structures by which top determinations can be made. For this reason the presence of isoclinal folding cannot be proved.

A factor to be considered when viewing the broad structural picture is the possible effect of the forceful intrusion of the batholithic masses. It is more than likely that their intrusion subsequent to the period of folding forced the invaded strata into new positions, and may have caused the cross-folding to take place. The evidence of forceful intrusion may lie in the fact that the roof pendants have attitudes differing considerably from the general attitude of the belts of older rocks. The manner in which the schistosity of the sedimentary formation follows the contour of the La Motte batholith also points to forceful intrusion. This last fact was fully described by Jones (1956).

The structural features of the granitic masses have been described in detail by Dawson (1954) and need not be repeated here. His tectonic map (map No. 2 in the folder) may be studied for an indication of the gross features of the Preissac-La Corne batholith. It may just be noted that the foliation in the granite is generally parallel to the foliation and bedding of the older rocks which surround it. The granite is assumed to be post-tectonic.

No major faults were observed but minor shear zones are numerous in the pre-batholithic rocks. Shears generally parallel the structural trend of the formations. From the distribution of the formations, however, it is evident that faulting across the strike of the formations must also be present. Geophysical surveys have indicated the presence of such faults. Talc schist zones in the ultrabasic rocks have been noted.

Joint directions are varied, but the majority cut the formations at high angles thereby indicating that they probably resulted from the compressive stresses which caused the folding of the anticlinorium.

The contact of the La Motte batholith dips to the south under the northern belt of sedimentary and volcanic rocks. It is not known whether this granitic mass joins the Preissac batholith and the Malartic stock at depth. If it does the older rocks would occur as inliers. On the other hand, the older formations may act as septa which divide the granite masses from each other.

ECONOMIC GEOLOGY

General Statement

The La Motte-La Corne batholith region is economically important because at present the only commercial concentrations of molybdenite in Quebec are being mined there. Zoned pegmatite dykes associated with the granite masses carry commercial quantities of spodumene and beryl. Rowe (1953) has described these pegmatite deposits in detail. Metallic mineralization is likely to occur in the rocks marginal to, or as inliers within, the batholith. One of the largest bodies of ultrabasic rocks in Western Quebec is present in the map-area. Such ultrabasic masses are notable source and host rocks for various types of ore deposits in particular nickel. This half of La Motte township has therefore good economic possibilities, but glacial debris and lake clays mantle the bed-rock and obscure most of the important contact areas where mineralization can be expected.

There are five types of mineral occurrences in the map-area:

(1) Nickel is found associated with the ultrabasic rocks in narrow, lenticular bodies of massive pyrrhotite, pyrite, and minor chalcopyrite in shears in peridotite and dunite. Small, scattered zones of pyrite with traces of nickel have been found by diamond drilling in the ultrabasic rocks.

(2) Molydbenite, in flakes or occasional pockets, occurs chiefly in quartz-veins and associated pegmatitic materials in the marginal zone of the Preissac batholith. Very small amounts of bismuthinite are present with the molybdenite.

(3) Molybdenite also occurs in very small quantities in the granite of the marginal zones of the masses. The mineralization appears to be associated with shears in the granite.

(4) Sulphide mineralization, principally pyrite with very small amounts of chalcopyrite, magnetite, and pyrrhotite are found in sheared greenstones (Fig. 35), or in the vicinity of granitic dykes cutting volcanic rocks.

(5) A few zoned pegmatite dykes with small quantities of spodumene have been found in an area along the north-east border of the map-area.

A few crystals of beryl and columbite-tantalite have been found in pegmatite phases of the granite masses.

One base-metal sulphide ore body has been discovered in the map-area. It is a nickeliferous pyrrhotite body on a property in range V held by the Marchant Mining Co. Ltd. There has been no attempt as yet to mine this ore, possibly because the tonnage estimated is too low to support an economical mining operation. Other deposits which have not been proved as yet to have commercial value are the Dupas Metals molybdenite-bearing quartz-vein occurring in range II, a molybdenite occurrence in granite in range VII, and a small zone of nickel-bearing basic rocks in range IV.

Mineralized areas have been investigated by stripping, trenching, and test-pitting. In 1957 extensive geophysical surveys covered most of the greenstone belts as well as part of the area of ultrabasic rocks. A total of approximately 37,000 feet of diamond drilling was done to investigate the anomalies found by the geophysical surveys. This resulted in the outlining of the Marchant Mines ore body, but the remainder of the results were disappointing. In 1955 and 1956 the search was primarily for pegmatite deposits in the northeastern part of the map-area.

