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JOGUES LAKE AREA

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OF

JOGUES LAKE AREA

Interim Report

by

T. Hashimoto

Ministère des Richesses Naturelles, Québec
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INTRODUCTION

General Statement

During the latter part of 1961 and 1962 considerable amount of exploration work was carried out in the Jogues Lake area - particularly around the northern portion of Colombet lake (called Wapaniskan lake at that time). This exploration activity prompted the Geological Exploration Service of the Quebec Department of Natural Resources to send a geological field party of 7 men into this area in 1963 to map the area on the scale of $\frac{1}{2}$ mile to the inch.

Location

The Jogues Lake area is located 75 miles south of Fort Chimo and 180 miles north-northwest of the iron-mining town of Schefferville. It comprises about 215 square miles and is bounded by longitudes $68^{\circ}40'$ - $69^{\circ}00'$ and latitudes $57^{\circ}00'$ - $57^{\circ}15'$.

Access

The only practical means of access is by float-plane, the nearest bases being at Fort Chimo and Schefferville. The map-area contains many large lake which are all suitable for float-equipped aircraft.

Field Work

The base map was completed by the Hydraulic Resources Branch of the Quebec Department of Natural Resources. As the area is sparsely forested much of the mapping was done by means of traverses using air photographs. In places pace-and-compass traverses were run at half-mile intervals.

The exposures were outlined, in the field, on air photographs ($\frac{1}{2}$ mile to the inch) and replotted on a base map of the same scale at camp. The published geological map was reproduced on a scale of 1 mile to the inch (map no. 1549).

Acknowledgements

During the summer of 1963 the following were members of the writer's field party:- D. Williams, A. Carrier, G. Robert, T. Lessard, R. Dupuis and P. Etienne. The writer wishes to thank these men for carrying out their share of the work.

The work was carried out under the general supervision of Dr. Robert Bergeron.

Previous Work

This area was mapped in 1954 by the Geological Survey of Canada (Fahrig, W.F.) on a scale of 4 miles to the inch and is included in the Lac Herodier (East Half) map-sheet published in 1956. Prior to this work by Fahrig the geological work appears to have been confined to limited amounts of prospecting and observations made by travellers. The exploration work done in the Jogues Lake area before 1961 appears to have been reconnaissance in nature.

A considerable amount of exploration work was carried out in the Jogues Lake area in 1961 and 1962. This exploration activity was precipitated by the discovery of a small but high grade copper-showing on the northwest side of Colombet lake and most of the work was concentrated in this area. The most extensive exploration work in this area was carried out by McIntyre Porcupine Mines Limited. The exploration work in the general Colombet Lake area included:- staking, line-cutting, prospecting, trenching, ground geophysical surveys (magnetometer, electromagnetic and induced polarization surveys), geological mapping and diamond drilling.

DESCRIPTION OF THE AREA

Settlement and Resources

There are no settlements of any kind in the area, and the nearest permanent settlements are at Fort Chimo, 75 miles to the north and Schefferville, 180 miles to the south-southeast. Fort McKenzie located 12 miles south of the map-area has more or less been abandoned and cannot be considered a permanent settlement at this time.

In general, the area is sparsely forested and many hill tops are barren. Most of the valleys are moderately forested by spruce with minor amounts of tamarack. Thick growths of alder and teabush are found on the sides of many hills.

Lake and speckled trout are plentiful in many lakes, the speckled trout being mainly in small lakes and streams, and the lake variety in such larger lakes as Colombet and Rouvière.

Although game is scarce, bear, cariboo, weasel, partridge, duck, and goose were seen.

Several copper-showings have been found in the area. Further exploration work may lead to the discovery of additional copper and nickel showings.

Physiography

The Jogues Lake area is characterized by parallel northwest-trending ridges which rise sharply 200 to 400 feet above the general level. Resistant gabbro sills form the ridges, and alternating soft sedimentary rocks underlie the valleys. In general, the topography is rugged owing to this differential erosion, the average relief being 200 to 300 feet.

In the north central sixth of the map-area, Pleistocene glaciation has played an important role in fashioning the present topography and has given many of the lakes a pronounced N.15°E. trend. The area is drained by the Kaniapiskau river, a tributary of the Koksoak. The latter flows into Ungava bay, 120 miles to the north.

GENERAL GEOLOGY

The area lies in the "Labrador Trough". The bedrock is Precambrian in age and is composed of sedimentary and volcanic rocks intruded by gabbro sills. These rocks have been highly folded and metamorphosed in the greenschist facies of regional metamorphism.

The late Precambrian or Proterozoic rocks (Kaniapiskau group) of the area include phyllite, dolomite, sandstone, quartzite, siltstone, arkose, iron-bearing rocks, greywacke, metabasalt, metamorphosed basic and acid tuffs, basic agglomerate and metagabbro. The metagabbro sills represent the youngest rock in the area. Phyllite, metabasalt and metagabbro make up 90 per cent of the rocks present in the map-area.

In the southwest corner of the area, Kaniapiskau strata rest unconformably on pink granite in 2 places. This granite has been interpreted as intrusive by some, but field evidence indicates that it represents "basement" rock. It is the only rock of the so-called "Archean basement" in the area and is of particular interest in that it is exposed within the limits of the "Labrador Trough". This granite is exposed through "windows" where the younger Kaniapiskau strata have been eroded away.

Parts of the area are covered by a thick blanket of morainal deposits. These deposits are Pleistocene in age and consist of boulder clay, silt, sand, gravel and boulders.

Recent deposits consist of peat formed in the swamps and river, and beach deposits.

The geological succession is summarized in the following table of formations. As far as possible the divisions in this table are chronological.

