RG 2005-04

GEOLOGY OF THE LAC MONTROCHAND AREA (33O)

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Sunset on Lac Malécot.

2006

Québec

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ABSTRACT

This report presents the results of a geological survey carried out in the summer 2002 at 1:250,000 scale. It covers the Lac Montrochand area (NTS 33O), located about 200 km northeast of the village of Radisson.

Lithological assemblages in the area are Archean in age, with the exception of a few Proterozoic diabase dykes. The various lithologies were grouped into two major assemblages: tonalite-granodiorite-granite suites and the Loups Marins Complex. Tonalite-granodiorite-granite suites comprise three lithodemic suites: the Favard Suite, composed of tonalite and granodiorite, the Coursolles Suite, composed of hornblende granodiorite and tonalite as well as diorite, and the Desbergères Suite, formed of equigranular or porphyritic monzogranite and granodiorite. Tonalites and diorites of the Favard and Coursolles suites are affected by a granitic infiltration phenomenon associated with the emplacement of monzogranites and granodiorites of the Desbergères Suite. The tonalitic and dioritic suites were also intruded by gabbros of the Châteauguay Suite. The Loups Marins Complex is composed of an orthopyroxene unit, which consists of hypersthene quartz diorite and enderbite, and a clinopyroxene unit. The latter is subdivided into sub-units equivalent to tonalite-granodiorite-granite suites, but which formed and were metamorphosed at higher pressure and temperature conditions. Late units in the area include mafic/ultramafic intrusions of the Qullinaaraaluk Suite and granites of the Tramont Suite.

The tonalite-granodiorite-granite suites underwent metamorphism at the middle amphibolite facies, whereas in the Loups Marins Complex, metamorphic conditions range from the upper amphibolite facies to the granulite facies. Retrograde metamorphism at the greenschist facies was locally observed along fault zones.

The Lac Montrochand area was affected by four phases of deformation. Phase D1 corresponds to a relic foliation preserved in enclaves enclosed in the various units. Phase D2 is responsible for the NW-SE orientation of the regional structural pattern and the development of the regional S2 foliation. This foliation was enhanced during phase D3 and dragged along major ductile faults that delineate large NW-SE to E-W-trending structural zones. Phase D4 generated a system of late brittle faults oriented ENE-WSW to WNW-ESE. This system appears to be associated with the Saindon-Cambrien and Richmond Gulf structural zones.

Three occurrences with anomalous copper and nickel grades were discovered during our mapping survey. These mineralized zones are hosted in gabbros of the Châteauguay Suite. Furthermore, the Lac Montrochand area (NTS 33O) is a promising target area for diamond exploration. It lies at the intersection of four important structural features: the Saindon-Cambrien (SCZ) and Richmond Gulf (RGZ) structural zones, the projection of the Kapuskasing tectonic zone and a major gravity lineament. The recent discovery of picroilmenite and chrome diopside in fluvioglacial sediment samples collected within the SCZ and the RGZ emphasizes the diamond potential of the area.

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INTRODUCTION

The Far North project was launched in 1997 by the Ministère des Ressources naturelles du Québec (MRN) in order to complete the geological mapping coverage of Québec at 1:250,000 scale, to acquire new geoscience data and to develop new territories north of the 55th parallel. Within the scope of this vast project, a mapping survey was conducted in the Lac Montrochand area (NTS 33O) during the summer 2002. This survey at 1:250,000 scale covers a quadrangle of about 14,200 km², bounded by longitudes 74°W and 76°W and latitudes 55°N and 56°N (Figure 1).

The Lac Montrochand area occurs along the westward extension of mapping surveys conducted in the Lac Gayot and Lac Bienville areas (Gosselin and Simard, 2001; Gosselin *et al.*, 2004), and to the southwest of the Maricourt and Lacs des Loups Marins areas (Simard *et al.*, 2002; Gosselin *et al.*, 2002). To the north, the area is bordered by the Lac à l'Eau Claire area, which was also mapped in 2002 (Simard *et al.*, 2004b). Based on lithotectonic subdivisions previously proposed by other authors for the northern Superior Province (Card and Ciesielski, 1986; Ciesielski, 1999; Percival *et al.*, 1991; Percival *et al.*, 1992), the Lac Montrochand area should be located in the heart of the Bienville Subprovince (Figure 1). Gosselin *et al.* (2004) suggested the Lac Bienville area should be included in the Minto Subprovince, based on the similarity of units encountered in the Lacs des Loups Marins and Lac Bienville areas. Our work also shows that units mapped in the Lac Bienville area extend westward into the Lac Montrochand area. However, we also noticed that rocks of the Bienville Subprovince are affected by a granitic infiltration phenomenon that is not widespread in the Minto Subprovince. In fact, it is characterized by vast granitic bodies that infiltrate and invade tonalitic units to produce a banded rock in which tonalites are preserved in relatively minor proportions (Figure 2). This phenomenon was also observed eastward in the Lac Bienville area (Gosselin *et al.*, 2004) as well as to the north, in the Lac à l'Eau Claire area (Simard *et al.*, 2004b). According to these authors, rocks occurring south of the Nastapoka Deformation Zone (Figure 1) are much more potassic than those to the north. This deformation zone may represent the boundary between the Bienville and Minto subprovinces (Parent *et al.*, 2002c; Simard *et al.*, 2004b). Apart from the abundance of granitic rocks, there are no other major distinctions between units of these two subprovinces. For this reason, we suggest the Bienville Subprovince be included within the Minto as a domain, in keeping with other domains already defined within this subprovince (Tikkerutuk, Utsalik, etc.).

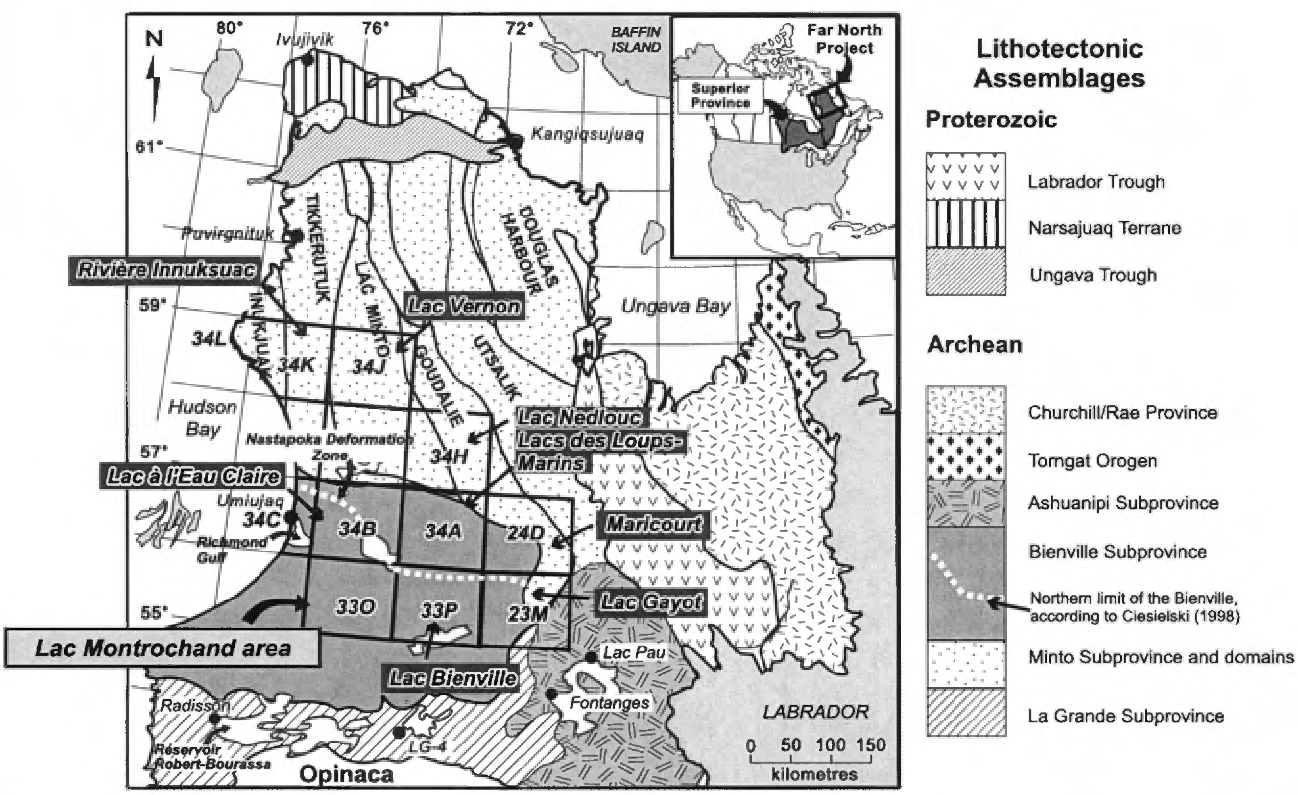

FIGURE 1 - Location of the Lac Montrochand area (NTS 33O, this report) and of adjacent areas, Lac Gayot (23M, Gosselin and Simard, 2001), Maricourt (24D, Simard *et al.*, 2002), Lacs des Loups Marins (34A, Gosselin *et al.*, 2002), Lac Bienville (33P, Gosselin *et al.*, 2004) and Lac à l'Eau Claire (34B and 34C, Simard *et al.*, 2004), covering parts of the Bienville Subprovince mapped within the scope of the Far North Project. Boundaries between major tectonostratigraphic assemblages in the northern Superior Province are modified after Card and Ciesielski (1986) and Percival *et al.* (1992).

Location, access and topography

The Lac Montrochand area (33O) is located east of the southern part of Hudson Bay, between longitudes 74°W and 76°W and latitudes 55°N and 56°N. It extends from the Grande Rivière de la Baleine (formerly known as the Great Whale River) to the southwest, to Lac à l'Eau Claire to the northeast (Figure 2). The area, located about 200 km northeast of Radisson, is only accessible by floatplane or by helicopter. The nearest airports to the central part of the area are located at LG-4 (about 190 km) and Umiujaq (about 140 km, Figure 1). A floatplane base also allows access to the area from LG-4. Furthermore, an outfitter's camp is located on Lac Mollet in the northeastern part of NTS sheet 33O (Figure 2). It offers, in addition to lodging during the summer season, a landing strip for Twin Otters open year-round and amenable for a Boeing 748 in the winter.

In the area, outcrops are generally abundant and widespread. However, certain areas covering several tens of square kilometres are nearly completely devoid of outcrop due to extensive wetlands, lakes and glacial overburden. These areas correspond to negative magnetic anomaly zones in the western and southwestern parts of the map area (Figure 3).

Methodology

The field survey was carried out in the summer 2002 by a team of seven geologists and six assistants. The base camp was located along the shores of Lac Malécot, in the north-central part of NTS sheet 33O (Figure 2). The survey was completed by traditional field traverses on foot. In areas where bedrock exposures were scarce, outcrops were mapped by successive helicopter spot checks. The shores of Lac Mollet were largely mapped using a motorboat. On average, 12 traverses roughly 10 km long were carried out in each 1:50,000 scale NTS sheet, and 1,828 stations were documented during the mapping survey.

Lithogeochemistry analyses were conducted to characterize observed lithologies and mineral occurrences. A total of 140 rock samples were analyzed for major and trace elements, including rare earth elements, and another 15 samples were analyzed to determine their economic element content. Also, 548 thin sections were cut and described qualitatively; the mineral content was visually estimated. Finally, eight samples were collected for U-Pb zircon analysis; five of these were actually dated. These age dating analyses were conducted by Jean David at the GEOTOP laboratory of the Université du Québec à Montréal. The entire set of analytical data was integrated to the geomining information system (SIGEOM) of the Ministère des Ressources naturelles, et de la Faune (MRNF).

Previous work

Reconnaissance mapping was carried out by the Geological Survey of Canada in the Lac Montrochand area between 1957 and 1959 at 1:1,000,000 scale (Eade, 1966). Subsequently, Card and Ciesielski (1986) proposed lithotectonic subdivisions for the northeastern Superior Province. Later work by Ciesielski (1983; 1991; 1998; 1999; Cielsielki and Plante, 1990) identified various lithological facies associated with the Bienville Subprovince.

Uranerz Exploration and Mining explored the Lac Montrochand area for uranium between 1976 and 1979 (Madon, 1979). A reconnaissance program was performed in the northern part of the study area to detect the presence of Sakami-type metasedimentary units. No metasedimentary rocks were observed in the area, and no showing was found during subsequent ground work to follow-up on airborne magnetic anomalies. Note that a Proterozoic outlier of the Sakami Formation, located to the east in the Lac Gayot area (23M), hosts a deposit with reserves estimated at 50 million metric tonnes at a grade of 0.10% U_3O_8 (Marcoux, 1980).

Diamond exploration was conducted in the Lac Montrochand area (33O) between 1996 and 1999. This work, which was never publicly released, was conducted by joint venture partners Ashton Mining and SOQUEM. The area was also covered by a lake sediment survey in 1997. This survey was conducted by the Ministère des Ressources naturelles du Québec, in partnership with five mineral exploration companies (MRN, 1998). Exclusive maps showing lake sediment anomalies were supplied by Marc Beaumier of Géologie Québec (MRNF). Finally, a fluvioglacial sediment (esker) survey was performed in the summer 2002, in conjunction with a glacial dynamics study, by Michel Parent of the Geological Survey of Canada (Parent *et al.*, 2002a). A picro-ilmenite grain, identified in one sample, and chrome diopside grains identified in five other samples, indicate that the Lac Montrochand area has promising potential in terms of diamond exploration (Parent *et al.*, 2002b).

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REGIONAL GEOLOGICAL FRAMEWORK

Based on subdivisions proposed by Card and Ciesielski (1986) and Percival *et al.* (1991; 1992) for the northeastern Superior Province, the Lac Montrochand area (33O) is located in the Bienville Subprovince (Figure 1). This subprovince is considered as a plutonic domain consisting of orthogneiss with tonalitic and granodioritic intrusions (Card and Ciesielski, 1986; Hocq, 1994; Percival *et al.*, 1992). Ciesielski (1998; 1999) described the Bienville Subprovince as a gneisso-plutonic assemblage dominated by granodioritic and granitic assemblages. The nature and the regional boundaries of this subprovince nevertheless remain ambiguous in many regards. Its northern limit and its relationship with the Minto Subprovince are still poorly defined. Despite modifications to this boundary proposed by Ciesielski (1998), the Montrochand area (33O) is still considered as entirely integrated within the Bienville Subprovince (Figure 1). However, mapping conducted by the MRNF in the Lac Bienville (33P) and Lacs des Loups Marins (34A) areas, in the Bienville Subprovince (Gosselin *et al.*, 2004; Gosselin *et al.*, 2002), has revealed that most lithodemic assemblages encountered in these areas are comparable to those in the Lac Nedlouc area (34H), within the Minto Subprovince (Parent *et al.*, 2001). On the other hand, mapping surveys conducted in 2002 in the Lac Montrochand (33O) and Lac à l'Eau Claire (34B) (Simard *et al.*, 2004b) areas indicate that units located to the south of the Nastapoka Deformation Zone (Figure 1) are more potassic than units located to the north, in the Minto Subprovince. In fact, these two areas are characterized by the presence of large granitic bodies that infiltrate and invade tonalitic units. The Nastapoka Deformation Zone may therefore represent the boundary between the Bienville and Minto subprovinces. The Bienville may represent a plutonic domain similar to the Tikkerutuk and Utsalik domains. Moreover, Hocq (1994) mentioned that the Tikkerutuk domain may represent the northward extension of the Bienville. The Tikkerutuk domain is mainly composed of massive to foliated and locally gneissic hornblende-biotite granodiorite (Percival *et al.*, 1992). In this domain, contact zones between granodiorites and granites are marked by injections of granitic material into granodiorites (Percival *et al.*, 1992). Furthermore, lithodemic units identified by Simard *et al.* (2004a) in the Rivière Innuksuak area (34K), located in the Tikkerutuk domain, show features similar to those described in this report.

The Lac Montrochand area (33O) is essentially underlain by Archean plutonic rocks (Figure 2). The area may be divided into two major lithological assemblages represented by tonalite-granodiorite-granite suites and the Loups Marins Complex (figures 2 and 3). The tonalite-granodiorite-granite suite assemblage covers the central and southwestern parts of the area and is characterized by a weak but well structured aeromagnetic gradient (figures 2 and 3). This assemblage is dominated by the Favard (Afav), Coursolles (Acou) and Desbergères (Adeb) suites, defined in the Lac Gayot and Maricourt areas (Figure 2; Gosselin and Simard, 2001; Simard *et al.*, 2002). Units in the Favard and Coursolles suites and the heterogeneous sub-unit of the Desbergères Suite (Adeb1a) are affected by a granitic infiltration phenomenon whereby granitic material invades, in variable proportions, early tonalites and diorites. This phenomenon, commonly observed within the map area, gives the rocks a banded aspect and is developed in such a way that the tonalite constitutes only a minor proportion of the rock. Based on our work and that of Gosselin *et al.* (2004), the granitic infiltration fraction is inferred to be derived from the same source as rocks of the Desbergères Suite (Adeb).

The second assemblage is represented by a complex of pyroxene-bearing rocks, the Loups Marins Complex (Alma), which was defined in the Lacs des Loups Marins area (Gosselin *et al.*, 2002). It covers the eastern part of the area as well as two sectors to the west (figures 2 and 3). On the shaded total magnetic field map, it is characterized by a mottled signature of high and low magnetic values (Figure 3). The Loups Marins Complex consists of intermediate to felsic orthopyroxene-bearing intrusive rocks (Alma2) (hypersthene diorite and enderbite) and clinopyroxene-bearing rocks (Alma1) (Figure 2). The latter were subdivided into three sub-units (Alma1a, Alma1b, and Alma1c), considered as lithological equivalents of the Favard, Coursolles and Desbergères suites, but which were emplaced at higher pressure and temperature conditions (Gosselin *et al.*, 2004).

