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Geological report, Grand-Détour - Village lakes area, Mistassini territory and New Quebec

QUEBEC DEPARTMENT OF NATURAL RESOURCES

Honorable Paul-E. Allard, Minister

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GEOLOGICAL REPORT 136

GRAND-DĒTOUR - VILLAGE LAKES Area

Mistassini Territory and New Quebec

by

P.R. Eakins, T. Hashimoto, and E.H. Carlson

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GEOLOGY

of the

GRAND-DÉTOUR - VILLAGE LAKES AREA*

Mistassini Territory and New Quebec

by

P.R. Eakins, T. Hashimoto and E.H. Carlson

INTRODUCTION

General Statement

The Grand-Détour - Village Lakes area comprises three quadrangles, mapped by Eakins (1960), Hashimoto (1961) and Carlson (1961), which were the subject of three preliminary reports: Natel lake (No. 454); Village lakes (No. 473); and Pivert lake (No. 483). This report** groups and correlates the geological observations and ideas put forth by the three geologists in their reports.

Location and extent of area

The area lies about 120 miles east of James Bay and 170 miles north-northwest of the mining town of Chibougamau. The Eastmain river, which crosses the area from east to west forms a large Z at the border of the Pivert Lake and Natel Lake areas which is appropriately called the Grand-Détour.

The maps, which cover an east-west distance of 46 miles between longitudes 75°10' and 76°15' and a north-south distance of 17 1/2 miles between latitudes 52°00' and 52°15' represent an area of about 800 square miles.

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* Translated from the French.

** Editors's Note:

Thanks are due to Dr. Guy Valiquette, professor of geology at Ecole Polytechnique, Montreal, for having undertaken the work of combining the final reports of these three geologists.

Access

Float-planes based at Caché lake, near Chibougamau, are the only practical means of access to this region. They are able to land on the Eastmain river at several localities, west of Grand-Détour, between Grand-Détour and Dôme rapids and east of Dôme rapids. However, when the water is low, several sections of the river become dangerous with sandbars and reefs. The numerous lakes are so distributed as to make nearly all corners of the area accessible by float-plane.

The canoe is the means of transport generally used within the area. It would be difficult to mount the Eastmain river from James Bay to the area because of the strong current and the numerous waterfalls, but, within the area studied, although the river is turbulent and has a generally rapid course, it is possible to move around by canoe from the border of the Village Lakes quadrangle to the top of the main rapids of the Grand-Détour, downstream from the outlet of Tournesol lake. These trips require experienced guides, particularly during periods of average or high flooding. At these times, the only obstacle to the passage is the Dôme rapids, which may be avoided by short portages along the bank.

There are no portages along the rapids of the Grand-Détour and it is not possible to draw a canoe along the bank. The main Eastmain river canoe route avoids these rapids by following the Eau-Claire river to Clarkie lake and, from there rejoins the Eastmain river by way of Lichteneger and Village lakes. This route on the Eau-Claire river is cut by numerous rapids and falls which may be passed by portages maintained by Indian trappers.

In the Pivert Lake quadrangle, the Pivert river joins Pivert lake to the Eastmain river, but the trip entails numerous portages and navigation in shallow water strewn with obstacles.

Caché creek, which drains the southeast section of the Natel Lake quadrangle is navigable to Boulder lake in periods of average flow.

Field work

Geological surveys were carried out on traverses spaced at 1/2 mile intervals using a compass and pace counter and assisted by aerial photographs at a scale of 1/2 mile and 1 mile to the inch. The results were plotted on 1/2 mile to 1 inch base maps made by Photo Air Laurentides Co., A.E. Simpson Ltd. and the Department of Natural Resources for the Pivert Lake, Natel Lake and Village Lakes quadrangles, respectively.

P.R. Eakins directed the mapping of about 300 square miles of the Natel Lake quadrangle in the summer of 1960, while in 1961, E.H. Carlson covered the Pivert Lake quadrangle and 60 square miles of the Natel Lake area (northwest corner), and T. Hashimoto studied the Village Lakes quadrangle.

Acknowledgements

The authors are grateful to persons who contributed to this work, especially to the geologists and assistants who participated in the field work, and to the professors at McGill University who collaborated with the laboratory work and assisted the authors with their advice.

Previous work

Few previous studies have been made on the area, because of the distance from inhabited areas and the small success reported by exploration companies. The outcrops along the Eastmain river were first described by A.P. Low (1896) in the course of his famous expedition to the Labrador peninsula.

Dome Mines Co. Ltd. made a reconnaissance map of certain sectors near the Eastmain river in 1935/36 and conducted more detailed exploration work to the east of the area.

In 1942, Shaw used a light float-plane to make a reconnaissance survey of an area that included the maps, supplementing this report. He separated the bands of metavolcanic and metasedimentary rocks and the granitic sequences. In 1958, Heywood and others made a similar study, using a helicopter, to the north of the area for the Geological Survey of Canada.

DESCRIPTION OF THE AREA

Topography

The average elevation of the area is about 1,000 feet above sealevel. The topography consists of numerous small to medium sized lakes and creeks which lie in and drain open valleys surrounded by broad hills. The local relief is 150 to 400 feet. North and east of Natel lake and in the neighborhood of Labyrinthe lake, sharp hills rising brusquely 300 to 400 feet above the adjacent shoreline form a scenic landscape, reminiscent of the Laurentian plateau north of Montreal and Quebec. In detail, the terrain consists of numerous rock knolls partly covered and surrounded by glacial debris and organic material.

The topography is principally controlled by the nature and the structure of the bedrock basement with modifications imposed by glacial action. Most low rounded hills have an east-west to east-northeast orientation, parallel to the structural trend of the area and are supported by the relatively resistant bedrock basement. In the west central part of the Pivert Lake quadrangle joint planes control the topography; in that locality the weakly foliated granitic rocks form an apparent domical structure. Glacial action accentuated the east-northeast orientation by depositing glacial debris in the form of ridges and irregular hills. Most lakes occupy basins dug by the glacier or blocked by eskers or irregular deposits of morainic material. Swamps cover, in particular in the Natel Lake quadrangle, three stretches of ground, two of notable size, which locally are impassable.

Drainage

The region is drained by the Eastmain river and its tributaries, all flowing to James Bay. The principal feeder streams are the Eau-Claire river and Caché and Anaconda creeks. The larger lakes are Village, Clarkie and Lichteneger lakes in the Village Lakes quadrangle; Aurélie, Natel and Casey lakes in the Natel Lake quadrangle; and Pivert lake in the Pivert Lake sector.

Several miles east of the area studied, the Eastmain river widens into several large lakes, but these are insufficient to stabilize the flow. Consequently the level of the river rises and falls in spectacular fashion according to periods of high precipitation or drought in its watershed. During the 1960 season the level dropped 12 feet in June and July. In the second half of July the level rose 10 feet than started to fall again.

The Eastmain river follows a more or less haphazard route roughly east-west across the area. Its course seems locally structurally controlled. However, at the Grand-Détour, the river cuts the structural trend of the rocks and forms a series of falls and rapids for a distance of at least four miles. At the foot of these rapids the river returns to its westward flow apparently following the structure.

Along its course, the river follows banks of different types. In the section of the rapids, the river flows in a series of cascades between rock walls. In still waters, natural levees of sand and old river deposits supported by occasional outcrops form the banks. In the south part of the river, east and west of the Natel Lake quadrangle, swamps and Yazoo-type tributaries make access to the mainland difficult.

The phenomenon of capture may be observed in many places. Anaconda creek, for example, has captured more than half of Avion-Brisé creek by headward erosion.

Petit-Détour creek is a wide canal, which, with Tournesol lake, previously formed the normal course of the Eastmain river. Today this route is only open during the course of spring floods.

Grande-Allée lake lies in the bed of a wide creek which drains into the Eastmain river; its trace appears again several miles to the east.

Beaches of sand and gravel are rare along the lakes and creeks of the area. Trees and erratic blocks generally occupy the shores. Meanwhile, large beaches of fine sand form the east shore of Aurélie lake and the large bay south of Dôme rapids. These beaches are doubtlessly the result of wave action on suitable material produced by the prevailing winds which blow from the west.

Flora and fauna

Forest fires kindled by lightning have devastated the area many times; brulées of different periods may be noted. The subsequent growth, which covers about 80 per cent of the area,is stunted and sporadic. It consists of clumps of black spruce, jackpine, tamarack, balsam, birch and poplar.

In places where the forest was not touched by fire, north of Natel lake for example, spruce and birch measuring up to 12 inches at the base constitute a good reserve of wood which may serve in the eventual development of the area.

Several clumps of alders and willows grow along certain rivers. The underbrush is generally covered by Labrador tea. Among the shorter plants, other than Labrador tea, sheeplaurel, blueberry and raspberry bushes, dwarf cornel, pitcher plants in the swamps, twin flowers, cinquefoil, vari-colored flags, yellow clintonia, meadow-rue, and Canada lily may be seen. The borders of small lakes are covered by water lilies.

Large game is rare in the area. Only one wolf, one bear and traces of moose were observed. Beaver, otter, muskrat, mink, hare, partridge and duck were observed in the field. Porcupines are rare, but loons abound and several large owls were also encountered.

Pike and pickerel abound in all the lakes of the area; Village lakes also contain whitefish and gray trout. Speckled trout were taken in the Grand-Détour rapids and in the rapids which discharge the waters of the Village lakes into the Eastmain river.

GENERAL GEOLOGY

General review

All the rocks of the area are Precambrian in age and belong to the Superior Province of the Canadian Shield.

In general, the lithology is similar in each of the three quadrangles, except that the Pivert Lake area contains a larger quantity of granitic gneiss than areas to the east, and that the Natel Lake and Village Lakes quadrangles are conspicuous chiefly because of an extensive area of volcanic and intrusive basic rocks and paragneiss. Primary structures have not survived metamorphism and deformation so that it is impossible to establish the real stratigraphic succession of the rocks. The stratigraphic order presented in the Table of Formations is based on indications and deductions more than on proofs, and also on concordant observations noted in the Cramoisy Lake area, adjacent to the Natel Lake and Village Lakes quadrangles to the south.

