RG 2004-06

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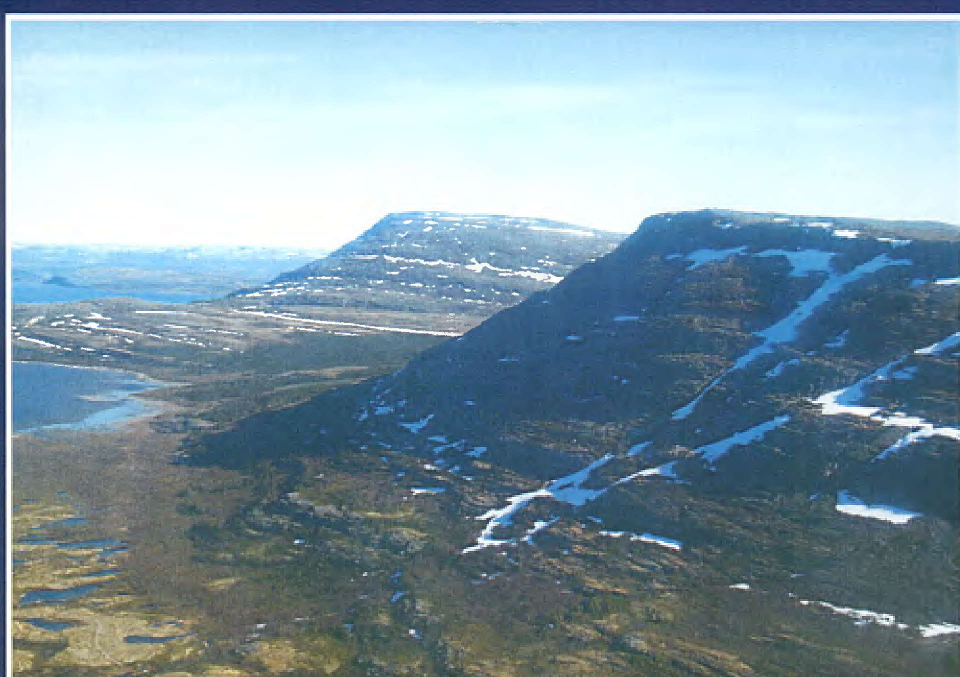

Cuestas formed by Proterozoic sequences along the shore of Lac Guillaume-Delisle.

2005

Québec

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Alain Leclair

Translation
Michelle Mainville

Editing
Jean-Pierre Lalonde

Drawing
Martin Simard
Martin Parent
Robert Thériault
Pascale Martel
Charlotte Grenier

Technical supervision
Charlotte Grenier
Nelson Leblond

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ABSTRACT

This report presents the results of a geological survey carried out at the 1:250,000 scale during the summer of 2002 in the Lac à l'Eau Claire area (NTS 34B and 34C). This area is located in Québec's Far North near the village of Umiujaq. The rocks are mainly Archean in age, with some exceptions: 1) a few Proterozoic diabase dykes, 2) a sequence of Proterozoic volcano-sedimentary rocks, the Richmond Gulf and Nastapoka groups, which unconformably overlies Archean rocks in the western part of the area, and 3) rocks produced by a meteorite impact during the Pennsylvanian,which make-up several islands in Lac à l'Eau Claire. Most Archean units consist of intrusive rocks, primarily composed of tonalite, granite and granodiorite, clinopyroxene and orthopyroxene-bearing felsic rocks, as well as mafic and ultramafic rocks. These intrusive rocks locally contain volcano-sedimentary bands of limited extent assigned to the Melvin Complex. Tonalites belong to two units: the Favard Suite, composed of biotite leucotonalite, and the Coursolles Suite, composed of biotite-hornblende diorite and tonalite. Granites and granodiorites are represented by the Desbergères Suite, which includes a unit of biotite-hornblende granodiorite and a unit of biotite granite-granodiorite. The Loups Marins Complex is composed of clinopyroxene-bearing tonalite and granodiorite, as well as orthopyroxene-bearing rocks, mainly enderbite. Small intrusions of massive gabbro, gabbronorite and ultramafic rocks assigned to the Qullinaaraaluk Suite are scattered throughout the area. Finally, a nepheline syenite intrusion, the Bourdel Syenite, constitutes the youngest Archean unit in the area (2675±1 Ma).

Based on a structural study of the area, five phases of ductile and brittle deformation (D1 to D5) were recognized. Phase D1 was only observed in enclaves and bands of supracrustal rocks. Phase D2 is responsible for the S2 fabric, the most penetrative, associated with the regional WNW-ESE to NW-SE structural trend. Phase D3, only weakly developed, is represented by a few local NE-SW folds. Phase D4 produced ductile E-W to ESE-WNW-trending shear zones, most of which are concentrated along the Nastapoca Deformation Zone. Finally, phase D5 is responsible for the development of a network of brittle E-W faults related to the formation of the Richmond Gulf Graben.