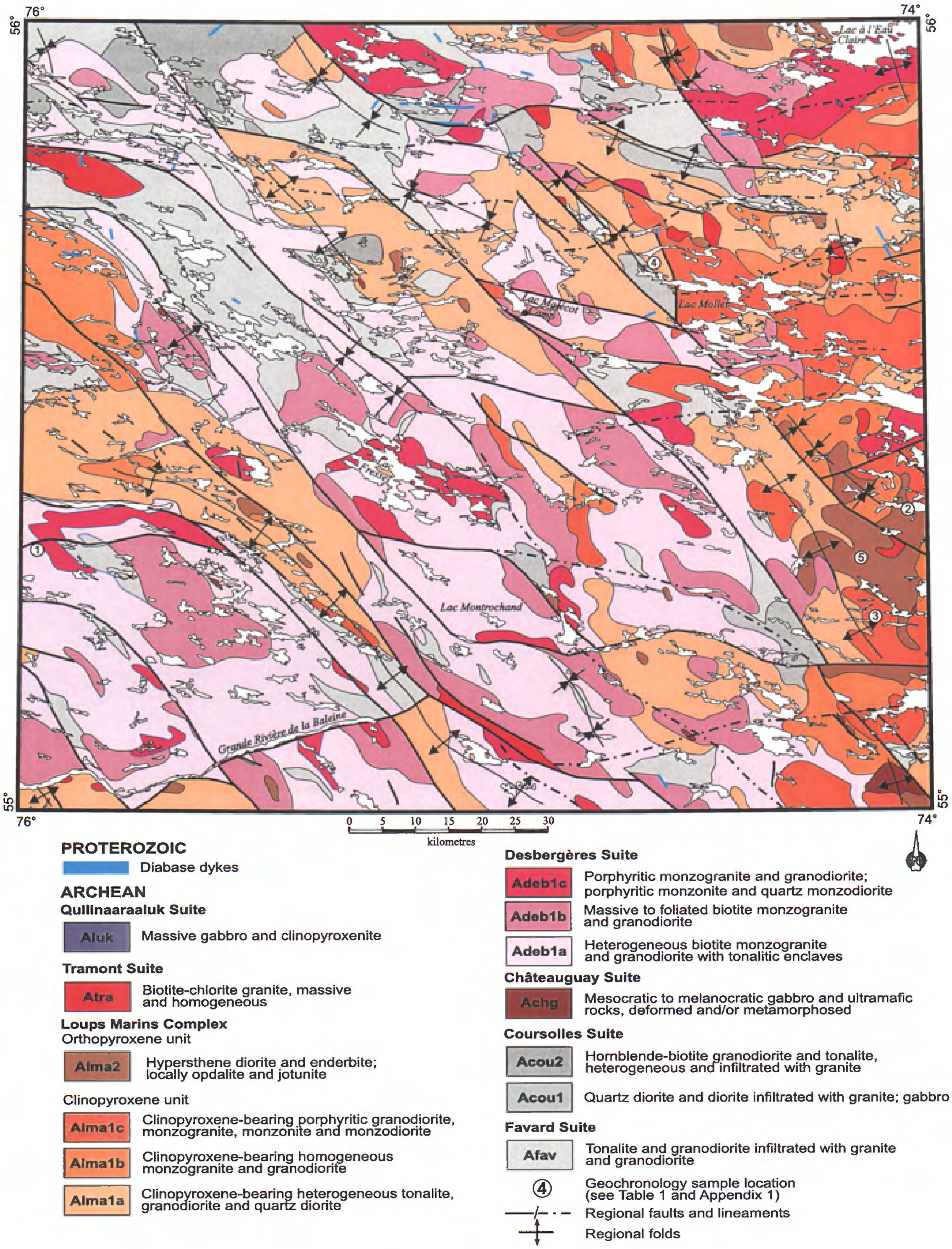
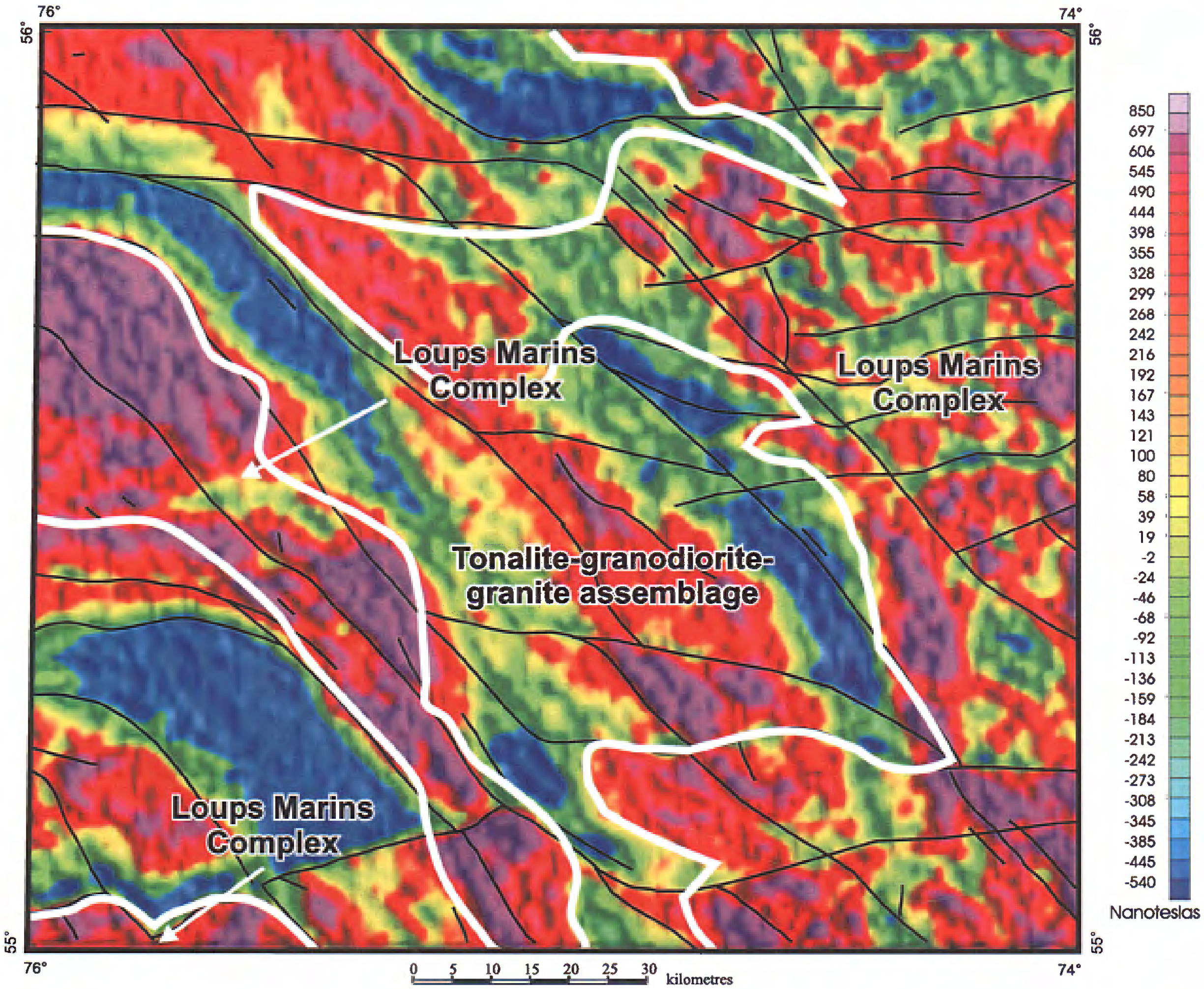


FIGURE 2 - Geology of the Lac Montrochand area (NTS 33O).



LEGEND

Interpreted lineaments — Boundaries of major lithological assemblages

FIGURE 3 - Shaded total magnetic field map of the Lac Montrochand area (NTS 33O), showing the location of: 1) boundaries between major lithological assemblages in the area, and 2) main interpreted lineaments. Aeromagnetic data taken from Dion and Lefebvre (2000).

Similar to the tonalite-granodiorite-granite suites, units Alma2 and Alma1a of the Loups Marins Complex are infiltrated by granitic material.

Archean mafic to ultramafic intrusions are also present in the area; the latter were assigned to two distinct suites. The Châteauguay Suite (Achg), defined by Simard *et al.* (2002) in the Maricourt area (24D), is composed of deformed and metamorphosed gabbro and ultramafic rocks, whereas the Qullinaaraaluk Suite, introduced in the Lac Vernon area (34J, Parent *et al.*, 2003), consists of massive mafic/ultramafic units. The youngest felsic unit in the area is represented by the Tramont Suite (Atra), composed of granite (Figure 2) and defined by Gosselin and Simard (2001) in the Lac Gayot area (23M).

The dominant structural pattern in the Bienville Subprovince trends NW-SE, although it locally shifts E-W (Ciesielski, 1991; 1999). The degree of deformation is widely variable, ranging from a weakly developed penetrative foliation to a strongly developed gneissosity (Ciesielski, 1999). From a structural standpoint, the Lac Montrochand area (33O) is comparable to the Lac Bienville area (33P) to the east, the Lacs des Loups Marins area (34A) to the northeast, and the Lac à l'Eau Claire area (34B) to the north. In these areas, the dominant structural trend is NW-SE, an orientation that characterizes the southern Minto Subprovince and the Bienville Subprovince (Gosselin *et al.*, 2002; 2004; Simard *et al.*, 2003; Ciesielski, 1999; Percival *et al.*, 1992). In the Lac Montrochand area, the regional NW-SE-trending penetrative foliation is weakly developed. It becomes more intense and is reworked along regional faults that define wide zones where the degree of deformation is much stronger. Finally, the Lac Montrochand area is cut by a network of brittle faults trending ENE-WSW to WNW-ESE, attributed to the Richmond Gulf (RGZ) and Saindon-Cambrien (SCZ; Portella, 1980) subsidence structures.

STRATIGRAPHY

The Lac Montrochand area (33O) is underlain by Archean intrusive units and a few Proterozoic diabase dyke swarms. The Archean rocks in the area were divided into lithodemic units in keeping with the stratigraphic nomenclature defined and used in recent mapping reports published for adjacent areas, namely the Lac à l'Eau Claire (34B and 34C), Maricourt (24D), Lac Gayot (23M), Lacs des Loups Marins (34A), Lac Bienville (33P), and Lac Vernon (34J) areas (Simard *et al.*, 2004b; Simard *et al.*, 2002; Gosselin and Simard, 2001; Gosselin *et al.*, 2002; Gosselin *et al.*, 2004; Parent *et al.*, 2003). Units are discussed in a chronological order, based on cross-cutting relationships observed in the field and isotopic (U-Pb) ages obtained from samples in the area. However, the Loups Marins Complex (Alma) does not fit well in this timeline, since it is composed of pyroxene-bearing units considered as equivalents to other suites that formed at different times and in different settings (Table 1). The description of each unit is based on field data and petrographic observations. A synoptic table of petrographic observations is provided in Appendix 1. Radiometric U-Pb analyses were conducted on zircon grains by *in situ* laser ablation, using an inductively coupled plasma high-resolution mass spectrometer (ICP-HR-MS); results are listed in a summary table provided in Appendix 2.

Archean

Enclaves

Enclaves form bodies that cannot be shown on a map at 1:250,000 scale, but which are ubiquitous in all units throughout the area. They generally account for less than 5% of lithologies although they locally reach up to 50%. Enclaves range in size from a few centimetres to several tens of metres. They have different origins, but are generally interpreted as pre-dating or coeval with the host rocks. These enclaves were grouped into three major assemblages based on composition: diorites, amphibolites, and gabbros and ultramafic rocks.

Diorite enclaves

Diorite enclaves generally occur as m-scale lenses. Their foliated and banded structure is occasionally reworked by folding or a second foliation. They are fine-grained and commonly contain feldspar, hornblende or pyroxene porphyroclasts. In thin section, these diorites exhibit a granoblastic texture indicating they have undergone recrystallization. They are mainly composed of sericitized plagioclase, biotite, and hornblende (Appendix 1).

Amphibolite enclaves

Amphibolite enclaves are not as abundant as diorite enclaves. They are cm-scale to m-scale and lens-shaped (Appendix 3, Photo 1). They range from fine to medium-grained and exhibit a granoblastic texture. They are foliated and sometimes display compositional banding. In thin section, amphibolite enclaves exhibit polygonal recrystallization textures. They are essentially composed of amphibolite (mostly green hornblende) and plagioclase, with minor amounts of biotite and magnetite (Appendix 1). Plagioclase grains are almost completely saussuritized or sericitized.

Gabbroic and ultramafic enclaves

This group of enclaves essentially contains gabbros and pyroxenites. Their size ranges from a few centimetres to several metres. The enclaves occur in many shapes: lenses, spherules, angular or sub-angular clasts, and are commonly grouped into clusters with enclaves of various compositions. They are fine to medium-grained and massive to moderately foliated. In thin section, pyroxenites and gabbros exhibit a granoblastic texture and commonly contain poikiloblastic green hornblende with inclusions of pyroxene and iron oxides. In addition to hornblende and clinopyroxene, the other main constituents are biotite, plagioclase and orthopyroxene. Olivine, altered to talc and iddingsite, was observed in some samples (Appendix 1).

Favard Suite (Afav)

The Favard Suite (Afav) was introduced by Gosselin and Simard (2001) in the Lac Gayot area (23M) to the east, to designate biotite tonalites. In the Lac Montrochand area (33O), the Favard Suite (Afav) consists of heterogeneous biotite tonalite and granodiorite, infiltrated by a significant proportion of late granitic material (up to 50%). It corresponds to rocks described in the Lac Bienville area (33P, Gosselin *et al.*, 2004). An age dating analysis conducted on a sample of "granitized" tonalite from the Lac Bienville area gave an age of 2741 ±4 Ma for the tonalite and an age of 2713 ±2 Ma for the infiltrating granite (Table 1). An age of 2749 ±4 Ma was previously obtained from a trondhjemite sampled in the Maricourt area (Table 1).

In the Lac Montrochand area (33O), the Favard Suite (Afav) occurs primarily in areas where the aeromagnetic signature is weak (figures 2 and 3). It is composed of leucocratic biotite tonalite and granodiorite, with a pinkish white to light grey weathered surface and a light grey to white fresh surface. These medium-grained rocks exhibit a foliation, which is overprinted by a mylonitic fabric in shear zones. Intermediate to ultramafic enclaves a few centimetres

TABLE 1 - Updated stratigraphy and geochronology correlations between the main units encountered in the Lac Gayot (23M), Maricourt (24D), Lacs des Loups Marins (34A), Lac Bienville (33P) and Lac Montrochand (33O, this report) areas. Table modified after Gosselin *et al.* (2004). See lithological, mineralogical and textural abbreviations in Sharma (1996).

Lac Montrochand area (33O) (this report)	**Lac Bienville area (33P)** (Gosselin *et al.*, 2004)	**Lacs des Loups Marins area (34A)** (updated from Gosselin *et al.*, 2002)	**Maricourt area (24D)** (updated from Simard *et al.*, 2002)	**Lac Gayot area (23M)** (updated from Gosselin and Simard, 2001)
Atra (inferred)	Atra (inferred), Atub?, Aoss?	Tramont Suite (Atra) I1B	Atra	Atra
Adeb1c (L) (inferred); Adeb1b (L) (inferred)	Amau (L) (inferred); Adeb (L) (inferred)	Maurel Suite (Amau) (L) I1C, PO	Amau (L) 2,685 Ga; Adeb (L) 2683+4/-2 Ma	Amau (L) 2.68 Ga; 2683±4 Ma
Atra (E)	Atra (E), I1B 2701±4 Ma			
Alma2 I2Q; I1T; I1S 2733±3 Ma, no.5	Alma2 I2Q;I1T;I1S 2720 ±2 Ma	Loups Marins Complex (Alma2) I2Q; I1T; I1S 2694±3 Ma	Du Gué Complex (Adug) I1T, I1P, PO Ox I1D 2729 Ma M21 M4 M1 (I1D)	
Adeb1c (E) I1M-I1C-I2E, PO; Adeb1b (E) I1M-I1C, hg; Adeb1a (E) I1M-I1C, hk 2732±4 Ma, no.1 — Alma1c Cx I1C-I1M-I2E-I2G, PO 2704±5 Ma, no.2 2704±5 Ma, no.3; Alma1b Cx I1M-I1C	Amau (E) I1C, PO 2707±5 Ma; Adeb (E) — Alma1c Cx I1C, PO; Alma1b Cx I1C 2709±2 Ma	Amau (E) I1C, PO; Desbergères Suite (Adeb) (E) I1C, 2714±12 Ma — Lussay Suite (Alus) equivalent to Alma1c 2713±5 Ma	Amau (E) (inferred); Adeb (E) (inferred)	Amau (E) (inferred)
Achg I3A-I4	Achg	Châteauguay Suite (Achg) I3A-I3Q	*Achg	
Acou2 (L) Hb I1C-I1D (I1B)	Acou2 (L) Hb I1D (I1B)	Coursolles Suite (*Acou) (L) Hb I1D, (I1B)	*Acou2a (L) Hb I1D, (I1B); *Acou2 (L) Hb I1D 2718+11/-8 Ma	Acou (L) Hb I1D, (I1B)
Acou1 (L) I2I-I2J	Acou1 (L) I2J-I2I 2719±2 Ma	*Acou (L) I2I-I2J previously assigned to Achg	*Acou1 (L) I2J-I2I	Acou (L) I2J-I2I replaces *Afav1
Afav I1E-I1C (I1B) — Alma1a Cx I1D, I1C and I2I, HK 2723±3 Ma, no.4	Afav I1E (I1B) (granodioritic fraction 2713±2 Ma and tonalitic fraction 2741±4 Ma) — Alma1a Cx I1D, I2I, I2G and I1C	Favard Suite (Afav): Afav1b I1E (I1B); Afav1 I1E; Afav1a I1E with layers of M1 (I1D) — Loups Marins Complex (Alma1) Cx I1D and I2I	Afav1b I1E (I1B); Afav1 I1E 2749 ±4, 2754 +11/-9 Ma; Afav1a I1E with layers of M1 (I1D)	Afav I1E (I1B) recognized in 2001; Afav2, I1E and Afav2a, magnetic I1E 2.73 Ga
		Acou (E) 2756±8 and 2758±11 Ma I1D, Hb	Acou (E) (inferred)	
	Abre	Brésolles Suite (Abre) M1 (I1D), 2811±4 Ma	Abre	Abre 2803 ±8 Ma

* = stratigraphic position modified relative to initial interpretation, (E) = early phase of unit, (L) = late phase of unit, (inferred) = presence possible but uncertain, no.4 = geochronology sample (location shown in Figure 2)

to several metres wide occur isolated or in clusters within the tonalite.

The tonalites are affected by a granitic infiltration phenomenon which may account for up to 50% of the volume of the rock. This phenomenon is similar to the "granitization" and "migmatization" described in previous reports from adjacent areas in the Lac Bienville, Lacs des Loups Marins and Maricourt areas (Gosselin *et al.*, 2004; Gosselin *et al.*, 2002; Simard *et al.*, 2002). These granite-infiltrated tonalites take on a banded aspect and were also described as composite gneisses with two types of granodiorite (Ciesielski, 1999). These terms were abandoned in this report given the confusion that may arise relative to certain metamorphic or structural processes. There is in fact no evidence of migmatization such as the presence of neosome and paleosome, which would indicate that the granite is the result of *in situ* melting of an earlier rock. Moreover, the term "granitization" is generally defined as a pervasive process (metasomatism, anatexis, etc.) through which a pre-existing rock is transformed into a granitoid (Wimmenauer and Bryhni, 2002). Finally, the degree of deformation is not sufficient to describe these rocks as gneisses. Therefore, we will use the expression "granitic infiltration" in this report. This infiltration phenomenon takes the form of injections of relatively young granitic material within earlier tonalite. This material was emplaced in mm-scale to m-scale bands, pockets or lenses, in diffuse contact with the tonalite. The granitic material was probably infiltrated along foliation planes within the tonalite; its emplacement was therefore facilitated by the presence of a pre-existing fabric. Evidence of recrystallization and a foliation are commonly observed in the granite, which indicates deformation persisted after the emplacement of the latter. These observations suggest the granite is syn- to late-tectonic. However, since the age of the deformation event is not known, the relative timing cannot be confirmed. On the other hand, in the Lac Bienville area, the interpreted age of an infiltrating granodiorite (2713 ±2 Ma) is similar to the age of granodiorites of the Desbergères Suite (2714 ±12 Ma), which also share a similar composition (Table 1). It therefore appears likely that the granitic infiltration is linked to the emplacement of the Desbergères Suite.

