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GRENVILLE PROJECT; MAGPIE, ST-JEAN AND ROMAINE RIVERS

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GRENVILLE PROJECT 1970

Geology of the

RIVIERE MAGPIE, RIVIERE ST. JEAN AND RIVIERE ROMAINE AREA

Duplessis County, Quebec

by

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Geology of the Rivière Magpie, Rivière St-Jean and Rivière Romaine area of Duplessis county, Québec

INTRODUCTION

During the summer field season of 1970 the Grenville Project was extended to the east of the region mapped in 1969 up to longitude 63°00'. The area mapped covers about 15,000 square miles between latitude 52°00' to the north shore of St. Lawrence River and longitude 63°00' to 66°00'. The small part of the area belonging to Labrador and Newfoundland was not mapped. The area mapped corresponds to 1: 250,000 maps of Manitou Lake (22I), Lac Fournier (22P), and parts of Havre St-Pierre (12L), and Lac de Morhiban (12M) of the National Topographic Series.

The area, in general, has a very rugged topography and is accessible only by float-plane based in Havre St-Pierre. The only existing road in the area is the one between Sheldrake and Havre St-Pierre along the north shore of St. Lawrence River. A small railroad, 25 miles long and between Havre St-Pierre and Lac Allard, is used by the Québec Iron and Titanium Company for transportation of the titanium ore. The main rivers - Mingan River, Romaine River, Rivière St-Jean, Magpie River, Rivière au Foin, Rivière au Tonnerre, Sheldrake River, Manitou River, Rivière au Bouleau - draining in general from north to south, are quite rough and contain lot of rapids thus rendering navigation rather difficult. Most of these rivers are used as a means of access towards north for hunting and fishing by American Indians and local inhabitants.

Elevations lie between the sea-level of St. Lawrence River and the 3,425 ft. near the northern part of Lac Tortue. The southern part of the region has a rather gentle topography, but the northern parts have a rugged and highly dissected topography. In general, the anorthosites, being the most resistant rock of the region, form huge mountains. Most of the mapped area is wooded with conifers and alders, except for some small areas near the central and southeastern part where the forest has been destroyed by forest fire.

The area had been subjected to glaciation that resulted in the development of various glacial features such as striations, grooves, polished rock surfaces, eskers, erratics, and glacial moraine deposits. Recent fluviatile deposits of gravel, sand and clay are also present. These deposits form terraces especially along Romaine River.

Wild life in the region includes caribou, moose, black bear, rabbit, beaver, muskrat, wolves, mink, etc. The different kinds of fishes present in the lakes, rivers and streams are trout, pike, wananish, touladis and salmon.

The climate in the region is rather cold. Most of the lakes in the region are frozen till the last week of May, and the ice starts to melt only in the first week of June. During the summer it rains about 30% of the time, thus rendering difficult the field work and the work of the float-plane. The maximum temperature encountered during the course of field work was about 85°F and the minimum about 25°F.

The field mapping was carried out by eleven geologists based in Havre St-Pierre for about 3½ months, from

the first week in June to the middle of September. The geologists were Luben Avramtchev, Michel Aguillaume, Dezsö Benkö, Antoine Franconi, Bernard Géry, Jean-Luc Pittion, Kamal Sharma, Jean-Pierre Soulas, Herbert Strohbach, Manohar Walia and Joseph Wallach. Gilles Caron who acted as a cook on the party did an excellent work. The student assistants were Jean-Marc Charbonneau and Jacques Bonneau.

The work of geological exploration was limited mostly to big lakes and navigable rivers. Plane hopping of small lakes and foot-traversing were carried out only in areas where there were no big lakes or rivers and thus lacked in enough geologic information. Additional foot-traverses were made in areas to examine the magnetic anomalies that seemed interesting on the aeromagnetic map. Like the two previous years the geological data were recorded in the field on "Outcrop Input Documents". The input documents were checked in the base camp and at the same time the hand specimens were also examined. In some cases the estimate of the mineralogy was upgraded by staining sawed rock samples or by inspection of hand specimens.

GEOLOGY

Almost all the consolidated rocks of the area are Precambrian except for the presence of some Paleozoic limestone outcropping along the northern shore of St. Lawrence River in the southeastern part of the area and on Mingan Islands, whereas all the crystalline rocks of the area are Precambrian in age and form part of the metamorphics of the Precambrian Grenville orogenic province of the Canadian Shield.

In contrast to the previous year's mapping the majority of the rocks in this year's map-area are plutonic and comprise, in decreasing abundance, of anorthosite, granite, mangerite-jotunite, gabbro, monzonite and syenite. The different gneisses represented in the area are "grey-gneiss", granitic gneiss, charnockitic gneiss, mixed paragneisses, Wakeham Group paragneisses, and migmatites. These gneisses are exposed in between the different massifs of intrusive rocks.

The last major deformation, metamorphism and recrystallisation took place during the Grenville Orogeny around 950 ± 150 million years ago. The effects of the major intrusive activity of Elsonian (1,400 million years ago) are the most conspicuous features of this map-area and are represented by huge anorthosite massifs and associated gabbros, mangerite-jotunite, monzonite, syenite and granite. The rocks belonging to post-Grenville Orogeny are mainly represented by unmetamorphosed granite-pegmatite and diabase dykes. In general, the grade of metamorphism ranges from upper Amphibolite to Granulite facies, but it goes down to lower Amphibolite and Greenschist facies in areas underlain by the paragneisses belonging to Wakeham Group.

Previous work

Most of the area was unmapped before, except for some detailed work done along the western margin and in the southern part of the area near the St. Lawrence River. The earliest work in the region was carried out by Greig and Retty in 1940 and 1941 during which they mapped Matamec Lake area and

the lower part of Romaine River respectively. The final results of these mapping projects were published later on in 1944 and 1945 by the Quebec Department of Mines. Among other geologists who worked in the region are Longley (1943, 1948), Claveau (1949), Grenier (1952), Hogan (1953), Klugman (1954, 1955), Emo (1956), Jenkins (1956, 1957), McPhee (1958), and Blais (1960).

DESCRIPTION OF FORMATIONS

BASEMENT GNEISS COMPLEX

This represents the smallest unit mapped in the present map-area. It includes four distinct lithological formations - "grey gneiss", banded gneiss, granitic gneiss and charnockitic gneiss. Out of these, the grey gneiss, banded gneiss and charnockitic gneiss often contain varying amounts of mobilizate. When these rocks contain more than 30% of mobilizate, they have arbitrarily been defined as migmatites in the field and an attempt is made to identify the original rock that can be observed in the non-migmatised portions of the outcrop. Thus, where possible, the migmatites are mapped as separate map-units.

Grey gneiss is a light to dark grey, homogeneous to heterogeneous, medium grained, well foliated rock containing quartz-feldspar as the main leucocratic minerals and biotite-hornblende as the main mafic minerals. In addition they may contain potash feldspar and pyroxene. At places these gneisses have compositional layering caused by segregation of leucocratic and mafic minerals into rather distinct bands. These represent the banded gneisses. It is not possible to separate these two

TABLE OF FORMATIONS

Quaternary	Fluvial Deposits	Sand, gravel and clay
	Glacial Deposits	Moraine, boulders, sand
Paleozoic	Sedimentary Rocks	Limestone
Proterozoic	Dykes	Diabase, granite-pegmatite, carbonatite dykes
	Migmatites	Migmatites after grey gneiss and Paragneisses
	Plutonic Rocks	Granite, with some pegmatites Syenite Monzonite Mangerite-Jotunite, with some Charnockite and hypersthene syenite Laurinite Diorite Amphibolite, metagabbro Gabbro, with minor diorite Gabbroic anorthosite, anorthositic-gabbro with some gabbro Anorthosite
	Paragneisses	Mixed paragneisses, Quartzite, Wakeham Group paragneisses
Archaean	Basement Gneiss Complex	Charnockitic gneiss Granitic gneiss Grey gneiss, Banded gneiss

rock-units at the present scale of mapping and as such they are mapped as a single map-unit of grey gneiss-banded gneiss. The banded gneisses tend to be finer grained than the grey gneisses. Many of the mafic bands in the banded gneisses are quite rich in mafic minerals and have the composition of amphibolites. In these gneisses the foliation is shown either by parallelism of biotite and amphibole grains or by the arrangement of mafics into thin streaks. These rocks are mainly found in the central part near Magpie Lake, in the northwestern part south of Eric Lake, in the southwestern part near Matamec Lake, in the northeastern part near Lac Garneau and as smaller outcrops elsewhere in the map-area.

The gneisses found near Magpie Lake have a rather heterogeneous character in that they vary from well foliated, homogeneous grey gneisses to banded gneisses that exhibit good compositional layering by concentration of mafics and quartzo-feldspathic material in different bands of varying thickness. They invariably contain some amount of mobilisate and locally become migmatitic with an abundance of mobilisate and various features of the migmatites. These gneisses contain lot of amphibolitic bands which in many cases can undoubtedly be shown as being derived from the metamorphism of the gabbros. The amphibolites have behaved rather incompetently during deformation and metamorphism as they have very irregular shape and size in different outcrops. On the southern side the gneisses are in rather sharp contact with very well crushed and foliated white anorthosite that is texturally a garnet bearing anorthositic gneiss. Most of the amphibolites and metagabbro sills found in

the gneisses contain garnet. The gneisses themselves locally contain fine, red garnets. In the eastern part the gneisses are in contact with the Romaine River anorthosite massif.

The grey gneisses and migmatites after grey gneisses that are found in the northeastern part of the map-area occupy only small regions in between the intrusive bodies of granite, syenite, mangerite and anorthosite. They outcrop between the granite body and mangerite near Lac Dueult and Lac Garneau, and also in a northeast trending band that cuts Romaine River. The rock in general is light to dark grey, fine to medium grained, well foliated and containing biotite and hornblende as the main mafics. At places it shows the development of some compositional layering. It contains 15 to 20% mafics, up to 10% quartz, and the rest plagioclase together with varying amounts of potash feldspar. The potash feldspar forms porphyroblasts locally. An increase in the mobilisate content changes the rock into a migmatite.

The grey gneisses that are mapped near Matamec lake and south of Erie lake are the homogeneous, well foliated type, containing variable amounts of mobilisate. It is only locally that these gneisses exhibit any compositional layering.

As has been pointed out earlier, the grey gneisses contain variable amounts of mobilisate which can be distributed in the rock in a variety of ways such as veins, patches, stringers, bands, etc. that are either parallel to foliation and compositional layering or having random orientations. In addition it may also contain the potash feldspar of the mobilisate homogeneously

distributed throughout the rock and when the potash feldspar content increases to an amount so that it becomes more than two-thirds of the total feldspar content, the rock acquires a granitic composition and thus giving rise to a granitic gneiss. These granitic gneisses often preserve the textures of the original grey gneiss or banded gneiss. They are encountered in the field either as distinct mappable units or as small bands or zones within an outcrop of grey gneiss or banded gneiss. In the present map-area the granitic gneisses were not found to be mappable at the scale of mapping, but were seen associated with the grey gneiss and banded gneiss. The map-units that appear as granitic gneisses on the accompanying map are actually deformed and foliated granite and are described later on in this report.