Most previous prospecting and mineral exploration work was carried out in the Proterozoic sequences near Lac Guillaume-Delisle. These rocks host Mississippi-Valley-type Pb-Zn-Ag showings in stromatolitic limestones of the Nastapoka Group, as well as Cu-Ag showings associated with volcanic rocks of the Richmond Gulf Group. The latter exhibit features typical of redbed copper deposits. Mafic to ultramafic intrusions of the Qullinaaraaluk Suite offer an interesting potential for Ni-Cu-PGE deposits. Two new showings are located in the Lac à l'Eau Claire area: the *Flipper* showing (1.0% Cu, 1.3% Ni, 200 ppb PGE and 149 ppb Au) and the *Ni Dance* showing (1.0% Cu, 2.5 g/t PGE and 295 ppb Au). Finally, the Richmond Gulf Structural Zone is a graben setting in which Proterozoic rocks of the Lac Guillaume-Delisle area were deposited. This zone of structural weakness consists of extension faults which may have served to channel uprising magma derived from greater depths and thus constitutes a favorable context for diamond exploration.

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INTRODUCTION

A field mapping survey was conducted during the summer of 2002 within the scope of the Far North Project, launched in 1997 by the Ministère des Ressources naturelles du Québec (MRN). The purpose of this project is to update the regional geological context at the 1:250,000 scale, to acquire new geoscience data in the area and to promote mineral exploration in a vast yet little-known territory located north of the 55th parallel. This new geological survey, conducted in the Lac à l'Eau Claire area, covers NTS sheets 34B and 34C (Figure 1). This survey follows in the wake of previous surveys conducted to the east in the Lacs des Loups Marins area (NTS 34A; Gosselin *et al.*, 2002) and to the southeast in the Lac Bienville area (NTS 33P; Gosselin *et al.*, 2004). It also occurs along the extension of structural and

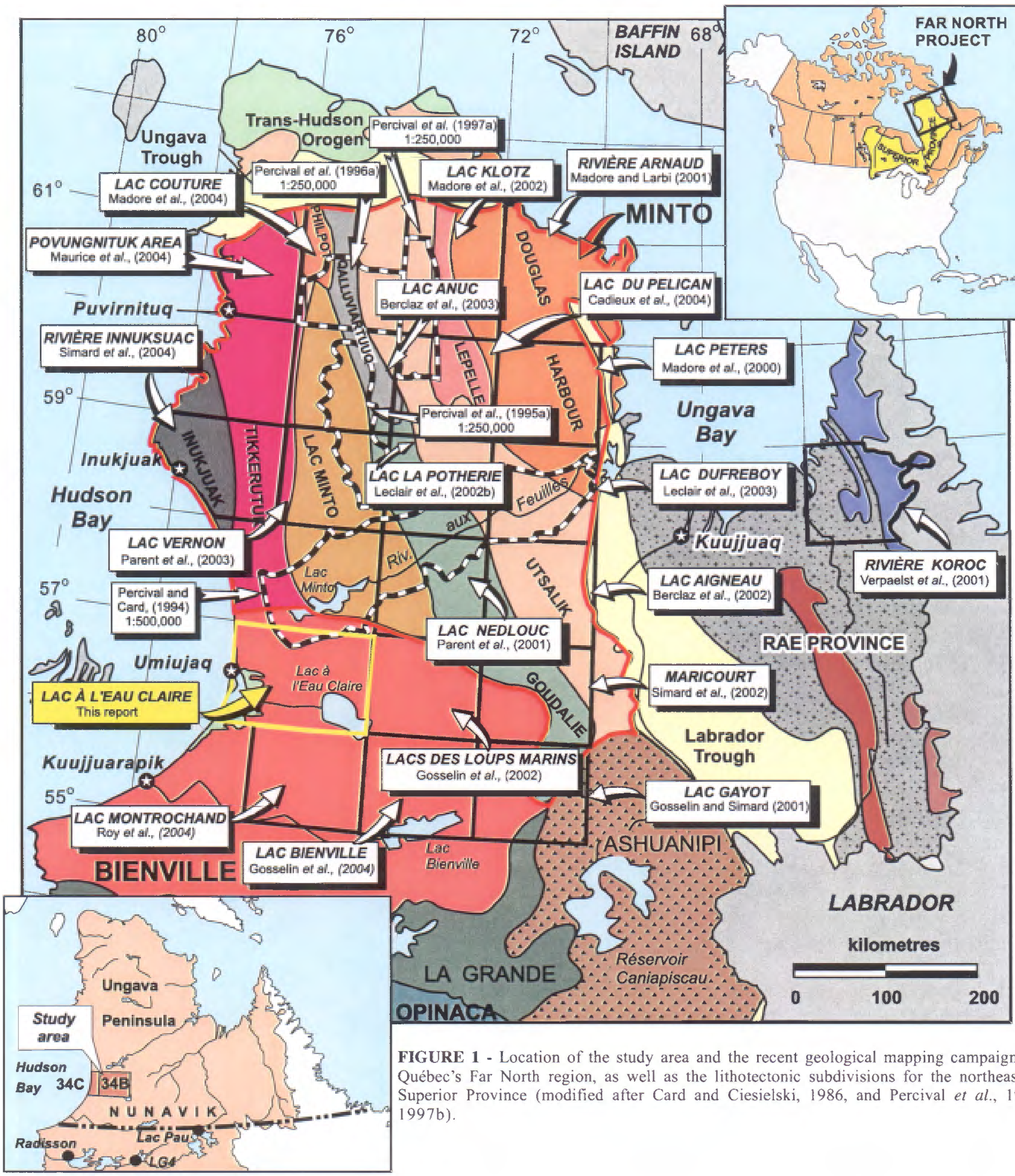


FIGURE 1 - Location of the study area and the recent geological mapping campaigns in Québec's Far North region, as well as the lithotectonic subdivisions for the northeastern Superior Province (modified after Card and Ciesielski, 1986, and Percival *et al.*, 1992, 1997b).