A great thickness of basic lavas, tuffs and agglomerates, graywackes, shales and siltstones was deposited and invaded by basic and ultrabasic sills. The complete sequence was later metamorphosed and deformed. A large quantity of granitic rocks seems to have been emplaced in the course of this period of deformation; some of these granitic rocks perhaps resulted from rocks metamorphosed to the point of local granitization and partial remobilization. However other granitic rocks are clearly intrusive, coming either from a magma chamber or melted sedimentary rocks.

The general trend of major folds is close to east-northeast except around Dôme rapids where the structure becomes more complex. At the regional level, the foliation of the rocks seems to be almost parallel to the axes of major structures, but locally, along the limbs of folds,it is possibly discordant.

Porphyroidal granite in concordant masses seems to have been emplaced after the granitic gneiss but before deformation had completely ceased.

Moreover, several varieties of granite were emplaced, cutting the preceding rocks. The youngest consolidated rocks in the area are dikes of diabase and gabbro.

TABLE OF FORMATIONS

CENOZOIC	Pleistocene and Recent	Sand, gravel, erratic blocks, glacial deposits, silt and clay.
	UNCONFORMITY	
PRECAMBRIAN		Dikes of diabase and gabbro. Glomeroporphyritic gabbro.
	Late granite	Pegmatite and aplite. Pink granite (quartz monzonite, biotite granite, biotite granodiorite).
	Porphyroidal granite	Gray granite with microcline phenocrysts.
	Oligoclase gneiss	Gneissic granodiorite and quartz diorite. Local migmatite zones.
	Basic intrusives	Ultrabasic rocks. Metadiorite and metagabbro (amphibolite).
	Metasedimentary rocks	Lichteneger lake banded (or injected) gneiss Clarkie lake biotite-sillimanite and andalusite paragneiss and pseudo-conglomerates. Lloyd lake biotite and staurolite paragneiss. Andalusite paragneiss. Hornblende-plagioclase paragneiss. Biotite-bearing quartzo-feldspathic paragneiss. Conglomerate and dolomite.
	Metavolcanic rocks	Basic lavas (amphibolite). Pyroclastic rocks (tuff, agglomerate, breccia). Rhyolitic lavas and pyroclastic rocks. Sedimentary rocks associated with volcanic rocks.

Metavolcanic rocks

The metavolcanic rocks constitute one of the most important geologic units of the Grand-Détour-Village Lakes area. Although these rocks occupy only a small part of the Pivert Lake quadrangle, they cover almost all the east half of Natel Lake section and extend to the east, south, and north of Village lakes. These are the only rocks likely to furnish indications of their stratigraphic position, by the pillowed flows which locally characterize them.

Pivert Lake section

A band of rocks of volcanic origin is well exposed in the northwest corner of the quadrangle over a length of four miles along an east-west hill fittingly called Agglomerate hill. The band attains a width of 2,000 to 4,000 feet and can be recognized along strike for 20 miles. While the northern segment of this band is easy to trace, the south becomes difficult to identify because of metamorphism and igneous activity. This band consists of amphibole schists, amphibolites, tuffs, agglomerates and metamorphosed breccias. These rocks are intimately interlayered and may not be separated in the field on this scale of field mapping.

Natel Lake and Village Lakes sections

The chief characteristic of these sections is a contorted band of volcanic rocks which extends east from Aurélie lake in the southwest corner, to the eastern extremity of the Village Lakes quadrangle south of the Eastmain river, and to the north across Natel lake forming a giant zigzag at the Eau-Claire river on its western front and the northern limit of the area. In the north these greenstones extend east between the southwest shore of Clarkie lake and the north shore of the Village lakes where they form a zone which decreases to 1/2 mile in width at the northern extremity of Village lakes.

This band of "greenstones" is in large part composed of massive and pillowed flows of basaltic and andesite lavas of varying degrees of metamorphism, and intrusions of diorite and gabbro in the form of sills. Several bands of tuff and agglomerate as well as a few narrow bands of meta-sedimentary rocks occur in the lavas. Rhyolitic flows and tuffs with small graphitic lenses are particularly abundant in the southern part of the volcanic zone between Caché creek and the Eastmain river.

The basic lavas are particularly well exposed southwest of Grande-Allée lake, where they form prominent hills.

TABLE 1

CHEMICAL ANALYSES REPORTED BY HASHIMOTO (1963)

Chemical analyses made at the Department of Geology, McGill University

Chemical analyses taken from Daly "Igneous Rocks and Their Origin" pp. 26-27

	Specimen H-6-3a Metabasalt Village Lakes area, New Quebec	Specimen H-6-3b Metagabbro	Gabbro (Osann)	Basalts including: 161 basalts, 17 olivine diabases, 11 melaphyres and 9 dolerites. (Osann)
Number of Analyses	1	1	41	198
SiO_2	47.89	47.55	48.24	49.06
TiO_2	1.13	0.92	0.97	1.36
Al_2O_3	15.24	15.20	17.88	15.70
Fe_2O_3	1.46	0.93	3.16	5.38
FeO	11.64	11.46	5.95	6.37
MnO	0.22	0.22	0.13	0.31
MgO	7.86	8.46	7.51	6.17
CaO	9.58	11.14	10.99	8.95
Na_2O	2.44	1.88	2.55	3.11
K_2O	0.83	0.33	0.89	1.52
P_2O_5	-	-	0.28	0.45
CO_2	0.70	0.83	-	-
S	-	-	-	-
H_2O^+	1.02	0.84	1.45	1.62
H_2O^-	0.14	0.11	-	-
Total	100.15	100.05	100.00	100.00

STRUCTURES IN THE LAVAS

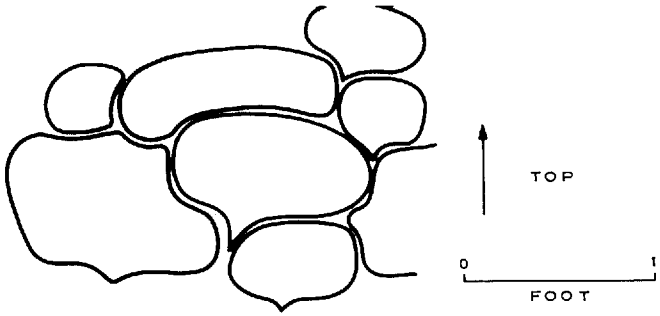

Figure 1a

TYPICAL PILLOW STRUCTURE IN BASIC LAVA SHOWING TOP INDICATION. OUTCROP EXPOSED ON SMALL ISLAND IN RAPIDES DU DÔME.

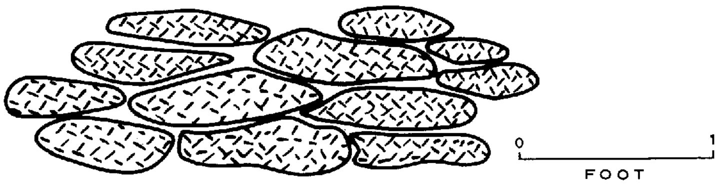

Figure 1b

COARSE AMPHIBOLIZATION OF WEAKLY DEFORMED PILLOWED LAVA NEAR GRANITE CONTACT ON RUISSEAU CACHÉ. UNORIENTED HORNBLENDE PORPHYROBLASTS UP TO AN INCH LONG ARE UNIFORMLY SCATTERED THROUGH THE ROCK.

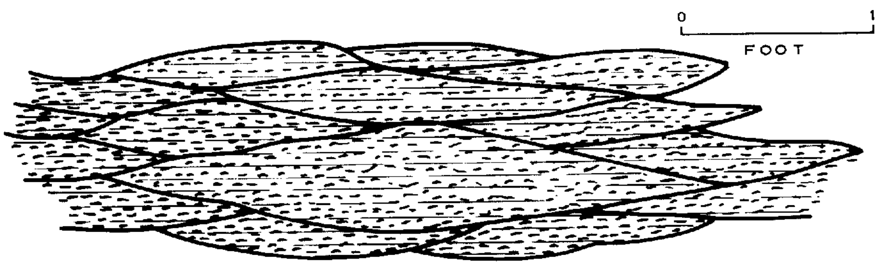

Figure 1c

TYPICAL HIGHLY DEFORMED PILLOW STRUCTURE IN METAMORPHOSED BASALT SOUTHWEST OF GILL LAKE.

D.N.R.Q.
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The basic lavas are fine to medium grained, dark green rocks, which resemble lavas commonly called "andesites" but whose composition approximates that of a basalt (Table 1). These rocks are massive or schistose and show pillowed flows at several localities in the Natel Lake quadrangle. However these structures are rare or non-existent in the Village Lakes section. In the Natel Lake quadrangle these pillowed structures, which vary from two to six inches, are more or less deformed locally, as shown in Figure 1.

The massive variety shows felty crystals of green hornblende in thin-section which form 55 to 70 per cent of the rock, and a variable quantity of plagioclase, occasionally accompanied by epidote. Biotite, quartz and carbonate are present in small quantity in certain specimens. Accessory minerals include apatite and magnetite which here and there constitute almost 5 per cent of the rock. In the field, certain isolated outcrops of metamorphosed basic lavas may not be differentiated from basic intrusive rocks which have suffered the same metamorphism.

The schistose variety of these metavolcanic greenstones, - one specimen in particulàr from the north shore of Aurélie lake, - consists of a large quantity of green hornblende (65%) which shows a preferential orientation, accompanied by about 30 per cent oligoclase and a minor quantity of quartz and magnetite.