In thin section, tonalites and granodiorites of the Favard Suite (Afav) are essentially composed of plagioclase, which is commonly sericitized. Quartz is abundant and often exhibits undulatory extinction or a grain size reduction indicating dynamic recrystallization. Microcline is widespread although not abundant; it often occurs as phenocrysts less than 1 cm in size. Green biotite, often altered to chlorite, is the most common ferromagnesian component (Appendix 1).

Coursolles Suite (Acou)

The Coursolles Suite (Acou) was defined in the Maricourt area (24D) (Figure 1; Simard *et al.*, 2002), where it consists of an early diorite unit (Acou1), a hornblende tonalite unit (Acou2) and a unit of granitized tonalite and granodiorite (Acou2a). A tonalite sample collected in that area gave an age of 2718 +11/-8 Ma (Table 1). A sample of diorite (Acou1) collected in the Lac Bienville area (33P) gave a similar age of 2719 ±2 Ma (Table 1).

The Coursolles Suite, as observed in the Lac Montrochand area (33O), consists of two units similar to those described in the Maricourt (24D) and Lac Bienville (33P) areas. The first (Acou1), particularly common in the eastern part of the map area, is composed of quartz diorite and diorite. The second (Acou2), concentrated in the northwestern part, consists of hornblende-biotite granodiorite and tonalite (Figure 2). The two units are generally heterogeneous and infiltrated by granitic material similar to that described in rocks of the Favard Suite (Afav). They also contain intermediate to ultramafic enclaves of various shapes and sizes (cm-scale to several metres). These enclaves generally account for less than 5% of outcrops, but are occasionally more abundant.

Quartz diorite and diorite unit (Acou1)

Unit Acou1 forms lens-shaped bodies several kilometres long by a few kilometres wide, clustered along fault zones (Figure 2). It is essentially composed of quartz diorite and diorite, but also includes gabbro and porphyritic monzodiorite. These rocks are medium to light grey in fresh surface, with a bleached weathered surface. They are medium to fine-grained. The diorites are generally foliated but locally appear to be massive (Appendix 3, Photo 2). In thin section, quartz diorites and diorites are essentially composed of sericitized plagioclase and green hornblende. Microcline occurs sporadically, as discontinuous phenocryst ribbons. Greenish biotite defines the foliation. Strongly deformed samples commonly exhibit granoblastic textures (Appendix 1).

Heterogeneous hornblende granodiorite and tonalite unit (Acou2)

Unit Acou2 forms irregular bodies concentrated in the northwestern part of the map area. It is composed of heterogeneous hornblende-biotite granodiorite and tonalite infiltrated with granite. The granodiorites and tonalites are light grey in fresh surface and white with a somewhat pinkish tinge in weathered surface. They are medium-grained, locally porphyritic, with a foliated to locally massive structure. The granitic infiltration, which occurs along foliation planes and which represents up to 40% of the rock, gives the rock a banded aspect. In thin section, plagioclase forms sericitized subautomorphic crystals. Quartz absorbs more deformation and often shows sub-grains. Microcline generally occurs as phenocrysts less than 1 cm in size. Ferromagnesian minerals are relatively abundant. They mainly consist of green hornblende and variably chloritized green biotite (Appendix 1).

Châteauguay Suite (Achg)

The Châteauguay Suite (Achg) was introduced by Simard *et al.* (2002) in the Maricourt area (24D), to designate small mafic to ultramafic intrusive bodies. In the Lac Montrochand area (33O), the Châteauguay Suite (Achg) generally forms tabular bodies reaching up to a few hundred metres in thickness, often unmappable at 1:250,000 scale, scattered throughout the map area. The largest intrusion is exposed in the southeastern corner of the map area (Figure 2). The suite is essentially composed of mesocratic to melanocratic gabbro, with minor ultramafic facies. The gabbros are nearly always injected with felsic, often pegmatitic, material, which gives the rock a typical brecciated or agmatitic aspect. Locally, lens-shaped enclaves of diorite are embedded in the gabbro. The latter is grey to dark green in fresh surface and green to brownish in weathered surface. The gabbros are generally strongly foliated and fine to coarse-grained with occasional hornblende poikiloblasts. This unit hosts mineral occurrences observed in the area, where anomalous metal grades were obtained (Gosselin *et al.*, 2004). In thin section, gabbro samples exhibit a granoblastic texture indicating they underwent recrystallization. They are composed mainly of plagioclase, green hornblende, clinopyroxene and brown biotite. Plagioclase is sericitized; a few porphyroclasts are locally preserved. In some samples, hornblende forms large poikiloblasts or rims around pyroxene. The latter is granoblastic or preserved as automorphic crystals showing simple twinning. Orthopyroxene was observed in appreciable amounts in some specimens (Appendix 1).

Desbergères Suite (Adeb)

The Desbergères Suite (Adeb) was introduced in the Maricourt area (24D), to the northeast of the Lac Montrochand area (Figure 1), to designate homogeneous biotite granodiorites and granites (Simard *et al.*, 2002). In the Lac Montrochand area (33O), the Desbergères Suite groups homogeneous monzogranites and granodiorites as well as porphyritic monzogranites and granodiorites. The latter were previously assigned to the Maurel Suite (Amau) in the Lac Gayot (23M), Maricourt (24D), Lacs des Loups Marins (34A) and Lac Bienville (33P) areas (Gosselin and Simard, 2001; Gosselin *et al.*, 2002; 2004; Simard *et al.*, 2002). Monzogranites and granodiorites of the Desbergères and Maurel suites are grouped together since the two suites are spatially and intimately associated. Moreover, they show similar lithic characteristics and yield similar ages in each map area where they were dated. However, the ages obtained vary from one area to the other, and appear to indicate a relative younging of units from the southwest to the northeast. In the Lac Gayot (23M) and Maricourt (24D) areas, the Maurel and Desbergères suites gave similar ages, namely 2683 ±4 Ma and 2683 +4/-2 Ma respectively (Table 1). To the west, in the Lacs des Loups Marins (34A) and Lac Bienville (33P) areas, ages of 2707 ±5 Ma, 2714 ±12 Ma and 2713 ±2 Ma were respectively obtained from a porphyritic granodiorite of the Maurel Suite, a homogeneous granodiorite of the Desbergères Suite and a granodiorite infiltrating a tonalitic unit (Table 1). In the southwesternmost part of the Lac Montrochand area, a sample of infiltrating porphyritic monzogranite gave an age of 2732 ±4 Ma (sample no. 1, Figure 2, Table 1 and Appendix 2), which is markedly older than those previously obtained for this unit. This discrepancy may be the result of contamination by zircons inherited from the Favard tonalite, which is significantly older.

In the Lac Montrochand area (33O), the Desbergères Suite was divided into three informal units: 1) a unit of heterogeneous biotite monzogranite and granodiorite (Adeb1a), which hosts tonalitic enclaves of the Favard Suite; 2) a unit of homogeneous and equigranular biotite monzogranite and granodiorite (Adeb1b), similar to the Desbergères Suite as it was originally described in the Maricourt area (Simard *et al.*, 2002), and 3) a unit of porphyritic monzogranite, granodiorite and quartz monzodiorite (Adeb1c), which corresponds to the Maurel Suite, as defined in the Lac Gayot area (Gosselin and Simard, 2001). Cm-scale to m-scale intermediate to mafic enclaves are commonly encountered in all three units of the Desbergères Suite (Adeb). They generally account for less than 5% of lithologies. Foliated to gneissic tonalitic enclaves are also present, reaching up to 50% in unit Adeb1a.

Heterogeneous monzogranite and granodiorite unit (Adeb1a)

The heterogeneous monzogranite and granodiorite unit (Adeb1a) is by far the most widespread. It covers an extensive surface area in the western part of the map area (Figure 2). This is a new unit, introduced to designate heterogeneous monzogranites and granodiorites that host abundant tonalitic enclaves (Afav and Acou) (Appendix 3, Photo 3). It is a mixed unit, somewhere between granite-infiltrated tonalites of the Favard Suite and homogeneous or porphyritic granites of the Desbergères Suite (Adeb1b and Adeb1c). In unit Adeb1a, the amount of granitic infiltration becomes the dominant component, such that the tonalite forms less than 50% of the rock. Monzogranites and granodiorites in this unit are characterized by an equigranular to porphyritic texture. They are compositionally similar to monzogranites and granodiorites of units Adeb1b and Adeb1c, described in the following paragraphs. However, equigranular (Adeb1b) and porphyritic (Adeb1c) facies were not differentiated in unit Adeb1a.

Homogeneous monzogranite and granodiorite unit (Adeb1b)

The homogeneous monzogranite and granodiorite unit (Adeb1b) corresponds to the Desbergères Suite as it was defined in the Maricourt area (Simard *et al.*, 2002). In the Lac

Montrochand area (33O), it forms intrusions several kilometres wide, elongated parallel to the regional tectonic pattern (Figure 2). Unit Adeb1b is composed of homogeneous and equigranular biotite monzogranite and granodiorite. These rocks are somewhat pinkish white in weathered surface and light grey to pink in fresh surface. Monzogranites and granodiorites are medium to coarse-grained and exhibit a homogeneous texture. They are massive to weakly foliated, but are transformed into striped gneiss in ductile deformation zones. In thin section, microcline, plagioclase and quartz are the main constituents of the rock. Plagioclase is sericitized. Quartz commonly exhibits sub-grains and an undulatory extinction; it is locally granoblastic. Green biotite is the dominant ferromagnesian mineral; it is altered to chlorite (Appendix 1).

Porphyritic monzogranite and granodiorite unit (Adeb1c)

The unit of porphyritic monzogranite, granodiorite and quartz monzodiorite (Adeb1c) corresponds to the Maurel Suite, as it was defined in the Lac Gayot area (23M; Gosselin and Simard, 2001) but which we did not maintain in this report. This unit also includes porphyritic monzonites and monzodiorites with biotite and green hornblende. Unit Adeb1c is widespread throughout the map area. If forms elongated bodies comparable in shape and size to bodies of unit Adeb1b (Figure 2). It is characterized however by the presence of abundant microcline phenocrysts from 0.5 to 5 cm in size, which may account for up to 40% of the rock. Porphyritic monzogranites and granodiorites are light grey to pink in fresh surface and pinkish white to orange in weathered surface. The main mineral fraction is medium to coarse-grained. The structure of porphyritic rocks is massive to weakly foliated. In thin section, sericitized plagioclase and quartz make up the fine fraction, in which microcline phenocrysts are embedded. Quartz usually exhibits undulatory extinction and sub-grains. Green biotite (1-10%) is ubiquitous and chloritized. Green hornblende (0-5%) is regularly observed and is altered to chlorite and carbonate (Appendix 1).

Loups Marins Complex (Alma)

The Loups Marins Complex (Alma) was defined in the Lacs des Loups Marins area (34A) and designates an assemblage of pyroxene-bearing felsic to intermediate intrusive rocks (Figure 1; Gosselin *et al.*, 2002). On the map showing the shaded total magnetic field of the Lac Montrochand area (33O), the complex is characterized by a strongly shifting aeromagnetic signature which gives it a typical mottled aspect (Figure 3). It covers nearly half of the map area and is mainly concentrated in the eastern half (Figure 2). The Loups Marins Complex (Alma) is subdivided into two units: a clinopyroxene unit Alma1, which includes three sub-units, and unit Alma2, composed of orthopyroxene-bearing intrusive rocks. The two units contain intermediate to mafic enclaves from 10 cm to 1 m in size, which, although similar to those observed in other units throughout the area, are characterized by the presence of red biotite and pyroxene.

Clinopyroxene unit (Alma1)

The clinopyroxene unit (Alma1) is composed of three sub-units comparable to certain regional lithodemic suites. However, the clinopyroxene unit was formed and metamorphosed at higher pressure and temperature conditions, at the transition between the amphibolite and the granulite facies. These emplacement conditions translate into the appearance of mineral phases that set unit Alma1 apart from regional tonalite-granodiorite-granite suites (Afav, Acou, Adeb). The three sub-units in unit Alma1 contain clinopyroxene, reddish biotite and burgundy or light green plagioclase. Burgundy plagioclase occurs in proportions ranging from less than 1% to more than 30%. When the plagioclase is greenish, unit Alma1 becomes quite difficult to distinguish from unit Alma2, which contains orthopyroxene in addition to clinopyroxene. Sub-unit Alma1a is composed of clinopyroxene-bearing heterogeneous tonalite, granodiorite and diorite. Sub-unit Alma1b forms an assemblage of clinopyroxene-bearing monzogranite and granodiorite. Sub-unit Alma1c is composed of porphyritic monzogranite, granodiorite, monzonite and monzodiorite.

Clinopyroxene-bearing heterogeneous tonalite and granodiorite sub-unit (Alma1a)

Sub-unit Alma1a is widespread throughout the map area (Figure 2). It is composed of clinopyroxene-bearing tonalite, granodiorite, quartz diorite and diorite. These rocks are similar to those of the Favard (Afav) and Coursolles (Acou) suites, but were emplaced at higher pressure and temperature conditions. These conditions translate into the appearance of clinopyroxene and red biotite. Sub-unit Alma1a is infiltrated by a granitic phase derived from granitic sub-units Alma1b and Alma1c, following a similar process to that described for granites infiltrating rocks of the Favard Suite (Afav). A sample of clinopyroxene-bearing heterogeneous tonalite was dated in the area (sample no. 4, Figure 2, Table 1 and Appendix 2). Its age of crystallization was interpreted at 2723 ±3 Ma, which corresponds to ages obtained for the Coursolles Suite (2719 ±2 Ma) and unit Alma2 (2720 ±2 Ma) in the Lac Bienville area (33P), to the east (Table 1).

Tonalites and granodiorites of sub-unit Alma1a exhibit a wide range of colours, but generally appear in shades of grey with a reddish or greenish tinge in fresh surface, and whitish or pinkish in weathered surface. Burgundy plagioclase is commonly observed in rocks of this sub-unit. The rocks are medium-grained and exhibit a foliated or banded structure, with granitic infiltrations parallel to foliation planes. In thin section, tonalites and granodiorites show textures ranging from igneous to polygonal granoblastic. The latter indicates that some of these rocks underwent tectono-metamorphic recrystallization at high pressure and temperature conditions. Microcline phenocrysts are scarce. Reddish biotite, clinopyroxene, green hornblende and magnetite commonly form clusters or bands of mafic minerals scattered in the dominant feldspar-quartz fraction (Appendix 1).

Clinopyroxene-bearing monzogranite and granodiorite sub-unit (Alma1b)

Sub-unit Alma1b is largely concentrated in the eastern and westernmost parts of the map area (Figure 2). It consists of clinopyroxene-bearing homogeneous monzogranite and granodiorite. Sub-unit Alma1b is composed of rocks similar in composition to those in unit Adeb1b of the Desbergères Suite, but with the addition of clinopyroxene and red biotite. For this reason, sub-unit Alma1b is considered as an equivalent to the Desbergères Suite (Adeb1b), which was however emplaced and metamorphosed at higher pressure and temperature conditions. A sample of monzogranite from sub-unit Alma1b was dated in the Lac Bienville area (33P) and gave a U-Pb age of 2709 ±2 Ma (Table 1). Monzogranites and granodiorites are pinkish to greenish grey in fresh surface and whitish to orange pink in weathered surface. These colours reflect the proportions of orange to brownish pink K-feldspar and burgundy or green plagioclase occurring in the rock. Monzogranites and granodiorites are massive to weakly foliated. They display a homogeneous texture and a medium to coarse grain size. Monzogranites of sub-unit Alma1b are regularly infiltrated into rocks of unit Alma2 and sub-unit Alma1a. In thin section, monzogranites and granodiorites contain K-feldspar, specifically microcline, locally occurring as phenocrysts. Quartz occasionally shows recrystallization textures. Sub-unit Alma1b is characterized by the presence of brown to red biotite; clinopyroxene is less abundant in this sub-unit relative to the other two sub-units (Alma1a and Alma1c) (Appendix 1).

Clinopyroxene-bearing porphyritic monzogranite and granodiorite sub-unit (Alma1c)

Sub-unit Alma1c of the Loups Marins Complex was introduced in the Lac Bienville area to replace the Lussay Suite (Alus), defined in the Loups Marins area (Gosselin *et al.*, 2002; 2004). It is composed of clinopyroxene-bearing porphyritic monzogranite, granodiorite, monzonite and monzodiorite. Sub-unit Alma1c is compositionally similar to sub-unit Adeb1c of the Desbergères Suite, but was formed and metamorphosed at higher pressure and temperature conditions, in which clinopyroxene was a crystallizing phase. Sub-unit Alma1c covers an extensive surface area in the eastern part of the map area (Figure 2). Two samples were collected in this sub-unit for U-Pb age dating analyses. A sample of clinopyroxene-bearing monzonite infiltrating an enderbite was collected, as well as a sample of clinopyroxene-bearing syenite (samples no. 2 and 3, Figure 2). The two samples gave identical ages of 2704 ±5 Ma (Table 1 and Appendix 2), compatible with our interpretation that the granitic material infiltrating enderbites of unit Alma2 is derived from sub-units Alma1b and Alma1c.

In outcrop, rocks of sub-unit Alma1c are pinkish grey to pink in fresh surface and pinkish to orange grey in weathered surface. K-feldspar phenocrysts (5-30%) range from 0.5 to 5 cm in length and are embedded in a medium-grained dominant fraction. The clinopyroxene-bearing monzogranites and granodiorites are massive to weakly foliated. In thin section, they contain up to 55% microcline. Quartz is an interstitial phase between feldspar grains. The porphyritic monzogranites contain red biotite, clinopyroxene and green hornblende as the main ferromagnesian phases (Appendix 1).

Orthopyroxene unit (Alma2)

The orthopyroxene unit (Alma2) was initially described in the Lacs des Loups Marins area (34A) (Gosselin *et al.*, 2002). In the Lac Montrochand area, it forms intrusive bodies with irregular shapes and variable sizes, generally surrounded by rocks of the clinopyroxene unit (Alma1a) (Figure 2). The orthopyroxene unit (Alma2) is essentially composed of hypersthene diorite (generally quartz diorite actually) and enderbite. It also includes minor amounts of opdalite and jotunite. A U-Pb age of 2733 ±3 Ma was obtained from a sample of enderbite (sample no. 5, Figure 2, Table 1 and Appendix 2). This age suggests that enderbites are early relative to hypersthene diorites, which were dated at 2720 ±2 Ma in the Lac Bienville area (Table 1).