aeromagnetic units of the Rivière Innuksuac area (NTS 34K and 34L; Simard *et al.*, 2004) located further north (Figure 1). The results of the mapping survey were used to establish the lithostratigraphic, structural and metal-logenic settings. They also bring to light new elements that help define the western part of Québec's Far North, which forms part of the Bienville Subprovince and the Tikkerutuk domain in the Minto Subprovince (Figure 1; Card and Ciesielski, 1986; Percival *et al.*, 1991, 1992).

Location and Access

The Lac à l'Eau Claire area is located near the coast of Hudson Bay, in southwestern Nunavik (Figure 1). It corresponds to NTS sheets 34B and 34C, bounded by latitudes 56°00' and 57°00' North and longitudes 74°00' and 76°45' West. It covers a surface area of roughly 17,000 km^2. The centre of the area is located about 80 km east of the village of Umiujaq, which sits along the coast of Hudson Bay (Figure 1). Several lakes located throughout the area are accessible by floatplane from air bases located near LG-4 and near Réservoir Caniapiscau (Lac Pau), respectively located some 250 km to the south and 300 km to the southeast. Most lakes in the area are free of ice from mid-June. There are also a few landing strips for short-airlift aircraft (Twin Otter-type) in a few locations within the study area, as well as an airport in Umiujaq.

Park and State Reserve

Nearly half of the surface area covered by this survey lies either within the Guillaume-Delisle and à l'Eau Claire lakes national park project or on lands reserved by the State (see Figure 8, section entitled "Economic Geology"). The park project covers Lac à l'Eau Claire and Lac Guillaume-Delisle, as well as all the land between the two lakes. This area is withdrawn from staking, from map designation, and from mineral exploration and mining. However, the lands reserved by the State cover a considerable area to the south of the Guillaume-Delisle and à l'Eau Claire lakes park project (Figure 8). These lands remain open to mineral exploration under certain conditions.

Methodology

Fieldwork was conducted by a team of seven geologists and took place over a period of 11 weeks, from early June to late August 2002. Mapping crews, each composed of one geologist and one assistant, were brought to the field by helicopter from the base camp located along Rivière Nastapoka, in the northwestern part of the area. Traverses ranging from 8 to 12 km in length were spaced every 4 to 10 km, depending on the complexity of the geology and the outcrop density. On average, a dozen traverses were completed per 1:50,000 scale NTS sheet. Isolated helicopter spot checks were carried out to complete the mapping coverage. Several samples representative of the various lithological units and mineralized zones were collected for geochemical analysis, for magnetic susceptibility readings and to make thin sections. Six samples were collected for geochronological déterminations. The latter were processed by Jean David (Géologie Québec) at the GEOTOP research centre of the Université du Québec à Montréal. Geological maps as well as related field data and geochemistry results were integrated into the geomining information system (SIGÉOM) of the Ministère des Ressources naturelles, de la Faune et des Parcs du Québec.

The Lac à l'Eau Claire mapping survey was carried out by the Ministère des Ressources naturelles du Québec (MRN). This department was renamed Ministère des Ressources naturelles, de la Faune et des Parcs (MRNFP) in April 2003. To avoid any possible confusion, these two departments will be referred to as the "Department" throughout this report.

Previous Work

The earliest recorded geological surveys in the Lac à l'Eau Claire area were conducted by Low (1902) and Leith (1910) in Proterozoic sequences of the Richmond Gulf Graben, located in the Lac Guillaume-Delisle area near Hudson Bay. Proterozoic units in this area were later studied from 1977 to 1981 by Chandler (1988), who mapped them at the 1:100,000 scale. Krank and Sinclair (1963) and Bostock (1969) mapped outcrops on islands in Lac à l'Eau Claire (western part) and described them as volcanic sequences. Dence (1964) however reported the presence of maskelynite (plagioclase vitrified by shock metamorphism) and of shatter cones on these islands, thereby relating these rocks to a meteorite impact. These rocks subsequently became the focus of various studies between 1965 and 1981 (Dence *et al.*, 1965; Simonds *et al.*, 1978; Phinney *et al.*, 1978; Reimold *et al.*, 1981). Finally, Rondot *et al.* (1993) mapped in detail Pennsylvanian-age impact sequences exposed on islands in Lac à l'Eau Claire.

A reconnaissance geological survey at 1:1,000,000 scale (Stevenson, 1968) as well as regional aeromagnetic (Dion and Lefebvre, 2000) and gravity (GSC, 1994) surveys cover the entire study area. These various surveys provide basic geoscience coverage for the entire northeastern Superior Province. During the 1990s, the Geological Survey of Canada performed a geological survey at the 1:500,000 scale along the Rivière aux Feuilles (Percival and Card, 1994) and three geological surveys at the 1:250,000 scale in three areas located further north (Percival *et al.*, 1995a, 1996a, 1997a; Figure 1). This work led to the subdivision of the Minto Subprovince into a series of domains. The Geological Survey of Canada also performed work in the Kuujjuarapik area, the Lac à l'Eau Claire area and the Lac Bienville area (Ciesielski, 2000), in order to describe the geology and lithogeochemistry of the eastern Bienville Subprovince. In 1997, the Far North Project undertaken by Géologie

Québec began with an extensive lake sediment geochemistry survey (MRN, 1998) and continued with 19 new geological surveys at the 1:250,000 scale, conducted since 1998 to cover the entire northeastern Superior Province (Figure 1).