A different form, which may be called amphibolitization, takes place in the lavas close to granitic masses. The hornblende formed has the same green pleochroism, but it is present in porphyroblasts with a poikiloblastic texture. The intensity of the deformation endured in the course of recrystallization determined whether the orientation of the porphyroblasts is random or preferential. For example, stretched pillows (Figure 1C) in a metavolcanic rock exposed on the top of the hill a mile south of the western extremity of Gill lake could be called hornblende gneiss. The rim of the pillows is fine grained whereas the interior consists of coarse porphyroblasts of hornblende (50-60%) well oriented in a schistose fine-grained matrix of quartz and feldspar (30-40%) containing minor quantities of calcite, magnetite and allanite. Magnetite is distributed in a dust disseminated in the rock or locally concentrated in trains of grains. Shreds of hornblende crystals partly chloritized may be observed.

A rock of similar composition and texture crops out on the north shore of Caché creek at the place where its course turns from southwest to northwest. At this locality, where the pillows witness a strong deformation, coarse, dark green needles of hornblende are randomly oriented in a granular light green matrix which resembles the "garben" post-kinematic schist of the Alps*.

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* Personal communication, Professor E.H. Kranck, McGill University.

Individual crystals of hornblende are up to 3/4 inch long and formed soon after the stretching of the pillows. Under the microscope, the rock shows large green, strongly pleochroic poikiloblastic hornblende crystals (45%) and disseminated flakes of biotite (8-10%) in a granoblastic matrix of quartz, epidote, calcite and magnetite. Magnetite occurs in elongated rod-shaped masses or in irregular grains. This latter structure is evidently post-kinematic and doubtlessly caused by the granitic intrusions.

All the basic rocks of volcanic origin were subjected to physico-chemical conditions which transformed them to high or low degree amphibolites.

These metavolcanic rocks have a chemical composition (Table 1) close to basalts. These basaltic rocks were exposed to variations of pressure and temperature which adapted their mineralogy and texture to equilibrium in obedience to the physico-chemical conditions. This metamorphism has an intensity which varies according to the environment of formation of the hornblende-plagioclase gneisses, which range from the epidote-amphibolite facies to the almandine-amphibolite facies.

The minerals which may compose these basalts at different stages of their evolution are listed in Table 2.

TABLE 2

CHARACTERISTIC ASSEMBLAGES FROM BASALT TO AMPHIBOLITE

Basalt	Greenschist	Amphibolite
Ilmenite	Leucoxene or sphene magnetite	Sphene Magnetite
Olivine Hypersthene Augite	Actinolite Chlorite Epidote	Hornblende
Calcic plagioclase	Albite carbonate	Oligoclase or andesine

Whether the resulting rock belongs to the epidote-amphibolite or the almandine-amphibolite facies depends on the intensity of changes of temperature and pressure in the milieu, or variations of water pressure acting on the rocks at the time of metamorphism. Indeed, in the basalt-greenschist conversion, an increase in the water pressure activates the reaction, but in the course of the passage from greenschists to amphibolite the rock must release water, and, in this case, if a high water pressure is trapped locally for some reason, the reaction will be held to the epidote-amphibolite facies, whereas neighboring areas will belong to the almandine-amphibolite facies.

Tuffs, agglomerates and breccias

Metamorphosed tuffs and agglomerates form one of the most easily distinguished units in the area. The agglomerates consist of lenticular fragments often more than three feet long in a matrix of similar texture (Plate 1-A). However, a marked contrast between the matrix material and that of the fragments also may be noted (Plate 1-B). The texture of the fragments is quite pronounced on weathered rocks which often show an irregular surface with areas standing out in relief by differential erosion. On fresh surfaces the distinction of fragments is generally impossible. The agglomerates consist of non-layered but definitely foliated rocks, fine-grained, greenish gray or grayish green in color.

The agglomerate beds pass imperceptibly into volcanic tuffs. The tuffs are generally banded in diverse layers, greenish white to dark green in color; the beds range from several millimeters to thicknesses of several feet. The thickest beds are commonly light colored, often weathered to a chalky white; the biotite orientation shows the foliation. Metamorphosed tuffs consist of fine-grained banded or laminated rocks composed of dark beds of plagioclase and amphibole and light-colored beds of quartz and plagioclase. These rocks have acid to intermediate compositions. The regional metamorphism produced local strongly banded and contorted augen gneisses which show almost no traces of primary fragmental texture; Plate 1-C illustrates beds of agglomerate and tuff strongly deformed and intruded by dioritic rocks.

These fragmental rocks display a crystalloblastic texture in thin-section. The grain size of the matrix ranges from 0.04 to 0.10 mm. in diameter. These rocks consist principally of plagioclase (albite-oligoclase) quartz and minor quantities of sericite, chlorite, epidote, carbonate, apatite, magnetite, pyrite and iron oxides. The principal ferromagnesian mineral is amphibole which commonly forms poikiloblastic grains 2 mm. long; locally, shreds of biotite porphyroblasts occur in greater quantity than the amphibole. Occasional relics of weakly zoned plagioclase phenocrysts (An_{25-31}) vary between 0.5 and 3 mm. in width. Rare automorphic porphyroblasts of garnet up to 2 mm. in diameter, or disseminated ragged flakes of muscovite occur. Although the mineralogical composition varies considerably in thin-section, a typical specimen contains approximately 50% plagioclase, 20% quartz, 25% amphibole and 5% biotite.

Rhyolitic lavas

Acid lavas were seen in the area. However, they are difficult to differentiate from sills and dikes of sheared quartzo-feldspathic porphyries which accompany them. The two rock types are almost identical megascopically, and unless they are seen in contact it is impossible to say if an outcrop belongs to one rock type or the other.

Rhyolitic lavas, tuffs and agglomerates intermixed with sills of quartzo-feldspathic porphyry form two bands southwest of Gill lake which appear to rejoin just east of the northwest-trending part of Caché creek. Similar rocks are unknown in the adjacent Village Lakes quadrangle. Graphitic schists are closely associated with the rhyolitic rocks. Thin beds of garnetiferous chlorite schist occur in the rhyolite bands, perhaps representing interbeds of pelitic rocks or basic tuffs. Banded rhyolitic lavas crop out on the north shore of Natel lake 1/2 mile from its eastern end.

Several other outcrops of rhyolitic agglomerate occur on the Eastmain river, several hundred feet from "Conglomerate Point". Rhyolite bands form interbeds with tuffs and rocks of probable sedimentary origin.

The bands are composed of angular fragments and blocks of rhyolitic composition up to six inches long, resting in a fine-grained fragment-bearing matrix. Some of these fragments are well banded; others have an andesitic composition.

An outcrop of rhyolitic tuffs lies along the north bank of the Eastmain river a short distance west of Conglomerate Point. The rock is rusty, fine-grained, gray on fresh surfaces, and consists of a schistose aggregate of irregular, coarse quartz grains, sporadic altered plagioclase grains and rock fragments composed of fine-grained mosaic quartz, in a fine-grained quartz, sericite and carbonate matrix with disseminated pyrite.

The common association of disseminated iron sulfides, acid volcanic rock and graphitic sediments indicates a syngenetic origin for the sulfides. A similar association of sulfides and black slates which form a part of the sedimentary interbeds in the volcanic assemblage also suggests a primary origin.

Metasedimentary rocks

The metasedimentary rocks are important in the Village Lakes quadrangle, but in the Natel and Pivert Lake sections they occur only as isolated islands or unmappable shreds among the lavas or granitic rocks.

The paragneisses of the Pivert Lake section, in general, are biotite quartzo-feldspathic and hornblende-plagioclase paragneisses, whereas the biotite-staurolite, biotite-andalusite, biotite-andalusite-sillimanite paragneisses occur in the Village Lakes and Natel Lake sections. In this latter section shreds of metasedimentary rocks of small surface area, but of great importance in establishing the genetic relation of the lithologic units, occur within the metavolcanic rocks. The injected gneiss of Lichteneger lake must be added to these rock types.

Sedimentary rocks associated with the volcanic assemblages in the Natel Lake quadrangle

A variety of rock types of sedimentary origin crop out in a narrow contorted band along the Eastmain river west of the mouth of Anaconda creek. The relation between these rocks and the rocks of volcanic origin is not clear, but the two varieties of rocks seem to form interbeds, due doubtlessly to periods of sedimentary deposition in the course of periods of volcanic tranquillity. The interbedded formation could also be caused by folding of concordant or discordant, overlying or underlying, sedimentary sequences.

The most important of these rocks of sedimentary origin is indisputedly the conglomerate which occurs in a band 50 feet wide at the locality called Conglomerate Point on the Eastmain river. This conglomerate consists of numerous cobbles of rocks which seem to be of volcanic origin, of occasional blocks and pebbles of granitic composition and of white quartz pebbles in a fine-grained matrix containing fine rock fragments, which locally shows a vague bedding. The matrix consists of fine-grains of quartz, biotite, chlorite and disseminated magnetite. A block of granitic material has the following composition: 50% plagioclase (An $_{20-40}$), 40% quartz, biotite and magnetite. Plagioclase appears to be replaced here and there by quartz. Exposures of slaty schists and other sediments, as well as the agglomerate of rhyolitic composition previously described, may be seen bordering this outcrop.

Another outcrop of conglomerate occurs on an island west of Dôme rapids. It appears to be a conglomerate similar to the preceding, but it also contains blocks and pebbles of dolomitic material as well as quartz and feldspar porphyries. The rock is schistose, and has an overall light gray color. A pebble of granitic material, examined under the microscope, revealed 30% quartz, 60% plagioclase, 10% biotite and chlorite and accessory quantities of epidote, zircon and sphene. Nearby, small isolated outcrops of dolomite and other sedimentary rocks may be seen.

It is important to note that the two specimens of granitic material taken from conglomerates from different localities are essentially the same composition, 50-60% plagioclase, 30-40% quartz and 10% biotite, without microcline, which is almost the composition of the oligoclase gneiss described by Valiquette (1964) in the Lemare and Cramoisy Lake areas. This oligoclase gneiss could, according to Valiquette (1964), constitute the partly remobilized basement on which the basic lavas and sediments of the Némiscau River zone were deposited. The discovery of pebbles of the same composition in a conglomerate which is apparently interbedded with the metavolcanic rocks is a new indicator in favor of the above-mentioned thesis.

