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LA GRANDE RIVER AREA (1973-1974 PROJECT)

NEW QUEBEC TERRITORY

Geological Report

by

Kamal N.M. Sharma

Québec

1975

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INTRODUCTION

The area mapped during the summer of 1973 covers about 3,240 square miles between latitudes 53°00' and 54°00' and longitudes 77°00' and 78°00', and between latitudes 53°00' and 53°15' and longitudes 76°30' and 77°00', (Figure-1). It covers townships numbered 2912 to 2915, 3012 to 3015, 3112 to 3115, 3212 to 3215, 3312 to 3315, 3412 to 3415, 2916, 2917, and parts of 3016 and 3017. Its central part is about 260 miles north of Matagami and about 65 miles east of Fort George on James Bay. The important LG-2 camp of the James Bay Development Corporation is situated near Atilla lake in the north central part of this area, 75 miles island from Fort George and is near the proposed site of LG-2 dam, which will be the largest of the four dams to be constructed on La Grande river. Dam LG-1 will be constructed to the west of this map-area.

The area mapped during the summer of 1974 covers about 2,460 square miles between latitudes 53°25' and 54°00', and longitudes 75°30' and 77°00'. It includes townships numbered 3416 to 3421, 3316 to 3321, 3216 to 3321, and parts of 3116 to 3121. Its central part is about 280 miles from Chibougamau or from Matagami, and about 110 miles from Fort George. The LG-3 camp situated on La Grande river is within the area, whereas the LG-4 camp is to the east of this area.

INDEX MAP — LIEU DE LA CARTE

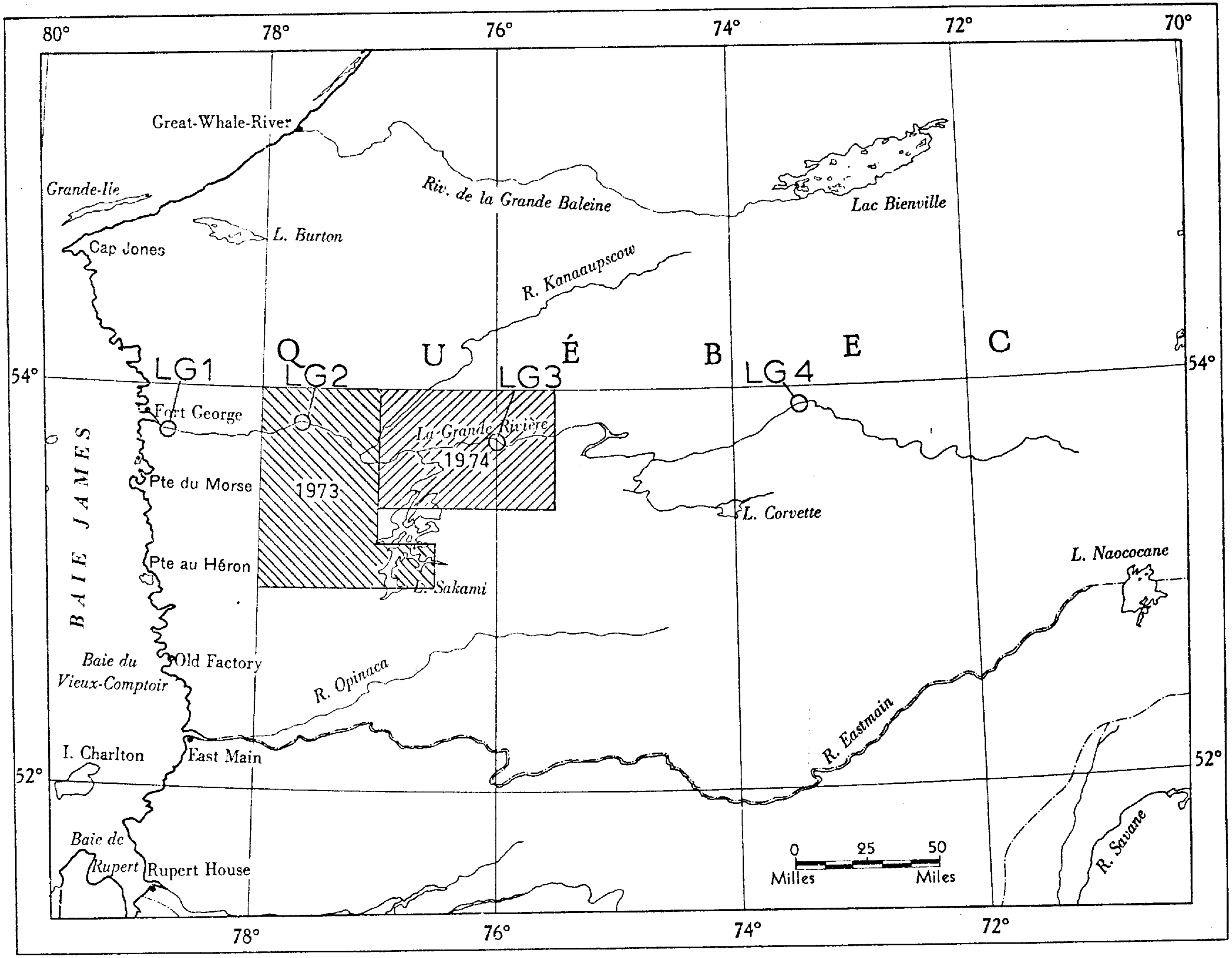

Figure 1 - Index Map showing the areas mapped in the summers of 1973 and 1974, and the sites of LG1, LG2, LG3 and LG4.

Some parts of the area in the vicinity of La Grande river, Long lake, Coutaceau lake, Kanaaupscow river, Bereziuk lake and Grande Pointe lake will be affected by the hydro-electric projects under way along La Grande river. The ground that will be inundated due to these projects represents about 10 to 15% of the area mapped during the two summers.

There are several other road-construction camps belonging to different contractors responsible for the construction of the road between Matagami and Fort George.

ACCESS

The area is easily accessible by float-planes based in Chibougamau, Matagami or Fort George. The central parts of the area may also be reached from Fort George by La Grande river canoe route. During the summer of 1973 work was in full progress for the construction of 430 miles long gravel road joining Matagami and Fort George. The road traverses the map-area, in a north south direction, between the milages 310 and 375 approximately. At this point it branches into two directions, the eastern branch goes to LG-2 camp and the western branch leaves the area around milage 385 and continues upto Fort George. During the summer of 1973 the access by this road and adjacent secondary roads was possible only during the winter season as various bridges on the major rivers in the south were still under construction. Now with the completion of the bridges the western parts of the map-area are easily accessible by road. During the summer of 1974, work was in progress for the construction of a road joining LG-2 camp and LG-3 camp.

There are regular flights by Nordair between Montreal and LG-2 via

Matagami, and by Quebecair between Bagotville and LG-2. During the summer of 1974 work was in progress for the construction of a new airstrip near LG-3 camp and which is supposed to be operational by 1975.

GLACIATION, TOPOGRAPHY AND DRAINAGE

The topography of the region is that characteristic of a heavily glaciated terrane as evidenced by the multitude of lakes and swamps. It is a result of the interaction of the geological structure and the relative resistance of different lithological units to glacial, fluvioglacial, fluvial and marine erosion and deposition after the retreat of the ice. The direction of the movement of ice as determined by glacial striae, glacial grooves, chatter-marks and eskers is mainly SW to WSW. Washboard moraines (annual moraines), trending N-S to NNW-SSE, are quite conspicuous on the air-photos. They form ridges spaced at 300 to 900 feet intervals. Eskers are common in low lying areas occupied by volcano-sedimentary rocks and areas with extensive glacial deposits.

Two Carbon-14 age determinations were made for Pierre LaSalle (personal communication), by the laboratories of the Quebec Department of Natural Resources, on the post-glacial marine transgression sediments collected from near LG-2 camp. The shells of <u>Hiatella arctica</u> (sample QU-101) gave an age of 7870 ± 170 years before present and those of <u>Pecten islandicus</u> (sample QU-102) gave an age of 7490 ± 150 years before present.

The topography, in general, is rather subdued over most of the area, but is quite mountainous in regions occupied by the Proterozoic Sakami Formation immediately to the north and northeast of Coutaceau lake, and in areas occupied by granitic rocks west of Pine Mountain lake. An indistinct to distinct linear trend predominates over the greater part of the area in a WSW-ENE direction. Departure from this overall direction is invariably due to the presence of plutonic rocks. The ground rises gradually to the east and may attain altitudes of 800 feet above sea-level in places. In the southern parts of Sakami lake area the altitudes may become as much as 1000 feet above sea-level, whereas west of the Pine Mountain lake the altitudes of about 1400 feet above sea-level have been recorded.

In areas occupied by the granitic and volcanic rocks the glacial cover is very thin, whereas in areas occupied by volcano-sedimentary rocks and migmatites the glacial cover is more extensive and thicker. Sand and clay deposits are common along rivers and lakes. There are numerous clay deposits along La Grande and Kanaaupscow rivers. Glacial, fluvio-glacial, lacustrine and fluvial deposits, swamps and string-bogs cover extensive areas, outlined on the geological maps, in the central, southeastern and eastern parts. These areas are devoid of bedrock outcrop.

The area mapped belongs to the hydrographic basin of La Grande river. The major rivers such as Sakami river and Kanaaupscow river drain into La Grande river which in turn drains westward into the James Bay.

FLORA AND FAUNA

Vegetation in the map-area is quite irregular and may vary from heavily forested to scantily forested areas. The vegetation is denser in low lying areas and in elevated areas it is sparse or devoid of any vegetation. Black spruce and jack pine are the most abundant conifer trees accompanied with minor tamarack trees. Birch and poplar are common only in proximity to water, such as near streams and lake shores, and in areas affected by forest-fires. All the trees, in general, are of small butt diameter due to scarcity of soil and rigorous climatic conditions. Alders are typically good indicators of streams and also grow abundantly near lake shores. Caribou-moss and shrubs are common. Lichen is ubiquitous, often presenting a problem in the examination of outcrops. Edible berries include blue, goose, black and red currant berries in order of importance. They ripen in the last two weeks of August.

Fur bearing animals sighted in the area include beaver, otter, muskrat, marten and wolf. Frequently observed droppings of lynx, suggesting a considerable population, is in agreement with a sizable density of rabbit, their main food source. A few black bears all in the 2 to 3 year old range and thin were observed.

Sizable populations of seagulls, partridges, geese, black ducks, Canada jays and sparrows were noted. A few falcons and owl were also observed. A few moose and only the tracks of caribou were seen.

Pike and walleye abound in the lakes and streams of the area. Speckled trout were caught only in smaller lakes where there are no pike and walleye, and which are separated from bigger lakes by rapids and waterfalls. Grey lake trout were caught in the Pine Mountain lake. White fish and carp were found in some lakes which are connected by streams to the La Grande river. Sturgeon is reported to be present in

La Grande river. The fish are more easily taken in lakes and rivers from the time the ice breaks through the month of July.

CLIMATE

Subarctic, moderately humid climate is indicated by vegetation, drainage density and string-bogs. The break-up of ice in the lakes and rivers generally takes place by the last week of May. The 1973 summer season was anomalous due to the low precipitation rate and temperature extremes. Low water level in lakes and rivers caused by lack of precipitation and excessive evaporation due to high temperature and long periods of continuous sunshine contributed to closed access to some areas, by float-planes and canoes, which would have been easily reached under normal conditions. The temperatures ranged from slightly above 90°F during the hot days in July to a low around 30°F during several of the colder mights in early June and late August.

METHOD OF WORK AND ACKNOWLEDGEMENTS

Both summers the field work was carried out by a party of about 20 men, including 9 geologists, based at Coutaceau lake. A "Beaver" float-plane was at the disposition of the party. The geological exploration work was accomplished by foot-traversing, geology of lake shore and of the navigable rivers and streams. All geological information was recorded on an outcrop input document (Figure-2) especially designed for the rocks of the Superior Province.

The senior field assistants during the 1973 summer field work were R.E. Routledge, J.P. Mills, C. Dubé, D. Millward, J.-P. Berger, A. Collado i Dols, J. Bélanger and P. Archambault. L. Noël, G. Harvey,

MINISTÈRE DES RICHESSES NATURELLES

PROVINCE GÉOLOGIQUE DU SUPÉRIEUR

1 2 Géologue — 3 6 No. Affleurement — 7 — 8 10 No. Traverse — 11 16 No. de la Carte — 17 [1] 18 Nbre. Échantillons — 19 Qualité (1- Frais, 2- Patine d'altération, 3- Altéré) — 20 Photo (0 No, 1 N & B, 2 Couleur)

TYPE D'ÉCHANTILLON (21)
Courant 1
Minéral 2
D'intérêt économique 3
Orienté 4
Échant. de Musée 5

ACCÈS À L'AFFLEUREMENT (22)
Par: Cheminement 1
Canot 2
Automobile 3
Hélicoptère 4
Avion 5

MIGMATISATION (23)
Mobilisat < 10% 1
Mobilisat 10 — 30% 2
Mobilisat 30 — 60% 3
Mobilisat > 60% 4

ASPECT DE L'AFFLEUREMENT (24)
Frais 1
Altéré 2
Couvert de Mousse 3
Surface plane 4
Falaise 5
Tranchée de route 6
Aff. douteux 7

ASPECT DE LA ROCHE COMPOSANT L'AFFLEUREMENT (25)
Homogène 1
Hétérogène 2
Massive 3

NOMBRE DE FACIÈS COMPOSANT L'AFFLEUREMENT (26)
1 à 9

GRANULOMÉTRIE (27–28 … 38)
Aphanitique
< 1mm.
1 — 5 mm.
5 — 10 mm.
10 — 50 mm
>50 mm.