Hypersthene diorites and enderbites are golden brown to greenish in weathered surface and "bottle green" in fresh surface. Orthopyroxene-bearing rocks are medium-grained and generally exhibit a foliated structure. Opdalites and jotunites contain 15 to 30% orange to brownish microcline phenocrysts. Unit Alma2 is heterogeneous and infiltrated by clinopyroxene-bearing granitic material associated with sub-units Alma1b and Alma1c. In thin section, hypersthene diorites and enderbites are granoblastic although igneous textures are locally preserved. Quartz always exhibits subgrains or polygonal crystals. The main ferromagnesian minerals are brown to red biotite, clinopyroxene, and orthopyroxene. Biotite grains sometimes host pyroxene inclusions. Clinopyroxene is commonly granoblastic or forms rims around orthopyroxene. The latter is nearly always altered to serpentine, chlorite, talc or iddingsite (Appendix 1). Green hornblende is locally present, generally as rims or uralite alteration of clinopyroxene.

Tramont Suite (Atra)

The Tramont Suite (Atra) was introduced in the Lac Gayot area (23M) to describe late granites (Gosselin and Simard, 2001). A Tramont granite (Atra) was dated in the Lac Bienville area (33P) at 2701 ±4 Ma (Table 1). It represents the youngest Archean felsic unit in the study area. In the Lac Montrochand area (33O), the Tramont Suite mainly consists of granitic dykes and injections from 10 cm to 10 m in size, that cross-cut previously described Archean units (Appendix 3, Photo 4). A few elongate intrusive bodies are clustered along deformation zones (Figure 2). Pegmatite dykes are widespread and appear to represent a late phase of this suite. The granite locally hosts cm-scale to m-scale enclaves of rocks from older units.

Granites of the Tramont Suite (Atra) are pinkish white in weathered surface and pink in fresh surface. They range from fine-grained to pegmatitic depending on the intrusive body. The granite is massive to weakly foliated outside of deformation zones. In thin section, it is mainly composed of microcline, quartz and plagioclase. Mortar textures develop in brittle fault zones, and a mylonitic "striped gneiss" fabric appears in ductile deformation zones (Appendix 3, Photo 5). Quartz commonly exhibits sub-grains and an undulatory extinction in massive or weakly foliated facies, but is recrystallized into a granoblastic texture, and eventually forms ribbons as the degree of deformation increases. Feldspars show a polygonal granoblastic texture in zones of striped gneiss. Biotite is the only significant mafic mineral; it is commonly chloritized (Appendix 1).

Qullinaaraaluk Suite (Aluk)

The Qullinaaraaluk Suite (Aluk) was defined in the Lac Vernon area (34J) and designates undeformed mafic to ultramafic intrusions similar to the intrusive rocks hosting the Qullinaaraaluk showing (Labbé *et al.*, 2001; Parent *et al.*, 2003). In the Lac à l'Eau Claire area (34B and 34C), this suite was dated at 2700 ±3 Ma (Simard *et al.*, 2004b). In the Lac Montrochand area (33O), mafic/ultramafic intrusions of the Qullinaaraaluk Suite are considered as late. They are distinguished from intrusions of the Châteauguay Suite (Achg) by their massive structure and the fact that they show no evidence of polygonization. The Qullinaaraaluk Suite forms small bodies generally less than one kilometre in size. Consequently, intrusions from this suite are shown in only two locations on the map at 1:250,000 scale and in Figure 2. Mafic/ultramafic intrusions of the Qullinaaraaluk Suite essentially consist of gabbro and clinopyroxenite. They are commonly injected with late granitic veins that give the rock a brecciated aspect (Appendix 3, Photo 6). They range from dark green to black, and exhibit a coarse-grained or poikilitic texture. In thin section, the main mineral constituent is green hornblende, often occurring as poikilitic crystals with pyroxene and magnetite inclusions. Clinopyroxene, plagioclase, orthopyroxene and biotite are the remaining main constituents of these rocks. Clinopyroxene grains commonly exhibit zoning, twinning and Schiller inclusions, indicating their primary origin. Quartz or olivine (altered to talc and iddingsite) were observed in certain intrusions (Appendix 1).

Proterozoic

The youngest rocks observed in the area consist of Proterozoic diabasic gabbro dykes. These dykes are concentrated in the northern half of the map area (figures 2 and 11). They are discontinuous and rarely exceed 25 m in thickness. Dykes exceeding 10 m thick were plotted on the map (enclosed) and in Figure 2 with an exaggerated thickness. They exhibit a subophitic texture, a massive structure and sharp contacts with Archean country rocks. They were divided into three groups or swarms based on their orientation, namely N to NNW-trending dykes, ENE to WNW-trending dykes and NE to NNE-trending dykes.

N to NNW-trending dykes

N to NNW-trending diabase dykes were mainly observed in the northern half of the area (figures 2 and 11). Their orientation ranges from N330° to N010° and their dip is subvertical. They are generally 10 to 30 m thick, but are locally less than 1 m wide. The dykes are grey to dark green in fresh surface and greenish grey or brown in weathered surface. They are aphanitic or fine to medium-grained; coarser-grained facies occur in the centre of thicker dykes. In thin section, the dykes contain sericitized plagioclase, uralitized clinopyroxene and occasional olivine altered to chlorite, serpentine and iddingsite (Appendix 1). The dykes are commonly fractured and altered to chlorite, calcite and epidote. Given their orientation, these dykes may belong to the Lac Esprit dyke swarm, dated at 2069 ±2 Ma, which trends N to NW and which was identified to the northwest of James Bay (Hamilton *et al.*, 2001).

ENE to WNW-trending dykes

ENE to WNW-trending diabase dykes are mostly exposed in the north-central part of the Lac Montrochand area (33O; figures 2 and 11). Their orientation ranges from N080° to N120°, with subvertical dips. They are generally fairly thin, between 10 cm and 20 m. They are dark grey, somewhat greenish in fresh surface, and brown with a green or orange tinge in weathered surface. These dykes contain medium-grained plagioclase phenocrysts embedded in a fine-grained or aphanitic groundmass. In addition to sericitized plagioclase, they contain, as main constituents, locally phyric clinopyroxene, chloritized biotite, and magnetite (Appendix 1). ENE to WNW-trending dykes are associated with the Richmond Gulf Graben (Fahrig *et al.*, 1986). They were also observed in the Lacs des Loups Marins and Lac à l'Eau Claire areas (Gosselin *et al.*, 2002; Simard *et al.*, 2004b).

NE to NNE-trending dykes

NE-trending diabase dykes are rare but relatively thick, ranging from 5 to 50 m (figures 2 and 11). Their orientation varies from N030° to N060° with steep dips. They are greenish grey in fresh surface and orange brown in weathered surface. The dykes display a subophitic texture and a fine grain size. They contain plagioclase and clinopyroxene phenocrysts. Plagioclase grains are sericitized, whereas pyroxene grains are uralitized or transformed into chlorite and calcite (Appendix 1). NE to NNE-trending dykes may be related to the NNE-trending Ptarmigan Swarm, which also contains clinopyroxene phenocrysts and which was dated at 2505 ±2 Ma (Buchan *et al.*, 1998).

LITHOGEOCHEMISTRY

To characterize the main lithologies in the various units, 140 rock samples were analyzed for major and trace elements including rare earth elements. Analyses were conducted at Acme Analytical Laboratories in Vancouver. Major element concentrations were determined by lithium borate ($LiBO_2$) fusion of samples, which were then analyzed by inductively coupled plasma – emission spectrometry (ICP–ES). Samples were partially digested by *aqua regia* for base and precious metals determination (Ag, As, Au, Bi, Cd, Cu, Mo, Ni, Pb, Sb, Se, Zn), and fusioned with lithium borate for rare earth elements (Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Th, Tm, U, Yb) and incompatible elements determination (Ba, Co, Cs, Ga, Hf, Hg, Nb, Rb, Sn, Sr, Ta, Tl, V, W, Y, Zr). All trace elements were analyzed by mass spectrometry (ICP–MS). Analytical results, part of which are shown in figures 4 to 8, are available in the SIGEOM database.

Samples from the different units were classified based on field observations as well as lithological and petrographic characteristics. Most suites identified in the area consist of felsic to intermediate intrusions; a few small-scale mafic intrusive units were also identified.

Felsic intrusions

All felsic units were analyzed, except for those of the Coursolles Suite (Acou2). Felsic intrusions show normative compositions ranging from granites to tonalites (Figure 4a). Most samples from felsic suites plot in the field of granites and granodiorites (Atra, Alma1b, Alma1c, Adeb1b and Adeb1c). Units Alma2, Alma1a and Afav however show a tonalitic to granodioritic composition (Figure 4a). Unit Adeb1a shows a hybrid composition derived from the infiltration of granitic material into tonalites, which yields a mixture of rocks of variable composition. On the discrimination diagram by Maniar and Piccoli (1989), granites and granodiorites range from peraluminous to metaluminous, whereas tonalites are clearly peraluminous (Figure 4b). On the diagram by Pearce *et al.* (1984), samples from tonalitic units (Afav, Alma1a, Alma2) correspond to a volcanic arc paleotectonic setting, whereas samples from granitic units (Adeb, Alma1b, Alma1c and Atra) plot in the volcanic arc or syncollisional fields (Figure 4c).

Felsic plutonic rocks in the area are rich in Al_2O_3 (12 to 19%) and SiO_2 (60 to 77%) but MgO-poor (0.1 to 2.3%). Binary diagrams showing major elements Al_2O_3, CaO, Fe_2O_3, MgO and TiO_2 versus SiO_2 all show negative correlations (Figure 5a, b, c, d, e), which suggests these felsic intrusive rocks are derived from highly differentiated magmas. Unlike other major elements shown in Figure 5, K_2O contents increase with increasing SiO_2. Granites and granodiorites (Atra, Alma1b, Alma1c, Adeb) are more enriched in potassium than tonalitic samples (Alma2, Alma1a, Afav) (Figure 5f).

The geochemistry of rare earth and trace elements is not helpful to distinguish felsic intrusive suites from one another (Figure 6). Rare earth element patterns normalized to chondrites show steep slopes. They indicate an enrichment in light rare earth elements relative to heavy rare earth elements for each suite (Figure 6a, c, e, g). Light rare earth elements are more fractionated ($[La/Sm]_{nCH}$ = 5.9-12.3) than heavy rare earth elements ($[Gd/Yb]_{nCH}$ = 2.4-4.9). Trace element patterns normalized to the primitive mantle also show the same characteristics from one suite to the next (Figure 6b, d, f, h). They show enrichment in Pb (LILE, large-ion lithophile elements) as well as negative anomalies in Nb, P, Ti and U (HFSE, high-field strength elements). This signature is typical of a crustal source.

Intermediate to mafic intrusions

Intermediate to mafic intrusive samples come from the Coursolles Suite (Acou1), the Loups Marins Complex (Alma1a and Alma2) and the Châteauguay Suite (Achg). Samples from the Qullinaaraaluk Suite (Aluk) were not analyzed, since this suite is not very widespread. Diorites of the Loups Marins Complex (Alma1a; SiO_2 = 49.9-63.1%, MgO = 1.45-5.97%) show a calc-alkaline affinity, whereas diorites of the Coursolles Suite (Acou1; SiO_2 = 46.5-59.1%, MgO = 2.0-4.3%) and leucogabbros-norites of the Loups Marins Complex (Alma2; SiO_2 = 47.5-50.2%, MgO = 3.8-5.3%) straddle the boundary between the tholeiitic and calc-alkaline fields (Figure 7a and b). On the paleotectonic diagram by Pearce and Cann (1973), diorites (Acou1 and Alma1a) and gabbro-norites (Alma2) are associated with a calc-alkaline setting (Figure 7c). Rare earth element patterns normalized to chondrites are similar for all three units and correspond to patterns typical of ocean island basalts (OIB) (Figure 8a). Multi-element plots normalized to the primitive mantle are also similar for all three units. They resemble OIB patterns, but show a marked depletion in certain elements such as Nb, P, U, Ti and Zr (Figure 8b).

Gabbros of the Châteauguay Suite (Achg) contain 8 to 15% MgO and 45.0 to 50.9% SiO_2. They plot in the field of basaltic komatiites, except for one sample plotting in the field of high-Fe tholeiites (Figure 7b). They are associated with a calc-alkaline tectonic setting (Figure 7c). Chondrite-normalized rare earth element patterns for these gabbros are very similar to OIB trends, with their enrichment in light rare earth elements (Figure 8c). Trace element patterns normalized to the primitive mantle are also very close to OIB patterns, but are depleted in Nb, P, Ti and Zr (Figure 8d). The enrichment in light rare earth elements coupled with Nb depletion suggests significant crustal contamination of a relatively primitive source for the gabbros.

Proterozoic diabase dykes

Analytical results for Proterozoic diabase dyke samples were grouped according to the three orientations defined above: N to NNW, ENE to WNW and NE to NNE. N to NNW-trending dykes show major oxide contents ($MgO \approx 7.0\%$, $TiO_2 \approx 1.9\%$, $K_2O \approx 0.8\%$, $P_2O_5 \approx 0.4\%$) similar to ENE to WNW-trending dykes ($MgO \approx 7.0\%$, $TiO_2 \approx 1.6\%$, $K_2O \approx 1.8\%$, $P_2O_5 \approx 0.2\%$), except for lower K_2O contents. However, porphyritic ENE to WNW-trending dykes contrast with their high Al_2O_3 content (14.8-15.7%) and low Fe_2O_3 (10.0-11.3%). The only analyzed sample from a NE to NNE-trending dyke shows low MgO (≈3.5%) and high TiO_2 (≈2.6%), K_2O (≈1.5%) and P_2O_5 (≈0.8%) relative to the previous groups.

Regardless of their orientation, diabase dykes show a tholeiitic affinity (Figure 7a and b). The presence of ENE to WNW-trending dykes in the calc-alkaline field on Figure 7a is probably due to their high plagioclase phenocryst content. Dykes show gently sloping rare earth patterns, midway between E-MORB and OIB patterns (Figure 8e). Light rare

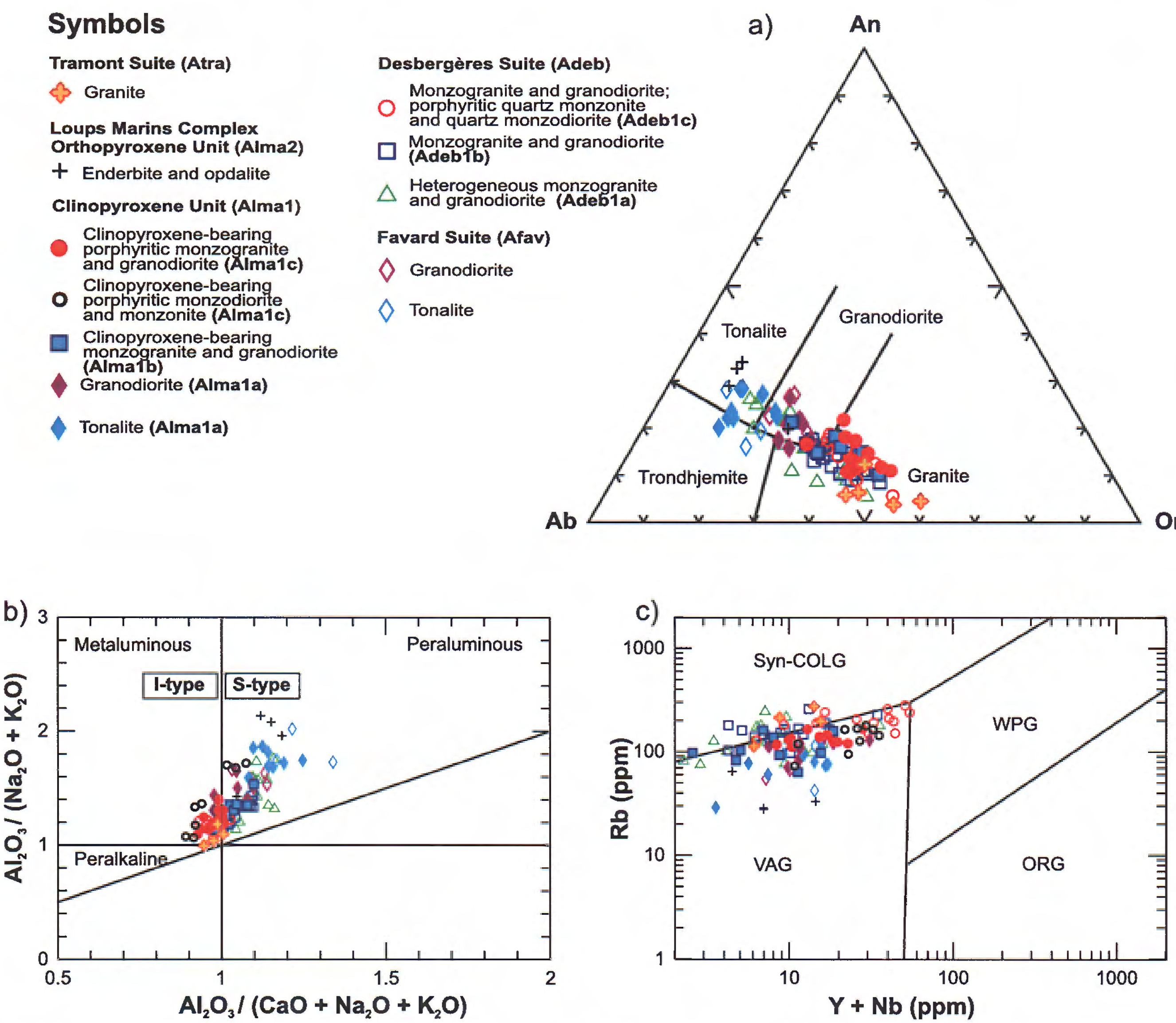


FIGURE 4 - Geochemistry of main felsic intrusive units of the Lac Montrochand area (NTS 33O). **a)** Normative anorthite-albite-orthoclase diagram (O'Connor, 1965). **b)** Discrimination diagram by Maniar and Piccoli (1989). **c)** Rb versus Y+Nb tectonic discrimination diagram (Pearce *et al.*, 1984) VAG = volcanic arc granite, Syn-COLG = syn-collisional granite, WPG = within-plate granite, ORG = ocean ridge granite.