A detailed study of these conglomerates will certainly shed new light on the structural interpretation, all the more so as the oligoclase gneiss in question forms an important lithologic unit in the Grand-Détour—Village Lakes area.

The sedimentary rocks associated with the volcanic rocks also contain conglomerates with slate fragments, quartz pebble conglomerates and several other types of sedimentary rocks, which may be graywackes, arkoses, and slates, but these units are poorly represented in the area.

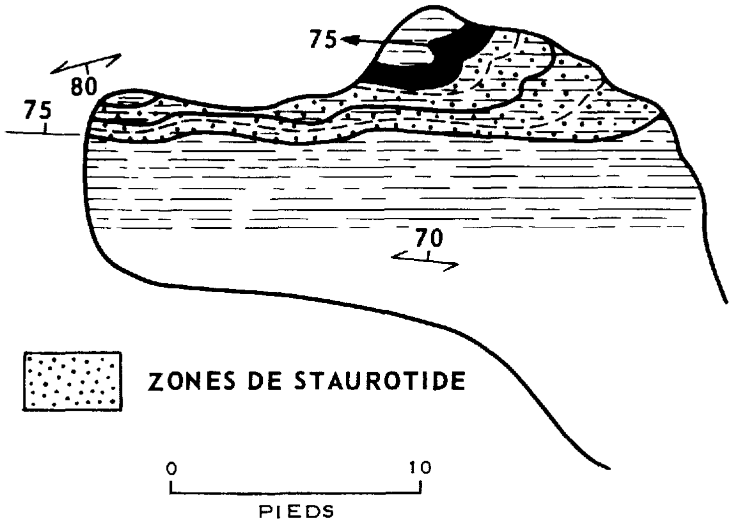
Numerous outcrops of dolomite are also found on the south bank of the Eastmain river about 1 3/4 miles downstream from Dôme rapids, close to a large outcrop of conglomerate. In outcrop the dolomite has all the appearance of a sedimentary rock, showing a vaguely defined but indisputable bedding. The rock has a soft surface of reddish brown color. It appears as a light gray aggregate of fine- to medium-grained carbonate containing some quartz grains.

Lloyd Lake biotite-staurolite paragneiss

Many outcrops of a micaschist of sedimentary origin occur between 500 and 1,000 feet east of Lloyd lake in the east-central part of the Natel Lake quadrangle. Similar rocks crop out south and west of this locality, but the exact extent of this assemblage cannot be delineated because of the poor exposure and the enclosing swamps.

Metavolcanic rocks surround this paragneiss, but they are nowhere observed in contact and it is therefore impossible to determine the stratigraphic relations between the two units. Dikes and sills of quartzo-feldspathic porphyry intrude these paraschists. The best outcrop (Fig. 2) immediately east of Lloyd lake consists of brown micaceous schist (lustrous on a fresh surface, spotted with sporadic little garnet crystals) which displays indefinite yet angular forms of pale brown staurolite porphyroblasts on a differentially weathered surface. The rock, in some places, is stained a light greenish color, and is composed of about 30% fine flakes of

Figure 2



PETITS PLIS ET CLIVAGE SECONDAIRE DANS LE SCHISTE À STAUROTIDE ET BIOTITE À L'EST DU LAC LLOYD.

M.R.N.Q. 1967 B-891

biotite, 20% muscovite, and 50% quartz containing poikiloblastic porphyroblasts of pink garnet and several large cross-twinned crystals of staurolite. Fine disseminated grains of magnetite and pyrite are the accessory minerals. In outcrop the bedding seems parallel to a well marked regional foliation which is cut obliquely by a late local transverse cleavage. Another specimen of the same outcrop consists of 50% quartz, 40% biotite and minor quantities of muscovite, magnetite, epidote, altered feldspar and chlorite altering biotite.

In the neighborhood of the typical pelitic schists described above, a band of light gray colored gneiss may be seen, marked by dark green hornblende needles oriented parallel so as to give the rock a linear as well as planar structure.

Clarkie Lake metasedimentary rocks

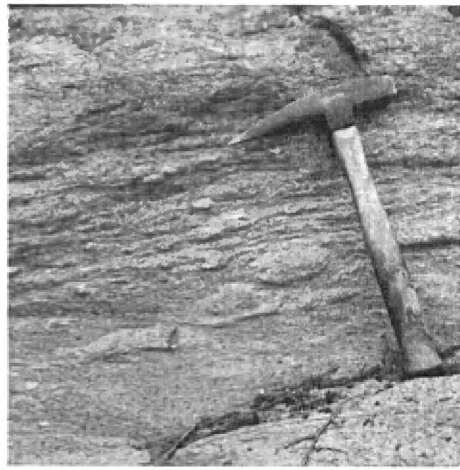
Gray, quartz-feldspar-biotite gneiss is the most common metasedimentary rock in the Natel and Village Lakes quadrangles. This gneiss undoubtedly has the same composition as those of Lloyd lake, but merits special consideration for its mineralogical peculiarities. This Clarkie lake-type of paragneiss occurs also in the southeast part of the Village Lakes quadrangle, south of the Eastmain river.

The general composition of the rocks around Clarkie lake is about 70% quartz and feldspar and 30% biotite. Hornblende is present locally. Table 4 shows a chemical analysis of a sample of quartz-feldspar-biotite-hornblende gneiss compared to the average arkose, graywacke and shale. The chemical analysis seems to relate the composition of the rock to that of a shale. As the specimen chosen for analysis appears to be characteristic of the metasedimentary rocks of the north of the area, it seems possible to affirm that these quartz-feldspar-biotite paragneisses, with or without hornblende,are derived from shales.

Quartz-feldspar-biotite gneisses or schists are also present southeast of the Eastmain river, but, in general, while the mineralogical composition is similar to that of the northern paragneiss, garnet is much more common, and quartz is more abundant. In certain places garnet occurs in sufficient quantity to be included in the rock name. Interbeds of quartz-biotite-garnet schist and quartz-garnet schist and small quantities of quartzite are found in the preceding gneisses. These interbeds are not widespread enough to be noted on a 1/2 mile to the inch map. The quartz-garnet schist contains up to 20-30% garnet locally. A thin-section of quartzite shows 70% quartz and 30% muscovite. These quartzites or muscovite-quartz schists are light gray in color.

PLATE I

A- Bed of agglomerate in a sequence of metamorphic volcanic rocks along Agglomerate Ridge: note the typical lenticular fragments.

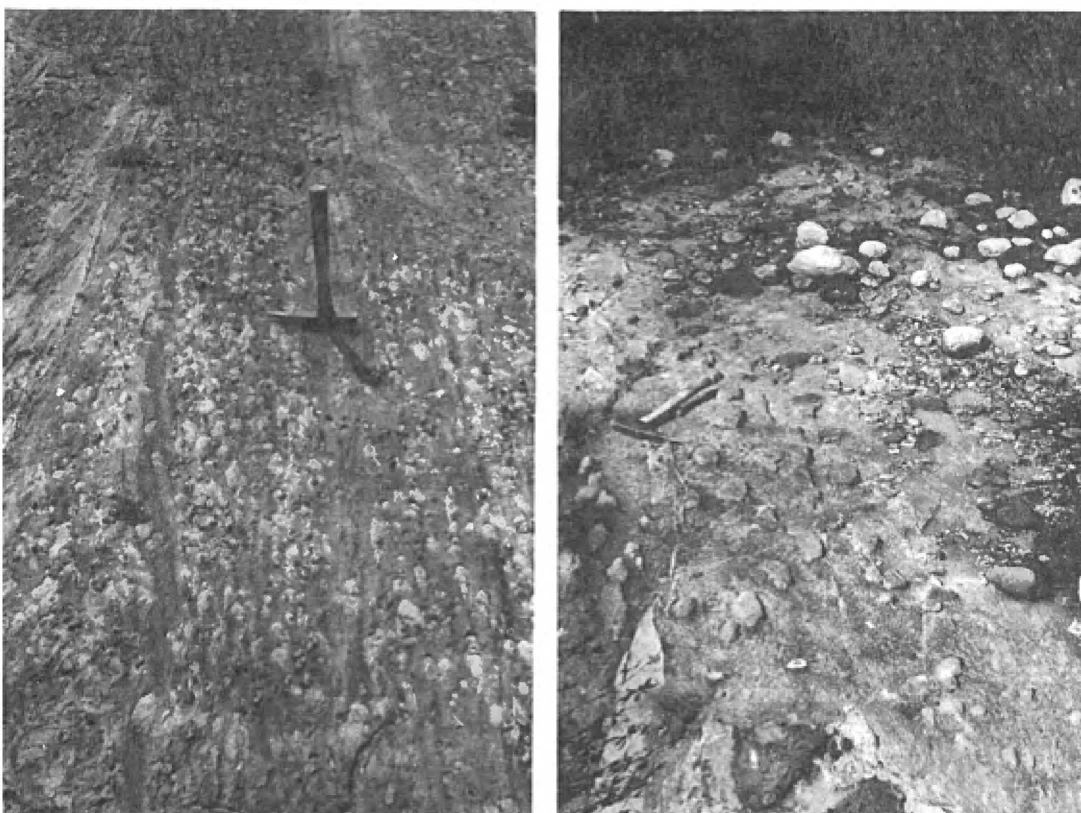


B- Bed of agglomerate in a sequence of metamorphic volcanic rocks, to the east of Eau-Claire river: note the fragmental nature of the rock.

C- Complex mass in the form of a porphyroidal diorite (light) sill intruding strongly deformed tuffs and agglomerates, along Agglomerate Ridge: note that the mass is much thicker in the background of the photo.