DIMENSIONS DE L'AFFLEUREMENT (39)
< 10 mètres carrés 1
10 — 25 mètres carrés 2
> 25 mètres carrés 3

RÉPARTITION DES MINÉRAUX (40)
Homogène 1
Ségrégation 2
En Aggrégats 3
En taches 4
Dispersés 5

STRUCTURES SÉDIMENTAIRES (41, 42, 43)
Litage / Stratification 1
Aspect stratiforme 2
Granoclassement 3
Struct. Entrecroisées 4
...ves 5
...ing 6
...arks 7
...oove Casts 8
Au... 9

COULEUR (49–50 Roche; 51–52 Phénocristaux)
Blanc 1
Translucide 2
Gris clair 3
Gris foncé 4
Gris-bleu 5
Gris-rose 6
Gris-vert 7
Rose 8
Rouge 9
Rose-vert 10
Jaune 11
Chamois 12
Brun 13
Vert 14
Vert foncé 15
Pourpre 16
Noir 17

STRUCTURES VOLCANIQUES (44)
Pillows (bien développés) 1
Pillows (Ébauchés) 2
Pillows déformés 3
Amygdales 4
Vésicules 5
Coulées volcaniques 6
Ségrégation ignée 7
Brèche volcanique 8
Débit polygonal 9
Autres 10

POLARITÉ (45; 46–48 Direction)
Normale 1
Renversée 2
Indéterminable 3

TEXTURES (53–54, 55–56, 57–58)
Équigranulaire 1
Inéquigranulaire 2
Granoblastique 3
Granulée 4
Clastique 5
Porphyroïde 6
Porphyroblastique 7
Ophitique 8
Sub-ophitique 9
Microlitique 10
Aphanitique 11
Variolitique 12
Sphérolitique 13
Maillée 14
En résidu 15
Gloméroporphyroïde 16
Décussate (HB) 17
Coronitique 18
Trachytoïdale 19
Graphique 20
Rapakivi 21
Anti-Rapakivi 22
Nodulaire 23
Oolithique 24
Pegmatitique 25
Autres 26

TEXTURES DE DÉFORMATION (59, 60, 61)
Oeillée 1
Flaser 2
Ribbon (QZ) 3
Streaky (Mafiques) 4
Cataclastique 5
Mylonitique 6
Bréchification 7
Figures de choc 8
Autres 9

CARACTÈRE DES BRÈCHES ET CONGLOMÉRATS
% Éléments clastiques (62–63)
% matrice (64–65)

TYPE (66)
Monogénique 1
Polygénique 2
Intraformationnel 3
Tillites 4

FORME DES ÉLÉMENTS (67, 68)
Angulaire 1
Sub-angulaire 2
Sub-arrondis 3
Arrondis 4
Bien-arrondis 5
Déformés 6
Striés 7
À facettes 8

NATURE DES ÉLÉMENTS (69, 70, 71)
Granitique
Dioritique
Gabbroïque
Lave Acide
Lave Basique
Métasédimentaire
Autres

ÉLÉMENTS PLANAIRES — 17 [2]
...ite 1
...t stratiforme 2
...n 3
...ité 4
... 5
Li... (continu) > 10 pieds. 6
Litage (discontinu) < 10 pieds. 7
Ségrégation ignée 8
Lamination cataclastique 9
Streaky-cataclastique 10

PRINCIPALE: 18 Type 20; 22 Direction 24; Pendage 25 26
SECONDAIRE: 27 Type 28; 29 Direction 31; 32 Pendage 33

LINÉATIONS (34 Type; 35–36 Plongement; 37–39 Direction)
Minérale 1
Microrrugations (Mullion, Rodding) 2
Gentle warps 3
Intersections (S) 4
Boudinage 5
Clasts déformés 6
Ripple marks 7
Flute / Groove casts 8
Autres 9

MICROPLIS (40)
Symétriques 1
Asymétriques (Z) 2
Asymétriques (S) 3

OUVERTURE (41)
Serré 1
Moyen 2
Ouvert 3

42 43 Plongement — 44 46 Direction

DIACLASES — 17 [3] — 18 20 — 21 22

FIGURES GLACIAIRES (23 Type; 24–26 Direction)
Stries 1
Auges 2
Roches moutonnées 3
Autres 4

MINÉRALOGIE
27, 29, 31, 33, 35, 37, 39, 41
43, 45, 47, 49, 51, 53, 55, 57

Nom de la Roche: 59–62 Principale; 63–66 Secondaire; 67–70 Secondaire

17 [4] Zone 19 — 20 Northing 25 — 26 Easting 30 — 31 32 %PF — Coloration 33 34 % PG — 35 36 %QZ — 37 38 MAP Unit — 39 Lame-mince 1 oui — 40 Analyse Chimique 1 oui — 41 Nbre de feuilles

MINÉRALISATION (42)
Non 1
Oui 2

Présente dans (43–46) — % Minéralisation (47–48)

MINÉRALOGIE 51 52, 53 54, 55 56, 57 58

COMPOSITION (49)
Sulfure 1
Oxyde 2
Carbonate 3
Natif 4
Autres 5

TYPE (50)
Massive 1
Disséminée 2
En veine 3
En fil (string) 4
En taches 5
Stratifiées 6
Autres 7

Parcours ....
Nombre de pas ....
No. de Photo ....
Date ....
Temps ....

SHARMA LEBANCUNI 197?

Figure 2. — Outcrop Input Document

J. Noël, M. Bélanger, R. Doucet, F. Landry, L. Landry, F. Lavoie, P. Cox and S. Ratt acted as canoemen. G. Coté and G. Savard acted as cook and assistant cook respectively.

In 1974 summer the field mapping party comprised of following senior field assistants: D.T. Aldiss, J.-P. Passeron, R. Bissonnette, D. Fischer, D. Leclerc, P. Archambault, A. Grenon, B. Lapointe and P. Guénard. G. Bouchard and M. Boucher acted as cook and assistant cook respectively. L. Noël, G. Harvey, J. Noël, M. Bélanger, M. Ferland, C. Régis, D. Jean and P.-E. Tremblay acted as canoemen.

All the members of the party carried out their respective assignments in a highly satisfactory manner. Special thanks are due to R.E. Routledge for his help in the installation and administration of the party from time to time, and to C. Dubé and C. Ducrot for their assistance during the preparation of the geological maps.

PREVIOUS WORK

The present map-area formed a part of a large scale helicopter reconnaissance mapping programme, at 8 miles to the inch, undertaken by the Geological Survey of Canada during the field seasons of 1957, 1958 and 1959. The results of this work are contained in a report by K. Eade (1966), and the information on surficial geology is provided in a map by Lee, Eade, and Heywood (1959). Later on during the 1958 and 1959 field seasons A.B. Baldwin carried out detailed geological mapping in the Yasinski Lake Area where Main Exploration Company held mining rights under Mineral Exploration License No. 142. He describes several interesting mineral occurrences in the area. In 1961, all the ground in this region held under concession was thrown open for staking, and during the years 1961 through 1966 several mining companies held claims and did active geological and geophysical exploration work and diamond drilling, most particularly near Duncan lake, southwest of Yasinski lake and around Long lake. Among the geologists and geophysicists who worked for the mining companies were: A.B. Baldwin (1959, 1961), O.A. Seeber (1960), W.N. Ingham (1961), J.C. Hansberger (1956,61,62), S.S. Szetu (1962), H.J. Bergmann (1962), R.F. Vallance (1962), J.B. Boniwell (1965, 1966) and J.A. Honsberger (1965).

The geological and geophysical work carried out in an area south of LG-3 is described by R. Ekstrom (1960, 1961), and the results of diamond drilling are reported by A.C.D. Terroux and Patterson (1964).

During the 1965, 1966 and 1967 summer field-seasons J.P. Mills mapped three areas around Sakami lake, Coutaceau lake and Long lake for the Geological Exploration Service of the Quebec Department of Natural Resources. This work was used by Mills (1974) in the preparation of a doctoral thesis submitted to the University of Kansas, Lawrence, Kansas, U.S.A.

GENERAL GEOLOGY

All the crystalline rocks of the area, except for the Proterozoic Sakami Formation, form part of the Superior Province of the Precambrian Canadian Shield. The rocks present in the area represent the typical assemblage of volcano-sedimentary rocks and associated granitic rocks typical of Archean geology observed in this tectonic province. The majority of the rocks in the southern, southeastern and east-central parts of the area are metavolcanic and metasedimentary, and form the oldest exposed rocks. They have been intruded by plutonic rocks, varying in composition from diorite to quartz-diorite to granodiorite to granite, which occupy large portions in the northern, southwestern, central and east-central parts of the area. All these rocks have suffered deformation and metamorphism during the Kenoran Orogeny around 2500 million years ago. The grade of metamorphism ranges from greenschist facies to lower amphibolite facies. The major structural trend is WSW-ENE. The dykes of gabbro, pegmatite and quartz veins are the youngest rocks.

Unmetamorphosed Proterozoic rocks of the Sakami Formation, consisting mostly of sandstone, arkose, mudstone, siltstone and conglomerate, form two outliers in the map-area.

TABLE OF FORMATIONS

QUATERNARY	Fluvial, marine, glacial and fluvio-glacial deposits	Sand, gravel, clay, silt, moraine, boulders and string-bogs
PROTEROZOIC	Sakami Formation	Pink to white sandstone Orange to pink sandstone Reddish conglomerate, arkose, mudstone and siltstone
ARCHEAN	Dykes	Diabase and gabbro dykes, Pegmatite dykes and masses - mostly unmetamorphosed
	Acid to Intermediate Plutonic Rocks	Granite-coarse grained, pink, massive to foliated, with minor variations to granodiorite and quartz-diorite Quartz-diorite-granodiorite with minor diorite and granite Granite-coarse to very coarse grained white to pink to red, in general migmatitic in origin
	Metasedimentary Rocks	Iron Formations Migmatites after the metasedimentary rocks Metasedimentary Rocks-rusty brown weathering and friable when weathered, with minor bands of basalt and amphibolite
	Volcanic Rocks	Rhyolitic tuff with interlayered basic lava and metasediments Intermediate lava-andesitic to dacitic, with minor interlayered basic lava and metasediments Ultrabasic Rocks-pyroxenites, pedotites, serpentinites and their metamorphosed equivalents Amphibolite and coarser gabbroic portions of basic lava Basic lava-predominantly basalt, with minor bands of interlayered metasedimentary rocks, intermediate to acid lavas and tuffs. In places coarse grained gabbroic and amphibolitic

VOLCANIC ROCKS

Among the volcanic rocks of the area, basalt is the most predominant member accounting for more than 95% of the volcanic rocks. Other volcanic rocks, present in minor amounts, associated with basalts include ultrabasic rocks, basic tuff, andesitic to dacitic to rhyolitic lavas and tuffs. The intermediate to acid volcanics occur either as small mappable units or as unmappable bands interlayered with the basic volcanics. In addition, there is always a small amount of interlayered metasedimentary rocks associated with all of these volcanic rocks. The volcanic rocks are also found interlayered with the metasedimentary rocks.

The volcanic rocks vary considerably in their state of metamorphism in different parts of the area. They are generally well foliated. The volcano-sedimentary rocks form several important belts with trends varying from NE-SW to ENE-WSW to E-W. Many of them can easily be picked up on the aeromagnetic maps by the characteristic high magnetic anomaly.

Basalt is generally grey-green on the weathered surface and when fresh it is very dark grey to black or grey-green to very dark green in colour, fine to medium grained, massive to well foliated or even schistose and generally has a good layered structure. In places, some layers are coarser grained and thus gabbroic in character. Metamorphism and accompanied recrystallization has resulted in an increase in their grain size and a change in their original composition. In most places the original pyroxenes have been transformed to actinolite, epidote, chlorite, biotite and calcite. The plagioclases have also suffered saussuritization and sericitization to varying degrees. However, in some localities near Sakami, Pat, Atilla, Duncan and Yasinski lakes well preserved to deformed pillows have been observed and where top determinations can be done in some cases.

Near the western shore of Sakami lake, where well preserved pillows were observed,the outcrop of basalt is extremely black and the weathering crust is light green. The pillows are approximately of equal size (18 inches by 12 inches) and have "Tails" preserved. The latter give direction of younging to the north. The black glassy margin around the pillows is ½ inch to 1 inch thick, and there is a concentric foliation, but no vesicles were noted. Interbedded with these volcanic rocks are metasediments which are the typical paragneiss type, with quartz + plagioclase + biotite ± muscovite as essential minerals, and which are quite extensive east of Sakami lake. These metasediments weather readily to a dirty brown colour and the whole rock may become friable. Some bands of feldspathic quartzite were also noted interbedded with the basalt. Bands of quartz-magnetite iron formation are also present interlayered with the volcano-sedimentary rocks of this area and show excellent development of minor folds. These iron formations are probably a continuation of the iron-formations found just northeast of Collado lake. Together they form an important area of iron occurrence which was unknown before.

Two belts of volcanic rocks are mapped near Duncan lake, one to the south and east with an E-W to ENE-WSW trend, and the other in the north trending NE to NNE.

The northern belt of Duncan lake is mainly composed of typical basic volcanics with a platy or blocky appearance and a rusty weathering crust. The fresh surfaces are usually grey-green. In some cases the foliation planes have a smooth soapy appearance due to the presence of abundant chlorite. Lenses and blebs of calcite are very common throughout the sequence. Near the southern portion of this belt there are several zones of very finely banded rocks which show light and dark green colour on the weathered surface. The bands may be upto 10 cms in thickness and probably represent a series of bedded basic tuffs. These tuffs are very well folded. The contact between the basalts and the granitic rock is well defined. As the contact is approached, the volcanic rocks contain numerous injections of the granitic material. The granitic rocks, which are mostly quartz-diorite to granodiorite in composition, contain only occasional xenoliths of basalt.

