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Preliminary report on Leaf bay area, New Quebec

PROVINCE OF QUEBEC, CANADA

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HON. W. M. COTTINGHAM, MINISTER

GEOLOGICAL SURVEYS BRANCH

PRELIMINARY REPORT

ON

LEAF BAY AREA

NEW QUEBEC

BY

PIERRE SAUVÉ

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INTRODUCTION

Leaf Bay area is on the southwest shore of Ungava bay. It covers approximately 750 square miles, bounded by longitudes 69°00' and 69°45' and by latitudes 58°30' and 59°00'.

The area is easily reached by boat and by float-plane. Small fishing boats may be chartered at Fort Chimo. Float-planes are available at Stewart lake, 3 miles northwest of Fort Chimo airport. Landing may be made on Ballantyne lake, which is in the southeastern part of the area and some 45 miles northwest of Stewart lake, and on many other water bodies within the area. Fort Chimo is serviced by regular flights from Montreal and Roberval, and by boats during the summer navigation season.

The area was mapped geologically during the field season of 1958. Traverses were spaced three-quarters of a mile apart. Outcrops are fairly abundant, except in the eastern third of the area.

The western third of the area is characterized by straight ridges and valleys aligned in a north or north-northwest direction; the highest ridges stand 300 to 700 feet above adjacent valleys. The eastern two-thirds is low and rolling, except for a few ridges of amphibolite. The highest point in the area is on the gabbro ridge southwest of Céline lake, and stands 893 feet above sea-level.

GENERAL GEOLOGY

The western half of the area is underlain by slightly to highly metamorphosed sedimentary, basic volcanic, and basic intrusive rocks of the "Labrador trough". The metasedimentary rocks consist mainly of mica and garnet schists, but calcareous rocks, iron formation, and quartzite are also present in small amounts.

Microcline gneisses are abundant in the eastern half of the area. They are associated with highly metamorphosed schists, iron formation, marble, and basic igneous rocks which are similar to, and may be of the same age as, the rocks of the "Labrador trough". Some of the microcline gneisses are similar in age to these schists, but some may be older and may belong to the "crystalline basement" on which the "trough" sediments were deposited.

All these rocks are Precambrian.

Table of Formations

Pleistocene and Recent	Till, gravel, sand, clay
Precambrian	Fresh diabase
	Pegmatite
	Meta-gabbro, amphibolite, blotchy gabbro, gabbroic rocks, ultramafic rocks. Meta-basalt. Mica schist, garnet schist, staurolite schist, kyanite, and sillimanite schists, quartzose schist, conglomeratic schist. Iron formation. Quartzite, conglomerate. Dolomite, diopside marble, olivine marble, diopside-actinolite rocks. Granitic gneiss, biotite-muscovite gneiss, hornblende-biotite gneiss, garnet gneiss, hypersthene-bearing gneiss.

Stratigraphy

Western Part of the Area

The stratigraphic succession is fairly well known west of the volcanic belt, but is almost unknown in the eastern part of the area. In the western part, the formations are repeated by folding but, in general, progressively younger rocks are met with in going from west to east.

The stratigraphic sequence in the western part of the area is as follows, in descending order:-

conglomeratic (?) and quartzose mica schist;

volcanics with minor garnet and mica schists- (a few to several thousand feet thick);

chlorite-biotite-muscovite schist and quartzite (about 1,000 feet thick);

iron formation (a few tens of feet thick);

chlorite-mica schist and phyllite, with quartzite and conglomerate beds and members, minor pillow lava (1,000 feet thick);

schist and phyllite;

alternating schist and carbonate beds;

green schist and quartzite.

The oldest rocks in the western part of the area are poorly exposed near the west boundary on the southeast shore of Leaf lake. They consist of light green chlorite-muscovite-quartz-albite-carbonate schist, quartzite, and a few calcareous beds. Fracture cleavage obliterates most primary structures in the quartzite and the calcareous beds.

