RG 2000-03

GEOLOGY OF THE LAC GAYOT AREA (NTS - 23M)

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(NTS 23M)

Charles Gosselin
Martin Simard

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Accompanies map
SI-23M-C2G-99K

Camp on the shore of Gayot Lake.

2001

Québec

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ABSTRACT

This report contains results from a geological survey carried out at a scale of 1:250,000 in 1999 in the Lac Gayot area (NTS sheet 23M) which is located a few tens of kilometres northwest of the Caniapiscau Reservoir, James Bay. The area is located at the junction of four geological subprovinces of the Superior Province, that are the Ashuanipi, La Grande, Bienville and Minto. However, in the mapped area, the Minto is represented by the Goudalie Domain. The nature and boundaries of these large regional subdivisions became clearer following this survey. The La Grande Subprovince and the Goudalie Domain are herein considered as the same tectonostratigraphic entity, the Goudalie-La Grande Assemblage.

Rocks in the area are of Archean age, except for a Paleoproterozoic sedimentary remnant of the Sakami Formation and some Proterozoic diabase dikes of the Bouteille Suite. The Goudalie-La Grande Assemblage consists mostly of tonalitic gneiss of the Brésolles Suite (2.79 Ga) and foliated tonalites of the Favard Suite (2.73 Ga). The occurrence of many volcanosedimentary belts assigned to the Gayot Complex (2.70 to 2.86 Ga ?) as well as some metasedimentary bands of the Aubert Formation are also characteristic. The Bienville Subprovince is represented by the La Bazinière Suite, which is formed mainly of granodiorotic rocks (2.70 Ga). The Ashuanipi Subprovince is characterized by diatexites of granodioritic composition of the Opiscotéo Suite (2.64 Ga) along with paragneiss of the Grosbois Formation and tonalites of the Beausac Suite (2.70 Ga).

Late intrusive suites such as the Maurel, Dervieux and Tramont have also been defined. The Maurel (2.68 Ga) and Dervieux suites are characterized by porphyritic granodiorites which posess a strong magnetic susceptibility. The Tramont Suite comprises generally massive granites locally affected by late deformation zones. This suite seems to correspond to the youngest Archean rocks.

Many deformation episodes occurred in the Gayot area. Remnants of an early D1 deformation episode were discovered within enclaves observed in the gneissic and foliated tonalites of the Goudalie-La Grande Assemblage. The most pervasive structural feature in the area is the S2 regional foliation, which resulted from the D2 deformation episode. This foliation was reoriented and folded by at least two later episodes. The D3 episode particularly affected the sector east of the Vaujours Fault, yielding F3 folds with NNW-SSE to NE-SW trending axes. The F4 phase is mainly noticeable west of this fault and is characterized by WNW-ESE to NW-SE trending fold axes along with a well-developed NW-SE striking fault system.

Many mineralized showings and occurrences were discovered as a result of this regional survey. The most important mineralizations are hosted in the different volcanic belts of the Gayot Complex found within the Goudalie-La Grande Assemblage. They consist of disseminated or semi-massive sulphide zones hosted in basalts or felsic tuff horizons, of sulphide zones associated with ultramafic rocks, and of oxide iron formations, which are sulphide and gold bearing in places. During the summer of 1998, Virginia Gold Mines and Makamikex also discovered new mineralized occurrences hosted in these same environment types. Finally, the Lac Gayot Paleoproterozoic uraniferous deposit occurs within the area. This deposit was found by Uranerz in 1976. Reserves estimated in 1980 totalled 50 million tonnes grading 0.10 % U_3O_8.

DOCUMENT PUBLISHED BY « GÉOLOGIE QUÉBEC »

Director
Alain Simard

Head of the Service géologique du Nord-Ouest
Robert Marquis

Geological inventories manager
Robert Marquis

Document accepted for publication on the 00/05/01

Critical reader
Pierre Pilotte

English translation
Michèle Mainville

Edition and page setting
Jean-Pierre Lalonde
Kamal N. M. Sharma

Computer assisted drawing
Paul Brouillette
Martin Simard
Charles Gosselin
Isabelle Lafrance
Manon Dufour

Technical supervision
André Beaulé

Dépôt légal – Bibliothèque nationale du Québec
ISBN : 2-551-20470-4

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INTRODUCTION

The field work for this survey was carried out during the summer of 1998 in the context of the Projet Grand-Nord. This project which was initiated in 1997 by the Ministère des Ressources naturelles du Québec (MRNQ) aims at completing geological mapping, acquiring new geoscientific knowledge and opening up new territories for mineral exploration north of the 55th parallel. The survey was carried out at the 1 : 250 000 scale and corresponds to the NTS sheet 23M (Figures 1 and 2). This rectangular area covers about 14 000 km^2 limited by the longitudes 70°00' and 72°00' and the latitudes 55°00' and 56°00'.

The Gayot area is located at the junction of four geological subprovinces of the Superior Province (Card and Ciesielski, 1986), that is Ashuanipi to the east, La Grande in the central south, Bienville to the west and Minto in the central north (Figure 1). In the area, the Goudalie Domain represents the Minto Subprovince. (Percival *et al.*, 1991, 1992). The nature and boundaries of these large regional divisions became clearer through this work. The La Grande Subprovince and the Goudalie Domain seem comparable in nature and are herein considered as the same tectonostratigraphic entity, the Goudalie-La Grande Assemblage (Figure 2). This assemblage is characterized by the occurrence of many Archean volcano-sedimentary belts, and therefore represents a favourable economic environment.

Access

The area surveyed is only accessible by floatplane or helicopter. The Lac Pau floatplane base is located less than 25 kilometers away to the southeast, near the Caniapiscau Reservoir (Figure 1). A gravel landing strip is also available. These facilities are in operation during the summer season. Access to Lac Pau is facilitated through a major and good quality gravel road by way of Brisay. The Brisay–Lac Pau stretch is however only practicable during the summer season.

Methodology

Fieldwork during the summer of 1998 was conducted by a team of seven geologists and six geological assistants. The base camp was located on the shore of Lac Gayot, in the north-central part of the area (Figure 2). The survey was carried out by the traditional foot traverses as well as by a series of helicopter stops in the farthest regions.

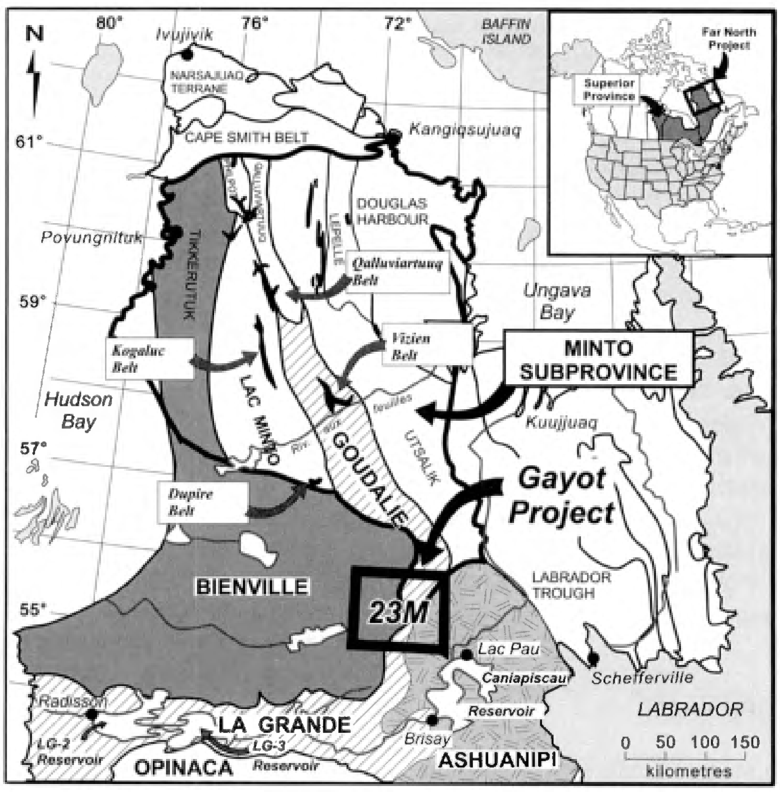


FIGURE 1 - Location of the study area (Gayot Project) and its position relative to the principal tectono-stratigraphic assemblages in the northern Superior Province (modified from Card and Ciesielski, 1986 and from Percival *et al.*, 1992).

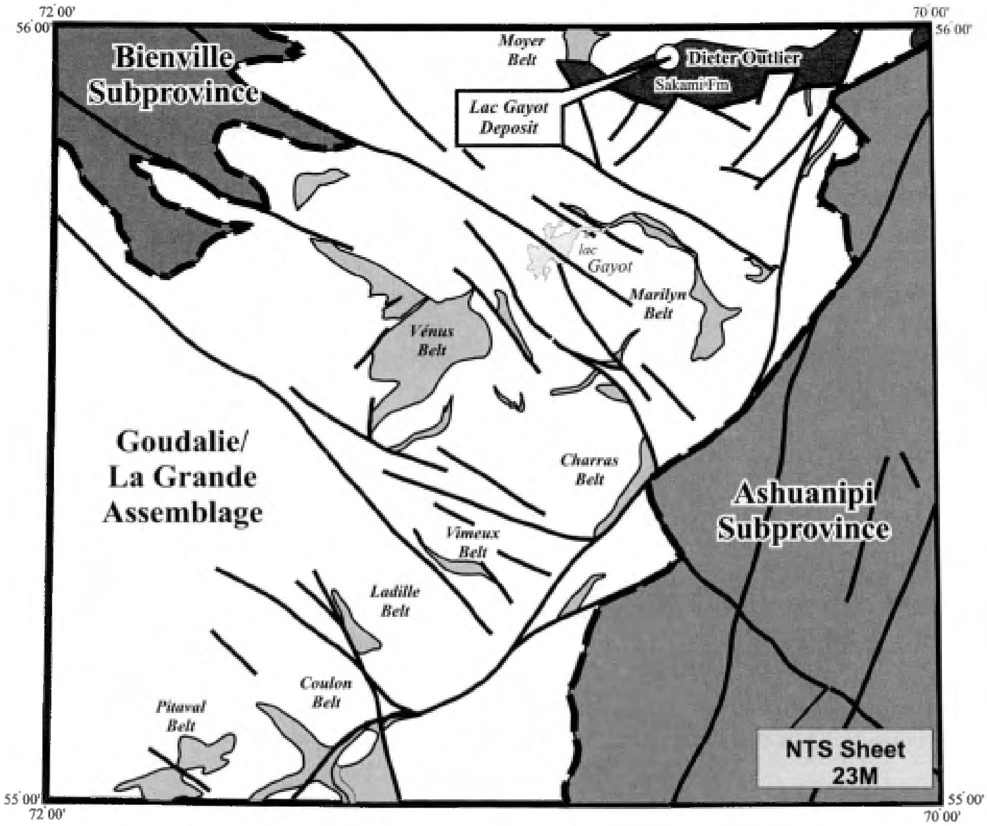


FIGURE 2 - Boundaries of the principal tectono-stratigraphic assemblages defined in this report; location and identification of the principal volcano-sedimentary belts of the Gayot Complex.

Each 1 : 50 000 NTS sheet was covered, on average, by fourteen traverses. Generally, the outcrop distribution is good over most of the territory. However, areas whose size is of the order of several hundred square kilometers are totally overlain by glacial deposits. These are found, in particular in the southwestern part of the mapped area as well as in its northwestern corner.

To better define the mapped lithologies and build up a rock geochemistry database for this distant area, 125 rock samples were analyzed for major elements, trace elements and rare earths. Minor elements of economic interest were also analyzed in 123 additional samples. All analytical data were incorporated into the Ministère des Ressources naturelles du Québec's geomining information system (SIGÉOM). About ten samples were collected for U-Pb dating and were processed by Jean David in the laboratories of the Université du Québec in Montréal.

Previous Work

Reconnaissance mapping work at a scale of 1 : 1 000 000 was conducted by the Geological Survey of Canada in the late 1950s (Eade, 1966). Work by Card and Ciesielski (1986) in relation to the subdivision into tectonostratigraphic assemblages within the Superior Province, and work by Percival *et al.* (1991, 1992), more specifically related to the Minto Subprovince, were major contributions which helped to define the Gayot area within a global setting.

The area was also covered by two lake sediment geochemical surveys. The first one was carried out in 1983 in the Caniapiscau River area and covers the eastern half of the mapped area (Beaumier, 1986). The second survey was completed in 1997 by the Ministère des Ressources naturelles du Québec, in partnership with several mineral exploration companies (Géologie Québec, 1998). It covers the western half of the area as well as most of the territory north of latitude 55° 00'.

Important exploration work was conducted by Uranerz in the Gayot area from 1976 to 1981. This work was carried out to evaluate the potential of the Lac Gayot uraniferous deposit, discovered in 1976 near Lac Dieter (Figure 2). This deposit is associated with the Paleoproterozoic sedimentary sequenceof the Sakami Formation. The estimated reserve is 50 million tonnes grading 0.10 % U_3O_8. Eldorado Nuclear was also very active in this same area from 1977 to 1979. Many exploration permits were recently granted in the area following the release of the 1997 lake sediment geochemical survey results.