Table of Formations

Cenozoic	Recent Pleistocene		Peat, river and beach deposits Silt, sand, gravel, boulders
Unconformity			
Pre- Cambrian	Proterozoic	Kaniapiskau Group	Metagabbro sills
			Metavolcanic rocks: Massive, sheared and pillowed basalt; basic tuff and agglom- erate; acidic tuff. Minor amounts of metagreywacke, phyllite, and quartzite as interbeds
			Metasedimentary rocks: Phyllite with some dolomite, quartzite; minor amounts of greywacke, silicate and chert- carbonate iron formation. Sandstone (siltstone or arkose locally)
Unconformity			
Pre- Cambrian	Archean		Granite

DESCRIPTIONS OF ROCK TYPES

The rocks in the Jogues Lake area have been divided into 2 distinct groups: "basement" granite and Kaniapiskau group. Metasedimentary rocks, metavolcanic rocks and metagabbro sills are subdivisions within the Kaniapiskau group. Phyllite, sandstone, quartzite, dolomite, chert-carbonate iron formation, siltstone and arkose make up the metasedimentary rocks while the principal members of the metavolcanic rocks are: basalt, basic agglomerate, basic and acidic tuff. In this section each of these rock types are described.

"Basement" Granite

Definition: The "basement" granite is a medium- to coarse-grained rock containing microcline, oligoclase, quartz, chloritized biotite and chlorite as the principal minerals. Both the weathered and fresh surfaces are pink.

Mineralogy: Microcline, oligoclase, quartz, chloritized biotite and chlorite are the dominant minerals. Microcline generally makes up about 50 per cent of the rock, oligoclase 25 per cent, quartz 10 per cent and the remaining 15 per cent is largely chloritized biotite and chlorite. The minor mineral constituents are epidote, apatite, sphene and a black opaque mineral which appears to be ilmenite. These accessory minerals sometimes make up about 5 per cent of the mineral present. Most of the oligoclase has been extensively sericitized and kaolinitized. In contrast the microcline is fresh in appearance and shows only minor amount of small scale alterations. Oligoclase is grey whereas microcline is pink. It is the abundance (35-50 per cent) of pink microcline which gives this granite its characteristic pink colour. In the field the micaceous light green mineral was thought to be chlorite. Although

chlorite is always present, thin-section studies have shown that a large portion of this platy material is chloritized biotite. The chlorite and chloritized biotite are similar in appearance but the difference in their interference colours is marked. Those that have high interference colours have been classified as chloritized biotite and the ones that show low interference colours chlorite. The chloritized biotite is faintly pleochroic green to light green or pleochroic brownish-green to light brownish-green. Chlorite displays green to light green or brown to yellowish-brown pleochroism. A common occurrence of chlorite is around chloritized biotite grains. There is little doubt that the original mafic mineral in this granite was biotite. This biotite has been either chloritized partially or completely. The common association of ilmenite with chlorite suggests that the opaque mineral may also have been derived from the original biotite.

Textures:

Texturally this granite can be separated into porphyritic granite and augen granite. Microcline forms the phenocrysts (0.8 x 1.2 cm). Quartz displays undulatory extinction and bent chlorite and chloritized biotite crystals are common. Oligoclase is subhedral and twinned.

The shearing of the porphyritic granite has resulted in the formation of the augen granite and hence this augen granite is a cataclasite. The augens of microcline (0.5 x 1.0 cm) show straining and have been fractured. Fine-grained chloritized biotite crystals surround these augens and outline the gneissosity. The fractures in the microcline have also been filled with chloritized biotite. Much of the twinning in the microcline and plagioclase have been destroyed by the shearing.

Occurrence
and Origin:

Granite is exposed at 2 locations in the southwest corner of the map-area. The larger mass occurs on the southwestern boundary where it forms a hill approximately 1 mile by 2.3 miles. This body of porphyritic granite extends outside the area to the west for a distance of 2 miles. The other mass of granite is smaller (0.5 mile x 0.75 mile) and crops out on the west shore of Colombet lake. It is made up mainly of porphyritic granite with some augen granite.

This granite has been interpreted as an intrusive by some workers but the fact that arkose overlies the granite in places indicates that the granite represents "basement" rock which is exposed through "windows" where the younger Kaniapiskau strata have been eroded away. Purplish siltstone, sandstone and arkose lie unconformably on the granite on Colombet lake but no cutting relationship between the granite and the overlying sedimentary rock was observed. According to Fahrig (1956) granite-bolder conglomerate also overly this latter granite mass. The writer has not seen this conglomerate.

The porphyritic granite and augen granite in the Jogues Lake area are exposed portions of the "basement" granite and hence represent the oldest rock in the map-area. It makes up only a few per cent of the exposed rocks in this area.

KANIAPISKAU GROUP

A. Sedimentary and Metasedimentary Rocks

From the point of the view of amount the sedimentary and meta-sedimentary rocks are the most important rocks in the Jogues Lake area. These rocks make up over 40 per cent of the rocks in the map-area.

(1) Arkose or Recomposed Granite

Definition: The Colombet lake arkose or recomposed granite is a clastic rock, with particles predominately of fine sand to coarse sand size, containing plagioclase and quartz as the essential minerals. The colour of both the fresh and weathered surfaces varies from buff with a slight pinkish tinge to pink.

Mineralogy: Plagioclase generally makes up between 70-45 per cent of the rock, quartz 30-20 per cent and dolomitic calcite several grains to 35 per cent. Epidote and apatite are the common accessory minerals. Plagioclase grains are usually angular and fresh in appearance - some have been slightly sericitized and kaolinitized. Quartz is much less angular and are irregular in form. It appears that the irregular shape of the quartz grains was due ^{in part} to partial solution of the fragments during compaction. The plagioclase and quartz grains are either welded together or cemented together by calcite. This calcite appears to be dolomitic as it has a slight buff colour. Most of the arkose examined contained some dolomitic calcite and this calcite is an important mineral constituent in the Colombet lake arkose.