Most of the prospecting and mineral exploration work carried out in the study area was focused on the Proterozoic sequences exposed in the western part of the area. The first Pb-Zn deposits hosted in carbonate rocks were discovered in the mid-18th century. Gulf Lead Mines conducted extensive work in the area from 1946 to 1949 and delineated three deposits totalling 900,000 t (Robinson, 1950). These Pb-Zn deposits were described in two Master's theses by Harwood (1949) and Parks (1949). One of these deposits, the Monte Lake deposit, is located within the study area. Later on, the three deposits were the object of exploration campaigns by Mokta (Velaine, 1965) and Penarroya (Darcy, 1968). From 1977 to 1979, Uranerz (Madon, 1980) conducted a series of airborne and ground exploration campaigns in the search for uranium deposits. Finally, the Department conducted, during the summer of 2002, a study of Cu-Ag occurrences associated with Proterozoic volcanic rocks in the Lac Guillaume-Delisle area (Labbé and Lacoste, 2004).

Acknowledgements

We wish to thank all the members of our mapping crew for their efficient work and their enthusiasm throughout the field season. The team included, in addition to authors Martin Simard, Martin Parent and Robert Thériault, geologists Dominique Meilleur, Julie Vallières, Gabrielle Rioux and Carl Bilodeau, and geological assistants Gaëlle Carrier, Marie-Hélène Grenon, Marie-Catherine Poulin-Talbot, Louis Grenier, François Rochefort, Tommy Leblanc and Jean Poisson. Aurel Noël acted as camp manager. Our chef, André Monette, made an important contribution to our team spirit thanks to his excellent cuisine. The authors benefited from discussions in the field with Jean-Yves Labbé, Alain Leclair and Pierre Verpaelst, all from the Department. James Moorhead from the Department supplied important information on the diamond potential of the area. Pilots Michel Frigon, Yvon Gingras and Réjean Dulong, and mechanics Jean-Paul Laurendeau, Philippe Dessureault and Richard Bergeron of Takatakiaq Helicopter Inc. provided safe and efficient transportation. We wish to thank Jean-Denis Fournier and André Laferrière of Falconbridge as well as Noah Inukpuk for their logistical support from the village of Umiujaq. Digital geological maps were produced thanks to the indispensable technical assistance of Pascale Martel, Hélène Gagné and Nelson Leblond. Marc Beaumier prepared exclusive lake sediment geochemistry maps to orient our fieldwork. Aeromagnetic maps were produced by Denis-Jacques Dion. The *Service des applications géospatiales* of the Department supplied regional spatiomaps derived from Landsat images. Finally, we wish to thank Alain Leclair who completed a critical review of the first draft of this report.

REGIONAL GEOLOGY

The northeastern Superior Province consists of a variety of Archean plutonic rocks which often host relics of deformed and metamorphosed supracrustal rocks. Plutonic rocks largely consist of intrusions of the TTG suite (tonalite-trondhjemite-granodiorite), which were emplaced at different times (2883-2690 Ma). These rocks generally correspond to weakly magnetic units. They enclose dismembered bands of volcano-sedimentary rocks, spaced several tens of kilometres apart, that record a series of successive volcanic episodes (3.8-2.7 Ga). Mineral assemblages observed in these different rock types show the latter underwent metamorphism ranging from the amphibolite facies to the granulite facies. TTG are intruded by large bodies of granite and granodiorite (2.73-2.70 Ga) related to an important potassic magmatic event generated by an episode of intracrustal melting. In conjunction with this potassic magmatism comes the emplacement of orthopyroxene-bearing intrusions derived from low-K magmas which mainly produced enderbitic rocks. These orthopyroxene-bearing rocks generally coincide with vast positive aeromagnetic anomalies. The northeastern Superior Province is characterized by a regional structural pattern trending NNW-SSE, marked by sharp aeromagnetic anomalies (Card and Ciesielski, 1986; Percival *et al.*, 1992). In many locations, the Archean craton in the northeastern Superior Province is bounded by Proterozoic sequences. These Proterozoic rocks belong to the Labrador Trough to the east, to the Ungava Trough to the north, and to the Hopewell, Nastapoka and Richmond Gulf groups to the west, along the coast of Hudson Bay. Proterozoic sequences are in faulted contact or overlie the Archean basement along an angular unconformity.