Acknowledgements

We wish to thank all members of our field crew for their efforts during the summer of 1998. This project would not have been achieved without them. Apart from the authors, the team comprised Isabelle Lafrance, Jeanne Lebel, Gabriel Machado and Ehouman N'Dah (all geologists) as well as Christine St-Laurent, Mireille Paris, Louise Duchesne, Geneviève Leblanc, Pierre Nadeau and Jonathan De Serres (geological assistants) and finally Guy Bouchard (camp superintendant) and Paul-Émile Cyr (cook). Furthermore, Isabelle Lafrance took part in the drawing of the geological map and figures for this report. Special thanks are due to Jean David (MRN) who took part in the fieldwork and provided us with preliminary geochronological results regarding the different lithologies. We express our gratitude to Michel Chapdelaine (Virginia Gold Mines) who provided us with unpublished information regarding the Venus Belt. Finally, we acknowledge the help of Pierre Pilote (MRN) for his critical review of this manuscript.

GENERAL GEOLOGY

The Gayot area contains parts of four geological subprovinces belonging to the Superior Province (Card and Ciesielski, 1986). These subprovinces are the Ashuanipi, Bienville, La Grande and Minto (Percival *et al.*, 1991, 1992). The Goudalie Domain herein represents the Minto (Figure 1). In the surveyed area, subprovince boundaries had mainly been identified from the distribution of regional aeromagnetic map anomalies. Our field work led to a better definition of these large assemblages and their limits were sometimes modified (Figures 2 and 3). Some of the main units that characterize the northeastern part of the Superior Province, including those defined in the Gayot area, are indicated in chronological order in figure 4.

The Ashuanipi Subprovince is a high grade metamorphic area in granulite facies, characterized by the distinct occurrence of orthopyroxene. This subprovince is essentially composed of coarse-grained diatexites of granodioritic composition, referred to as the Opiscoteo Suite in the Lac Bermen area (Leclair *et al.*, 1998). These rocks were emplaced between 2682 to 2650 Ma (Figure 4; Chevé and Brouillette, 1991; Percival *et al.*, 1992 ; Leclair *et al.*, 1998), and even up to 2637 Ma in our area (Figure 4; David, 1999). Preserved supracrustal rocks also occur within the Ashuanipi. These rocks are more or less migmatized and consist mostly of paragneiss and sometimes mafic to felsic volcanics (2707-2711 Ma; Leclair *et al.*, 1998).

In the Gayot area, the Ashuanipi Subprovince is also formed of the same units. Its contact with the Goudalie-La Grande Assemblage is intrusive (Figure 2). This boundary corresponds roughly to the transition from the granulite to the amphibolite facies. It is also partly defined by a major regional fault zone, the Vaujours Fault (Figure 3).

The Bienville Subprovince is characterized by plutonic assemblages mostly made up of orthogneiss as well as tonalitic and granodioritic intrusions (Card and Ciesielski, 1986; Hocq, 1994; Percival *et al.*, 1992). Its nature and regional limits remain, however, quite inaccurate in several aspects. Its northern boundary with the Minto Subprovince is still not well defined. Interpretation from aeromagnetic maps suggests that the Tikkerutuk Domain could represent the Bienville's northerly extension (Figure 1; Hocq, 1994). This domain is mainly composed of massive to foliated and locally gneissic hornblende-biotite granodiorite (Percival *et al.*, 1992). It also contains many enclaves of diorite, gabbro and pyroxenite. An age of 2693 +13/-11 Ma is reported by Percival *et al.*(1992) for a granite intruding a granodiorite.

The southern contact of the Bienville with the La Grande Subprovince is better defined. It is marked by the late tectonic, porphyritic, plutonic Bienville Suite (Hocq, 1994), as for instance the Radisson monzonitic pluton (Goutier *et al.*, 1998a) dated 2712 +/-3 Ma (Mortensen and Ciesielski, 1987). The eastern boundary of the Bienville is present in our area (Figure 1). In the southwestern part of the 23M sheet area, a " La Grande " type tonalitic gneiss (Brésolles Suite) dated 2794 Ma (Figure 4; David, 1999) was observed. The presence of this gneiss led us to modify significantly the Bienville boundaries in this sector (Figure 2). Consequently, the volcanosedimentary sequences identified by Eade (1966) in the southern part of the area and corresponding to the Pitaval and Coulon belts (Figure 2) are no longer considered as part of the Bienville (Hocq, 1994). The granodioritic La Bazinière Suite dated 2.70 Ga (David, 1999) thus remains the sole Bienville unit observed in the area studied (Figure 3).

The volcanoplutonic La Grande Subprovince mostly comprises variably metamorphic igneous rocks and, to a lesser degree, volcanosedimentary bands. More specifically, in the area of La Grande Rivière basin, the subprovince is formed of an old tonalitic basement, more or less preserved and continuous volcanosedimentary sequences, and a series of tonalite, granodiorite and granite intrusions cutting all these rocks (Figure 4; Gauthier *et al.*, 1997; Gauthier and Larocque, 1998; Goutier *et al.*, 1998b).

The tonalitic basement is dated between 2881 and 2788 Ma (Gauthier and Larocque, 1998) and referred to as the Langelier Complex south of Radisson (Figure 4; Goutier *et al.*, 1998a). There, it is overlain in disconformity by the uraniferous sandstones and conglomerates of the Apple Formation (Goutier *et al.*, 1998b). A volcanosedimentary sequence consisting of two distinct volcanic cycles, overlies this formation. The first, a mafic-felsic cycle, corresponds to the Lac Guyer volcanics, dated 2749 Ma (Ciesielski, personal communication) as well as the Yasinski Group volcanics, dated 2732 Ma (Figure 4; Goutier *et al.*, 1998b). The second cycle, identified by Skulski *et al.* (1984) in the LG-3 area, consists of intermediate to felsic volcanics dated 2708 Ma (David and

Parent, 1997). Finally, most of the late intrusions discovered in the La Grande Subprovince were emplaced between 2750 and 2618 Ma.

The La Grande Subprovince shows a general E-W trend and extends eastward as far as the Caniapiscau Reservoir area (Figure 1). In this area, the northerly extension of the La Grande up to the Gayot area is essentially based on aeromagnetic map interpretation and remains to be validated by mapping in the field.

The Goudalie Domain of the Minto Subprovince is described as an assemblage of tonalitic rocks. It includes an old basement of tonalitic gneisses with supracrustal rock belts of volcanosedimentary origin, as well as late tonalite, granodiorite and granite intrusions (Percival *et al.*, 1992) (Figure 4). In the Rivière aux Feuilles area (Figure 1), the tonalitic gneiss is dated 2940 and 3010 Ma (Percival *et al.*, 1992). The numerous volcanosedimentary bands comprise various lithologies comparable to those in the La Grande. The dates obtained from many of these bands lead to notice that the volcanic episodes occurred at different time periods in the Goudalie Domain and the Minto Subprovince (Figure 4).

The late Goudalie intrusive suites consist of hornblende-biotite granodiorite (2702 Ma), slightly foliated tonalites (2700 Ma) and various kinds of granite, including a late pegmatite dated 2693 Ma (Figure 4).

No distinctive feature permitted the discrimination of the La Grande Subprovince from the Goudalie Domain in our area, as these entities bear many similarities (Figure 4). Effectively, an ancient tonalitic basement occurs within the Goudalie-La Grande Assemblage (2794 Ma), as well as many volcanosedimentary belts and several late tonalite, granodiorite and granite intrusions. In the Gayot area, the Goudalie-La Grande Assemblage shows a NE-SW to NNE-SSW trend and is affected by a northwest trending very penetrative deformation.

Thus, this area appears to be a kind of intermediate zone between the La Grande Subprovince, whose main trend is predominantly E-W, and the Goudalie Domain, showing a NW-SE to NNW-SSE orientation (Figure 1). We propose that these large tectonostratigraphic entities should, for the moment, be considered as the same and referred to as the " Goudalie-La Grande Assemblage ". It is however possible that the boundary between these two large assemblages could be located south or north of the Gayot area.

Paleoproterozoic sediments of the Sakami Formation (the Dieter outlier) were observed in the northern part of the area (Figure 2). Defined by Eade (1966), this formation designates a set of outliers of Proterozoic sedimentary rocks deposited in disconformity over the Archean basement (the Aphebian disconformity). These isolated outliers are considered as preserved remnants within a basin that extended from the Lac Cambrien area, located some 75 kilometers N-E of the Gayot area to as far as the James Bay area (Marcoux, 1979). The series of Sakami outliers occur within two main ENE-WSW trending zones. The first one corresponds approximately to the basin of the La Grande Rivière and the second one is located around latitude 56°00', between the 69°00' and 73°00' longitudes.

LITHOSTRATIGRAPHY

Apart from the major tectonostratigraphic divisions of the northeastern part of the Superior Province, defined on the basis of large scale reconnaissance work (Eade, 1966), the Gayot area was not covered by a survey providing a global image of the main lithostratigraphic assemblages. Figure 3 presents a general picture of the different units herein defined along with their regional distribution. In this figure and in the map accompanying the report, the stratigraphic order presented in the legend was established from preliminary zircon U/Pb dating results (David, 1999) and cross-cutting relations observed in the field.

Goudalie-La Grande Assemblage

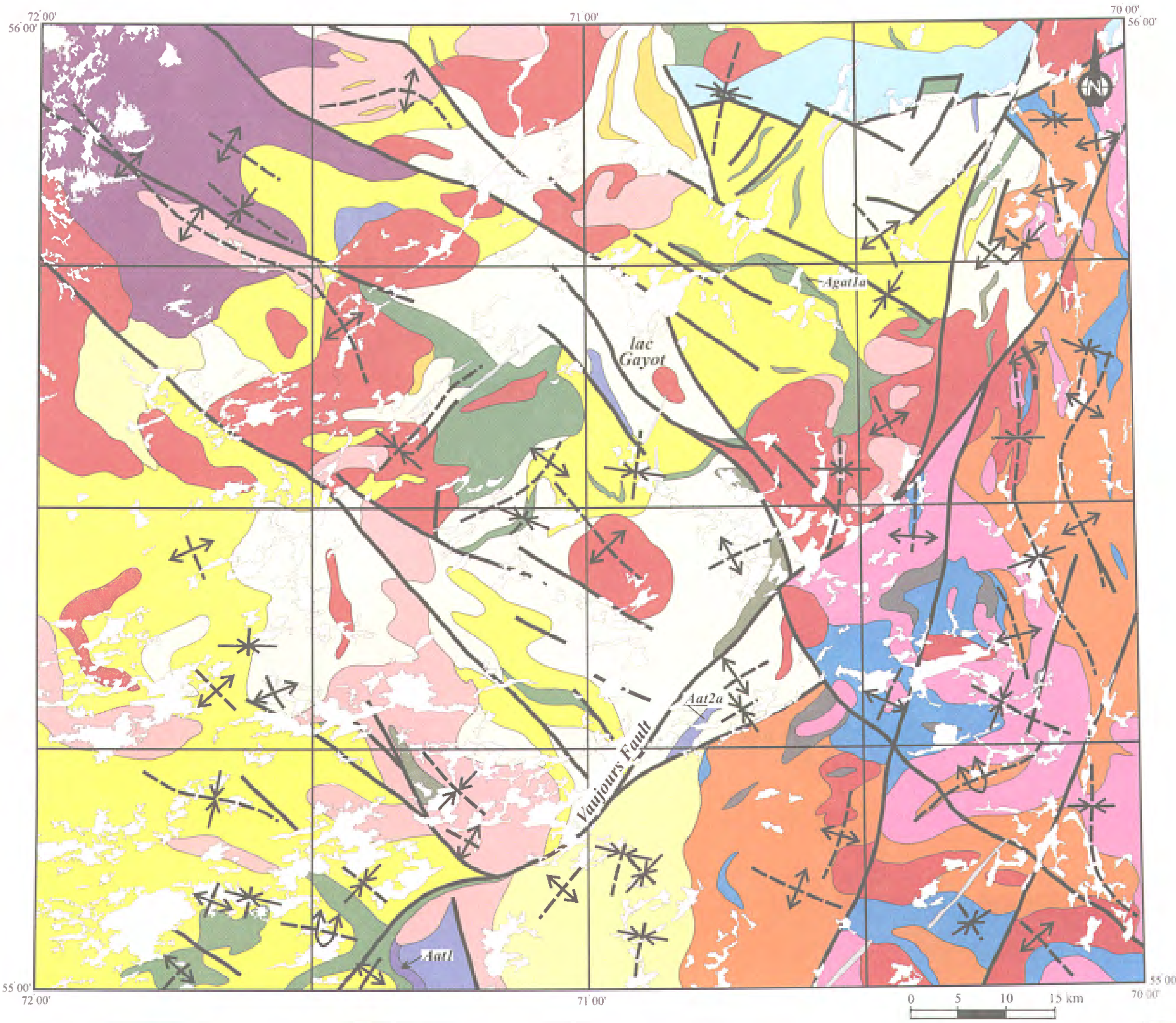
The Goudalie-La Grande Assemblage forms a band some 60 kilometers in width, crossing the surveyed area following a NE-SW to NNE-SSW trend (Figure 2). It is comprised mostly of the tonalitic gneisses of the Brésolles Suite (Abre) and foliated tonalites (Afav1 and Afav2) of the Favard Suite. The Goudalie-La Grande Assemblage contains several bands of supracrustal rock of the Gayot Volcanic Complex (Agat) and the metasedimentary Aubert Formation (Aat).