The only good outcrops of charnockitic gneisses were encountered near Lac des Eudistes. This is at the contact with the western limit of Havre St-Pierre anorthosite massif. The rocks very close to the contact are green in colour and rather porphyritic, but very well foliated by streaks of mafics, and could represent the cataclastically deformed mangerite. But in other parts away from the contact the rock is medium grained, well foliated, streaky charnockitic gneiss having a good green colour and showing the typical brownish weathering. In some places the charnockitic gneisses show good compositional layering by concentration of mafics into bands. The mafics are mostly pyroxenes and hornblende with only some biotite.

PARAGNEISSES

The mixed-paragneisses, sometimes containing sillimanite, are found in the northwestern and southwestern parts of the map-area. These rocks are much less abundant here as compared to that in the previous year's region. The mixed-paragneisses found in the northwestern corner of the map-area, that is around Erie Lake, Bright Sand lake are typically Grenville Group type mixed-paragneisses. They are light to dark grey in colour, fine to medium grained and possess a very good compositional layering. It consists of quarts and plagioclase as the main leucocratic minerals, whereas biotite and hornblende are the main mafics. Red garnet is nearly always present, though in variable quantities. Sillimanite is also observed in different outcrops. The rock shows good mineral lineation and microcorrugation lineation on the foliation plane. At places the rock contains big, augen shaped, pink potash feldspar porphyroblasts that have their long axes parallel to foliation direction. This is observed especially west of Ethel Lake. Some quartzite bands are associated with the paragneisses. It also has some amphibolitic bands that show good foliation and mineral lineation. The paragneisses along the railroad and close to Bright Sand Lake and south of Erie station are strongly migmatized with the mobilizate being distributed lit-par-lit. In between the bands of this granitic material the rock is garnet-sillimanite bearing paragneiss. There are some diabase dykes also present in the paragneisses.

The mixed-paragneisses mapped in the southwestern part, that is around Nipisso lake, Manitou lake and Lac des Eudistes, are also fine to medium grained, light to dark grey, well layered, and containing red garnet porphyroblasts. They contain mobilisate in varying amounts in different outcrops. Near Lac des Eudistes the paragneisses are in the granulite facies as they contain pyroxene and green feldspar, but they still preserve the original texture and well layered structure of paragneisses.

The paragneisses mapped south of Lac à l'Aigle and just north of Manitou lake are rather unique in that they do not resemble the typical Grenville Group type mixed-paragneisses. These rocks are extremely fine grained with very thin compositional layering shown by small variations in the mafic minerals content of different layers. The thickness of these layers varies from fraction of an inch to few feet. The main mafic minerals present are biotite and epidote. The epidote also occurs in grains that are coarser than the average grain size of the rock. They also contain some magnetite. The rock shows very good mineral lineation of biotite on the foliation plane that is parallel to the layering. Dykes, veins and patches of granitic and pegmatitic material are also present.

A small band of heterogeneous, layered, fine to medium grained paragneisses consisting of quartz, plagioclase, biotite and amphibole is found just west of Lac Coupeaux.

A different kind of metasedimentary rocks were encountered close to Lac La France near the eastern limit of the map-area. These consist of very fine grained, heterogeneous,

very well layered schists interlayered with quartzitic bands. The rock is generally light grey to dark grey in colour and has a shiny appearance. Some of the bands contain porphyroblasts of garnet. At places it also shows very well developed minor folds. In one outcrop sedimentary cross-bedding was also observed. Some amphibolitic bands are also interlayered with these paragneisses. The main minerals present in these schists are quartz, plagioclase, muscovite accompanied by epidote, chlorite, biotite and garnet. These paragneisses seem to belong to the Wakeham Group of metasedimentary rocks that outcrop east and south of this locality. This is because of the fact that the quartzite associated with these schists is rather impure and resembles the quartzite of the Wakeham Group. Moreover some gabbro is also interlayered with these rocks and the amphibolitic bands may represent the metamorphic equivalents of the gabbros. The gabbro here is greenish in colour and contains tremolite that is replacing the original pyroxene.

Similarly the paragneisses mapped along Romaine River, just west of Lac Duit, appear to belong to the Wakeham Group. These are well layered, very fine grained, light to dark grey paragneiss interbedded with pure to impure quartzite and bands of amphibolite. They contain quartz, plagioclase, biotite, and amphibole as the main minerals with some garnets at places and some schistose bands rich in biotite and muscovite. It shows very well developed mineral lineation of biotite.

More of the Wakeham Group paragneisses are mapped in the southeastern part, close to the eastern limit of the present map-area. These paragneisses are known to extend further

east from the previous work done by Claveau (1943), Grenier (1949-50), Cooper (1951-52), Blais (1955), McPhee (1958), Bassaget (1970). These paragneisses are heterogeneous, well layered, fine to medium grained, light grey to dark grey, with a well developed foliation parallel to the compositional layering. The main minerals present include quartz, plagioclase, biotite and amphibole. Other minerals that are observed associated with these rocks are muscovite, epidote and garnet. Sillimanite and pyroxene were observed in only a few outcrops. Impure quartzite, generally light grey to dark grey in colour, is seen interlayered especially with the paragneisses of Lac du XXII-Mille, Lac Perland, Lac Cimon, lake northeast of Lac Bernard, and lake northeast of Lac du XXII-Mille. The quartzite may vary in thickness from a fraction of a foot to several feet. The quartzite bands in this region are not mappable as separate map-units at the present scale of mapping and as such are mapped with the Wakeham Group paragneisses. The impurities in the quartzite consist mainly of feldspar, biotite, muscovite and magnetite. In some localities good sedimentary cross-bedding was observed in the quartzite. At places the paragneisses become schistose in character by abundance of muscovite, sericite and biotite, for example at Lac Cimon. The minor structures present in these paragneisses include mineral lineation, minor folds, microcorrugation lineation and gentle warps. Some outcrops of "Nodular gneiss" were encountered at Lac Buit and Lac Forget. These consist of nodules composed of quartz, sillimanite (fibrolite), with or without muscovite, developed in the paragneisses. The nodules are subcircular to elliptical in shape. The long axes of the nodules is parallel to the foliation

direction and defines a lineation, in the plane of foliation, that has the same attitude as the minor folds and mineral lineations observed in these paragneisses. The presence of similar nodular gneisses is reported by Rasmaget (personal communication) east of the map-area. The paragneisses of Wakeham Group also contain varying amounts of mobilisate. The thin granitic bands, as shown on the map, follow the complex structural pattern of the paragneisses and are believed to be the products of anatexis.

The Wakeham Group paragneisses differ from the mixed-paragneisses by its more heterogeneous nature and by its frequent association with interbedded quartzite and sills of gabbro. These paragneisses are generally lower in the grade of metamorphism than the mixed-paragneisses as they often contain epidote, muscovite, and chlorite. The quartzites found with these paragneisses are generally rather impure and darker grey in colour than these found associated with the mixed-paragneisses.

PLUTONIC ROCKS

ANORTHOSITES

The rocks mapped under this category consist essentially of anorthosite (0 to 10% mafics), gabbroic anorthosite (11 to 20% mafics) and anorthositic gabbro (21 to 35% mafics) with only local occurrences of gabbro (>35% mafics). Wherever possible the anorthosites consisting more than 10% of mafics and thus representing gabbroic anorthosite and anorthositic gabbro are indicated on the map. Gabbros have been mapped as a separate

map-unit. As shown on the map, the anorthosites form several huge massifs in the area, notably:

(a) the Lac Fournier massif, north of Magpie lake, trending northeast and continuing into Labrador above the latitude 52°00',
(b) the Havre St-Pierre massif trending east-west from Havre St-Pierre to Sheldrake,
(c) the Romaine River massif, also trending northeast. It is connected in the south to the Havre St-Pierre massif.

Apart from these huge massifs there are some smaller bodies of anorthosite - south of Lac Fournier and near Lac Camitit, south of Lac à l'Aigle, near Lac Tortue, and near Matamec lake. The anorthosites in general are white to light grey in colour, but they are also dark grey, purple, blue grey and black in colour. All the massifs have suffered intense deformation during Grenville Orogeny and exhibit various features of cataclasis and recrystallisation.

The Lac Fournier massif mapped in the northern part of the map-area represents the massif that has been least deformed and preserves most of its igneous features. This anorthosite body becomes quite mafic in the eastern part, consisting mostly of gabbroic anorthosite and anorthositic gabbro, with some gabbros. This mafic portion is indicated on the map. The anorthositic part (containing less than 10% mafics) of this massif occurs in a region occupied by Lac Thévet, Lac Bellanca, Lac Fréchette, parts of East Magpie River, parts of Magpie River,

Lac Belmont, Lac Saubosq, Lac Dolbel, Lac Rezée, Lac Chéron, Lac Pierre, Lac Catignan, Lac Vital and parts of Lac Fournier. In general, the anorthosite here is dark grey and blue grey in colour, but some purple anorthosite was observed in the region of Lac Fréchette. Apart from this some light grey, white, grey green and black anorthosite was also observed locally. The anorthosite is mostly massive, medium to coarse grained, porphyritic with megacrysts of dark grey, blue grey, purple and black colour. At places it shows the development of good trachytoidal texture by sub-parallel arrangement of laths of plagioclase. It is only at few places that the anorthosite shows cataclastic, augen and streaky texture. The cataclastic feature is observed only near its contact with the granite that outcrops in the eastern part of the massif. It is more or less undeformed, but shows some effects of protoclasis. At places it contains huge plagioclase crystals. The mafic present is mostly orthopyroxene and clinopyroxene, accompanied by hornblende and biotite. The mafics show good corona texture of clinopyroxene surrounding orthopyroxene or of biotite and/or hornblende surrounding the pyroxenes. Some alteration to chlorite is also observed. Some pegmatite dykes and veins are found in the anorthosite that sometimes contain small pieces of the surrounding anorthosite as inclusions. Diabase dykes are also present. Magnetite and ilmenite are the main ore minerals that occur either uniformly distributed in the anorthosite or segregated in small patches and bands. The small body of anorthosite found near Lac Camitit and Lac Raobus has essentially the same character as that of big anorthosite mass east of it.

The mafic part (containing more than 10% mafics) of Lac Fournier massif occurs in a region occupied by Lac Verrier, parts of Rivière Labône, Lac Poisset, parts of Magpie and West Magpie River. There is no sharp limit between this mafic part and the anorthosite of the western part. The mafic part is in contact with the porphyritic pink granite in the east. The rocks belonging to the anorthosite suite that occur in this region are quite heterogeneous in composition as well as in texture. The composition varies from gabbroic anorthosite to anorthositic gabbro to gabbro. These rocks are medium to coarse grained, equigranular to porphyritic and in general, dark grey to blue grey in colour, with only some purple, light grey and black varieties. Some of these contain dark grey, purple, blue grey or black plagioclase phenocrysts. They have the tendency to become medium grained and equigranular near its contact with the granite of the western part. The coarse grained as well as medium grained varieties often show a good ophitic texture. Coronitic texture is also quite common in the mafics. Trachytoidal texture is observed only in few outcrops. Magnetite and ilmenite occur either uniformly distributed in the rock or forming small bands and patches. These rocks show only slight effects of deformation and it is only medium grained varieties that show some foliation. In one locality, at the extreme north of the chain of lakes north of Lac Marsal, troctolite (olivine gabbro) was observed. East of Lac Verrier these rocks pass into Laurinite. Thus, the main characters of this mafic mass are its high content of mafics, coarse grained texture becoming medium grained near its borders and heterogeneity in composition.