The overlying formation consists of phyllite and slate interbedded with carbonate. Commonly, the carbonate beds are a few inches to a foot thick, and are separated by well-bedded phyllites in zones six inches to a few feet thick. Locally, carbonate is more abundant than phyllite, and some carbonate units are several feet thick. This formation grades upward into phyllites and slates without carbonate beds. A slightly calcareous, bluish-black slate, with dark rust-brown weathered surface, is common. At the contact of meta-gabbro sills, the rocks are changed to finely laminated, white and pale green hornfels. Repetition by folding has prevented determination of the thicknesses of these three lower formations.

The fourth formation or member consists of quartzites and minor conglomerates interlayered with biotite-muscovite-chlorite schists and phyllites. The quartzites are less abundant than the phyllites. They are generally fairly pure, but some contain much chlorite and muscovite. They occur commonly in units a few feet up to about 250 feet thick. The quartzites are abundant north of Larochelle lake and in the valley south of Raymond lake. At the latter place, more than 900 feet of quartzite and phyllite crop out and, as more quartzites are found westward, the formation may be more than 1,000 feet thick. The conglomerate is in beds and lenses a few inches to several feet thick. Quartz pebbles ½ inch in diameter are common, but some as much as 2 to 3 inches are present; a few small dolomite pebbles are also found. A few tens of feet of porphyritic, pillow lavas are found on the west shore of a small bay 5 miles north of Larochelle lake. More pillow lavas are probably present southwest of Raymond lake. These lavas apparently lie within the quartzite and phyllite formation.

The succeeding unit is an iron formation which, although only a few tens of feet thick, is persistent. The rock grades from a well laminated, reddish-weathering argillite, with thin, black magnetite-rich laminae spaced from ¼ to ½ inch apart, to a bluish black, strongly magnetic, siliceous rock with a metallic lustre. A thin band of pyrite-bearing, rusty-brown-weathering schist overlies the magnetic rocks and is easily visible from a distance. Near Raymond lake, this rock contains garnet and a ferruginous amphibole.

The schists, quartzose schists and quartzites above the iron formation are similar to those below it. Approximately 1,000 (stratigraphic) feet of these rocks separates the iron formation from the overlying volcanics southeast of Raymond lake. However, a thrust fault may be present at this place. Rusty weathering, black slates and phyllites are common just below the volcanic rocks.

A belt consisting mainly of volcanic rocks, from 2½ to 4 miles wide, crosses the area from north to south. The lavas are very fine-grained and green to black. They may be massive or pillowed. Their volcanic origin is not everywhere evident especially where highly sheared or where, as in the eastern part of the belt, they have been metamorphosed into amphibolites. Lenses of black biotite-chlorite schists, garnet schists, and black, impure quartzites occur within the lava belt. Some of the thinner units may belong to the volcanic formation. It is not clear, however, whether the thicker units are roughly contemporaneous with the lavas, or whether their presence in the volcanic belt is due to thrust faulting. Sills of meta-gabbro occur near Leaf bay and a dolomite member outcrops near the northern limit of the area. Again, their presence among the volcanics may be due to thrust faulting. Intense deformation

prevents determination of the original thickness of the volcanic formation.

Some of the rocks lying just east of the volcanic belt apparently overlie the volcanics. They are mainly light grey quartzo-feldspathic schists. Some contain small lenses, which may be deformed pebbles. An amphibole-carbonate-rich schist is common also east of the volcanic belt, near Leaf bay. Its weathered surface is pitted. Its origin is in doubt, but small lenses in it suggest a fragmental rock.

The stratigraphic relationships between the group of rocks just described and those found farther east are not clear.

Eastern Part of Area

Metasedimentary Rocks

Schists

A wide belt of fine- to medium-grained, light grey, biotite-muscovite-quartz-plagioclase schists occurs east of the volcanics belt described above. The mica content, at many places, is relatively low. Some of the schist contains spherical to lens-shaped quartz and quartzo-feldspathic fragments up to 6 inches but commonly ½ inch to 2 inches long. The fragments may be abundant or scarce, and are probably deformed pebbles. At some places, only a few thin layers with few fragments are found; at others, zones of conglomeratic schists are several hundred feet wide. Some mica-rich and garnetiferous schists occur at a few places in the garnet-free schists. Staurolite and possibly chloritoid are found in schists about 3 miles south of Leaf bay and one mile east of the volcanic belt. Garnet schist interbedded with quartzite occurs also on the south shore of the bay.