Textures: The particle size varies from fine sand to coarse sand with the sand size being most common. The plagioclase grains are twinned and these fragments exhibit random orientation. The particles are generally subrounded to angular and the sorting is moderate. In places the porosity is high due to the solution of portions of the calcite cement. A examination of the thin-section of what appears to be a silicified arkose breccia showed that most of the plagioclase grains are bent and many have been fractured. The most important copper-showing in the Jogues Lake area, is found in this brecciated arkose where chalcopyrite and quartz have filled in the spaces between the arkose fragments.

Occurrence and Origin: Arkose or recomposed granite overlies the mass of "basement" granite exposed on the west side of Colombet lake. This arkosic rock is a basal or residual type and forms a thin, local blanket over the older granite. It lies at the base of a sedimentary sequence and is associated with sandstone. Arkose represents less than 1 per cent of the exposed rocks.

(2) Siltstone

Definition: Siltstone is a clastic rock in which the majority of the particles are in the silt-size range. In general the ratio of silt-size quartz to clay minerals is 2 to 1. This siltstone is purplish in colour due to the presence of minor amounts of hematite.

Mineralogy: A typical siltstone is composed of 60 per cent quartz, 35 per cent clay minerals (including about 2 per cent hematite), with the remaining 5 per cent being made up of microcline and plagioclase. Quartz, microcline and plagioclase represent the minerals present in the silt fraction. These particles are cemented by clay minerals. Microcline and plagioclase are fresh in appearance.

Textures: Quartz, microcline and plagioclase particles are angular. The grains of microcline and plagioclase are twinned.

Occurrence and Origin: This siltstone contains thin beds (paper thin to 0.5 cm. thick) of purple shale. Some beds of fine, purple sandstone has also been noted. In places this sandstone is feldspathic. Cross-bedding is common in the siltstone and "top" determinations were possible. This basal siltstone (with thin beds of shale and sandstone) is local in extent and is only found in the southeast corner of the area where it overlies the "basement" granite. It constitutes less than 1 per cent of the rocks in the Jogues Lake area.

(3) Sandstone

Definition: A massive sandstone composed largely of quartz grains 0.5 mm. in diameter or less and some clay material. The sandstone is usually white. A purplish variety is found near the contact with the basal siltstone.

Mineralogy: The sandstone is usually composed of about 80 per cent quartz and 20 per cent clay material. Some of the quartz grains are overgrown but the original rounded quartz grain boundaries can be readily seen under the microscope. These quartz grains are either welded together or cemented by the clay fraction. The clay fraction is made up of muscovite and biotite. The purple coloured sandstone on the southwest boundary is similar in composition except that very fine-grained powder of hematite is dispersed through the rock (mainly in the clay fraction) giving the rock a very pronounced purplish colour. The vast majority of the sandstone is white and contain no hematite.

Textures: The quartz grains are rounded to subrounded and the sorting is moderate to good. A certain amount of recrystallization has taken place. This process may have taken place both during compaction and regional metamorphism. The sedimentary characteristic of this sandstone shows very little affect of the regional metamorphism. Texturally this rock is a sandstone rather than a quartzite. Most of the quartz shows undulating extinction.

Occurrence and Origin: This highly quartzose sandstone is not widespread and is restricted to the immediate area surrounding the 2 exposed bodies of the "basement" granite. Around the lake Colombet granite this sandstone is white and lies over the local, basal arkose. On the southwestern boundary the quartzite is underlain by a purple, basal siltstone. Most of the sandstone in this area is white but portions are purple. From the point of view of amount this sandstone is unimportant as it make up only a few per cent of the exposed rocks.

(4) Chert-Carbonate Iron Formation

Although only 4 exposures of the chert-carbonate iron formation were found during the field work, a study of this rock type was made as the mineral assemblage found in this type of iron formation is usually rather sensitive to temperature changes and hence would give a good idea as to the grade of regional metamorphism.

One exposure of chert-carbonate iron formation was found on the southwest corner of the map-area. This chert-carbonate iron formation varies from greenish-grey to purplish-red in colour. The greenish-grey variety is composed of 60 per cent microcrystalline quartz, 10 per cent carbonate which

appear to be ferrodolomite and 30 per cent minnesotaite. The minnesotaite forms microcrystalline needles and are arranged in bundles or sheaves in a groundmass of microcrystalline quartz. The ferrodolomite is concentrated in patches. The development of minnesotaite in this chert is important as it indicates that the rocks has been affected by very low grade regional metamorphism - lower greenschist facies.

An examination of the greyish purple chert-carbonate iron formation showed that the rock is made up of 30 per cent microcrystalline quartz and 20 per cent siderite containing a small amount of fine-grained hematite. The bulk of the rock is composed of siderite and the chert occurs in small microcrystalline aggregates or are found as minute quartz grains scattered through the siderite.

This chert-carbonate iron formation is very local in extent and overlies the lower sandstone at 1 place near the "basement" granite on the southwest boundary.

