RP 498(A)

PRELIMINARY REPORT, GEOLOGY OF RUPERT BAY - MISSISICABI RIVER AREA, ABITIBI AND MISTASSINI TERRITORIES

P.R. NO. 498

DEPARTMENT OF NATURAL RESOURCES

RENE LEVESQUE, MINISTER

P.-E. AUGER, DEPUTY MINISTER

GEOLOGICAL SURVEYS BRANCH

H. W. MC GERRIGLE, CHIEF

Geology

of

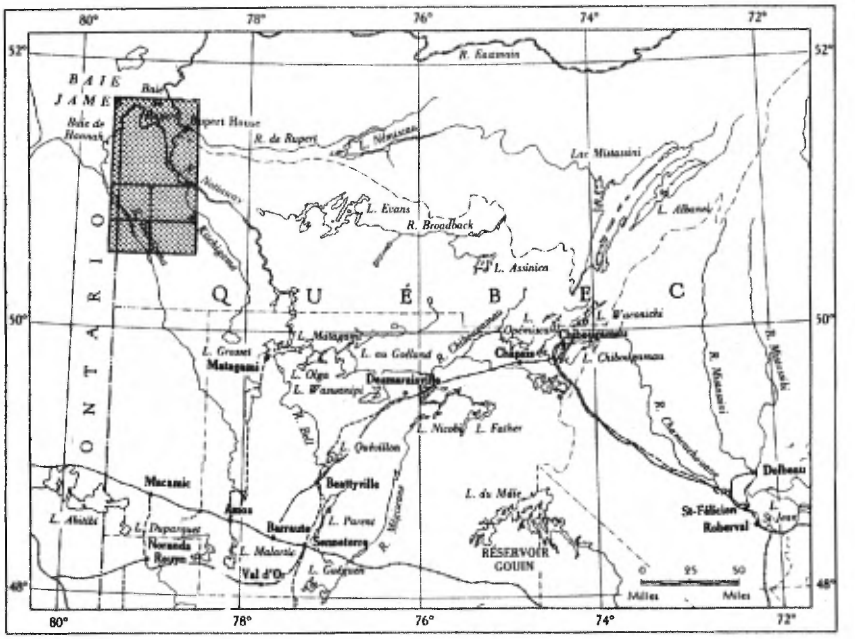
Rupert Bay-Missisicabi River Area

ABITIBI AND MISTASSINI TERRITORIES

PRELIMINARY REPORT

BY

J.H. Remick, P.-R. Gillain and C.J. Durden



QUEBEC

1963

P.R. NO. 498

PRELIMINARY REPORT

on

RUPERT BAY - MISSISICABI RIVER AREA

ABITIBI AND MISTASSINI TERRITORIES

by

J.H. Remick, P.R. Gillain and C.J. Durden

INTRODUCTION

The Rupert Bay - Missisicabi River area was geologically mapped during the summer of 1961. Traversing was shared by eight two-man teams, which were transported along with their supplies to and from fly camps by a Bell G-2 helicopter. Abundant landing areas for the helicopter were provided by patches of muskeg and by the many lakes and ponds.

The map-area is bounded by latitudes 50°30' and 51°40' and by longitude 78°30' and the Quebec-Ontario boundary (79°31'). Its south boundary is about 135 miles north-northwest of Amos, and the greater part of Rupert bay is included at the north.

The entire area is illustrated by the accompanying generalized geological map on the scale of 8 miles to the inch. In view of the scarcity of rock outcrops to the north of latitude 51°00' the usual mile-to-the-inch maps are omitted for this part of the area. Nevertheless, all exposures noted directly from the air or on photographs north of latitude 51°00' and west of longitude 78°40' were examined on the ground. That part of the area to the north of latitude 51°00' and east of longitude 78°40' was not directly examined. Four maps at the usual scale of one mile to one inch are provided for that part of the area south of latitude 51°00.

Access

Several aviation companies, with bases at Amos, Senneterre, La Sarre, Watson lake and Moosonee, provide transportation into the area. A biweekly air service is maintained between Rupert House and Moosonee on James bay, and small cargo ships haul food and supplies between these localities several times between mid-June and the end of September.

Float planes can land on Broadback river above the first rapids, in a few places on Harricana and Nottaway rivers at times of high water, and on a few of the lakes. The best plane access to the Obamska volcanic band is by the several wide sections of Obamska river and, on Kitchigama river, at the north contact of the band.

The western part of the area may be reached by canoe from Moosonee, Ontario, via Hannah bay and Harricana river. The eastern part may be reached from Rupert House southward along Rupert bay and Nottaway river to Kitchigama river, and also from Grasset lake northward along Kitchigama river. Boulder rapids on Kitchigama river from latitude 50°30' northward to the Nottaway make canoe travel difficult. Large near-shore boulders in the southern part of Rupert bay necessitate travelling several miles out from shore at low tide.

Canoe travel within the area is practical along even the larger rivers only at times of high water.

Inhabitants

The only settlement in the area is Rupert House at the mouth of Rupert river. About 500 Cree Indians reside here along with Catholic and Anglican clergy, a nurse, school teacher, Hudson's Bay post factor, and an official of the Fur Service of the Quebec Department of Game and Fisheries. Fifty to sixty Rupert House canoes are produced here each year from April through September, giving employment to a dozen men. In the winter the men turn to trapping.

Topography and Drainage

The surface of the area is a plain sloping gently toward James bay. The highest point is in the southeast corner and is about 750 feet above sea-level. Topography is gentle and geologically controlled for the most part.

The west half of the area, underlain mainly by Paleozoic rocks, is a flat clay plain covered by muskeg with some sandy areas and with sand hills, and strand lines rising generally to less than 25 feet. An area 9 miles long and 7 miles wide of fluvio-glacial sediments has the most relief in the northern part of the area. This area is about 7 miles south of Cabbage Willows bay. It is surrounded by, and contains, multiple beach ridges and has a south-facing escarpment about 100 feet high. Rivers have cut gorges in the clay in this western lowland, some being as much as 100 feet deep along the northern part of Harrricana river. Steep cliffs of clay and silt are also present along the lower parts of Rupert river and along the shore of Rupert bay between the south tip of Lemoine island and the mouth of Nottaway river.

Precambrian granite and volcanic rocks, outcropping mainly in the eastern half of the area, form hills rising up to 150 feet above the level surface. Hills of volcanic rocks are generally higher and broader than those of granite, and those north of Obamska river give the most pronounced relief in the area. A prominent straight-line scarp 10 to 50 feet high in the granite marks the eastern side of the area believed to be underlain by Paleozoic rocks.

