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GEOLOGY OF TUK RIVER AREA

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MINISTÈRE
DES RICHESSES
NATURELLES

DIRECTION GÉNÉRALE
DES MINES

TUK RIVER AREA

T. Hashimoto

Interim report

MINISTERE DES RICHESSES NATURELLES
EXPLORATION GEOLOGIQUE

GEOLOGY
OF
TUK RIVER AREA

Interim report

by

T. Hashimoto

1965

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MAP: 1"= 2 mi.

Manuscript: Tuk River area

Geology
of
THE TUK RIVER AREA, QUEBEC
Interim Report
by
T. Hashimoto

INTRODUCTION

General Statement

In 1963 the Geological Exploration Service of the Quebec Department of Natural Resources began a programme to map some 3,400 square miles in the Plétipi Lake region on the scale of 1/2 mile to the inch. During that summer some 1,500 square miles were mapped by a geological field party of 23 men under the general supervision of Dr. J. Bérard (Matonipi Lake and Rivière aux Outardes areas - J. Bérard; Lac Deux Décharges and North Plétipi Lake areas - E.H. Chown). In the 1964 field season this project was completed by a party of 24 men under the direction of Dr. E.H. Chown (East Péribonca River area - E. H. Chown; Plétipi Lake South area - E.H. Chown and T. Hashimoto; Tuk River - T. Hashimoto). The mapped region consists of nine map sheets 30 minutes of longitude by 15 minutes of latitude. This report deals with the northeastern most map-sheet - Tuk River area.

Location

The Tuk River area is bounded by latitudes 52°00' and 52°15' and longitudes 69°30' and 70°00'. It lies in the northwestern part of Saguenay county, about 210 miles north-northwest of Baie-Comeau and 70 miles slightly north of west of the iron-mining center of Gagnon. It covers some 370 square miles, including all of Bernard township, almost all of Noël, and a narrow strip of Forget township along the eastern border, as well as unsubdivided ground in the north. The map-area is immediately east of Upper Outardes River area and north of Matonipi Lake area, both mapped in 1963 by Bérard (1964).

Access

The best means of access is by float-plane, the nearest bases being at Louise lake (close to Manicouagan-5), about 100 miles to the southeast, and at Gagnon.

Numerous small lakes and streams occur throughout the area, but most of the streams are not navigable and the lakes are too small to afford good waterways.

Field Work

The base map was completed by Hydraulic Resources Branch of the Quebec Department of Natural Resources. The geology of the area was mapped by pace-and-

compass traverses run at half-mile intervals and by shore-line geology. The outcrops were outlined, in the field, on air photographs (1/2 mile to the inch) and replotted on a base map of the same scale at camp. In the central part of the map-area and the northern three-quarters of the western half rock exposures are relatively scarce. Outcrop exposure in the remaining portion is fair. The field map was made on a scale of 1/2 mile to the inch.

Acknowledgements

During the summer of 1964 the writer's party consisted of S.B. Hixon, M. Nakashiro, R. Bogoch, R. Hardy, Y. Panneton, J.L. Caty, C. Jobin, D. Lacroix, A. Carpentier and M. Lessard. 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. E.H. Chown.

Previous Work

The adjoining areas to the west and south were mapped in 1963 by Bérard (1964) for the Geological Surveys Branch of the Quebec Department of Natural Resources on a scale of 1/2 mile to the inch. As far as the writer knows this work represents the first time that this area has been mapped on the scale of 1/2 mile to the inch.

Parts of the area have been prospected, but it appears that the work was reconnaissance in nature and no geological work of any consequence has resulted.

DESCRIPTION OF THE AREA

Settlement and Resources

There are no settlements of any kind in the area, and the nearest permanent settlements are at Gagnon, 70 miles to the east and Manicouagan-5, about 100 miles to the southeast.

Most of the area is moderately forested by coniferous trees, the common types being jack pine and black spruce. Balsam fir and tamarack are scarce, birch and poplar rare. The area has been burnt over several times.

Game is sparse, but porcupine, rabbit, beaver, mink, muskrat, moose, cariboo, partridge, duck and goose were seen during the course of the field work. Fishing is not good, but some pike, lake trout and speckled trout were caught.