Three isolated exposures of chert-carbonate iron formation crop out just northeast of Jogues Lake. At 1 place the iron formation is interlayered with dolomite and graphitic phyllite while in the other 2 it is interbedded with phyllite. This chert-carbonate iron formation has a rusty-brown weathered surface and is grey to dark grey on the fresh surface. It is composed mainly of quartz, siderite and stilpnomelane. Magnetite and grunerite may be present or absent. Some limonite is always present as an alteration product. The percentages of the mineral constituents vary considerably. Both quartz and siderite are very fine-grained to microcrystalline and in places are quite well mixed. The fineness of the quartz grains strongly suggest that the quartz represents recrystallized chert. Iron-rich silicate portions of this iron formation are sometimes well banded - greyish-yellow (grunerite-rich layer) and greenish-black (stilpnomelane-rich layer). These beds are often 0.3 cm. to 1.3 cm. in width. In the thin-section examined the carbonate was identified as siderite. However, it is quite probable that other carbonates are present in certain portions of this iron formation and hence the writer

has chosen to adopt the more general term chert-carbonate rather than chert-siderite iron formation. The co-existence of siderite and stilpnomelane indicates that this metamorphic iron formation belongs to the greenschist facies of regional metamorphism. The presence of grunerite in this low metamorphic grade iron formation is not aberrant as iron-rich grunerite is stable in the upper greenschist facies. This grunerite would be towards the FeO-end of the grunerite-cummingtonite series. The presence of grunerite and the absence of minnesotaite suggests that this chert-carbonate iron formation belongs to a slightly higher grade of regional metamorphism than the iron formation found in the southwest corner of the map-area.

(5) Dolomite

At 1 location in the southwest corner of the area dolomite is exposed near the base of the Kaniapiskau group and overlies the sandstone. In this portion of the map-area the dolomite is very local in extent and forms a thin layer which extends along the contact of the sandstone for a distance of 2 miles. This dolomite is very fine-grained, massive, light pink to grey and weathers to a light buff colour. The buff colour extends only 0.2 mm. into the rock - ie. forms a sort of a very thin crust. Fine-grained or microcrystalline quartz is present as a box-like network of stringers (0.5 mm. - 1 mm. wide) and as scattered fine grains intimately intermixed with the dolomite. In certain places small blob-like concentrations (0.5 cm. x 1 cm.) of quartz were noted. The quartz stringers stick out on the weathered surface of the rock due to the fact that quartz is more resistant to solution than the dolomite. The box-like network of quartz stringers and the buff colour of the weathered surface are 2 diagnostic features of this dolomite. A few scattered grains of pyrite and chalcopyrite have been found in the rock.

The dolomite exposed north of Rouvière lake is identical to the dolomite described above. However, this dolomite is interbedded with the phyllite and appears to be higher in the stratigraphic sequence than the lower dolomite. The dolomite near Rouvière lake represents the largest exposure (approximately 2 miles by 3 miles) of dolomite in the area. Several

other small, lens-like bodies of dolomite have been found interlayered with the phyllite. Dolomite represents only a few per cent of the exposed rocks. Dolomite is also found interlayered with phyllite in the area west and northwest of Leroux lake and northeast of Jogues lake. Although much of this dolomite is similar in appearance to the dolomite described earlier, some do not contain fine-grained quartz veinules and do not have the characteristic buff weathering surface.

(6) Phyllites

The phyllites are thought to have been formed by low-grade metamorphism of shales and siltstones. These phyllitic rocks make up the bulk (approximately 90 per cent) of the sedimentary rocks of the Kaniapiskau group and constitute about 40 per cent of all the exposed rocks in the area. In this section the phyllites have been separated into 2 groups - graphitic phyllite and non-graphitic phyllite.

(i) Graphitic Phyllite

Definition: A fine-grained, well foliated, black rock containing graphite, quartz, muscovite and biotite as the principal minerals. The foliation surfaces have a skiny, black luster due to the smearing out of graphite along these planes.

Mineralogy: Graphitic phyllites contain chiefly graphite, quartz and fine-grained muscovite and biotite. Pyrite is a common accessory mineral. In most thin-sections it is impossible to estimate the percentages of the minerals present because of the masking affect of the graphite. The fine grain size also makes estimations difficult. In 1 thin-section the mineral contents were estimated at 55 per cent quartz, 35 per cent biotite and 10 per cent graphite. The percentages of quartz, muscovite, biotite and graphite vary considerably.

Quartz and graphite are always present but muscovite and biotite may occur together or separately. Muscovite is generally more common than biotite. It is interesting to note that many of these graphitic phyllites contain extremely thin (1 mm. thick) layers of finely crystalline or microcrystalline quartz. These quartz layers probably represent original chert layers which have been recrystallized.

Textures
and Micro-
structures:

The texture of the graphite phyllites is fine-grained, but the mineral constituents can be identified microscopically. A very high degree of orientation of the minerals is characteristic and parallel alignment of quartz, biotite, muscovite and graphite can be readily seen under the microscope. These rocks have been intensely deformed and plicated foliation is often developed. Microfolds (1 mm. across) and faults are common. Some phyllites contain porphyroblasts of pyrite.

Occurrence:

Most graphitic phyllites occur in the area surrounding Rouvière and Colombet lakes, but some are found in other parts of the map-area. These rocks make up about 20 per cent of the phyllitic rocks and are sometimes interlayered with the metabasalt. A bed of graphitic sandstone has been found in these phyllites west of Colombet lake. *North* of Jogues lake lens-like beds of chert-carbonate iron formation and folomite are interlayered with a graphitic phyllite. It is interesting to note that the Colombet lake "basement" granite is overlain at 1 place by a graphitic phyllite.

(ii) Non-Graphitic Phyllite

Definition:

The graphite free phyllitic rocks of the Jogues Lake area may be defined as fine-grained, micaceous rocks with a highly developed foliation. The foliation planes usually have a satiny luster due to the development of fine-grained muscovite or biotite. Quartz, muscovite and biotite are the principal mineral constituents.

Mineralogy:

Fine-grained muscovite, biotite and quartz are the dominant minerals and the common accessories are sphene and chlorite. The percentages of the mineral constituents vary considerably and the percentage thin-section estimates of 3 different phyllitic rocks are now present to give the reader an idea of the variations that exist:- (i) 55 per cent quartz, 30 per cent muscovite, 10 per cent sphene and 5 per cent chlorite and biotite; (ii) 50 per cent quartz, 45 per cent biotite and 5 per cent limonite; (iii) 20 per cent quartz, 70 per cent muscovite and 10 per cent sphene. A few phyllites contain magnetite and calcite. One phyllite was found to contain 20 per cent magnetite. Quartz is a major mineral constituent in all the phyllites in the Jogues Lake area and generally make up 40 to 50 per cent of the mineral content. The amount of muscovite and/or biotite usually varies from 30 to 50 per cent. In many phyllites muscovite or biotite is the dominant micaceous mineral and in these rocks the other mica is often present in small amounts (less than 5 per cent) or is absent.