The east-west trending belt which passes through the southern and eastern parts of Duncan lake contains very little tuffaceous material. Here again the weathering crust of basalt is generally rusty or light green. The rock has a platy appearance where foliation is well developed. Lenses and streaks of calcite are common throughout the sequence. Blocks of volcanic material are quite common in some layers in the southern part of Duncan lake. The blocks may vary in size from 1 inch by 2 inches to upto 18 inches by 12 inches, and they also vary in angularity - some being very angular and others quite rounded. These fragments may represent either volcanic bombs or volcanic breccia. Deformed pillows, varying in size from 9 inches by 5 inches to 2½ feet by 1 foot and with about ½ inch thick glassy margin have also been observed here, but their "tails" have all been lost.

A large magnetic anomaly occurs on the aeromagnetic map for the southern part of Duncan lake and is proved to be caused by the presence of a very important sequence of impure quartzite and quartz-magnetite iron formations described in detail in the economic geology chapter. The rock outcrops here are very rusty weathering, smooth and polished. There is roughly equal proportion of magnetic and non-magnetic material layers.

The big volcanic belt which starts from south of Bruce lake and extends eastward through Yasinski, Pat and Beaver lakes is also mainly basalt although some tuffaceous material does occur. The basic lava in general has a rusty weathering crust but can also be grey-green or light green on the weathered surface. The fresh surface is usually dark green to dark grey in colour. Well preserved to badly deformed pillows have been observed in several places along the length of this belt. Small calcite lenses and pods are common. Some lavas of lighter grey-green, light grey to grey-pink colour have been observed interlayered with basalt and may be andesitic to dacitic in composition. Bands of acid tuff, siltstone and metasediments have also been noted. Several thin bands of quartz-magnetite iron formation are present near Pat lake and north of Beaver lake. (Figures3 & 4)

Similarly the belt of volcanic rocks which traverses a major part of the area in an east-west direction, starting from north of Duncan lake through north of Atilla lake and then passing through Long lake is composed predominantly of basalt with minor intermediate to acid lava and tuffs especially in the Long lake area. Mills (1967) also mapped iron formation bands in the Long lake area. In addition, important occurrences of previously unknown iron formations have been located to the

Figure 3 - Bands of siltstone and metasediments interlayered with the basalts near Pat lake.

Figure 4 - Bands of metasediments and iron formations interlayered with the basalts near Pat lake.

north and west of Atilla lake.

The volcanic belt mapped in the eastern part of the map area is northeastward continuation of the belt mapped by Mills (1972, 73) in the Sakami lake areas mapped in 1965 and 1966. The belt has a general NE-SW trend and shows the development of a synform near its eastern extremity. The belt is predominantly composed of fine to extremely fine grained basalt with dark green to black colour in fresh surface. Some thin bands of intermediate lava, acid tuff, siltstone, greywacke and paragneiss have also been observed in places.

Petrography

Petrographic study of the metabasalts from different parts of the area indicates that these rocks are generally fine to very fine grained. The average grain size varies from 0.1 mm to 2.5 mm. The texture is equigranular, with the quartzofeldspathic minerals showing polygonal mosaic texture, whereas the amphiboles show a good nematoblastic texture and thus define a foliation in the rock. The amphibole is generally actinolite or hornblende. Actinolite is very light green in colour, only faintly pleochroic and occurs in long prismatic crystals. The hornblende is pleochroic from light greenish yellow to dark bottle green colour. The amphiboles show alterations to biotite, chlorite, epidote (pistacite, clinozoisite) near their grain margins or along cleavage traces. The plagioclase is generally highly saussuritized and sericitized, and is often completely replaced by a combination of epidote, sericite, muscovite and calcite grains. But in some cases the plagioclase grains with polysynthetic twinning can be observed. Quartz is present in minor amounts. The accessory minerals present include iron-oxides, pyrite, zircon, sphene etc. In some cases the fractures in the rock are filled by calcite.

The metabasalt of the volcanic belt in the eastern part of the area is fine to extremely fine grained, very dark in colour and quite dense. Petrography of these basalts suggests that these rocks must be near the limit of devitrification as they are composed of extremely fine grained minerals in which chlorite needles, epidote with vague crystal outlines and rare actinolite needles are the only identifiable minerals. In some thin sections calcite was also observed.

The metabasalts from the Sakami lake area are rather coarser and amphibolitic in composition. The rock shows a granoblastic texture and the amphibole is generally hornblende. In a thin section of the metabasalt from this area clinopyroxene is found associated with hornblende The rock possesses a polygonal mosaic texture. The hornblende and clinopyroxene grains have the same habit of occurrence which leads to believe that the two minerals recrystallized together during metamorphism. The hornblende is pleochroic from greenish yellow to dark green colour and shows brownish interference colours. The clinopyroxene is very pale green in colour, nearly non-pleochroic and shows strong birefringence. The plagioclase of the rock is more or less completely saussuritized and is dotted with sericite needles and epidote grains. Minor amount of epidote, chlorite and biotite is also present.

In another thin section of the metabasalt from the Sakami lake area garnet was also observed associated with clinopyroxene and hornblende. The garnet is highly xenomorphic and poikiloblastic, and has a rather unique pinkish-orange colour.

Intermediate to acid lavas and tuffs

The intermediate to acid lavas (andesite, dacite and rhyolite) and tuffs (mostly rhyolitic)are generally lighter in colour in comparison to the basalts. They vary in colour from dark grey to grey-green, grey-pink to pink. They are characterized by the abundance of quartzo-feldspathic minerals, porphyritic texture, trachytoidal texture etc. The various tuffs of the area preserved their original finely layered nature by which they can easily be identified in the field. All these rocks present themselves in bands interlayered with basalts and account for less than 5% of the total volcanic rocks.

Petrographically, the intermediate lavas are characterized by the scarcity of amphibole and the abundance of epidote (pistacite and cli-nozoisite), chlorite, biotite and quartzofeldspathic minerals. Here again the plagioclase shows intense saussuritization and sericitization, whereas microcline remains quite fresh.

The rhyolitic volcaniclastic rocks are commonly dark grey in co-lour, massive looking, and have the aspect of an aphanitic rock in fresh surface. It shows a weathering crust, upto 5 mm in thickness, which is buff or pinkish in colour. This weathered crust shows the tuffaceous character of the rock. In thin section these rocks are characterized by quartzofeldspathic composition, scarcity of mafic minerals, and by the porphyritic texture shown by the presence of quartz, plagioclase and microcline phenocrysts set in a microcrystalline mosaic of recrystallized quartz and feldspar. The average grain size of the matrix varies from 0.005 mm to 0.1 mm, whereas the average grain size of the phenocrysts varies from 0.35 mm to upto 3 mm. The phenocrysts many be euhedral, subhedral or subrounded. Recrystallization of the rock appears to be the factor responsible for the modification of the shapes of phenocrysts, although in many cases sharp edges are well preserved. Most of the quartz phenocrysts have recrystallized into an aggregate of polygonal quartz grains. Some rare feldspar phenocrysts indicate the presence of zoning. Microcline phenocrysts are well twinned and fresh. Plagioclase phenocrysts show polysynthetic and carlsbad twinning, and exhibit the effects of saussuritization and sericitization to varying degrees. The intensely altered plagioclase phenocrysts are more or less completely replaced by a combination of sericite, muscovite, epidote, calcite etc. In many cases the quartz and feldspar phenocrysts show the effects of corrosion and fracturing caused by the surrounding matrix. In thin section, the rock also shows the presence of numerous, sub-parallel, closely spaced lines of variable thickness which predominantly contain minutely crystalline epidote grains. These zones appear to be close to the limit of devitrification. This feature probably reflects the extremely thinly layered tuffaceous character of the rock. Other minerals that may be present include chlorite, muscovite, epidote, sericite, iron oxides, calcite and rarely actinolite, biotite etc.

Ultrabasic Rocks

The Ultrabasic rocks, principally peridotites, serpentinites and pyroxenites, occur as lenses, pods, masses or bands associated with the volcanic belts at several locations in the map-area. Their largest occurrence is near the eastern end of Beaver lake. The peridotites show extensive serpentinization and in some places there is development of asbestos (chrysotile) and talc. The pyroxenites are now changed to hornblendites and are composed essentially of hornblende with only minor amounts of biotite, chlorite, epidote, calcite, etc.

The serpentinized peridotite is massive, dark grey in colour, with a slight greenish tinge. It usually has a thin weathered crust, 3 to 5 mm thick, which is brownish or rusty in colour. It has a soft soapy touch in hand specimen when it is rich in talc. The netted structure resulting from the alteration of olivine to serpentine may be visible on the weathered surface.

In thin section the serpentinized peridotite is predominantly composed of serpentine (antigorite) with only very minor amount of relic olivine. The original shape of the pre-existing olivine crystals may be identified by the distribution pattern of the clusters of iron oxide grains. Some iddingsite is also observed associated with olivine. Talc occurs in platy or fibrous forms. The fibres of talc are extremely fine and show radiating, parallel or intertwined growth. Chlorite, calcite, tremolite may also be present. Chlorite is pleochroic from nearly colourless to light green colour and shows brownish or bluish interference colours. Calcite forms numerous patches.

In a few places veins of very young pyroxenite emplaced parallel to the foliation of metabasalts were observed. The veins are green in colour. In thin section it shows an excellent example of cumulate texture characterized by the occurrence of euhedral to subhedral crystals of clinopyroxene with their interstices occupied by plagioclase. The clinopyroxene is very pale green in colour, practically non pleochroic and is commonly twinned. The plagioclase is well twinned and only partly saussuritized.

The volcanic rocks are older than the quartz-diorite, granodiorite and granite as evidenced by the presence of numerous xenoliths of volcanic rocks observed in the younger granitic rocks, most particularly near Pat, Duncan and Atilla lakes. Even in outcrops where the volcanics are the main rock types, the quartz-diorites and granites show intrusive relationships.

Chemical Analyses

The results of chemical analyses for the basalts of the area are presented in Table I. The analyses indicate that the basalts are tholeiitic in composition.

	KS-5A	PB-351B	CD-337	DM-289A	KS-9A	KS-20B
SiO_2	50.10	49.50	49.70	55.15	52.75	53.25
Al_2O_3	15.15	14.40	14.90	17.30	13.25	17.65
Fe_2O_3	3.86	3.45	1.63	2.00	3.87	4.72
FeO	8.78	8.25	10.00	6.10	6.55	3.39
MgO	6.14	7.50	6.75	4.10	8.05	3.15
CaO	10.06	12.35	13.14	8.05	8.25	9.78
Na_2O	2.67	2.10	0.85	3.60	2.81	3.97
K_2O	0.24	0.19	0.14	0.94	0.67	0.98
H_2O-	0.09	0.10	0.08	0.11	0.09	0.09
H_2O+	1.53	1.53	1.06	1.40	1.22	1.87
TiO_2	1.40	0.98	0.90	0.95	0.75	1.17
P_2O_5	0.11	0.08	0.07	0.19	0.33	0.09
MnO	0.23	0.20	0.21	0.16	0.21	0.28
CO_2	0.03	0.06	0.10	0.04	0.24	0.07
S	0.08	0.03	0.01	0.02	0.01	0.07
	ppm	ppm	ppm	ppm	ppm	ppm
Cu	80	87	11	42	39	80
Zn	100	74	72	73	88	55
Ni	88	68	110	120	83	45
Cr	100	212	180	110	330	130
U	-	-	-	-	-	-
Rb	10	9	7	43	63	31
Zr	79	50	50	118	82	70

Table I - Chemical analyses of Basalts

METASEDIMENTARY ROCKS

The metasedimentary rocks of the area present themselves, as the volcanic rocks, in E-W to ENE-WSW trending belts. The areas mapped as composed of metasedimentary rocks almost always contain a certain amount of interlayered volcanic rocks. Similarly, some metasedimentary rocks are present in areas mapped as volcanic belts.

Among the metasedimentary rocks two principal varieties of paragneisses have been identified based on their lithological character. The paragneisses occurring in the southern parts of the area are well layered, commonly rusty weathering,fine to medium grained, friable and much more migmatized than the paragneisses occurring in central parts. They are commonly associated with varying amounts of white to pink granite and pegmatite of migmatitic origin and show the development of garnet porphyroblasts in places. It is quite common to observe a complete gradation from good paragneisses to migmatite to granite based upon the percentage of the mobilizate present. Some outcrops may entirely be composed of white or pink granite with little evidence of the presence of paragneisses. In the Sakami lake area it was possible to separately map the areas consisting mostly of this kind of granite with some associated migmatites and paragneisses.

A part from a few bands of volcanic rocks, the rest of the area near Sakami lake consists basically of two rock types - granites and paragneisses. There is a distinct relationship between these two rock types and the topography. In general, the granites form the high ground and rounded hills, and the paragneisses occupy the intervening hollows. Over most of the area the granites are easily recognizable on the airphotos by their white appearance. The outcrops of granites are well rounded and often quite smooth despite the coarse grained nature of the rocks. Lichen is also quite a common covering. The rounded hills often show exfoliation type jointing. The granites are massive to well foliated, white to pale pink to rarely red in colour, coarse to very coarse grained and even pegmatitic in places. There is, however, considerable variation in grain size, colour and texture in different parts of the area. Both coarse and finer grained granites occur with a texture varying from equigranular to porphyritic, and in some places graphic. Lenses, bands and xenoliths of paragneisses are quite common and there is a gradation from this granite to migmatite to paragneisses. The granites have quartz,potash feldspar, plagioclase, biotite and/or muscovite as essential minerals. Biotite shows alterations to chlorite. It is believed that the granites in this part of the area are in large part of migmatitic origin.

The paragneisses of Sakami lake area are fine to medium grained, well layered - the layering being shown by variations in the content of biotite and/or muscovite. Their outcrops are generally smooth, flat, although occasionally small cliffs do occur. The weathering crust is generally rusty-brown and may be quite thick. In some cases the rock has become very friable. The fresh rock is light to dark grey in colour with a good lineation on the foliation plane. Minor folds are quite abundant. The essential minerals are quartz-plagioclase-biotite-and/or muscovite and only occasionally hornblende. Garnet porphyroblasts have been noted in some localities.