At present, the Mouchalagane river for water power, and the coniferous trees for pulp, sum up the known natural resources of this area. No significant mineral showings have been found in the area.

Physiography

As a whole the map-area has a rolling topography with the average relief about 200 feet. Low hills and swamps are generally characteristic, except in the northeast corner of the area where hills rise 500 to 1,000 feet above Mouchalagane river. The area drains southward to St. Lawrence river via Mouchalagane - Manicouagan and Outardes rivers.

Although Pleistocene glaciation played an important role in developing the present topography, the hills and valleys generally reflect trends in the bedrock structures. As a whole the area has an east-west trend which coincides with the rough trend of the underlying rocks. Glacial striae indicate that the direction of movement of the ice was north-south. In the central part of the map-area and the northern three-quarters of the western half rock exposures are relatively scarce due to the widespread morainal cover left by the receding ice.

GENERAL GEOLOGY

The consolidated rocks of the area are Precambrian in age. Gneissic granite and/or granite gneiss, biotite paragneiss, layered quartz-plagioclase-biotite gneiss, and amphibolites form about 95 per cent of the exposed rocks. The remaining 5 per cent is essentially made up of leucogranite, anorthositic gabbro, micaceous

quartzite and ultrabasic rocks.

The gneissic granite and/or granite gneiss appears to be the oldest rock in the map-area. It is overlain by the other gneisses and intruded by small bodies of leucogranite, granite pegmatite, anorthositic gabbro, and ultrabasic rocks. The age relations between the layered quartz-plagioclase-biotite gneiss, biotite paragneiss, amphibolites, and anorthositic gabbro are not clear. The ultrabasic rocks probably represent the youngest rocks in the area.

The origin of the gneissic granite and/or granite gneiss is not known. The other gneisses except the amphibolites are probably metasediments. All the amphibolites appear to have been derived from gabbro and/or basalt.

The rocks in the area have been strongly deformed. Except for some of the anorthositic gabbro, leucogranite, tourmaline granite, granite pegmatite and ultrabasic rocks they are generally well foliated. The folding is complex, but the major directions of folding are roughly east-west and north-south. No large faults were recognized.

Portions 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.

TABLE OF FORMATIONS

CENOZOIC	Recent Pleistocene	Peat, river and beach deposits Silt, sand, gravel, boulders	
Unconformity			
PRECAMBRIAN	Late	Intrusive Rocks	Ultrabasic rocks Biotite granite, leucogranite, tourmaline granite, pegmatite
		Gneiss Group	Amphibolite, hornblende gneiss Biotite paragneiss, quartzite Layered quartz-oligoclase-biotite gneiss
	Early	Moucha- lagane Group	Serpentinite, blotchy amphibolite, matagabbro and metabasalt amphibolites, dolomitic marble, metasomatized meta-sediments, micaceous quartzite. Anorthositic gabbro
		Granitic Complex	Gneissic granite and/or granite gneiss

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.

DESCRIPTIONS OF ROCK TYPES

The rocks in the Tuk River area have been divided into 4 groups: granitic complex, Mouchalagane group, Gneiss group and late intrusive rocks. The members of these groups are listed in the table of formations. In this section each of these rock types are described.

Granitic Complex

Gneissic Granite and/or Granite Gneiss

Definition. The gneissic granite and/or granite gneiss are medium grained rocks containing microcline, oligoclase, quartz and biotite as the principal minerals. In most cases the amount of microcline exceeds that of oligoclase. The colour of the fresh surface varies from pink to grey-white but the greyish variety often has a slight pinkish tinge. The weathered surface is generally pink or greyish-white.

Mineralogy. Microcline, oligoclase, quartz and biotite are the dominant minerals. Microcline generally

makes up 45 per cent of the rock, oligoclase 20 per cent, quartz 20 per cent and biotite 5 to 10 per cent. Muscovite is often present and its percentage varies from a few grains to about 5 per cent. In a few cases hornblende is the principal mafic mineral in these granitic rocks. The minor mineral constituents consist of: epidote, apatite, chlorite, zircon, sphene, allanite and pyrite. Microcline is fresh in appearance whereas the oligoclase usually shows some small scale alterations (kaolinite and sericite). Biotite is brown to light brown and in some thin-sections a few biotite crystals appear to be altering to chlorite. Some of the muscovite clearly replaces biotite along margins and cleavages. Epidote sometimes forms around allanite grains or metamict mineraloids which appear to have originally been allanite.