Marchant Mining Company Ltd.

The company property, located in lots 6 to 17 inclusive, range V, was the scene of a programme of magnetometer, resistivity and electromagnetic check surveys, as well as a geological reconnaissance survey, in 1957. This followed the discovery of a surface exposure, approximately 120 feet long and 10 feet wide, of a nickel-bearing mineralized zone associated with ultrabasic rocks (Fig. 36). The geophysical surveys outlined an oval-shaped anamalous area, approximately 3,500 feet long and 1,200 feet wide. In detail three anomalous zones were outlined within this area, and an extensive drilling programme delineated the nickel ore body, but failed to uncover any further areas of mineralization. Approximately

Fig. 35. Pyrite mineralization along narrow shear zones in volcanic rocks. Lot 21, range IV.

Fig. 36. Surface exposures of the Marchant Mines ore body. Lot 9, range V.

20,200 feet of drilling was done in 43 closely spaced holes.

The discovery outcrops were covered by a gossan (Fig. 37), and stripping of overburden exposed further areas of gossan. The strike of the ore body is approximately northwest, and it dips to the northeast at about 45°. The main ore zone appears to be composed of one or more narrow, possibly lenticular, veins of massive sulphides. In some cases narrow stringers of sulphides are separated by waste material. Scattered patches of mineralization, and some dissemination of the sulphides is also evident. At the northwestern end the ore zone appears to have been faulted northwards for about 25 feet. A subsidiary zone of low grade sulphide mineralization is present approximately 200 feet north in the hanging wall of the ore body. The strike length of the body varies with depth, averaging about 400 feet in length. The widths of the main zone of massive sulphides appear to vary considerably, the average for the best widths recorded is about 8 feet. The average grade of about 250,000 tons of ore is 2 per cent Ni. The body has been proved to the 800 foot horizon.

The geology is very complex because of the similarity between peridotite, altered volcanic rocks, and fine-grained gabbro. The writer maintains that all three rock types are present, and that mineralization is liable to be found in any one of these types. On the other hand, company reports show that only varieties of ultrabasic rocks and granite dykes were intersected in the diamond drill holes, and the massive sulphides are only found in ultrabasic rocks.

The sulphide bodies are composed of nickeliferous pyrrhotite, pyrite and chalcopyrite. The nickel-bearing mineral pentlandite which is mixed with the pyrrhotite cannot be recognized macroscopically.

The structural control of the ore body is probably a fracture system which acted as a passageway for mineralizing solutions. A second system of faults may have limited the size of the ore body.

The company proposes to sink a shaft at some future date to carry out an underground examination of the ore body.

Continental Mining and Exploration Ltd.

Lots 20, 21 and 22, the southern half of lots 23 to 29 inclusive range IV as well as the northern half of lot 23, and lots 25 to 28 inclusive, range III, are known as the Cubric Option, and were held by Continental Mining in 1957. Magnetometer, resistivity, electromagnetic and geological surveys were done over an anomaly which can be seen on the Preliminary Aeromagnetic Map G.P. 23.

A few narrow veins of nickel sulphides were found in altered peridotite. Trenching and 11 packsack drill holes delineated the body. Assays of the pyrrhotite, pyrite and chalcopyrite stringers showed values as high as 7.46 per cent Ni, but the body is too small to be of economic importance.

Violamac Option Property

The group of claims, lots 8 to 15 inclusive, range IV, held by John Ataman, were optioned by Violamac in 1957 for the period of a year. Magnetometer, resistivity and electromagnetic check surveys were done on the northern halves of the lots with no positive results. Sulphide mineralization, mostly pyrite and small amounts of chalcopyrite and pyrrhotite, are found in altered acid to intermediate lavas. As early as 1938 shallow trenching had been done along the mineralized outcrops. Samples were assayed for gold with no success.

East Sullivan Mines

This company with Sullivan Consolidated Mines Ltd., hold the claims to lots 1 to 7 inclusive, range VI, and lots 1 to 5 inclusive, range V. The Le Blanc Option ground, lots 16 to 19 inclusive, range IV, was examined at the same time as the above property. Magnetometer surveys and approximately 17,000 feet of drilling done in 1957 failed to establish the presence of an orebody. Magnetic anomalies are believed to have been caused by high concentrations of magnetite or iron carbonate in the ultrabasic intrusive rocks.