These paragneisses show migmatization to varying degrees by the presence of white to pink, coarse mobilizate of granitic composition.

It causes the rock to become a migmatite in places with very good ptygmatic folding and then passes into a rock of granite composition described above. In this general area the granites, migmatites and paragneisses are all intimately associated and at the present scale of mapping it is very difficult to make an attempt to separate them in any great detail. Therefore, an attempt has been made to separate areas which are predominantly paragneisses and areas which are predominantly granites and migmatites. Hence, in areas mapped as paragneisses there are zones which may be migmatites or even granites. Similarly, in areas mapped as granite there are numerous remnants or inclusions of paragneisses and migmatites. A certain amount of volcanic rocks-mainly basalt and amphibolite - also occurs as thin bands interlayered with the paragneisses. Bands of impure quartzite, light grey to white in colour, also make up a small part of this sequence.

The second variety of metasedimentary rocks forms several E-W to ENE-WSW trending belts in the map-area. Their most important development is south of Duncan lake, south and east of Alder lake, near Yasinski and Bruce lakes, and in the east-central parts of the area. They are also found interlayered with the metavolcanic rocks. These paragneiss are rather more homogeneous, quite fresh and sometimes interlayered with quartz-magnetite iron formations of varying thickness. These metasediments generally have a light grey to whitish weathered surface. The fresh rock is light to dark grey in colour, fine to medium grained, well foliated and composed essentially of quartz, plagioclase, microcline, biotite, and/or hornblende, epidote, chlorite etc. Pink garnet has been observed in a few localities. The thickness of bands may vary from a few inches to upto 10 feet or more. The banding may also be caused by the presence of more frequent bands of basalt or amphibolite (Figures 5& 6). On air-photos these paragneisses can easily be differentiated by a distinct lineation combined with well developed roches-moutonnées and very light tone. A certain amount of mobilizate is present either lit-par-lit or in lenses parallel to foliation. The amount of this mobilizate is much less in comparison to the mobilizate observed in the metasediments around Sakami lake. (Figure 7)

A variation of the second category of paragneisses has been noted northwest of LG-3 in an area around Marc, Diane and Bruno lakes. These rocks are quite leucocratic and possess a good streaky texture shown by biotite streaks. The rocks show very minor amount of rusty weathering. They are interlayered with bands of very fine grained amphibolites with a good lineation shown by amphibole needles. These amphibolites most probably represent metamorphosed basalts.

Because of complete recrystallization it is now very difficult to speculate about the original character of these paragneisses before metamorphism. However, in many places good examples of metasedimentary rocks which may be classified as graywacke, siltstone and argillite have been noted interlayered with the metavolcanic rocks and the iron formations. These metasediments show only minor effects of recrystallization and preserve their original sedimentary textures and structures. When fresh, they are light grey to dark grey in colour and without the greenish tinge as observed in the metabasalts. The rocks are fine to extremely fine grained. They often possess a very finely layered structure. Pink to red garnet porphyroblasts have also been noted in a few localities.

The quartz-magnetite iron formations show a very good layered

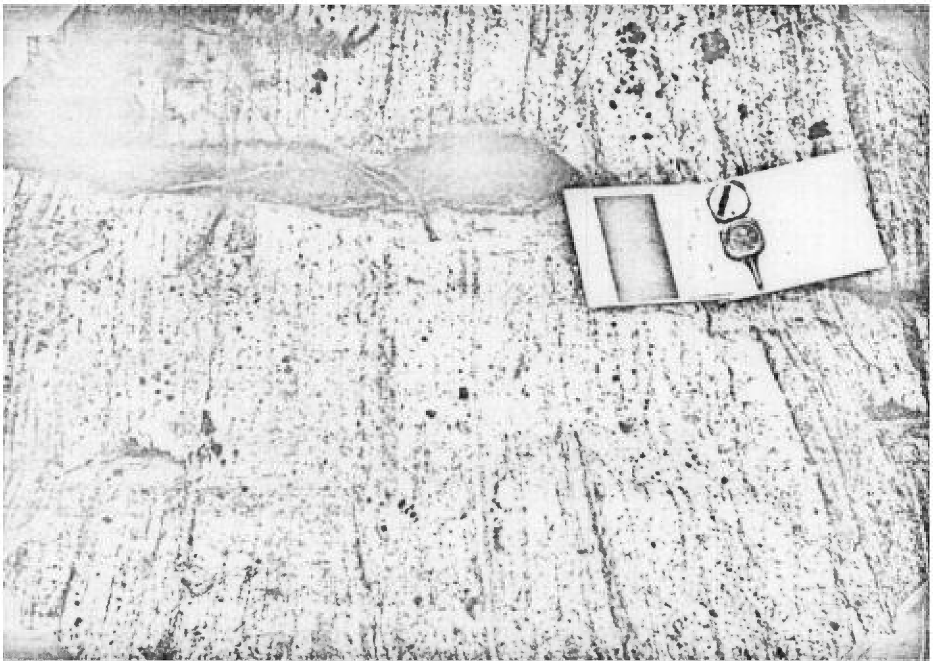

Figure 5 - Well foliated and thinly layered metasedimentary rocks, west of Diane lake.

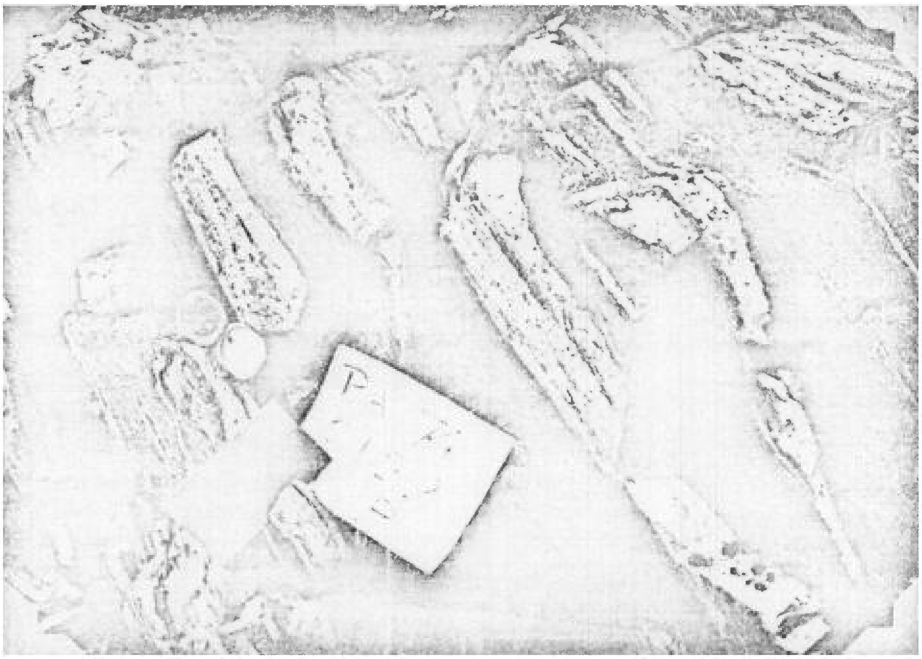

Figure 6 - Interlayered metasedimentary rocks and amphibolites, west of Diane lake.

Figure 7 - Strongly migmatized metasedimentary rocks, west of Diane lake.

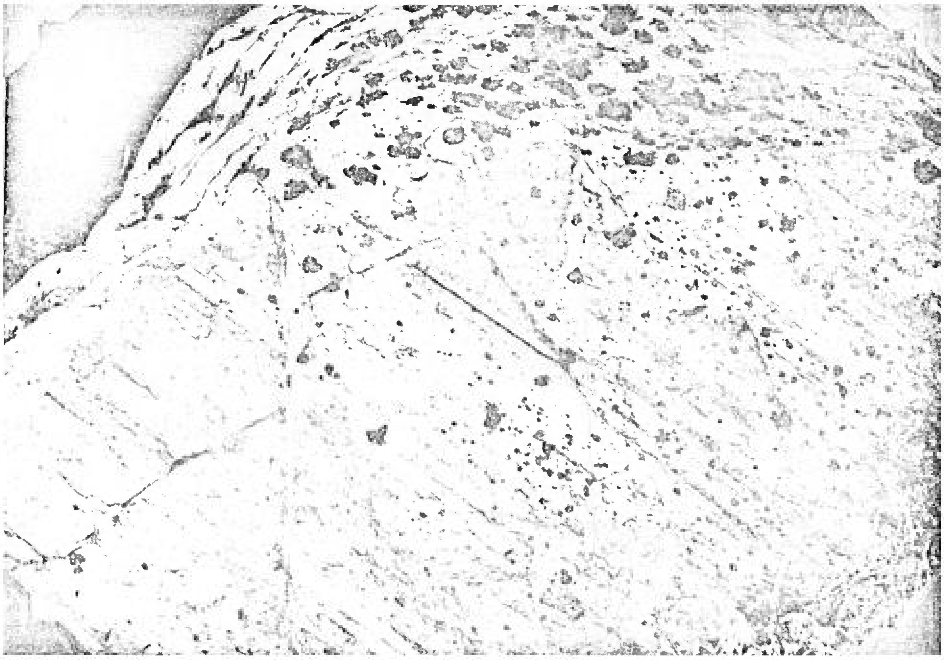

Figure 8 - Metasedimentary rocks with good microcorrugation lineation on the foliation plane.

structure defined by the presence of magnetite rich layers and quartz rich layers. The quartz is probably recrystallized chert. Some disseminated pyrite is also present. The iron formations vary in thickness from a fraction of an inch to several hundred feet. In places, the iron formations are quite intricately folded. (Figures 9 & 10)

Petrography

The paragneisses in Sakami lake area are fine to medium grained, the grain size varying from 0.1 mm to 1.5 mm. Their texture is granoblastic with polygonal quartzofeldspathic grains and lepidoblastic biotite and muscovite. Quartz is the predominant mineral. The plagioclase is saussuritized and sericitized to varying degrees, some grains may even be replaced by a combination of epidote, sericite, muscovite, calcite etc. Microcline may or may not be present. The biotite is the main mafic mineral. It is pleochroic from pale straw yellow to dirty green or in some rare cases to reddish brown colour. It shows alterations to chlorite and epidote. Many of the biotite flakes show pleochroic halos around zircons. Other mafic minerals that may also be present are amphibole, muscovite, chlorite, epidote (pistacite and clinozoisite), garnet etc. When present, the amphibole usually shows pleochroism from pale greenish yellow to bottle green colour. The accessory minerals include iron-oxides, zircon, sphene, apatite, allanite, pyrite etc.

The bands of quartzite interlayered with the paragneisses of Sakami lake area are quite fine grained with an average grain size of 0.5 mm. The texture is granoblastic - the quartz grains show well developed polygonal mosaic texture. The feldspans are rare and muscovite is the chief micaceous mineral accompanied by very minor chlorite.

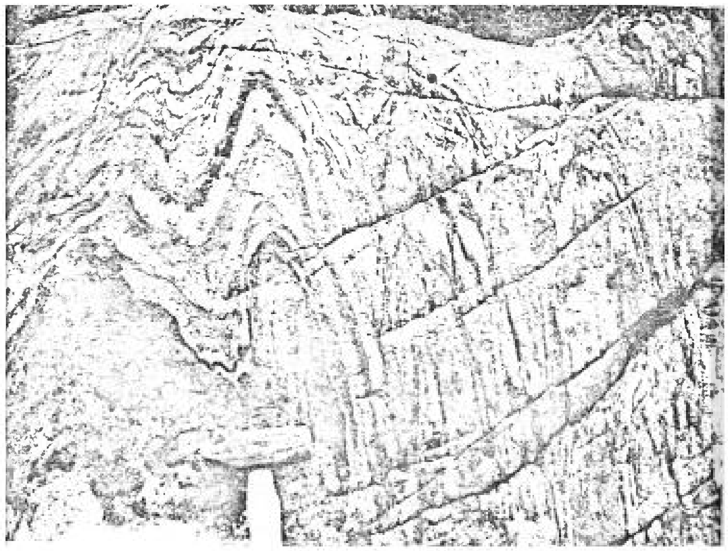

Figure 9 - Layered structure and folding observed in the iron formations.

Figure 10 - Intricately folded iron formations.

In the garnetiferous paragneiss from one locality the presence of orthopyroxene was noted. The orthopyroxene occurs in large grains, whereas the garnet is highly xenomorphic and poikiloblastic.

In some metasediments interlayered with the iron formations of Sakami lake area, there are certain garnetiferous schistose layers which contain garnets upto ½ inch in diameter. In these schists the garnet is subhedral to anhedral and highly poikiloblastic. The garnets are set in a matrix composed of chlorite, tremolite, actinolite, quartz and biotite. The accessory minerals are zircon, iron-oxides and calcite. These rocks generally show highly crumpled schistosity.

The second variety of paragneisses are petrographically identical to the paragneisses of the Sakami lake area. They are also characterized by a granoblastic texture demonstrated by xenoblastic to polygonal quartzofeldspathic grains. The quartz content generally exceeds the feldspars, but in some cases quartz and feldspar may be present in equal proportions. Plagioclase is the main feldspar accompanied by minor microcline. The plagioclase is saussuritized and sericitized to varying degrees, but good polysynthetic twinning is observable. Microcline grains are fresh and well twinned. Lepidoblastic biotite is the common mafic mineral accompanied by nematoblastic amphibole in places. These mafic minerals define a good foliation in the rock. The biotite is pleochroic from straw yellow to dark greenish brown or dirty green colour. The hornblende is pleochroic from light greenish yellow to bottle green or dark green colour. In a few localities pink garnet is also noted. The biotite and amphiboles show alterations to chlorite and epidote. The epidote is also present in independant grains. Muscovite and chlorite may also be present. The accessory minerals include zircon, sphene, apatite, iron-oxides etc.