The Havre St-Pierre massif underlies a region occupied by Lac Puyjalon, Lac Allard, Lac Gros Diable, Manitou lake, Lac Esnault, Lac Pelletier, Mine lake, Magpie lake, Lac Neudl, parts of Mingan, St-Jean, Magpie, Sheldrake and Manitou Rivers. This anorthosite body has supposed intense deformation during Grenville Orogeny as compared to the Lac Fournier massif described above. Another characteristic feature of this massif is that it is quite poor in mafics and thus its composition is anorthositic. However, in small areas especially area around Lac au Renard and Mine lake the mafic content increases and the rock consists of gabbroic anorthosite and anorthositic gabbro. In general, the anorthosite of Havre St-Pierre massif is white to light grey in colour, medium to coarse grained, equigranular to porphyritic with megacrysts of plagioclase that maybe white, light grey, dark grey or blue grey in colour. Apart from this the anorthosite may also be dark grey, blue-grey, grey-green, pink-green, green or even black in colour. The anorthosite is usually well foliated, but it also massive at places. The rock has been deformed cataclastically and the crushed, white to light grey, plagioclase has a typical sugary texture most frequently observed in the crushed anorthosites of the Grenville Province. At places in the crushed, white anorthosite the plagioclase has been recrystallized into transparent to translucent plagioclase porphyro-blasts (neoblasts) that resemble quartz. Locally the anorthosite is very coarse grained, uncrushed and preserves its igneous character. It possesses trachytoidal texture in some outcrops. Plagioclase crystals up to 9 inches long and huge clinopyroxene crystals up to few feet long have been observed in the rock.

Foliation in the anorthosite is shown by streaks of mafics or by augen shape of plagioclase. In some cases these streaks are up to 6" long. The streaks are less resistant to erosion and as such form grooves in the outcrop, thus defining a foliation direction on the weathered surface. The mafic minerals present are mostly clinopyroxene, orthopyroxene, hornblende and biotite. There is good development of corona of hornblende and biotite around the pyroxenes.

At places the anorthosite consists of elongated zones parallel to foliation where the rock becomes more mafic thus becoming gabbroic anorthosite to anorthositic gabbro in composition. This appears to represent original igneous lamination because many of these mafic-rich zones still preserve a good ophitic texture. This phenomenon is especially well observed around Magpie lake.

The anorthosites found in the region of Magpie lake, Mine lake, Lac Roudl, and the whole area west of Magpie and Mine lakes are unusually rich in garnet. The anorthosite here is white light grey in colour, well crushed and foliated. The rocks show very well developed corona of fine grained garnet around hornblende and pyroxenes or in some cases a core of garnet is surrounded by hornblende. It also consists of big crystals of garnet up to 1 inch in diameter.

A special variety of anorthosite of green colour was observed around a small lake just west of Magpie lake. The rock here is medium to coarse grained, equigranular to porphyritic and with a good green colour. It consists of very well developed corona of fine grained pink to red garnet around the pyroxenes and amphibole.

At Lac Puyjalon, near the contact between the anorthosite and mangerite, the anorthosite has been broken into blocks and in the gap between these blocks rusty brown weathering, porphyritic mangerite is emplaced. It is quite evident from these exposures that the mangerite was much more mobile than the anorthosite as it wraps around the blocks of anorthosite. The photo shows these features very clearly. In one of these outcrops the bottom part of a cliff consists of light grey, well crushed anorthosite whereas mangerite forms a kind of "roof" on top of the anorthosite. Some of the outcrops of mangerite near the contact contain lots of inclusions of good porphyritic as well as crushed anorthosite of varying sizes. These inclusions vary from being angular to subangular and the mangerite wraps around these inclusions. Sometimes the inclusions are only of huge, single plagioclase crystals. Inclusions of anorthosite were also observed in well foliated mangerite outcrops near the road just west of Havre St-Pierre.

The Havre St-Pierre anorthosite massif consists of lot of mineralisations of ilmenite and magnetite of varying dimensions. The magnetite and ilmenite occurs either as dissominations or as segregations into bands, patches or big masses. In the mineralised areas the rock is usually more mafic, i.e. gabbroic anorthosite to anorthositic gabbro in composition. Important mineralisations occur at Lac Puyjalon, Lac Allard, Lac Tio, Lac Manitou and Magpie lake. Some pyrite mineralisation was also observed at Lac du Gros Diable. Out of these mineralisations the ilmenite deposit of Lac Tio is currently under production.

Numerous pegmatite dykes usually less than 3 feet thick have been observed traversing the anorthosite. The contact between anorthosite and pegmatite is very sharp. In some outcrops the anorthosite shows kaolinisation along joint planes.

Romaine River anorthosite massif is similar in many respects to the Havre St-Pierre anorthosite massif, for example, the homogeneity of composition, appearance, degree of deformation etc. This massif is almost entirely enveloped by mangerite-jotunite rocks. Several cross-sections across this massif were studied by means of traverses made along Rivière Garneau Ouest, Rivière Garneau, Rivière Aguanus, Lac Lacombe, Lac Ledieu, Lac Desaulniers, Lac Barthe, Lac Pacaud, Lac Charpeney, MacKay lake, Ternet lake, parts of Rivière Mingan Nord-Ouest, Rivière St-Jean Nord-Est, Lac Charles, etc.

The anorthosite of Romaine River massif is very uniform in composition and consists of more than 90% of plagioclase in majority of cases. The outcrops of gabbroic anorthosite and anorthositic gabbro form a very small minority and are found mostly near the contact zone. The colour of the anorthosite is also more or less uniform; it varies from white to light grey to blue grey. The white and light grey anorthosites are the most characteristic feature of this massif. Field observations suggest that, in general, the white and light grey anorthosite is abundant near the border of the massif e.g. along Rivière Garneau Ouest, Rivière Garneau, Rivière Aguanus, Lac Pacaud, Lac Barthe, Rivière Olapion, etc. In addition there is also blue grey and purple anorthosite that is mainly found near the central parts of the massif. The purple anorthosite was mostly observed near Lac

Charpeney. The anorthosite is nearly always coarse grained and porphyritic. The phenocrysts in nearly all cases are dark grey, blue grey to nearly black in colour and are very well twinned.

The anorthosite has suffered varying degrees of cataclasis. The crushed, recrystallized plagioclase is medium to coarse grained and forms the matrix of the porphyroclasts of plagioclase. In some cases these original phenocrysts have been crushed down to augen shapes that define a foliation by alignment of their long axes. In general, because of the paucity of the mafics in this predominantly monomineralic anorthosite, it is difficult to decipher the foliation. But at places where it contains enough mafics or where it becomes gabbroic anorthosite to anorthositic gabbro in composition, a good foliation can be observed. The mafics in such a case are arranged in streaks. The various cataclastic and deformation textures are observed more near its contact with the envelopping mangerite. Some trachytoidal texture has also been observed in different localities and is believed to represent an original primary igneous texture. Ophitic texture is also present. Mafics present in the rock are mostly clinopyroxene, orthopyroxene, hornblende and biotite. The pyroxenes sometimes show good coronitic texture.

Ilmenite and magnetite occur either as disseminations in the anorthosite or as segregations into bands, patches or

masses. Important concentrations of these minerals have been observed at Lac Ledieu and Lac Charles.

GABBRO

Gabbros form two big bodies, one in the southwestern part and the other one around the northern part of Magpie lake. It also appears as small bodies and as segregations within the anorthosites. Numerous small masses of gabbro occur in the northeastern part of the map area associated with the acidic intrusive rocks. In addition, the paragneisses of the Wakeham group are characteristically associated with sills of gabbro. All these gabbros are quite varied in composition and their physical characteristics.

The biggest gabbro body mapped in the present map area outcrops in the southwestern part. It extends from Lac Tortue in the north to Lac Méchant and Matamek lake in the south. The most characteristic feature of this gabbro body is its grain size. It is mostly fine to medium grained, dark grey to black to dark grey-green in colour. The gabbro that is found in the immediate vicinity of the small anorthosite mass at Lac Tortue is very fine grained, crushed and well foliated, the foliation generally following the contact between the anorthosite and gabbro. Away from the contact and in other parts of the gabbro body, the rock is rather massive, only locally foliated, and possesses a very good ophitic texture. At places the percentage of ferromagnesian minerals may change, thus making the rock a gabbroic anorthosite

to anorthositic gabbro compositionally. The main mafic minerals present in the rock are pyroxenes and amphibole. In the foliated varieties of gabbro, the pyroxenes seem to concentrate in very thin bands that are only a fraction of an inch thick. These mafic bands are resistant to erosion. In this gabbro body we have also included the fine to medium grained, dark grey to black, foliated rock that had been called amphibolite by Grenier (1952), and Hogan (1953). It is believed that the amphibolites represent metamorphosed and foliated gabbro. Some troctolite has been observed near the south end of Lac Tortue. Small bodies of mangerite-jotunite rocks that outcrop in this region are associated with high magnetic anomaly. The mangerites have suffered intense cataclastic deformation and possess a good Rapakivi texture. The gabbro also contains veins, patches and small masses of granite and pegmatite. Sometimes the granitic material is emplaced parallel to the foliation of gabbro. Lot of bands of well layered, garnetiferous mixed paragneisses were observed in this area.

Another smaller body of gabbro outcrops around the northern part of Magpie lake. This gabbro body has a very characteristic feature that it shows highly cataclastic deformation texture. The rock is dark grey to black in colour, mostly medium grained but also contains small areas where a coarse grained variety with good ophitic texture is present

viz. small lake west of the northern part of Magpie lake. The plagioclase varies in colour from light grey to greenish and pinkish. The medium grained variety has a very good foliation, shows at places subophitic to ophitic texture and development of corona of amphibole around pyroxene. It becomes amphibolitic in composition in some outcrops. The massive, medium grained variety of gabbro show an ideal ophitic texture — the interstices between rectangular plagioclase laths being occupied by pyroxene or amphibole.

The small band of amphibolite mapped on the eastern shore of the northern part of Magpie lake is dark grey to black, equigranular and very well foliated. It contains zones that resemble the meta-gabbro described above. Thus, it may also be a metamorphic equivalent of a gabbro body.

Various smaller bodies of gabbro occurring in the northeastern part of the map area are described as follows.

The gabbro body east of Lac Duboys is medium grained, equigranular, massive, dark grey to black and with a subophitic texture. It contains nearly equal amounts of plagioclase and mafics. Mafic is generally pyroxene with some amphibole and magnetite. Some coronitic texture is present at places.