The drainage in the area is northward into Rupert and Hannah bays. Stream levels rise rapidly during or after rains and may be very high in the spring.

Mapping Methods

Ground traverses were made at half-mile intervals in the areas in which outcrop was indicated. Areas where no exposure was indicated either from aerial photographs or actual helicopter flights were not traversed.

Traverses by canoe or on foot were made along all the larger rivers

and streams. All streams and creeks in the area underlain by Paleozoic rocks were traversed by helicopter, and ground traverses were made where outcrop was noted. A long summer drought enabled the mapping of many river exposures of Paleozoic rocks that probably would be inacessible in a year of normal rainfall.

GENERAL GEOLOGY

The consolidated rocks in the eastern third of the area and along its southern edge are Precambrian and those in the remainder of the area are Paleozoic. Unconsolidated sediments of Cenozoic age are widespread.

Metamorphosed volcanics with concordant layers up to 50 feet thick of sedimentary rocks and small bodies of meta-gabbro are the oldest Precambrian rocks. They outcrop in the southeastern part of the area and are similar to rock assemblages of other volcanic belts in western Quebec.

Pink and grey gneisses and granites with small areas of amphibolite lie adjacent to the volcanic and to the Paleozoic areas. The granitic rocks are cut by narrow dykes and small masses of pegmatite and by quartz veins.

The youngest Precambrian rocks are narrow diabase dykes that trend northerly to easterly.

Flat-lying limestone, dolomite, siltstone and sandstone of post-Precambrian age outcrop in the western part of the area. Well preserved invertebrate fossils indicate a Silurian age for the rocks of formations I to IV. Formation V lacks the invertebrates, but contains lignitic material and pollen and so may be Mesozoic in age.

The easternmost and northernmost extents of the post-Precambrian rocks are believed, as shown on the accompanying maps, to be very close to outcrops of Precambrian rocks. Exposures of rocks of both ages actually are close together west of Again river, on Laforge brook, and near the north end of Sept-Milles island.

In the Precambrian of the eastern part of the area the predominant structural trend is easterly and the dips are steep to vertical. In the exposed Precambrian to the west the structural trend is east-southeast in the eastern two-thirds and north-northwest near the interprovincial boundary. A synclinal structure is indicated in that part of the area underlain by metamorphosed volcanic and sedimentary Precambrian rocks.

Table of Rock Units

CENOZOIC	Recent	Peat Fluvial silt, sand, gravel, boulders Marine clay, silt, sand	
	Pleistocene	Till, silt, clay, sand, gravel	
	UNCONFORMITY		
MESOZOIC ?		Formation V	Silt, siltstone, sandstone
		Formation V?	Coarse, arkosic sandstone
	UNCONFORMITY		
PALEOZOIC	SILURIAN (See under "Paleozoic-Mesozoic" for a more detailed table)	Formations I to IV	Siltstone, limestone, dolomite sandstone, clay
	UNCONFORMITY		
PRECAMBRIAN		Basic dykes	Diabase, gabbro
		Granitic rocks	Quartz veins; pegmatite and granite dykes
			Missisicabi granite
			Pink hornblende granite Pink biotite granite (porphyritic in certain areas)
			Foliated, grey, biotite granite Biotite and/or hornblende gneiss with amphibole schist and amphibole inclusions
			Garnetiferous biotite gneiss and granite
		Basic intrusive rocks	Meta-gabbro
		Metamorphosed volcanic and sedimentary rocks	Pillowed and non-pillowed lavas with thin layers of tuff, sandstone, siltstone, and iron-bearing rocks

PRECAMBRIAN

Metamorphosed Volcanic and Sedimentary Rocks

Lava flows of intermediate to basic composition with associated meta-gabbro and with conformable, thin beds of tuff, iron-bearing rocks, sandstone, and siltstone occur in an east-northeast-trending zone 2-10 miles wide and 19 miles long in the area. It extends east of the area for 2 miles to Kitchigama river, where it is little more than a mile wide. East of the Kitchigama it swings sharply northward toward Nottaway river for at least another 8 miles. This is the first official notice of this volcanic-sedimentary zone.

Lavas

The lavas, probably basaltic to andesitic in composition originally, are metamorphosed and may be pillowed or massive. On fresh surfaces they generally are greenish grey to black, the more recrystallized rocks being the darker. The weathered surfaces are generally bluish black, although some are dull green and others are rusty brown.

The pillow lavas are fine grained and generally are more greenish than the massive varieties. They are interlayered with fine- to medium-grained, non-pillowed lavas and, in places, with medium- to coarse-grained massive lavas or meta-gabbro and with thin bands of metasedimentary rocks. It is difficult to distinguish between the coarser portions of a lava flow and the meta-gabbros. The thicknesses of the various rock types vary from 5 to 100 feet or more. Volcanic breccia was noted in a few outcrops.

Pillow structures, outlined in places by a thin dark rim, were noted throughout the belt. Most have been elongated and many are too indistinctly outlined to provide top and bottom characteristics. They range from 8 inches to several feet long and are up to a foot wide.

These lavas, throughout, are darker and more metamorphosed (chiefly recrystallized) than those in the Chibougamau-Mattagami band to the south. Recrystallization of the lavas is most pronounced near contacts with granite in many shear zones. Reddish brown garnet occurs in some of the more recrystallized zones. The volcanic rock at and near the southern granite contact is slabby amphibole schist with small needles of amphibole and grains of feldspar.

Granite and recrystallized lavas are interlayered in bands 10 to 200 feet thick for a distance of more than one mile near the western edge of the zone along Obamska river. The contacts between the two rock types are sharp.

Sandstone, Tuff

Conformable layers of impure sandstone and siltstone occur in places within the volcanic belt, particularly along Obamska river east of the big north-south bend. The exposed thicknesses vary from a few feet to about 30 feet. The rock is fine to very fine in grain and consists of quartz, feldspar, minor biotite, and accessory pyrite. It has a siliceous appearance, and its light grey weathered surface and medium to dark grey fresh surface distinguish it from the lavas.

Most outcrops are massive, but some have laminae 2 to 5 mm. thick.

The lamination is faint on the fresh surface but shows as various shades of grey on the weathered surface. The laminated rocks break into slabs.

Tuff(?) or siltstone outcrops in the north bank of Obamska river where the river swings to the north in the middle of the volcanic area. The layer is about 5 feet wide and lies against pillowed lava to the north. The rock is fine grained, laminated, light grey where weathered and dark grey where fresh.