Textures. The rocks of the granitic complex are gneissic and the gneissosity is outlined by parallel alignment of the biotite grains. In general the gneissosity is best observed in the exposures and hand specimens and is less obvious in some of the thin-sections.

The plagioclase grains are usually well twinned. Quartz often displays undulatory extinction and bent, chloritized biotite plates have been observed in a few thin-sections. In some of the granitic gneisses porphyroblasts of microcline have been noted.

Occurrence and Origin. The gneissic granite and/or granite gneiss is the most common rock type in the

Tuk River area and makes up about 50 per cent of the exposed rocks. It is widespread and is probably the oldest rock in the map-area.

Both igneous and metasedimentary origins for these granitic rocks can be proposed but with the facts available these theories would be little more than pure conjecture. The origin of these granitic rocks remains a problem.

Mouchalagane Group

Anorthositic Gabbro

Definition. The anorthositic gabbro is a medium to coarse grained rock containing andesine-labradorite, hornblende and epidote as its main minerals. It is grey on the fresh surface and greyish white on the weathered surface, and varies from massive to slightly foliated.

Mineralogy. Plagioclase (andesine-labradorite), hornblende and epidote are the principal minerals. Both the plagioclase and hornblende content is quite variable and estimates of 50 to 75 per cent for plagioclase and 35 to 10 per cent for hornblende have been made. The epidote content was found to be about 15 per cent. Biotite and magnetite are the minor constituents. Hornblende is light green to dark green. Some of the biotite replaces hornblende along the latter's margins and cleavages. Epidote appears to be derived from both hornblende and plagioclase. The plagioclase grains are saussuritized but some are only very

slightly sericitized.

Textures. The anorthositic gabbro varies from massive to slightly foliated. In general, the gneissosity is not obvious in thin-section and can be noted more readily in the exposures or hand specimens. The plagioclase crystals are well twinned.

Occurrence and Origin. The anorthositic gabbro occurs in the southwest corner of the map-area where it crops out as a high hill approximately 1 mile by 1 mile. This rather uniform massif extends into the Upper Outardes River area (Bérard, 1964) to the west for a distance of about 1 mile. There is little doubt that this anorthositic gabbro is of igneous origin.

Micaceous Quartzite

Definition. Micaceous quartzite is medium-grained, white to light grey, and well foliated. Quartz usually makes up about 75 per cent of the rock, biotite and muscovite 15 per cent and plagioclase 10 per cent.

Mineralogy. Quartz is the dominant mineral and its abundance gives the rock a white to light grey colour. The biotite and muscovite content is variable but is usually around 15 per cent. Biotite is generally more abundant than muscovite. In thin-section it was difficult to distinguish between quartz and plagioclase which are untwinned and unaltered.

The plagioclase content has been estimated to be about 10 per cent. Epidote and pyrite are the common accessories. The biotite is brown to light brown. In general, the plagioclase is only very slightly sericitized and kaolinitized.

Textures. The micaceous quartzite displays readily observable foliation due to the parallel alignment of biotite and muscovite. The rock is medium grained but, in places, becomes fine grained. In thin-section some bent biotite grains were noted. Quartz and plagioclase often show mosaic texture. Most of the plagioclase grains are untwinned and only a few twins were observed. The twinning is rather poor and no determinations were made as to the anorthite content of the plagioclase. Quartz displays undulatory extinction.

Occurrence and Origin. Micaceous quartzite is exposed in the northeast and north-central parts of the map-area where it is interlayered with metabasalt and meta-gabbro amphibolite. The micaceous quartzite is not an important rock type as its exposures number less than a dozen.

This micaceous quartzite was derived from an impure sandstone.