Lithotectonic Subdivisions

The northeastern Superior Province was subdivided into various lithotectonic domains by Card and Ciesielski (1986) and Percival *et al.* (1992, 1997b) based on aeromagnetic, lithological and structural criteria (Figure 1). Work by Percival *et al.* (1990, 1991) along the Rivière aux Feuilles led to the definition of the Inukjuak, Tikkerutuk, Lac Minto, Goudalie, Utsalik and Douglas Harbour domains within the Minto Subprovince. Based on subsequent work further north (Percival *et al.*, 1995b, 1996b, 1997b), the Philpot, Qalluviatuuq and Lepelle domains were later defined. The boundaries of all these domains were eventually extrapolated to cover the entire subprovince based on the extension of various aeromagnetic anomalies. These domains may extend over several hundred kilometres parallel to the main NW-SE structural trend. Further south, Ciesielski (1998, 2000) suggested the boundary between the Bienville and Minto subprovinces previously established by Card and Ciesielski (1986) be moved further south, primarily based on magnetic contrasts.

Recent work performed by the Department however raised many issues concerning the boundaries and relationships between these major lithotectonic assemblages. These contacts remain uncertain mainly due to the lack of observable structural boundaries in the field and the presence of numerous intrusive suites that cross domain boundaries. According to the lithotectonic subdivisions defined by Card and Ciesielski (1986) and Percival *et al.* (1992, 1997b), the Lac à l'Eau Claire area (NTS 34B-34C) should be located in the Bienville Subprovince, due south of the Tikkerutuk domain (Figure 1). Data collected further north in the Rivière Innuksuac area (Simard *et al.*, 2004) and the Lac Vernon area (Parent *et al.*, 2003), and further east in the Lacs des Loups Marins area (Gosselin *et al.*, 2002), suggest however that the Tikkerutuk domain may extend towards the southeast into the Lacs des Loups Marins area. Furthermore, the boundary between the Bienville and Minto subprovinces was not recognized in the field during these surveys. The hypothesis of a continuity between the Tikkerutuk domain and the Bienville Subprovince, proposed by Hocq (1994), was then considered (Simard *et al.*, 2004). However, the results of our mapping, conducted during the summer of 2002, demonstrate the existence of lithological differences between the northern and southern parts of the Lac à l'Eau Claire area (NTS 34B-34C). The northern part is characterized by a considerable amount of tonalitic units, whereas the southern part is dominated by more potassic units represented by granodiorites and granites. The boundary between the two corresponds to a major regional deformation zone, the Nastapoca Deformation Zone, which transects the entire Lac à L'Eau Claire area along a NW-SE to E-W axis. This deformation zone roughly corresponds to the boundary proposed by Ciesielski (1998) between the northwestern Bienville Subprovince and the southwestern Minto Subprovince.

LITHOSTRATIGRAPHY

The Lac à l'Eau Claire area (NTS 34B-34C) is mainly composed of Archean intrusive and volcano-sedimentary units cut by thin Proterozoic diabase dykes. It also contains Proterozoic sedimentary and volcanic units in the Lac Guillaume-Delisle area, at the westernmost edge of the map area. However, the latter were not mapped in detail during this geological survey, and the summary description provided herein is derived from the work of Chandler (1988). Archean rocks in the area were grouped into lithodemic suites and complexes in keeping with the guidelines of the North American Stratigraphic Code (MER, 1986). The stratigraphic nomenclature of Archean rocks was established, whenever possible, based on that defined in adjacent areas during recent regional mapping surveys (Gosselin and Simard, 2001; Gosselin *et al.*, 2002; Simard *et al.*, 2002; Gosselin *et al.*, 2004). Figure 2 and the two geological maps which accompany this report list all the units observed in the Lac à l'Eau Claire area (NTS 34B-34C). The established stratigraphic order is based on data derived from recent geological surveys, from cutting relationships observed in the field and from U-Pb ages available as of October 2003.

Archean

Melvin Complex (new unit, Amel)

Volcano-sedimentary rocks in the area were grouped into a new unit, the Melvin Complex (Amel). They form small bands, for the most part located within the Nastapoca Deformation Zone itself or to the north of it (Figure 2). The Melvin Complex was divided into four sub-units based on dominant lithologies: 1) felsic volcanic rocks (Amel1), 2) amphibolite (Amel2), 3) paragneiss (Amel3), and 4) granoblastic diorite and gabbro (Amel4).

Felsic Volcanic Rocks (Amel1)

Felsic volcanic rocks were observed in two locations. They form a belt some 25 km long by 2 km wide (Natwakupaw Belt), exposed in the north-central part of the area, as well as a small band a few hundred metres long in the western part, near the contact with Proterozoic rocks of the Richmond Gulf Group (Figure 2). A sample of felsic rock from the Natwakupaw Belt yielded an age of 2741±4 Ma. Unit Amel1 is mainly composed of very fine-grained felsic rocks with or without quartz phenocrysts. This unit possibly represents a mixture of metamorphosed tuffs and lavas. Most rocks are strongly deformed and commonly display a mylonitic fabric. However, the least-deformed rocks exhibit primary textures and structures (Photo 1 in appendix). Felsic volcanic rocks are light to medium grey, sometimes slightly greenish, with a whitish weathered surface. They may be massive or flow-banded. A few rusty pyrite-rich zones up to 10 m wide were locally observed within this unit.

In thin section, the felsic rocks exhibit a very fine grain size and a granoblastic texture composed of variable proportions of fine-grained quartz, plagioclase and K-feldspar. The foliation is well developed and marked by the presence of brown to greenish brown, partially chloritized, small biotite flakes. Several samples contain completely recrystallized coarse quartz crystals that are subrounded or slightly stretched along the foliation. Fine-grained epidote aggregates overprint biotite. Magnetite, muscovite, apatite and zircon occur in minor amounts, whereas allanite, sphene and carbonate are rather rare. Plagioclase grains are intensely sericitized in a few samples.