Iron-bearing Rocks

Conformable layers 10 to 25 feet wide of well-bedded, magnetite quartzite were noted in five places, approximately on strike, in the north part of the volcanic belt. The quartzite is continuous for many feet and consists of alternating quartz layers $\frac{1}{2}$ inch to 2 inches wide and magnetite layers 1/16 to $\frac{1}{2}$ inch wide. The quartz layers are usually white but are locally light grey on fresh surfaces. A light pyrite mineralization has imparted a rusty stain to the weathered surface of some outcrops.

Meta-gabbro

Medium- to coarse-grained gabbros consisting mainly of plagioclase and hornblende occur within the volcanics, particularly to the southeast, and form tabular bodies roughly conformable to the strike. The rock is dark blue and black, has a rough weathered surface owing to resistant hornblende, and is roughly jointed. The amount of hornblende and plagioclase is variable. Accessory pyrite and pyrrhotite were noted in many outcrops and chalcopyrite was seen in a few.

Large lenticular inclusions of lava occur in a gabbro along Obamska river in the eastern part of the zone.

Granitic Rocks and Metamorphic Inclusions

General Relations

Pink and grey gneisses and granites with inclusions of amphibole schist and amphibolite underlie the area adjacent to the volcanic group and the Paleozoic rocks. The granites vary in age, mineralogy, colour, texture, and structure. Quartz veins and narrow dykes and small masses of pegmatite cut the granite and gneiss.

The Missisicabi granite is the only rock type that forms a discrete pluton. The other types occur intermixed either throughout the granitic area or locally.

Gneiss, amphibole schist and one or more types of granite may occur in a single outcrop. Gneiss may be present in one outcrop and absent in a nearby outcrop. Thus, it is difficult to draw meaningful geological contacts within the granitic areas. However, in broad areas certain generalizations can be made on the prevalence of one rock unit over another.

Outcrops north of latitude 51°00' consist of gneiss and, in a few places, granite. Much of the gneiss is well layered.

Outcrops south of latitude 51°00' and west of longitude 79°00'

contain substantial amounts of gneiss and the whole may be classed as a granite-gneiss complex. The area east of longitude 79°00' and south of latitude 51°00' is predominantly granitic and contains only minor amounts of gneiss. North of the volcanic zone pink biotite granite predominates, whereas to the south foliated grey and pink biotite granites predominate. Foliation is more pronounced and the amount of gneissic rock is greater in the area south of the volcanics than in that to the north.

Garnetiferous Biotite Gneiss and Granite

Garnetiferous gneiss, with or without conspicuous biotite, outcrops in a few places along Missisicabi river near its junction with Patrick river, on an island near the mouth of Nottaway river, and on the east coast of Rupert bay north of Pontax river. The rock is fine to medium grained and poorly layered except for a few outcrops on small islands in the northern part of Rupert bay where garnet occurs in distinct lines.

Mineralogically, the rock consists of quartz, feldspar, light pink garnet, and biotite. The garnet is in small clusters of anhedral grains. The gneisses appear to be of sedimentary origin.

These rocks are cut by garnetiferous biotite granite on Missisicabi river near its junction with Patrick river, on Kitchigama river north of latitude 51°00', and north of Pontax river on the east shore of Rupert bay and inland. White leucocratic granite and pegmatite also cut the granite at the first-mentioned locality. Rusty weathering, garnetiferous-biotite granite, with scattered small inclusions of biotite gneiss, outcrops in a few hills just north of latitude 51°00' and west of Kitchigama river.

The garnetiferous, biotite granite is massive, generally medium grained, and grey to white. It has a rough weathered surface and is usually broadly jointed. It consists of quartz, plagioclase and potash feldspar (perthite and anthi-perthite occur), biotite and accessory amounts of pink garnet and pyrite. In many places the garnet is in small groups of anhedral grains intermixed with quartz. Some of the feldspar shows a light olive green alteration. In the more leucocratic specimens, microcline occurs in rectangular grains from 5 to 12 mm. across.

The distinguishing features of these granites are the presence of garnet, the grey to white colour, the general absence of pink granite, and the absence of hornblende.

Biotite and/or Hornblende Gneiss with Amphibole Schists and Amphibolite Inclusions

Biotite Gneiss - Outcrops of biotite gneiss occur with granite or separately throughout the area. The greatest concentration in the southern part of the area is west of longitude 79°00', where biotite gneiss forms small to large parts of most outcrops. It is in smaller zones in some of the outcrops east of longitude 79°00', and is less common in the granite north of the volcanic zone than in that to the south. Well-layered, biotite gneiss with associated layers of hornblende-biotite gneiss and hornblende gneiss occurs along Broadback river. Poorly layered biotite gneiss occurs near the mouth of Nottaway river.

The form of the gneissic structure varies from thin to thick layers

to swirly laminae. Most of the biotite gneiss consists of thin to thick layers of quartz and feldspar alternating with quartz, feldspar and biotite. In places, there are granitic and pegmatitic layers. However, the layering is variable in width and is not everywhere evident.

The layered biotite gneiss is usually grey and in straight, well-defined layers. Well-layered gneiss occurs along the shoreline of the central part of Sept-Milles island. It also occurs along Broadback river, where it is associated with hornblende-biotite gneiss and hornblende gneiss. Some layers here may be followed for a hundred feet or more and are uniform in width. The gneiss in the northern part of the area is, in general, more distinctly layered than to the south.

Much of the swirly biotite gneiss is pink and associated with pink granite. The mafic layers are very thin and curved and in a few places show ptygmatic folding. Less biotite and more granitic material is present in the swirly biotite gneiss than in the well-layered variety, and the rock type is nearly a granitic gneiss. Swirly biotite gneiss is well exposed at the north end of Sept-Milles island and forms the northernmost outcrops of Precambrian rock on Missisicabi river.

It is commonly difficult to distinguish between foliated biotite granite and biotite gneiss. In places the two rock types are gradational. Some outcrops consist of a homogeneous foliated rock containing evenly distributed quartz, feldspar and biotite with lit-par-lit layers of quartz and feldspar or pegmatite. Layers or laminae rich in biotite weather out more easily leaving the quartz-feldspar-rich layers in relief. The weathering out of biotite gives some outcrops a rough weathered surface. Veins of pegmatite, granite or quartz stand above the weathered surface.

Mineralogically the gneiss consists of biotite, quartz, feldspar, accessory magnetite and pyrite, and, locally, hornblende. Small concentrations of pyrite occur in a few places and are marked by rusty weathered surfaces.