Metasomatized Metasediment

Two exposures of a massive rock composed of garnet-quartz-mica were found in the north-central portion of the area. This gneiss is interlayered with the

metabasalt amphibolite. The rock is greenish on the fresh surface but is a light brown on the weathered surface. In fact, the rock is stained brown below the weathered surface and hand specimens are often completely brown in colour. The garnetiferous quartz-mica metasediment is medium to coarse grained and contains garnet, quartz, biotite and muscovite as the principal minerals. The proportions of these mineral constituents are highly variable but garnet and quartz are dominant. In one thin-section, a few per cent of sillimanite was found. An estimate of the percentages of the mineral constituents in this particular thin-section is as follows: 60 per cent garnet, 25 per cent quartz, 10 per cent biotite and 5 per cent muscovite plus sillimanite. The accessory minerals are: epidote, chlorite, plagioclase, hornblende and pyrite and possibly andalusite. The sillimanite occurs as fibers in a quartz groundmass. The garnet is violet and this colour is rather typical of pyrope-almandine. An inclusion in the garnet was identified as andalusite. In a few places biotite appears to be replacing garnet. The biotite is brown to light brown. Quartz shows undulatory extinction. The rock is massive and the assemblage garnet-quartz-biotite-muscovite-sillimanite is a higher temperature assemblage than that of the surrounding rocks (lower to middle amphibolite). A tourmaline granite occurs near these exposures and some tourmaline have been introduced into the surrounding rock. It is the writer's opinion that

this unusual garnet-quartz-biotite-muscovite-sillimanite rock is a product of metasomatism of a metasediment by solutions emanating from the tourmaline granite. The micaceous quartzite may have been the original rock.

Dolomitic Marble

One exposure of dolomitic marble was found interlayered with the metabasalt amphibolite. The outcrop does not appear to be continuous and appears to be sort of a lens in metabasalt amphibolite. The rock is coarse grained, massive, light brown on the fresh surface and a darker brown on the weathered surface. It is composed entirely of dolomitic calcite. At the contact with the metabasalt some hornblende has developed in the dolomitic marble.

Metabasalt and Metagabbro Amphibolites

The metabasalt and metagabbro amphibolites are found in the northeast section of the area. These amphibolites are interlayered and are similar in composition and the distinction between them, made in the field, is based mainly on differences in relict grain size. The metabasalt and metagabbro amphibolites each make up 5 to 10 per cent of all the exposed rock. The mineral assemblages present, in the metabasalt and metagabbro amphibolites, are of metamorphic origin, and the most common assemblage is

hornblende-oligoclase with some epidote.

Metabasalt Amphibolite

Definition. The metabasalt amphibolite is fine grained, dark green, foliated, and is composed essentially of hornblende, oligoclase and epidote.

Mineralogy. An estimation of the average percentages of the three dominant minerals are:: 55 per cent hornblende, 30 per cent oligoclase and 10 per cent epidote. The remaining 5 per cent is made up of the minor mineral components which include sphene, chlorite, calcite, zircon, pyrite and a metamict mineraloid which appears to have been allanite. Sphene is by far the most common accessory mineral and is present in all the metabasalt amphibolites, It often occurs within the hornblende crystals. The ratio of the main minerals is highly variable. Hornblende content has been estimated to vary from about 20 per cent to 80 per cent, oligoclase from 15 to 40 per cent and epidote between 0 to 35 per cent. Hornblende is pale green to green brown and some of the plagioclase grains have been sericitized and kaolinitized. Many of the epidote occur as elongated grains.

Textures. Most of the metabasalt amphibolites are foliated but few are rather massive. The foliation is easily seen in the exposures and hand specimens. In thin-

section, many of the hornblende prisms have a parallel orientation. The majority of the plagioclase crystals are not twinned.

Origin. The mineralogical composition of these fine-grained amphibolites correspond to that of a metamorphosed gabbro or basalt in the lower amphibolite facies of regional metamorphism. The fineness of the grain size suggest that these amphibolites were probably derived from basaltic lavas. Some fragmental phases may be present, but none were recognized in the field or in the thin-sections examined.

Metagabbro Amphibolite

Definition. The metagabbro amphibolite is medium grained, dark green and composed essentially of hornblende and plagioclase with some epidote. The rock is generally foliated but some are rather massive.