The schists still farther east are variable in composition. Some are poor in mica although biotite and muscovite are everywhere present and grade into gneisses. Chlorite is missing in most schists and is in minor amount in nearly all the others. Garnet is fairly common. Staurolite occurs one mile west of the widest part of Ballantyne lake, 3 miles west of the northwestern bay of Ballantyne lake, and on the south shore of Leaf bay ¼ mile west of the westernmost occurrence of gneisses. Kyanite occurs with sillimanite ¾ mile east of the last-mentioned occurrence of staurolite. Sillimanite is common in schists near and among the gneisses. It is commonly very fine-grained but occurs in white, nodular aggregates, from ½ to 1 inch in diameter. The nodules stand out on the weathered surface of the schists, and are easily recognized.

Marble, Calc-silicate Rocks

Diopside-actinolite marble occurs north of Ballantyne lake, and also west of an amphibolite basin near longitude 69°15', about 5 miles south of Leaf bay. Some diopside crystals are as much as 3 feet long. Other diopside-actinolite rocks, derived from calcareous rocks, are found at a few places in the area, especially near the contact of gneisses and schists. Diopside is mainly light green, coarse-grained, and easily recognized by its good parting. In some places, dark diopside is associated with hornblende, epidote, and plagioclase; it is not clear whether this rock is of sedimentary or of igneous origin. A thin layer of olivine-bearing marble occurs at the lower contact of an augite-hypersthene gabbroic rock at the eastern edge of the area, near the south shore of Leaf bay.

Iron Formation

Iron formation appears a few miles northeast of Ballantyne lake, at the outlet of Ballantyne lake and about 6 miles north of this outlet. The rock is well layered, and made up of quartz, iron-bearing amphibole, magnetite and, in many places, garnet. The proportion of these minerals varies widely: some rocks are largely of quartz, some are strongly magnetic and dark. The formation is intricately folded, and its thickness and lateral extent are not known. Iron formation occurs also at a few places a few miles west of Ballantyne lake, but it is apparently thin and commonly poor in magnetite.

Gneisses

A large part of the gneisses are granitic in composition. They are made up essentially of microcline, quartz, and plagioclase, with minor biotite and less muscovite. Gneisses relatively rich in mica are also abundant, and the varieties richest in mica are gradational into schists. Schists and mica gneiss, some with garnet, are common from 5 to 10 miles northwest of Ballantyne lake as well as east of Ballantyne lake. Next in abundance are gneisses bearing a minor amount of hornblende and biotite and very little or no muscovite. They are common east of Ballantyne lake and also south of Leaf bay, near the eastern limit of the area. South of Leaf bay, near longitude 69°15' is an undifferentiated band containing much amphibolite, biotite-hornblende rock, hornblende-rich gneiss grading into amphibolite, and hornblende- and garnet-bearing gneisses. Overlying these rocks to the north are highly garnetiferous gneisses. Much of the rock contains about 10 per cent garnet, and some contains much more. A dark rock, made up largely of garnet, biotite and hornblende, or of any two of these minerals, is present at many places in these garnet gneisses. In part, it occurs in irregular patches, and has formed by replacement of the garnet gneisses. Highly garnetiferous gneisses are found also near the eastern limit of the area, a few miles south of Leaf bay; they

are commonly poor in potash feldspar and rich in plagioclase, and contain hornblende, biotite, hypersthene (in some phases) and little or no muscovite.

The gneisses relatively rich in mica are well foliated. Gneisses with a fair amount of minerals other than quartz and feldspar, especially those with much garnet, are commonly well layered.

The layering suggests a former bedding and a sedimentary origin for much of the gneisses. The presence of layers of metasedimentary schists among the gneisses also supports this hypothesis. The layering in the schists is parallel to the contacts with the gneisses and to the layering in the gneisses. However, much of the granitic gneisses show only poor layering, and are free of bands of schists over large areas. Here, a sedimentary origin is uncertain.