The gabbro found near Norman lake has a rather heterogeneous composition from diorite to gabbro. Grain size varies from fine to medium grained.

Gabbro body occurring northwest of Lac Rougemont

and west of Romaine river is medium grained, equigranular, dark gray to black, with a sub-ophitic texture. It shows corona of hornblende and garnet around pyroxene. This gabbro is associated with a high magnetic anomally.

Other smaller bodies of gabbro are situated near Lac Garneau, Lac Dusult and a lake west of Lac Dusult. These are also medium grained, equigranular and subophitic in texture. Some amphibolites are also associated with these rocks. In addition, gabbro also occurs as dykes and lenses within granite and syenite rocks of this region.

Diorites occurring in this region differ from the gabbro in being lighter in colour and containing a smaller percentage of mafics. They also contain a small amount of potash feldspar and are generally foliated. Mafics are mostly hornblende and biotite.

A diorite body is mapped in the northeastern part of the map area, southeast of Lac Thévet. It is subcircular in shape, dark grey to blue grey in colour and sometimes becoming grey-pink. The diorite is medium to coarse grained, equigranular, generally foliated, the foliation being shown by alignment of mafics that are mostly hornblende and biotite with some pyroxene. It consists of 70 to 90% plagioclase, up to 10% potash feldspar, up to 15% quartz and 5 to 25% mafics. It is traversed by many granitic-pegmatitic veins and dykes. There are some fine to medium grained, dark grey to black, ophitic gabbro associated with this diorite mass.

In southeastern part of the map area gabbro is mainly found as sills interlayered with the Wakeham group paragneisses. The gabbro associated with these paragneisses is of variable character. It can vary from fine to medium grained, dark grey to black massive to foliated and occurs in bands of varying thickness from few feet to several hundred feet thick. The foliated varieties may even be altered to amphibolites. It shows good ophitic and coronitic texture at places. Main mafics present in the rock are pyroxene, amphibole and biotite that compose from 35 to 65% of the rock. It also contains some magnetite and ilmenite as the main opaque ores. The gabbros are usually metamorphosed and as such the pyroxenes have been uralitized to varying degrees. In some cases the alteration of mafics gives rise to actinolite. In some of the amphibolites biotite is changing into chlorite. Amphibolites, in general, have a good foliation and occasionally a good lineation. It is possible in the field that the same band of gabbro may show good ophitic texture at one place and become amphibolitic in other parts when traced along the strike. Similarly, in some thick bands of gabbro the central part is still good ophitic gabbro, while it has been changed to amphibolite near its margins. Generally the thinner bands of gabbro are more of amphibolitic composition. The gabbros are younger than the paragneisses and were emplaced in them before the deformation took place.

The bands of gabbro within the Wakeham group paragneisses are very helpful in tracing out the structure as they serve to be a good lithologic unit that can be followed easily on air photos and in the field. These gabbro bands are much more useful in tracing out the structure than any other lithologic unit because of the fact that the Wakeham group paragneisses are quite heterogeneous in composition and does not contain any good lithological markers that can be traced successfully for long distances.

LAURINITE

A new kind of rock was encountered this summer along the margins of several anorthosite bodies and it appears to be a border facies of the anorthosite massifs. We propose the name "Laurinite" for this rock. It forms three mappable bodies east and northeast of the northern part of Magpie lake. Other outcrops were also nearly always observed close to the margins of anorthosite bodies. The rock is light grey to dark grey in colour, coarse grained, equigranular to porphyritic and massive. Compositionally it is an anorthosite except for the presence of small quantities of potash feldspar and quartz. Potash feldspar is also grey in colour and can be identified only by staining. Quartz generally has a bluish tinge and sometimes occurs in ribbons. The texture of this rock is also similar to that of the anorthosites and it always contains light grey to dark grey to blue grey phenocrysts of well twinned plagioclase as observed in the anorthosites.

MANGERITE - JOTUNITE - CHARNOCKITE - HYPERSTHENE SYENITE

Mangerite-jotunite and related rocks are either closely associated with the different anorthosites of the map-area, especially in the marginal zones, or they form separate small bodies. Mangerite, jotunite, charnockite and hypersthene syenite are mapped as a single map-unit. In this map-unit mangerite is the most predominent rock, whereas jotunite, charnockite and hypersthene syenite occur only locally as a result of variations in the relative percentages of plagioclase and potash feldspar, and also due to variations in the mafic content of the rock.

A thin zone of mangerite and related rocks almost completely envelopes the Romaine river anorthosite massif. The mangerite is a coarse grained, in equigranular, porphyritic rock green in colour. Weathered parts show brownish colour and have a typical white weathered surface that varies in thickness from fraction of an inch to few inches. The thickness of the weathered zone varies greatly in different outcrops thus rendering it difficult to obtain a fresh sample in many cases. The rock may be massive or well foliated. The trend of the mangerite can be picked up from the aeromagnetic maps as it gives rise to higher magnetic anomaly than the anorthosites. The phenocrysts in the rock

are mostly of potash feldspar and at some places show good Rapakivi texture (a core of potash feldspar surrounded by plagioclase). The amount of mafics in the rock varies from 5 to 25% and the total feldspar is more than 70%. Quartz may or may not be present. Systematic staining done for feldspars indicates that rocks is of monzonitic composition with plagioclase being slightly more abundant than potash feldspar. The mafics present are mostly pyroxene and amphibole with some biotite. The mangerite and related rocks have suffered cataclastic deformation to varying degrees. The phenocrysts in the deformed rocks acquire augen shapes and define foliation, whereas mafics may form streaks. In some cases the rock has been so much crushed that it resembles a well foliated charnockitic gneiss, while in other cases the rock becomes nearly equigranular with only few original phenocrysts left. Magnetite and ilmenite are also present. Depending on the rock colour and the presence of pyroxene the mangerite grades into grey-pink, grey, or pink-green monzonites.

The mangerite associated with the Romaine river anorthosite massif consist of some jotunite at places. Jotunite is an equigranular, medium to coarse grained rock, having a darker green colour than the mangerites and a dioritic composition. It contains more mafics, magnetite and ilmenite than the mangerite. The jotunites are usually found near the contact between anorthosite and the envelopping mangerite, but it also occurs as small lenses within the main body of anorthosite

and contains a high percentage of magnetite and ilmenite, viz. lenses east of Rivière Aguanus.

Mangerite and related rocks partly surround the Havre St. Pierre anorthosite massif. Other rocks present with the mangerite of this part of the map-area consist of hypersthene syenite and charnockite. Hypersthene syenite is green to brownish in colour, coarse grained and equigranular. Staining done for feldspars reveals that it is very rich in PF and contains only minor amounts of plagioclase. Charnockite or hypersthene granite is also coarse grained, equigranular to porphyritic and shows brownish weathering. It possesses a good foliation shown by ribbons of quartz. The mangerites of this region contain lot of inclusions of anorthosite as described earlier. Eastward the mangerite grades into monzonite.

The rocks belonging to mangerite suite have also been mapped near the contact between the granite and the southwestern part of Lac Fournier anorthosite massif. Here the mangerite outcrops in a region occupied by Lac Mariauchau, Lac Kaobus and Lac Daine. The rock here is very coarse grained, porphyritic, massive, dark grey to green in colour and varies in composition from dark grey monzonite to hypersthene syenite to mangerite with only occasional jotunite. This mangerite body is quite distinct because of its high mafic content. The mafics are mostly pyroxene and amphibole which may be present up to 30%. The hypersthene syenite shows good corona of hornblende around orthopyroxene.

Other smaller bodies of mangerite occur at different places in the map area and are usually associated with high magnetic anomaly.

MONZONITE - SYENITE

Monzonites and syenites occur most abundantly in the northeastern and southeastern parts of the map area where they form big bodies of very irregular shape. Apart from this smaller occurrences of these rocks have been mapped north of Magpie lake and east of Lac à l'Aigle.

In the northeastern part of the map area syenite is mapped in a region occupied by Norman lake, Lac Marquier, Lac Eon etc. It forms a wide, irregular rim close to the granite body found on the west side. The rock is pink to red in colour, medium to coarse grained and equigranular. The coarse grained varieties have a tendency to be porphyritic. It is massive in general, but sometimes has weak to well defined foliation. Mafics present in the rock are biotite and hornblende which are uniformly disseminated when the rock is massive and form streaks when the rock is foliated. Compositionally syenites consist of 50 to 90% potash feldspar, 5 to 20% plagioclase, 0 to 7% quartz and 5 to 25% mafics. Locally it becomes monzonitic in composition with an increase in plagioclase content. The only difference between this syenite and the granite of the western part is in the quartz content, otherwise the rock has the same appearance. Also

the syenites, in general, have more mafic than the granite. Syenite intrudes into gabbro. Some diabase dykes are present in the syenite.

Monzonites occurring in the northeastern part of the map-area are always associated with the mangerite. Apart from the two small bodies of monzonites occurring along Rivière Aguanus and northeast of Lac Dusult, the other occurrences of monzonites are not mappable separately and as such are included with the mangerite. Monzonite is a coarse grained, porphyritic rock, grey pink to pink in colour. It is generally foliated, the foliation being defined by potash feldspar augens and streaks of mafics. It consists of 40 to 55% potash feldspar, 30 to 40% plagioclase, up to 10% quartz and 5 to 15% mafics which is mostly biotite and hornblende. The monzonites gradually pass into mangerite.

Monzonite mapped in the southeastern part of the map-area occupies a big area that is quite irregular in shape. The rock is grey pink to pink, porphyritic with potash feldspar phenocrysts, and massive to foliated. The foliation is markedly augen shaped potash feldspar phenocrysts and the streaks of mafic minerals, mostly hornblende and biotite with minor pyroxene at places. It varies from quartz-monzonite to monzonite in composition. It consists of 25 to 55% potash feldspar, 25 to 50% plagioclase, up to 25% quartz and 5 to 20% mafics. Sometimes quartz is bluish in colour. The rock shows local variations in composition,

thus becoming a granite or syenite depending on the relative abundance of potash feldspar and plagioclase. At places it becomes mangeritic in character because of brownish or greenish colour and the presence of pyroxene. It contains some lenses of gabbro, amphibolite and paragneisses.

The northeast trending body of syenite-monzonite, near the northern tip of Magpie lake, consists of coarse grained, foliated, equigranular to porphyritic rock, grey pink to pink in colour and varying in composition from syenite to monzonite. The rock has been deformed cataclastically and shows well developed augens of potash feldspar and streaks of mafics that are mostly hornblende and biotite. Mafic content is variable and in the case when mafic content increases, the rock consists mainly of big augens of potash feldspar embedded in a matrix of mafics.

GRANITE - PEGMATITE

Granites occupy big areas near the western margin and the northeastern part of the present map area. The also form small bodies in the southeastern part and elsewhere in the map-area. The different granites are quite varied in their physical characteristics and have suffered varying degrees of deformation. The main granite masses are described as follows.