Mineralogy. The average percentage of hornblende has been estimated to be about 60 per cent, oligoclase 30 per cent and epidote 5 to 10 per cent. The amount of hornblende in these rocks is quite consistent and estimation of the variation is from 60 per cent to 70 per cent; oligoclase is less regular and varies from 25 to 40 per cent. The percentage of epidote varies from 0 to 15 per cent. Sphene, chlorite, pyrite and biotite make up the accessory minerals. In all the metagabbro amphibolite thin-sections examined, sphene is always present. Hornblende

is green to green brown and its grain size is usually larger than that of the co-existing plagioclase. Some hornblende crystals have been chloritized and in one section a partial replacement of a few hornblende grains have been observed. The plagioclase grains are only slightly sericitized and kaolinitized.

Texture. Although the gneissosity can be seen in some thin-sections, it is best observed in the hand specimens. The hornblende grains are often aligned but in a few cases have a rather random orientation. Most of the plagioclase crystals are untwinned and many display undulatory extinction.

Origin. Regional metamorphism of a basic igneous rock in the lower amphibolite grade would result in the assemblage hornblende-oligoclase-epidote. The relict texture of this medium-grained amphibolite indicates that it was probably formed from a gabbro.

Blotchy Amphibolite

One outcrop of blotchy amphibolite was found interlayered with the metabasalt amphibolite in the northwest corner of the map-area. The rock is porphyritic and consists of large phenocrysts (3 cm. by 2 cm.) of saussuritized plagioclase in a medium-grained hornblende-plagioclase groundmass. This groundmass is made up of about 65 per cent hornblende and 35 per cent plagioclase with minor amounts of biotite and sphene. In the area surrounding the phenocrysts the groundmass is composed of biotite, plagioclase and epidote.

The biotite content has been estimated to be 55 per cent, plagioclase 40 per cent and epidote 5 per cent. The biotite plates are aligned and bend around the plagioclase phenocrysts. It is brown to light brown and some of the biotite is definitely replacing hornblende. The hornblende is green to brownish green.

This blotchy amphibolite is not continuous and appears to be lens-shaped. It was probably originally a porphyritic gabbro.

Serpentinite

A lens-shaped mass of serpentinite occurs in the middle of the metabasalt and metagabbro amphibolite. This serpentinite crops out as three separate small exposures. The rock is fine-grained, massive and olivine green to dark green on the fresh surface and has rusty brown weathered surface.

Antigorite is the dominant mineral with tremolite and a sulphide which appears to be pyrrhotite as the other principal constituents. Calcite is present in minor amounts. In two of the thin-sections, the percentages of these minerals have been estimated as 60 to 65 per cent antigorite, 25 per cent tremolite, 10 per cent pyrrhotite and 5 per cent to a few grains of calcite. The other section contains 85 per cent antigorite and 15 per cent pyrrhotite. The tremolite is fibrous in form and is colourless. The pyrrhotite occurs as more or less round grains

whose edges have been corroded.

This rock is definitely a serpentinitized ultrabasic rock. The age relationship between this serpentinite and the other small, round, isolated bodies of ultrabasic rocks scattered through the northern two-thirds of the map-area is not known. In general, these ultrabasic rocks are not nearly as serpentinitized as the serpentinites described above. Since these serpentinites appear to be interlayered or occur within the metabasalt and metagabbro amphibolites, they have been separated from the other ultrabasic rocks and are thought to be of a different age.

Gneiss Group

Layered quartz-oligoclase-biotite Gneiss

Definition. The layered quartz-oligoclase-biotite gneiss is migmatitic in appearance, and consists essentially of two parts: a well foliated, gray, medium-grained biotite paragneiss; and numerous, virtually concordant quartz-oligoclase layers or stringers 1-5 cm. thick. The latter rock is medium-to coarse-grained and light buff in colour.

Mineralogy. A description of the biotite-rich portion of the layered quartz-oligoclase-biotite gneiss is not given here as it is similar in mineralogy and texture to the biotite paragneiss which is described in the following section. In order to avoid unnecessary repetition the reader is referred to that section.