Hornblende-biotite gneiss and Hornblende Gneiss - Hornblende-biotite gneiss and hornblende gneiss occur as interlayers usually 1/2 inch to 6 inches wide in biotite gneiss. This is the predominant rock in a northeast-trending belt about 1,000 feet wide at the Quebec-Ontario boundary at latitude 50°33'. Large outcrops of hornblende gneiss occur with biotite gneiss near the mouth of Broadback river.

The rock consists of hornblende, biotite, feldspar, and quartz. Sphene, epidote and pyrite may be accessories. Hornblende gneiss and hornblende-biotite gneiss contain less quartz than the biotite gneiss and, in many cases, a higher percentage of mafic minerals. The rock is darker than biotite gneiss and the weathered surface is usually smoother, Amphibole schist grades into hornblende gneiss in a few places in the western part of the area and in an outcrop along the lower part of Missisicabi-Ouest river. In a few places hornblende gneiss grades into hornblende granite.

Amphibolite - Massive, medium- to coarse-grained, green amphibolite occurs in large outcrops and small hills in several places in the granitic terrain south of the area of volcanic rocks. It consists of fresh, green, actinolitic hornblende, up to 10% feldspar, and accessory pyrite. The feldspar is in small interstitial grains. Granitic dykes cut the rock.

The rock is undoubtedly of metasomatic origin, and perhaps was originally volcanic or sedimentary. It is similar to small masses of amphibolite noted (Remick, 1961) in granite to the south.

Amphibole Schist ("amphibolite" of some authors) - Layers, lenses and blocks of amphibole schist occur in the granite and gneiss throughout the area. They are most common near the southern granite-lava contact and in the southwestern part of the area. The lenses and blocks are a few inches to 4 feet long, and some layers are more than 100 feet long. The foliation and the long direction of the amphibole schist inclusions parallel the foliation of the wall rock.

The rock is medium to fine grained and black on both fresh and weathered surfaces. Amphibole makes up 30% to 70% and plagioclase feldspar, the remainder. Biotite is present in accessory amounts in some of the medium-grained inclusions and is a major constituent in some of the finer-grained inclusions.

Blocks of amphibole schist are in sharp contact with the granite and may be subdivided into smaller fragments by granite-filled fractures; lenses of the schist may be in sharp or gradational contacts with the granite. In a few of the western outcrops, the outer part of the amphibole schist inclusion grades into a coarse-grained rock consisting of about 15% amphibole in well formed crystals up to 2 cm. long. Layers of amphibole schist are "granitized" to various extents and their contacts with the granite are not pronounced.

Foliated, Grey, Biotite Granite

Foliated, grey (locally with a pink tinge), fine- to medium-grained, biotite granite is the most widespread rock type in the area, althought it does not generally occur in large masses north of the volcanic zone. It is essentially identical with the gneissic or foliated biotite granite elsewhere in the Keewatin - Temiskaming subprovince and is probably the oldest granite in the area. It contains blocks and layers of gneiss and amphibole schist. Lit-par-lit layers of a coarser-grained, white, leucocratic granite and biotite-rich laminae occur in some outcrops and give the rock a gneissic appearance. In places, the foliated, biotite granite grades into biotite gneiss and it may be difficult to draw a line between the two rock types. Many outcrops are cut by variable amounts of pink biotite granite, pegmatite and quartz veins.

Mineralogically this granite consists of biotite, quartz, feldspar and, locally, accessory amounts of pyrite and magnetite. Biotite occurs as well aligned flakes about 1 mm. in diameter. Quartz and feldspar are generally slightly larger.

Pink Biotite Granite

Several types of granite, probably closely related in age, but varying slightly in texture and mineralogy, are grouped as pink, biotite granite. The general type outcrops throughout the area. Inclusions of gneiss and amphibole schist occur in many outcrops.

This granite, in contrast to the grey, foliated, biotite granite, is usually massive, pink and coarser grained and contains less biotite and plagioclase feldspar and more magnetite and potash feldspar. Also, associated pegmatite is more common in outcrops of pink, biotite granite and the weathered surface is

rougher owing to the coarser grains of resistant quartz and feldspar.

Mineralogically the rock consists of quartz, microcline, plagioclase biotite and accessory amounts of magnetite, pyrite and, rarely, epidote. Biotite makes up 1% to 4% or the rock and much of it is partly chloritized. North of the volcanic area, some coarse (5 to 10 mm.) feldspar grains impart a semi-porphyritic texture to the rock. A small area of porphyritic pink granite, in which the feldspar phenocrysts are from 1 to 4 cm., occurs north of the volcanic zone and west of Kitchigama river.

Pink Hornblende Granite

A few isolated outcrops of pink hornblende granite were noted on the east shore of Sept-Milles island at latitude 50°31' and on Truites river at latitude 50°31'.

The granite is medium to coarse grained and contains 3% to 5% green hornblende, about 10% quartz, and the remainder feldspar except for accessory sphene and magnetite. Hornblende crystals up to 3/4 of an inch were noted at the Sept-Milles Island outcrop.

A finer-grained, pink, hornblende granite outcrops just south of the area on Riordon river and west of the west shore of Harricana river.

Missisicabi Granite

The Missisicabi granite constitutes a small, rounded pluton of biotite granite lying across Missisicabi river. Characteristic features of this granite are the resistant quartz grains on weathered surfaces, large flakes of biotite, granulated feldspars, and an almost complete lack of inclusions, schlieren or local textural variations. Rock outcrops are monotonously alike except that the grain size tends to decrease from north to south. The uniformity of the Missisicabi granite throughout its extent, the lack of inclusions, and the rounded outline of the mass point to an intrusive magmatic origin. It is probably younger than the other granites in the area.

The rock is medium to coarse grained, homogeneous and broadly jointed. It contains 30% to 35% quartz, 2% to 3% biotite, and accessory magnetite, sphene, epidote and pyrite. Octahedral magnetite is the most abundant accessory mineral. The weathered and fresh surfaces are grey although small parts of some feldspar grains in some outcrops are stained orange. Quartz grains stand out on the weathered surface and are aligned in places. Feldspar is usually granulated although there are a few whole plagioclase grains. Biotite occurs in flakes from 2 to 4 mm. in diameter and thus is coarser than that in the foliated, grey, biotite granite or pink granite.

Granite and Pegmatite Dykes; Quartz Veins

Small masses and irregular dykes of pink leucocratic granite cut pink and grey granite. The contact between dyke and wall rock is sharp, but the width is variable in any outcrop. The rock is medium to coarse grained and may show pegmatitic centres. Other dykes show an increase in grain size from edge to centre. Accessory magnetite and biotite, often chloritized, occur in some outcrops. Grey granite is coloured pink near intrusions of pink, leucocratic granite.