Granites found in the northwestern part of the

map-area, that is in the region of Lac Fournier, Lac à l'Aigle, Wacouno lake etc., differs from the granite that is mapped east of Lac Fournier anorthosite massif by the fact that this granite is in general medium to coarse grained, equigranular, rather well foliated and is only occasionnally porphyritic. The colour of the rock varies from grey pink to pink to red. This granite is quite coarse grained and porphyritic especially around Lac à l'Aigle, Lac Froidevaux, Lac Georgette, Reclusе lake, and in the region east of these lakes. But west of Lac Fournier anorthosite massif the granite exhibits good foliation marked either by augen shaped potash feldspar or by streaks of mafics (mostly hornblende and biotite). For example, the granite found around Wacouno lake, Lac François is medium to coarse grained and equigranular, but only locally porphyritic. Further west this granite body becomes more and more foliated, fine grained and equigranular. Thus, an attempt has been made to distinguish these two types of granite. The fine to medium grained, well foliated variety is therefore mapped as granitic gneiss on the map. The contact between these types of rocks is gradational and based purely on the grain size and degree of foliation. But even in the granitic gneiss there are medium to coarse grained varieties of the granite present. Both the granite and the granitic gneiss contain bands and sills of gabbro, as well as bands of paragneisses. Some of these bands can be traced for long distances, while others are too small to be reported on the map at the present scale

of mapping. Locally the granites contain veins and patches of pegmatitic material.

The granite mapped in the region occupied by Lac Bigot, southern part of Nipisso lake, and Lac Caosoni is massive with no foliation, homogeneous, very coarse grained with well developed potash feldspar crystals and containing quartz in the interstices between feldspar crystals. The colour varies from pink to red. It is rather poor in its mafic content that are mostly biotite, hornblende and minor magnetite. Compositionally it consists of 60-75% potash feldspar, up to 10% plagioclase, 10 to 30% quartz and mafics usually less than 10%. This granite body was previously being mapped in the western part by Grenier (1952).

Granite occurring around Lac Boutereau, Lac Delaunay and Rivière Sault Plat is pink, homogeneous, coarse grained, porphyritic and foliated. Foliation is very well developed by alignment of streaks of mafics (biotite and hornblende) and augens of potash feldspar. It consists of 60 to 80% potash feldspar, up to 15% plagioclase, 10 to 20% quartz and less than 10% mafics.

Granites occupy a big area in the northeastern part of the map, immediately east of the Lac Fournier anorthosite massif. It outcrops in a region occupied by Lac aux Sauterelles, Rivière aux Touladis, part of Romaine river, Lac Marquier, and the northern part of Rivière St. Jean. In general this granite

is very coarse grained, porphyritic, grey pink to pink to red in colour, with potash feldspar occurring as big crystals. It is quite rich in quartz that is sometimes smokey in colour. Mafics present are mostly hornblende and biotite. The rock is rather massive in the vicinity of the Lac Fournier anorthosite massif and acquires a good foliation in the southern and eastern parts. The foliation is shown by mafics occurring in streaks and by the augen shaped potash feldspar. The more foliated varieties are rather medium grained and more or less equigranular, but they still contain remnants of the original crushed phenocrysts of potash feldspar. Plagioclase occurs in the rock forming individual crystals as well as exsolved material in the perthites. Compositionally it consists of 45 to 80% potash feldspar, up to 20% plagioclase, 10 to 30% quartz, and up to 20% mafics. Locally the rock may vary in composition from granite to syenite to monzonite depending upon the amounts of quartz and plagioclase. It contains small lenses and dykes of foliated gobbro. Near the eastern limits of this granite, the rock becomes syenitic in composition. Further east, that is east of Lac Duboys, the rock mapped is granitic gneiss that seems to be a highly sheared and foliated granite. Some of these rocks are quite coarse grained, inequigranular and porphyritic in character, undoubtedly indicating their plutonic origin. But in other cases they have suffered varying degrees of cataclasis giving rise to augen and flaser feldspars, streaky mafics, and ribbon quartz. Thus, the rock has very well

developed foliation and their grain size has considerably been reduced as compared to the coarse grained granite.

A small mass of granite is mapped in the eastern part in the region of Lac Buit, Lac Forget and Lac Sansen. Other smaller bodies of granite occur in the southeastern part of the map-area. These granites, in general, are medium to coarse grained, equigranular to porphyritic, grey pink to pink and well foliated. The foliation is defined by augen shaped potash feldspar or by streaks of mafics and in some cases also by ribbons of quartz. The streaks of mafics often define a good mineral lineation. Mafics are mostly biotite and hornblende. The granites consist of 50 to 80% potash feldspar, up to 25% plagioclase, 10 to 30% quartz and up to 20% mafics. Locally the composition of the rock may vary from granite to monzonite even in the same outcrop. Near Lac Buit and Lac Sansen there are some outcrops of Wakeham group paragneisses and migmatites after these paragneisses. As marked on the map, in the northern part of Lac Buit there is shear zone running northeast-southwest which has resulted in crushing and shearing of granite along its lengths.

DYKES

Numerous granite-pegmatite dykes and unmetamorphosed diabase dykes are found in the region cutting the

different rocks described above. The diabase dykes in many cases show a good ophitic texture and sometimes have porphyritic texture.

STRUCTURAL GEOLOGY

The structural pattern of the area is greatly influenced by the presence of huge massifs of anorthosite and other plutonic rocks. Out of the three major anorthosite massifs present in the map-area, the Lac Fournier massif shows the least effects of cataclasis and deformation. It preserves most of its igneous character and shows the effects of crushing and recrystallisation only near its borders. The other two massifs of anorthosite - Havre St. Pierre massif and Romaine river massif - have suffered highly cataclastic deformation, metamorphism and recrystallisation throughout the massifs. The effects of deformation and recrystallisation are exhibited by the presence of crushed plagioclase of the anorthosite with only few original phenocrysts of plagioclase left in this crushed ground mass. In many cases the phenocrysts are augen and flaser shaped. Other effects of crushing and recrystallisation are the development of streaks of mafic minerals, corona structures in mafics, development of garnets etc.

In contrast to the previous year's mapping, the various gneisses present in this map-area form a very small minority among the rocks present here. The different gneisses represented in the area are "grey gneiss", granitic gneiss, charnockitic gneiss, and mixed paragneiss. These gneisses are mostly exposed in between the different massifs of plutonic rocks and usually follow the outlines of the massifs. As a result their structure is highly influenced by the shapes of the plutonic rocks and thus they are not suitable for a systematic structural analysis as carried out for the gneisses in the previous years.

The paragneisses belonging to Wakeham Group outcrop in the southeastern part of the map-area. They are known to extend eastward from the detailed work done by earlier geologists. These paragneisses show a very complex structural pattern. They are interlayered with sills of gabbro and are together folded and faulted. The structures present mostly consist of north-south and east-west trending anticlines, synclines, domes and basins. The paragneisses have been intruded by irregular bodies of granite-monzonite.

The Paleozoic rocks form small isolated exposures on the shores of St. Lawrence river and also outcrop on the Mingan Islands near Havre St. Pierre. These consist

of flat-lying limestones and shales that have not gone through any deformation.

ECONOMIC GEOLOGY

INTRODUCTION

The presence of large bodies of anorthosite and related rocks in the map-area offer potential deposits of iron and titanium in the form of magnetite and ilmenite. Some of these larger deposits have already been studied in detail and described by earlier geologists. One such deposit is presently under exploitation. Apart from these deposits there are several other showings of magnetite-ilmenite that do not seem to be of much economic importance.

In addition to the magnetite-ilmenite occurrences there are mineralisations of pyrite-chalcopyrite and uranium that are associated with the rocks other than the anorthosites and occur especially in the eastern part of the map-area.

The detailed descriptions of all these mineral deposits are as follows.

MAGNETITE - ILMENITE DEPOSITS

I. Lac Allard, Lac Puyjalon and Manitou lake area

As shown in figure , this area lies immediately north of Havre St. Pierre and contains the most important occurrences of magnetite - ilmenite found in the whole region. The area is underlain by white to light grey, massive to foliated, porphyritic to cataclastic anorthosite that locally

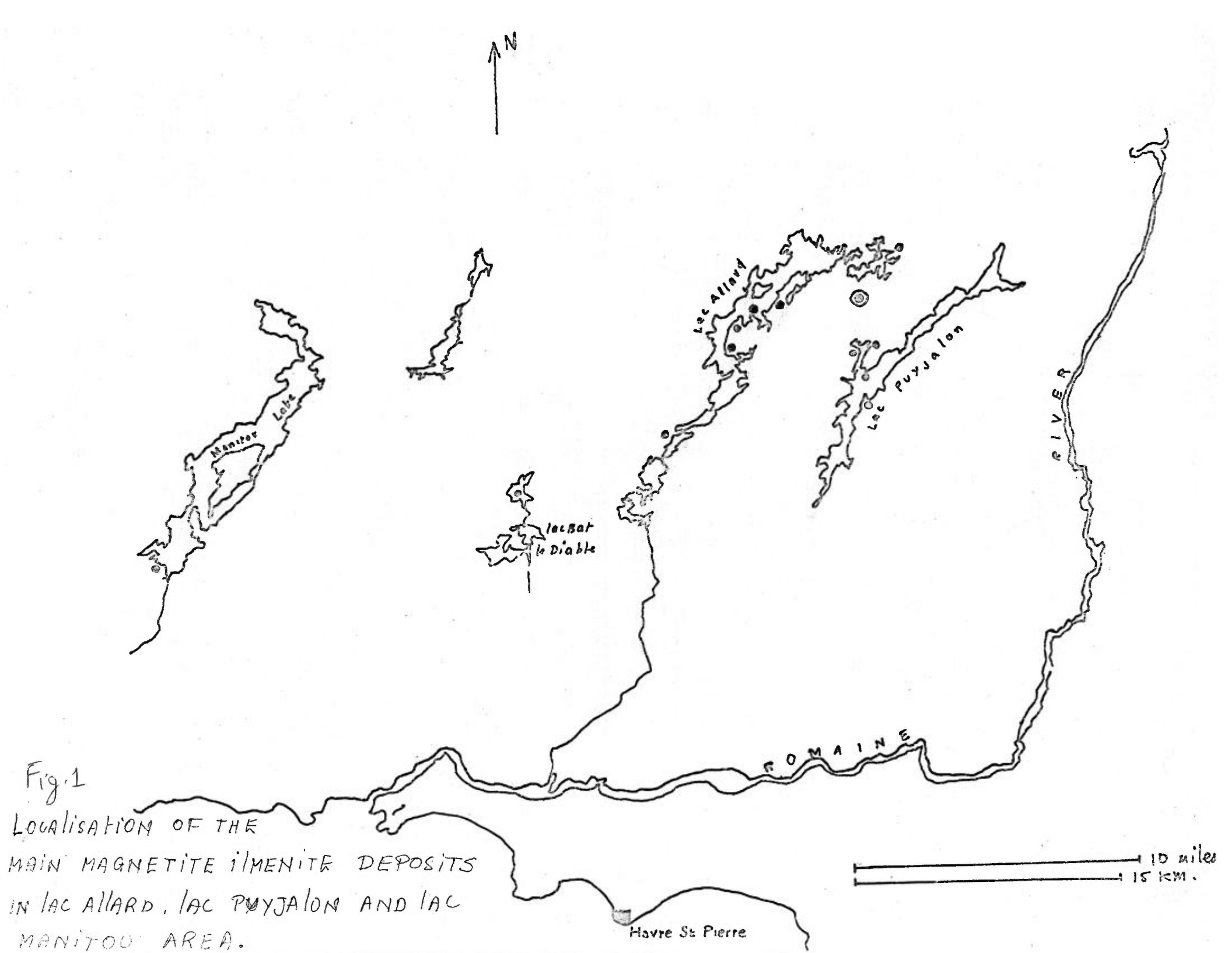


Fig. 1
LOCALISATION OF THE MAIN MAGNETITE ILMENITE DEPOSITS IN LAC ALLARD, LAC PUYJALON AND LAC MANITOU AREA.

becomes gabbroic anorthosite to anorthositic gabbro compositionally with an increase in the percentage of mafic minerals. The various occurrences of magnetite-ilmenite deposits observed in this area are indicated in the figure .