The quartz-oligoclase layers of the gneiss are, as the name implies, composed almost entirely of these two minerals. A typical sample was found to be made up of 85 per cent oligoclase, 10 per cent quartz and 5 per cent biotite. The common minor constituents are: epidote, apatite, allanite, zircon, muscovite and microcline. Garnet, magnetite and chlorite were noted in one thin-section.

Textures. The quartz-oligoclase layers are often igneous appearing and these two minerals commonly show a mosaic texture. The biotite grains are aligned but the rock is not well banded due to its small content of biotite.

Quartz usually shows undulatory extinction. Many of the oligoclase grains are twinned.

Occurrence and Origin. The layered quartz-oligoclase-biotite gneiss occurs mainly in the southeast section of the map-area and appears to overlie the gneissic granite and/or granite gneiss. It makes up approximately 15 per cent of all the exposed rocks and is the third most common rock type in the Tuk River area.

The origin of the layered quartz-oligoclase-biotite gneiss is a problem. Three possible theories on the origin of this gneiss are presented below:

- (i) injection of material rich in quartz and oligoclase along the foliation planes of some of the biotite paragneiss;

- (ii) metamorphic segregation into felsic and biotite-rich layers;
- (iii) the quartz-oligoclase and biotite-rich layers may represent differences in original composition.

Biotite Paragneiss

Definition.

In the Tuk River area the biotite paragneiss is a gray, well foliated, medium- to coarse-grained rock which contains oligoclase, biotite and quartz as the main essential minerals.

Mineralogy. A typical biotite paragneiss is composed of 55 per cent oligoclase, 30 per cent biotite and 15 per cent quartz. However, the percentages of these minerals vary considerably and in some cases the biotite content has been found to be in excess of 50 per cent. In the field these biotite schists were grouped with the biotite paragneiss. One outcrop of garnetiferous quartz-biotite gneiss was found in the west central border of the map-area. This rock has also been included with the biotite paragneiss. The biotite in the biotite paragneiss and layered quartz-oligoclase-biotite gneiss are all light to dark brown in colour. A few are a green brown but these represent biotite grains which are altering to chlorite.

Epidote is the most common accessory mineral and is always present. The amount of epidote varies from

a few grains to several per cent and in a couple of thin-sections the epidote content has been estimated to be as high as 15 per cent. In thin-section the epidote grains usually have a metamict core which appears to have originally been allanite and this particular occurrence of epidote is characteristic of not only the biotite paragneiss but also the layered quartz-oligoclase-biotite gneisses. Microcline is usually present as a minor constituent but in some samples it comprises a significant percentage and several specimens were found to contain 5 per cent microcline. Microcline often occurs as interstitial material between oligoclase grains and is fresh in appearance. Oligoclase has been sericitized and kaolinitized as is the case in the earlier described layered quartz-oligoclase-biotite gneiss. The other minor constituents are: zircon, apatite, allanite, muscovite, hornblende and chlorite.

Textures. The biotite paragneiss displays a marked foliation due to the parallel alignment of abundant biotite. In general the rock is gneissic but some contain large amounts of biotite and are essentially schists.

The size of the biotite plates range from medium- to coarse-grained and some of them have been bent. Quartz grains often show undulatory extinction.

Occurrence and Origin. The biotite paragneiss comprises some 20 to 25 per cent of the exposed rocks and is the third most abundant rock type in the map-area. This

gneiss occurs mainly in the south and east central portions of the area.

The presence of much biotite and oligoclase indicates that the rock was formed from aluminous sediments such as a shale. In the Matonipi Lake area (Bérard, 1964) immediately to the south quartzite, crystalline limestone and iron-formation are found interlayered with this biotite paragneiss.

Quartzite

One outcrop of quartzite was found interlayered with the biotite paragneiss in the south-central part of the map-area. It is medium grained, white, foliated, and composed of 85 to 90 per cent quartz, 10 per cent muscovite and a few per cent of microcline. Several grains of plagioclase and pyrite are present as accessories.

The muscovite plates are well aligned. An examination of the thin-section showed that the quartz grains are also elongated parallel to the foliation plane. Some of the quartz display undulatory extinction.

This quartzite was formed by regional metamorphism of a relatively pure sandstone.