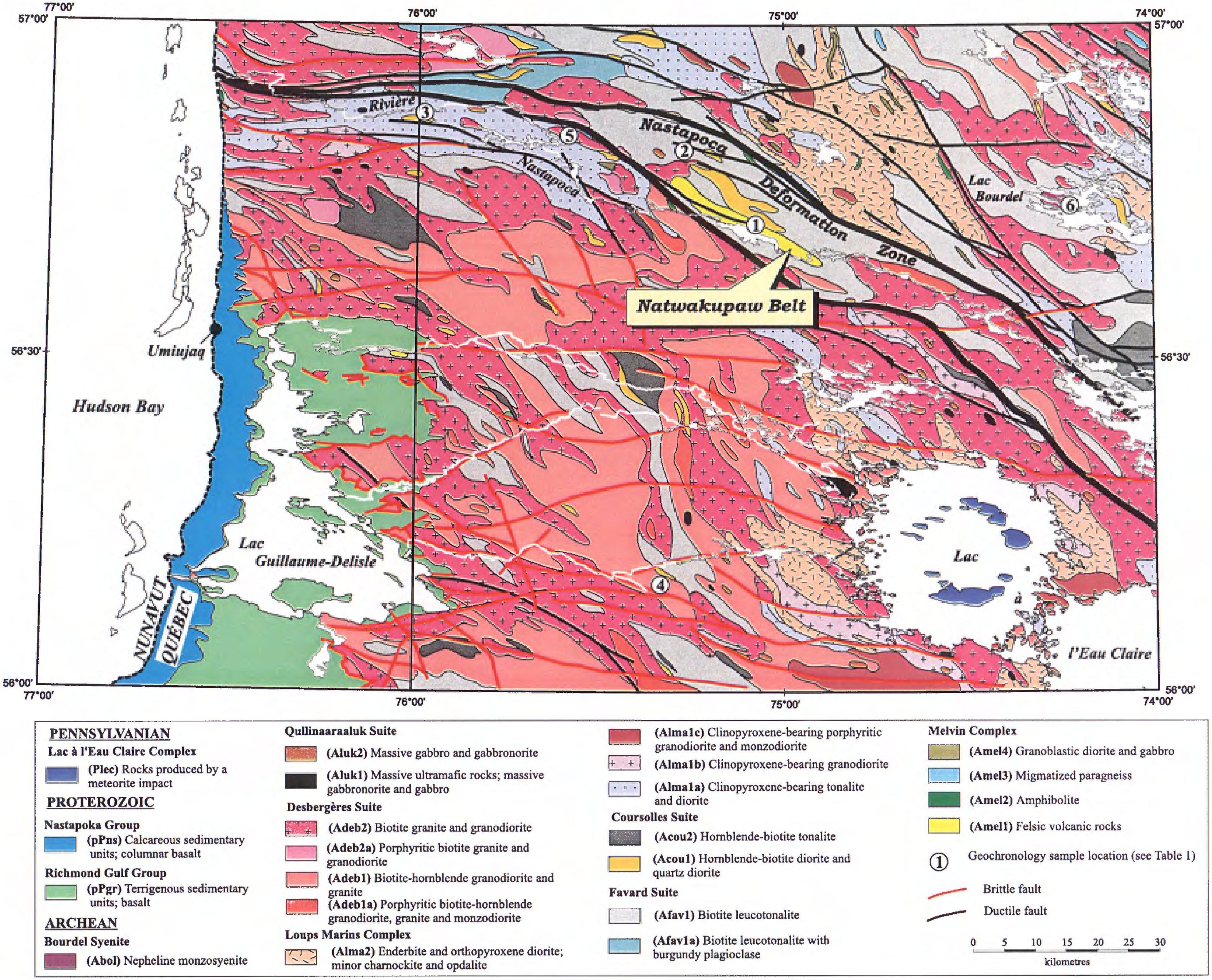


FIGURE 2 - Simplified geology of the Lac à l'Eau Claire area (NTS 34B and 34C).

Amphibolite (Amel2)

Amphibolites are not abundant in the area. They form minor small-scale bands mainly located in the northeastern part of the area (Figure 2). They consist of dark grey fine-grained rocks that are commonly banded. They exhibit a well-developed foliation and a granoblastic texture. The intrusive or effusive origin of these amphibolites is difficult to establish given the intense metamorphic recrystallization in these rocks. In certain locations, mm-scale to cm-scale layers of whitish mobilizate with clinopyroxene and orthopyroxene grains are observed (Photo 2 in appendix). A few rusty pyrite-rich zones, from 1 to 10 m thick, were observed in amphibolite sequences.

In thin section, amphibolites exhibit a very well developed granoblastic texture composed of polygonal grains of twinned plagioclase, hornblende, orthopyroxene and clinopyroxene in variable proportions. All these minerals are weakly altered. Mafic minerals are generally aligned parallel to the foliation. The rock contains 1 to 5% fine-grained xenomorphic magnetite, disseminated throughout the rock and commonly associated with the mafic minerals. Biotite, apatite and zircon occur in minor amounts.