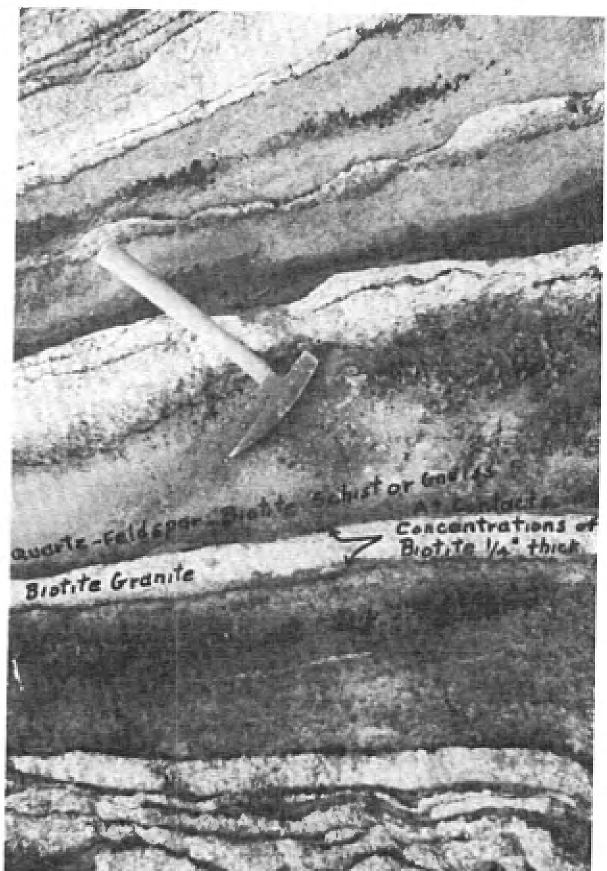
D- Unloading canoe at the foot of Grand-Détour rapids; outcrop of dioritic gneiss.

PLATE II



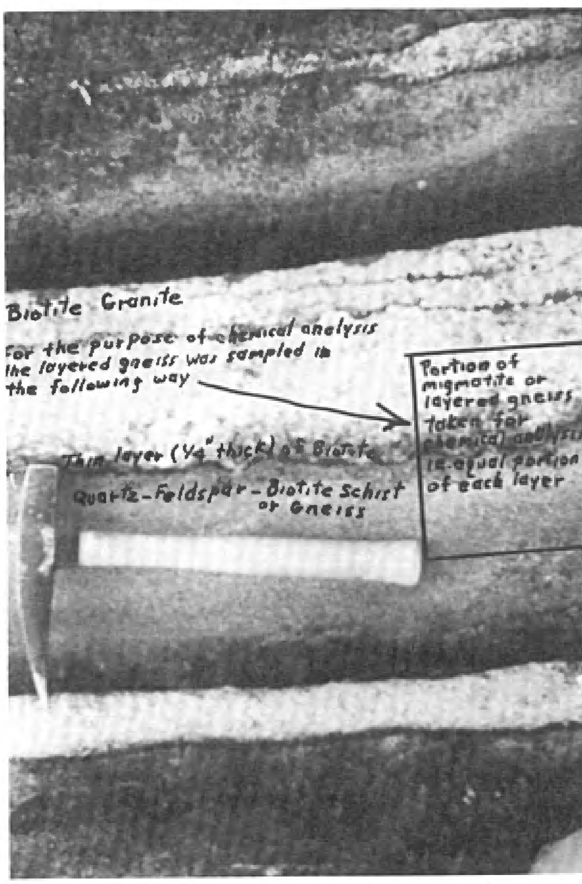
A and B - Quartz-biotite-andalusite schist or gneiss showing the variation of the size of the andalusite porphyroblasts, south of the Eastmain river. The andalusite porphyroblasts stand out in relief on the surface of the outcrops because of the weathering in situ.

PLATE III



Layered gneiss or migmatite, north shore of Lichteneger lake.

PLATE IV



Outcrop of glomeroporphyritic gabbro 1,200 feet north of Boule-de-Neige lake in the southeast corner of the Natel Lake quadrangle.

A facies of this biotite gneiss, peculiar enough to be noteworthy, occurs on the islands along the northwest shore of Clarkie lake. Of particular interest is the island located north of the mouth of the large northeast-trending jagged bay. The shores of this island are made of a rock which on weathered surfaces has the appearance of an injection gneiss affected here and there by boudinage. However, polishing a block about one square foot shows numerous pebbles with more or less sharp contacts locally confused by areas of matrix with a coarse-grained gneissic structure.

It appears, however, to be a conglomerate composed of greenish white pebbles of granitic gneiss which suffered a more or less pronounced deformation, in a matrix of partly granitized biotite gneiss.

On outcrop surfaces polished and washed by lake water, the metaconglomerate has more the aspect of an irregular injection gneiss which in places passes into a rock which might be called migmatite or augen gneiss.

Typical biotite gneiss described above, in direct contact with this metaconglomerate, shows black nodules over an area 12 feet wide on the surface of the outcrop. On fresh surfaces, these nodules form small dark blue lenses in the rock within which tiny vitreous fibers elongated parallel to the schistosity of the rock may be seen. Areas of poikiloblastic andalusite appearing to be isolated grains in optical continuity, crossed by fibers of sillimanite, may be seen under the microscope in this quartz-biotite-muscovite schist.

The presence of these high temperature minerals suggestive of contact metamorphism coincides with the idea of a zone of injection or migmatite which, in some places, almost erased the distinctive character of the conglomerate.

Quartz-biotite-andalusite gneiss

Quartz-biotite-andalusite gneisses are light gray colored rocks composed of a base of quartz-biotite schist covered by nodules of andalusite up to three inches long (Plate-II A and B). The nodules are generally ovoid in shape and wine-red to pink-white in color, depending on the amount of quartz which occurs as inclusions. On the average the rock is composed of about 45% quartz, 30% biotite, 25% andalusite and smaller quantities of garnet and magnetite. Garnet sometimes becomes an important part of the matrix.

These outcrops of andalusite gneiss cover a width of about a mile and a length of about seven miles in the central part of a tight syncline, between a northwest-trending fault and the east border of the area, south of the Eastmain river. The presence of a zone of andalusite gneiss as widespread as this in an area practically devoid of intrusives of this scale suggests that this mineral assemblage is the product of a regional metamorphism to the amphibolite facies under conditions of low pressure and intermediate temperature.

Lichteneger Lake layered gneiss

The layered gneisses of the area seem to be migmatites. These gneisses crop out in two places, north of Lichteneger lake and northeast of Village lakes. A characteristic specimen is composed of alternating layers of medium-grained quartz-feldspar-biotite gneiss, and coarse-grained biotite granite. These layers are commonly two to 10 inches thick and are separated by a selvedge of biotite 1/4 inch thick (Plate III).

These gneisses show a perfect layering, and an attempt has been made to determine if they are veinites or arterites, that is to say, if they formed by segregation or by injection of magma. A sample which spans two layers of different composition was taken for complete chemical analysis.

If the material in the layers was derived by segregation from a sedimentary rock rich in silica and alumina, this chemical analysis would probably be similar to that of a gneiss characteristic of this area. It is shown in Table 3 that a quartz-feldspar-biotite-hornblende gneiss taken from between Clarkie and Lichteneger lakes has the composition of a common shale. The migmatite sampled does not have this composition but has more the composition of an average granite. Obviously one could foresee variations on a regional scale (Table 4), but the differences shown in this table are too great, and it is unlikely that the material noted in the migmatite veins was derived by segregation of an original sedimentary rock. The chemical analyses in Table 4 indicate that the migmatized sediment was probably richer in SiO_2, and poorer in CaO and Al_2O_3 than the metamorphosed shales which were analysed (H-1-1 in Table 4).

The felsic layers of these migmatites (Plate III) have a granitic composition and seem to be granite injections. All these layered gneisses are found in the neighborhood of granitic massifs and seem to be injection gneiss or arterites.

The migmatites northeast of Village lakes are similar to those of Lichteneger lake, but the layering is not regular and some of the rocks may be formed of a mixture of basic lavas and granitic material.

TABLE 3

Constituents	Average composition of an arkose (p. 259)	Average composition of a graywacke (p. 250)	Chemical composition of normal shales (Table 83, p. 285)			Composition of a quartz-feldspar hornblende-biotite schist or gneiss of the Village Lakes Area, New Quebec Sample H-1-1
	All the compositions given in this part of the table are taken from F.J. Pettijohn, Sedimentary Rocks					
			A[a]	B[b]	D[d]	
SiO_2	75.5	64.2	56.29	60.88	54.76	55.54
TiO_2	-	0.5	0.64	0.62	1.16	1.11
Al_2O_3	11.4	14.1	19.22	17.78	17.65	18.14
Fe_2O_3	2.4	1.0	-	1.94	5.46	1.29
FeO	-	4.2	4.39	4.07	2.88	6.38
MnO	0.2	0.1	-	-	0.10	0.14
MgO	0.1	2.9	1.65	3.53	3.45	3.38
CaO	1.6	3.5	0.09	2.77	1.96	5.35
Na_2O	2.0	3.4	0.19	2.65	2.80	3.39
K_2O	5.6	2.0	10.85	3.16	3.00	4.45
H_2O	0.6	2.1	2.04	1.91	3.01	0.55
H_2O-	-	0.1	3.54	0.13	2.44	0.88
P_2O_5	T	0.1	-	0.29	0.15	-
CO_2	0.4	1.6	-	-	-	-
SO_3	-	-	0.72	-	-	-
C	-	-	-	1.70	1.18	-
S	-	-	-	0.10	-	-
Total	99.8	100.00	99.62	101.53	100.00	99.98

a) Glenwood shale, Ordovician, Minneapolis, Minn.; R.B. Ellestad, analyst; Am. Min., Vol. 22, 1937, pp. 842-846; orthoquartzitic clan.

b) Knife lake slate, Archean, Minn.; F.F. Grant, analyst; average of three analyses; Geol. soc, Amer., Bull., Vol. 44, 1933, p. 997; graywacke clan.

d) Combined light and dark portions of late-glacial varved clay (Equal parts of each).