Brésolles Suite (new unit, Abre)

The Brésolles Suite designates a tonalitic banded gneiss unit mainly located in the western and northeastern parts of the area. This unit was also identified in the central part, but covers a smaller area (Figure 3). The Brésolles Suite represents an ancient sequence since a preliminary U/Pb age obtained on a dioritic gneiss is of 2794 Ma (David, 1999).

A banded appearance resulting from alternating whitish tonalitic bands and dark grey intermediate to mafic bands is often visible in the Brésolles Suite gneissic rocks. On the whole, the leucocratic bands are larger and more abundant, although dark banding is locally profuse. Some of these melanocratic bands could represent intensely stretched amphibolite enclaves. Highly common amphibolite enclaves occur effectively within the unit. Their width varies from a few centimetres to a few decimetres and their quantity between 1 and 30 %. Some more or less continuous metric size amphibolite horizons have also been noted. Finally, the observed centimeter thick hornblende and biotite rich bands could result from mineral segregation. The gneissosity is often very much deformed within the Brésolles Suite and presents complex fold patterns.

A thin section study permitted to evaluate that dark bands comprise between 20 and 35 % mafic minerals, predominantly



PROTEROZOIC

Bouteille Suite (Pboe) informal

Diabase dyke

Sakami Formation (pPsa)

Orthoquartzite, quartz arenite, mudshale and conglomerate

ARCHEAN

Late Intrusions

Tramont Suite (Atra)

Massive, fine to coarse-grained granite; pegmatite

Dervieux Suite(Ader)

Porphyritic, magnetic granodiorite and granite; diatexite enclaves of the Opiscotéo Suite

Maurel Suite (Amau)

Porphyritic, magnetic granodiorite and granite

Ashuanipi Subprovince

Opiscotéo Suite (Aopi)

Granodioritic diatexite with paragneiss enclaves

Beausac Suite (Abea)

Finely foliated tonalite to granodiorite

Grosbois Formation (Ags)

Migmatized paragneiss; oxide-facies iron formation horizons

Bienville Subprovince

La Bazinière Suite (Abaz)

Well-foliated, locally gneissic granodiorite and quartz monzodiorite

Goudalie-La Grande Assemblage

Favard Suite (Afav)

Strongly magnetic massive to foliated tonalite (Afav2a)

More or less foliated, locally gneissic tonalite (Afav2)

Diorite, quartz diorite, minor gabbro (Afav1)

Aubert Formation (Aat)

Hornblende-biotite paragneiss (Aat2); orthopyroxene-bearing paragneiss sub-unit (Aat2a); polygenic conglomerate, quartz arenite and wacke at the base of the unit (Aat1)

Gayot Complex (Agat)

Basalts; ultramafic rocks; felsic to intermediate tuffs; oxide-facies iron formations (Agat1); fragmental sub-unit restricted to the Marilyn belt (Agat1a)

Pyroxenite and peridotite; minor basalt and gabbro (Agat2); a few gabbro and diorite dykes (Agat2a)

Brésolles Suite (Abre)

Biotite-hornblende tonalitic gneiss

FIGURE 3 - Simplified geology of the study area (NTS sheet 23M).

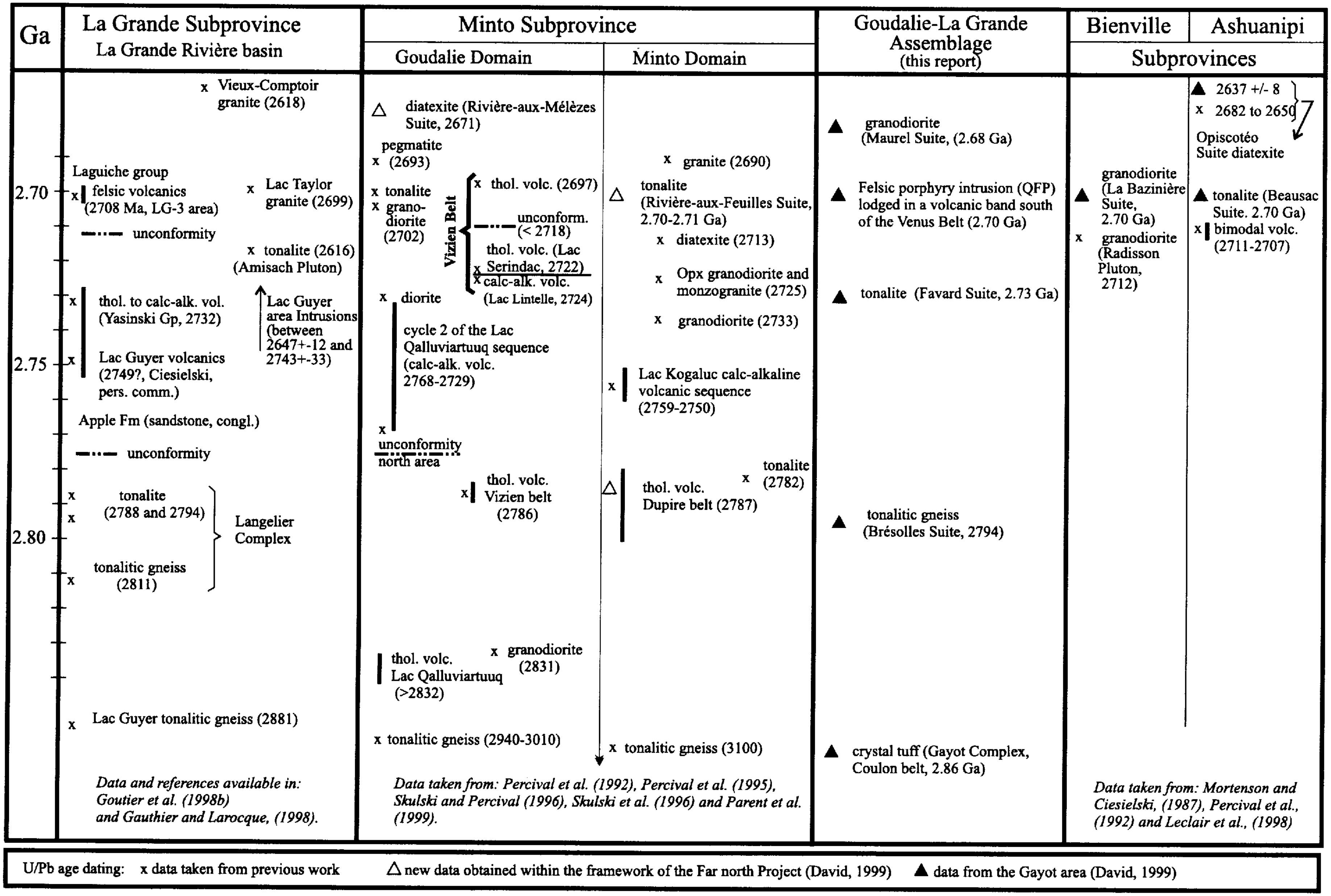


FIGURE 4 - Principal units found in the major tectono-stratigraphic assemblages in the NE part of the Superior Province and their relative age relationship with respect to the rocks of the Gayot area.

green hornblende, with frequently greenish biotite in smaller quantities. Epidote and sphene occur almost always in association with mafic minerals and often penetrate biotite and hornblende grains. Leucocratic bands comprise less than 5 % mafic minerals in the form of short biotite flakes. Plagioclase is generally more altered within the leucocratic bands. Apatite is always present and allanite can sometimes be observed within the epidote.

Decimetric to metric size horizons of an early and strongly foliated granite occur locally, mainly in the western part of the area. They are parallel to or slightly oblique to the regional gneissosity. This granite could represent an early mobilizate related to a partial melting of the gneisses. The Brésolles gneissic rocks are highly injected by granite and pegmatite dykes from the Tramont Suite, as well as by the foliated tonalites probably from the Favard Suite. These occur abundantly in the gneissic rocks located in the NE part of the area.

Gayot Complex (new unit, Agat)

The Gayot Complex refers to all volcanogenic rock belts occurring within the area (Figure 2). These rocks are generally affected by amphibolite facies metamorphism, although the upper greenschist facies rocks are locally seen. The complex mostly consists of extrusive volcanics, mafic-ultramafic intrusions and pyroclastics. The sequence also comprises horizons of sedimentary rock and oxyde iron formation. However, the present work scale was not suitable for the mapping of these different lithologies.

Informal units were introduced to delineate predominant lithological characteristics for the different belts (Figure 3; Simard et Gosselin, 1999). Belts that are characterized by several lithologies and generally dominated by a more or less amphibolitized basalt are referred to as the Agat1 unit. For example, the Pitaval, Coulon, Vimeux, Venus, Marilyn, and Moyer belts (Figures 2 and 3). The Marilyn belt also comprises a fragmental rock horizon of uncertain origin some ten kilometers in length (Agat1a). The Agat2 unit is characterized by the predominance of intrusive and possibly extrusive ultramafic rocks, as for instance the Ladille and Charras belts. A few gabbro dykes located in the N-E part of the area were included in the Agat2a unit.

Two U/Pb age determinations were carried out on rocks taken from the Gayot Complex. One of these was obtained from a crystal tuff taken in the Coulon belt. It gave an especially old age, 2.86 Ga (Figure 4; David, 1999). The second rock came from a felsic horizon, probably a QFP or crystal tuff, intercalated between basaltic flows within a band located south of the Venus belt. This rock gave a relatively young age of around 2.70 Ga. For the moment, a rather complex history is suggested by these preliminary results regarding the evolution of volcanism within the Gayot Complex. It can however be deduced that the complex could be primarily constituted of rocks older than 2.73 Ga. This age probably corresponds to that of the tonalitic dykes related to the Favard Suite, which cut across the volcanic sequences in many places.

The extrusive volcanic rocks are mainly represented by more or less amphibolitized basalts. It is the predominant rock type in the complex. These rocks are generally deformed and often banded. When deformation is less important, primary textures can locally be preserved. Pillows and amygdules were observed in the Coulon and Venus belts. Spinifex textured komatiites were observed in the Venus belt (Michel Chapdelaine, Virginia Gold Mines, personal communication). Lithogeochemical analytical results obtained from lava samples, originally described as banded basalt, allow us to conclude that ultramafic flows are also present in the Marilyn and Coulon belts, south of the Vaujours Fault. Metric size rhyolitic lava horizons were noted in some places, in association with felsic pyroclastics.

Mafic and ultramafic intrusions were observed within all belts. Ultramafic intrusives, especially, are the second most abundant lithology within the Gayot Complex. They constitute the predominant lithology of the Ladille and Charras belts and are particularly profuse within the Vimeux, Marilyn and Venus belts. In the Coulon belt, the ultramafics are concentrated south of the Vaujours Fault.

Ultramafic intrusions include pyroxenites and peridotites that form 3 to 30-metre thick sills. They are fine to medium-grained, dark grey to black, with a dark brown weathered surface that is quite distinctive and easy to identify. Peridotites often contain 15 to 20 % rounded olivine crystals, strongly serpentinized and 1 to 3 cm in diameter. These crystals produce a "ball texture" on weathered surfaces. Primary cumulate textures were also observed in several places. These intrusions also contain more or less continuous magnetite ribbons or veinlets generally parallel to the regional foliation.

Gabbros are less abundant but do occur in all belts. They have a massive texture, are medium-grained and greenish grey with a brownish green weathered surface. They form sills intercalated within basalt sequences, or alternating with ultramafic intrusions. In the latter case, the gabbros could represent the upper part of the differentiated ultramafic sills. In the area south of the Sakami Formation, the gabbro lenses that extend for a few kilometres in a NE-SW to NNE-SSW direction were assigned to unit Agat2a (Figure 3).

Pyroclastic rocks are common but only account for a small proportion of the sequence. They form 10-cm to 10-m thick horizons mainly comprised of felsic to intermediate banded ash tuff and crystal tuff. Rhyolitic rocks, possibly effusive, were also described. Several horizons of lapilli tuff and lapilli and block tuff were observed alternating with ultramafic intrusions in the Venus belt. Finally, the most important pyroclastic horizon, which is over 90 metres thick, was encountered in the Coulon belt.

A particular unit of fragmental rocks of uncertain origin was traced over 10 kilometres in the northern part of the Marilyn belt (Aga1a). It consists of 30 to 50 % felsic fragments floating in a medium-grained amphibolite groundmass.

The fragments are sub-rounded to sub-angular and vary from 1 to 10 cm in diameter. These rocks form one to several-metre thick horizons, alternating with massive amphibolite horizons, also 1 to 10 metres thick, which probably represent gabbros. However, the origin of these rocks remains ambiguous given the highly altered nature of the felsic fragments. They could represent volcanic breccia units or gabbros with feldspar glomerocrysts that were completely altered.

Irons formations observed in the Gayot Complex form 1 to 10-metre thick horizons intercalated in the basalt sequence, or less commonly associated with felsic rocks. They consist of oxide-facies, and sometimes sulphide-facies, iron formations formed of alternating magnetite and chert layers one to 10 centimetres thick. In the central part of the Coulon belt, a pyrite and garnet-bearing iron formation unit about 5 m thick was traced over nearly 5 km. Another iron formation, outcropping in the Vimeux belt, forms a massive horizon of a few tens of metres thick, nearly exclusively composed of magnetite. In the Venus belt, an iron formation horizon, which yielded up to 5.6 g/t Au, was traced over more than 10 km by Virginia Gold Mines inc. (Michel Chapdelaine, personal communication). This magnetite and pyrrhotite-rich horizon could be the source of the extremely high regional aeromagnetic anomaly centred on the Venus belt.