Some phyllites contain thin (1 cm. thick or less) beds of microcrystalline quartz. These beds are normally less than 1 cm. thick and probably represent chert layers which have been recrystallized.

Textures and

Microstructures: megascopically. Many of the mineral constituents cannot be identified. The texture is fine-grained and the minerals display a very high degree of orientation. Elongation of quartz as grains or narrow lenses or stringers, and fine-grained muscovite and biotite in parallel flakes or aggregates is characteristic. Microfolds and microfaults have been developed in some of these phyllites. A few phyllites contain porphyroblasts of magnetite (3 mm. in diameter or less).

Occurrence: The "non-graphitic" phyllites is the most common rock type in the Jogues Lake area and represents about 30 per cent of the exposed rocks. The bulk of these phyllites occur in the western half of the map-area. Thin beds of quartzite, dolomite and chert-carbonate iron formation are interlayered with the phyllites.

(7) Quartzite

Beds of quartzite are interlayered with the phyllite. Except for a few, these beds are rather discontinuous and form thin, lens-like layers in the phyllite. These quartzite are concentrated around Butte lake or near the north-central border of the area. In general these rocks are medium-grained, white and equigranular. They are composed of 80 per cent or more of quartz. Some of the quartz grains are interlocking. Muscovite is a common minor mineral constituent. The Butte lake quartzite is of this type and may be a higher metamorphic equivalent of the lower sandstone found on lake Colombet and west of it.

A few exposures of grey quartzite have been found near the north-central border of the map-area. This grey quartzite is fine-grained and equigranular. A thin-section examined showed that this quartzite is composed of 70 per cent quartz, 20 per cent dolomite and less than 10 per cent fine-grained muscovite.

These quartzites appear to have been formed by the regional metamorphism of sandstones. It constitutes 1 or 2 per cent of the rocks in the Jogues Lake area.

B. Metavolcanic Rocks

Metavolcanic rocks are a common rock type in the Jogues Lake area and make up some 25 per cent of all the rocks in the area. Metabasalt, metamorphosed basic agglomerate and tuff, and metamorphosed acidic tuff are the subdivisions within this group. Metabasalt makes up about 85 per cent of the metavolcanic rocks while the remaining ¹⁵ per cent is largely made up of metamorphosed basic agglomerate and tuff. Metamorphosed acidic tuff is present in minor amounts and makes up about 3 per cent of the metavolcanic rocks.

(1) Metabasalt

Definition: Metabasalt is a fine-grained, grey to green, massive rock containing albite, chlorite and actinolite as the principal minerals.

Mineralogy: Albite generally makes up about 45 per cent of the rock, chlorite 20-30 per cent and actinolite 10-15 per cent. Epidote, sphene and magnetite are also common mineral constituents. The amount of each of these minerals often exceeds that which is normally considered to be accessory - highly variable. Spene and magnetite are always present. The amounts of both sphene and magnetite can vary from less than a per cent to 15 per cent. It is interesting to note that when either of these 2 minerals is abundant the other is present in very small amounts (several grains to 2 per cent). The epidote content usually varies from 0 to 10 per cent. A typical metabasalt was found to be made up of 40 per cent albite, 30 per cent chlorite, 15 per cent actinolite, 15 per cent sphene and a few grains of magnetite.

Albite is often fresh in appearance and shows only minor amounts of small scale alteration (kaolinite and sericite). Actinolite is light green and is pleochroic to faintly pleochroic. Epidote often forms around the edge of chlorite grains but is also associated with albite, actinolite and sphene. In a few cases grains of sphene completely surrounded by epidote have been noted. Sphene sometimes has a common grain boundary with epidote or magnetite. It sometimes completely surrounds magnetite grains.

Textures:

Relict ophitic or sub-ophitic texture is characteristic. Albite usually form lath-shaped crystals and are well twinned. In a few cases the original porphyritic texture of the basalt has been preserved with the earlier formed, more calcic plagioclase phenocrysts being replaced by albite. Actinolite is often found as fibrous aggregates. Chlorite does not have good crystal outlines. Most of the sphene form round grains but a few have the characteristic wedge-shape. Some of the magnetite show corroded edges. In general the metabasalt is fine-grained and massive but a small amount of well foliated variety has also been found. These finely foliated metabasalt are probably metamorphosed basic tuff.

Occurrence
and Origin:

Most of the metabasalt are found in the northeast and southwest sections of the map-area. Around Colombet and Rouvière lakes small amounts of metamorphosed acidic tuff, graphitic phyllite, phyllite and dolomite are interlayered with the metabasalt - many of the acidic tuff, phyllite and dolomite beds are thin and lens-shaped. In a few places the metabasalt around these 2 lakes contain pillows but almost all were too badly deformed for "top" determinations. The

metabasalt around Jogues lake contain a few thin, discontinuous, lens-shaped beds of metagreywacke, phyllite and quartzite. The metamorphosed acidic tuff is described further on in this report. The description of the minor rock types have been omitted.