Parallel dykes of fine-grained, light pink, leucocratic granite cut the Missisicabi granite and several may occur in one outcrop. The dykes are straight-walled and are a few inches to a few feet wide. The rock consists of quartz, feldspar and accessory magnetite.

Grey pegmatite cuts volcanic rocks and the garnetiferous-biotite gneiss on Missisicabi river, and in the western half of the area. This pegmatite is associated with the foliated, grey, biotite granite and may be comagmatic with it. The rock consists of white feldspar and quartz with local accessory biotite. Booklets of muscovite and small pink garnets occur in a pegmatite that cuts volcanic rocks. A similar muscovite pegmatite with beryl was noted in hornblende schist about 12 miles south of the area on the east side of Harricana river (Remick, 1961).

Dykes and masses of pink pegmatite cut outcrops of granite throughout the area. Although most are a few inches to a few feet wide, several large dykes were noted south of the volcanic zone on Missisicabi-Ouest river. This pegmatite consists of microcline and quartz, with magnetite and booklets of biotite in a few bodies. Some of the microcline shows carlsbad twinning.

A few corundum crystals were noted in a pink pegmatite on the west shore of the north part of Sept-Milles island. Separate occurrences of molybdenite and beryl were noted in pegmatites on the east shore of Harricana river, 7 and 12 miles, respectively, south of the area (Remick, 1961).

Quartz veins cut all rock types except diabase. They are generally barren, but some in the volcanic zone and a few in granite contain a little pyrite. The veins are most common in the lava where many follow joints or shear planes, the most common directions being N.20°E and S.40°E. They are from a few inches to 3 feet thick and stand out slightly above the weathered surface of the lava. A few pyrite cubes occur in some quartz veins and also in the lava an inch or so from the quartz vein.

Basic Dykes

Diabase

Dykes of diabase from a few inches to 5 feet wide cut the granite in various places throughout the area. The dykes trend north, east-northeast and east-southeast. In places, several parallel diabase dykes occur together.

The rock is dark olive green, fine grained, fresh and massive. The weathered surface is rusty brown and, in many places, has the feel of sandpaper. Small plagioclase laths and pyrite grains can be seen on the fresh surface. The rock is well jointed, the best joints being normal to the strike of the dyke.

A well-weathered diabase dyke containing joints filled, and overlain in places, by aphanitic yellowish-white calcite outcrops on the west shore of Harricana river about 2 miles north of Sept-Milles island. The weathering, calcite filling, and close proximity of the dyke to Paleozoic rocks indicate that the dyke formed part of the erosion surface before the deposition of the Paleozoic sediments. As no dykes were noted cutting Paleozoic rocks in the area, these dykes may be considered to be pre-Silurian in age and probably Precambrian.

Gabbro

A small island composed of gabbro outcrops about a mile southeast of the mouth of Rupert river. The rock is medium grained, diabasic in texture, and contains accessory magnetite and biotite. Small lenticular segregations of pegmatitic diabase occur in a few places. The joints strike N.55°E. and S.45°E., and the island itself trends S.45°E.

PALEOZOIC AND MESOZOIC (?)

The post-Precambrian rocks of the area are sedimentary and lie at the eastern edge of the Hudson Bay Lowland. This Lowland is a broad depression within the Precambrian Shield extending inland from the southwest shore of Hudson bay and the west and south shores of James bay for distances up to 225 miles. It is, in effect, a shallow embayment open to the north and northwest within the Precambrian Shield. The total area of the Lowland is roughly 125,000 square miles, of which only about 1% is within the Province of Quebec.

In Ontario, the post-Precambrian rocks of the Lowland comprise Ordovician, Silurian, Devonian, and Cretaceous ages. In Quebec, the rocks involved comprise four Silurian formations, and an uppermost formation that is non-fossiliferous, except for lignite and pollen, which may be Mesozoic.

All four Paleozoic formations are near-shore, shallow, marine deposits. With a total outcrop thickness of about 320 feet, they include sandstone, siltstone, limestone, and minor shales and evaporite. The Mesozoic (?) rocks, consisting of sandstones, siltstones, and thin layers of silt, are 22 feet thick.

The most northerly outcrop of post-Precambrian sedimentary rock noted in the Rupert Bay area is at latitude 51°02' on Missisicabi river. Large slabs of limestone occur in the middle of Missisicabi river at latitude 51°06'. No other rock outcrop was noted on the peninsula bounded by latitude 51°00' on the south and by James bay and the west coast of Rupert bay.

Except for one small area of outcrop inland about 3 miles west of the central part of Sept-Milles island, all outcrops of post-Precambrian sedimentary rock occur along the shores of rivers, streams, creeks, and a few lakes. The heavily forested areas, which are slightly higher than the muskeg, are covered by sand. Paleozoic outcrop is usually only a few feet or less above the normal water-level and is covered by Pleistocene sediments varying from a few feet tc 100 feet thick or more.

Table of Post-Precambrian Formations

AGE	FORMATION	MEMBER	LITHOLOGY	THICKNESS IN FEET
Mesozoic?	V		Greenish grey and brick-red silts and siltstones	5
Cretaceous?	?		Brown and red sandstones	7
			Coarse-grained sandstone with feldspar	10

Table of Post-Precambrian Formations (Cont.)

AGE	FORMATION	MEMBER	LITHOLOGY	THICKNESS IN FEET
Paleozoic Silurian Niagaran	IV		Red and green siltstone with gypsum	10
	III	Upper	Algal limestone	2
			Soft calcilutite and calcareous sandstone	13
			Calcarenitic dolomite	3
		Lower	Dolomitized and undolomitized fossiliferous reefal limestone	15
			Soft, fossiliferous calcilutite	16
			Silty calcilutite	15
			Medium- and fine-grained sandy calcarenite	10
			Coarse- and medium-grained calcarenitic sandstone	.2
			Limestone conglomerate with bryozoa and corals	.3
	II	Upper	Fossiliferous and unfossiliferous fine-medium- and coarse-grained calcareous-matrix sandstone	8
		Middle	Dolomite and dolomitic limestone	18
			Calcareous-matrix, fossiliferous sandstone with interbedded limestone	10
		Lower	Clean to sandy, lithographic limestone	5
			Ostracode-rich, silty limestone and coquina	13
			Calcareous-matrix sandstone	3
	I	Upper	Calcilutite, fossiliferous, part dolomitized and lithographic limestone	13
		Lower	Fossiliferous calcilutite, sandstone, calcareous siltstone, coquinal and fine-grained calcarenite, in part dolomitized	82
			Calcareous-matrix sandstone; yellow and grey chloritic calcareous siltstone; algal calcite nodules; (weakly petroliferous in places)	50
			Grey, sandy, micaceous, calcareous siltstone and sandstone	20.8
			Red and greenish grey siltstone; yellow, clay-matrix sandstone; grey sticky clay	14.7
Precambrian basement			Kaolinized gneiss	1
			Granitic gneiss	

An outline of the various units is given in the accompanying table and some particular points only are discussed in the text below.