No strong evidence for an igneous origin of the gneisses was seen, and the rocks are probably not syntectonic or posttectonic intrusives. In the few places where it could be ascertained, the granitic gneisses that occur in large bodies underlie metasedimentary schists and marble with much amphibolite. The latter rocks are very similar to the "trough" rocks found farther west. It is possible, therefore, that some of the gneisses belong to the "crystalline basement" over which the "trough" sediments accumulated.

Meta-gabbros, Amphibolites, Ultramafic Rocks

Sills of metamorphosed gabbro and diabase are abundant among the schists west of the volcanic belt. The thickness of the sills varies from a few feet to more than 4,500 feet, and in some cases varies greatly within short distances. These rocks have been metamorphosed to the greenschist facies. Shearing has been mild to negligable at many places, and the original texture is partly preserved. The rocks are composed largely of albite, clinozoisite, chlorite, and actinolite or hornblende, with minor quartz, titaniferous magnetite, leucoxene, and biotite. Some sills intruded into the dolomitic phyllites near the western limit of the area, at latitude 58°37', are highly carbonatized. They consist of chlorite, albite, quartz, carbonate, minor muscovite and possible rutile. Near the same place, a highly feldspathic, porphyritic gabbro is fairly common. This rock commonly forms only a part of the sills in which it is found. Blotchy gabbro occurs within the volcanic belt. In part, it is in thin, extensive layers. The rock is characterized by abundant, light-coloured patches of plagioclase and clinozoisite, from ½ inch to 4 inches long.

The rocks of basaltic composition lying east of the volcanic belt have been metamorphosed to the amphibolite facies. They are mainly dark green to black, fine-to medium-grained, schistose rocks composed of hornblende, subordinate

plagioclase, and minor epidote and quartz. They probably are derived from gabbro sills and basalt flows similar to those found farther west.

A minor amount of hornblende-rich rock contains much carbonate and quartz. The quartz may occur in lenses, giving a fragmental appearance to the rock. This rock occurs in part among the conglomeratic schists. Its origin is uncertain. It may be derived from carbonatized gabbro, calcareous sedimentary rock, or from volcanic conglomerate or agglomerate.

A few gabbroic rocks occur near the eastern limit of the area, a few miles south of Leaf bay. They consist of hypersthene, augite, and generally minor amounts of plagioclase, biotite, and hornblende. Hornblende is rare in some rocks and abundant in others. The relationship of the gabbroic rocks to the amphibolites is not known. Perhaps they take the place of the amphibolites in a more highly metamorphosed region.

The ultramafic rocks commonly weather brownish red and are, for the most part, magnetic. They consist of serpentine, chlorite, colourless (in thin section) amphibole, magnetite, and minor carbonate. In the western part of the area, they are aphanitic and have a green fresh surface. In the middle and eastern parts of the area, the amphibole is coarser and may appear as fine needles and the fresh surface is commonly bluish grey. Pyroxene occurs in ultramafic rocks roughly 10 miles north-northeast of Ballantyne lake. Ultramafic rocks occur in bands or lenses in the two very thick sills near Larochelle lake. They may have formed by differentiation within the sills. Ultramafic rocks also form a large part of a sill a few hundred feet thick, lying close to the western boundary of the volcanic belt, in the southern part of the area. Differentiation took place here, but the average composition of the sill is much more mafic than that of other sills in the area. Ultramafics occur in lenses in the volcanic belt to the north of Leaf bay and mixed with amphibolites southwest and north-northeast of Ballantyne lake. A few outcrops of ultramafics are present among granitic gneisses near the northwest shore of the same lake. They form possibly lenticular pods a few tens of feet long.

Most, and possibly all of the metamorphosed, basic igneous rocks were introduced before the main period of folding. Some meta-gabbro may be contemporaneous with the volcanic rocks.