Kopp Mines Ltd.

This company formerly held lots 15 to 30 inclusive, the land portion of lot 31 and the land portion of the northern half of lots 32 and 33, all in range V, and the southern half of lots 28 to 33 inclusive, range VI. A dip needle and geological survey of the property was completed in January, 1956. Prior to this date an aeromagnetic survey had been done for the company. A pronounced magnetic low was found at the center of the group of claims, close to outcrops of epidote-rich aplite granite. As no mineralization was found the claims were not held in 1957.

Ascot Metals Corporation Ltd.

The portions of lots 28 to 33 inclusive, range VII, which are in the west half of La Motte township comprise part of the claim group held by Ascot Metals. In 1955 electromagnetic, magnetometer, and geological surveys were conducted and 27 holes were drilled in the search for lithium-bearing pegmatites and their extensions. Most of the work was done on those claims lying in the eastern half of the township; only 6 diamond drill holes are on the west side of the center line of the township.

Pegmatite and aplite dykes are the mineralized rocks. They were found to be from a few inches up to 20 feet in width. Lengths from several feet to 900 feet were found. Biotite granodiorite was found to be a favourable host rock but aplites and pegmatites are present in all rock types older than the batholithic granites. The larger pegmatite dykes are zoned and these contain the greatest concentrations of spodurnene crystals. An ore deposit was not found.

Ciglen Claims.

In 1956 a geological and magnetometer survey was done on the northern halves of lots 28 to 33 inclusive, range VI. No minerals of economic importance were found.

New Goldvue Mines Corp. Ltd.

Lots 29 to 32 inclusive, range VIII, are part of a block of claims held by the company, the remainder of the claims being in the northeast quarter of the township. Electromagnetic, self-potential, magnetometer, and geological surveys were carried out in 1955. Six conducting zones were outlined by the electromagnetic survey and three of the anomalies were drilled in the eastern section of the property. No sulphides were found and it was concluded that water in the overburden caused the anomalies.

Wilrich Petroleums Ltd.

The portion of the property in the west half of La Motte township held by this company consists of the southern halves of lots 28 to 32 inclusive, range X, and the northern halves of lots 31 and 32, range IX. A geological survey was done in 1956. The granite in the western section of the property was devoid of any noticeable structures of mineralization.

Fig. 37. Gossan on one of the Marchant Mines discovery outcrops. Lot 9, range V.

Fig. 38. Molybdenite flakes and pockets in the Dupas Metals quartz vein. Lot 5, range II.

A few small occurrences of finely disseminated beryl crystals in pegmatites were found in the eastern section of the property, but they are not of economic size or grade.

Dupas Metals Ltd.

This company owns four claims, comprising lots 4 to 7 inclusive, range II. In the middle of lot 5, on the east slope of a granite ridge, a large quartz vein is exposed. It is 800 feet long in a northerly direction, and dips less than 30° east. The vein contains a few inclusions of aplitic granite material and muscovite-feldspar-quartz pegmatite segregations. Contacts with the granite are not sharp.

Patches of molybdenite 2 to 3 inches wide and one inch thick are occasionally found, but most of the molybdenite occurs in small, well formed hexagonal crystals sparsely disseminated in quartz and pegmatitic material (Fig. 38). A few cyrstals of bismuthinite are also present. Two zones of mineralization were trenched after a geological examination was made of the property in 1951. In March, 1957, four holes totalling 640 feet were drilled, and they showed that the true width of the vein is approximately 10 feet. Four assays showed between 0.05 per cent to 0.43 per cent MoS_2 present in the vein, and 0.063 per cent Bi was the highest value of bismuth obtained.

Savigny - Ouelette Claims

A molybdenite occurrence in granite in the south-east corner of lot 4, range VII, has been exposed by stripping. The molybdenite, possibly associated with minor shearing in the granite, occurs in patches and a few disseminated crystals. Inclusions of biotite schist are scattered through the granite around the mineralized area, and the contact between the granite and the sedimentary belt is a short distance to the south. The grade and size of the mineralized zone has not been determined. A more detailed examination is scheduled to be carried out at some future date.