<u>TABLE 4</u>

	Samples from Village Lakes Area, New Quebec		Chemical composition of granite (p. 193 - Johannsen Vol. II)			
	H-1-1 Metamorphosed shale	P-9-7 Part of a migmatite	Average of 23 samples	Limits found	Possible limit	Daly's average of 236 samples
SiO_2	55.54	67.63	69.35	77.47-58.46	80.70-49.67	69.92
TiO_2	1.11	0.71	0.35	0.85-		0.39
Al_2O_3	18.14	13.64	14.27	16.49-10.88		14.78
Fe_2O_3	1.29	1.25	1.22	3.75- 0.10		1.62
FeO	6.38	3.80	2.33	6.67- 0.79		1.67
MnO	0.14	0.08	0.07	0.36- 0.00		0.13
MgO	3.38	2.06	1.13	3.67- 0.13		0.97
CaO	5.35	2.26	2.18	5.24- 0.47		2.07
Na_2O	3.39	4.14	2.95	4.38- 1.08	15.53- 2.85	3.28
K_2O	4.45	3.09	5.36	8.36- 2.84		4.07
H_2O	0.63	1.01	0.55	2.03-		0.78
P_2O_5	-	0.07	0.17	0.61-		0.24
BaO	-	-	0.03	0.27-		0.06
SrO	-	-	0.01	0.10-		0.02
FeS_2	-	-	0.01	0.18-		-
CO_2	0.18	0.60	-	-		-
Total	99.98	100.34	99.98			100.00

Pivert Lake sedimentary rocks

Three bands of metamorphosed sedimentary rocks are noted in the Pivert Lake quadrangle: the first two appear as isolated members close to the rapids on the Eau-Claire river, and the other in the middle of the Grand-Détour rapids. This band is composed of hornblende gneiss and schist, quartzo-feldspathic gneiss, schistose ortho- and para-amphibolites and gneissic granodioritic rocks. These rocks are well layered and, at times, formed of thin laminae. The stratification is parallel to the foliation at numerous points but is separately visible at certain localities. The west contact shows a more or less gradual passage to gneissic granodioritic rocks (oligoclase gneiss) and to migmatites; sometimes it is quite sharp.

A second band occurs at the southern extremity of the area. Its largest extent within the area, is two to three thousand feet. The rocks which compose it are uniform hornblende gneiss and schist, schistose amphibolites, biotite-quartz gneiss and schist, sporadic augen gneiss, muscovite-quartz schist and gneissic granodiorite. These rocks are well layered and in many localities are constituted of thin laminae, and, where visible, the stratification is parallel to the foliation. The south contact of this band is a gradual transition either to gneissic granodioritic rocks (oligoclase gneiss) or to migmatites.

Part of the sedimentary rocks of this zone pass gradually to the principal outcrop zone of the metamorphosed volcanic rocks of the north part of the area. This band crops out only at a few localities but it seems to have a width of several thousand feet. It is principally composed of hornblende gneiss and schist, biotite-quartz gneiss and schist and biotite schist.

In resumé, the metasedimentary rocks of all the bands are of three types, amphibole schists, amphibole-plagioclase gneiss, and quartzo-feldspathic gneiss.

The amphibole schists common to all the sedimentary bands have compositions and textures more variable than the amphibolites of volcanic origin, and moreover they pass gradually into gneissic rocks. They occur in bands some inches to several feet thick.

These rocks have a schistose structure and are dark gray and fine to medium grained. The rock weathers greenish brown or occasionally reddish brown. The very variable composition ranges from 30 to 90% amphibole, from 0 to 45% plagioclase (oligoclase-andesine) and from 5 to 20% quartz.

Amphibole-plagioclase gneisses are the most common para-gneisses of the area. They are composed principally of plagioclase and amphibole and show a great variation of texture and composition. They are fine- to medium-grained rocks, banded or finely laminated, composed of dark green, amphibole-rich bands and light gray bands principally constituted of fine-grained plagioclase. The laminae vary from less than 1 mm. to 5 mm. thick. Under the microscope the composition of the rock varies between 25 and 50% amphibole, 25-65% plagioclase (oligoclase-andesine), 5-35% quartz, 0-5% biotite and 0-5% chlorite. Small quantities of chlorite, sphene, apatite, zircon, sericite, magnetite and pyrite are also noted.

The quartzo-feldspathic gneisses are also abundant in the area. These consist of lightly banded rocks with a fine grain and yellowish gray color, composed largely of quartz and plagioclase with flakes of biotite. Thin-sections show 45-60% plagioclase (oligoclase-andesine) 25-30% quartz, 10-20% micas (biotite, muscovite, and chlorite) and 0-5% microcline.

A sedimentary origin is favored for these rocks of the Pivert Lake quadrangle by reason of the banding of different compositions, of the great variation in the composition and textures over a short distance across the layers, of the fine grain size, and of the lack of relict textures suggesting any other origin.

Basic intrusions

Only the Village Lakes map shows basic intrusions and many of these are of uncertain origin. The two other quadrangles also contain basic intrusions, but, metamorphosed to the amphibolite facies characteristic of this area, these intrusions cannot, with certainty, be separated from the basic rocks of volcanic origin. In fact they generally appear as hornblende-plagioclase gneisses, or amphibolites, which occur as concordant sills, easy to recognize among paragneiss or felsic rocks, but inseparable from the basic volcanic rocks.

An outcrop of uralitic gabbro occurs about 2 1/2 miles south of Gill lake. The rock consists of a massive dark green, medium-grained aggregate which shows a salt and pepper weathered green and white surface. This gabbro is composed of 60% olive green hornblende, 25% completely saussuritized plagioclase, 10% magnetite and traces of quartz. This rock is a typical example of gabbro metamorphosed to the almandine amphibolite facies, marked by complete recrystallization of the original magmatic pyroxene to hornblende.

Other amphibolites show a green amphibole with a blue tint, and an appreciable quantity of epidote, which suggests that the rock pertains mostly to the epidote amphibolite facies. The alteration of the plagioclase does not permit precise determination of the anorthosite percentage. It is possible that this case indicates low temperature and pressure conditions but it may also indicate the capture of a high local water pressure at the same conditions of temperature and pressure.

Numerous outcrops of basic intrusives occur 2 1/2 miles north-northeast of Pivert lake. These appear to be sills or concordant masses which occur in the migmatites as inclusions in many intrusive zones of recent and older granites, which indicates that they were emplaced before the deformation of the area.

The rock is fine grained, generally massive and dark gray, and is composed almost exclusively of plagioclase and amphibole. Where the regional metamorphism is greatest, the rock is medium grained and distinctly foliated.

A specimen in thin-section shows 45-55% plagioclase (An_{32-53}), 40-55% amphibole, 3-5% quartz and accessory quantities of epidote, biotite, chlorite, sericite, zircon, apatite, magnetite and pyrite.

Laths of plagioclase are about 0.2 to 1.0 mm. long; they are zoned and slightly altered. Poikilitic grains of amphibole 0.3 to 2.0 mm. long may be seen. Quartz is present in disseminated small grains. The texture is granoblastic.

A chemical analysis of a sample of these basic intrusives from the Village Lakes quadrangle (Table 2, sample H-6-3b) shows a composition comparable to that of a sample (H-6-3a) of metavolcanic rock, which appears to be of basaltic origin.

The intrusive rocks or metagabbro have followed the same trend of evolution as the basalt indicated in Table 3 between an intrusive gabbro and its metamorphosed equivalent, amphibolite.

Serpentinites

It was not possible to determine the stratigraphic position of the metamorphic derivatives of ultrabasic rocks, but they appear to be old. The serpentinites, which are abundant in the Natel Lake quadrangle, south and east of Dôme rapids along the Eastmain river, are composed of massive and schistose assemblages of talc, carbonate, serpentine and magnetite in varying amounts. Serpentine, which seems to be a pseudomorph of olivine, suggests that at least some of the serpentinite masses are derived from a rock of peridotitic composition. These massifs of serpentinite are narrow and discontinuous.

Gneissic granodiorites and oligoclase gneiss

The gneissic granodiorites and oligoclase gneiss form a lithologic unit which covers the largest area in the Pivert Lake quadrangle (about 65%) and a good part of the western half of the Natel Lake section. An important zone of oligoclase gneiss is also noted to the southeast of the Natel Lake and Village Lakes quadrangles, which extends to the south into the Cramoisy Lake and Lemare Lake areas (Valiquette, 1964; 1965).

Under close examination, the lithology shows numerous variations which would be impractical to try to present on a map at 1/2 mile to the inch scale.

Certain criteria were used in the field to distinguish the oligoclase gneiss and gneissic granodiorite from the granitic rocks with which they may, locally, be confused. These criteria do not apply everywhere, but are of some use. The old granitic rocks are generally characterized:

1) by a strong foliation parallel to the trend of the regional structure;
2) by numerous small shear zones;
3) by a relative abundance of quartz veins;
4) by gradual contacts;
5) by a lack of pegmatite and aplite;
6) by the presence of basic and intermediate dikes which cut the gneissosity, by dikes metamorphosed to the amphibolite facies;
7) by the paucity of microcline in these rocks.

The characteristic rock of this unit could, depending on the locality, be called more or less gneissic quartziferous diorite, more or less gneissic granodiorite, and also, locally, lit-par-lit injection gneiss and migmatites. However, all these variations lose their significance in a regional scale and may advantageously be grouped under the term gneissic granodiorite or oligoclase gneiss.

The typical rocks of the largest part of this geologic unit are those which line the Eastmain river below the Grand-Détour rapids (Plate 1-D). They appear as pale gray, fine- to medium-grained rocks principally composed of plagioclase, quartz and biotite. The foliation is exceptionally well marked along the Eastmain river, whereas elsewhere it appears more or less as traces, depending on the grain size.