Paleozoic

The Paleozoic-Precambrian contact is of some interest. The basal beds of the Paleozoic crop out on Again river and in cliffs north of Sept-Milles island. The contact with the Precambrian is concealed at the former locality, but, at the latter, arkosic sandy siltstone lies on granitic gneiss. The gneiss is kaolinized to a depth of at least 1 foot. Angular, fresh, pink feldspars up to 1 cm. across are concentrated in the lowest inch, and occur in the lowest 3 feet, of the siltstone.

In Unit 3 of Formation I, weak oil films on water were yielded by grey, calcareous sandstones on upper Laforge brook and on upper Malouin river.

Units 4 of Formation I is notable for its calcareous content inclusive of beds up to 4 feet thick of coarse, bryozoan and crinoidal, coquinal calcarenite. This is one of the more fossiliferous units. Unit 5 contains two beds of lithographic limestone 3/4 to 1 foot thick, and a 3-inch layer of conglomerate made up of limestone chips. Five feet of clean and sandy lithographic limestone characterize Unit 3 of Formation II, and both this formation as well as Formation III are essentially limestones of one type or another. However, the uppermost Unit 6 of Formation II is mostly fine-grained sandstone capped with a foot or so of limestone-pebble conglomerate with horn corals and bryozoa.

A calcilutite (Unit 8 of Formation III), with fine fractures filled by hematite, is overlain by large botryoidal masses of algal limestone (Unit 9) on the south end of Low Shoal island and on the south shore of Harricana river at, and just west of, the Quebec-Ontario boundary.

The algal limestones just referred to are overlain by evaporite beds constituting Formation IV. The latter comprise 11 feet of siltstone containing chips of indurated silt cemented in a matrix of an evaporite mineral, possibly gypsum. Clusters of red and amber crystals of selenite up to 3 inches across and seams of satin spar gypsum up to 2 inches thick occur in the siltstone. Selenite crystallization appears to have been contemporaneous with deposition, for the crystals have clean upper faces and silty inclusions on the lower faces.

The upper 4 feet of the siltstones may be lateritic and are hematite red; the lower 7 feet are grey. The dividing line between the two colours is irregular. This formation probably occupies the northwest corner of the area under the heavy overburden.

Physical Features. - Crossbedding was noted in sandstone in Unit 2 of Formation I. Crossbedding and ripple mark in Unit 3 of Formation I indicate southerly and easterly paleocurrent directions. Rare ripple marks and mud cracks are present in the lithographic limestone of Unit 5, Formation I. Unit 1 of Formation II is strongly ripple-marked in the only place exposed, on Again river.

The lower 10½ feet (Units 1,2, and 3) of Formation III remain on Malouin river as an erosional remnant lying on a deeply pitted surface of the dolomite of the Lower member of Formation I. Unit 4 of Formation III is ripple-marked in places, with windrows of brachiopod shells.

Mud cracks occur in northern outcrops of Unit 8, Formation III.

Fossils. - The fossils named below are provisionally identified, although some key forms were verified by Drs. Brian Norford and G.W. Sinclair of the Geological Survey of Canada, who agree that a Silurian age is indicated. It is a pleasure to acknowledge the kind cooperation of these authorities.

No fossils were noted in the lowest unit. Lingula, Leperditia?, and some poorly preserved bryozoa were noted in Unit 2 of Formation I. Apparent algal concretions in low mounds up to 13 feet long, Leperditia? forming 60% of the rock in places, brachiopods and gastropods occur in Unit 3 of Formation I. In Unit 4, bryozoa, crinoids, corals (Cystihalysites, Favosites, Syringopora, Multisolenia), and brachiopods are common, and there are some cephalopods and trilobites. There are a few silicified fossils in Unit 1 of Formation II, and Favosites and ostracods, including a 4-foot bed of ostracod coquina, in Unit 2. The sandstones of Unit 4 are rich in horn corals and stromatoporoids and there are a few Syringopora; the limestones carry trilobites and brachiopods. Unit 6 of Formation II contains bryozoa, horn corals as well as the colonial forms Syringopora and Quepora, and cephalopods.

The lower member of Formation III has yielded eurypterid fragments, Lingula and other brachiopods; the corals Favosites, Halysites, Multisolenia, Paleocyclus and Syringopora; Encrinurus with other trilobites; and fish remains. The Upper member of this formation is fossiliferous only on Fossiles brook; where Encrinurus, brachiopods and pelecypods were collected.

Preliminary study of the fossils collected from Formations I to IV indicates a correlation with the Interlake series of Manitoba and the Lake Temiskaming series. Both these series are of Silurian (Clinton) age.

Mesozoic

Formation V is exposed on lower Missisicabi river. Grey-brown and red, fine- to medium-grained sandstone extends from $\frac{1}{4}$ mile east to $1\frac{1}{2}$ miles northwest of the mouth of Salomon brook. The sandstone is quartzose but contains some feldspars, hematite, clay and, in one bed, lignite. The lignite was seen $\frac{1}{2}$ mile west of the Salomon brook in a pinkish-brown, medium-grained sandstone layer 1/10 inch thick. It occurs as soft, black, tabular fragments up to 6 cm. long.

Sandy and clayey silts and siltstones of Unit 2 crop out northwest of the sandstone as far as $5\frac{1}{2}$ miles below the Salomon. They vary in colour from greenish grey to brown and red.

The presence of lignite in these beds suggests a Mesozoic or younger age and they may be equivalent to the Mesozoic Mattagami formation of Ontario. A definite age assignment probably will follow analysis of the pollen content.

Sandstones of Uncertain Age.

On the river directly east of Nogeau lake, brick-red to yellow-brown, coarse, arkosic sandstones at least 10 feet thick are exposed. The section includes thin beds of conglomerate with quartz pebbles composed of interlocking medium grains. Crossbeds and ripple-marks in the lower beds suggest paleocurrents running north and northeast. Lithologically these sandstones are more closely related to Formation V than to any of the others.

