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LA GRANDE RIVER AREA (1974 PROJECT)

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Preliminary Geological Report

by

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INTRODUCTION

The area mapped during the summer of 1974 covers about 2,460 square miles between latitudes $53^{\circ}25'$ and $54^{\circ}00'$, and longitudes $75^{\circ}30'$ and $77^{\circ}00'$. It includes townships numbered 3416 to 3421, 3316 to 3321, 3216 to 3221 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 on James Bay. The LG-3 camp of the James Bay Development Corporation situated on La Grande river is within the area, whereas the LG-2 camp is about 20 miles to the west of the western limit of the map-area. Some parts of the area in the vicinity of La Grande river, Coutaceau lake, Kanaaupscow river, Bereziuk lake and Grande Pointe lake will be affected by the hydro-electric projects under way along La Grande river.

ACCESS

The area is easily accessible by float-planes based in Chibougamau, Matagami or in Fort George. The central parts of the area may also be reached from Fort George by La Grande river canoe route. There are regular flights by Nordair between Montreal and LG-2 via Matagami, and by Quebecair between Bagotville and LG-2. The new

gravel road joining Matagami to Fort George and LG-2 passes through the area mapped during the summer of 1973 and which is immediately to the west of the present map-area. During the summer of 1974 work was in progress for the construction of a new air-strip 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, fluvio-glacial, 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 etc is mainly SW to WSW. Washboard moraines (annual moraines), trending N-S to NNW-SSE, are quite conspicuous on the air-photos. Eskers are common in low lying areas occupied by volcano-sedimentary rocks.

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 younger intrusives.

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 commonly in proximity to water, such as near streams and lake shores, and in areas affected by forest-fires. Caribou moss, shrubs and lichen are abundant. Edible berries include blue, goose, black and red current berries.

Fur bearing animals present in the area include beaver, otter, muskrat, marten, wolf, lynx, rabbit etc. A few black bears were also 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 carpe 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.

METHOD OF WORK AND ACKNOWLEDGEMENTS

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 accompanied by foot-traversing, geology of lake shore and of the navigable rivers and streams. All geological information was recorded on an Outcrop Input Document especially designed for the rocks of the Superior Province.

The senior field assistants during the summer field work were 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 C. Ducrot for his assistance during the preparation of the geological map.

PREVIOUS WORK

The present map-area formed a part of a large scale 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.E. Eade (1966).

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. The work led to the discovery of a few sulphide bearing zones and iron formations.

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 earlier exploration work.

During the 1965, 1966 and 1967 summer field-seasons J.P. Mills mapped areas respectively around Sakami lake, Coutaceau lake and Long lake for the Geological Exploration Service of Quebec Department of Natural Resources.

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 and central parts of the area are metavolcanic and metasedimentary and are 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 western, northern, 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, diabase, pegmatite and quartz veins are the youngest rocks. The Proterozoic rocks of the Sakami Formation 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

The volcanic rocks consist predominantly of basalts associated with minor amounts of interlayered intermediate lavas, rhyolite, basic and acid tuffs, metasedimentary rocks and some ultrabasic rocks. The volcanic rocks have been metamorphosed and are generally well foliated. They form two important belts in the map-area 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 anomaly. The volcanic rocks are also found interlayered with the metasedimentary rocks mapped in the central and southern parts.

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, very fine, fine or medium grained, massive to well foliated or even schistose, and generally has a good layered structure. In places, some layers are coarse grained and thus gabbroic in character. Metamorphism accompanied recrystallization has resulted in an increase in their grain size and a change in their original composition and texture. In most places the original pyroxenes have been transformed to an assemblage of actinolite, epidote, chlorite, biotite and calcite. The plagioclase have also suffered saussuritization and sericitization to varying degrees. It is quite rare to observe well preserved or even deformed pillows. But, the various tuffs preserved their original finely layered nature by which they can easily be identified in the field. The intermediate and acid lavas are much lighter in colour in comparison to basalts. They vary in colour from dark grey to light grey-green, grey-pink to pink. They are characterized by the abundance of quartz-feldspathic mine-

rals, porphyritic texture, trachytoidal texture etc. The ultrabasic rocks occur as small masses associated with the volcanics and are mostly peridotite and pyroxenite. Most of the olivine of the peridotite is transformed to serpentine, talc, calcite, and magnetite, but the original shapes of olivine can still be identified by the distribution of magnetite grains. The pyroxenites are now changed to hornblendites and are composed essentially of hornblende, with only minor amounts of biotite, chlorite, epidote, calcite, quartz etc.