Retty (1944) was the first to describe the mineral occurrences of Lac Allard, Lac Puyjalon and Lac Bat-le-Diable. His work was published by the Quebec Department of Mines. The results of chemical analysis given by him for Lac Bat-le-Diable and Lac Allard deposits indicate an average content of FeO = 55% and that of TiO_2 = 35%. At Lac Bat-le-Diable the ilmenite occurs in the form of tabular bodies, few tens of feet long. At Lac Allard also the ilmenite occurs in the form of bands or lenses varying in length from few feet to tens of feet. The concentration of ilmenite in the anorthosite varies from 20 to 80%. These bands, in general, have a northeast trend and dip southward.

At Lac Puyjalon there are four showings of ilmenite-magnetite. On the eastern side of the lake the mineralization is in the rock that is compositionally anorthosite to gabbroic anorthosite to anorthositic gabbro to gabbro. The mineralization is in the form of bands or segregations, rich in ilmenite-magnetite, parallel to foliation. The rock shows highly rusty weathering. The ilmenite is more abundant than magnetite. In the anorthositic parts of the outcrop the ilmenite occurs as isolated patches and small discontinuous bands parallel to foliation, whereas in the anorthositic gabbro to gabbroic

portions it forms well segregated bands striking northeast and dipping south.

On the western side of Lac Puyjalon also the ilmenite-magnetite concentrations are found associated with anorthositic gabbro. At one place the mineralized body is about 15 to 20 feet thick and it contains small pieces and blocks of anorthosite embedded in it. Apart from these mineralized locations, the rock is coarse grained, massive to foliated, white to light grey anorthosite.

In the southwestern part of Lac Gros-Diable, that is southwest of Manitou lake, the rock is very heterogeneous in composition, consisting of bands of anorthositic gabbro to gabbro parallel to foliation. The whole outcrop shows rusty weathering which seems to have been caused by the presence of pyritic bands. The other mineralized bands consist of ilmenite and magnetite, striking northeast and dipping south.

Lac Tio Ilmenite Deposit

This is the only deposit in the region that is presently under exploitation by Quebec Iron and Titanium Company. Claiming started in this region since 1942 by Kennco Explorations, (Canada) Ltd. and by The New Jersey Zinc Company. But it was only in 1946 that the Kennco geologists located eight ilmenite deposits out of which the lac Tio deposit was found to be of more economic importance. For the purposes of development and exploitation of the ore,

Quebec Iron and Titanium Corporation was formed in 1946. This corporation is owned two-thirds by Kennecott Copper Corporation and one-third by The New Jersey Zinc Company. A small railroad, 25 miles long and between Havre St. Pierre and Lac Tio, was constructed in 1948 by the corporation and is used for the transportation of ore. This deposit is associated with a small negative magnetic anomaly. The deposit is about 3600 feet long in a north-south direction, has a maximum width of 3400 feet in east-west direction, and occupies an area of 140 acres.

The ilmenite ore contains pieces and blocks of anorthosite as inclusions. The ore consists of well developed ilmenite crystals up to 10 mm. in size. Gangue minerals include plagioclase, pyroxene, biotite, pyrite, pyrrhotite and chalcopyrite. The analysis indicates that ore contains on an average 32 to 36% TiO_2, and 39 to 43% Fe. It has a specific gravity of 4.5 to 4.9 and a constant $Fe:TiO_2$ ratio. In addition, the ore contains minor amounts of silicon, aluminium and magnesium. It also contains traces of calcium, manganese, sulphur, phosphorus, vanadium and chromium. The shipped ore contains about 90% of combined oxides. Total ore reserve is about 125 million tons of ore, with 35% TiO_2 and 40% iron.

II. Mont Magpie Deposit

This deposit is west of Rivière St. Jean and southwest of Lac Coupeaux, and about 80 miles north of Mingan or 50 miles northwest of Lac Tio ilmenite deposit. The deposit is associated with the gabbroic anorthosite and is surrounded by well foliated, pink, medium to coarse grained granite. The deposit was first claimed by Messrs. Atwater and Lapointe in 1953. Later on Hollinger (Quebec) Exploration Company Ltd. optioned the claims and did the exploration and development work. It was found that the ore is titaniferous magnetite from which titanium cannot satisfactorily be removed magnetically. Later on, in 1958, the property was optioned jointly by Stratmat Ltd. and Halmon Mining and Processing Ltd., and carried on detailed exploration, development work and smelting tests.

The mineralization occurs both as massive titaniferous magnetite deposit as well as in bands interlayered with gabbroic anorthosite and anorthositic gabbro. The deposit has a north-south trend and is about 4.5 miles long and 2000 feet wide. It contains inclusions of anorthosite and gabbroic anorthosite in it. There are some diabase dykes also present in the area. The ore is fine to medium grained, dark grey to black titaniferous magnetite, with a specific-gravity of 4.0. Total ore reserves in the deposit amount to more than 500 million tons of titaniferous magnetite. The results of chemical analysis for the average of three deposits as given by Rose (1969) are as follows:-

Total iron	-	43.69
TiO_2	-	10.91
SiO_2	-	5.95
CaO	-	0.60
MgO	-	5.78
V_2O_5	-	0.17
Al_2O_3	-	11.57
Cr	-	1.45
S	-	0.027
P	-	0.078

III. Lac Ladieu Deposit

This ilmenite deposit is situated about 85 miles northeast of Havre St. Pierre. It outcrops on the west shore of a lake about three miles north of Lac Ladieu and connected to it by other smaller lakes. This mineral occurrence was unknown previously. It occurs in a white to light grey, cataclastically deformed, augen anorthosite with big plagioclase phenocrysts. The anorthosite belongs to the eastern part of the Romaine river anorthosite massif.

The ilmenite occurs in the form of bands, lenses and patches, generally striking N280° and dipping steeply towards north. The contact between the ore and anorthosite is quite sharp and as such there is no contamination of the ore body by the anorthosite. The largest ore body here has been roughly estimated to be 1200 feet long and 550 feet wide. The mineralised

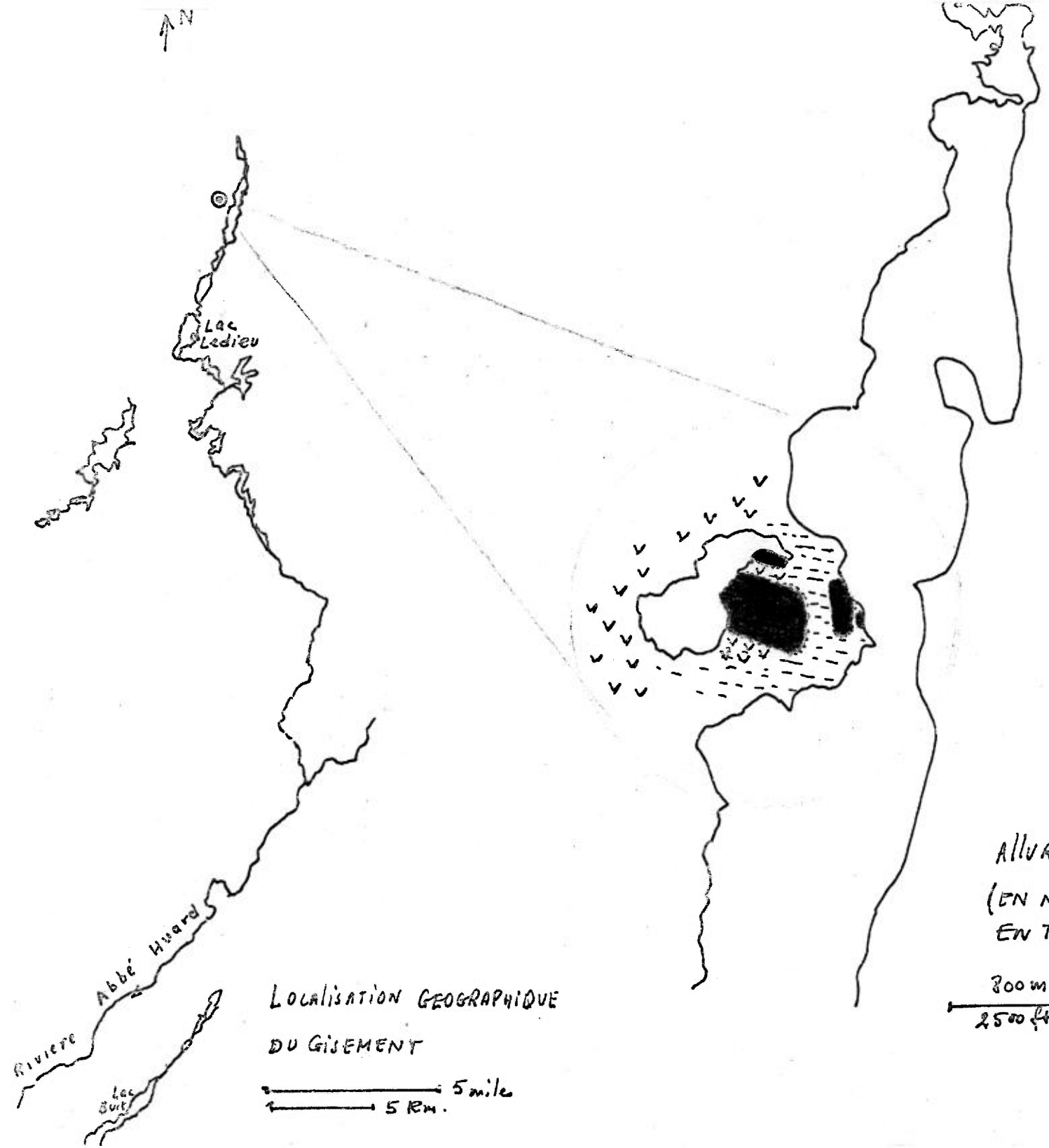


Fig. 2.