The relict textures and the mineralogical composition indicate that the massive, fine-grained, grey to green basic rock was formed by low grade regional metamorphism (greenschist facies) of basalt. Although the finely foliated variety was grouped with the more common massive metabasalt, it is interesting to speculate that these foliated basic rocks represent sheared basic tuffs. During regional deformation it would not be unreasonable to expect the less competent tuff to shear more readily than the massive, more competent basalt. The possible metamorphosed basic tuff is mainly found around Colombet and Rouvière lakes. It appears to have approximately the same composition as the metabasalt. Two thin sections of this possible metatuff were examined and the estimated percentages of the mineral constituents are now presented:-

- (i) 45 per cent chlorite, 20 per cent each actinolite and sphene, and 15 per cent plagioclase.
- (ii) 30 per cent each plagioclase and calcite, 25 per cent chlorite and 5 per cent each sphene and biotite.

The plagioclase in these rocks are untwinned and unaltered. It is quite possible that the original twinning in the plagioclase grains were destroyed by the shearing.

No fragments were recognized in either of the 2 thin-sections. However, in such highly sheared rocks one would not normally expect to find recognizable small fragments. The texture is metamorphic and with the possible exception of some sphene, the minerals are also of metamorphic origin. The presence of metamorphosed basic agglomerate in the eastern half of the area supports this idea that the sheared, fine-grained basic rocks, in the eastern half, were originally basic tuffs. The occurrence of basic agglomerate leaves little doubt that metamorphosed basic tuffs are present in the Jogues Lake area. The nature of the shearing, distribution and composition all suggest that the sheared basic rocks in this area were derived from basic tuffs.

(2) Metamorphosed Basic Agglomerate

Definition: A dark green, foliated, basic rock in which angular metabasalt fragments (0.2 cm. x 0.5 cm. to 2 cm. x 2.5 cm.) are cemented in a fine-grained calcite - chlorite groundmass.

Mineralogy: The ratio of fragmental portion to cement varies from 2/1 to 1/1. The cement or matrix is composed essentially of calcite, epidote, magnetite and sphene with minor amounts of plagioclase and chlorite. The fragments are generally made up of 10 to 35 per cent sphene, 30 per cent chlorite, 40 to 30 per cent plagioclase (albite) and 15 to 5 per cent actinolite and 5 per cent to several grains epidote and hence has the composition of a metamorphosed basalt. A few crystals of pyrite have also been noted in these rocks. An estimate of

the mineral composition of the agglomerate made from 1 thin-section is as follows:- 30 per cent each albite and chlorite, 15 per cent epidote, 10 per cent each actinolite and sphene, 5 per cent calcite, and several grains of magnetite. The epidote is concentrated mainly in the groundmass or matrix and has a very characteristic yellowish-green colour. Magnetite is almost entirely concentrated in the matrix where it forms porphyroblasts up to 0.1 cm. in diameter. However, the bulk of the magnetite porphyroblasts are less than 0.1 cm. in diameter. Some of the larger ones were found to contain microscopic inclusions of epidote and plagioclase. Both epidote and sphene are often found in or around chlorite grains. In the field several rounded volcanic "bombs" (up to 15 cm. by 15 cm.) were noted in this metamorphosed basic agglomerate. These "bombs" were found to be composed of 50 per cent albite, 20 per cent sphene, 10 per cent calcite and 20 per cent chlorite plus biotite.

Textures:

The metabasalt fragments are angular, massive and are commonly 0.2 cm. by 0.5 cm. but some are larger (2 cm. by 2.5 cm.). Many of these fragments are aligned and the rock displays fair to well developed foliation. The rock has an appearance of a breccia. The plagioclase usually shows a small amount of small scale alteration (sericite and kaolinite) and is not well twinned. In a few cases the albite forms relict phenocrysts. These phenocrysts are lath-shaped and display good twinning. Magnetite porphyroblasts form euhedral crystals. Epidote sometimes form porphyroblasts. Sphene rarely shows good crystal outlines. As a whole the grain size of the minerals is fine-grained. The mineral grains in the matrix are coarser-grained than those in the fragments. The few rounded volcanic bombs (up to 15 cm. in diameter) were found to contain amygdules (1-2 mm. by 2-3 mm.). These amygdules have been somewhat deformed and are now filled with calcite.

Occurrence
and Origin:

The metamorphosed basic agglomerate is concentrated in the areas (islands) in and around the northern portion of Jogues lake. A few exposures also occur on the east side of Butte lake. In some cases the shearing has destroyed many of the fragments and it is difficult to recognize these rocks as metamorphosed agglomerates. The metamorphosed basic agglomerates north and slightly to the west of Jogues lake fit into this category. The presence of minor amounts of magnetite is a diagnostic feature of these rocks. These fragmental rocks are basic agglomerates which have been metamorphosed in the greenschist facies of regional metamorphism and may be of the same age as the supposed metamorphosed basic tuffs around Colombet and Rouvière lakes. If one were to accept the hypothesis that the sheared metabasalts were originally basic tuffs, the distribution of these rocks and the metamorphosed basic agglomerates would seem to indicate that the center or centers of these volcanic eruption or eruptions lie northeast of Jogues lake.

(3) Metamorphosed Acidic Tuff

Definition:

Metamorphosed acidic tuff is a fine-grained to micro-crystalline, grey to black rock composed essentially of quartz, biotite, plagioclase (albite) and epidote. The rock is both massive and well-foliated.

Mineralogy:

In the field the presence of quartz and feldspar were guessed mainly on the basis of hardness and the general appearance of the rock. However, microscopic work was necessary to identify each of the mineral constituents. The vast majority of the feldspar crystals are untwinned. Plagioclase (albite) is present but it is not known whether or not this rock contains any potassic feldspar. The lack of twinning plus the fine

grain size made the estimation of the ratio of quartz to feldspar difficult. In general the metamorphosed acidic tuff has been estimated to contain 55 per cent plagioclase (possibly some K-spar), 20 per cent quartz, 15 per cent biotite and 10 per cent epidote. Chlorite is a common accessory mineral. Some of the feldspar grains are slightly altered. Biotite is pleochroic buff to brown or reddish-brown. Chloritized biotite is pleochroic light green to green. The small amount of chlorite present is an alteration product of biotite.