METASEDIMENTARY ROCKS

The metasedimentary rocks occupy important zones in the southeastern and central parts of the map-area. They also present themselves 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 characters. The paragneisses occurring in the southern parts of the area are well layered, commonly rusty weathering, friable and much more migmatized than the paragneisses occurring in the 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

be composed entirely of white or pink granite with little evidence of the presence of paragneisses.

The paragneisses found in the central parts and the ones found interlayered with the metavolcanic rocks are rather more homogeneous, quite fresh and sometimes interlayered with quartz-magnetite iron formations of varying thickness. Both types of paragneisses are light grey to dark grey in colour when fresh, fine to medium grained, and homogeneous to well layered. Mineralogically they are composed of quartz, plagioclase, microcline, biotite and/or amphibole, epidote, chlorite etc.

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 can be classified as graywacke, siltstones and argillites have been noted interlayered with the metavolcanic rocks and the iron-formations. These metasedimentary rocks show only minor effects of recrystallisation and preserve their original sedimentary textures and structures.

The quartz-magnetite 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. Some disseminated pyrite is also present in the iron formations.

PLUTONIC ROCKS

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 major portions in the northern, western and east-central parts of the map-area. In some places they are quite porphyritic due to the presence of big microcline and plagioclase phenocrysts. The plutonic rocks show the effects of deformation and metamorphism by the development of cataclastic textures and foliation developed 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 plutonic rocks. Inclusions of metavolcanic rocks were frequently encountered in the plutonic rocks.

The rocks of quartz-diorite to granodiorite composition 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 essential minerals present include quartz, plagioclase, microcline, hornblende and biotite. In majority of cases the plagioclase shows much saussuritization and sericitization, sometimes with development of big grains of sericite, muscovite, epidote and calcite. It is only in a few thin sections that completely fresh plagioclase can be seen.

The hornblende is the predominant mafic mineral which shows alteration to biotite, and biotite shows alteration to chlorite and epidote. The mafic content of the rock 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.

Granite outcrops mainly in the northwestern part of the area. It is pink to grey-pink, coarse to very coarse grained, and generally porphyritic with big microcline crystals showing good carlsbad twinning visible in hand specimen. The predominant feldspar is microcline. Other minerals present in the rock include quartz, plagioclase, hornblende, biotite, chlorite, epidote etc.

DYKES

The dykes of gabbro, diabase, pegmatite and quartz veins are the youngest rocks of the area which traverse all the previously mentioned rocks. 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. Many of them show an extremely fine grained chilled margin. The rock is dark grey to nearly black or grey-green when fresh, and dark brown to grey-brown on weathered surface. 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 common. Compositionally they consist of plagioclase, pyroxene, hornblende, biotite and iron-oxides. The plagioclase of these dykes

possess a greenish tint because of extreme saussuritization. Greenish phenocrysts of plagioclase are quite common in many places.

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. 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-photo lineaments are presented on the geological maps. These lineaments clearly bring out the outlines of the major anticlines, synclines, and faults present in the metavolcanic and metasedimentary rocks. These 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. 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.

A preliminary study of the measurements of axes of minor folds and lineations, together with the distribution pattern of the metasedimentary and metavolcanic rocks, indicate the presence of two phases of folding. The major phase gave rise to tight EW 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, sericite, calcite in the metasedimentary, metavolcanic and plutonic rocks.

SAKAMI FORMATION

The Proterozoic rocks of the Sakami Formation outcrop near Cou-taceau 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.

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 iron-formations, but in 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.

The chemical analysis of a representative sample of the most common pink sandstone is as follows:-

SiO ₂	-	94.50
Al ₂ O ₃	-	2.08
Fe ₂ O ₃	-	1.23
FeO	-	0.06
MgO	-	0.34
CaO	-	0.07
Na ₂ O	-	0.65
K ₂ O	-	0.30
H ₂ O ⁻	-	0.00
H ₂ O ⁺	-	0.07
TiO ₂	-	0.06
P ₂ O 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 I- Chemical analysis of Sakami Sandstone.

ECONOMIC GEOLOGY

Disseminated pyrite is commonly observed in the metavolcanic, metasedimentary and ultrabasic rocks. Chalcopyrite is less common than pyrite. Only in one region, south of LG-3 in an area previously held under Exploration Permit No. 153 by Tyrone Mines Limited, were a few chalcopyrite, malachite and pyrite bearing veins observed in metavolcanic rocks.