Sedimentary rocks are scarce in the Gayot Complex. Rare paragneiss bands of a few metres thick were observed in the Marilyn and Venus belts. Virginia also reported the presence of conglomerate with tonalitic gneiss fragments in the Venus belt (Michel Chapdelaine, personal communication).

Aubert Formation (new unit, Aat)

The Aubert Formation designates a metasedimentary sequence formed of 15 to 100 km^2 bands. It has been divided into two informal units: Aat1 and Aat2.

Unit Aat1 is restricted to the Coulon belt area, in the SW part of the map area (Figures 2 and 3). It consists of thick beds of polygenic conglomerate with fragments of amphibolitized basalt, crystal tuff, tonalitic gneiss and iron formation. The fragments are stretched parallel to the foliation, and their size varies from 1 to 8 centimetres. These conglomerates alternate with 1 to 4-metre thick beds of quartz arenite and argillaceous sandstone (wacke) beds.

Field relationships as well as the composition of fragments in the conglomerates lead us to conclude that the Aubert Formation overlies the Gayot Complex, and accumulated following a period of erosion that affected the volcanic sequence in this area. This situation may be compared with the James Bay area, where conglomerates of the Laguiche Group unconformably overlie volcanic units (Gauthier *et al.*, 1997). The Laguiche conglomerates are considered there as an important marker horizon (Chartrand and Gauthier, 1995), and they are locally associated with felsic volcanic rocks in the LG-3 area (Figure 1, Gauthier *et al.*, 1997).

Unit Aat2 is more widespread. It consists of fine to medium-grained, dark grey banded paragneiss, slightly migmatized and injected with abundant granitic material. These paragneisses contain 15 to 35 % mafic minerals, namely hornblende and biotite. Epidote is ubiquitous and may form up to 2 % of the rock. Small allanite crystals are often associated with the epidote. Sphene and potash feldspar have also been observed. Cordierite-andalusite-garnet schists present south of the Coulon belt have also been included in this unit.

A particular paragneiss sub-unit (Aat2a) was observed about 12 km SSW of the Charras belt, east of the Vaujours fault (Figures 2 and 3). It forms an elongate band that rarely outcrops. Its surface area is estimated at about 20 km^2. It is associated with a strong aeromagnetic anomaly and contains a biotite paragneiss unit that is frequently rusty and locally magnetite-rich. This paragneiss sequence also contains several oxide- and sulphide-facies iron formation horizons 10 cm to 1 m in thickness. The presence of orthopyroxene indicates that these rocks are metamorphosed to the granulite facies, which is atypical of the rocks of the Goudalie-La Grande Assemblage.

Favard Suite (new unit, Afav)

The Favard Suite occupies a large portion of the Goudalie-La Grande Assemblage (Figure 3). It is divided into two units : an older restricted foliated diorite unit (Afav1) and the main foliated tonalite unit (Afav2), which includes a magnetic foliated tonalite sub-unit (Afav2a). U/Pb dating of unit Afav2 yielded an age of 2.73 Ga (David, 1999; Figure 4).

The foliated diorite unit (Afav1) forms small lenticular bodies that are restricted to the northern part of the area. The most important lenses are found west of the Sakami Formation (Figure 3). It also occurs as mappable enclaves within a granodiorite of the Maurel Suite in the NW part of the area. This unit is mainly composed of diorite and quartz diorite, locally with minor gabbro. The rock is medium to dark grey and has a massive to foliated aspect, sometimes even gneissic.

Foliated diorites of unit Afav1 appear to represent an early intrusive phase of the Favard tonalitic Suite. Evidence to this effect includes the presence of tonalitic dykes cross-cutting the diorites in several locations, and the presence of dioritic enclaves, most likely belonging to unit Afav1, within tonalites of unit Afav2.

The foliated tonalite (Afav2) is the principal unit of the Favard Suite. It occupies an important surface area within the Goudalie-La Grande Assemblage (Figure 3). It consists of medium-grained whitish to pinkish tonalite, which contains less than 10% mafic minerals, dominanted by biotite. The texture of the tonalite is quite variable, even on an outcrop-scale, from massive to strongly foliated or even gneissic. These variations generally appear to be associated with an increase in the degree of deformation near the margins of late plutons, or in the vicinity of fault zones. However, the tonalite generally displays a roughly banded aspect, produced by biotite concentrations along poorly-defined cm-scale layers. It may be difficult to distinguish Favard tonalites from older Brésolles gneisses when the former have a gneissic texture. However, Favard tonalites were observed cross-cutting preserved remnants of tonalitic gneiss belonging to the Brésolles Suite. A hornblende-biotite tonalite, containing 15 to 25 % mafic minerals was observed in a few places. It is particularly abundant in the NE part of the area, where diorites of unit Afav1 are present.

Numerous cm- to m-scale enclaves of amphibolite and amphibolitized diorite are present in unit Afav2. Their percentage is variable, but it generally increases near the volcano-sedimentary belts, or in the vicinity of Afav1 diorite lenses. An increase in the number of amphibolite enclaves is often accompanied by an increase in mafic minerals, mainly amphiboles, within the tonalite itself. The enclaves are often stretched, and generally display an internal foliation parallel to the regional foliation, although a few enclaves feature an early foliation that is crenulated by the regional foliation. Finally, enclaves of Brésolles tonalitic gneiss as well as of Aubert paragneiss were also observed locally.

In thin section, the tonalite contains less than 5 % partially chloritized biotite. Green hornblende is also present in minor quantities. Epidote and sphene often occur along biotite grain margins, and allanite has been observed in certain epidote grains. Quartz grains nearly always exhibit a pronounced undulating extinction, and plagioclase is altered. Potash feldspar constitutes less than 1% of the rock. It occurs in the interstices between quartz and plagioclase grains. Idiomorphic apatite is fairly common.

The magnetic foliated tonalite sub-unit (Afav2a) was defined to designate two tonalitic bodies characterized by a strong magnetic susceptibility, outlined on aeromagnetic maps. The first lies in the NW part of the area, near the contact with the Bienville Subprovince, and the second is in the southern part, in contact with the Ashuanipi Subprovince. This unit is very similar to unit Afav2 described above, apart from its high magnetic susceptibility, and a pinkish colour which gives it a granodioritic aspect. In thin section, biotite is more abundant and sometimes exceeds 10 %. The sphene content generally increases along with the biotite content. However, epidote is absent, whereas 1 to 2 % magnetite is systematically observed, mainly along fractures within biotite and sphene grains.

Bienville Subprovince

The NW part of our area is underlain by rocks of the Bienville Subprovince (Card and Ciesielski, 1986; Figures 2 and 3). It is represented by the La Bazinière intrusive Suite (new unit), composed mainly of well-foliated granodiorite.

The Bienville – Goudalie-La Grande contact appears to be essentially intrusive, and no structural or metamorphic feature could be defined. Furthermore, the exact location of this contact could not be accurately established, due to the presence of very similar lithologies within the two major lithotectonic assemblages.

La Bazinière Suite (new unit, Abaz)

The La Bazinière Suite was mapped in an area where outcrops are scarce and of poor quality. The interpretation of this area on the map, and the nature of the suite itself should therefore be considered with some caution. The La Bazinière intrusive Suite is mainly composed of granodiorite, with minor monzodiorite and quartz monzodiorite. These rocks are pinkish grey to whitish grey, and medium to coarse-grained. They sometimes display a porphyritic texture due to the presence of 1 to 3-cm long potash feldspar phenocrysts. Their texture varies from massive to gneissic. This variation may even be observed on an outcrop-scale. The magnetite content is also quite variable in these rocks, which vary from non-magnetic to strongly magnetic. Rare m-scale enclaves of diorite and amphibolite were observed locally. This paucity contrasts with the Lac Bienville area (Ciesielski, 1984) and the Poste-de-la-Baleine area (Ciesielski, 1983) where widely variable trains of enclaves were reported in the Bienville. A few outcrops of diorite, quartz diorite and tonalite were also found in the La Bazinière Suite.

Two representative samples of the La Bazinière Suite were analyzed and studied in thin section. According to the Q-A-P classification diagram by Le Maître (Figure 5a), these fall in the upper part of the quartz monzodiorite field (I2G). These rocks display a heterogranular texture, defined by xenomorphic quartz, plagioclase and potash feldspar . Quartz is characterized by a strongly developed undulating extinction. Biotite and green hornblende make up about 15 to 20 % of the rock. Well-crystallized sphene and epidote are also observed. U/Pd age dating performed on a massive to foliated porphyritic granodiorite, most likely belonging to the La Bazinière Suite, yielded an age of about 2.70 Ga (David, 1999; Figure 4), compared to 2712 Ma in the Radisson area (Mortensen and Ciesielski, 1987).

Ashuanipi Subprovince

The Ashuanipi Subprovince occupies the eastern part of the Lac Gayot area. Three principal units are present: the Grosbois Formation, the Beausac Suite and the Opiscotéo Suite (Leclair *et al.*, 1998; Figure 3). The Grosbois Formation is the oldest unit consisting of migmatized paragneisses. They are cross-cut in places by finely foliated tonalitic to granodioritic intrusions that we have assigned to the Beausac Suite. The Opiscotéo Suite corresponds to diatexites of granodioritic composition that are injected in the other two units.

The metamorphic grade appears to decrease from south to north in the Ashuanipi Subprovince, from the granulite facies to the amphibolite facies. This variation is mainly outlined by the disappearance of orthopyroxene in diatexites

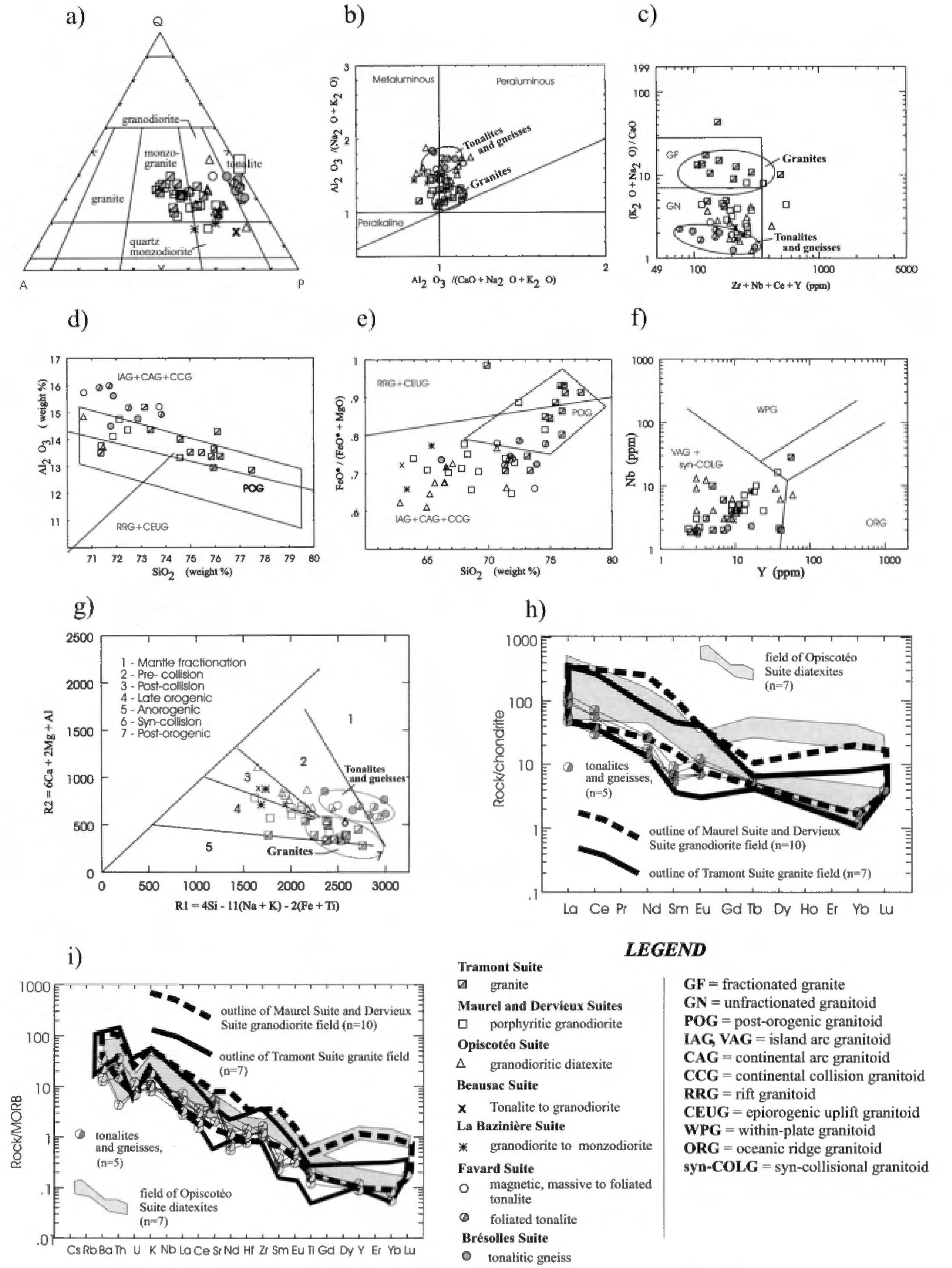


FIGURE 5 - Principal felsic intrusive suites in the diagram : **a)** from Le Maitre (1989), **b)** from Maniar and Piccoli (1989), **c)** from Whalen *et al.* (1987), **d and e)** from Maniar and Piccoli (1989), **f)** from Pearce *et al.* (1984), **g)** from Batchelor and Bowden (1985), **h)** chondrite-normalized rare earth distribution diagrams (normative values from Sun and McDonough, 1989), **i)** MORB-normalized multi-element distribution diagram.

and paragneisses, accompanied by a change in the colour of biotite, which gradually shifts from dark reddish brown in the south to light brown in the north.