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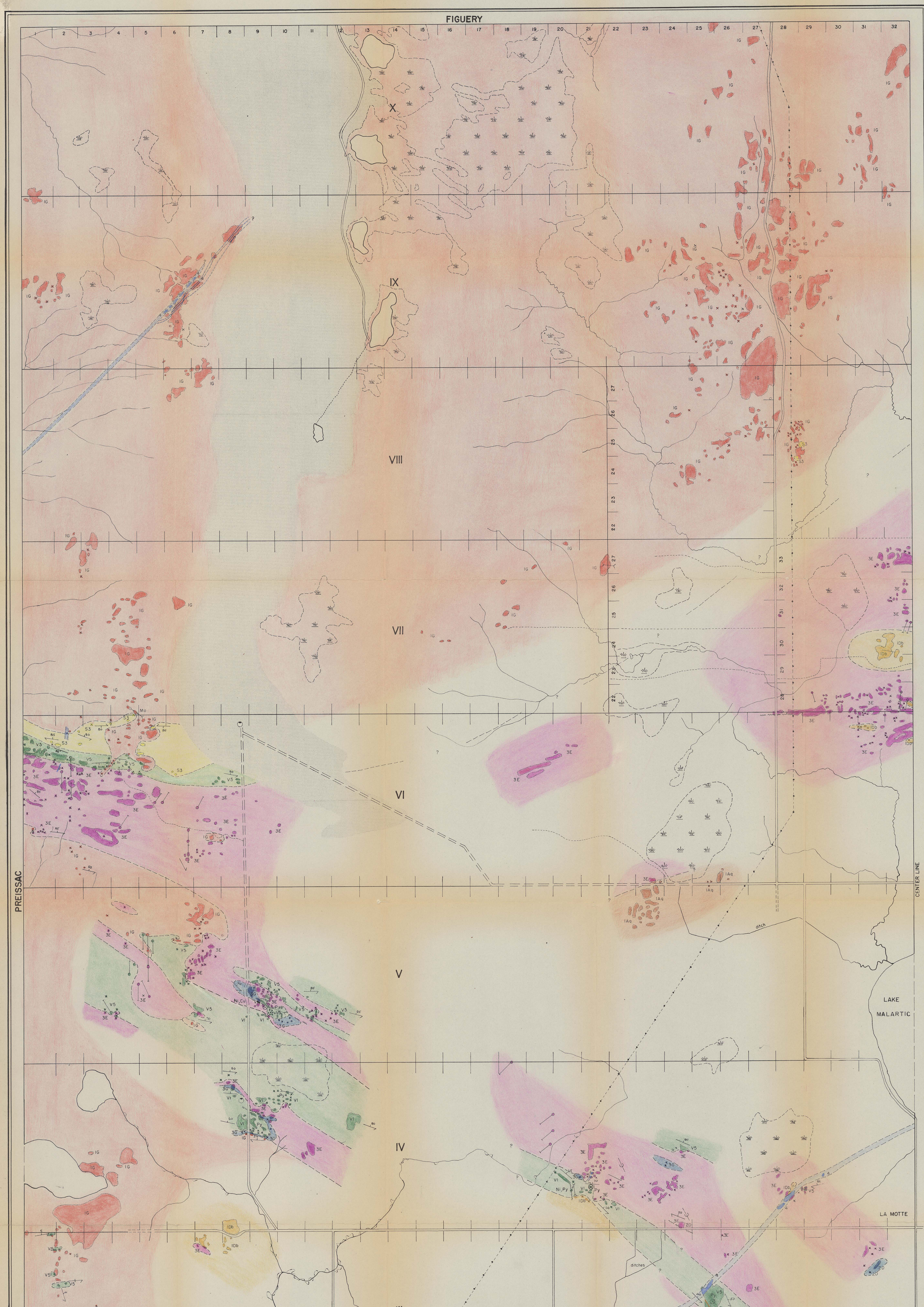
PROVINCE OF QUEBEC, CANADA

DEPARTMENT OF MINES



LEGEND

CENOZOIC

PLEISTOCENE

Esker material

LATE PRECAMBRIAN

KEWEENAWAN ?