Large Erratics; Doubtful Outcrops

Slabs of fine-grained, calcarenitic limestone and silty calcilutite lie on an island and along the shore of Missisicabi river at latitude 51°06'. The slabs are separated by gaping joint fissures that are strongly curved and that make it appear that the slabs are settling into unconsolidated sediments. The strike of the joints is somewhat off the major regional strike. Thus, although the slabs occur for 3/4 of a mile along the river, and hence might reasonably be considered local in origin, they may represent very large blocks that were transported southward by ice.

Blocks of fossiliferous (reefy), silty calcilutites (Formation III?) lie on granite gneiss 2 miles west of the mouth of Patrick river. Glacial striae on the gneiss trend S.87°E.

Paleozoic boulders are rare north of latitude 51°15'.

Pleistocene and Recent

The Nottaway river within the area appears to mark the approximate boundary between two major directions of ice movement. South of the mouth of the Nottaway the striae trend south-southeasterly, whereas along the Nottaway and to the east and to the north (Low, 1902; Remick, 1962) the striae trend west-southwesterly. A third set of striae trending nearly east was noted on the shores of Rupert bay and as far south as latitude 50°40' on Harricana river and latitude 50°58' on Missisicabi river. The time order represented by these three sets of striae is not known. Longley (1940) found that a south-southwest set of striae was cut by a southeasterly set on the shores of Grasset and Matagami lakes. Lee (1959) recorded an eastward movement of ice probably from a dome over Hudson bay that he believed was earlier than the last glacial flow in the region.

During the recession of the ice the area was covered by the fresh waters of Lake Barlow-Ojibway and later by the salt waters of an expanded James bay. The southern boundary of the salt waters probably was south of the area.

Banded (varved?) clay was seen on Harricana river 1½ miles north of the northern end of Sept-Milles island, 1 mile south of Malouin river, and 1¾ miles north of Joncas river. A generalized section at the last locality is as follows:

		Feet
Post-marine	: Surface, mixed peat and sand	3.2
Marine	: Sands, silts, some clay with marine shells	51.0
Glacial till	: Clay and some silty clay till	4.7
Glacial lake	: Silts and sands, banded in part	40.1
Glacial till	: Silty till with clay till in the upper foot	26.2

Raised sea-beaches were seen in many parts of the area. On sand plains they are commonly littered with fragments of marine shells. In muskeg areas they are marked by lines of trees that are well shown on aerial photographs.

Most lakes of the area lie in acid muskegs and are receiving deposits of detrital peat. Up to 7 feet of peat was seen in some muskegs sectioned by streams. In a few lakes (appearing white on aerial photographs) marl is accumulating.

STRUCTURAL GEOLOGY

Precambrian Rocks

Schistosity, Foliation, Gneissic Structure

South of Latitude 51°00'. - An almost east-west structural trend is predominant in the eastern half of the area and the dips here are steep to vertical. Schistosity in the volcanic zone strikes about N.80°E. and faces north in the southern part of the volcanic belt and south in the northern part, suggesting a synclinal structure.

Foliation in the gneissic rocks and granite strikes from east to east-southeast. Lineation of feldspar phenocrysts in the pink porphyritic granite north of the volcanic zone and west of Kitchigama river, as well as much of the foliation, strikes roughly north-northeast.

Along the southern boundary of the area, western half, the foliation strikes east-southeast in the eastern two-thirds and north-northeast to north-northwest (following the general trend) near the interprovincial boundary.

North of Latitude 51°00'. -- The foliation strikes north-northwesterly to northerly and dips to the east at the mouth of Nottaway river. Foliation along Broadback river strikes about west and dips moderately to the north. North of Pontax river the strike is also west and the few dips recorded are moderate to steeply to the south.

Joints

The massive granite commonly has the best developed joints. Two vertical sets are usually present and a horizontal set may also occur. One set parallels the direction of foliation in many cases. Quartz veins, diabase dykes, leucocratic granite dykes, and epidote and pink feldspar fillings follow some joints. Two sets of joints occur in the late Precambrian gabbro and diabase dykes, the stronger set being normal to the strike of the dyke.

Pillow Structure

Pillows in the lava flows are elongated parallel to the schistosity. A few top determinations made in the southern part of the volcanic zone indicate that the pillows face north. However, most of the pillows are too distorted to afford reliable determinations.

Open Linears in the Volcanic Belt

Aerial photos show several directions of open linears in rock outcrops in the volcanic zone, some of which extend for several miles. Two major directions at N.65°E. and N.20°E., respectively, one minor direction at S.25°E. and one direction parallel to the strike are apparent.

Paleozoic Rocks

Folds

The Paleozoic rocks of the James Bay Lowland in Quebec lie in a

shallow embayment of the Precambrien Shield, open to the north and northwest. There is no evidence of major folds. Apart from widespread shallow undulations, with maximum dips up to 7°, minor folds are restricted to the vicinity of Papillons rapids on Harricana river. Here, a series of shallow folds, with a difference in elevation of only 15 feet between crest and trough, trends east across the river. Similar shallow folds on Joncas river appear to be part of the same set, and trend parallel to the Precambrian-Paleozoic boundary.

Faults

Dips up to 25° in the sandstones along the western margin may be due to initial deposition on hilly Silurian topography but they appear to be related to a tilt in the Precambrian rocks. At the Precambrian-Paleozoic boundary on Again river, a joint plane in the gneiss parallels the bedding plane in the adjacent sandstone and dips 25° to the east. The joint plane may represent sheeting structure resulting from unloading of the gneiss just prior to the deposition of the sandstone. This may have developed on the side of a hill, but it seems more likely that the sheeting was horizontal. Thus the whole block, including the overlying sandstone, may have been downfaulted to the east.

Near Laforge brook outcrops of clean sandstone on a small stream lie 500 feet north of the first sandstone outcrop. Here the edge of the Precambrian outcrop is steep and is marked by large blocks. The top of the gneiss outcrop is 50 feet above the sandstone. A fault is suspected at this point.

Joints

Vertical joints predominate in the Paleozoic rocks. Directions of strong joints are N., N.10°E., N.50°-60°E., E. to S.80°E., and S.40°-20°E. These joint directions occur throughout the map-area. The strongest joints are between Papillons rapids and Sapins island on Harricana river. Here the direction N.55°E. is not so strong as the other directions.