These rocks which, in the Lemare Lake and Cramoisy Lake areas (Valiquette, 1964; 1965), farther south, contain no inclusions, are seen in the northwest corner of the Grand-Détour-Village Lakes area, to contain lenticular inclusions of fine-grained green schistose rocks, consisting principally of chlorite and epidote. These inclusions are generally oriented in the direction of the gneissosity of the enclosing rocks. The gneisses are characterized by numerous northeast-trending shear zones in the Pivert Lake quadrangle. These zones are less than two feet wide most of the time. It appears that the foliation of the gneissic rocks is parallel to the shearing direction only where it is intense; elsewhere, the foliation, which is parallel to the orientation of the lenticular inclusions, makes an acute angle with the shearing direction, leaving two directions of foliation to be seen. The sheared material consists of a schistose banded rock with fine grain size and light green color, chiefly composed of plagioclase, quartz and chlorite.

Migmatitic zones occur on two small islands in the Eastmain river two and four miles from the foot of the Grand-Détour rapids. These migmatites are fine- to medium-grained rocks, well banded and plicated, the individual layers of which range from a fraction of an inch to several feet in width. In certain outcrops the transition between true oligoclase gneiss and migmatite is imperceptible.

At several localities in the oligoclase gneiss, the surface of the outcrop is marked by granules of quartz which stick out, and by plagioclase twin planes; both are slightly coarser than the matrix, giving the rock (especially seen under the microscope) a porphyroblastic texture.

Under the microscope, the rock shows a modal composition of approximately: 45-60% oligoclase and andesine; 20-30% quartz; 5-15% biotite; 0-10% hornblende; 0-5% microcline; and 0-5% muscovite. Amphibole is important locally and composes up to 20% of the rock. Also noted are accessory quantities of epidote, carbonate, chlorite, apatite, sphene, magnetite and pyrite. Grain size ranges from 0.01 to 0.2 mm. and grains of quartz occur in veinlets and pods to 3 mm. long. Some plagioclase porphyroblasts attain a length of 3 mm. Biotite, muscovite and amphibole form poikiloblastic grains slightly coarser than the matrix. Local cataclastic textures are apparent, and, where the gneiss was sheared, the ferromagnesian minerals are almost completely converted to chlorite, and muscovite seems to have formed at the expense of microcline.

The zone of gneissic granodiorite and oligoclase gneiss which extends southeast of the Natel Lake and Village Lakes quadrangles is characterized by alternating bands of slightly foliated oligoclase gneiss, and sills of basic rocks metamorphosed to the amphibolite facies. These sills locally send out dikes many feet wide which cut the foliation of the neighboring gneiss. These dikes appear mineralogically similar to the amphibolite facies.

The presence of granitic blocks and pebbles with a composition comparable to this oligoclase gneiss in the conglomerate intercalated in the metavolcanic rocks at Conglomerate Point on the Eastmain river was noted above.

It seems plausible to suggest that the oligoclase gneiss, with structures regionally concordant with those of the paragneiss and metavolcanic rocks, and seemingly represented by blocks and pebbles in the conglomerate intercalated in the lavas, was the basement on which were deposited the lavas and sediments that today appear metamorphosed to the amphibolite facies. This basement, which in places shows certain characteristics of synkinematic granites, perhaps underwent partial remobilization at the time the overlying rocks were regionally deformed and metamorphosed.

Porphyroidal microcline granite

An intrusive stock of porphyroidal microcline granite marked by several small apophyses crops out around the southern curve made by the Eastmain river upstream from the Grand-Détour rapids. A small massif is also known from the vicinity of Labyrinthe lake.

The rock is light gray and medium grained, and its foliation is very poorly developed. It is chiefly composed of plagioclase, microcline, quartz, amphibole and biotite. Its particular character comes from the presence of numerous automorphic phenocrysts of microcline 1/2 inch long, and smaller scale phenocrysts of hornblende elongate in the form of laths.

This rock hides numerous subrounded inclusions ranging from several inches to several feet long which are generally amphibolite in composition. The inclusions and laths of microcline and hornblende which, in places, show a coarse parallel orientation, form a detectable foliation on most outcrops. This foliation generally trends northwest except where it follows almost parallel to contact zones. These contacts are generally sharp, but in certain localities they appear as zones slightly richer in ferro-magnesians in the granite, and where microcline porphyroblasts are absent; these zones appear in part due to a contact chill zone and in part to wall-rock contamination.

The porphyroidal granite from Labyrinthe lake is generally sheared and altered, but it shows abundant porphyroblasts of microcline.

Dikes of pegmatite, aplite, microgranite and diabase cut the porphyroidal granite. Two types of pegmatite are associated with the granite. One of the two contains rare earths. The rare-earth-bearing dike crops out in the vicinity of the apophysis located west of Pivert creek. Microgranite dikes are confined to contact zones.

The modal composition of porphyroidal granite is as follows: 45% plagioclase (An_{14-29}), 22% microcline, 18% quartz, 9% hornblende, 4% biotite and accessory quantities of apatite, sphene, zircon, epidote, chlorite, magnetite and pyrite. The texture is typically hypidiomorphic although it may be partly modified by late metasomatic activity. Small areas of fine-grained matrix composed chiefly of quartz, plagioclase and microcline in grains varying from 0.05 to 0.40 mm. in diameter are noted in several thin-sections. Plagioclase laths are weakly zoned and have an average length of 0.5 to 1.0 mm., sometimes attaining more than 4 mm. Poikiloblastic microcline grains may be longer than 4 mm. in the matrix; the large grains are generally perthitic. Small protuberances of myrmekite occur at the contacts between grains of microcline and plagioclase. Amphibole and biotite are from 0.5 to 2.0 mm. in diameter.

The replacement textures shown by microcline suggest a late potassium metasomatism.

Late granite

The late granites form three isolated massifs, at the western extremity of the Grand-Détour_Village Lakes area, and cover a large surface area along the Eastmain river east of Village lakes. It appears to be an intrusive granite that cuts all the previously described rocks. The two massifs which occur on the western limit of the area are separated by 3,000 to 4,000 feet of metamorphosed sedimentary and volcanic rocks.

This pinkish white, medium-grained granite has a poorly developed foliation and a granitic texture. It is largely composed of plagioclase, quartz, potassic feldspar and a minor amount of biotite; certain greenish white phenocrysts of plagioclase are up to 5 mm. long. The rock generally has a uniform composition. However, locally, as in the south of the northern of the two masses lying on the map boundary, hornblende replaces biotite and becomes the predominant mafic mineral.

East of Village lakes, particularly along the Eastmain river, the granite passes gradually from a massive to a gneissic structure. This gneissic structure is generally caused by shear zones, and,at these places, the rock is megascopically indistinguishable from the oligoclase gneiss described above. Inclusions are rarely seen in the granite. Locally, flakes of biotite are perceptibly aligned in a west-northwest direction; in contact zones, however, the mafic minerals tend to follow the orientation of the contact with the neighboring rocks. The contacts are sharp only in the metamorphosed sedimentary and volcanic rock terrains, but among the older granites, tne contacts, although intrusive, are difficult to spot. Small pegmatite and aplite dikes are numerous.

The average mineralogical composition, determined on six thin-sections, is 55% plagioclase (An_{18-29}), 26% quartz, 11% microcline, 5% biotite, 0-3% amphibole, and trace amounts of muscovite, sphene, apatite, epidote, zircon, sericite, chlorite and magnetite. The texture is granular and varies from xenomorphic to hypidiomorphic. The groundmass consists chiefly of grains of quartz, plagioclase and microcline varying from 0.05 to 0.3 mm. in diameter. Plagioclase occurs in laths up to 5 mm. long; many grains are zoned and are much altered from the center out. Microcline forms poikiloblastic grains up to 3 mm. long. Protuberances of myrmekite occur on the contact between plagioclase and microcline grains. Biotite and amphibole porphyroblasts seem to cut all the other minerals. The replacement textures shown by the microcline suggest a potassium metasomatism.

Pegmatite and aplite

The pegmatites are present in the form of dikes, sills and small masses which cut the metavolcanic, metasedimentary and granitic rocks. In the Village Lakes quadrangle, muscovite pegmatites abound over all the area, whereas tourmaline pegmatites have a more restricted distribution.

In the Pivert Lake quadrangle the acid dikes, associated principally with the last granitic events, but also widespread in the adjacent terrains, are divided into three categories:

1) pegmatitic and pink aplitic granites;

2) microgranites;

3) white, rare-earth-bearing pegmatites.

The aplites are massive, granular, fine-grained, pinkish white rocks composed of about 40% oligoclase, 33% quartz, 25% microcline and minor amounts of muscovite, sphene, epidote, chlorite and magnetite.

Pegmatites, by nature more diverse, are pale to dark pink rocks with grain size varying from medium to coarse, chiefly constituted of plagioclase, quartz and microcline.

Many microgranite dikes intruded the contact zone between the oligoclase gneiss and the Pivert lake pink intrusive granite massifs and the porphyroidal granite. These intrusions range in thickness from one to 10 feet. The rock is characteristically yellowish gray, with a foliated structure, a fine-grain size and an igneous texture. It is composed of 48% plagioclase (An_{29}), 25% quartz, 20% microcline, 7% biotite and trace amounts of apatite, sphene and magnetite. The 2 mm. long plagioclase phenocrysts are zoned. Small flakes of biotite are aligned parallel to dike contacts.

The pegmatites which merit most attention are those containing rare earths; these are most abundant south of the Pivert Lake area. They seem connected to the porphyroidal granite which lies west of Pivert creek. In general these pegmatite dikes vary in width between one and 10 feet, but some exceed 30 feet. They trend northwest, almost without exception, and have a steep northern dip. They are composed principally of coarse grains of quartz, potassic feldspar, albite and muscovite; at certain places spodumene is abundant. In the largest dikes, concentrations of biotite, tourmaline, lepidolite and small pods of molybdenite occur. These white pegmatite dikes cut aplite, pink pegmatite and microgranite dikes.