The boundary between the Ashuanipi Subprovince and the Goudalie-La Grande Assemblage is relatively sharp. It consists of an intrusive contact between younger Opiscotéo diatexites and various units of the Goudalie-La Grande. As a general rule, the metamorphic grade rapidly decreases from the granulite facies in Ashuanipi units to the amphibolite facies in those of the Goudalie-La Grande. A fair portion of this contact is masked however in the east-central part of the area, by the Vaujours fault, and by the presence of an important porphyritic granodiorite intrusion assigned to the Dervieux Suite that appears to postdate the Opiscotéo (Figure 3).

Grosbois Formation (new unit, Ags)

The Grosbois Formation is formed of variably migmatized paragneiss remnants preserved within the Ashuanipi. These rocks are similar to those described elsewhere in the subprovince, and where the protolith is interpreted as a clastic sedimentary sequence dominated by greywacke (Percival *et al.*, 1992; Leclair *et al.*,1998). The Grosbois Formation is probably equivalent to rocks of the Hublet Group (Leclair *et al.*, 1998) observed in the Ashuanipi south of this area, as well as to rocks of the Mercator Formation present in the easternmost part of the Opinaca Subprovince (Lamothe *et al.*, 1998; Lamothe, 1998). Since the Mercator Formation has also been interpreted as a lateral equivalent of migmatized metasediments of the Laguiche Group (Simard and Gosselin, 1998) that characterize the Opinaca Subprovince, we can conclude that the Grosbois Formation is probably equivalent to Opinaca paragneisses.

Paragneisses of the Grosbois Formation form remnants that cover a few kilometres to over 200 square kilometres (Figure 3). These paragneisses are migmatized, and have a banded aspect, due to the presence of alternating bands of dark grey to brownish grey paleosome and light grey to whitish leucosome. The paleosome is fine to medium-grained, well-foliated and alters to a rusty colour. In thin section, it has a granoblastic texture and contains 15 to 25 % mafic minerals including biotite, orthopyroxene and minor green hornblende. The leucosome forms 5 to 50 % of the rock. It is medium to coarse-grained, and even pegmatitic on occasion. Its composition varies from tonalitic to granitic. It forms continuous to lenticular bands 1 mm to 10 cm thick, parallel to the regional foliation. These bands of mobilizate are strongly deformed and commonly display ptygmatic folding.

Oxide-facies iron formation horizons, 10 cm to 10 m thick, were also observed locally in the paragneiss sequences of the Grosbois Formation. These are banded, and formed of cm-scale alternating beds of magnetite and chert. The presence of pyrite and pyrrhotite in these horizons often produces a rusty colour that stands out on outcrop.

Leclair *et al.* (1998) and Lamothe *et al.* (1998) respectively divided paragneisses of the Hublet Group and of the Mercator Formation into two distinct units, based on the presence or not of garnet in the paleosome. In paragneisses of the Gayot area, garnet is fairly rare, and is randomly distributed. Thus it does not constitute a reliable mapping criteria. Where garnet is present, it is generally concentrated along the margins or within mobilizate bands. Locally, some cm-scale to m-scale paragneiss horizons very rich in garnet are also observed, associated with iron formation horizons. In the Grosbois Formation, orthopyroxene is abundant in the south part of the subprovince, but is practically absent in the north. This could be explained by a decrease in the metamorphic grade northward. Furthermore, this regional variation in the orthopyroxene content has also been observed in diatexites of the Opiscotéo Suite.

Beausac Suite (new unit, Abea)

The term Beausac Suite is proposed to designate strongly foliated intrusive rocks of tonalitic to granodioritic composition. These rocks were observed as large enclaves, several kilometres in size, in intrusions of the Dervieux Suite and occasionally in the Tramont Suite. Where they come in contact with paragneisses of the Grosbois Formation, these intrusive rocks form m-scale bands within the paragneiss sequences, parallel to the regional foliation. Elsewhere, this suite is often injected with abundant late granitic material. A U/Pb age of 2.70 Ga was obtained for this unit (David, 1999).

Rocks of the Beausac Suite are grey, fine to medium-grained and very strongly foliated to banded. They contain about 10 % green hornblende and biotite. A few orthopyroxene grains were also observed. The rock displays a poorly-defined granoblastic texture. Two samples were analyzed; one is a quartz monzodiorite and the other a granodiorite (Figure 5a). However, feldspar staining revealed that several samples have a tonalitic composition.

Opiscotéo Suite (Aopi)

The Opiscotéo Suite was defined by Leclair *et al.* (1998) in the Lac Bermen area, SSE of the Caniapiscau Reservoir (Figure 1). It mainly consists of diatexites of granodioritic composition. These rocks are equivalent to the diatexites that characterize the Ashuanipi Subprovince in general, and their formation is thought to have occurred between 2650 and 2682 Ma (Figure 4; Chevé and Brouillette, 1991; Percival *et al.*, 1992). In our map area, a preliminary age of 2637 +/- 8 Ma was obtained from one of these rocks (David, 1999).

Diatexite is an intrusive rock formed through anatexis, and where melting may be total. Percival (1991) mentioned that the mineralogy and composition of diatexites and paragneisses in the Ashuanipi were comparable. He therefore considered that the diatexites could be derived from the partial melting of a protolith similar to paragneisses mapped in the Ashuanipi Subprovince.

In the Gayot area, Opiscotéo diatexites form masses that extend over several hundred square kilometres, and their magnetic susceptibility varies from weak to very strong. These rocks are whitish grey to greenish grey. Brownish to orange brown weathered surfaces are due to biotite alteration. They are heterogranular, and vary from fine-grained to pegmatitic. Potash feldspar phenocrysts 1 to 8-cm long often give the rock a porphyritic texture. The diatexites are generally well-foliated. This foliation is accentuated by the presence of biotite schlieren and stretched paragneiss enclaves that give the rock a banded, irregular and discontinuous aspect. Paragneiss enclaves vary from a few centimetres to a few metres in size. They generally represent between 5 and 25 % of the rock, but this proportion may increase locally, particularly near the contact with paragneisses of the Grosbois Formation. The enclaves are migmatized, and their internal foliation is usually at an angle relative to the regional foliation. Rare amphibolite and ultramafic rock enclaves were also observed. These are generally smaller and less deformed than paragneiss enclaves.

The diatexites are essentially granodioritic in composition (11C, Figure 5a). They are composed of quartz, often smoky, plagioclase, potash feldspar and 10 to 25 % mafic minerals, mainly biotite with orthopyroxene, and less commonly green hornblende. Orthopyroxene is ubiquitous in the southern half of the area. In the northern part however, it was not observed in thin section, although its presence was noted on certain outcrops. The colour of biotite grains also varies from reddish brown in the south part to greenish brown in the north part. These observations suggest, as is the case for paragneisses of the Grosbois Formation, a regional decrease in metamorphic intensity northward.

Garnet was observed in a few rare locations within the area. In the Lac Bermen area however, Leclair *et al.* (1998) were able to define sub-units within the Opiscotéo based on the abundance of this mineral. Garnet is also abundant in the Schefferville area, i.e. in the NE part of the Ashuanipi Subprovince (Percival *et al.*, 1992).

Late Intrusive Suites

Late plutonic rocks are spatially distributed without regard to the boundaries of lithotectonic domains. These intrusive rocks belong to three distinct suites: the Maurel granodioritic Suite, the Dervieux granodioritic Suite and the Tramont granitic Suite.

Maurel Suite (new unit, Amau)

The Maurel Suite consists of porphyritic granodiorite characterized by a high magnetic susceptibility. It forms intrusive bodies several kilometres in size, or occurs as injections and dykes within older units. The latter occurrences do not appear on the maps due to their restricted size. A sample collected from a pluton in the NW part of the area yielded a preliminary age of about 2.68 Ga (Figure 4).

The Maurel Suite is mainly composed of granodiorite (Figure 5a) and has a distinctive porphyritic texture caused by the presence of potash feldspar phenocrysts 1 to 5 cm long. The phenocryst content varies from 5 to 25 %, but may reach up to 50 % locally. Rocks of this suite are pinkish grey to dark pink, and medium to coarse-grained. They are either massive or weakly foliated, except in fault zones where they display a strong foliation. Enclaves are scarce. They are generally about 10 cm in size, and consist of various lithologies that correspond to the surrounding country rock.

In thin section, rocks of the Maurel Suite are heterogranular, and grain boundaries are often dendritic. Graphic textures are widespread. These rocks contain 5 to 15 % biotite and green hornblende in variable proportions, but generally dominated by biotite. The latter has a greenish tinge, and is variably replaced by chlorite. The rock always contains magnetite, associated with biotite, which explains the highly magnetic nature of the unit. Also present are idiomorphic to hypidiomorphic grains of sphene, as well as apatite and sometimes epidote.

Dervieux Suite (new unit, Ader)

The Dervieux Suite is restricted to the Ashuanipi Subprovince. It is composed of granodiorite and granite, characterized by a strong magnetic susceptibility and a widespread porphyritic texture produced by the presence of potash feldspar phenocrysts 1 to 5 cm long. These rocks are pinkish grey and medium to coarse-grained. They are generally massive to weakly foliated. Enclaves are relatively widespread, and mainly consist of diorite, foliated tonalite and paragneiss of the Grosbois Formation. Diatexite enclaves of the Opiscotéo Suite were also observed in a few locations. In thin section, the rock contains between 5 and 10 % biotite and hornblende, biotite being the dominant phase. In fact, certain thin sections did not contain any hornblende. Biotite is variably chloritized. Omnipresent magnetite is associated with biotite.

It is difficult to differentiate between the Dervieux Suite and the Maurel Suite, both on outcrop and in thin section. The only distinction is based on the presence of enclaves of Opiscotéo diatexites in granodiorites of the Dervieux Suite. These enclaves suggest that the Dervieux Suite is younger than the Opiscotéo Suite, dated at 2637 +/- 8 Ma, whereas an older preliminary age of 2.68 Ga was obtained from a granodiorite of the Maurel Suite (Figure 4).

Tramont Suite (new unit, Atra)

The Tramont granitic Suite is widespread in all the subprovinces within our study area. It constitutes the youngest

Archean lithology. The presence of diatexite enclaves of the Opiscotéo Suite within these granites suggests they are younger than 2637 +/- 8 Ma. The Tramont Suite is formed of several km-size intrusive bodies, or dykes and multiple injections 1 to 10 metres in size. These rocks were injected into other units, where they often form over 10 % of the outcrops. Near the contacts of plutonic bodies, the injection phenomenon becomes so important that numerous enclaves of country rock are isolated, and the rock takes on an intrusive megabreccia aspect.

Rocks of the Tramont Suite are compositionally very homogeneous, and fall within the monzogranite field (I1M, Figure 5a). The rock is pinkish, homogeneous, massive to weakly foliated except in deformation zones where a nearly gneissic texture is developed. The grain size varies from fine to coarse, but remains constant at the scale of an outcrop. Pegmatitic injections are frequently observed; these seem to correspond to a late phase of the suite.

The Tramont granite contains less than 1 % biotite or chlorite. It contains minor white mica as an alteration phase of plagioclase. Potash feldspar crystals are commonly perthitic. A few idiomorphic garnets were locally observed. As a general rule, these granites contain 1 to 10 % cm-scale to m-scale enclaves of the surrounding country rock.

Proterozoic Rocks

Sakami Formation (pPsa)

The Sakami Formation was defined by Eade (1966). It groups several outliers of Paleoproterozoic sedimentary rocks dated at about 2.0 Ga (Séguin *et al.*, 1981). This formation is present in the NE part of our map area, where the Lac Dieter outlier extends from east to west over more than 40 kilometres, as well as the Lac Pons outlier, part of which is present in the NE corner of the map area.

In the Lac Dieter outlier, the Sakami Formation forms a regular monoclinal sequence oriented E-W and dipping 20° south. Eade (1966) subdivided it into two units: a lower sequence of continental deposits formed of red beds, conglomerate, arkose, mudstone and siltstone and an upper epicontinental sequence of quartz arenite. The base of the lower sequence consists of a 55-m thick unit that was interpreted as having formed in a torrential and lacustrine environment (Meusy, 1982). It begins with a red conglomerate, and is characterized by alternating red sandstone and argillite beds with green to greenish grey sandstone and argillite beds. This unit is overlain by a 135-m thick sequence of relatively homogeneous whitish sandstone associated with a fluviatile environment, then by a thick (at least 700 m) sequence of orthoquartzite and deltaic quatrz arenite, massive or cross-bedded. Paleocurrent measurements taken in the Lac Dieter area (Orr, 1979) indicate a direction of flow from the N or NW. Further south, NE directions were obtained (Meusy, 1982).