The metasediments that may be classified as metagraywacke are extremely fine grained (0.05 mm to 0.1 mm or finer), dark grey in colour and show some shiny reflections in hand specimens due to the presence of quartz. In thin section the rock is characterized by mosaic texture shown by polygonal quartzofeldspathic grains and by fine disseminations of iron-oxides. The quartz content is superior to that of plagioclase and microcline. In general the plagioclase grains are saussuritized, but the lamellar twinning may still be observed in some grains. Lepidoblastic or randomly oriented minute flakes of biotite constitute the main mafic mineral. It is pleochroic from straw yellow to dark brown or dirty dark green colour. It shows alterations to chlorite. Epidote is also common. The iron-oxides are uniformly disseminated and may compose upto 5 to 7% of the rock. Muscovite has been observed in some thin sections. The accessory minerals include iron-oxides, pyrite, calcite, sphene etc. In some cases garnet porphyroblasts which are quite euhedral and devoid of inclusions are also noted, whereas in others the garnets are highly poikiloblastic with a preferred orientation of quartz inclusions which define the existence of an earlier planar feature in the rock before the development of garnet porphyroblasts. In both cases the foliation of the rock wraps around the porphyroblasts.

The siltstones are equally extremely fine grained, with their average grain size varying in the range 0.05 mm to 0.3 mm. In thin section the rock shows an extremely thinly layered nature shown by variations of grain size in individual layers and by slight variations in the content of mafic minerals which are mostly muscovite and epidote. The rock texture is polygonal mosaic. Quartz is the predominant mineral. The muscovite is highly lepidoblastic and defines a foliation parallel to the layering. It is probable that the majority of the plagioclase is replaced by epidote. The other minerals present in minor amounts are microcline, actinolite, sericite, iron-oxides etc.

The quartz-magnetite iron formations of the map area are characterized by a thinly layered structure consisting of magnetite rich and quartz rich bands. The latter may be termed as quartzites, The individual bands may vary in thickness from a fraction of an inch to several feet. The quartzite is white or light grey in colour and usually with a rusty staining due to the presence of interlayered iron ~~formations~~ bands. Even within these quartz rich bands there is a layering shown by variations in grain size of quartz grains. The quartz rich bands show an excellent mosaic texture of polygonal quartz grains. These layers contain quartz as the only mineral with only a few grains of magnetite or grunerite. The mafic layers may be composed of magnetite, grunerite, or magnetite and grunerite with only a few grains of quartz. In the mafic bands composed of both magnetite and grunerite, the magnetite grains are interspersed with grunerite grains. The grunerite occurs in fibrous to sub-radiating or nematoblastic aggregates of prismatic crystals. The sections with oblique extinction (10° to 15°) show polysynthetic twinning and strong birefringence, whereas the sections with parallel extinction show low first-order colours. The twin lamellae are usually very thin.

The grunerite crystals occurring in magnetite rich layers are very small as compared to the ones occurring in grunerite rich layers. In only one thin section of the iron formation the amphibole present is riebeckite instead of grunerite.

PLUTONIC ROCKS

(Quartz-diorite, Granodiorite, Diorite, Granite and Monzonite)

The metasedimentary and metavolcanic rocks have been intruded by plutonic rocks with a composition predominantly in the quartz diorite-granodiorite range, but they may also be dioritic, granitic or even monzonitic in places. These plutonic rocks occupy extensive areas in the northern, central, southwestern and east-central parts of the map-area. The plutonic rocks show the effects of deformation and metamorphism by the development of cataclastic textures and foliation to varying degrees. In general, the plutonic rocks are more foliated and sheared in the vicinity of metasedimentary and metavolcanic rocks, and are quite massive or only faintly foliated away from their contact with these rocks. The granites appear to be the least deformed among the intrusive rocks. Inclusions of volcanic rocks were frequently observed in the plutonic rocks.

The change from a rock of quartz-diorite composition to a granodiorite composition is characterized by a slight increase in the potash feldspar content. Both these rocks are coarse grained, massive to foliated, occasionally porphyritic, and grey to grey-pink to pink in colour. In many places these rocks tend to acquire a greenish grey to a reddish grey colour which has been confirmed by petrographic study to be caused by highly saussuritized and sericitized nature of the plagioclase of these rocks. The coarse grained nature of the rocks is very clear in the weathered surface, which is very well pitted due to the weathering out of the softer amphibole crystals. The weathered surfaces are well rounded and the jointing is of a larger scale. The essential minerals present include quartz, plagioclase, potash feldspar, hornblende and biotite. The mafic content varies from 7 to 25% and quartz content from 5 to 30%. The varieties poor in quartz and richer in mafics give rise to a rock of dioritic composition. In places pegmatitic phases of these rocks are also present. All these rocks are traversed by numerous veins, patches, masses and dykes of younger granite-pegmatite. In the vicinity of metavolcanic and metasedimentary rocks they tend to be more foliated and may resemble a highly foliated quartzo-feldspathic gneiss.

Inclusions of rocks which are now amphibolitic in composition are quite common in the quartz diorite-granodiorite of the area. The amphibolites vary in grain size from fine to medium grained, with some varieties being coarse to very coarse grained. (Figure 11)

Granite occupies a large area in the northwestern part. Other masses of granite are mapped near Awichina lake, south of Duncan lake, near Pat, Yasinski and Bruce lakes, and east of Baldwin lake. The granite occurring in the northwestern part of the area is coarse to very coarse grained, porphyritic, generally massive to foliated, varying in colour from pink to grey-pink to occasionally red. The main minerals present are quartz, potash feldspar, plagioclase, hornblende and biotite. The quartz content varies from 10 to 30%, whereas the mafics vary from 5 to 25%.

The granite to the south of Duncan lake is generally massive and pink, with biotite as the predominant mafic mineral. The rough weathered surface is usually white to pink, whereas the fresh surface is pink to red. Pink phenocrysts of potash feldspar are common, as are small

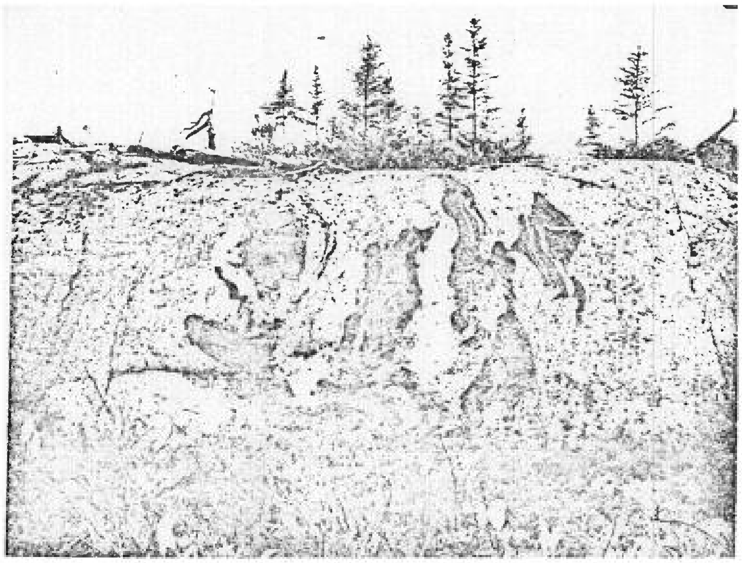

Figure 11 - Metabasalt inclusions in quartz-diorite

mafic xenoliths and hornblende rich streaks. The mafic xenoliths are of amphibolite.

The granite outcropping in the region of Bruce, Yasinski and Pat lakes is rather unique, compared to the other granites, by the fact that in the area northeast of Bruce lake it contains numerous euhedral and well zoned crystals of potash feldspar phenocrysts that may attain dimensions of upto 15 cms or more. The phenocrysts are not evenly distributed, but occur in concentrations in different parts of the mass. The zoning is visible even in hand specimens and is marked by the arrangement of mafic inclusions. The granite is pink, generally massive, the weathering crust is whitish pink and very rough. The main minerals present are quartz, potash feldspar, plagioclase, hornblende and biotite. This unit is conspicuous on air-photos by hummocky terrain and joint pattern which appear slightly concentric parallel to the pluton margin.

Petrography

The petrographic study of quartz-diorite, granodiorite and diorite shows that the massive unfoliated varieties of these rocks are generally equigranular and sometimes porphyritic due to the presence of euhedral to subhedral feldspar phenocrysts. In foliated varieties the foliation is shown by the streaky nature of the mafics, by the arrangement of individual mafic minerals, or by augen shaped feldspar. The highly foliated varieties may resemble the paragneisses of the area. The rocks are generally composed of xenoblastic quartzofeldspathic grains with highly sutured grain boundaries. They may show the effects of cataclastic deformation by the development of a mortar texture aruond the grain margins of quartzofeldspathic grains, by the strained quartz which shows lamellar extinction generally with a preferred orientation parallel to the foliation direction in the rock, and by broken and bent twin lamellae. The crushed and recrystallized portions show the development of polygonal texture.

In quartz-diorite plagioclase is the dominant feldspar which in majority of cases shows much saussuritization and sericitization, sometimes with the development of big grains of sericite, muscovite, epidote and calcite. It is only in less altered plagioclase or in unaltered remnants of plagioclase grains that the polysynthetic and carlsbad twinning may be observed. Sometimes it is possible to identify earlier traces of twin lamellae even in the saussuritized parts. The altered plagioclase has a dirty looking network of minutely crystalline sericite, epidote and calcite. In rare cases a good zoning has also been observed in the plagioclase. The quartz content is generally more than 10%. Microcline may be absent or present only in minor amounts. The microcline grains are fresh and well twinned. In some thin sections myrmekitic texture is observed in some plagioclase grains adjacent to microcline. The principal mafic minerals are hornblende and biotite.

Hornblende is strongly pleochroic from yellowish green to dark bottle green colour and shows different stages of alterations to biotite, chlorite and epidote either near its margins or along cleavage directions. Biotite is pleochroic from straw yellow to dirty greenish brown, and shows alterations to epidote and chlorite. Pistacite, clinozoisite and zoisite are the main minerals of the epidote group present. Chlorite is pleochroic from nearly colourless to pale green, and shows Berlin blue or brownish interference colours. The accessory minerals present include iron-oxices, apatite, zircon, sphene, allanite etc. Allanite forms the core of a few epidote grains. Radial fractures caused by radiation have been observed around some allanite grains. Zircon shows pleochroic halos in hornblende and biotite.

The highly cataclastic varieties of quartz-diorite possess a greenish colour, with shiny appearance on foliation planes due to the presence of sericite and chlorite. In these rocks the augen shaped feldspar phenocrysts are set in a fine matrix, with polygonal texture, resulting from crushing and recrystallization. The plagioclase of the cataclastic varieties of quartz-diorite is more or less completely replaced by sericite, epidote, calcite and muscovite. The quartz grains show strongly lamellar extinction and highly sutured grain margins.

Granodiorite is texturally similar to the quartz-diorite. It is only with an increase in the amount of microcline that the quartz-diorite becomes a granodiorite.

The rocks having a composition of a diorite are also present in some places. They are dark grey to grey to grey-pink in colour, equigranular to porphyritic and may be massive or foliated. Here again, the alteration of plagioclase gives rise to a reddish, pinkish or greenish tinge to the rock. The diorite is richer in mafics compared to the quartz-diorite. Quartz and microcline are either absent or present in very minor amounts. In thin section the rock is composed of subhedral to xenomorphic plagioclase and hornblende. The plagioclase commonly shows carlsbad twinning in addition to the polysynthetic twinning. In rare cases the plagioclase shows zoning. The plagioclase shows much saussuritization and sericitization accompanied with the development of sericite, epidote and calcite. Hornblende, showing strong pleochroism from yellowish green to bottle green colour, is the main mafic mineral, sometimes accompanied by biotite. Hornblende and biotite show alterations to chlorite and epidote. The accessory minerals include iron-oxides, apatite, zircon, sphene etc.

In some outcrops north of Atilla lake and in the northeastern part of the area, a very coarse grained porphyritic rock of monzonite composition has also been noted. These rocks are grey-pink in colour and contain numerous euhedral pink feldspar phenocrysts upto 2 cms in length. The carlsbad twinning of the feldspar is quite obvious in hand specimens. The bigger feldspar phenocrysts are mostly microcline, and the smaller phenocrysts are both plagioclase and microcline. The microcline phenocrysts are well twinned and commonly show patch-perthites. The exsolved plagioclase in the perthite and the plagioclase occurring as phenocrysts or in the matrix are highly saussuritized and sericitized. The feldspar phenocrysts are set in a medium to coarse grained quartzofeldspathic matrix. Quartz grains sometimes show lamellar extinction. Hornblende and biotite are the main mafics. Hornblende is more or less stable, but biotite shows alterations to chlorite and epidote. The accessory minerals include iron-oxides, sphene, zircon and apatite.

The granite encountered in areas mapped as quartz diorite-granodiorite and the granite occurring in the northwestern part of the map-area is pink to grey-pink in colour, equigranular to porphyritic, massive to faintly foliated. The porphyritic granites contain augen shaped microcline showing carlsbad twinning visible in hand specimens. Microcline is the predominant feldspar associated with very minor amounts of plagioclase

The quartzofeldspathic grains are xenoblastic. The microcline grains are fresh, well twinned and occur in different sizes. Some of the bigger grains are perthitic. Plagioclase shows polysynthetic and carlsbad twinning. It is partly saussuritized. The plagioclase grains adjacent to microcline show abundant myrmekitic texture. Quartz often shows lamellar extinction. The primary mafic minerals include hornblende and biotite. Hornblende is pleochroic from green to dark green colour and shows alterations to biotite and epidote. Biotite is pleochroic from straw yellow to dirty brown colour. It also shows alteration to chlorite and epidote. The accessory minerals are iron-oxides, allanite, zircon, sphene, apatite etc.