4 — Gabbro Dykes

EARLY PRECAMBRIAN

POST – TEMISCAMIAN TYPE

1Aq — Epidote-rich aplite granite

1G — Muscovite- and biotite-bearing quartz monzonite

1Db — Biotite granodiorite

PRE – TEMISCAMIAN TYPE

3E — Peridotite – Dunite

3G — Gabbro, 2D Diorite

KEEWATIN TYPE

S3 — Quartz-biotite schist derived from graywacke

V — V1 Acidic to intermediate volcanic rocks; V5 Intermediate to basic volcanic rocks

SYMBOLS

Strike and dip of schistosity, cleavage and foliation — 1. inclined 2. vertical 3. dip not known

Strike and dip of bedding and of lava flows — 1. inclined 2. vertical 3. dip not known

Fault, shear or fracture zone — 1. located 2. assumed

Glacial striae

Outcrop or group of outcrops

Diamond drill hole, vertical and inclined

Geological boundary 1. defined 2. approximate

Swamp

Range and lot lines, lot number

Highway or improved road

Road under construction

Trail or winter road

Power line

Prospect pit and trench.

Gravel pit.

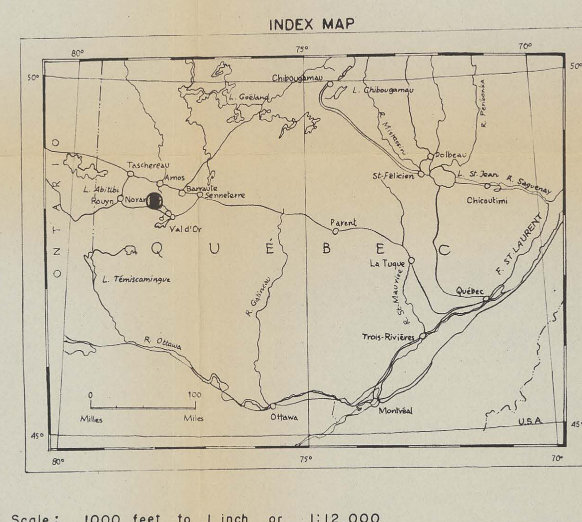
Old river channel

MINERALIZATION

Ni	Nickel
Mo	Molybdenum
Py	Pyrite
Cu	Copper

MAGNETIC DECLINATION 14°W

INDEX MAP



Scale: 1000 feet to 1 inch or 1:12,000

GEOLOGY BY: W.R. LEUNER 1958

WEST HALF OF LA MOTTE TOWNSHIP

ABITIBI COUNTY

CANADA
DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

LEGEND

PRECAMBRIAN

- Gabbro
- Granitic rocks of the Preissac-Lacorne batholith
- Pre-batholithic rocks, including members of the Blake River, Kewagama, Malartic, and Kinojevis groups

Joints (inclined, vertical, dip unknown)

Flow lines–direction and angle of plunge known; direction of plunge known, angle of plunge unknown; due to mineral parallelism (m), due to structural features (s)

Foliation or bedding in pre-batholithic rocks and foliation in batholithic rocks (inclined, vertical, dip unknown)

Pegmatite dykes (inclined, vertical, dip unknown)

Aplite dykes (inclined, vertical, dip unknown)

Porphyry dykes (dip unknown)

Quartz veins (inclined, vertical, dip unknown)

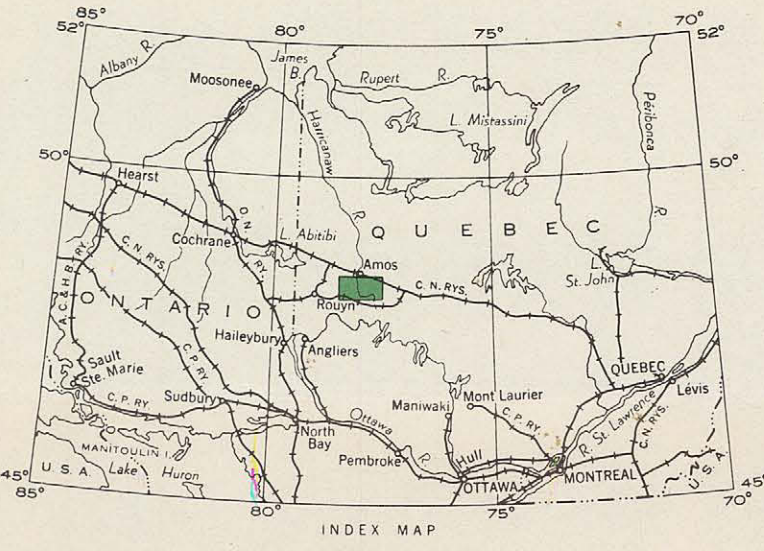
Geological contact (defined, approximate, based upon aeromagnetic data)