Orthoquartzite is by far the most abundant lithology. It forms 2 to 10-cm thick beds, generally massive but rarely laminated, that vary in colour from whitish to orange red. Thin beds (1-2 cm) of red mudshale are occasionally present, and Eade (1966) noted the presence of somme conglomeratic lenses with well-rounded quartz pebbles within the sequence. In thin section, the orthoquartzite is composed of 99 % equigranular very well-rounded quartz grains and a minute quantity of clay matrix. A few rare grains of plagioclase and recrystallized quartz-rich rock are also present.

The Sakami Formation unconformably overlies the Archean rocks, however the nature of the contact is often obliterated by late faults. Work performed by Uranerz led to the identification of a uraniferous zone associated with the lower unit of the Lac Dieter outlier (Orr, 1977; Orr and Holmstead, 1979). The main mineralized horizon is located at the top of a green silty shale sequence, near the transition to a dirty sandstone unit.

Bouteille Suite (new informal unit, Pboe)

The informal term Bouteille Suite is proposed to designate the entire series of diabase dykes present within the map area. These dykes, less than 1 metre to over 100 metres thick, were observed on about 60 different outcrops. Their lateral extension is generally quite limited, and only a few were important enough to trace on the map. These dykes are generally strongly magnetic, but are rarely visible on regional aeromagnetic maps due to their restricted extent. In the Lac Bouteille area, these dykes cross-cut the Sakami Formation, and a K-Ar age of 1598 +/- 92 Ma was obtained (Meusy, 1982), i.e. at the boundary between the Paleo- and Mesoproterozoic.

Diabase dykes in the area have three principal orientations, namely NE-SW, N-S and NW-SE. A few E-W dykes occur in the westernmost part of the area. The diabase dykes are massive, and do not appear to have undergone any deformation. They are fine to medium-grained, dark grey to greenish grey, with a dark brown weathered surface. In thin section, diabase samples have a subophitic texture and consist of elongate plagioclase grains, with interstitial clinopyroxene and magnetite. They also contain a few partially serpentinized olivine grains.

LITHOGEOCHEMISTRY

Major and trace elements, as well as rare earth elements, were analyzed in 125 rock samples representing the principal lithologies in the area. Analytical results were plotted on diagrams shown in Figures 5 and 6, and were divided into three broad groups, which will be discussed summarily: 1- granitoids, 2- the Gayot volcanic Complex, and 3- mafic to ultramafic enclaves and horizons observed within granitoids.

Granitoids

The Gayot area mainly consists of igneous rocks at various metamorphic grades, that were assigned to different intrusive and metamorphic suites described in the previous section. Results of lithogeochemical analyses performed on samples from these various suites were plotted on the diagrams in Figure 5. The mesonormative diagram of Le Maître (1989, Figure 5a) helps to specify the nature of rocks forming each of these suites. Most diagrams using correlations between major element associations were useful in subdividing granitoids into three major groups (Figure 5b, 5c, 5d, 5e and 5g): the first corresponds to granites of the Tramont Suite, the second comprises the Favard tonalites and the Brésolles tonalitic gneisses, and finally the third includes rocks of granodioritic composition of the Dervieux, Maurel, Beausac and Opiscotéo suites.

In general, granitoids in the area are slightly peraluminous, although several samples cross over into the field of metaluminous rocks (Figure 5b). In the diagram by Whalen *et al.* (1987; Figure 5c), Tramont granites fall in the fractionated granite field, whereas analyses of other suites fall in the unfractionated granitoid field.

Diagrams used to discriminate geotectonic environments show that analyses of the Tramont granites are grouped in the post-orogenic granitoid field (Figures 5d and 5e), whereas analyses of tonalitic and granodioritic rocks could be associated with an island arc environment, or a continental arc or a continental collision environment (Figures 5d, 5e and 5f). In Figure 5g, tonalites appear to be associated with a pre-collisional event, granodioritic rocks to syn- to post-collisional periods and granites to post-orogenic to syn-collisional events.

Diagrams using trace element correlations are less discriminant compared to major element diagrams (Figures 5c and 5f). This statement also applies to rare earth and minor elements distribution diagrams (Figures 5h and 5i). Although the patterns of these latter elements reflect the distinctive features of each suite, the general patterns are relatively similar. Nevertheless, they do indicate that Tramont granites have lower Sr, Sm and Eu values than granodioritic rocks of the Dervieux, Maurel and Opiscotéo suites. The pattern associated with tonalites and tonalitic gneisses is slightly depleted in light rare earths relative to other granitoids. It also displays a weak positive Eu anomaly. As for Opiscotéo diatexites, three samples are abnormally enriched in heavy rare earths (Yb and Lu), which produces a fork-like pattern (Figures 5h and 5i). These samples also have anomalous Zr/Y ratios of 3.5 compared to an average value of about 15 for all other granitoid samples. The geochemical signature of these three samples remains unexplained for the moment.

The Gayot Complex

The scale at which we conducted this study provided a global view of the Gayot Complex which represents a series of volcanic belts, isolated from one another, whose internal structure has yet to be defined. Consequently, the collected samples should be considered as the products of a random sampling program carried out in a more or less dismembered volcanic sequence. These samples were collected from all the mapped volcanic bands, and were selected in such a way as to represent the principal lithologies of the complex.

The most frequently observed lavas in the Gayot Complex are tholeiitic basalts (Figures 6a, 6b and 6d). They have distinctive Zr/Y ratios of about 2.8, and their rare earth patterns are typically flat (Figure 6e). In the Ti vs Zr diagram (Figure 6c), the distribution of basalt samples indicates a geotectonic environment corresponding either to an island arc or an oceanic floor. Two samples from the Venus belt are ferrotholeiites most likely belonging to the same volcanic suite. These ferrotholeiites are highly differentiated (Figure 6b), and are slightly depleted in light rare earths (Figure 6e). Still in the Venus belt, two analyses indicate the presence of calc-alkaline andesites in the sequence (Figures 6a and 6d). Their Zr/Y ratio is higher than 7 and their rare earth pattern is clearly enriched in light rare earths (Figure 6e). Finally, two samples exhibit characteristics typical of transitional basalts (Zr/Y = 5, and slight enrichment in light rare earths).

Tuffs in the complex are dacitic to rhyolitic, and clearly calc-alkaline (Figure 6a, 6b and 6d). They are enriched in light rare earths (Figure 6f), much like the calc-alkaline andesites. Thus, it appears that the area experienced both effusive and extrusive calc-alkaline volcanic activity.

Ultramafic rocks of the Gayot Complex generally belong to sills intercalated in the volcano-sedimentary sequence, or sometimes to komatiitic flows. In Zr vs Y and Ti vs Zr diagrams, these rocks fall on the same fractional crystallization trend as the tholeiitic basalts (Figures 6b and 6c). The presence of ultramafic lavas was originally outlined when spinifex textures were identified in the Venus belt by the staff of Virginia Gold Mines (Michel Chapdelaine, personal communication). Two rocks described in the field as banded basalts are in fact deformed komatiitic lavas, according to our analyses. These rocks are geochemically very similar to ultramafic sills, although they are somewhat more evolved (Figures 6a, 6b, 6c and 6g).

Mafic and Ultramafic Enclaves and Rocks

Analyses were performed on samples collected from mafic to ultramafic enclaves and horizons from three different settings: mafic-ultramafic bodies generally observed in

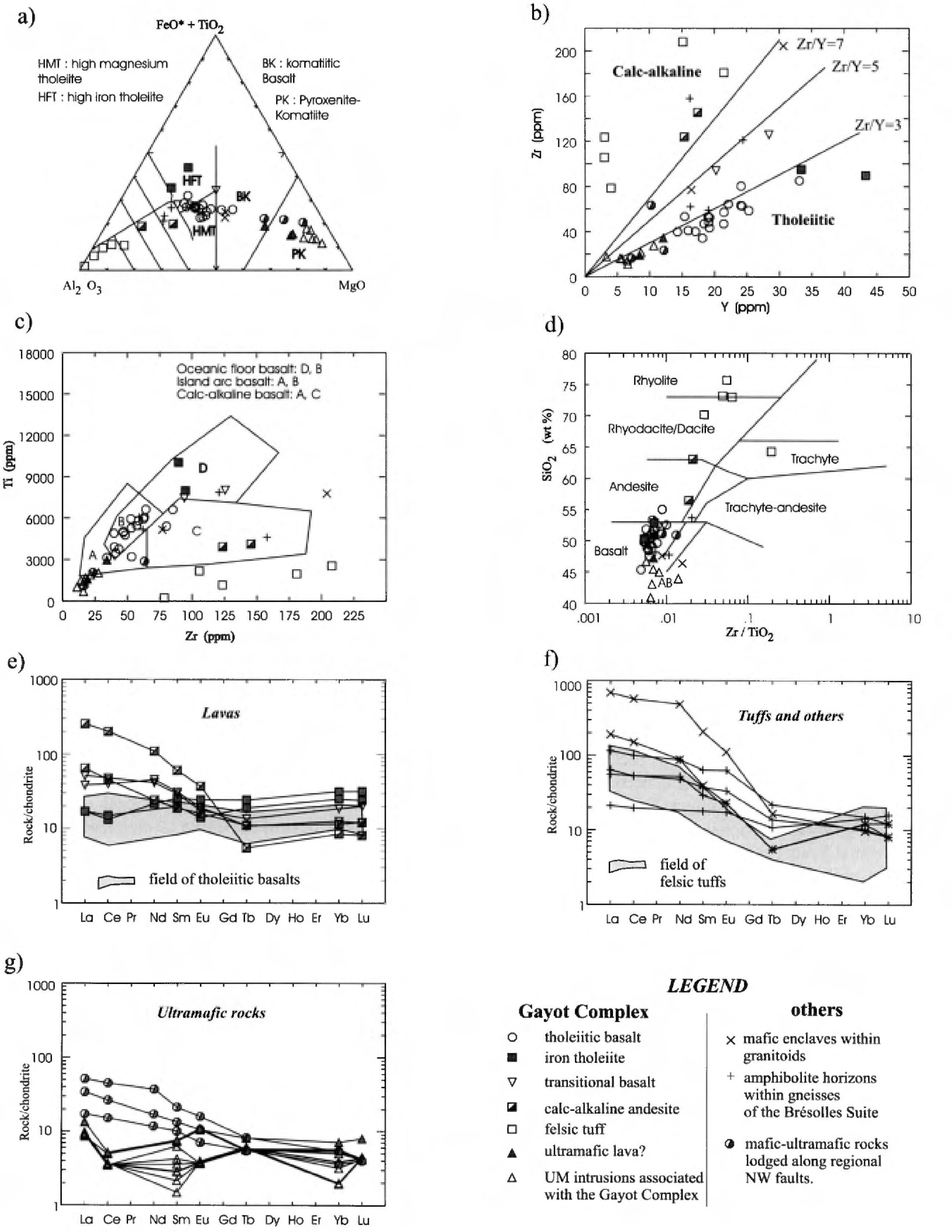


FIGURE 6 - Geochemical diagrams of the various lithologies encountered in the Gayot Complex, and of samples from the mafic to ultramafic horizons, enclaves and intrusive bodies; **a)** diagram from Jensen (1976), **b)** Zr vs Y diagram, **c)** diagram from Pearce and Cann (1973), **d)** diagram from Winchester and Floyd (1977), **e), f)** and **g)** chondrite-normalized rare earth distribution diagrams (normative values by Sun and McDonough, 1985).

regional fault zones oriented NW-SE, amphibolite layers found within the Brésolles gneisses, and mafic enclaves identified in granitoids.

Mafic-ultramafic bodies are a few tens of metres thick, and thus are not shown on our map given the scale. They are nevertheless identified on the SIGÉOM map (Simard and Gosselin, 1999) where lithology codes I3A and I4B appear near outcrops where they were observed. These rocks are deformed, and may sometimes be confused on outcrop with ultramafic rocks of the Gayot Complex. However, they may be distinguished by a clear enrichment in light rare earths (Figure 6g), and by a lower Mg content (between 15 and 19 % MgO).

Amphibolites forming m-scale layers or enclaves within tonalitic gneisses of the Brésolles Suite are mafic to intermediate in composition (Figures 6a and 6d). Their magmatic affinity varies from tholeiitic to transitional, except for one sample of diorite which is calc-alkaline (Figure 6b). Most of the analyzed samples are enriched in light rare earths, except for one sample with a flat pattern, comparable to that of tholeiitic basalts (Figure 6f). These characteristics are not sufficient to determine the nature of these amphibolites. However, a volcanic origin is possible, given the relatively old age (2.86 Ga) of volcanism associated with the Coulon belt (Figure 4).

Two samples were collected from mafic enclaves within a porphyritic granodiorite of the Maurel Suite and a granite of the Tramont Suite. These enclaves are mafic in composition (Figures 6a and 6d), and have a transitional to calc-alkaline magmatic affinity (Figure 6b), which suggests a different origin than for mafic volcanic rocks of the Gayot Complex. Furthermore, these samples are particularly enriched in light rare earths (Figure 6f). This feature leads us to assume an igneous origin comparable to that of mafic-ultramafic bodies, which are also strongly enriched in light rare earths (Figure 6g).