The southern two-thirds of the area underlain mostly by meta-volcanic and metasedimentary rocks is 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 programme. Some parts of the 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 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 1. The belt starts from just north of Coutaceau lake, traverses La Grande river in the 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 II. In addition, several other smaller showings of iron-formations were encountered, also associated with 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

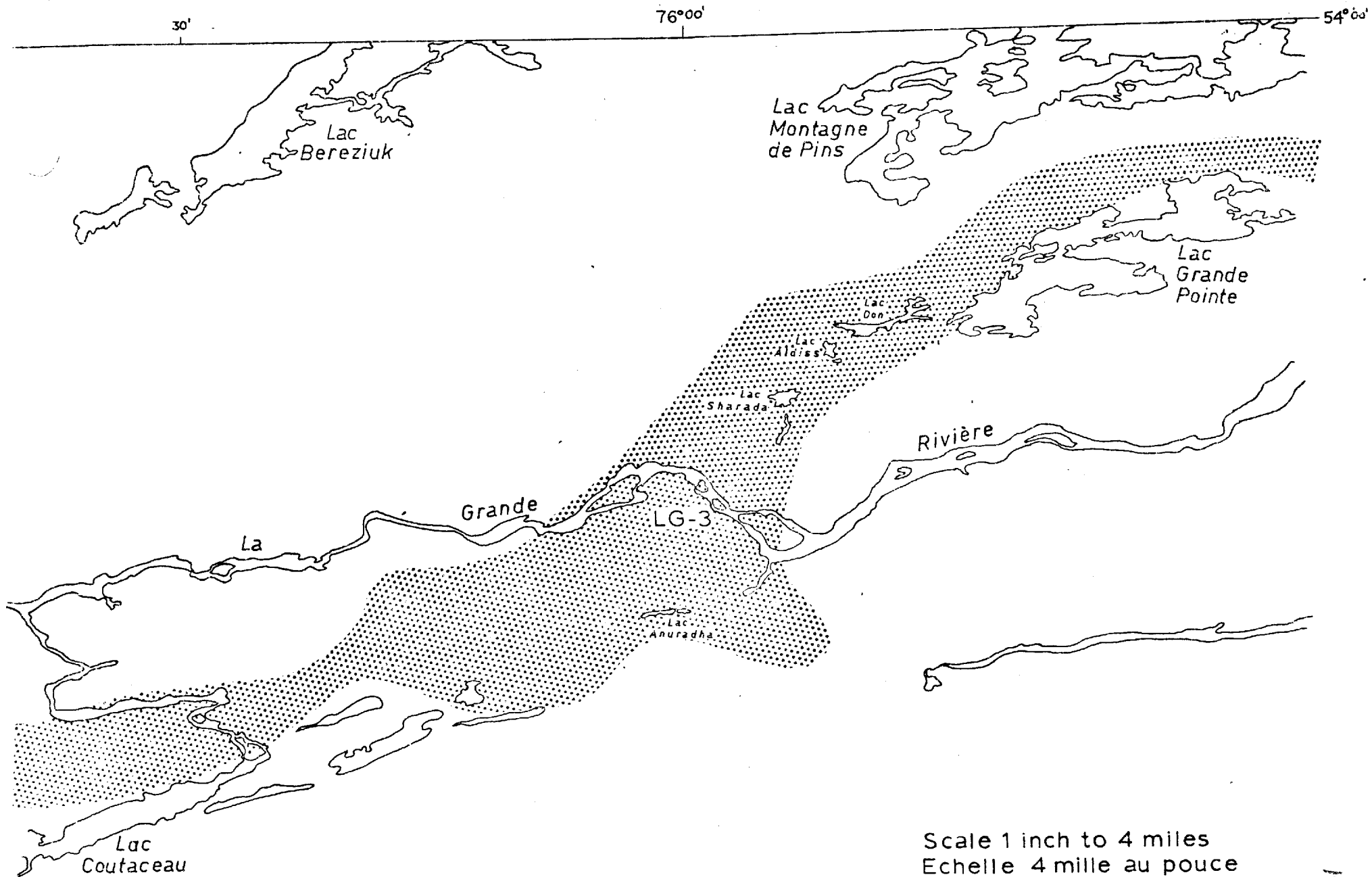


Fig. I. Belt of high aeromagnetic anomaly

detailed work must be carried out to systematically map and outline in detail the extensions 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 I indicates that the rock has a very high percentage of SiO_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 II. Chemical analysis 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 ₂ O ₃	0.05	0.05	0.78	2.41	1.82	1.30	0.55
Fe ₂ O 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 ₂ O 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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