The granites outcropping west of Yasinski lake and south of Duncan lake are coarse to very coarse grained, pink, porphyritic. Microcline is the predominant feldspar, associated with minor plagioclase. The microcline grains show patch-perthites. The plagioclase occurring in perthites as well as the plagioclase forming independent grains is saussuritized. The plagioclase grains adjacent to microcline show myrmekitic textures. Augen and streaky textures are well developed in places and they define a foliation in the rock. Hornblende and biotite are the main mafics. They show alterations to epidote and chlorite.

The granite occurring in the Sakami lake area is closely associated with the metasedimentary rocks and migmatites. It varies in colour from pink to white, and is characterized by the scarcity of the mafic minerals. The rock is coarse to very coarse grained, often pegmatitic. Their texture is highly xenomorphic due to sutured grain boundaries of the quartzofeldspathic minerals. Well twinned microcline is the predominant feldspar. Sometimes it is perthitic, with the exsolved plagioclase showing saussuritization. Plagioclase occurs in well twinned grains, smaller than microcline and shows saussuritization and sericitization to varying degrees. It shows myrmekitic texture when in contact with microcline. Quartz occurs in variable grain sizes and in some cases shows lamellar extinction. Biotite and muscovite are the main mafic minerals, but hornblende may also be present in places. Biotite is pleochroic from pale straw yellow to dirty dark green colour and shows alterations to chlorite and epidote. Hornblende is pleochroic from pale greenish yellow to bottle green colour. In some white granites muscovite is the only mafic mineral present. In several places the presence of pink to red garnet, associated with the mafics, is also noted. The accessory minerals are iron-oxides, apatite, zircon, sericite etc.

Mafic inclusions of amphibolitic composition are frequently observed in the plutonic rocks of the area. The amphibolites are dark grey to black in colour, equigranular, well foliated, and composed of plagioclase and nematoblastic hornblende. The hornblende is quite fresh, but sometimes shows minor alterations to biotite, epidote and chlorite. Quartz is rare or is present in very minor amount. Iron-oxides, sphene, zircon and allanite are present as accessory minerals.

Chemical analysis.

Table II gives the chemical analyses of two representative samples of quartz-diorite.

	PA-39	PA-71
SiO_2	54.00	53.30
Al_2O_3	21.60	20.50
Fe_2O_3	2.00	1.26
FeO	2.85	2.79
MgO	2.65	3.46
CaO	9.30	9.36
Na_2O	6.60	5.96
K_2O	0.05	0.20
H_2O-	0.05	0.05
H_2O+	0.65	0.74
TiO_2	0.63	0.52
P_2O_5	0.17	0.78
MnO	0.07	0.07
CO_2	0.09	0.09
S	0.005	0.007
	ppm	ppm
Cu	10	16
Zn	45	38
Ni	39	61
Cr	44	48
U	---	---
Rb	<7	<7
Zr	116	37

Table II. Chemical analyses of quartz-diorite.

DYKES

The dykes of gabbro, diabase, pegmatite and quartz veins ~~are the youngest rocks of the area which~~ traverse all the previously mentioned rocks of the area. Most of the gabbro-diabase dykes are unmetamorphosed, although a few, older, metamorphosed and foliated gabbro-diabase dykes have also been noted. Some of the unmetamorphosed gabbro-diabase dykes are mappable and possess a general NW to NNW trend. Some of them can be traced for over 12 miles and vary in width from a few feet to 700 feet. Their weathered surfaces are dark brown to grey-brown, susceptible to roches moutonnées and are resistant to erosion. They show sharp contacts with the enclosing rocks. Many of the dykes show an extremely fine grained chilled margin. When fresh the rock is dark grey to nearly black or grey-green in colour. The grain size varies from fine to coarse, and the term diabase is used for finer grained varieties, and gabbro for the coarse grained varieties. Ophitic to subophitic texture is frequently observed. Compositionally they consist of plagioclase, pyroxenes, hornblende, biotite and iron oxides. The plagioclases of these dykes have suffered extreme saussuritization and sericitization. Greenish phenocrysts of plagioclase are quite common in many dykes and here again the greenish colour of the plagioclase is attributed to saussuritization. The clinopyroxene of the gabbros is very light green in colour and only faintly pleochroic. It shows alterations to hornblende, biotite and even to chlorite. Hornblende is pleochroic from light green to dark green. The primary biotite is typically reddish brown in colour with a pleochroism from very pale straw yellow to reddish brown colour. But, the biotite formed as a result of alteration of pyroxene and hornblende is dirty yellowish green in colour. Magnetite is the most important accessory mineral.

The chilled margin of the gabbro dykes is an aphinitic rock, nearly black in colour. Petrographically, it is characterized by an excellent porphyritic texture shown by the presence of well formed phenocrysts of plagioclase with sharp edges, and by phenocrysts of a mineral which probably could have been pyroxene and/or olivine but are now represented by clusters of light green chlorite. The phenocrysts are set in an extremely fine grained matrix with hyalo-ophitic texture i.e. randomly oriented microlites of plagioclase set in a glassy matrix.

Chemical analysis

Table III gives the chemical analyses of 3 gabbro dykes and 2 chilled margins. The dykes show a uniform composition. The sample DM-98A of gabbro and the sample DM-98B of the chilled margin from the same outcrop show identical compositions. Similarly the analysis of the sample RR-153B of a chilled margin gives more or less the same composition.

	RR-153B	DM-98B	DM-98A	PB-79	DM-40
SiO_2	47.00	48.50	47.90	48.20	48.40
Al_2O_3	14.93	14.65	14.88	14.40	13.65
Fe_2O_3	2.10	3.15	3.55	2.85	2.80
FeO	11.49	9.60	10.00	10.90	10.67
MgO	6.19	6.20	6.00	6.15	6.06
CaO	9.02	9.00	8.80	9.05	9.60
Na_2O	2.91	3.35	3.40	2.60	2.40
K_2O	1.15	0.95	1.14	1.34	0.90
H_2O^-	0.10	0.10	0.13	0.11	0.12
H_2O^+	2.64	2.32	2.25	2.13	2.32
TiO_2	2.06	1.65	1.90	1.80	1.71
P_2O_5	0.26	0.18	0.24	0.20	0.25
MnO	0.24	0.23	0.23	0.25	0.25
CO_2	0.13	0.07	0.10	0.10	0.20
S	0.21	0.33	0.13	0.17	0.25
	ppm	ppm	ppm	ppm	ppm
Cu	41	30	43	53	68
Zn	74	70	89	100	58
Ni	72	77	68	73	70
Cr	65	100	77	90	110
U	---	---	---	---	---
Rb	51	40	39	67	46
Zr	116	121	28	121	118

Table III - Chemical analyses of gabbro dykes and their chilled margins.

STRUCTURE AND METAMORPHISM

The metasedimentary and metavolcanic rocks of the area have been folded into major E-W to ENE-WSW trending structures and minor N-S to NNW-SSE trending structures. The metasedimentary rocks possess a good compositional layering and a well developed foliation parallel to it. The volcanic rocks, particularly the basalts, have been metamorphosed to fine to medium grained amphibolites with a well developed foliation in many places, however, the original characters of the basalts and a few well preserved pillows are easily identifiable. Also, the various tuffs preserve their original finely layered nature. The plutonic rocks have also developed a foliation to varying degrees in different parts of the area.

Because of the present scale of mapping and the difficulty of access to certain areas occupied by metasedimentary and metavolcanic rocks it was not possible to map the various structures in detail. However, to demonstrate the complexity of folding and the pattern of major folds present in these areas air-photos lineaments are presented on the geological maps. These lineaments clearly bring out the outlines of all the major anticlines and synclines, and faults present in the metavolcanic and metasedimentary rocks.

A study of the measurements of axes of minor folds and lineations, together with the distribution pattern of the metasedimentary and metavolcanic rocks, indicates the presence of two phases of folding. The major phase gave rise to tight E-W to ENE-WSW trending folds with moderate to steep plunges, whereas a later minor phase gave rise to rather open N-S to NNW-SSE trending folds in the region.

The grade of metamorphism ranges from greenschist facies to lower amphibolite facies, as evidenced by the frequent occurrence of epidote, chlorite, actinolite, muscovite in the metasedimentary, metavolcanic and plutonic rocks.

SAKAMI FORMATION

The Proterozoic rocks of the Sakami Formation outcrop near Coutaceau lake and near La Grande river east of LG-3. They are in faulted contacts with the surrounding Archean rocks. The faulting has resulted in the development of sheared and mylonitized zones, and has also caused the tilting of the rocks of the Sakami Formation which are otherwise subhorizontal and completely unmetamorphosed. The lower part of the formation consists of reddish conglomerate, arkose, mudstone and siltstone; whereas the upper part is orange, pink or white sandstone with well sorted quartz-sand and carbonate matrix. The conglomerates vary in thickness from a fraction of an inch to a few feet. The sedimentary structures observed include cross-bedding, mud cracks, rolling of mud sheets etc. The upper sandstones are possibly dune deposits as indicated by the presence of large scale cross-bedding. (Figure 12,13,14 & 15)

The conglomerates are reddish in colour and consist of angular to subangular pebbles of vein-quartz, iron formations, granitic rocks and argillaceous rocks of Sakami Formation in decreasing order of abundance. The pebbles of iron formations found in the conglomerates are predominantly hematite and hematite-jasper iron formations, but in a few places pebbles of magnetite iron formations have also been observed.

The sandstones show a variety of colours-orange, pink and white - but they are quite comparable in their composition. They consist predominantly of well rounded quartz grains, and very minor feldspar or rock fragments, set in a carbonate matrix and very rarely in an argillaceous matrix. In some thin sections the matrix shows the presence of a few sericite needles and epidote grains with very vague outlines. In

Figure 12 - The lower part of Sakami Formation consisting of reddish conglomerate and arkose. The rocks are steeply dipping and are in faulted contact with the Archean rocks. Location-south shore of Coutaceau lake.