STRUCTURAL GEOLOGY

From the standpoint of major regional structures, the Gayot area is quite different from the La Grande Subprovince. The NE-SW to E-W structural trend characteristic of the La Grande was not identified in the area. The only comparable element is the NW-SE system of late dextral faults, locally developed in the La Grande Rivière area (Chartrand and Gauthier, 1995). This system could correspond to a similar system that is well-developed in the Lac Gayot area. As for the Goudalie Domain, the NNW-SSE orientations typical of this domain are omnipresent in our map area. Percival *et al.* (1992) considered that the deformation associated to this structural trend had developed before an important intrusive phase extending from 2725 to 2693 Ma. They mention that the distribution of relatively massive sheet intrusions suggests that the injections were controlled by a pre-existing structural trend oriented NW-SE. In the Gayot area, this situation does not seem to have prevailed, or else it could not be identified. The main phases of deformation affected all the Archean rocks of the area to varying degrees. They contribute to a complex structural history that could extend over a long period. The Paleoproterozoic Sakami Formation however, is not deformed, except along late brittle faults that generally correspond to the reactivation of older structures.

Phases of Deformation

Several successive phases of deformation affected the Gayot area. Relics of an early D1 deformation phase are noted within amphibolite enclaves in the Brésolles gneisses and in the foliated tonalites of the Goudalie-La Grande. Paragneiss enclaves within Ashuanipi diatexites also display an early foliation that predates the regional foliation.

The regional foliation is the most widespread and most penetrative structural element affecting the Archean rocks in the area. It occurs in the form of a discrete mineral foliation, a schistosity or a gneissocity, depending on the rock type and the intensity of the deformation. In fact, variations in the intensity of deformation are often observed even within a single outcrop. The regional foliation is considered to be realted to D2 phase of deformation, although the history of earlier deformation events appears to be much more complex. For example, the gneissocity observed in the Brésolles Suite is not comparable with the foliation developed in diatexites of the Opiscotéo Suite, given the important age difference between the two suites. Whatever the case may be, the phase or phases of deformation that produced the S2 regional foliation were obliterated by at least two subsequent phases of deformation that affected all the Archean rocks in the area. Phases D3 and D4 reoriented and folded the regional S2 foliation (Figure 7). Folding phase F3 clearly dominates the structural domain east of the Vaujours fault, whereas folding phase F4 particularly affects the western domain (Figures 7 and 8).

Orientation of Regional Foliation

Variations in the orientation and dip of the regional foliation were useful in identifying folds associated with phases D3 and D4 (Figure 7). F3 folds are oriented NNW-SSE to NE-SW whereas those of phase D4 are oriented WNW-ESE to NW-SE. F3 folds mostly occur to the east of the Vaujours fault. A compilation of foliations in sub-domain 1 reveals an average folding orientation at 002/48, which approximately corresponds to the average orientation of lineations measured in the field (Figure 8), as well as to the orientation of the

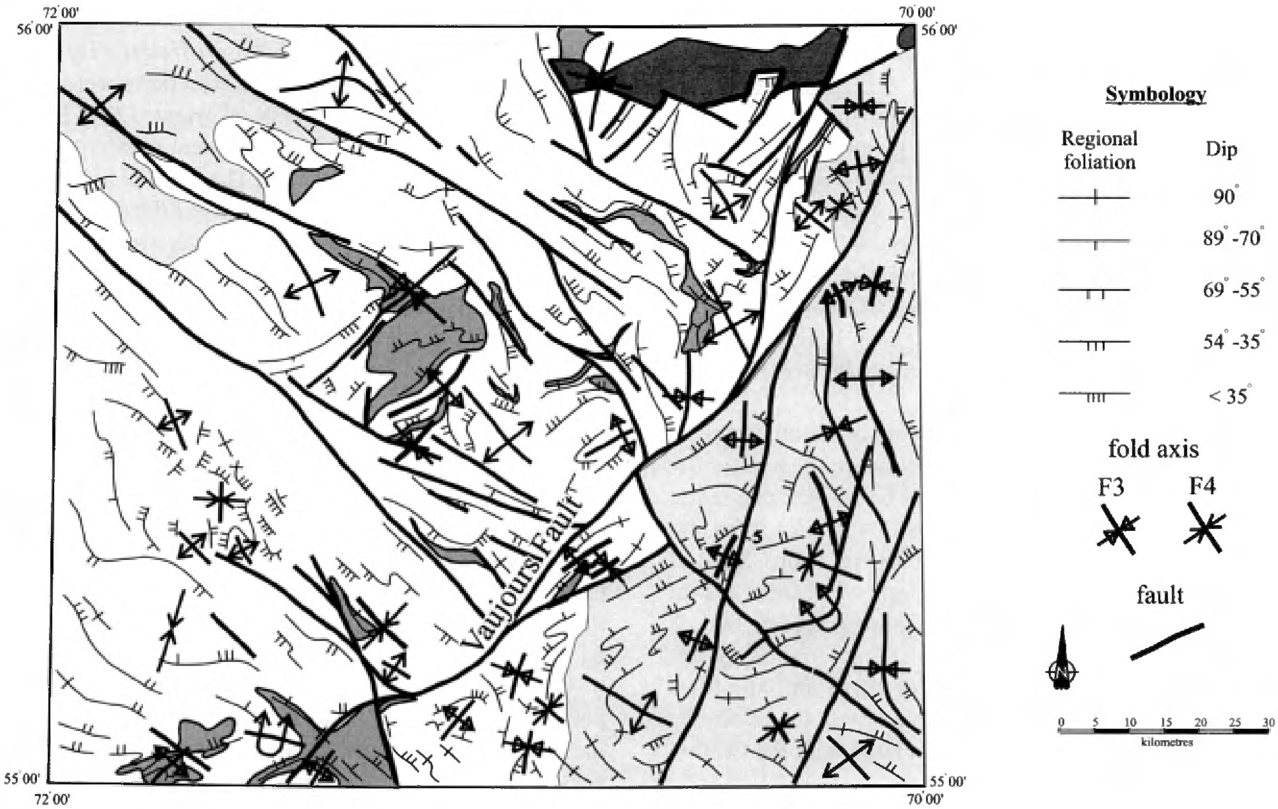


FIGURE 7 - Orientation of the regional foliation and distribution of major faults and principal folds affecting the foliation (please refer to Figure 8 for the location of structural sub-domains).

main fold axes traced on the map and plotted on Figure 7. Further south, sub-domain 2 presents a random or "shotgun" distribution pattern for foliations, due to the growing influence of F4 folds that superpose F3 folds.

In domains west of the Vaujours fault, a few F3 fold axes were interpreted. They are oriented NNE-SSW to NE-SW, and their extension is limited due to the D4 phase that controls the structural trend in this sector. A dome and basin pattern produced by the superposition of folding phases F3 and F4 was preserved in sub-domain 6 (Figure 7). Data compilation also outlined a structural basin indicated by the convergence of F4 folds in sub-domains 5 and 6 (Figure 8). Other convergence situations may be observed in sub-domains 7 and 8, and probably between domains 3 and 4. Although a more detailed study is required, the convergence of fold plunges suggests that the Goudalie-La Grande Assemblage corresponds to a structural basin oriented NNE-SSW. The latter is presumably associated with the F3 phase, and refolded at right angles by phase F4.

Major Faults

The Gayot area is transected by an important network of orthogonal faults formed of a NW-SE striking system and a second NNE-SSW to NE-SW directed system. The latter system includes the regional Vaujours fault, which represents a major tectonic discontinuity. The two fault systems appear to cross-cut F3 and F4 folds (Figure 7). Thus, they may be related to a final phase of the D4 deformation event, or to a distinct D5 phase. The relationship between the two fault systems could not be established. However, it must be pointed out that NW-SE directed faults are much better developed in the domain located west of the Vaujours fault. In fact, most of these faults do not seem to cross this limit.

Most of the faults were interpreted from lineaments observed on aeromagnetic maps and Landsat images. In the field, they correspond to sheared or intensely foliated zones that affect all Archean units. Rocks affected by these zones are also strongly hematized, epidotized and chloritized. The regional foliation is often reoriented parallel to the direction of the deformation zones. It is however possible that the fault zones may have generated their own planar system associated with a late D4 or D5 phase. This system is generally confused with the S2 regional foliation. On rare occasions however, a crenulation cleavage affecting the regional foliation was observed. The development of a fault-related late foliation is also suggested by the presence of an intense foliation observed to be concentrated in restricted zones within late granitoids that are on the whole only weakly foliated.

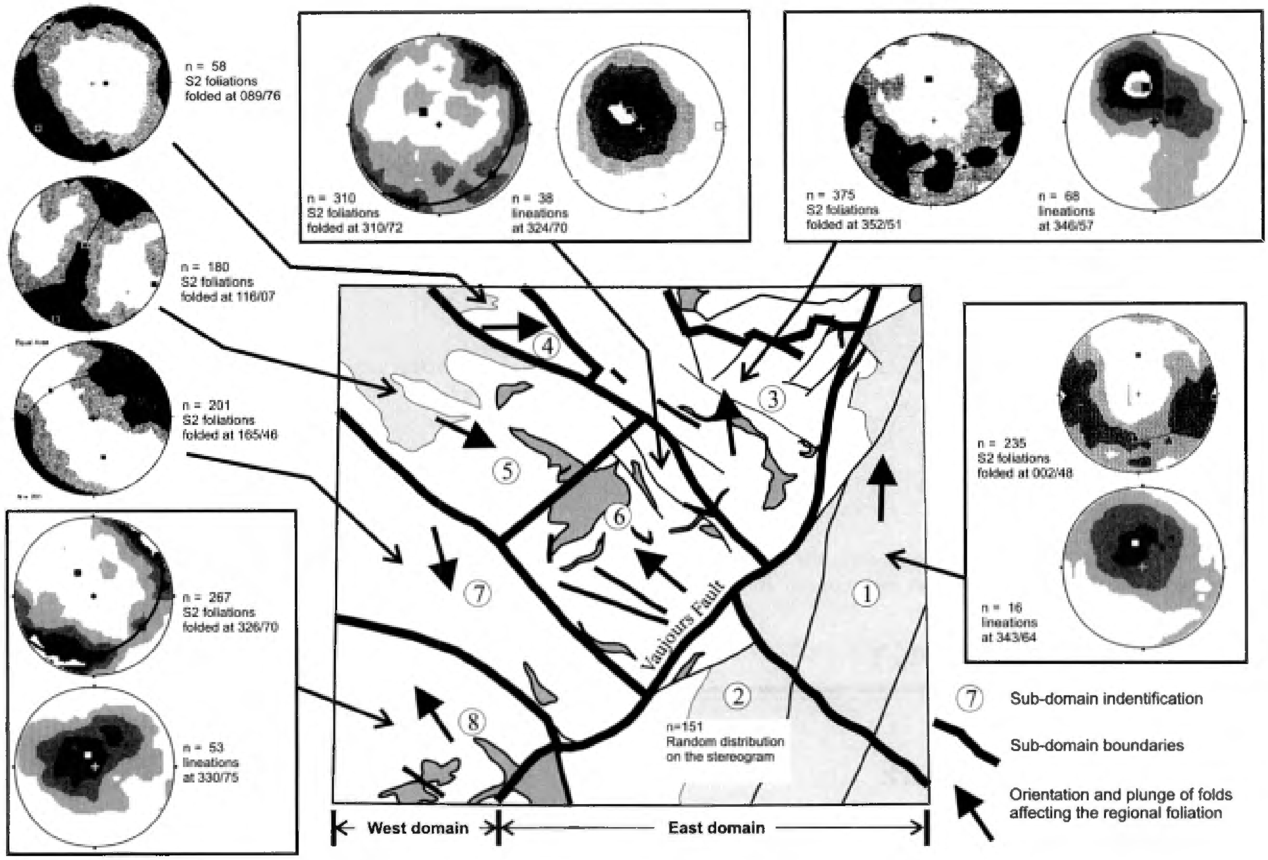


FIGURE 8 - Statistical stereographic compilation of regional foliation and lineation measurements.

The Vaujours Fault

The Vaujours fault is the most important fault in the area. Observations made in the vicinity of the Charras and Coulon belts suggest that it is an Archean fault with a reverse movement towards the SE (N'Dah, É. and Goulet, N., personal communication). It would therefore roughly correspond to a zone of thrusting of the Goudalie-La Grande Assemblage over the Ashuanipi Subprovince. The amount of displacement is not known. The fault splits into two branches northward. The eastern branch is well-defined on aeromagnetic maps and Landsat images. The western branch forms the eastern margin of the Sakami sedimentary basin, which indicates that this fault was reactivated during the Proterozoic, at least in this sector.

Relationship between Sakami and Archean Rocks

The contact between the Sakami Formation and the underlying Archean rocks essentially corresponds to a major angular unconformity. The Dieter outlier (Figure 2) is bounded to the north by the unconformity, although an examination on a detail scale reveals that NE-SW faults modify its trace (Figure 9; Orr, 1978). The southern limit of the Dieter outlier, however, is clearly affected by faults (Meusy, 1977). The two regional fault systems (NNE-SSW and NW-SE) described above are identified. These would therefore have been reactivated during the Proterozoic. Also present are ENE-WSW oriented faults. Their orientation is atypical of regional structures observed in Archean rocks in the area, which suggests they are directly related to the Sakami. In this sector, Meusy (1982) estimated the depth of the unconformity to a few hundred metres. This situation indicates that ENE-WSW faults could correspond to the general orientation of a rift zone related to the presence of a Proterozoic graben. It is noteworthy that, on a regional scale, Sakami outliers are grouped within two principal zones oriented ENE-WSW. The first approximately corresponds to the basin of the La Grande Rivière, and the second follows the 56th parallel between longitudes 69°00' and 73°00'. The orientation of a sedimentary basin becoming deeper southward would concur with paleocurrent directions obtained in the area. These directions are seen to vary from SE-NW to SW-NE (Orr, 1979; Meusy, 1982). It is these same syn- to post-sedimentation extensional faults which are presumably responsible for the preservation of Sakami deposits from erosion (Eade, 1966; Orr, 1977).