Textures:

Massive, microcrystalline, metamorphosed acidic tuffs are black while the sheared variety is often grey and coarser-grained. Relict phenocrysts of quartz and plagioclase (albite) are best preserved in the massive variety but some were also recognized in the sheared or foliated variety. Again the former contains better twinned plagioclase than the latter. In general the plagioclase crystals do not display good twinning. The biotite forms needle-like crystals which are aligned parallel in the foliated variety.

Occurrence
and Origin:

The metamorphosed acidic tuff occurs as thin layers or lens-like beds in the metabasalt around Colombet and Rouvière lakes. It is essentially made up of the assemblage quartz - albite - epidote - biotite which is stable in the greenschist facies of regional metamorphism. The composition and the occurrence of these rocks as thin layers or lens-like beds strongly suggest that these rocks metamorphosed equivalents of acidic tuffs.

C. Metamorphosed Gabbro

The metamorphosed gabbro occurs as sills and represents the youngest rock in the Jogues Lake area. It is the only intrusive rock found in the area and makes up some 25 per cent of the exposed rocks. The majority of this intrusive metagabbro was observed within the phyllites of the Kaniapiskau group while the remainder intrudes the metavolcanic rocks of the same group. The metagabbro sills vary in thickness from several feet to more than a half mile thick but some of these may represent multiple sills rather than simple ones. The thicker sills show differentiation and sometimes contain inclusions of metasedimentary rocks. The thick sill along the east shore of lake Leroux exhibits differentiation over a thickness of 1,300 feet and shows that at least this portion of the sill was intruded as a single unit and differentiated in place. Five samples were taken over a thickness of 1,300 feet (between Leroux and Butte lakes - 2.5 miles due east of the northern tip of Rouvière lake) and the mineral assemblages recorded, from base to top, are as follows:-

- (i) albite - clinozoisite - ferrotremolite
- (ii) albite - epidote - chlorite - actinolitic hornblende - magnetite - sphene
- (iii) albite - chlorite - actinolite - magnetite - epidote - stilpnomelane - sphene
- (iv) albite - chlorite - quartz - sphene (epidote, magnetite, biotite)
- (v) albite - chlorite - biotite - epidote - quartz (sphene, magnetite, apatite)

The minerals placed in brackets are those present in amounts less than 5 per cent each. The variation in colour from base to top is:- grey to green to greenish-black to greenish-grey to green. Gabbro (1) was anorthositic; (ii) and (iii) mafic-rich; (iv) and (v) quartz gabbros. The amount of actinolitic amphibole decreased from metagabbro (i) to (iii) and is absent in (iv) and (v). Metagabbros (ii) and (iii) are mafic-rich and each contains 10 per cent magnetite. Quartz metagabbros (iv) and (v) each contains 20 per cent light blue quartz.

Definition: In general the metamorphosed gabbro in the Jogues Lake area may be defined as a medium-grained, massive, grey to green rock composed of albite, chlorite, actinolite and epidote as the main minerals.

Mineralogy: In most metagabbros albite, chlorite, actinolite and epidote are the dominant minerals. Some contain 10 to 20 per cent quartz or magnetite, and in a few metagabbros biotite or stilpnomelane make up 10 to 20 per cent of the mineral constituents. In general sphene, magnetite and pyrrhotite are the common accessory minerals. The composition of the metamorphosed gabbros is variable. Much of the compositional differences can be attributed to differentiation in the thicker sills.

Although the percentages of the mineral constituents vary considerably, many of the metagabbros contain 30 to 50 per cent albite, 30 to 20 per cent chlorite, 30 to 10 per cent actinolite, 5 to 15 per cent epidote and 5 per cent sphene plus magnetite. Plagioclase grains are slightly to highly altered. The chlorite is light green and faintly pleochroic. Actinolite is normally light green and slightly pleochroic but some are nearly colourless (ferrotremolite). It is often found on the edges or grows across chlorite grains and appears to be replacing chlorite in many cases. Epidote sometimes occurs on the boundary between albite and actinolite or chlorite grains. In places portions of the plagioclase crystals have altered to epidote and the occurrence of epidote within or around chlorite grains is common. Sphene usually forms rims or partial rims around magnetite crystals - a sort of a corona with the nucleus being magnetite. Sphene is also found within chlorite grains.

Biotite is normally pleochroic, light-brown to brown but some have been chloritized and these are pleochroic light greenish-brown to greenish-brown. Stilpnomelane is pleochroic rusty-brown to dark rusty-brown and may be passed over as an unusual biotite. In hand specimen, the quartz in the metagabbros have a diagnostic light blue or blue colour.

Textures:

Most of the metagabbros have a relict, subophitic texture. These metamorphosed gabbros are usually medium-grained but some are fine-grained. The bulk of these rocks are massive but in places a few have been sheared and is foliated. Plagioclase is often lath-shaped and is well to poorly twinned. In twinned plagioclase crystals the twinning is sometimes partially destroyed by small scale alteration (epidote, sericite, kaolinite) of the plagioclase. Chlorite does not have good crystal outlines. Actinolite is normally fibrous in form. Stilpnomelane is also fibrous but differs from biotite in that it does not have the "birds-eye" texture. Sphene usually forms coronas or partial coronas around magnetite grains. Quartz occurs as round, anhedral grains.

Occurrence
and Origin:

The bulk of the metamorphosed gabbro occurs on both sides of Butte lake and extends northwest and southeast across the entire map-area. The remainder of the metagabbro sills are almost all concentrated in the northeast corner of the map-area. Of all the rock types in the Jogues Lake area, the outcrops of metagabbro are best exposed. These rocks were formed by regional metamorphism of differentiated and undifferentiated gabbro sills in the greenschist facies of regional metamorphism.