Pegmatite

Pegmatite dykes are present in the eastern third of the area, and are abundant to the northeast of Ballantyne lake and on the south shore of Leaf bay. The dykes are rarely more than 200 feet wide. A spectacular pegmatite body, which branches off in all directions, occurs 2 miles south of Leaf bay

near latitude 69°08'. It outcrops over a wide area, but it is probably gently dipping and its thickness may not be great. The pegmatite is white or pink. It is composed of quartz, microcline, plagioclase, and minor amounts of biotite, muscovite, tourmaline, and garnet. Pegmatite dykes cut all the metamorphosed rocks of the area. They are probably roughly contemporaneous with the period of deformation and metamorphism.

Fresh Diabase

A narrow dyke of nearly fresh diabase transects the gneisses on an island in the northern part of Leaf bay, near longitude 69°25'. It strikes N. 60°W. The rock consists of plagioclase, augite, minor amounts of opaque minerals, and green and brown, micaceous, alteration minerals. The plagioclase is zoned. The largest crystals show strong oscillatory zoning, and some have a core replaced by a green aggregate. The age of the diabase is not known, but it is younger than the period of metamorphism.

STRUCTURE

All the metamorphosed rocks of the area are tightly folded. The axial planes of the folds strike commonly slightly east of south, and dip steeply east. West of the volcanic belt, the folds are essentially large drags. They are "Z"-shaped or dextral, and all major folds plunge to the southeast. The plunge in the volcanic belt is also to the southeast. There, only a few folds were found and nearly all the tops of the pillows determined face eastward. However, the pillows are so deformed in many places that top determinations cannot be made on them, and many tight folds may be present. Small, southeastward-plunging folds are innumerable in the mica schist east of the volcanic belt. These obscure the main structure, and only one large anticline and one large syncline were detected east of Bleichert and Butt lakes. The structure in the gneisses is highly complex and poorly known. The plunge of the folds is steep at some places; it is either to the northwest or to the southeast, and domes and basins are common.

Longitudinal faults may be common in the area, but their presence could not be demonstrated. An important, high-angle reverse fault is certainly present in De Freneuse area (Sauvé, 1956) to the south of the present area. This fault may extend northward through the valley of Céline and Larochelle lakes. The volcanic rocks are highly sheared in large part and longitudinal faults may be present in them. Possibly, some of the large sedimentary lenses were not originally between volcanic rocks, but were brought in by faulting. One transverse fault, which extends north-northeast from Bleichert lake, is indicated on the aerial photographs by a distinct lineament. It strikes about N. 20°E., and has a steep dip. The mica schists in the vicinity of the fault are bent into a broad "S"-shaped fold plunging about 60° in the direction N. 20°E. In contrast, all the folds in the schists some distance from the fault plunge gently southeastward.

Two sets of transverse faults of very small displacement are indicated on the aerial photographs of the volcanic belt north of Leaf bay. The faults strike about N.40°E. and N.30°W. The strike separation of some of the southeast striking faults is left-handed. The only dyke of fresh diabase found in the area also strikes N.30° W., its orientation possibly being controlled by a fault plane.

ECONOMIC GEOLOGY

Iron

Iron formation occurs a short distance west of the volcanic belt and to the north and northeast of Ballantyne lake.

At the first-named locality, the formation is a few tens of feet thick. Parts of it are strongly magnetic and fine-grained. It dips eastward about 65° in the southern part of the area, and between 40° and 50° near Leaf bay. The north end of Larochelle lake may be of special interest, as the formation here may be thickened by folding.

The formation near Ballantyne lake is coarser-grained. It also appears to be fairly thin, but it is thickened locally by highly complex folding. Further investigation of the formation near the noses of folds seems warranted.

Sand and Gravel

Eskers in various parts of the area provide sources of sand and gravel that may become important when the iron deposits of the general region are being brought to development. The largest esker is in the northeastern part of the area, between 4 and 10 miles south of Leaf bay.

REFERENCE

Sauvé, Pierre (1956) - Preliminary Report on De Freneuse Lake Area (west half); Que. Dept. of Mines. P.R. No. 332, 1956.