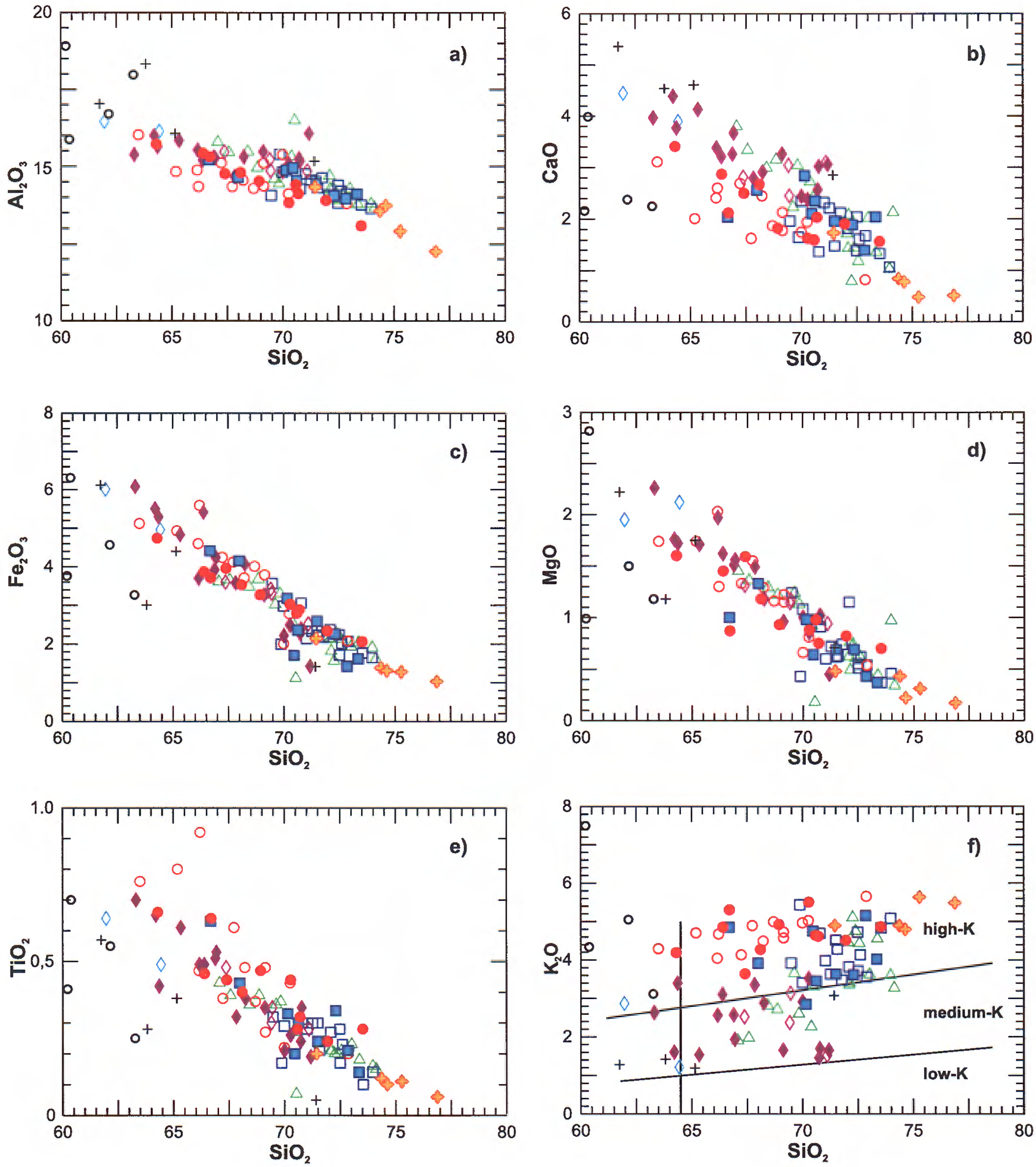


FIGURE 5 - Binary diagrams showing variations in Al_2O_3, CaO, Fe_2O_3, MgO, TiO_2 and K_2O (%) relative to SiO_2 (%) content, to illustrate the magmatic evolution of felsic plutonic rocks of the Lac Montrochand area (same symbols as in Figure 4).

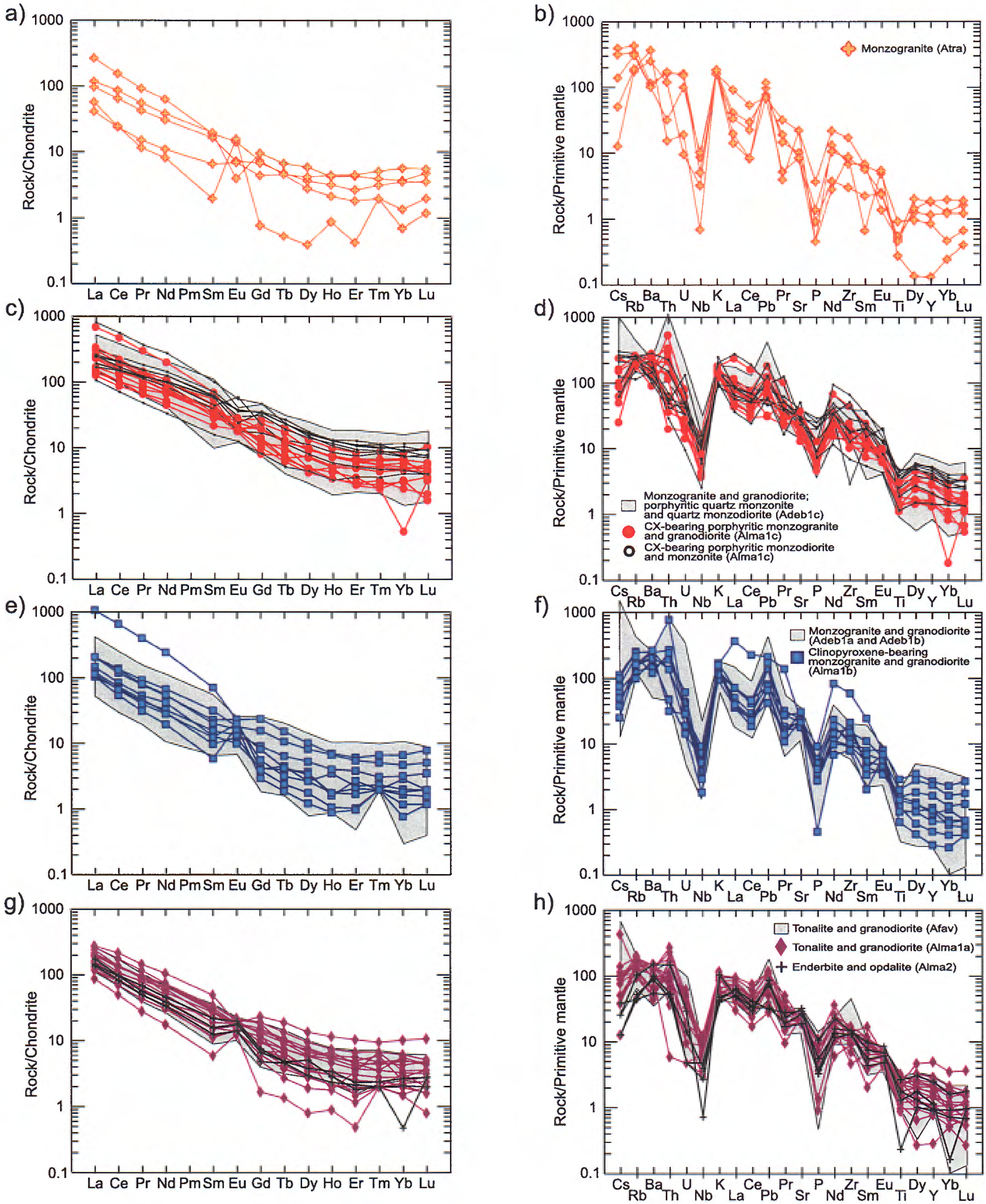


FIGURE 6 - Rare earth element diagrams normalized to chondrites (a, c, e, g) and multi-element diagrams normalized to the primitive mantle (b, d, f, h) showing chemical analytical results from felsic intrusive units of the Lac Montrochand area (NTS 33O). Normalization values taken from Sun and McDonough (1989).

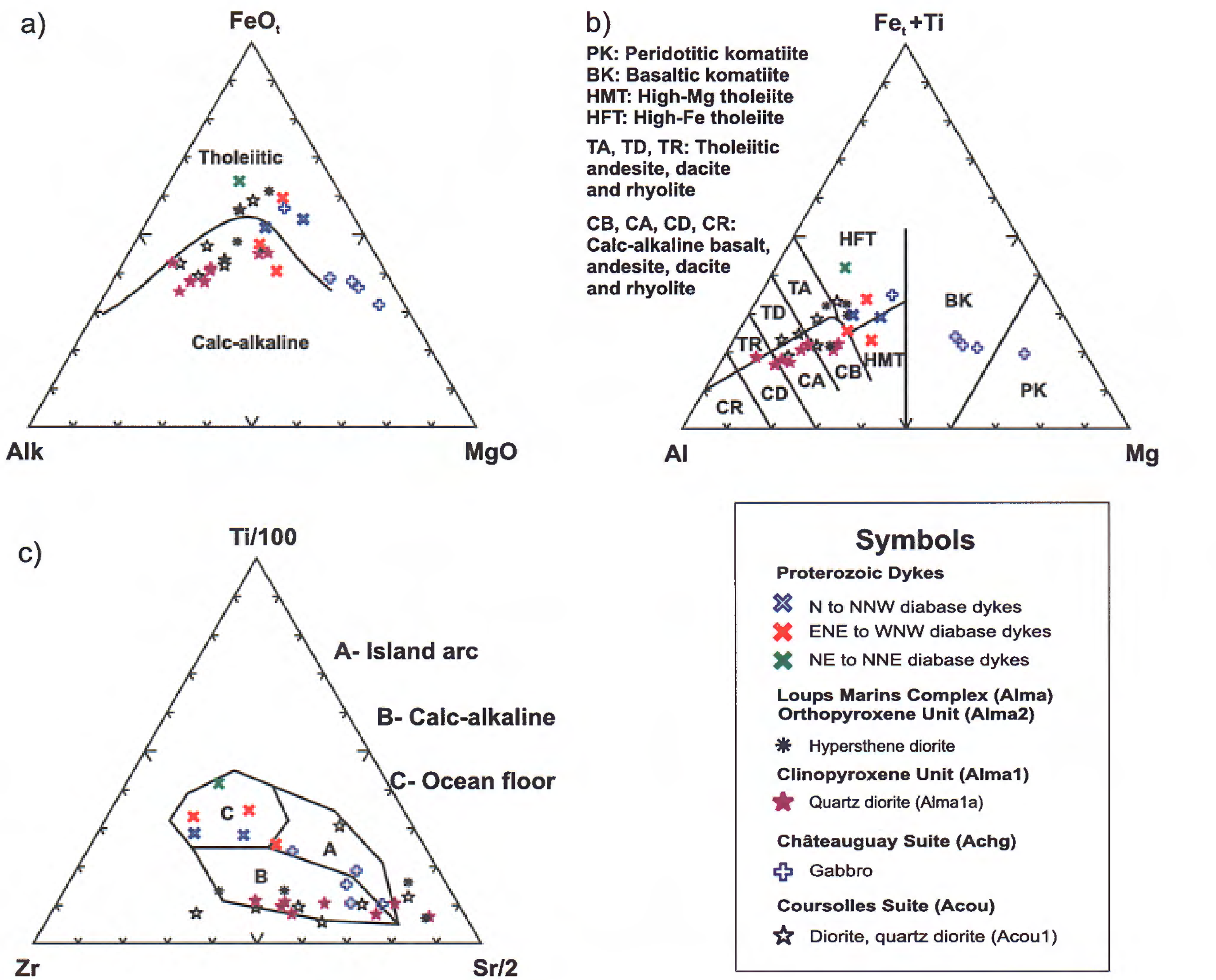


FIGURE 7 - Diagrams showing main intermediate to mafic units of the Lac Montrochand area (NTS 33O). **a)** AFM ternary diagram by Irvine and Baragar (1971). **b)** Jensen cation plot (1976). **c)** Ti/100 – Zr – Sr/2 paleotectonic diagram by Pearce and Cann (1973).

earth elements ($[La/Sm]_{nCH} = 2.5$) are more fractionated than heavy rare earth elements ($[Gd/Yb]_{nCH} = 1.7$), which show a relatively flat pattern. On trace element diagrams, dyke patterns once again plot midway between E-MORB and OIB fields (Figure 8f). These patterns show negative anomalies in Nb, Sr, Th, U and Zr (HFSE) and in Ti, and positive anomalies in Pb and Rb (LILE). These anomalies, coupled with an enrichment in light rare earth elements, suggest these dykes are probably derived from a basaltic magma that assimilated a continental crust component.

Summary of lithogeochemistry

In the Lac Montrochand area, felsic intrusive units are relatively homogeneous and appear to form a continuum. Early peraluminous tonalites are associated with a volcanic arc setting, whereas granites and granodiorites evolve from a volcanic arc environment to a syncollisional environment (Figure 4c).

Diorites show a calc-alkaline affinity (Alma1a) or transitional between calc-alkaline and tholeiitic fields (Acou1, Alma2), whereas gabbros (Achg) have a tholeiitic basaltic komatiite signature (Figure 7a and b). Nevertheless, it seems that all Archean intermediate to mafic rocks (Achg, Acou1, Alma1a, Alma2) are associated with a calc-alkaline paleotectonic setting (Figure 7c).

Rare earth element patterns for all Archean units, whether felsic, intermediate or mafic, show enrichment in light rare earth elements relative to heavy rare earth elements. Furthermore, all these units show multi-element patterns with negative anomalies in Nb, P and Ti, while most have a positive Pb anomaly. These characteristics, associated with

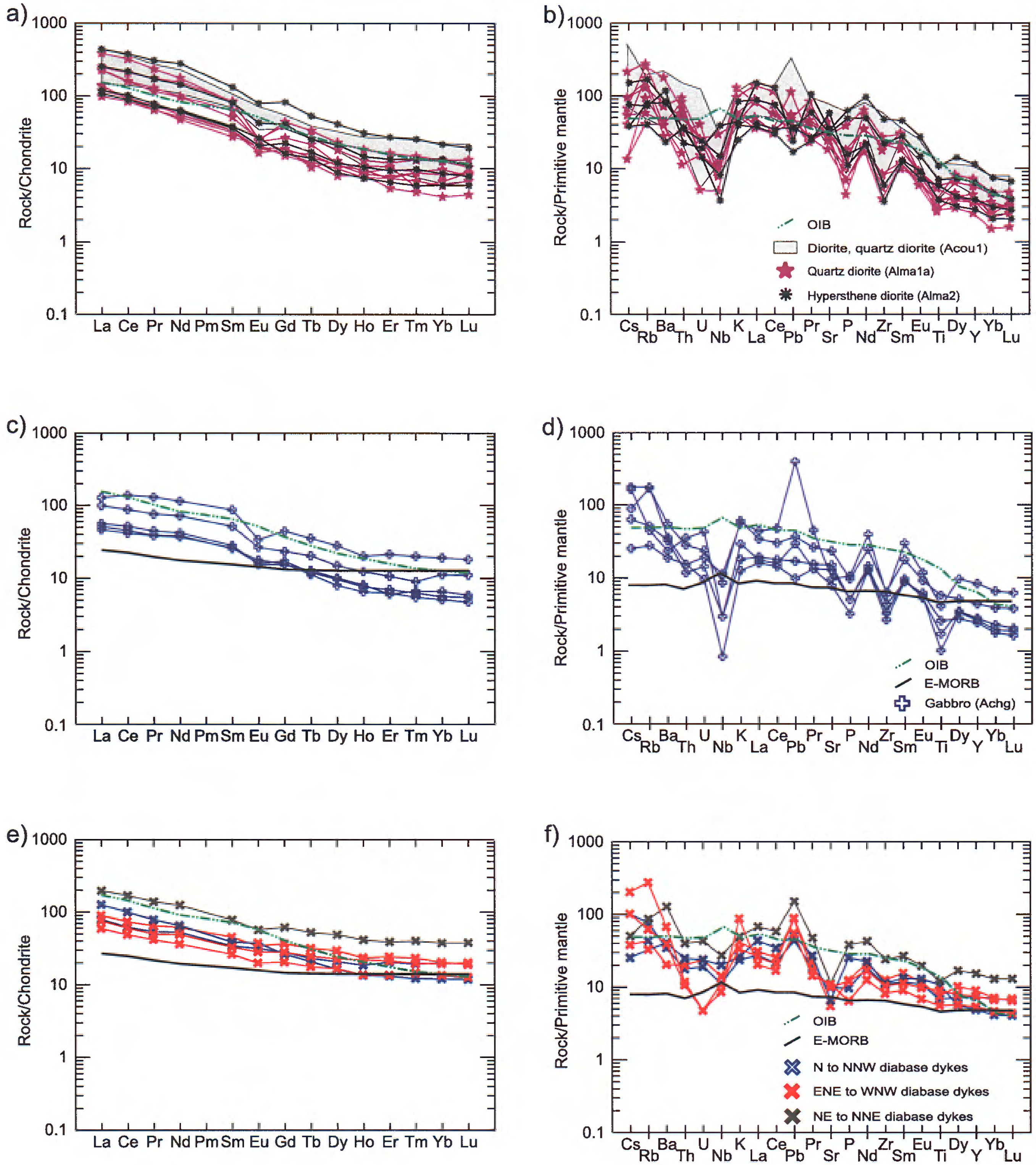


FIGURE 8 - Rare earth element diagrams normalized to chondrites (a, c, e, g) and multi-element diagrams normalized to the primitive mantle (b, d, f, h) showing chemical analytical results from intermediate to mafic units of the Lac Montrochand area (NTS 33O). Normalization values and patterns associated with "ocean island basalts (OIB)" and "enriched mid-ocean ridge basalts (E-MORB)" taken from Sun and McDonough (1989).

trace element geochemistry, suggest that magma sources which generated all these Archean units are either crust-derived or have assimilated an important crustal component. The various suites appear to have been emplaced in an island arc or a continental margin environment.

METAMORPHISM

The absence of supracrustal rocks in the Lac Montrochand area makes it quite difficult to interpret metamorphic conditions, since these rocks generally contain the most diagnostic mineral assemblages to determine metamorphic facies. Rocks exposed in the area essentially consist of felsic to intermediate intrusions with a minor proportion of mafic to ultramafic rocks. Most rocks observed exhibit primary textures, indicating that mineral assemblages reflect pressure and temperature conditions which prevailed during their emplacement. Mineral assemblages observed in certain recrystallized rocks are the same as those in primary assemblages, and are typical of metamorphic conditions ranging from the amphibolite to the granulite facies. Late alteration produced retrograde alteration minerals. Retrograde metamorphism at the greenschist facies is associated with late deformation and hydrothermal fluid circulation in brittle fault zones.

The central and western parts of the map area are underlain by tonalite-granodiorite-granite suites (figures 2 and 3). Mineral assemblages observed in the latter generally exhibit preserved primary textures which suggest the mineralogy reflects the initial conditions of emplacement of the rock. The mineral assemblage green biotite + green hornblende + plagioclase + quartz ± epidote ± muscovite is typically observed in tonalite-granodiorite-granite suites. Polygonal recrystallization textures were also observed in these rocks, but are not accompanied by changes in the mineral assemblage. This suggests that part of these rocks underwent tectono-metamorphism which preserved the initial mineral assemblage typical of the middle amphibolite facies.

The Loups Marins Complex covers the eastern part of the area as well as the southwestern corner (figures 2 and 3). It is characterized by high-grade mineral assemblages. It consists of a clinopyroxene unit (Alma1) and an orthopyroxene unit (Alma2). The clinopyroxene unit is by far the most widespread. It is characterized by the assemblage clinopyroxene + reddish biotite + plagioclase + quartz ± hornblende. The mineral assemblage and the presence of preserved primary textures in these rocks indicate they formed at pressure and temperature conditions typical of the upper amphibolite facies or the lower granulite facies. Granoblastic textures, frequently observed in these rocks, indicate they underwent recrystallization, probably as a result of tectonic events, but with no change in metamorphic conditions, since mineral assemblages are preserved. The orthopyroxene unit (Alma2) forms the core of the Loups Marins Complex (Figure 2). It is characterized by the assemblage orthopyroxene + clinopyroxene + brown-red biotite + plagioclase + quartz ± hornblende. This unit exhibits both primary magmatic textures, with well-preserved automorphic pyroxene crystals, and granoblastic textures. The coexistence of the two indicates that primary orthopyroxene-bearing intrusions were emplaced within the complex at pressure and temperature conditions typical of the granulite facies, and then underwent metamorphic recrystallization, with no change in prevailing conditions.