Thickness of Section

The basin covered by Paleozoic rocks is not more than 1,300 feet deep, a figure obtained by assuming a dip of $\frac{1}{2}$° to the northwest. As most of the rock appears to be flat, and some slight southerly dips are present in undulant sections, the total thickness of the beds is probably considerably less than 1,000 feet. The sum of outcrop thicknesses, taking into consideration facies changes, amounts to about 300 feet. Thus, 600 feet would seem to be a reasonable figure for the depth of the basin.

The presence of some loosely cemented sandstones and shales (almost unlithified sands and clays) in the lowest beds indicates that they could not have been subjected to pressure such as would result from the weight of a thick series of overlying sediments and that any burial of the sediments since Silurian time must have been relatively shallow.

ECONOMIC GEOLOGY

Very little, if any, prospecting was done in this area prior to the summer of 1962 and, as of May, 1962, no claims had been recorded. However, the discovery by Noranda Mines prospectors of gold in a quartz vein in the Obamska volcanics sparked a rush of prospecting, and by mid-summer of 1962 most of the

volcanic-sedimentary band in this area had been staked. Although most attention has been attracted to the volcanic-sedimentary zone the possibility of finding rarer minerals in pegmatite dykes, and even of oil in the Paleozoic rocks, should not be overlooked.

Volcanic Rocks

The volcanic zone appears to be the most favourable for sulphide and gold mineralization and the abundant exposures of rock makes it ideal for ground prospection. Native gold in quartz was found by Noranda Mines prospectors in a quartz vein near the middle of the volcanic zone. Chalcopyrite occurs in veins and shears in several places, and pyrite, arsenopyrite, pyrrhotite, sphalerite and magnetite have been noted. The minerals have been found in lava, meta-gabbro and iron-bearing rocks,as well as in shear zones and near quartz veins.

Granite and Gneiss

Mineralization in the granitic and gneissic terrain is of two main types, namely, zones and patches of pyrite, and minerals in pegmatites. Of the two, the latter seems to be the most favourable for deposits of economic value. However, the former should not be overlooked in the area north of latitude 51°00' where pyrite has been noted in many localities.

A rusty band containing pyrite occurs in the gneissic rocks at the upper end of the first falls east of the mouth of Broadback river. The band is about one foot wide and more than 50 feet long and contains lenses of pyrite from 1/2 to 1 inch wide and 1 inch to 1 foot long.

Small lenses of pyrite occur in a small, rocky island of hornblende gneiss near the mouth of Nottaway river. The lenses are along joints and fractures over a zone 18 feet wide and 140 feet long. Four assays from pyrite zones along Broadback and Nottaway rivers showed no values in gold, a trace to 0.03 ounce of silver per ton, and 0.01%-0.10% copper.

Beryl and corundum were found in a few pegmatites on the west shore of the central part of Sept-Milles island. Beryl and molybdenite in pegmatites occur south of the area on Harricana river (Remick, 1961).

The corundum-beryl-bearing pegmatites occur as veins and dykes 1 inch to 14 inches wide and up to 18 feet long in foliated, biotite granite. Five such veins and one lens, 4 by $1\frac{1}{2}$ inches, were found in an area 60 feet by 40 feet.

The pegmatites are buff to orange and are associated with purple-red (caused by pink feldspar) zones in the granite. They contain 85 to 90% feldspar, 2-4% brown mica, up to 4% beryl, about 2% corundum and accessory quartz. The corundum crystals occur as disseminated phenocrysts in the pegmatite and are deep blue to purple, rounded, and usually 1/4 to 1/2 inch in diameter with a maximum of $1\frac{1}{2}$ inches. Mica flakes surround the corundum. The beryl occurs as yellow, $\frac{3}{4}$-inch crystals associated with the feldspar.

A calcite dyke 12 by 15 feet as exposed outcrops in an altered brick-red granite on the west shore of Harricana river opposite the beryl and corundum pegmatites just described. Coarsely crystalline orange and white calcite makes up more than 90% of the dyke and contains disseminated green amphibole, magnetite,

pyrite, yellowish white apatite, quartz, chlorite, titanite and limonite, and specks of tourmaline and epidote.

Paleozoic Rocks

No seepages of oil were noted, but a few rock types, such as the calcareous sandstone member of Formation I, exposed on upper Laforge brook and on Malouin river, and a sandstone of the lower limestone member of Formation I gave oil films when immersed in water. The estimated depth of the sedimentary rocks (less than 600 feet) is shallower than most oil-producing basins, but it is possible that oil has migrated up dip from the deeper strata of the Moose River basin in Ontario.

Satin spar and selenite varieties of gypsum were noted in five seams in siltstone, each being 1 inch to 2 inches thick and 100 feet or more long. They outcrop at the south end of Low Shoal island on Harricana river, about 3/8 mile west of the Interprovincial boundary. Red, perhaps lateritic, hematite has coloured the upper part of the outcrop. Selenite crystals were noted in glacial debris on the south shore of Harricana river just opposite Low Shoal island.

Satin spar occurs in flat seams generally parallel to the bedding but in places cutting the beds. The long axis of the mineral is normal to the bedding. A few remnants of the host rock are contained in the satin spar seams. Clusters of red and amber selenite crystals occur in a few places near the interface of the satin spar and siltstone layers.

BIBLIOGRAPHY

Bell, R. (1902) - Report on the Geology of the Basin of Nottaway River with a Map of the Region; Geol. Surv. Canada Ann. Rept., Vol. XIII, 1900, Pt. K, Map 702.

Bergeron, R. (1956)- Geology North of the 50th Parallel in the Province of Quebec; Que. Dept. Mines, Map 1060.

Cooke, H.C. (1927) - The Nottaway Sheet; Geol. Surv. Canada, Map 190A.

Dresser, J.A. and Denis, T.C. (1944) - Geology of Quebec, Volume II, Descriptive Geology; Que. Dept. of Mines, Geol. Rept. 20.

Fritz, M. and Cranswick, J.S. (1953) - Lower and Middle Devonian of the James Bay Lowland; Geol. Assoc. Canada, Vol. 6, part 1, p. 69-74.

Lee, H.A. (1959) - Eastward Transport of Glacial Erratics from Hudson Bay; Bull. Geol. Soc. Amer., Vol. 70, p. 219-221.

Ontario Dept. of Mines (1952) - Sixty-first Annual Report, Vol. LXI, part 6.

Remick, J.H. (1961) - Manthet-Jérémie-La Forest Area, Abitibi-West and Abitibi-East Counties and Abitibi Territory; Que. Dept of Natural Resources, P.R. No. 458.

Shaw, G. (1942) - Preliminary Map, Eastmain, Quebec; Geol. Surv. Canada, Paper 42-10.