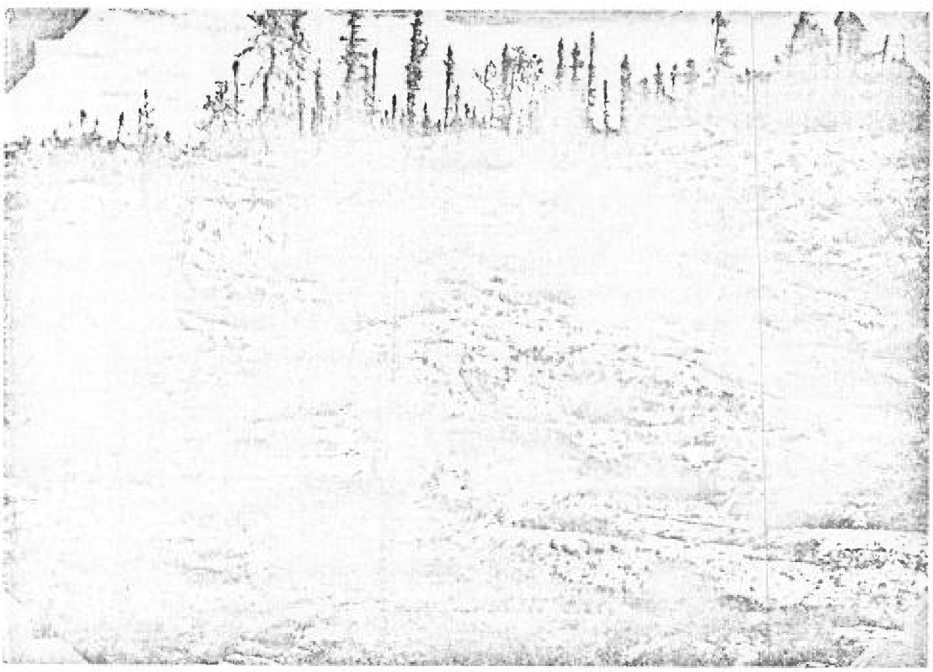

Figure 13 - Subhorizontal to gently dipping Sakami sandstone

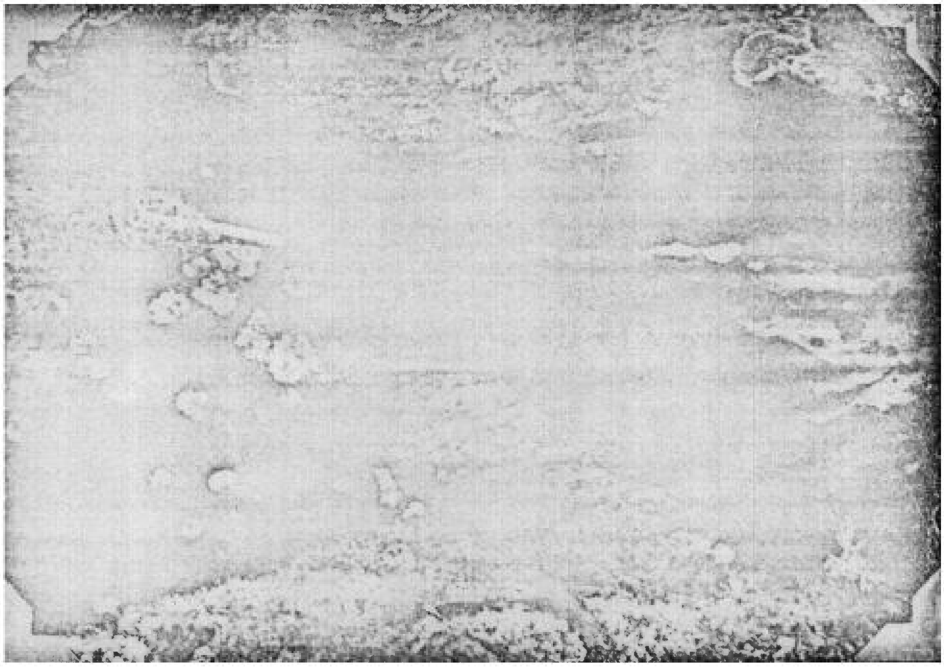

Figure 14 - Cross-bedding in Sakami sandstone

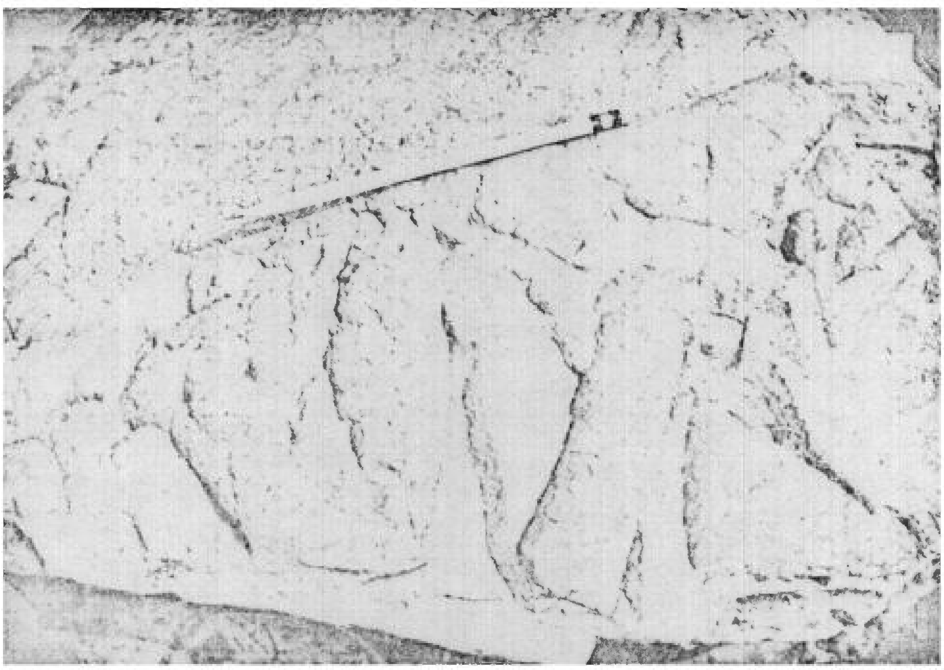

Figure 15 - Rolled mud-sheets with mud-cracks on the upper surface.

one thin section there is practically no matrix due to secondary overgrowth around the quartz grains, and the rock texture is now characterized by an interlocking aggregate of anhedral quartz grains. The quartz grains present in the sandstones vary in grain size from 0.05 mm to 1.0 mm, but with the majority of grains having a grain size of about 0.5 mm.

The chemical analysis of a representative sample of the most common pink sandstone is given in Table IV.

SiO_2	-	94.50
Al_2O_3	-	2.08
Fe_2O_3	-	1.23
FeO	-	0.06
MgO	-	0.34
CaO	-	0.07
Na_2O	-	0.65
K2O	-	0.30
H2O −	-	0.00
H2O +	-	0.07
TiO_2	-	0.06
P_2O_5	-	0.03
MnO	-	0.17
CO_2	-	0.07
S	-	0.008

Cu	-	16 ppm
Zn	-	4 "
Ni	-	9 "
Cr	-	46 "
U	-	< 1 "
Rb	-	14 "
Zr	-	100 "
Th	-	< 2 "

Table IV - Chemical analysis of Sakami Sandstone.

ECONOMIC GEOLOGY

The map-area consists of numerous volcano-sedimentary belts and associated plutonic rocks which represent a favourable assemblage of host rocks for sulphide mineralizations as well as for the banded iron-formations. They offer a good opportunity of discovering mineral occurrences similar to the ones already known to the south, in the mining areas such as Matagami, Chibougamau, Val d'Or and Noranda. The occurrence of the well known quartz-magnetite iron-formations of Duncan lake were known as early as 1949. Several mining companies have carried out extensive geological and geophysical exploration activity from 1958 to 1966, which led to the discovery of several interesting mineralizations. Their work was mostly confined to Yasinski, Long and Duncan lakes area. All known mineral occurrences of importance including the ones found during the present mapping project are briefly described here.

An area of about 546 square miles around Bruce, Yasinski, Beaver, Pat and Baldwin lakes was held under Mineral Exploration Licence No. 142, effective December 1958 by Main Exploration Company Limited. During the years 1958 to 1960 the company carried out prospecting, exploration, geological mapping, geophysical surveys, trenching, blasting, drilling and sampling. The geological work was carried out under the direction of A.B. Baldwin (1959). The geophysical work consisted of airborne electromagnetic and magnetometer surveys.

A prospecting team made the first mineral discovery about 400 feet south of Discovery lake. Subsequent prospecting revealed additional fourteen mineralized occurrences along a potential east-west trending zone 6000 feet in length and 1000 feet in width. Assays with up to 7.86% Cu, 6.54% Pb, 3.53% Zn, 0.99 ounces Au and 10.25 ounces Ag were reported by Baldwin.

Possibilities for sulphide mineralization were suggested near Anomaly lake.

Near Ultra lake Baldwin reports the existence of iron-formation bands, a long tabular body of peridotite and Cu-Ni sulphide mineralization north of the peridotite. Geophysics shows the sulphide conductors to occur over a length of 7000 feet and it may contain Cu-Ni sulphide mineralization. The sulphides, chalcopyrite-pyrrhotite-minor pyrite and galena-occur in patches. Flakes of native copper were also noted in oxidized portions of some patches.

An airborne electromagnetic anomaly about 2 miles in length was located west of Taylor lake. In its western part, this anomaly is known to be caused by rusty pyritic quartzites and iron-formations, weareas pyrrhotite is the common sulphide in its eastern part. Similarly, another airborne electromagnetic anomaly occurs near Morrison lake and is associated with a chalcopyrite-pyrite bearing brecciated zone about 7000 feet in length and from 5 to 100 feet in width.

A base metals mineralization zone about 2000 feet in length and upto 45 feet in width occurs near the east end of Beaver lake. The occurrence of chrysotile is also reported from the ultrabasic body found here.

Bands of magnetite iron-formations of variable extensions and disturbed by later granitic intrusions were mapped by Baldwin near the south shore of Pat lake. The iron-formation band was outlined by an airborne magnetometer survey. Its character is similar to the iron-formations of Duncan lake. The following assay is from a typical sample of the material:

Total Fe	-	40.0%
Acid soluble Fe	-	39.2%
Magnetic Fe	-	37.9%
Titania (TiO_2)	-	< 0.2%
Silica (SiO_2)	-	42.0%
Sulphur (S)	-	0.02%
Phosphorous (P)	-	0.03%

The iron-formation occurs at two main localities. Widths at both occurrences are over 200 feet. It is quite regular, strikes northeast and dips 60° towards the northwest. Baldwin calculates a potential tonnage of 96,000 tons of ore per vertical foot for the eastern deposit and 48,000 tons of ore per vertical foot for the western deposit. One 20 pound sample of this iron-rich material was subjected to a Davis Tube Test. The sample assay was satisfactory, but it was not possible to produce an acceptable grade of concentrate.

A small sulphide mineralization containing pyrite, chalcopyrite, sphalerite and galena occurs about 3000 feet west of Drum lake.

In 1961, when all the ground in this area held by Main Exploration Company Limited under concession was thrown open for staking several mining companies acquired claims and did exploration. These companies are listed here: Godfrey A. Clarke, St.Mary's Exploration Limited, Zulapa Mining Corporation Limited, Duvan Copper Company Limited, Northern Exploration Limited, Pennbec Mining Corporation, Demros Mines Company Limited, Duncan Range Iron Mines Limited, Bornite Copper Corporation, Grandroy Mines Limited, Mercury-Chipman Company Limited, Satellite Metal Mines Limited, Canadian Dyno Mines Limited, Vanguard Explorations Limited and International Helium Company Limited. Since the formation of James Bay Development Corporation in 1971, this government-owned company acquired the rights to develop and exploit all the natural resources in this area.

In 1961, Duvan Copper Company Limited claimed an area surrounding the Discovery lake where first mineral discovery was made by Main Exploration Company Limited. Later on Pennbec Mining Corporation claimed an area which consited of Discovery lake and areas to the south and east of the lake. J.A. Honsberger (1965) visited Pennbec property in September 1965 and did some sampling. Two channel samples taken by Honsberger across a true width of 13.0 feet in Trench No. 7 returned assay results as follows:

Width	Cu%	Zn%	Pb%	Au ozs.	Ag ozs.
0-5.5ft	0.15	2.40	5.35	0.01	3.50
5.5-13.0ft.	0.05	1.15	1.13	Tr	0.55

A chip-sample taken by Honsberger over the full 14 feet width of trenching on No. 1 vein returned following assay Values: -

Width	Cu%	Au ozs.	Ag ozs.
0-14.0 ft.	2.00	0.01	1.10

A channel sample taken by Honsberger across a 3.5 feet true width section on vein No. 8 gave the following results: -

Width	Cu%	Au ozs.	Ag ozs.	Bi
0-3.5 ft.	6.60	0.23	6.00	0.075

The area surrounding the occurrence of the famous "Duncan Range Iron Formations" were staked by J.C. Honsberger in March 1953 for Duncan Range Iron Mines Ltd. The area was covered by an airborne magnetometer survey. In the note associated with this map Honsberger states that, in the area outlined on this map, preliminary chip-sampling, surface prospecting, ground magnetometer surveys and metallurgical investigations have indicated 540,000,000 tons of magnetic iron ore suitable for open pit mining, grading 30 to 35% in iron, from which marketable concentrates have been produced. Later on in another report Honsberger (1961) mentions that in this northeast trending belt of volcanic rocks extending from the southeastern part of Duncan lake, to Lac Atilla (previously called Desaulniers lake) occurrences of quartz-magnetite iron formations are located. This area has been subjected to aeromagnetic, ground magnetic, sampling, geological and feasibility surveys by W.N. Ingham and H.U. Ross. The results of all the surveys indicate the availability of over 2 billion tons of magnetite iron-formation of an average grade of 32% soluble iron and suitable for open pit mining. Concentrates obtained from chip-samples taken from most of the iron deposits averaged 66.06% Fe, 6.6% silica, and negligible amounts of Ti, S, P or any other deterious impurities. This area was visited during the course of the present mapping work and seems to be most promising for iron in the area.

In a preliminary report on the claims of International Helium Company Ltd., situated in the eastern part of Duncan lake and adjoining to the north the claims held by Duncan Range Iron Mines Ltd., Honsberger

(1962) describes a pyrite mineralization with submarginal copper-nickel values in a zone 7500 feet by 2500 feet.

On september 26, 1961, a prospector working for Duncan Range Iron Mines Ltd. discovered an impressive copper showing on the south side of the peninsula on Long lake. Duncan Range immediately staked 55 claims surrounding this discovery. W.N. Ingham examined the discovery on October 21 & 22, 1961. He reports the presence of a sulphide replacement body lying in an east-west trending shear zone. Preliminary sampling of the showing indicated 8.1% Cu, 1.13 oz. Ag, 0.01% selenium per ton across a width of 44 feet. On the recommendation by Ingham a diamond drilling program was conducted during the winter of 1961-62 on the properties held by Duncan Range Iron Mines Ltd. and Canadian Dyno Mines Ltd. The detailed results of this programme are contained in a report by R.F. Vallance (1962). Nine holes with a total footage of 1642 feet were drilled along a strike length of 350 feet and to a depth of 365 feet below the lake surface. Only five of these contained copper in excess of 1% over narrow widths and no ore was located. The drilling positions were chosen based on anomalies indicated by geophysical surveys. Seven other holes were drilled to explore anomalies and totaled 3148 feet. Vallance suggested further geological mapping and detailed examination of areas not examined.

As a result of this copper discovery, several other mining companies staked claims in areas adjoining Long lake. These companies were Bornite Copper Corporation, Grandroy Mines Ltd., Zulapa Mining Corporation, Satellite Metal Mines Ltd., Canadian Dyno Mines Ltd., Mercury-Chipman Company Ltd., and Chimo Gold Mines. The reports written by the geologists and geophysicists for these companies recommended detailed exploration programmes which were never executed, except for the electrical resistivity survey and a magnetometer survey carried out by S.S. Szetu (1962) on the property of Mercury-Chipman Company Ltd. The surveys encountered no indication of the occurrence of a sizable deposit of conductive base metals.

Boniwell (1965, 1966) reports that electromagnetic and magnetometer surveys were carried out on the property of Godfrey A. Clarks Claims situated on the west side of Sakami lake. No important anomalies were established. But the geophysical work carried out on the property of St. Mary's Explorations Limited indicated the possibility of sulphide mineralizations and iron-formations. The geophysical work done on the property of Zulapa Mining Corporation gave rather more encouraging results. The magnetic anomalies coinciding with the electromagnetic work suggest the possibility of conductor horizons-possibly bedded iron-formations. 2184 feet of diamond drilling carried out on this property has indicated the presence of magnetite layers, banded, massive and disseminated pyrrhotite.

After a reconnaissance work of the summer of 1959, Tyrone Mines Limited carried out airborne magnetometer and electromagnetic surveys, and geological exploration work during the winter and summer of 1960 in an area in the townships 3220 and 3320. This area, south of LG-3, was held under Exploration Permit No. 153 by Tyrone Mines Limited. The work led to the discovery of a few sulphide bearing zones and iron formations. The reported sulphides were mainly pyrite and pyrrhotite with only minor chalcopyrite at some locations. The assay values reported by Ekstrom

(1961) are quite poor. During the present mapping program, the field work done in this area in 1974 summer showed the presence of a few discontinuous chalcopyrite, malachite and pyrite bearing veins in the metavolcanic rocks.