Gabbros of the Châteauguay Suite display a granoblastic texture. The mineral assemblage observed in these rocks corresponds to the granulite facies; it is characterized by the following minerals: clinopyroxene + orthopyroxene + hornblende + brown biotite + plagioclase + quartz.

The plutonic rocks are affected by late alteration which transformed primary mineral assemblages. Plagioclase is commonly sericitized. Clinopyroxene is partially uralitized or transformed into carbonate, epidote and chlorite. Orthopyroxene is altered to serpentine, iddingsite, talc, carbonate and magnetite. Hornblende is altered to chlorite, epidote and calcite. Biotite is replaced by chlorite.

In brittle fault zones, greenschist-facies retrograde metamorphism appears to be the result of deformation and hydrothermal fluid circulation. In these zones, plagioclase is intensely altered to sericite, biotite is transformed into chlorite, and hornblende into chlorite, epidote and calcite. Pyroxene phases are almost entirely replaced by secondary minerals, making them nearly impossible to detect. The rocks overall are strongly hematized, chloritized and epidotized.

STRUCTURAL GEOLOGY

From a structural standpoint, the Lac Montrochand area is characterized by a dominant NW-SE tectonic pattern, typical of the southern Minto Subprovince and the Bienville Subprovince (Percival *et al.*, 1992). This trend is clearly visible on the shaded total magnetic field map (Figure 3). Structural data collected during the field work was used to generate a map of foliation and lineation trajectories. The regional foliation is established based on mineral foliation, migmatitic layering and gneissosity measurements. The average trajectory of regional foliations and lineations is shown in Figure 9, along with a statistical compilation on stereograms. Regional faults were studied in greater detail, based on the distribution of deformation indices and the nature of faults interpreted in the field. The results of this regional fault study are shown in Figure 10.

Structural analysis

The distribution of foliation trajectories is fairly homogeneous, thus the area was divided in only two structural domains (Figure 9). These domains were established based

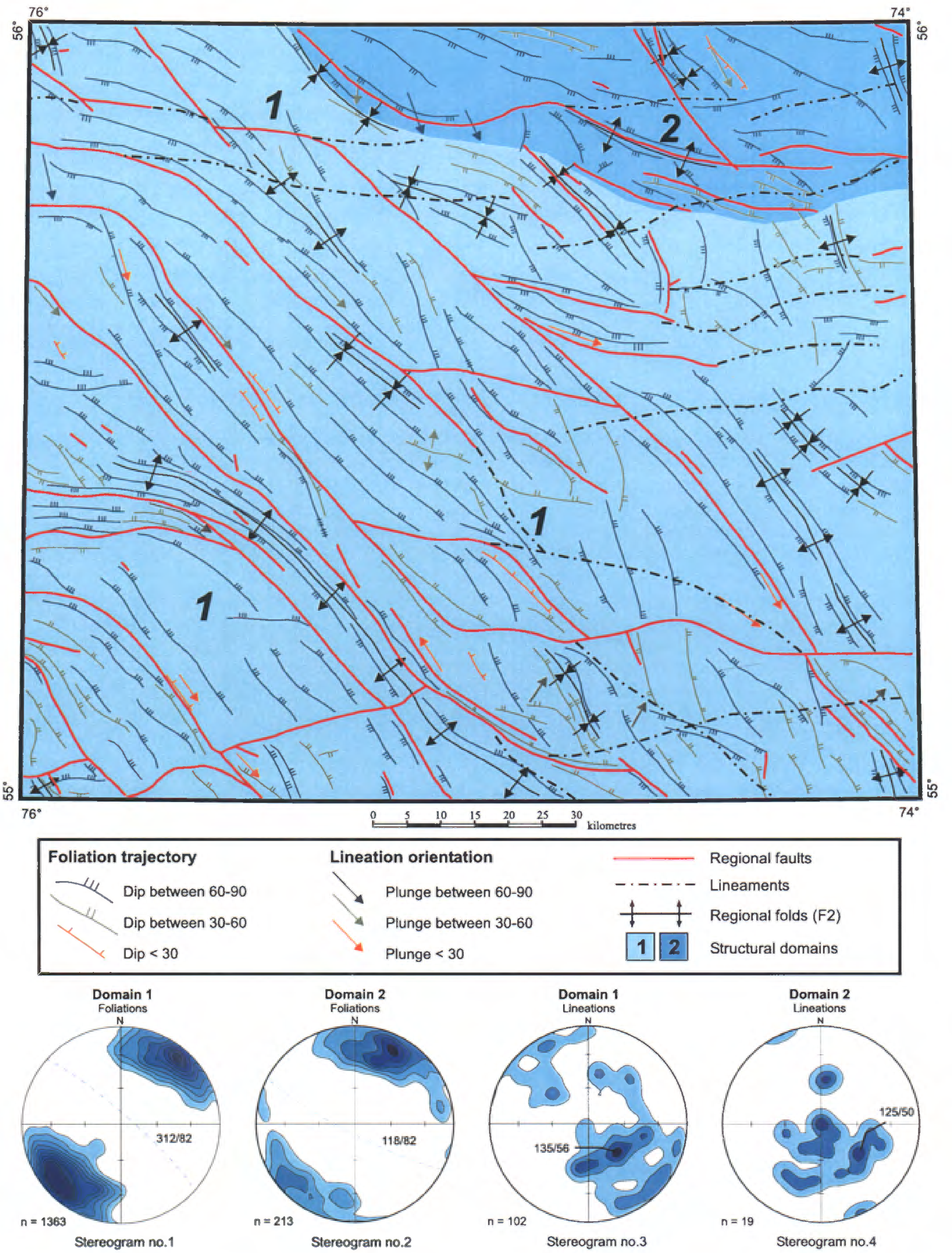


FIGURE 9 - Extent of the two structural domains and trajectory of regional foliation S2. Statistical compilation of foliation (S2) and lineation measurements associated with each domain on Schmidt stereograms. n = number of measurements.

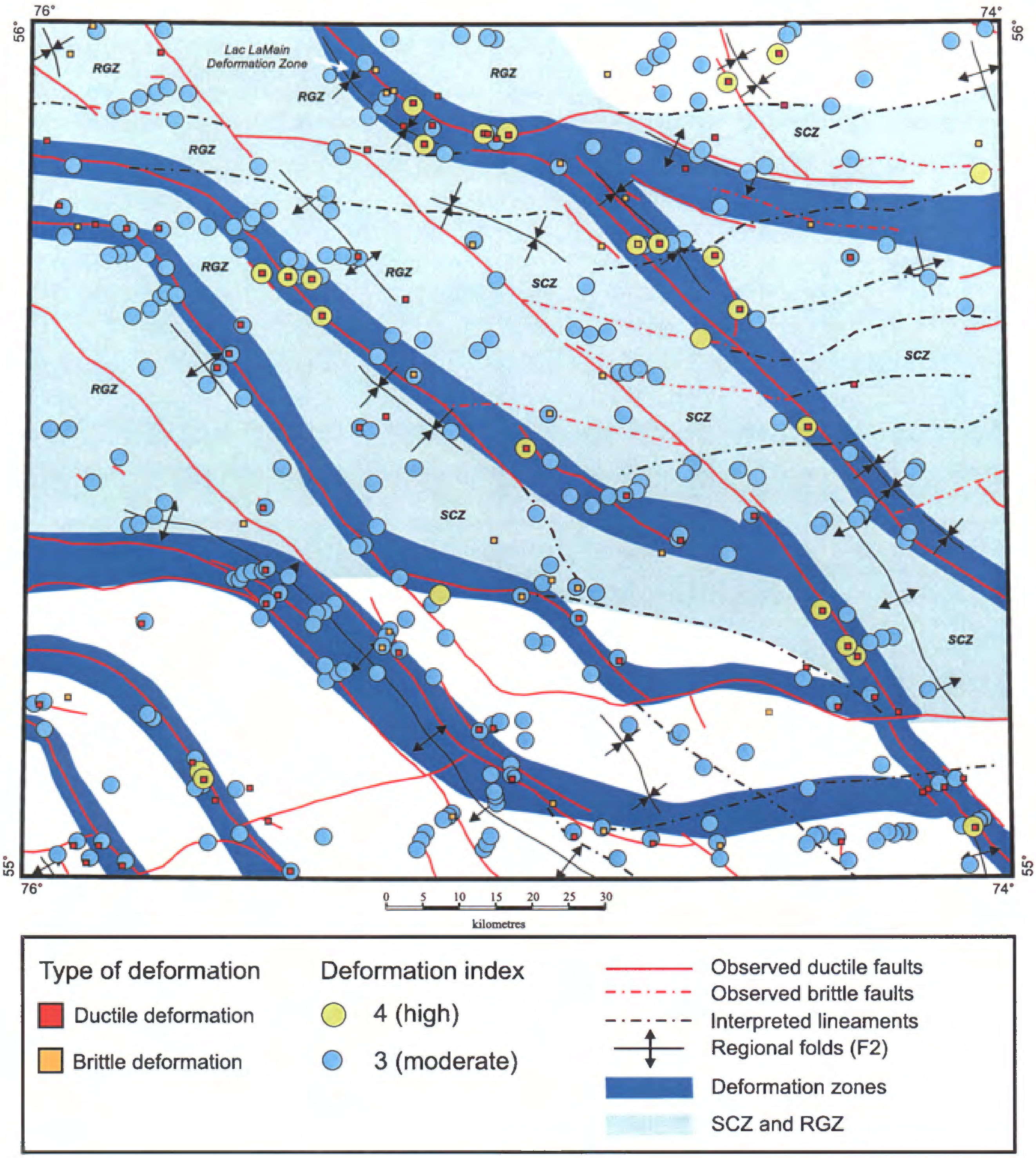


FIGURE 10 - Distribution of faults observed in the field and interpreted from aeromagnetic maps. Presentation of major structural zones characterized by high deformation indices and brittle-ductile deformation. Proposed extent of the Saindon-Cambrien (SCZ) and Richmond Gulf (RGZ) structural zones.

on the average orientation of the regional foliation, and are bounded by major faults. The statistical compilation using Schmidt stereograms for each domain is shown at the bottom of Figure 9. In the area, the main planar structure is a penetrative foliation of variable intensity and broadly oriented NW-SE. This foliation is dragged along fault zones where it is overprinted by a mylonitic fabric.

Domain 1 covers a significant proportion of the map area. It is characterized by an average foliation striking NW-SE and steeply dipping (stereogram no. 1, Figure 9). Locally, an E-W foliation is observed along fault zones of the same orientation. Linear structures associated with domain 1 consist of stretching lineations; these were observed mainly in strongly deformed units along NW-SE-trending fault zones (Figure 9). They plunge moderately to weakly toward the southeast (stereogram no. 3, Figure 9). Lineations are preferentially developed in zones where the local anisotropy is relatively high compared to the global average. Domain 2 is located in the northeastern part of the area (Figure 9). It is bounded to the south by a deformation zone. This domain is characterized by an average foliation striking ESE-WNW and steeply dipping (stereogram no. 2, Figure 9). A lineation, moderately plunging to the SSE, was also observed (stereogram no. 5, Figure 9). The latter tends to become vertical along ESE-trending fault zones (Figure 9).

During the field survey, a visual estimate of the degree of deformation was systematically recorded at each station. This qualitative evaluation is based on a scale of 1 to 4, where 1 represents a massive rock and 4, a strongly deformed rock. Figure 10 shows the distribution of higher deformation indices (3 and 4) associated with regional faults, as well as the type of deformation (brittle or ductile) assessed in the field or in thin section. The geographic distribution of deformation indices outlines the presence of wide corridors where the degree of deformation is higher. These zones are located on either side of major NW-SE faults that transect the area. Units along these faults show a stronger anisotropy marked by the presence of gneissosity and mylonitic foliation. These faults are therefore of a brittle-ductile nature. On the other hand, most ENE-WSW to ESE-WNW faults are brittle, and were specifically observed in the northern part of the map area (Figure 10).

Phases of deformation

Cross-cutting relationships observed on outcrops and the structural analysis indicate that tectonic events which affected the Lac Montrochand area may be associated with four more or less continuous phases of deformation (Table 2). The first three are ductile whereas the last brittle event may be associated with the Saindon-Cambrien and Richmond Gulf subsidence structures (figures 10 and 12).

Phase D1 is related to an early S1 foliation observed in enclaves preserved in the various units. These enclaves occur in variable proportions in units, and range in composition from mafic/ultramafic rocks (hornblendite, gabbro, amphibolite) to intermediate and felsic rocks (diorite and tonalite). They occur isolated or in clusters, in variable shapes and sizes. Enclaves are commonly stretched and flattened parallel to the regional foliation (Appendix 3, Photo 1). They sometimes also show an internal foliation or folding, the orientation of which varies from one enclave to the next within a single outcrop. Therefore, several enclaves already had a planar fabric (S1) when they were incorporated into the granitoids. This S1 foliation in enclaves is inferred to represent the only remaining evidence of deformation prior to regional foliation S2.

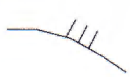
Phase D2 is responsible for the development of regional foliation S2, which affects all Archean rocks in the area. It is generally not as strongly developed in younger units such as granites of the Tramont Suite (Atra). The map showing planar structure trajectories in Figure 9 outlines the average NW-SE orientation of the regional foliation. An interpretation of the distribution of S2 foliations seems to indicate the presence of major regional folds (F2), synforms and antiforms that form part of the structural make-up of the area. In the field, the foliation is defined by the alignment of ferromagnesian minerals and the elongation of enclaves parallel to S2. In outcrop, units of the Desbergères (Adeb1a), Coursolles (Acou), Favard (Afav) suites and the Loups Marins Complex (Alma1a and Alma2) show a well-developed regional S2 foliation. These rocks are affected by a widespread granitic infiltration phenomenon throughout the area. The granitic material, infiltrated to variable degrees in these rocks, is distributed parallel to S2 (Appendix 3, Photo 3). Contacts with host rocks are diffuse and no evidence of migmatization or *in situ* melting, either partial or advanced, was observed. The presence of granitic material regularly following foliation planes indicates that its introduction was facilitated by the presence of this planar fabric. If the material had been introduced as granitic veins or dykes with different orientations, the injected material would have shown evidence of transposition or minor folding. The scarcity of this type of feature suggests that granitic infiltrations were controlled by the planar fabric, and therefore that their emplacement is syn- to late-D2. Late granitic units (Atra) show cross-cutting relationships occurring as dykes in earlier units (Appendix 3, Photo 4) and are rarely foliated, except for intrusions located along regional faults. Their emplacement is therefore late- to post-D2.

Phase D3 is associated with the development of NW-SE deformation zones. Most stretching lineations measured in the field occur within these deformation zones. The structural analysis has shown that the development of stretching lineations is associated with an increase in the degree of deformation along NW-SE to E-W deformation zones. Within the latter, lithological units and infiltrated granitic material are more intensely foliated, the grain size is reduced and a mylonitic fabric is locally developed (Appendix 3, photos 2 and 5). In thin section, these rocks show evidence of dynamic recrystallization such as grain size reduction and sub-grain development, as well as ribbon quartz formation. These textures are locally associated with brittle deformation features such as fracturing in feldspar crystals. D3 faults form a slight angle relative to regional foliation S2. This phenomenon was observed in outcrops and in thin section, where C/S fabrics are developed in units cut by the Lac LaMain Deformation Zone, located along the boundary between the two structural domains in the northern part of the area (figures 9 and 10; Lafrance, 2003). Stretching lineations measured in the field have a tectono-metamorphic origin and are defined by the preferential orientation of minerals such as biotite, hornblende and ribbon quartz. Lineations in domain 1 plunge moderately to weakly to the southeast (stereogram no. 3, Figure 9). This attitude, associated with subvertical fault planes, suggests strike-slip movements with a slightly oblique component. On the other hand, in domain 2, lineations plunge moderately to steeply toward the south-southeast (stereogram no. 4, Figure 9), which suggests a vertical movement. A reverse component was inferred from the analysis of microstructures in the Lac LaMain Deformation Zone (Lafrance, 2003).

Phase D4 is essentially represented by the development of late ENE and WNW-trending faults. These faults are well developed in the northeastern and northwestern parts of the map area, and extend eastward into the Lac Bienville area (Gosselin *et al.*, 2004) (Figure 9). They are generally well exposed in the field. However, certain faults were interpreted from indirect methods using aeromagnetic, remote sensing and topographic maps as well as aerial photographs. They are represented by black dotted lines in Figure 10. Brittle D4 faults, unlike D3 faults which drag the regional foliation, cross-cut earlier structures without influencing the orientation of their specific fabrics. D4 faults are brittle and exhibit evidence of cataclastic deformation, characterized by mortar textures. The rock is intensely fractured and riddled with hematite, epidote and quartz stringers. Stronger pervasive hematite-epidote-chlorite alteration was also observed in these zones. These faults are possibly associated with the Proterozoic Saindon-Cambrien and Richmond Gulf subsidence structures (figures 10 and 12). According to Portella (1980) and Moorhead *et al.* (1999), these zones are namely characterized by the presence of ENE-WSW and ESE-WNW to E-W brittle faults.

The Lac Montrochand area is the meeting point between the Richmond Gulf subsidence structure (RGZ), oriented WNW-ESE, and the Saindon-Cambrien Zone (SCZ), oriented ENE-WSW (Figure 10) (Portella, 1980). The boundaries of these corridors within the study area were defined based on the presence of interpreted lineaments and brittle D4 faults. The RGZ extends for 100 km in length from Richmond Gulf (Lac Guillaume-Delisle) to the northwestern part of the study area. It is essentially composed of WNW-ESE to E-W faults that form a graben which hosts sedimentary rocks of the Richmond Group (Portella, 1980). The SCZ extends for 350 km from east to west between Lac Cambrien in the Labrador

TABLE 2 - Summary of the four phases of deformation interpreted in the Lac Montrochand area (NTS 33O).

D1		Deformation D1: Early S1 foliation preserved in enclaves enclosed in the various regional units.
D2		Deformation D2: Regional NW-SE foliation (S2). Infiltration of granitic material along S2 foliation planes.
D3		Deformation D3: NW-SE deformation zones associated with D3 faults. Development of stretching lineations. The planar regional fabric S2 is reoriented along deformation zones.
D4		Deformation D4: Late ENE and WNW brittle faults that cross-cut earlier fabrics.