Amphibolite and Hornblende Gneiss

The amphibolite and hornblende gneiss form small lens-like bodies interbanded with the layered quartz-

oligoclase-biotite gneiss and biotite paragneiss.

Three outcrops of amphibolite were found in the east central section of the area. This rock is medium grained, dark green and foliated. It is essentially composed of hornblende and plagioclase with some epidote. Minor amounts of biotite and quartz are locally present. This amphibolite appears to have been derived from a basic igneous rock.

One outcrop of hornblende gneiss crops out in the northwest corner of the map-area and another is exposed in the central portion. These gneisses are medium grained, green, well foliated and are essentially made up of hornblende, plagioclase, and epidote. Although the mineralogical composition of these two hornblende gneisses are similar, the ratio of the mineral components vary. An estimation of the percentages of the minerals of the hornblende gneiss which occurs in the northwest section is as follows: 35 per cent hornblende, 35 per cent plagioclase plus quartz, 15 per cent each of biotite and epidote. Sphene, apatite and garnet are the accessories. The other hornblende gneiss is composed of 25 per cent hornblende, 40 per cent oligoclase, 20 per cent quartz and 15 per cent biotite. The minor constituents are epidote, apatite, zircon, sphene and allanite. In both these rocks the hornblende and biotite grains are aligned. Hornblende is green to brown green and the biotite brown to light brown. Most of the plagioclase crystals are

untwinned. The plagioclase are quite fresh in appearance and have been only slightly sericitized and kaolinitized. Quartz displays undulatory extinction. In places the banding between hornblende, biotite and plagioclase, quartz is pronounced.

It is not known whether these hornblende gneisses are ortho- or para-gneisses.

Late Intrusive Rocks

The late intrusive rocks in the Tuk River area consist of biotite granite, leucogranite, tourmaline granite, granite pegmatite, and ultrabasic rocks. Except for the tourmaline granite these rocks occur as small bodies scattered throughout the map-area and are intrusive into the rocks of the Gneiss Group and the granitic complex. The tourmaline granite is restricted to the northeast corner of the area and intrude rocks of the Mouchalagane group. These intrusive rocks make up only a few per cent of the exposed rocks.

Biotite Granite

The biotite granite is medium grained, pink to greyish white on the fresh surface and grey white with a slight pinkish tinge on the weathered surface. The rock is usually massive but some are slightly gneissic. Quartz, microcline, sodic oligoclase and biotite are the principal minerals. It is usually made up of 20 per cent quartz,

10 per cent biotite and 70 per cent microcline plus sodic oligoclase. In general the microcline is more abundant than the oligoclase. The accessory minerals consist of muscovite, epidote, chlorite, apatite, sphene and allanite. Microcline is fresh in appearance. Oligoclase is usually untwinned and slightly kaolinitized and sericitized. Quartz often shows undulatory extinction. Biotite is brown to dark brown. In the thin-sections examined some of the muscovite and chlorite definitely replace biotite.

Leucogranite

The leucogranite is pink, medium grained and massive. Its mineral constituents are generally made up of 20 to 40 per cent quartz, 65 to 50 per cent microcline and 15 to 10 per cent sodic oligoclase. The common accessory minerals are: muscovite, biotite, epidote and magnetite.

Tourmaline Granite

The tourmaline granite is white with a slight yellowish tinge, medium to coarse grained, and usually massive. It is difficult to estimate the average mineral composition of this rock as the tourmaline crystals are often concentrated in patches. It appears that most of these granites contain about 30 per cent quartz, 55 per cent sodic oligoclase and 10 per cent tourmaline. The microcline content varies from a few grains to about 5 per cent.

Muscovite and epidote are often present as accessories. In thin-section the oligoclase is only very slightly sericitized and most of the crystals are finely twinned. Quartz shows undulatory extinction. Microcline occurs as interstitial material between the oligoclase grains or within the oligoclase crystals. The tourmaline is black and the grain size varies from very fine to crystals 1/2 cm. by 4 cm.. Tourmaline crystals 1 cm. in length are common.