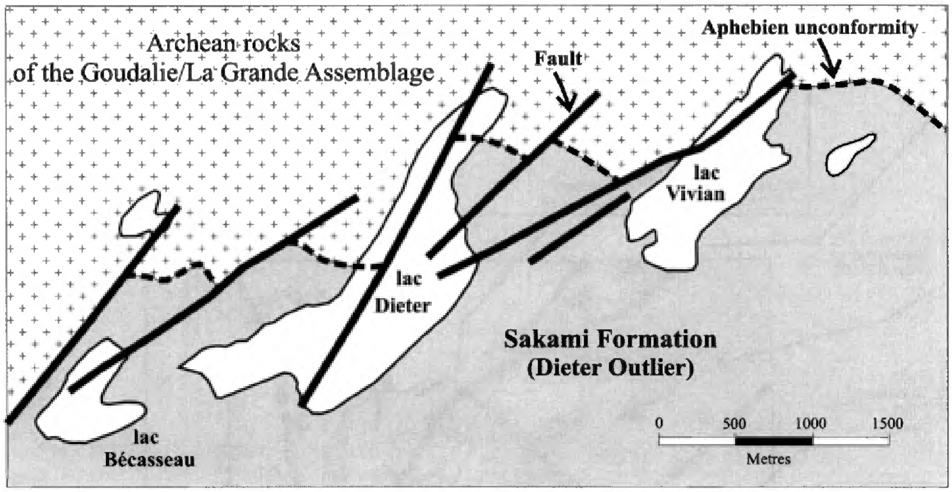


FIGURE 9 - Unconformable contact between the Sakami Formation (northern part of the Dieter outlier) and Archean rocks (taken from Orr, 1978).

ECONOMIC GEOLOGY

Previous Work

Eade (1966) reported the presence of minor chalcopyrite mineralization in volcanic rocks located in the south part of the area (Coulon belt). This mineralization constituted the only known occurrence of base metals in the Gayot area before our field program. Most of the exploration work conducted to date took place in the 1970s; the target was uranium deposits hosted in Paleoproterozoic sedimentary rocks of the Sakami Formation. This work, carried out by Eldorado Nuclear and Uranerz, led to the discovery of a uranium deposit located in the northern part of the area (Figure 10).

The Lac Gayot Uraniferous Deposit

The Lac Gayot Paleoproterozoic uranium deposit was discovered in 1976 by the company Uranerz in the Dieter outlier located in the north part of our area (Figure 10). In 1980, possible reserves were estimated at 50 million metric tonnes at 0.10 % U_3O_8 or between 10 to 15 million tonnes at 0.25 % U_3O_8 (Marcoux, 1980). The main mineralized zone is located 20 to 40 m above the unconformity, within the lower unit of the Sakami Formation. It is associated with a sequence of red and green, chloritic and carbonated mudshale. The mineralization consists of finely disseminated pitchblende, with minor quantities of chalcopyrite, pyrite and galena. According to Gehrisch (1987), the Lac Gayot uranium deposit is a syngenetic mineralization that underwent an enrichment process, i.e. a deposit of intermediate nature between older, purely detrital deposits such as Elliot Lake, and more recent deposits of chemical origin, mainly Early Paleozoic in age.

Discoveries Made by Mining Companies in 1998

The Gayot area was covered by a lake sediment geochemical survey (Géologie Québec, 1998), carried out by SIAL in 1997 as part of the Far North project. This survey, funded by the MRN and five partners from the mining industry, attracted several explorationists to take permits in the gayot area and carry out exploration programs. The principal discoveries that résulted from this effort and that were brought to our attention were made during the summer of 1998 by Virginia Gold Mines in the Venus volcanic belt, and by Makamikex L.G. in the Charras belt (Figure 10).

Virginia's best showings were discovered in several contexts. A VMS-type mineralization, associated with an exhalite horizon, contains 0.3 % Cu, 0.2 % Zn, 2.18 g/t Au and 2.7 g/t Ag. Interesting grades of 0.24 % Ni, 0.27 % Cr and 0.3 % Co were reported in association with komatiites and ultramafic intrusions. An oxide-facies iron formation contains gold concentrations between 0.4 and 5.6 g/t, and finally, grades in silver (35.2 g/t), lead (3.8 %) and zinc (2.7 %) were obtained from a sheared zone with quartz-sericite schist.

In the Charras belt, the "Isabel" showing, found by Makamikex, is an important chalcopyrite and bornite mineralization associated with ultramafic rocks. The orientation and extent of the zone have not yet been defined, but a channel sample yielded 13.8 % Cu, 8.3 g/t Ag and 1 g/t Au over a length of 6 metres, including 1.9 g/t Au over 3 metres.

Results of our Field Campaign

Our regional mapping program led to the discovery of several mineral occurrences and showings in the Ashuanipi Subprovince and in the Goudalie-La Grande Assemblage (Figure 10). This work also allowed us to identify new volcano-sedimentary belts (Venus, Moyer, Ladille and

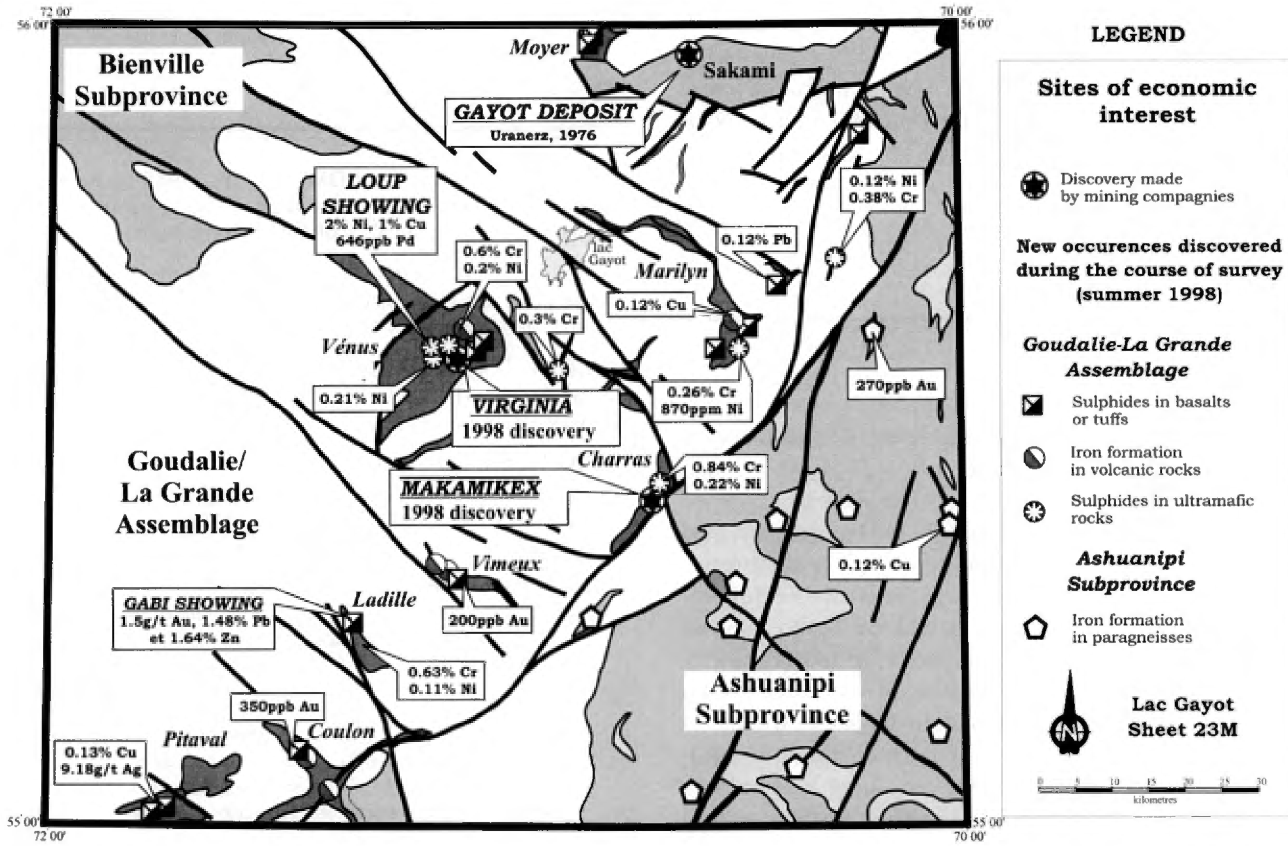


FIGURE 10 - Location of the principal sites of economic interest in the area, and presentation of the best analytical results.

Vimeux belts), and to better define previously known belts, namely the Pitaval, Coulon, Charras and Marylin belts. The discovery of new volcano-sedimentary belts has contributed in outlining the mineral potential of the Gayot area, given the fact that the most promising sites of economic interest are generally associated with volcanic rocks.

Mineralization in the Goudalie-La Grande Assemblage

Mineral occurrences in the Goudalie-La Grande Assemblage are essentially associated with the various volcanic belts of the Gayot Complex (Figure 10). We subdivided these into three types. The first type and most widespread corresponds to zones of disseminated or semi-massive sulphides, hosted in basalts or in felsic tuff horizons. These zones vary from one to a few metres in thickness, and generally consist of pyrite sometimes accompanied by pyrrhotite. Significant analytical results are presented in Figure 10. Anomalous gold, copper, lead and silver values were obtained. The Gabi showing, located in the Ladille belt, contains the best grades. A sample with minor sulphide mineralization yielded 1.5 g/t Au, 1.48 % Pb and 1.64 % Zn. It was taken in a sheared felsic horizon, probably a tonalite or a tuff, intercalated between ultramafic flows or intrusions.

The second type corresponds to iron formations a few metres thick intercalated in the volcanic rocks. These oxide-facies iron formations often contain sulphides. They are very similar to those found in the Ashuanipi. In the Marilyn belt, one of these zones yielded 0.12% Cu (Figure 10). Remember that Virginia Gold Mines obtained, in an iron formation in the Venus belt, gold grades of 0.4 to 5.0 g/t Au, thus confirming their potential.

The last type of mineralization corresponds to sulphide-rich zones associated with ultramafic rocks (Figure 10). They consist of 2 to 8-metre thick rusty zones, rich in pyrite and pyrrhotite. In the Venus belt, the Loup showing contains grades up to 2 % Ni, 1 % Cu, 646 ppb Pd and 195 ppb Pt. These grades were obtained in a sulphide-rich silicified zone within an ultramafic intrusion. In the Charras belt, an ultramafic rock sample from a sheared and completely epidotized zone contains 0.84 % Cr and 0.22 % Ni. This category also contains the "Isabel" discovery (described above) made by Makamikex within the Charras belt.

Iron Formations in the Ashuanipi

Sites of economic interest identified in the Ashuanipi correspond to m-scale iron formation horizons intercalated in paragneiss sequences (Figure 10). These frequently contain sulphide bearing rusty zones and occasionally smoky quartz veins. Assays from these zones yielded relatively modest results. One of these sites yielded a grade of 270 ppb gold, and another 0.12 % Cu. However, the true potential of these zones remains to be fully assessed through more detailed exploration. The search for structural traps associated with these zones is certainly an important element to consider.

CONCLUSION

The boundaries between the major lithotectonic assemblages of the Superior Province in Québec's Far North region are mostly based on extrapolation of geophysical data and geological observations made in very restricted areas. Based on these divisions, the Gayot area should have represented a junction between four major geological assemblages, namely the La Grande Subprovince, the Bienville Subprovince, the Ashuanipi Subprovince and the Minto Subprovince, herein represented by the Goudalie Domain (Figure 1).

Our work did not permit to distinguish between the La Grande Subprovince and the Goudalie Domain , whether it be from a lithological, a structural or a metamorphic standpoint. The contact between these two large assemblages could therefore be located further north or further south. It is also possible that the Goudalie represents the northward extension of the La Grande, and that the two entities form a single and the same lithotectonic assemblage. Our work also indicates that the Bienville Subprovince covers a much more restricted surface area than was previously interpreted. Even the presence of the Bienville Subprovince itself, in the NW corner of our map area, is uncertain. This part of the map area is poor in outcrops, and the foliated to gneissic granitic and granodioritic assemblages that were included in the La Bazinière Suite could in fact correspond, at least in part, to the late Tramont and Maurel suites. However, a granodiorite of the La Bazinière Suite yielded a preliminary age of 2.70 Ga, which is older than one obtained from a granodiorite of the Maurel Suite (2.68 Ga).

Finally, our work has highlighted the economic potential of the Gayot area. Numerous showings and mineral occurrences were discovered, and several volcano-sedimentary belts were also identified in the Goudalie-La Grande Assemblage. These belts represent high priority targets for prospecting and mineral exploration, since most of the mineralized showings in the area are associated with volcanic rocks. The Goudalie-La Grande Assemblage extends northward, westward and southward of our map area, thus adding significant economic interest for future mapping projects in areas adjacent to the Gayot area. Furthermore, recent discoveries by Virginia Gold Mines in the Venus belt and by Makamikex in the Charras belt have demonstrated that detailed exploration work in the volcano-sedimentary belts is successful in uncovering new base and precious metal showings in diverse geological settings.

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