Glomeroporphyritic gabbro

Southeast of the Natel Lake quadrangle, three large outcrops of glomeroporphyritic gabbro indicate the presence of a giant NNW.-trending dike. The outcrops are composed of a spectacular accumulation of spheroidal masses of feldspar reaching the size of a football in a less abundant groundmass of dark green amphibole and chlorite (Plate IV). Contacts with the adjacent rocks are not exposed. The feldspar is much altered, but two microscopic determinations indicate the composition is plagioclase-labradorite (An_{50-60} and An_{60-65}). The composition of the rock seems to be that of an anorthositic gabbro.

Not far from these outcrops, but in the Village Lakes quadrangle, similar rocks form two hills elongated in the same direction. The heart of the phenocrysts in these latter outcrops is a pink feldspar measuring two to three inches in diameter surrounded by a ring about 1/2 inch wide of steel-gray plagioclase. The phenocrysts are separated by a matrix of chlorite and hornblende. The most important hill of this dike measures 500 feet wide and crops out over a length of one mile.

Pleistocene and Recent

The Pleistocene glaciers apparently progressed in a direction from S.60°W. to S.65°W. as indicated by numerous striated surfaces, gouge marks and the elongation of several large hills which approach drumlin shape. The retreating glaciers deposited a thick mantle of drift over most of the area; only the peaks of several ridges are exposed. Many long and irregular eskers (up to 10 miles long) are elevated 15 to 30 feet above the neighboring ground. These eskers are almost always parallel to the direction of the glacial drainage, but some trend towards the west. An important esker forms a chain of islands in Clarkie lake and disappears into the ground towards the west.

Many vestiges of old terraces composed of poorly sorted sand and gravel lie along the Eastmain river. These vestiges now occur between 12 and 50 feet above the present level of the watercourse. Many terraces 12 feet high, chiefly composed of sand, are seen in the neighborhood of the south bend of the Grand-Détour. These may possibly be proglacial alluvial deposits.

STRUCTURAL GEOLOGY

With the exception of the younger granitic rocks and the young basic dikes, all the rocks of the area were subjected to deep and complex deformations caused by folds and faults which took place in many distinct phases. A heterogeneity of structural models which may be traced just on small outcrops and megascopic samples has resulted from these deformations.

Folds

Many folds are presumed to occur in the area, except in the Natel Lake quadrangle where there is no formation capable of furnishing top determinations. In the Natel Lake quadrangle, the pillowed flows of the metavolcanic rocks furnish top determinations, but these rocks are rarely in contact with paragneiss and the readings are too scattered to assure a plausible interpretation.

Northwest of Pivert lake, a vast west-plunging synclinal structure slightly overturned towards the north is postulated. Many minor folds affect the north flank. Possibly these latter folds, apparently overturned to the southeast, belong to a second period of folding. This seems to be corroborated by the interpretation of the lineations.

Between Aurélie and Gill lakes, south of Dôme rapids, top determinations suggest the presence of a tight syncline with an inclined axial plane, but the complexity of the structure and the scattering of the readings necessitate certain reservations on this interpretation.

Southeast of the Village Lakes country the trend of the lavas and metamorphosed sedimentary rocks suggests a synclinal form refolded in an east-west direction into an almost isoclinal shape. It seems that an almost isoclinal east-west syncline with steeply dipping flanks first formed. This structure was later refolded by an east-west compression.

Lineations

Lineations are well developed in general, and are caused by alignment of hornblende crystals, or lenses of biotite and by the axis of drag-folds. At a certain number of outcrops two or more of the same type of lineations occur with different orientations. Apparently many types of lineations, as well as secondary foliation,were subjected to deformations.

Faults and shear zones

Indications are present of an important fault trending N.40°W. which passes through the southeast extremity of the Village Lakes area, and extends south and west of Clarkie lake. The dip of this fault seems almost vertical, but the elements necessary for determining the throw are not available. The indications of the presence of this fault are as follows:

1) The trace of a continuous narrow linear valley seen on aerial photographs;

2) The disappearance of the quartz-biotite schist or gneiss and the biotite-andalusite gneiss or schist south of the Eastmain river on the west side of the linear valley;

3) The occurrence of mylonite and slickensides at two places in the valley.

East of Dôme rapids, the Eastmain river flows in a straight line for nearly 30 miles. The granites along the bank are generally sheared and suggest that the river may follow a shear zone. Caché creek also follows a linear valley which may be a fault or a shear zone.

In the Pivert Lake section, the most pronounced fracture direction of the area trends N.70°E. to east; the dips are steep. This direction is practically parallel to that of the fold axes. The mutually associated faults and shear zones are particularly well exposed in the gneissic granodioritic rocks along the Eastmain river. One of these zones in the north of the area has a width of seven to 12 feet. The granodiorite is strongly sheared and mylonitized, mineralized with barren quartz and later folded. Many other faults and shear zones of the same type occur along the Grand-Detour rapids; most are small, but,here and there, several shear zones have a thickness of more than eight feet. Many among the smaller shear zones are invaded by veins of intermediate or basic composition; some of these were later sheared and, in places, intensely mylonitized.

ECONOMIC GEOLOGY

Major mineralization has not been discovered in the Grand-Detour-Village Lakes area yet, but, apparently the country has not been subjected to any intensive exploration. A.P. Low (1895, p. 253) was the first geologist to mention mineralization in the vicinity of this area. This was a bed of massive pyrite carrying traces of gold located 16 miles west of the area, 1/2 mile east of the mouth of the Wabamisk river. In 1935/36, the land located east of Dôme rapids along the Eastmain river was subjected to intense prospecting for gold. Dome Mines Ltd. dug many trenches and drilled many shallow holes across arsenopyrite-bearing shear zones in the volcanic and basic intrusive rocks. Other than these previous works, indications of prospecting are few.

Pivert Lake quadrangle

Disseminated sulfides: The area most strongly mineralized with pyrite occurs along the rapids of the Eau-Claire river, in the metamorphosed sedimentary rocks. Pyrite, in places, replaces the rock along stratification and foliation planes; it forms thin bands with a maximum thickness of 2 mm. in these localities. Pyrite is found in appreciable quantity throughout the sequence of metamorphosed volcanic rocks in the northwest part of the area. A little disseminated chalcopyrite was noted at one place.

Pegmatite veins

The south central part of the area contains numerous rare earth pegmatite veins, which seem to be associated with the porphyroidal microcline granite, and occur chiefly along the south border of the west apophysis, where they extend up to three miles southwest of the contact. The thickness of these veins varies generally from two to 10 feet but some have a thickness of more than 30 feet. These trend generally NW.-SE. and dip steeply to the north. The pegmatites are chiefly composed of quartz, potassic feldspar, muscovite and albite. Spodumene is abundant in places, accompanied by pockets of biotite, tourmaline and lepidolite. Pods of molybdenite are also dispersed throughout the rock. No beryl was noted.

Veinlets of quartz and molybdenite

Two small quartz molybdenite veinlets were discovered: one in the zone of pegmatite vein outcrops, the other close to the Eastmain river, upstream from the Grand-Détour rapids about 3,000 feet southwest of a large island. The first occurs in granitic gneiss and is composed largely of quartz, a small amount of feldspar, and several pods of molybdenite disseminated in the rock; it has a width of two inches, a strike N.65°E. and a dip of 65°N. The second is constituted mainly of quartz and feldspar; it has a thickness of one and a half inches enclosing a central band of molybdenite one-eighth of an inch thick. This vertically dipping east-west vein occurs in a medium-grained hornblende gneiss.

Natel Lake quadrangle

The search for gold by Dome Mines Ltd. never yielded significant results. Most of the trenches made in 1935/36 are covered over or stained by weathering, but good mineralized showings may be seen on the north shore of a small round lake about 1,000 feet south of the Eastmain river, approximately two miles upstream of Dôme rapids.

The dark green mineralized schist consists of arsenopyrite needles up to one inch long, disseminated in a sheared quartz-chlorite-carbonate schist containing scattered, irregular auriferous quartz with rare chalcopyrite grains. The rock also contains tourmaline porphyroblasts.

This mineralization is typical of that found in many gold mining camps, except that the gold is not in exploitable quantity.

Sulfides

Small disseminated pyrrhotite grains and a little chalcopyrite occurs in many places in the rhyolites, as well as fine-grained siltstones or graphitic tuffs along the Eastmain river. The band of acid rocks north of Caché creek contains rusty zones having up to 20% sulfides. Traces of chalcopyrite in a small quartz vein were also noted north of the eastern end of Natel lake.

Village Lakes quadrangle

Augustus Explorations Limited staked 80 claims on the west side of Village lakes in February 1961. Draper, Dobie and Company, Toronto, bought these claims and granted an option on the northeast half of the group to Kerr-Addison Gold Mines Limited in the summer of 1961. The rocks underlying these 80 claims are metavolcanic rocks, gabbros and metagabbros.

During the latter part of August 1961, Kerr-Addison Gold Mines Limited made preliminary studies on these claims; Noranda Mines Limited and Corporation Administrative Service Limited carried out other prospecting works.

On the Kerr-Addison claims several slight indications of chalcopyrite, pyrite and pyrrhotite were exposed in the lava along shear zones in the lavas and the gabbros. One of these zones has a width of three feet enclosing a silicified band six feet long and two feet wide containing 10-15% chalcopyrite. Grains of bornite occur with the chalcopyrite . Another silicified zone shows minor quantities of nickeliferous pyrrhotite.

During the 1961 field season a fair number of rusty alteration zones were found, mineralized sometimes by pyrite, sometimes by pyrrhotite disseminated in the lavas. The most important zones are shown on the map. Besides seeing small quantities of chalcopyrite in quartz veins in the lavas, strong magnetic deviations were noted at three localities. In one case this deviation was caused by the presence of quartz-magnetite rocks; the two others probably result from the presence of pyrrhotite.

In the course of the summer of 1964 several companies, among these The Patino Mining Corporation places parties of prospectors along the Eastmain river, around Pivert lake and west of Village lakes.

Sand and gravel

Numerous terraces along the Eastmain river, as well as eskers, constitute a good source of sand and gravel, which will be used for the eventual development of the area.

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