Trough and Lac Saindon, in the heart of the Bienville Subprovince, east of the Lac Montrochand area. It is defined by ENE-WSW lineaments and by the alignment of Proterozoic sedimentary outliers of the Sakami Formation (Moorhead *et al.*, 1999; Moorhead *et al.*, 2000). The SCZ is characterized in the Lac Bienville area by the presence of major regional ENE-WSW faults that extend westward into the Lac Montrochand area (figures 10 and 12). No evidence of Sakami Formation outliers was noted in the study area. D4 faults, trending ENE-WSW, occurring in the northeastern part of the area, are inferred to be related to the SCZ, whereas ESE-WNW to E-W faults, occurring in the northwestern part of the area, would be related to the RGZ (Figure 10). Some of these faults and fractures may have been reactivated in several occasions during the Paleoproterozoic, as indicated by the presence of several diabase dykes trending ENE and WNW (figures 11 and 12).

ECONOMIC GEOLOGY

Results of the mapping campaign

Three occurrences with anomalous base metal grades were uncovered during our mapping campaign (Figure 11). These mineralized zones, identified during field traverses, were sampled and assayed for trace elements including base and precious metals. One site in particular (site no. 3, Figure 11) was analyzed for platinum group elements (Pt, Pd, Rh). The three occurrences are all associated with similar lithologies, namely deformed gabbroic units of the Châteauguay Suite.

Mineral occurrences

Sites 1 and 2 (Figure 11) contain anomalous Cu and Ni, associated with disseminated sulphides in a gabbroic host rock. At site #1, the sulphides are hosted in a gabbro assigned to the Châteauguay Suite (Achg), within a NW-trending deformation zone (Figure 11). The showing is characterized by magnetite, pyrite and trace chalcopyrite. A hand sample gave anomalous grades in Cu (0.12%), Ni (787 ppm) and Au (51 ppb). Site #2 corresponds to disseminated sulphides in a foliated gabbro of the Châteauguay Suite (Achg) (Figure 11). In thin section, opaque minerals consist of disseminated pyrite and chalcopyrite. Assay results from a hand sample gave anomalous Cu (0.11%), Ni (431 ppm), Ag (130 ppm) and Au (26 ppb). Site #3 is located in a rusty zone within an orthopyroxene gabbro assigned to the Châteauguay Suite (Achg, Figure 11). Here, assay results from a hand sample gave anomalous Cu (625 ppm). This sample was also analyzed for platinum group elements, but no significant grades were obtained. The sample is weakly magnetic and contains minor disseminated sulphides (trace pyrite). The gabbroic rocks at all three occurrences are medium-grained and foliated. They are composed of plagioclase, altered to sericite and carbonate, clinopyroxene and hornblende. Plagioclase grains exhibit a granoblastic texture and hornblende occurs in phenocrysts. These characteristics suggest that these gabbros underwent regional metamorphism and deformation. This type of mafic/ultramafic intrusion is widespread throughout the area (Figure 11).

A minor proportion of mafic/ultramafic intrusions in the area appear massive and are associated with the Qullinaaraaluk Suite (Aluk, Figure 11). This suite bears the same name as a showing formed of massive sulphides associated with a pyroxenite. It is locally brecciated and injected with granitic material (Appendix 3, Photo 6). The Qullinaaraaluk showing, located in the Lac Minto area (NTS 34G), gave grades reaching 2.8% Ni and 1.80% Cu (Labbé *et al.*, 2001). Consequently, this type of massive intrusion represents an interesting target for exploration.

Diamond potential

Recent kimberlite discoveries in Québec are all located within structural zones defined by the geotectonic approach of Moorhead *et al.* (1999). The Lac Montrochand area hosts major structural features described by Moorhead *et al.* (1999; 2000) as significant for diamond exploration. The study area is transected by the ENE-WSW Saindon-Cambrien Structural Zone (SCZ) and the Richmond Gulf Structural Zone (RGZ), which trends NW-SE (Figure 12). Furthermore, the potential northeastward projection of the Kapuskasing tectonic zone cuts across the area, as well as the Richmond-Otish gravity lineament, oriented NW-SE (Figure 12). Kimberlite fields are generally associated with structural features like these as they cut across stable Archean cratons (Moorhead *et al.*, 1999; 2000).

Saindon-Cambrien and Richmond Gulf structural zones

The Saindon-Cambrien structural zone (SCZ) extends along an ENE-WSW axis over a distance of 350 km, from the Labrador Trough to an area south of Lac à l'Eau Claire (Figure 12). It forms a corridor some 75 km wide, defined by the alignment of 7 outliers of Proterozoic sedimentary rocks of the Sakami Formation (Figure 12) and of two carbonatite complexes located within the Labrador Trough (Moorhead *et al.*, 1999; 2000). It is formed of ENE-WSW lineaments interpreted from satellite images and aeromagnetic maps, the most prominent being the Petite Baleine Fault (Figure 12, Portella, 1980).

The Richmond Gulf Structural Zone (RGZ) extends for about 100 km, from Richmond Gulf (Lac Guillaume-Delisle) to the northwest of our study area, where it joins up with the SCZ (Figure 12). It forms a graben delineated by ESE-WNW-trending faults, in which Proterozoic sediments of the

Richmond Group were deposited; two occurrences of diatreme breccia are also reported (Figure 12, Portella, 1980; Parent *et al.*, 2002c; Simard *et al.*, 2004b).

In the Lac Montrochand area (33O), the SCZ and the RGZ show certain features indicating a favourable setting for the emplacement of kimberlitic magmas. First, the two structural zones join up within the study area, and the junction corresponds to a flexure zone, where faults trending ENE-WSW in the SCZ are reoriented to the ESE-WNW in the RGZ. This flexure zone may correspond to the projection of the NE-trending Kapuskasing tectonic zone, and may represent a zone of crustal permeability (Moorhead *et al.*, 2000; Portella, 1980). An important gravity lineament, trending NW-SE, the Richmond-Otish lineament, also crosses the junction zone (Roy and Gosselin, 2003). Moreover, these corridors contain subsidiary brittle faults trending ENE-WSW to ESE-WNW which represent conduits that may have served to channel alkaline magmas. In fact, Proterozoic diabase dykes mapped during the field campaign are concentrated within the confines of these two zones, thereby confirming the existence of conduits favouring the emplacement of Proterozoic intrusions (Figure 11).

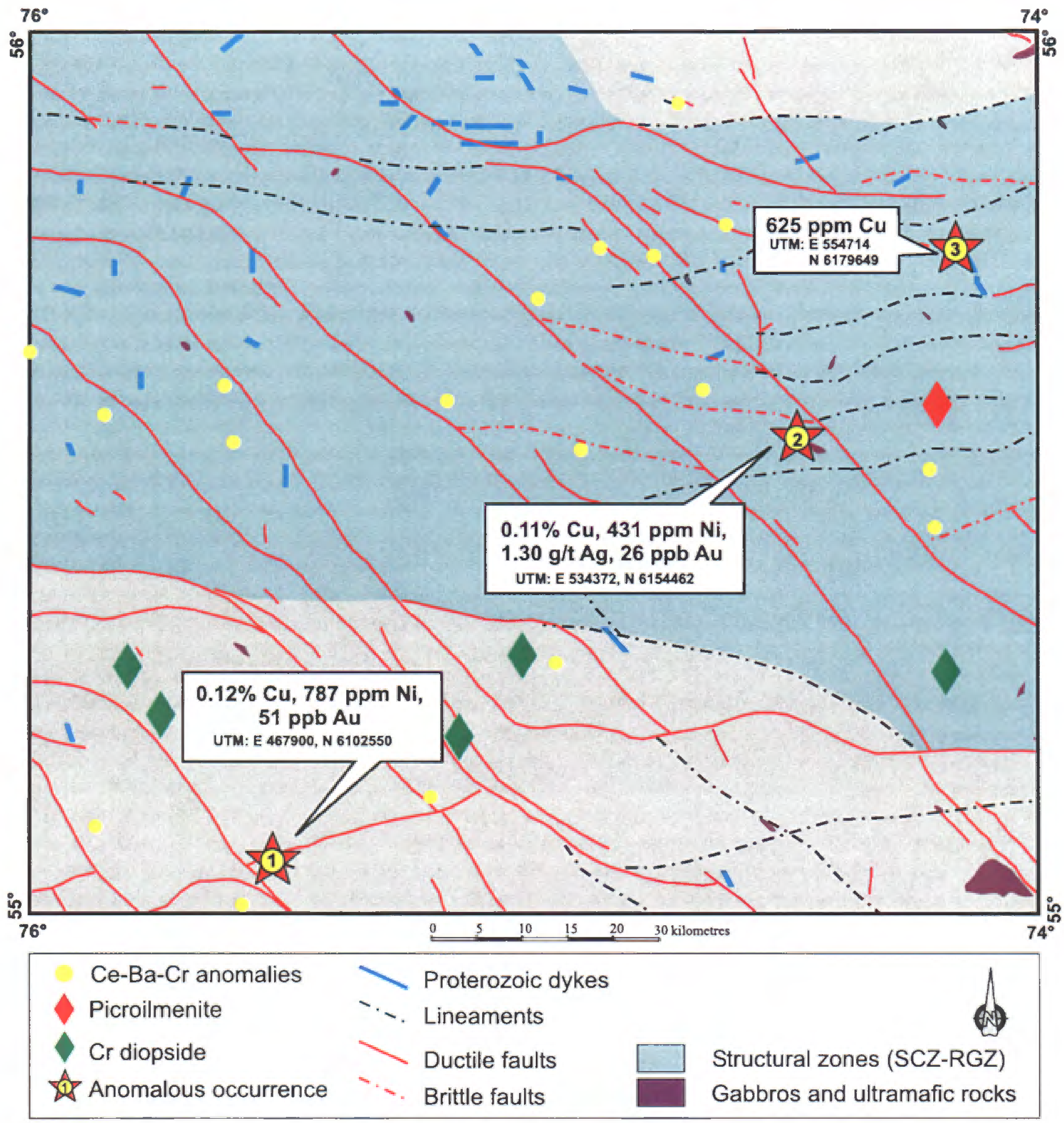


FIGURE 11 - Location of main sites of economic interest and diamond potential indicators in the Lac Montrochand area (NTS 33O). Geochemistry anomaly map prepared by Marc Beaumier using data from DP 98-01 (MRN, 1998). Location of indicator minerals taken from Parent *et al.* (2004).

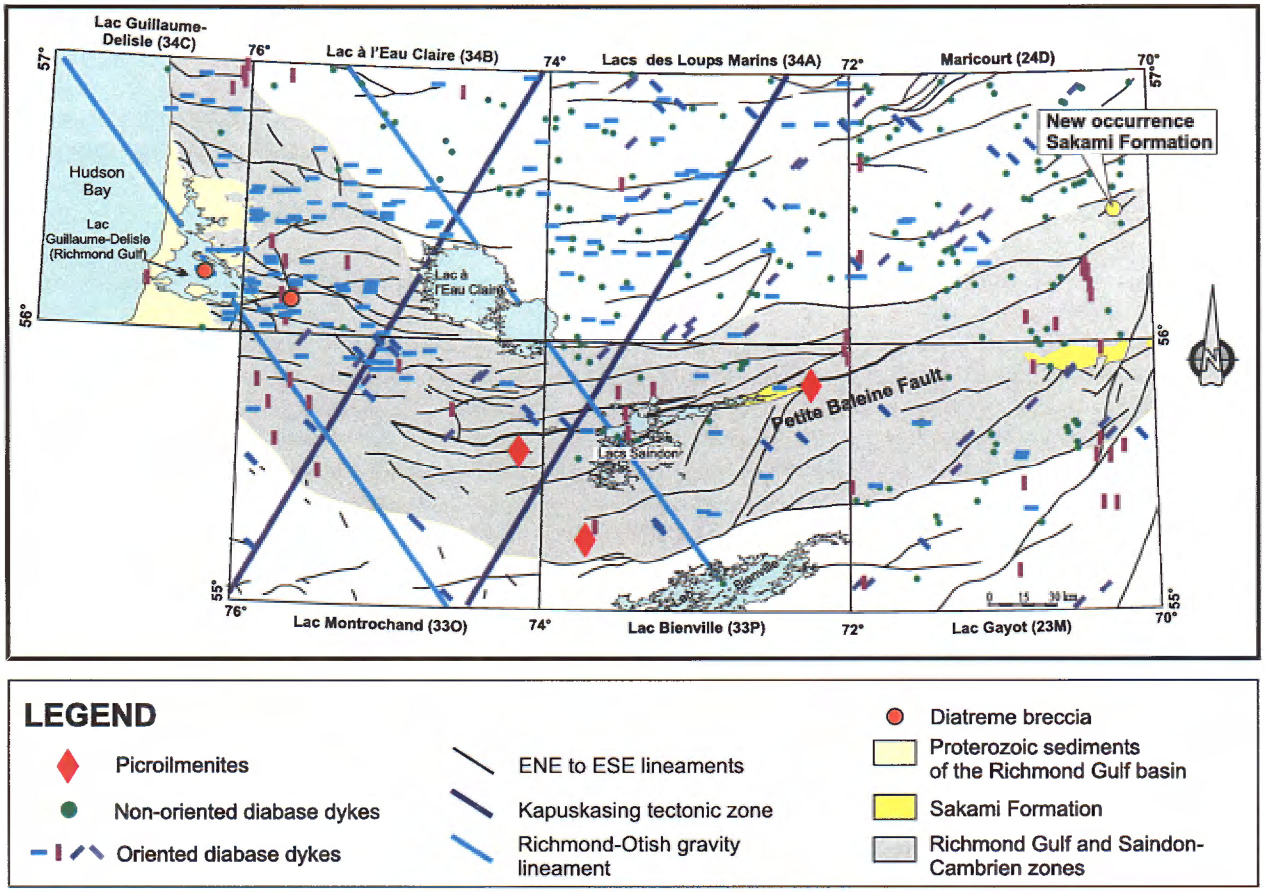


FIGURE 12 - Richmond Gulf Structural Zone and western part of the Saindon-Cambrien Zone. Location of lineaments, diabase dykes, diatreme breccias and Proterozoic sedimentary basins compiled from work by Gosselin and Simard (2001), Gosselin *et al.* (2002; 2004), Simard *et al.* (2002; 2004b) and the results of this survey. Location of kimberlite indicator minerals taken from Parent *et al.* (2004).

Geochemical surveys and glacial movements

In 1997, a lake sediment geochemistry survey conducted by the MRNF in conjunction with private industry partners, covered the entire study area. Figure 11 shows the location of discrete Ce-Ba-Cr multi-element anomalies (yellow dots). The latter mainly occur in the northern part of the area, within the Saindon-Cambrien and Richmond Gulf structural zones. In lake sediments, elevated contents in Ba, lithophile elements (Al, Mg, Na, K), siderophile elements (Fe, Ni, Cr) and light rare earth elements (Ce) may indicate the proximity of kimberlitic rocks (Beaumier *et al.*, 1993; Moorhead *et al.*, 1999). Lake sediment samples collected in the Lac de Gras area in the Northwest Territories show that combined Ba-Ce-Cr anomalies are clustered around kimberlite fields (Kjarsgaard *et al.*, 1992; Moorhead *et al.*, 2000).

Thirty-six samples of fluvioglacial sediments were collected from eskers in the Lac Montrochand area (33O) by Parent *et al.* (2002a) during the 2002 field season. Kimberlite indicator minerals were found in these samples (Figure 11, Parent *et al.*, 2004). One sample contained chrome-rich picroilmenite and another contained chrome diopside; both are located within the Saindon-Cambrien Zone, in the eastern part of the area (Figure 11). Furthermore, four other samples collected along the southern margin of the SCZ and the RGZ also contained chrome diopside (Figure 11, Parent *et al.*, 2004).

Parent *et al.* (2002a) were able to retrace the history of the main glacial movements in the Lac Montrochand area. The most recent regional glacial movement is west-directed. Important glacial dispersal trains such as those formed by impactite blocks from Lac à l'Eau Claire, are directed to the west and associated with this movement (Parent *et al.*, 2002b). The penultimate movement trends NW. Its impact on glacial transport from sources as small as kimberlite pipes is not known (Parent *et al.*, 2002b). The earliest movement recognized in the area trends NNE. These glacial movements are important elements to consider when searching for the source of kimberlite indicator minerals. The combination of all these factors listed above indicates that the Lac Montrochand area offers good potential for the discovery of kimberlitic rocks.

CONCLUSIONS

The results of our mapping survey were used to define the geological setting of the Lac Montrochand area (33O) at 1:250,000 scale and to describe in greater detail the stratigraphic, geochemical and structural framework of the area. The rocks in this area have long been considered as being part of the Bienville Subprovince. Our work suggests this subprovince should be considered as a plutonic domain of the Minto Subprovince. This interpretation is based on the presence of stratigraphic units of comparable ages and compositions to those in the Tikkerutuk and Utsalik domains, two plutonic domains assigned to the Minto Subprovince.

Units in the Lac Montrochand area are Archean in age, except for a few Proterozoic diabase dykes (Figure 2). These rocks are represented by two major lithodemic assemblages: a tonalite-granodiorite-granite assemblage composed of rocks of the Favard (2741 ±4 Ma), Coursolles (2719 ±2 Ma) and Desbergères (2714 ±12 Ma) suites, and an assemblage of granulitic rocks and pyroxene-bearing intrusions of the Loups Marins Complex (Alma1a: 2723 ±3 Ma; Alma1b: 2709 ±2 Ma; Alma1c: 2704 ±5 Ma). Mafic/ultramafic intrusions (Châteauguay Suite) are also present in the area as well as late units formed of granitic rocks (Tramont Suite: 2701 ±4 Ma) and mafic to ultramafic rocks (Qullinaaraaluk Suite).

The regional metamorphism is estimated at the middle amphibolite facies for units associated with tonalite-granodiorite-granite suites, but reaches the upper amphibolite and the granulite facies for rocks of the Loups Marins Complex. Retrograde metamorphism at the greenschist facies was locally observed along fault zones.

In the Lac Montrochand area, four phases of deformation were observed. Phase D1 represents a relic foliation preserved in enclaves hosted in the various units of the area. Phase D2 is responsible for the development of the NW-SE-trending regional foliation S2, which affects all Archean rocks in the area. Phase D2 is related to the emplacement of granitic material infiltrated in the two major regional lithological assemblages. This granitic material is infiltrated parallel to S2 foliation planes, which indicates that its injection was facilitated by the presence of this planar fabric. Phase D3 is associated with the development of regional NW-SE to E-W-trending deformation zones. Within these zones, the S2 foliation is reworked and becomes more intense. Phase D4 is responsible for the formation of a network of late brittle faults oriented ENE-WSW to WNW-ESE. This system appears to control the Saindon-Cambrien and Richmond Gulf subsidence structures.

Our work led to the identification of three mineral occurrences hosted in gabbros of the Châteauguay Suite (Achg). The three occurrences contain disseminated sulphides, mainly pyrite and chalcopyrite, with anomalous copper and nickel grades (no. 1: 0.12% Cu, 797 ppm Ni; no. 2: 0.11% Cu, 431 ppm Ni; no. 3: 625 ppm Cu).