METAMORPHISM

The common mineral assemblages in the pelitic and basic rocks indicate that the rocks in the Jogues Lake area belong to the greenschist facies of regional metamorphism. The pelitic and basic rocks make up 90 per cent of all the rocks present in the area - phyllite = 40 per cent, metabasalt and metagabbro = 25 per cent each. The common mineral assemblages in these rock types are:-

A. Phyllite

- (i) quartz - muscovite - chlorite - biotite
- (ii) quartz - biotite - muscovite
- (iii) quartz - muscovite
- (iv) quartz - biotite

B. Metabasalt

- (i) albite - chlorite - actinolite - sphene
 - (ii) albite - epidote - chlorite - actinolite - sphene
- Magnetite is a common accessory mineral
- Calcite is sometimes present

C. Metagabbro

- (i) albite - epidote - chlorite - sphene
 - (ii) albite - epidote - chlorite - actinolite - sphene
 - (iii) albite - epidote - actinolite
 - (iv) albite - epidote - chlorite - actinolite - stilpnomelane - sphene - magnetite
- Magnetite is a common accessory mineral

From the point of view of regional metamorphism, the mineral assemblages in the chert-carbonate iron formation are of interest as the assemblages present in this rock type are more sensitive to temperature changes than those of other rock types in this area. The assemblage in the iron formation at the southwest corner of the map-area are: - quartz - ferrodolomite - minnesotaite; quartz - siderite - hematite. The chert-carbonate iron formation in the northeast corner of the area (just northeast of Jogues lake) contains the following mineral assemblage: - quartz - siderite - stilpnomelane - grunerite - magnetite. These assemblages belong to the greenschist facies of regional metamorphism. The presence of grunerite in the assemblage near Jogues lake suggests that this mineral assemblage was formed at a higher temperature condition than that in the southwest corner and points out the possibility that the grade of metamorphism increases slightly from southwest to northeast.

CENOZOIC

Glacial striae indicate that the direction of movement of the ice was roughly north-south. In the north-central portion of the map-area and the area 4 miles northwest of Rouvière lake exposures are relatively scarce due to morainal cover left by the receding ice.

STRUCTURAL GEOLOGY

In general, the pattern of deformation resembles that in other parts of the "Labrador Trough" and is the result of thrusting from the northeast direction. Most of the compressional forces appear to have been taken up by folds and bedding faults in the less competent phyllitic rocks. The net result has been folds overturned to the west. Although some dips to the west have been recorded, the vast majority of the rocks in the area dip to the east.

Folds

The rocks in the Jogues Lake area have been tightly folded but locally, open folds have been outlined. The general trend of the rocks is in a rough northwest direction and the dips usually vary from 45° to 75° E.

The most impressive structural feature in the area is a $N45^{\circ}$ W trending syncline. This syncline is overturned to the west and its fold axis passes through Butte lake and runs diagonally across the map-sheet in a northwest direction. The presence of quartz gabbro on both sides of this fold axis shows that this structure is an overturned syncline. In the Jogues Lake area the best "top" determinations were made by noting the presence of quartz gabbro - ie. quartz occurs at the top of the differentiated gabbro sills.

Faults

Except for portions of the metabasalt, metagabbro and granite, the rocks in the Jogues Lake area exhibit bedding or schistosity. Most of the schistosity appear to be bedding type and have been used extensively to work out structures.

The phyllitic rocks represent the *least* competent rocks in the area and are the most schistosed. This is particular true of portions of the graphitic phyllite where intense shearing has taken place. From the reconnaissance field work it appears that much of the faulting in this area are bedding faults.

In order to obtain a better idea of the structural geology of this area, more detailed work will have to be done in critical, well-exposed, areas.

ECONOMIC GEOLOGY

Prior to 1961 the exploration activities in the Jogues Lake area appear to have been reconnaissance in nature. With the discovery of a small but high-grade chalcopyrite showing on the northwest side of Colombet lake in 1961 various mining and exploration companies became interested in this area and a considerable amount of exploration work was carried out during 1961 and 1962. The majority of the work was concentrated in the area around Colombet and Rouvière lakes and the work done included:- staking, line-cutting, prospecting, trenching, ground geophysical surveys (magnetometer, electromagnetic and induced polarization), geological mapping and diamond drilling. At this time the original and most favourable copper-showing in the area (on the northwest side fo Colombet lake) was held by McIntyre Procupine Mines Limited.

Although several companies were active in the Jogues Lake area in 1961 and 1962 by far the most intensive exploration work was done by McIntyre Porcupine. The copper-showing in the arkose and sandstone on the northwest side of Colombet lake were tested by diamond drilling by McIntyre and the results showed that these occurrences were small and not of economic interest. In 1962 McIntyre held a total of 515 claims in this area. Conwest Exploration Company Limited and Rio Canadian Exploration Limited also carried out some exploration work in this general area.

It is of interest to note that a concentration of large, angular arkose and quartzite boulders mineralized with pyrite, chalcopyrite and malachite occur on McIntyre's ground just north of the granite on Colombet lake. The writer is of the opinion that further effort to trace these "floats" would be worthwhile.

During the course of the present field work several small mineralized zones were noted in the metamorphosed sedimentaries, basalts and gabbros. Most of the mineralization is pyrite or pyrrhotite, but there are also small amounts of chalcopyrite and nickeliferous pyrrhotite. The more important zones have been indicated on the accompanying map.

The fact that extensive exploration work was done in 1961 and 1962 has not eliminated this area but has only shown that certain copper-showings found at that time are uneconomic. The Jogues Lake area holds considerable interest for the prospector and detailed prospecting may lead to the discovery of additional copper and nickel showings.

REFERENCE

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