Allure du Gisement
(En noir: ilmenite marine
En tireté: Recouvrement glaciaire

800 m.
2500 ft.

parts consist essentially of ilmenite with some magnetite. The ilmenite is rather coarse grained, 0.5 to 1 cm in grain size. It shows some rusty weathering. The chemical analysis done, by the Quebec Department of Natural Resources Laboratories, on grab samples taken from this deposit gave following results.

Quantitative Analysis

Total iron	-	45.50%
TiO_2	-	36.76%
V_2O_5	-	0.32%
S	-	0.48%
P_2O_5	-	0.049%

Semi-quantitative Analysis

Ca	-	1 to 5%
Mg	-	0.5 to 2%
Al, Cr, Mn	-	0.1 to 1%
Si, V	-	0.05 to 0.5%
Ni, Na	-	0.01 to 0.1%
Cu, Mo, Sn	-	0.001 to 0.01%
Ag	-	<0.001%

Magnetic separation results.

	%MgO	%CaO	$\%TiO_2$	%Total Fe	%Cr	$\%V_2O_5$
Magnetic fraction	-	-	11.95	62.09	0.75	0.45
Non-magnetic fraction	1.91	0.01	37.94	43.09	0.28	0.34

Polished section study reveals that the ore is composed of ilmenite with magnetite a little spinel, a very

little pyrite, chromite, traces of hematite, chalcopyrite, pyrrhotite and non-metallics. The ilmenite is associated intimately with the magnetite in the ore. The magnetite occurs in en-echelon laminae within ilmenite (Fig.). These laminae do not exceed 100 microns in diameter and a lot of these are barely discernible being less than 1 micron in diameter. Some magnetite occurs in blebs to irregular grains exceeding 100 microns in diameter (Fig.), but smaller than 500 microns. The magnetite laminae and grains that exceed 10 microns, themselves contain ilmenite laminae which are about 1 micron or less in diameter. Only a small amount of ilmenite contains no magnetite (Fig.).

Detailed work is recommended to delimit the size of the ore body more precisely.

IV. Other smaller occurrences of Ilmenite-Magnetite

In addition to the large ilmenite-magnetite deposits described above, there exist several smaller occurrences of ilmenite-magnetite in the present map-area. For location of these refer to the geological map.

(i) A magnetite rich mineralized zone, about 10 feet thick, was observed by Blais (1960) along the railroad, going to Schefferville, about 82.1 miles north of Sept-Iles. The extension of this zone is not known. Chemical analysis on a sample gave the following result.

Total iron	-	36.47%
TiO_2	-	1.22%
Cr	-	0.01%

(ii) Several mineralized zones containing ilmenite and magnetite were noted by Klugman (1955) and by us during the 1970 summer field season, between Rivière-à-la-Chaloupe and Sheldrake. These are in the form of bands or lenses of varying and thickness, from few inches to tens of feet. These mineralizations seem to be along the shear zones, as the gabbroic anorthosite found near these show effects of cataclasis and possess a rather well developed foliation. The mineralization must have taken place after the emplacement and cataclasis of the anorthosite, as they often contain pieces and blocks of anorthosite and gabbroic anorthosite. Chemical analysis of samples taken by Klugman gave the following results.

	Riv.-à-la-Chaloupe	Cap Rond
Total iron -	49.52%	35.84%
TiO_2 -	16.34%	11.37%
S -	0.08%	1.35%

(iii) Jenkins (1957) reports the presence of some mineralized zones southwest of Marcot lake which is on the west side of the southern tip of Manitou lake (west). The development work done in 1952 and 1953 by Hollinger (Quebec) Exploration Ltd. indicated the presence of three main zones rich in magnetite, varying in length from 1000 to 1600 feet and about 20 feet wide on the average. Locally these bands become as much as 100 feet wide. These zones are in the migmatized paragneisses and are

associated with the amphibolites. Systematic sampling done in these zones gave the following results.

Total iron - 52.00%

TiO_2 - 2.2%

SiO_2 - 20.0%

Detailed exploration work done by Dufresne (1953) helped in delimiting a zone 500 feet wide and 4400 feet long containing several stringers and lenses of massive magnetite and magnetite rich material. The magnetite is steel blue to black in colour, coarse grained, and is associated with some quartz, feldspar and amphibole. There is only a minor amount of titanium present in the ore. This zone contains four major lenses or bodies of magnetite present in the area that have been estimated to contain 10,000 tons per vertical foot of high grade non-bessemer iron ore with an average chemical analysis as follows.

Total iron - 61.50%

TiO_2 - 1.52%

SiO_2 - 7.82%

P - 0.111%

S - 0.075%

(iv) A small magnetite bearing band, 25 feet long and 3 feet wide, was described by Jenkins (1956) that outcrops northwest of Lac Canot and just west of Rivière Manitou. The analysis of the samples taken by him is as follows.

Total iron	-	53.50%
TiO_2	-	0.92%
S	-	0.20%
P	-	2.40%

(v) A mineralisation of ilmenite, in the Romaine river anorthosite massif, was observed by Clavesu (1949) in the northern part of Romaine river, about 2 miles north of its confluence with the Olapion river. This mineralized zone is about 75 feet wide and 120 feet long, having an attitude of $N60^{\circ}$ and dipping 70° north. The exposure is found only on the eastern bank of Romaine river. Ilmenite forms the central, lens shaped mass of this zone, surrounded by ilmenite rich anorthosite which in turn is surrounded by anorthosite.

(vi) The occurrences of ilmenite in the beach sands of various lakes and rivers were noted by Longley (1948). He gives an analysis of the sample collected from the beach sands of Lac Metivier as follows.

FeO	-	29.03%
Fe_2O_3	-	33.76%
TiO_2	-	22.90%
Cr_2O_3	-	0.08%
SnO_2	-	0.06%
V	-	0.08%

In addition to the small magnetite-ilmenite mineralisations observed by previous geologists, some additional small occurrences were found during the course of the field

work in the summer of 1970. These occurrences are described as follows:-

(vii) A magnetite-ilmenite mineralization was observed along Rivière Baubert, a tributary of Romaine river, at the contact between the anorthosite and the enclosing mangerite. It consists of medium to fine grained disseminations of magnetite-ilmenite in a rock having the composition of jotunite. The magnetite and ilmenite together make up for about 40% of the rock.

(viii) <u>Rivière Aguanus mineralization</u>:- Some interesting showings of magnetite-ilmenite are localized in small jotunite lenses found near the northeastern boundary of the Romaine river anorthosite massif along the Rivière Aguanus and northeast of Lac Marthe. The mineralization is associated with a high, positive magnetic anomaly. The mineralized lenses are about 120 feet thick and extend along the foliation direction. Their lateral extension has not been delimited, but it is quite likely that these lenses continue eastward, outside the limits of the map-area. The ore occurs in the form of disseminations, the magnetite and ilmenite being homogeneously distributed throughout the rock and make up about 20% of the rock. There are also smaller lenses or bands upto about 6 feet thick that consist almost essentially of magnetite and ilmenite. There are two main showings in the area. The results of chemical analysis of samples from one of these localities are as follows.

Total iron in the sample	-	42.28%
Magnetic fraction in the sample	-	30.50%
Total iron in the magnetic fraction	-	69.44%
TiO_2 in the magnetic fraction	-	0.57%
V_2O_5 in the magnetic fraction	-	0.54%

(ix) Lac Charles mineralization:- Magnetite, ilmenite and pyrite is found associated with the mangerite-jotunite rocks southwest of Lac Charles. This locality is near the contact with Romaine river anorthosite massif. The rocks here are somewhat sheared. The mineralization is confined to the high positive magnetic anomaly that is about 3 miles long and one mile wide. The ore is found mostly in the form of small patches and masses that are rather elliptical in shape. The ore is fine to medium grained and granular. Some anorthosite is also associated with it. The anorthosite situated just north of this deposit contains 5 to 25% of disseminated magnetite and ilmenite. Results of analysis of grab samples are as follows.

Total iron in the sample	-	40.18%
Magnetic fraction in the sample	-	36.00%
Total iron in the magnetic fraction	-	66.08%
TiO_2 in the magnetic fraction	-	1.72%
V_2O_5 in the magnetic fraction	-	0.36%

(x) Magnetite was also observed near a small lake southeast of Lac à l'Aigle. Here there are several veins of magnetite upto 4 inches thick in the paragneisses, but more

commonly the veins are less than one inch thick. They follow the foliation plane but occasionally branch across the foliation in different directions.

Conclusions on Ilmenite-Magnetite Deposits

The large number of mineralized occurrences of ilmenite-magnetite of various dimensions in the map-area are always associated with the anorthosite and related rocks. These rocks form a great majority in the region and as such provide an excellent opportunity for discovering some interesting and economically exploitable magnetite-ilmenite deposits. Apart from the ilmenite-magnetite deposits of Lac Tio and Mont Nagpie that are currently under production and detailed development respectively, the newly found deposit of Lac Ledieu appear to be a promising mineralization of ilmenite, whereas the deposits at Rivière Aguanus and Lac Charles seem interesting for the magnetite as both are associated with high positive magnetic anomalies that occupy a big area.

MINERALIZATIONS OTHER THAN MAGNETITE - ILMENITE

SULPHIDE MINERALIZATIONS

The main mineralizations of copper sulphides and pyrite are located in the southeastern part of the map-area, in the region of Lac Forget and Lac Sanson. Retty (1944) was the first who noted and described seven mineralized occurrences of copper in this area. At Lac Sanson a chalcopyrite bearing quartz vein, 8 feet long by 10 inches wide, cuts the amphibolite. The minerals present include chalcopyrite, pyrite, pyrrhotite and small amount of magnetite. The chemical analysis done on grab samples gave following results:

Copper - 4.21%

Silver - 0.175 ounce per ton.

The area was first claimed by J. Olasson in 1942. Recently, in 1968, Cumex Mines Ltd. carried out geochemical and detailed prospecting work in the area, and found the deposits to be of no immediate economic interest.

A mineralized zone, about 200 feet long, was observed along Romaine river just south of Bassin des Murailles. The paragneisses here are traversed by quartz veins parallel to layering. Chalcopyrite occurs both in the quartz vein and in the paragneisses.

The mineralizations occurring on the east side of Lac Forget were initially observed by Retty (1944), but Longley (1948) who did the detailed geological mapping of Lac Forget area described these occurrences in greater detail.

The mineralisations are mostly concentrated southeast of Lac Forget and are found in the Wakeham group paragneisses. Chalcopyrite occurs both as disseminations in the paragneisses or concentrated in fractures and in quartz veins. The concentration of ore minerals is more in the garnet bearing layers of the paragneisses, whereas in quartzites the ore occurs only in fractures and in narrow quartz veins about one inch thick. Analysis done on a sample from a showing 4 miles east of the southern limit of Lac Forget gave the following results.

Copper	-	0.34%
Gold	-	0.006 ounce per ton
Silver	-	0.035 ounce per ton

Apart from these, several other smaller occurrences of chalcopyrite mineralization have been reported by earlier geologists who did detailed geological mapping of small areas in the region of present map-area. But these showings are not of any economic importance.