Paragneiss (Amel3)

Paragneisses are exposed in three small bands located in the northeastern part of the area, north of the Nastapoca Deformation Zone (Figure 2). They consist of biotite-garnet paragneisses forming sequences a few hundred metres thick. These paragneisses are fine-grained and medium grey with a yellowish grey weathered surface. They are strongly migmatized and characterized by the presence of cm-scale to m-scale bands of whitish granitic mobilizate. This mobilizate accounts for 5 to 40% of the volume of the rock, locally reaching more than 80%. Subautomorphic garnet grains from 1 to 10 mm in diameter are also observed in the paragneiss. The garnet content ranges from 1 to 5%, although certain mobilizate layers (10 cm) contain more than 30%.

Granoblastic Diorite and Gabbro (Amel4)

Unit Amel4 occurs in the form of small bands located in the northeastern part of the area, north of the Nastapoca Deformation Zone (Figure 2). These bands consist of fine to medium-grained, strongly foliated diorite and gabbro characterized by a well-developed granoblastic texture. These rocks are a slightly greenish medium grey colour with a brownish grey weathered surface. They generally exhibit a very strong magnetic susceptibility. In many locations, the diorite and gabbro contain 5 to 15% whitish mobilizate in small mm-scale to cm-scale bands. Garnet, clinopyroxene and orthopyroxene grains from 1 to 10 mm in size are commonly observed in these mobilizate bands.

In thin section, the diorite and gabbro exhibit a granoblastic texture composed of polygonal grains of twinned plagioclase, clinopyroxene, orthopyroxene and occasional hornblende. Mafic minerals account for 15 to 35% of the total volume of the rock. They often form recrystallized aggregates elongated along the foliation direction. A few samples contain 10 to 20% red biotite flakes that define a strong foliation. Magnetite occurs in small xenomorphic grains (2 to 5%), which explains the strong magnetic susceptibility of these rocks. A few samples contain 1 to 3% quartz. Sphene, apatite and zircon are present in trace amounts.

Favard Suite (Afav)

The Favard Suite (Afav) was defined in the Lac Gayot area (NTS 23M) to describe a unit of biotite trondhjemite and leucotonalite with minor foliated diorite (Gosselin and Simard, 2001). This suite was also recognized in the Maricourt area (NTS 24D; Simard *et al.*, 2002), the Lacs des Loups Marins area (NTS 34A; Gosselin *et al.*, 2002), the Lac Bienville area (NTS 33P; Gosselin *et al.*, 2004) and the Lac Montrochand area (NTS 33O; Roy *et al.*, 2004). In all these areas, with the exception of the Lac Gayot area, biotite trondhjemites and tonalites of the Favard Suite are affected by a "granitization" phenomenon marked by the presence of a granitic or granodioritic phase in diffuse and transitional contact with the tonalitic phase. U-Pb ages obtained from various samples collected in adjacent areas range from about 2730 to 2749 Ma (Gosselin and Simard, 2001; Simard *et al.*, 2002; Gosselin *et al.*, 2004). A leucotonalite sample from the Lac à l'Eau Claire area yielded a new preliminary age of about 3020-3040 Ma.

In the Lac à l'Eau Claire area, the Favard Suite is mainly encountered to the north of the Nastapoca Deformation Zone (Figure 2). It consists of a biotite leucotonalite unit (Afav1) with a sub-unit (Afav1a) of biotite leucotonalite with burgundy plagioclase. The leucotonalites are affected by a "granitization" phenomenon that translates into the presence of a pinkish grey medium to coarse-grained granodioritic to granitic phase. This phase forms bands, pockets or lenses from 1 to 10 cm in size, in diffuse and transitional contact with the tonalitic phase, which gives the rock a banded heterogeneous aspect. In many locations, cm-scale K-feldspar phenocrysts occur individually or clustered in aggregates within the tonalite. The granitic phase is heterogeneously distributed on a regional scale, on the scale of the outcrop and even in hand sample. The granitic phase is generally more abundant near the contact with granite and granodiorite intrusions of the Desbergères Suite. This observation suggests a link may exist between the "granitization" phenomenon and the emplacement of these intrusions.

Biotite Leucotonalite (Afav1)

The leucotonalite is light grey in fresh surface and whitish to slightly pinkish in weathered surface. It ranges from fine to medium-grained and is generally massive to weakly foliated. The leucotonalite contains less than 10% biotite, locally concentrated along cm-scale bands with poorly defined contacts, giving the rock a somewhat banded aspect.

The unit contains cm-scale to m-scale enclaves of diorite and amphibolite. These enclaves are fine-grained, strongly foliated and exhibit a well-developed granoblastic texture. The proportion of enclaves is widely variable on a regional scale (1 to 40%) but generally represents less than 5% of outcrops. In many locations, enclaves are concentrated in layers a few tens of metres thick within the tonalite. The enclaves are generally stretched along the foliation plane and are strongly assimilated by the tonalite. A reaction rim from 1 to 10 cm thick is frequently observed along the contact between enclaves and leucotonalite. This reaction rim is characterized by a greater concentration of hornblende crystals. The presence of stretched enclaves combined with the "granitization" phenomenon give the unit a heterogeneous aspect.