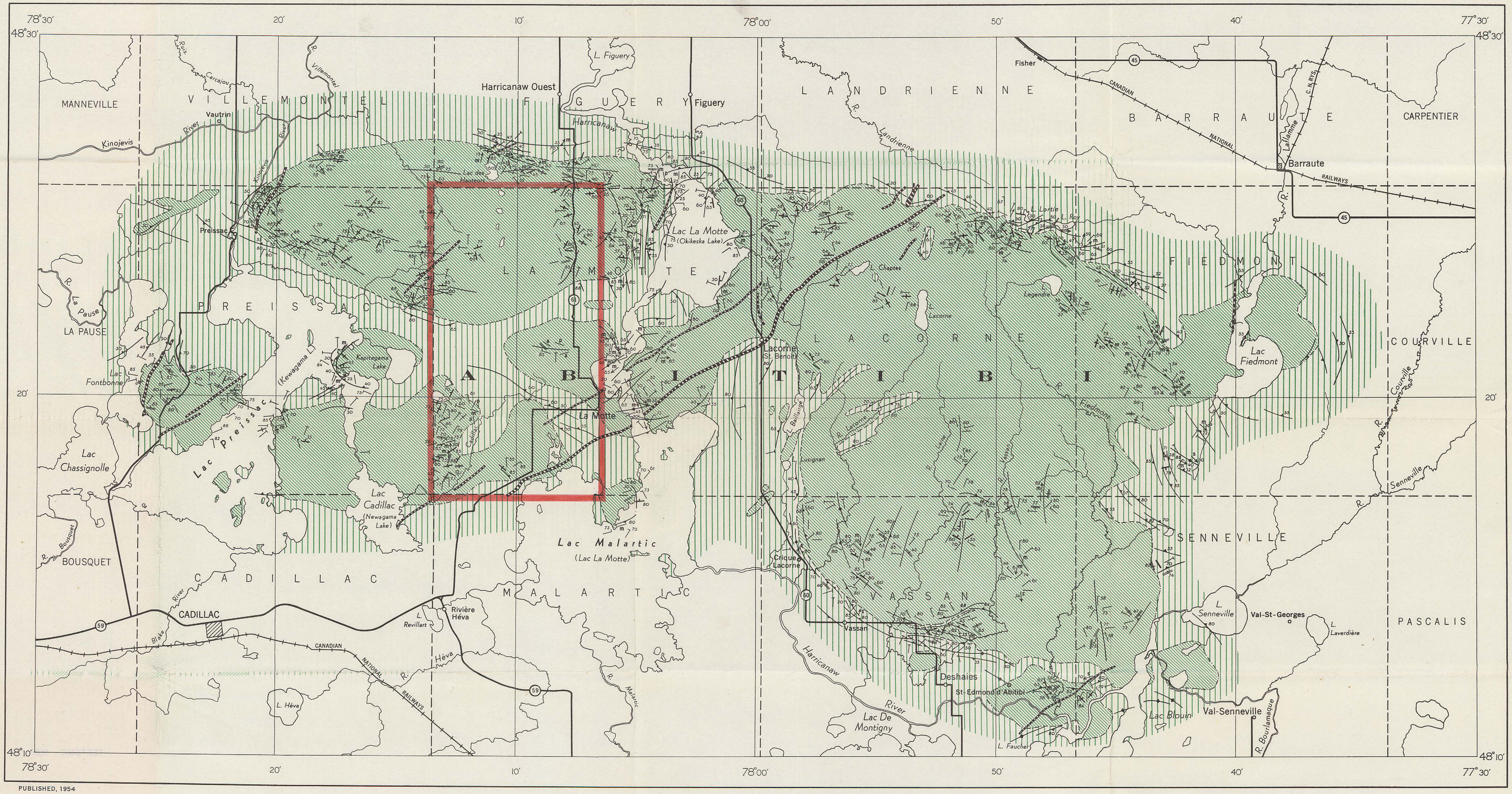
Geology by K. R. Dawson, 1952

Cartography by the Geological Cartography Division, 1953

To accompany Paper 53-4 by K. R. Dawson

Approximate magnetic declination, 13°51′ West





PUBLISHED, 1954

Figure 1

Tectonic map of the Preissac-Lacorne batholith, Quebec

Scale of Miles

2 0 2 4 6