In 1964, Phelps Dodge Corporation of Canada Limited carried out 10 diamond drill holes in the iron formation zone of townships 3220 and 3320 outlined by the earlier exploration work by Tyrone Mines Limited.

Mills (1967, 1972, 1973) also reports the presence of banded quartz-magnetite iron formations and sulphide mineralizations associated with the volcano-sedimentary rocks in the Sakami lake and Long lake areas.

During the present mapping program some of the mineralizations described above were visited. In addition several other previously unknown mineral occurrences were discovered. These are described below.

One of the important occurrence is that of banded quartz-magnetite iron formations located near the western shore of Sakami lake, which may extend westward to up to north of Collado lake. The iron-formations are associated with predominantly volcanic rocks. Table V gives the chemical analysis of a sample of iron formation from this area. Similarly a zone containing pyrite disseminations in metabasalts and metasedimentary rocks was also discovered in the same area. In places it may contain up to 20% pyrite. In the same general region, International Nickel Company of Canada carried out a drilling program, in the summer of 1973, in a location with uranium occurrence reportedly discovered by an airborne radiometric survey. During the summer of 1974 additional radiometric survey was carried out. Thus, a detailed examination of this region is hereby recommended.

Another important occurrence of iron-formations is about 6 miles to the west-northwest of the western limit of Atilla lake. This area is now of easy access because of the construction of the new road going to Fort George. These are east-west trending, highly contorted bands of magnetite iron-formations interlayered with volcanic rocks.

Sample Ac - 104

SiO_2	26.15
Al_2O_3	1.46
Fe_2O_3	31.32
FeO	32.37
MgO	3.56
CaO	1.61
Na_2O	0.03
K_2O	0.08
H_2O^-	0.08
H_2O^+	1.25
TiO_2	0.15
P_2O_5	0.11
MnO	0.50
CO_2	1.28
S	0.03

Table V - Chemical analysis of an iron formation from near Collado lake.

A re-examination of the ultrabasic mass near the east end of Beaver lake has shown that it contains mostly peridotites which contain serpentine, talc and asbestos. This area must be examined in detail for asbestos, talc and copper-nickel mineralizations.

Other smaller occurrences of ultrabasic rocks equally containing serpentine, talc and asbestos were observed near Collado lake, along Poplar river and northeast of Yasinski lake.

Several thin bands of quartz-magnetite iron-formations were noted interlayered with basalts in the region of Pat lake.

Concentrations of pyrite up to 25% were noted in many places associated with the metasedimentary rocks found southeast of Duncan lake. These concentrations are sometimes continuous over the strike-length of successive horizons and impart an extremely rusty, friable, gossan - like appearance on weathering.

The eastern portion of the map-area underlain mostly by metasedimentary and metavolcanic rocks is also quite promising as far as the deposits of quartz-magnetite iron formations are concerned. Several thick zones of these iron formations were discovered during the mapping work carried out in the summer of 1974. Some parts of these iron formations lie in zones that will be flooded due to the proposed hydro-electric projects along La Grande river.

The iron-formation bands occur associated with the metasedimentary rocks interlayered with the metavolcanic rocks. The bands vary in thickness from a fraction of an inch to several hundreds of feet thick.

In some places the metasedimentary rocks associated with the iron-formations are garnetiferous. Bands rich in grunerite have also been observed interlayered with the iron-formations in places. The iron-formations show a very good layered structure defined by the presence of magnetite rich layers and quartz rich layers. The quartz is probably recrystallized chert. In some places disseminated pyrite, in amounts less than 1%, is also present in the iron-formations.

The occurrence of iron-formations in this part of the map-area is closely associated with the high positive magnetic anomalies found on the aeromagnetic maps. The most important zone of high magnetic anomaly forms a continuous belt trending ENE-WSW to NE-SW as shown in Figure 16. The belt starts from just north of Coutaceau lake, traverses La Grande river inthe region of LG-3 and then continues northeastward upto the western and northern parts of Grande Pointe lake. Within this zone of high magnetic anomaly numerous occurrences of iron-formations were recorded during the mapping programme, but because of the limited time and the scale of mapping it was not possible to trace their extensions in great detail. The most important occurrences of iron-formations, which may prove to be of economic interest upon detailed exploration, are in the vicinity of Don, Aldiss and Sharada lakes west of Grande Pointe lake, and Noemi and Anuradha lakes south of LG-3. The iron-formations of Noemi lake were the object of exploration work in 1959 and 1960 by Tyrone Mines Limited and diamond drilling in 1964 by Phelps Dodge Corporation of Canada Limited. Another important occurrence of iron-formation is near Lionel river in the southeastern part of the map-area. The results of Chemical analyses obtained for the representative samples from each of the localities mentioned above are presented in Table VI. In addition, several other smaller showings of iron-formations were encountered, also associated with

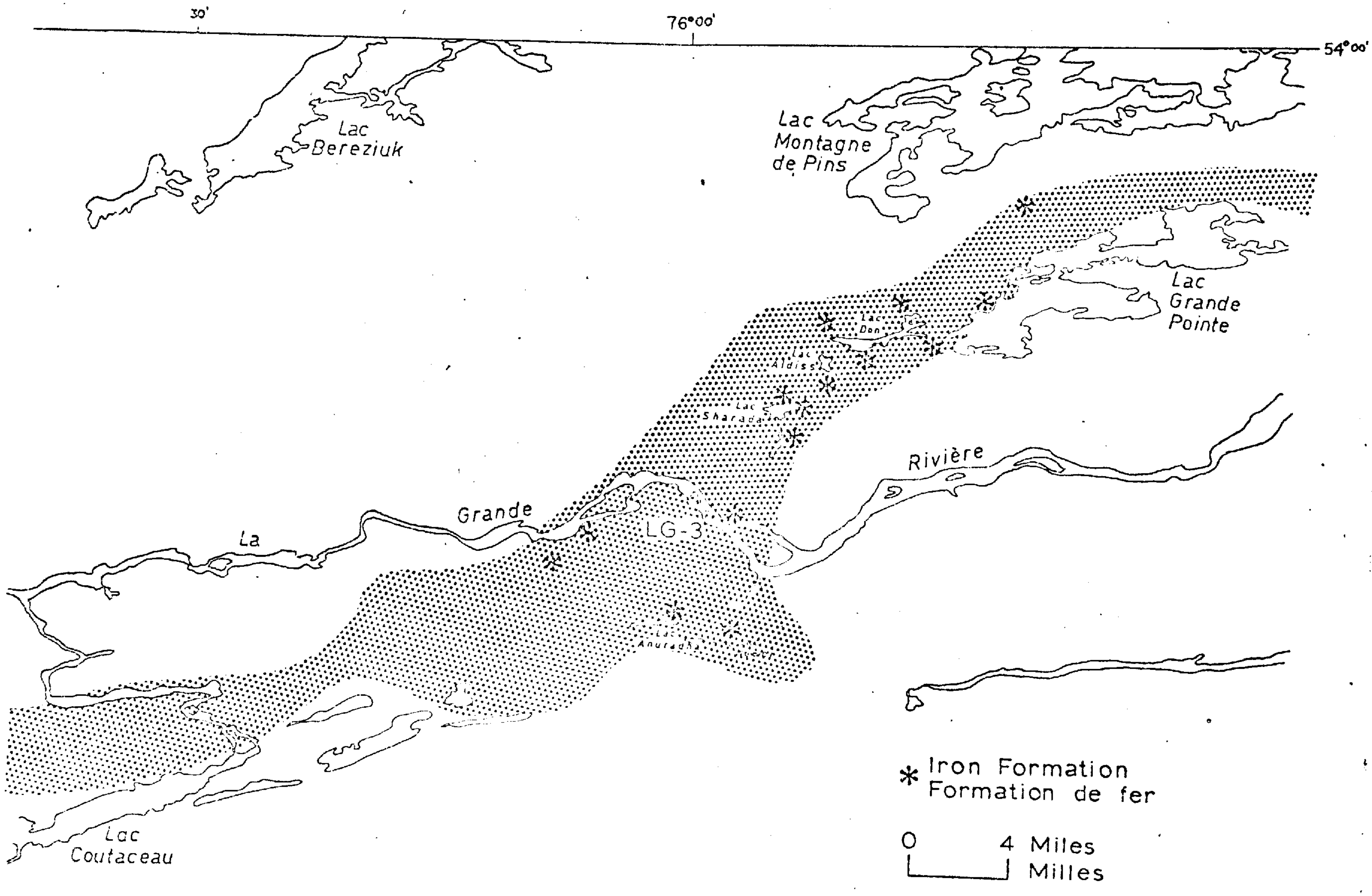

Figure 16 - Belt of high aeromagnetic anomaly.

the metasedimentary and metavolcanic rocks, in various parts of the area.

Considering the size and abundance of the iron-formations noted particularly in the high aeromagnetic anomaly belt, it is proposed that detailed work must be carried out to systematically map and outline in detail the extension of all the iron-formations present in this belt in order to establish their economic potential before any flooding is effectuated in the area.

The high aeromagnetic anomaly trending E-W and situated immediately north of Coutaceau lake remains unexplained. This area is underlain mostly by the rocks of the Sakami formation which are in faulted contacts with the surrounding Archean rocks. Field observations and petrographic study of the rocks of the Sakami formation indicate no apparent reason for such a high anomaly as simply due to the rocks of the Sakami formation. Thus, it is recommended that some work be carried out to explain this anomaly.

The chemical analysis of a representative sample of Sakami sandstone given in Table IV indicates that the rock has a very high percentage of $Si0_2$ and because of its uniform composition may be used as a good source for the extraction of silica. Due to its hardness, resistance to erosion, beautiful colour, uniform composition and easy access this sandstone may also be exploited for building stone.

Table VI - Chemical analyses of Iron-formations.

	JP-290A	JP-392	KS-1	DA-208C	DA-238	DA-254B	DA-277A
SiO_2	41.70	45.25	34.35	50.00	48.70	52.35	46.30
Al_2O_3	0.05	0.05	0.78	2.41	1.82	1.30	0.55
Fe_2O_3	39.42	32.64	47.35	29.54	32.34	29.67	33.15
FeO	16.34	19.55	16.60	14.02	13.51	12.22	13.50
MgO	1.45	1.08	0.25	1.23	0.73	0.32	0.83
CaO	0.52	0.68	0.05	0.22	2.42	1.23	6.15
P_2O_5	0.26	0.26	0.004	0.08	0.19	0.09	0.14
MnO	0.00	0.01	0.01	0.03	0.02	0.01	0.01
S	0.07	0.01	0.03	0.01	0.03	0.04	0.17

Location of Iron-Formations

JP-290A - North of Noemi lake and south of LG-3

JP-392 - Lionel river in the southeastern part of the map-area.

KS-1 - Anuradha lake, southwest of LG-3.

DA-208C - Don lake, west of Grande Pointe lake.

DA-238 - Don lake, west of Grande Pointe lake.

DA-254B - Aldiss lake, west of Grande Pointe lake.

DA-277A - Sharada lake, southwest of Grande Pointe lake.

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GUIDE TO URANIUM PROSPECTING

RÉGION DE LA GRANDE RIVIÈRE

DP-311 (addendum) Québec, octobre 1975

Le ministère des Richesses naturelles du Québec annonce l'addition d'une note au rapport de Kamal N.M. Sharma sur la région de la Grande Rivière, rapport qui a fait l'objet de l'avis DP-311 en juillet dernier. Cette note est reproduite ci-dessous pour que les personnes qui ont acheté le rapport puissent l'y insérer.

GRANDE RIVIÈRE AREA

DP-311 (addendum) Québec, October 1975.

The Quebec Department of Natural Resources announces the addition of a note to the report by Kamal N.M. Sharma on the Grande Rivière area, which was placed in open file last July (DP-311). The note is reproduced hereunder to allow its addition to the purchased copies of the report.

"As mentioned earlier, the Proterozoic rocks referred to as Sakami Formation form three outliers in the map area. One of these outliers occupies a large area near Coutaceau river, whereas the other two outcrop over much smaller areas near La Grande river east of LG-3. These Proterozoic rocks are always in faulted contact with the surrounding Archean rocks. The Proterozoic rocks are nearly flat-lying except near the faults which have only caused tilting of the beds. The faulting has resulted in the development of highly cataclasic, sheared and mylonitized zones which can easily be identified in the field. In the majority of cases the rocks surrounding the Sakami Formation are quartz diorite - granodiorite. In the fault zones the quartz diorite - granodiorite have also suffered shearing, cataclasis and mylonitization to varying degrees. In less deformed parts, these granitic rocks have developed an excellent mortar texture and ribbon quartz. With increasing deformation both the feldspars and quartz grains show considerable stretching and the development of lamellar twinning. At the same time there is considerable transformation of the mafics and of the plagioclase into chlorite, sericite, calcite, epidote etc. The extremely cataclastic and mylonitic varieties of the quartz diorite - granodiorite are very dark green or grey green chloritic schistose rocks which may easily be mistaken in the field for meta-volcanic rocks. Some of the best examples of the development of these sheared, cataclastic and mylonitic zones are near the eastern and western extremities of Coutaceau lake, the northern shore of Suzanne lake, the southern shore of Cecil lake, and along La Grande river east of LG-3. It is in these sheared rocks that the presently known occurrences of uranium mineralization are situated in the map-area (except for the occurrence of uranium in the quartzite near Sakami lake on INCO's property). This clearly suggests that these shear zones, resulting from faulting, facilitated the access of uranium mineralizing solutions. This idea can serve as an important tool in the search for uranium within the map-area. All the faults which limit the Sakami Formation are indicated on the geological map. It must be emphasised here that a similar set of faults also affects the Archean rocks away from their contacts with the Sakami Formation. Here again, the faults are associated with sheared, cataclastic and mylonitic zones. Therefore, for uranium prospecting, it is recommended that a detailed investigation of all the fault systems and the resulting shear zones in the map area be carried out, both near the Sakami Formation and away from it."