Granite Pegmatite

The granite pegmatites are pink and white, leucocratic and composed of 80 per cent microcline and 20 per cent quartz. The accessory minerals consist of muscovite, apatite, plagioclase, and epidote. The microcline grains are commonly slightly sericitized and kaolinitized. Quartz displays undulatory extinction. Some of these pegmatites show graphic quartz-microcline intergrowths.

Ultrabasic Rocks

A dozen small outcrops of ultrabasic rocks were found during the course of the field work. These rocks are usually massive and medium to coarse grained. They are usually dark green on the fresh surface and rusty brown on the weathered surface. A couple of pale green ultrabasic rocks composed essentially of tremolite and chlorite crop out in the central portion of the area. The mineralogical composition of the ultrabasic rocks is quite variable and ranges from pure serpentinite to those made up almost entirely

of hypersthene, tremolite and olivine. All the rocks are devoid of quartz and feldspar. The principal minerals are hornblende, tremolite, hypersthene, olivine, antigorite and chlorite. The minor mineral constituents include spinel, pyrrhotite, magnetite and calcite. The pyrrhotite grains have corroded edges. A rock composed of hornblende and garnet occurs in the northwest corner of the map-area and has been included in the ultrabasic rocks.

The ultrabasic rocks are younger than the rocks of the granitic complex, Mouchalagane and gneiss groups, but the age relationship between these ultrabasic rocks and the younger intrusive granites is not known.

Metamorphism

The common mineral assemblage of hornblende-oligoclase-epidote present in the metabasalt and metagabbro amphibolites of the Tuk River area is considered to be quite typical for metamorphosed basaltic and gabbroic rocks in the lower amphibolite facies of regional metamorphism. In the layered quartz-oligoclase-biotite gneiss and biotite paragneiss the most common assemblage is quartz-oligoclase-biotite-epidote (-microcline-muscovite).

It appears that the rocks of the Tuk River area belong to the lower amphibolite grade of regional metamorphism.

Cenozoic

Glacial striae indicate that the direction of movement of the ice was north-south. In the central part of the map-area and the northern three-quarters of the western half rock exposures are relatively scarce due to the widespread morainal cover left by the receding ice.

Prominent north-south eskers traverse the map-area.

STRUCTURAL GEOLOGY

The structural geology of the Tuk River area is complex and the rocks have been intricately folded. No large faults were recognized.

Folds

Fold structures in the area were difficult to work out due to the absence of marker beds, scarcity of exposures in certain parts, and the complexity of the folding. However, several anticlines and synclines have been determined, and their axes are shown on the accompanying geologic map. Although their trends are highly variable, two main directions are apparent - east-west in the central part of the area, and north-south in the northeast corner. This indicates that the area was affected by at least two distinct periods of folding, with the result that the large folds are rather discontinuous. Both open and closed folds are present.

Major folds are most clearly defined in the northeast corner of the map-area, where the metabasalt and metagabbro amphibolites are tightly folded along north-south axes. Almost all the limbs dip 50° - 60° to the west; all but one of these folds is overturned to the east.

Foliation and Lineation

Although most of the rocks in the map-area are well foliated, some are massive. The massive rocks are: leucogranite, tourmaline granite, granite pegmatite, ultrabasic rocks, and some of the anorthositic gabbro and amphibolites.

In some outcrops lineation is well developed. Two types of lineation were recorded: orientation of mineral grains and the axes of small folds.

ECONOMIC GEOLOGY

No claims have been staked in the area during recent years. There is field evidence that parts of it have been prospected, but it appears that the work was reconnaissance in nature and that no significant concentrations of minerals were found.

During the field work no important rusty-weathering zones were seen; however, small amounts of disseminated pyrrhotite and chalcopyrite were noted in some of the amphibolites. It appears that these rocks, which are most abundant in the northeast corner of the map-area, are the most favorable for sulfide mineralization.

REFERENCES

- BERARD, Jean (1964) - Geology of Upper Outardes River Area, Chicoutimi County; Quebec Dept. Nat. Res., P.R. No. 512 (with map No. 1547).
- BERARD, Jean (1964) - Geology of Matonipi Lake Area, Saguenay County; Quebec Dept. Nat. Res., P.R. No. 521 (with map No. 1543).