URANIUM

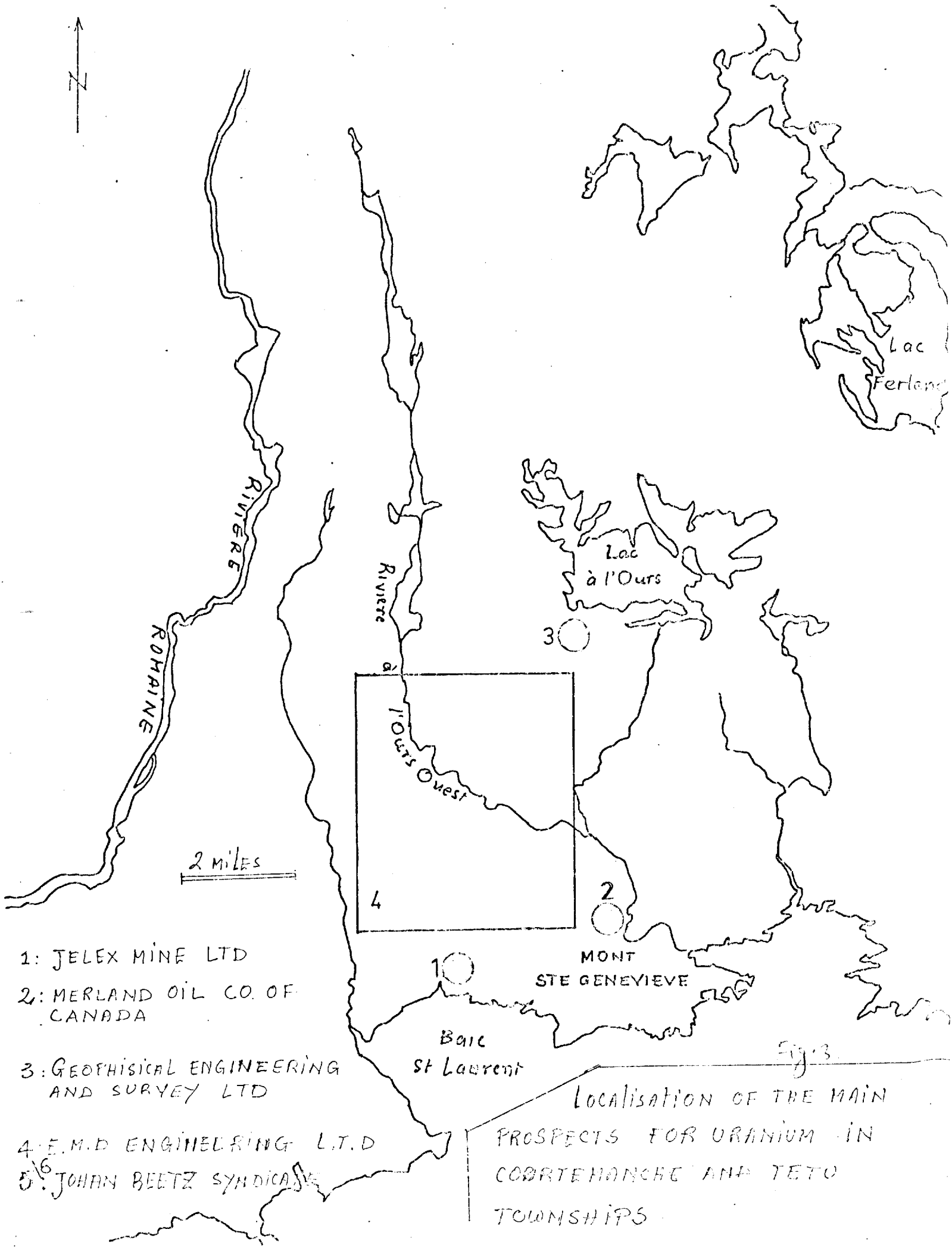
Uranium showings have been reported from the map-area in the region of Tetu township and Courtemanche township, northeast of Havre St. Pierre. In addition, uranium also occurs further east, outside the eastern limit of the map-area.

In 1967 the Johan Beetz Syndicate, which includes Canadian Nisto Mines Ltd., carried out 15,000 miles of airborne radiometric survey in the region east of Havre St. Pierre.

As a result of this survey 35 claims in the vicinity of Lac Sanson and 185 claims in the vicinity of Lac Nobel were staked. These areas have previously been mapped by Longley in 1942 and Claveau in 1943 respectively. The rocks here consist mostly of Wakeham group paragneisses intruded by granite-monzonite. The radiometric surveys helped in delineating some localities of high radioactivity. But no further ground examination and sampling were carried out in these areas.

In 1967 and 1968 several other companies that carried out airborne scintillation counter surveys in Tetu township include Zulapa Mining Corporation, United Buffadison Mines Limited, St. Mary's Exploration Limited, Pumsly Exploration Limited, Crusader Mines Limited, Clero Mines Limited, Canadore Mining and Development Corporation, and Cana Mines Limited.

The Courtemanche township that extends from south of Lac à l'Ours to the north shore of St. Lawrence river has been an area of extensive prospecting for uranium. In the years 1967 and 1968 various mining and exploration companies carried out airborne scintillation counter surveys which in some cases revealed interesting anomalies that encouraged subsequent ground radiometric surveys. The companies involved in the exploration work were as follows. E.M.D. Engineering carried out aerial radiometric survey in October 1967 for Vespar Mines Ltd. on 323 claims lying in a region north of Baie St. Laurent. In 1968, The Bonaventure Mining Society did 27 miles of ground scintillometer survey on the property



1: JELEX MINE LTD

2: MERLAND OIL CO. OF CANADA

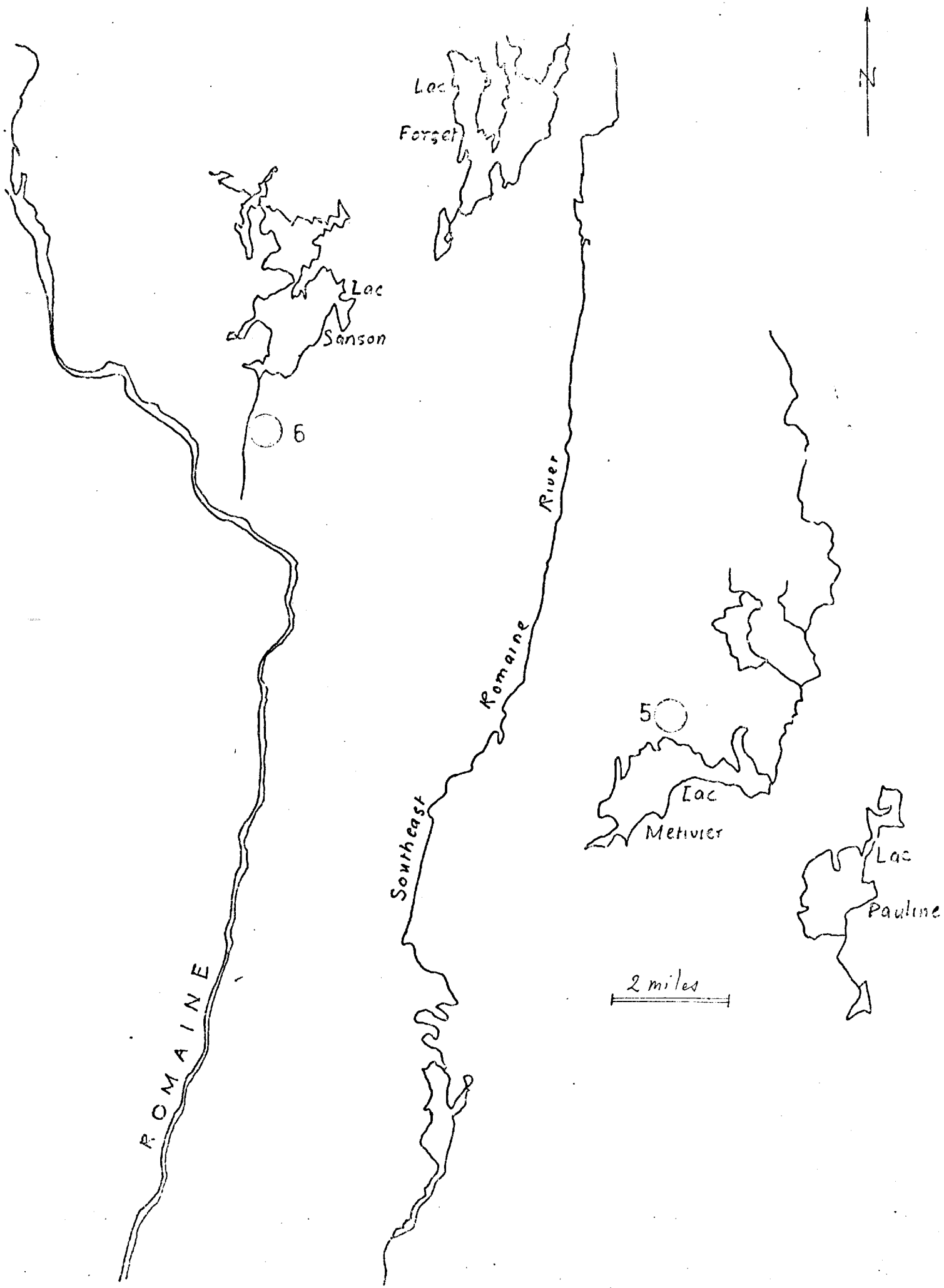
3: GEOPHISICAL ENGINEERING AND SURVEY LTD

4: E.M.D ENGINEERING L.T.D

5/6: JOHAN BEETZ SYNDICATE

Fig 3

Localisation of the main prospects for uranium in Cobrtehanche and Teto townships


N
Lac
Forget
Lac
Sanson
6
5
Romaine River
Southeast
ROMAINE
Lac
Metivier
Lac
Pauline
2 miles

of Gaspex Mines Ltd. In November and December 1967, Merland Oil Company of Canada Ltd. carried out ground scintillometer survey on anomalies pointed out by earlier airborne scintillometer survey in the region of Mont Ste. Geneviève. In 1967 and 1968, Geophysical Engineering and Surveys Ltd. carried out airborne scintillometer survey on the property of Keevil Mining Group Ltd., located immediately south of Lac à l'Ours. This work was completed in December 1967 by a detailed ground study of some interesting showings. Jelex Mines Ltd. did ground Geiger counter survey on 70 claims located close to the Baie St. Laurent.

All this systematic prospecting work carried out by various companies resulted in delimiting certain areas that could be of some economic interest. Thus in the region of Mt. Ste. Geneviève, two radioactive zones have been located in granites-pegmatites. Here the radioactive minerals are associated with magnetite and ilmenite. Similarly, some radioactive zones have also been localised in granites-pegmatites south of Lac à l'Ours. Additional trenching work done in this region helped in locating many interesting showings.

In conclusion, after all the prospecting work done for uranium in this general area, it is believed that the uranium mineralization is related to the acidic intrusives, especially the pegmatites, intrusive into the Wakeham group paragneisses. A detailed aeromagnetic study of the region will probably help in delineating radioactive zones, because it has been observed in several locations that the magnetite-ilmenite is almost always associated with the radioactive minerals.

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