Several important features for diamond exploration were identified in the Lac Montrochand area. The area is transected by the Saindon-Cambrien (SCZ) and Richmond Gulf (RGZ) structural zones. Ba, Ni, Cr and Ce anomalies were found in lake sediment samples collected within these structural zones. Furthermore, the presence of diabase dykes within the two zones suggests a favourable setting for the emplacement of late intrusions, Proterozoic or more recent in age. Finally, picroilmenite and chrome diopside (kimberlite indicator minerals) were recovered from fluvioglacial sediment samples collected in the area. The combination of all these factors supports the recommendation made by Moorhead *et al.* (2000) that the western end of the Saindon-Cambrien Zone should be considered as a priority target area for diamond exploration in Québec.

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TABLE 3a - Synoptic table of petrographic observations for each unit.

Unit	Enclaves					Favard		Coursolles				Châteauguay		Desbergères	
Sub-unit	[I2J]		[M16]	[I3A-I4]		Afav		Acou1			Acou2	Achg		Adeb1a	
Lithology*	I2J	I2Q	M16	I3A	I4	I1C	I1D	I2G	I2I	I2J	I1C	I3A	I3A, MX	I1C	I1M
Sample #	13	4	5	2	6	8	15	4	7	7	9	10	4	22	25
Quartz	<7	TR	18-67	TR	<3	45-60	40-65	10-20	5-20	<6	20-32	<2	<3	20-35	20-40
Plagioclase	40-75	45-75	<4	10-43	<10	8-15	<5	55-65	55-75	40-70	35-60	25-50	10-15	30-60	30-40
Microcline	(<7)				(<3)	17-36	20-41	5-15	(<2)		5-20			7-25	20-40
Biotite	7-17	8-15	(<7)	10-15	<25	3-8	3-15	5-8	5-17	8-20	2-10	4-15	3-6	<15	<9
Hornblende	(<50)	2-35	32-75	30-55	10-80	(<3)	(<8)	2-15	3-23	10-30	<11	5-35	1-80	(2-5)	(<5)
Clinopyroxene	(<15)	5-10	(<10)	10-30	(20-75)			(TR)	(<3)	(2-4)		20-35	3-80		
Orthopyroxene		<7		1-3	(<10)							3-20	15-20		
Olivine					(3-5)								(15-20)		
Sericite	(X+)	X	X++	(x)	(x+)	X+	X+	X	X	X	X	X	X	X+	X+
Chlorite	(<3)	X	(<8)		(X++)	<4	<5	(TR)	(TR)	(TR)	(<10)	(TR)	(TR)	<8	<5
Carbonates	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)			X	X	X	(X)	(X)
Hematite					(X)										(X)
Muscovite	(TR)		(TR)		(TR)	(TR)	TR	(TR)	(TR)	(TR)	(TR)			TR	TR-3
Epidote	(<6)		(TR)	(TR)	(TR)	<2	<5	(<2)	(TR)	(<2)	<4	(TR)		<2	<2
Allanite						(TR)	(TR)	(TR)	(TR)		(TR)			TR	(TR)
Titanite	(<2)	(TR)	(TR)		(TR)	(TR)	(TR)	TR	(<2)	(<2)	(<2)			(TR)	TR
Apatite	<3	TR	TR	TR	TR	TR	TR	TR	TR	TR	(<2)	TR	TR	TR	TR
Zircon	TR	TR	(TR)			TR	TR-1	TR	TR	(TR)	TR(4-10)			TR	TR
Opaques	<8	1-6	<4	TR	TR	<3	<4	2-4	<4	<6	<4	<7	<6	<4	<2
Deformation	2-4	2-4	1-2	2-3	1-2	2	2-3	2	2	2	1-2	2	2	1-2	1-2
Structures	GS	GS	FO	RU	FO	FO	FO	FO	FO(RU)	FO(RU)	FO(RU)	FO	FO	FO	FO
Textures	GF, HK GR	GF, HK GR	GF-GM GR	GF GR	GF-GM PQ (GR)	GM-GG (PO)	GM	GF-GM (PO)	GM (GR, PO)	GF (HG)	GM-GG (PO)	GF-GM GR	GF-HG GR (PQ)	GM-GG (HK, PO)	GM (PO, HK)

Dark blue = main constituents of the rock, red = alteration minerals, blue = accessory minerals, green = textures and structures.
Mineral abundance: TR = mineral in trace amounts, X = mineral is present, X+ = mineral is abundant, X++ = mineral is very abundant, (in parentheses) = mineral is observed sporadically.
Intensity of deformation: 1 = undeformed, 2 = weak, 3 = moderate, 4 = high.
Structures/textures: FO = foliated, GF = fine-grained, GG = coarse-grained, GM = medium-grained, GR = granoblastic, GS = gneissic, HG = heterogranular, HJ = homogeneous texture, HK = heterogeneous texture, MA = massive structure, PO = porphyritic, PQ = porphyroblastic, RU = banded, OP = ophitic.
*Refer to Sharma (1996) for the meaning of lithological codes.

TABLE 3b - Synoptic table of petrographic observations for each unit.

Unit	Desbergères					Loups Marins									
Sub-unit	Adeb1b		Adeb1c			Alma1a				Alma1b		Alma1c			
Lithology*	I1C	I1M	I1C	I1M	I2E-I2G	I1C	I1D	I2G-I2F	I2I-I2J	I1C	I1M	I1C	I1M	I2E-I2F	I2G-I2H
Sample #	12	32	10	17	13	26	40	9	28	12	22	7	12	16	11
Quartz	20-40	18-35	18-35	20-35	5-18	19-37	18-38	10-18	1-20	22-39	17-35	20-47	20-39	<16	<20
Plagioclase	29-53	22-45	35-60	25-40	27-55	40-55	42-70	40-55	50-75	40-55	25-40	35-50	20-35	25-50	48-73
Microcline	15-25	20-45	10-24	25-45	13-45	4-27	(<6)	8-30	(<4)	15-25	25-48	14-25	25-50	20-55	5-25
Biotite	1-7	3-8	2-12	3-9	1-11	3-13	1-16	6-15	3-20	4-8	2-8	4-7	1-9	2-8	4-10
Hornblende			(2-8)	(TR-5)	(1-10)	(<6)	(<13)	<8	<12	(<4)	(<4)	<6	(<6)	<12	<15
Clinopyroxene						(<3)	(<4)	(1-5)	3-10	(<2)	(<4)	<7	(<3)	<10	(<7)
Orthopyroxene															
Olivine															
Sericite	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+	X+
Chlorite	<8	<5	<3	<6	<7	<5	(<6)	(<3)	(<7)	<4	<6	<5	<6	<4	(<7)
Carbonates	(X)	(X)		(X)		(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Hematite				(X)							(X)		(X)		
Muscovite	TR	<2	(TR)	TR	(TR)	(<2)	(TR)	(TR)	(TR)	TR	<2	(TR)	(TR)	(TR)	TR
Épidote	<3	<3	(<3)	(TR)	<2	(TR)	(<2)	(TR)	(<2)	(<2)	(<4)	(<2)	(TR)	(<2)	(<2)
Allanite	(TR)	(TR)	(TR)	(TR)	(TR)	(TR)	(TR)			(TR)	(TR)		(X)	(X)	(X)
Titanite	(TR)	(TR)	<3	<2	<3	(TR)	(TR)	(<2)	(TR)		(TR)	(<2)	(<2)	(<2)	TR
Apatite	TR	TR	TR-1	TR	TR	TR	TR	TR	<2	TR	TR	TR	TR	TR	TR
Zircon	TR	TR	TR-1	TR	TR	TR	<2	TR	TR	TR	TR	TR	TR	TR	TR
Opaques	<3	TR	<3	<3	<3	<3	<4	<5	1-7	<2	<4	<4	<3	<4	1-4
Deformation	1-2	1-2	1-2	1-2	1-2	1-3	1-3	1-2	1-3	1-2	1-2	1-3	1-2	1-3	2-3
Structures	FO	FO	FO	FO	FO	FO	FO	FO	FO	FO	FO	FO	FO	FO	FO
Textures	GM-GG HJ	GM-GG HJ	GM, PO	GM-GG PO	GM-GG PO	GM (PO)	GM-GG (PO)	GM (PO)	GM-GG (PO)	GM (PO)	GM (PO)	GM, PO	GM-GG PO	GM, PO	GM, PO

Dark blue = main constituents of the rock, red = alteration minerals, blue = accessory minerals, green = textures and structures.
Mineral abundance: TR = mineral in trace amounts, X = mineral is present, X+ = mineral is abundant, X++ = mineral is very abundant, (in parentheses) = mineral is observed sporadically.
Intensity of deformation: 1 = undeformed, 2 = weak, 3 = moderate, 4 = high.
Structures/textures: FO = foliated, GF = fine-grained, GG = coarse-grained, GM = medium-grained, GR = granoblastic, GS = gneissic, HG = heterogranular, HJ = homogeneous texture, HK = heterogeneous texture, MA = massive structure, PO = porphyritic, PQ = porphyroblastic, RU = banded, OP = ophitic.
*Refer to Sharma (1996) for the meaning of lithological codes.

TABLE 3c - Synoptic table of petrographic observations for each unit.

Unit	Loups Marins				Tramont		Qullinaaraaluk		Dykes de diabase		
Sub-unit	Alma2				Atra		Aluk		ENE-WNW	NE-NNE	N-NNW
Lithology*	I1S	I1T	I2P	I2Q	I1L	I1M	I3A	I4	I3B	I3B, PO	I3B
Sample #	9	5	5	11	5	18	1	2	11	3	4
Quartz	20-32	18-43	<18	<12	20-40	20-40	8-11	<2	<2	<2	<2
Plagioclase	40-60	47-70	45-75	45-75	15-25	20-40	29-34	<11	48-70	60-70	50-65
Microcline	12-30	<4	<25	(<6)	45-56	25-40					
Biotite	1-8	3-7	1-12	4-14	<4	<5	<6	7-8	<5	<5	(<4)
Hornblende		<1	<1	<15			38-43	45-70	X	X	(X)
Clinopyroxene	<4	<3	<18	4-14			<6	3-30	10-30	15-30	<35
Orthopyroxene	<6	<6	<13	<5			TR	<25		(X)	
Olivine								X			<9
Sericite	X+	X+	(X+)	(X)	X+	X+	X+		X+	X+	X+
Chlorite	(<3)	(TR)	(TR)	(TR)	1-5	<5	(TR)		<10	3-8	X+
Carbonates	(X)	(X)	(X)	(X)		(X)	X	X	(X)	(X)	(X)
Hematite					(X)	X				(X)	
Muscovite	(TR)	(TR)	(TR)	(TR)	TR	<3	TR		(<2)	(<3)	(TR)
Epidote	(TR)				(<2)	(TR)	TR	(TR)	(<8)	(<3)	(X)
Allanite					(TR)	(<2)	TR				
Titanite			(TR)		(TR)	(<2)			(TR)		
Apatite	TR	TR	<3	<2	TR	TR	<3	(TR)	TR	TR	TR
Zircon	TR	TR	TR	TR	TR	TR			(TR)		
Opaques	<3	<2	1-5	1-8	<2	<2	TR	<6	<7	3-7	<5
Deformation	1-3	2	2	1-2	1	1-2	1	1	1	1	1
Structures	FO	FO	FO	FO	MA	FO	MA	MA	MA	MA	MA
Textures	GM-GG (PO)	GM-GG	GM	GM	GM-GG PO	GM-GG	GM	HG	OP, GF (PO)	OP, GF (PO)	OP, GF

Dark blue = main constituents of the rock, red = alteration minerals, blue = accessory minerals, green = textures and structures.
Mineral abundance: TR = mineral in trace amounts, X = mineral is present, X+ = mineral is abundant, X++ = mineral is very abundant, (in parentheses) = mineral is observed sporadically.
Intensity of deformation: 1 = undeformed, 2 = weak, 3 = moderate, 4 = high.
Structures/textures: FO = foliated, GF = fine-grained, GG = coarse-grained, GM = medium-grained, GR = granoblastic, GS = gneissic, HG = heterogranular, HJ = homogeneous texture, HK = heterogeneous texture, MA = massive structure, PO = porphyritic, PQ = porphyroblastic, RU = banded, OP = ophitic.
*Refer to Sharma (1996) for the meaning of lithological codes.,

TABLE 4 - Geochronology data for the Lac Montrochand area (NTS 33O).

Site (see Figure 2)	Unit	Lithology	Age	Interpretation
1	Desbergères (Adeb1a) with **Favard (Afav)** enclaves	Porphyritic monzogranite with **tonalitic** enclaves	2732 ±4 Ma 2.75-2.83 Ga	Crystallization Inherited
2	**Loups Marins (Alma1c)** infiltrated into Loups Marins (Alma2)	**Clinopyroxene-bearing monzonite** infiltrated in enderbite	2704 ±5 Ma 2710 ±2 Ma	Crystallization Crystallization
3	**Loups Marins (Alma1c)**	**Clinopyroxene-bearing syenite**	2704 ±5 Ma	Crystallization
4	**Tramont (Atra)** **Loups Marins (Alma1a)**	**Late granite** injected in **clinopyroxene-bearing heterogeneous tonalite**	2698 ±8 Ma 2723 ±3 Ma ±2742 Ma	Late granite Clinopyroxene tonalite Inherited
5	**Loups Marins (Alma2)**	**Enderbite** (clinopyroxene and orthopyroxene-bearing tonalite)	2733 ±3 Ma	Crystallization

Ages were obtained by U-Pb zircon analysis by in situ laser ablation, using a high resolution inductively coupled plasma mass spectrometer (ICP-HR-MS). Analyses were conducted in the GEOTOP laboratories at the Université du Québec à Montréal (UQAM) by Jean David (MRNF).

APPENDIX 3 – Photographs

PHOTO 1 - Amphibolite (AM) enclaves, enclosed in a tonalite of the Favard Suite (Afav), are stretched and aligned parallel to the regional foliation (S2). The enclaves exhibit an internal foliation (S1).

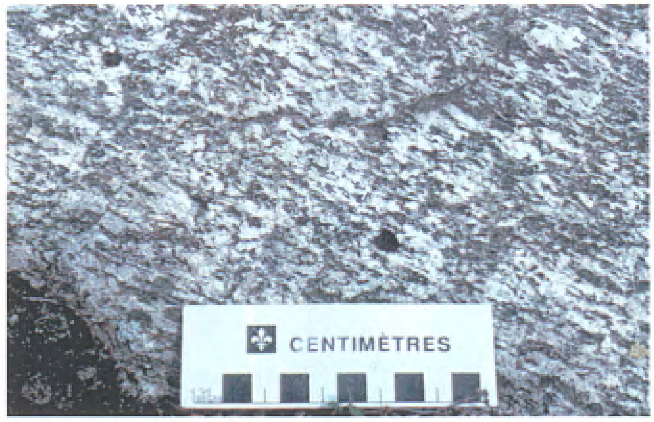

PHOTO 2 - Diorite of the Coursolles Suite (Acoul) showing a well-developed foliation within a NW-SE-trending deformation zone (D3).

PHOTO 3 - Heterogeneity of unit Adeb1a of the Desbergères Suite (Adeb). The monzogranitic material (Adeb1a) is infiltrated in a heterogeneous granodiorite of the Favard Suite (Afav), preserved as enclaves. The infiltrated material is distributed parallel to the regional foliation (S2).

PHOTO 4 - Granitic dykes of the Tramont Suite (Atra) injected in a quartz diorite of the Coursolles Suite (Acoul). Contacts between the two units are sharp and well-defined.

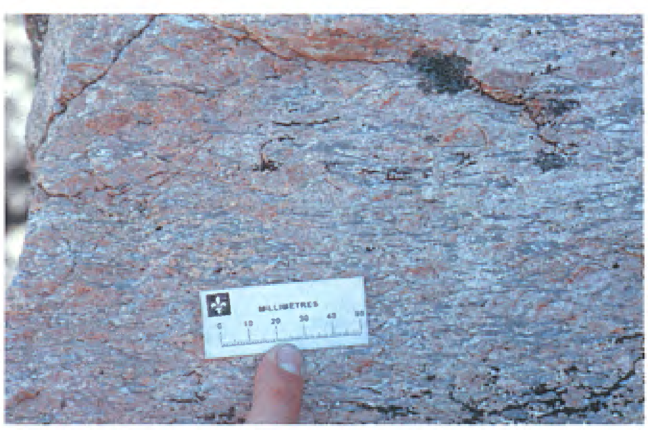

PHOTO 5 - Mylonitic granite of the Tramont Suite (Atra) occurring in a NW-trending deformation zone (D3). This structure is characterized by long quartz ribbons.

PHOTO 6 - Clinopyroxenite of the Qullinaaraaluk Suite (Aluk). The rock is locally brecciated and injected with granite.

ABSTRACT

This report presents the results of a geological survey carried out in the summer 2002 at 1:250,000 scale. It covers the Lac Montrochand area (NTS 33O), located about 200 km northeast of the village of Radisson.

Lithological assemblages in the area are Archean in age, with the exception of a few Proterozoic diabase dykes. The various lithologies were grouped into two major assemblages: tonalite-granodiorite-granite suites and the Loups Marins Complex. Tonalite-granodiorite-granite suites comprise three lithodemic suites: the Favard Suite, composed of tonalite and granodiorite, the Coursolles Suite, composed of hornblende granodiorite and tonalite as well as diorite, and the Desbergères Suite, formed of equigranular or porphyritic monzogranite and granodiorite. Tonalites and diorites of the Favard and Coursolles suites are affected by a granitic infiltration phenomenon associated with the emplacement of monzogranites and granodiorites of the Desbergères Suite. The tonalitic and dioritic suites were also intruded by gabbros of the Châteauguay Suite. The Loups Marins Complex is composed of an orthopyroxene unit, which consists of hypersthene quartz diorite and enderbite, and a clinopyroxene unit. The latter is subdivided into sub-units equivalent to tonalite-granodiorite-granite suites, but which formed and were metamorphosed at higher pressure and temperature conditions. Late units in the area include mafic/ultramafic intrusions of the Qullinaaraaluk Suite and granites of the Tramont Suite.

The tonalite-granodiorite-granite suites underwent metamorphism at the middle amphibolite facies, whereas in the Loups Marins Complex, metamorphic conditions range from the upper amphibolite facies to the granulite facies. Retrograde metamorphism at the greenschist facies was locally observed along fault zones.

The Lac Montrochand area was affected by four phases of deformation. Phase D1 corresponds to a relic foliation preserved in enclaves enclosed in the various units. Phase D2 is responsible for the NW-SE orientation of the regional structural pattern and the development of the regional S2 foliation. This foliation was enhanced during phase D3 and dragged along major ductile faults that delineate large NW-SE to E-W-trending structural zones. Phase D4 generated a system of late brittle faults oriented ENE-WSW to WNW-ESE. This system appears to be associated with the Saindon-Cambrien and Richmond Gulf structural zones.

Three occurrences with anomalous copper and nickel grades were discovered during our mapping survey. These mineralized zones are hosted in gabbros of the Châteauguay Suite. Furthermore, the Lac Montrochand area (NTS 33O) is a promising target area for diamond exploration. It lies at the intersection of four important structural features: the Saindon-Cambrien (SCZ) and Richmond Gulf (RGZ) structural zones, the projection of the Kapuskasing tectonic zone and a major gravity lineament. The recent discovery of picroilmenite and chrome diopside in fluvioglacial sediment samples collected within the SCZ and the RGZ emphasizes the diamond potential of the area.

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