In certain locations, the leucotonalite unit contains layers 1 to 10 m thick of melanocratic tonalite and quartz diorite. These layers contain 10 to 35% mafic minerals, predominantly hornblende and biotite, as well as a greater proportion of mafic enclaves.

In thin section, the leucotonalite is medium-grained with an equigranular and somewhat homogeneous texture. It is mainly composed of quartz (20 to 35%) and plagioclase (50 to 75%). The K-feldspar content is generally low (1 to 8%) but may reach 20% in "granitized" samples. The rock contains less than 10% greenish or brownish biotite which is partially chloritized. These biotite grains are disseminated in the rock or clustered to form aggregates. A few rare green hornblende crystals were observed in certain samples. Sphene, apatite, zircon, epidote, magnetite, allanite and muscovite occur in minor amounts. Quartz grains often display undulatory extinction. In samples collected in strongly deformed areas, quartz is recrystallized to form a mosaic of small grains around coarser-grained plagioclase. The foliation in these cases is strongly developed and marked by the alignment of biotite grains. Antiperthitic textures are frequently observed in plagioclase grains. The latter are partially altered to sericite, except in areas affected by regional faults, where more intense alteration in plagioclase occurs in conjunction with the chloritization of biotite.

Biotite Leucotonalite with Burgundy Plagioclase (Afav1a)

This sub-unit was only observed in the northwestern part of the area, just north of the Nastapoca Deformation Zone (Figure 2). It consists of the same biotite leucotonalite as that assigned to unit Afav1, but with 2 to 5% burgundy-coloured plagioclase crystals. These plagioclase grains give the rock a slightly purplish tinge. In thin section, the constituents are identical to those described in leucotonalites of unit Afav1. Plagioclase grains contain fine reddish brown needles aligned parallel to the crystal planes, which appear to be responsible for the burgundy colour. Similar needles are commonly observed in burgundy plagioclase grains occurring in clinopyroxene-bearing rocks of the Loups Marins Complex (described below). All leucotonalite samples assigned to sub-unit Afav1a show quartz recrystallization textures attributable to the influence of the Nastapoca Deformation Zone.

Coursolles Suite (Acou)

The Coursolles Suite was defined in the Maricourt area (Simard *et al.*, 2002) to describe a unit of early diorite (Acou1) and a unit of tonalite (Acou2), both with hornblende and biotite. It was subsequently recognized in the Lacs des Loups Marins area (Gosselin *et al.*, 2002), the Lac Bienville area (Gosselin *et al.*, 2004) and the Lac Montrochand area (Roy *et al.*, 2004). The stratigraphic position of the Coursolles Suite is uncertain. U-Pb geochronology results obtained in adjacent areas suggest the existence of two different magmatic episodes that produced Coursolles-type intermediate to felsic intrusions. The earliest would be at about 2750 Ma (Gosselin *et al.*, 2002) and the most recent at about 2718 Ma (Simard *et al.*, 2002; Gosselin *et al.*, 2004).

In the Lac à l'Eau Claire area, the Coursolles Suite covers a small area (Figure 2). It is composed of a dioritic unit (Acou1) and a tonalitic unit (Acou2).

Hornblende-Biotite Diorite and Quartz Diorite (Acou1)

Unit Acou1 forms small lenses a few kilometres long. These lenses are relatively abundant in the north-central part of the area, just north of the Natwakupaw volcanic belt (Figure 2). They consist of light to medium grey diorite and quartz diorite that commonly exhibit a slightly greenish tinge. These rocks are massive to strongly foliated with a medium to coarse grain size. They contain 10 to 30% mafic minerals occurring in cm-scale aggregates often stretched along the foliation. They show a moderate to high magnetic susceptibility related to the presence of fine-grained magnetite associated with the mafic minerals. The unit locally contains diorite and amphibolite enclaves from 10 cm to 1 m in size. These enclaves are generally aligned parallel to the foliation. They are foliated, fine-grained and exhibit a well-developed granoblastic texture.

In thin section, the diorite and quartz diorite are mainly composed of plagioclase (65 to 85%) and quartz (3 to 15%). K-feldspar (0 to 2%) is generally an interstitial phase. Mafic mineral aggregates contain brown or green biotite and green hornblende, in equal proportions or dominated by hornblende. Magnetite, sphene and apatite grains and fine-grained epidote aggregates are often associated with the mafic minerals. Allanite and zircon occur in trace amounts.

Hornblende-Biotite Tonalite (Acou2)

Unit Acou2 is well-exposed in the central, northwestern and east-central parts of the area, where it covers many square kilometres. Elsewhere, it occurs in lenses a few kilometres in length (Figure 2). Unit Acou2 is composed of tonalite, minor granodiorite and a few horizons (10-m thick) of diorite and quartz diorite similar to those described in unit Acou1.

All these rocks are affected by a "granitization" phenomenon identical to that affecting tonalites of the Favard Suite (Afav1). This "granitization", which accounts for 5 to 35% of the volume of outcrops, translates into the presence of a granitic phase with diffuse and gradual contacts. Rocks in unit Acou2 are slightly pinkish, light grey and medium to coarse-grained. They show a high magnetic susceptibility. These rocks generally display a strong foliation marked by the alignment of stretched cm-scale aggregates of mafic minerals, although outcrops are locally massive.

In thin section, the tonalite is composed of plagioclase (45 to 75%), quartz (20 to 30%) and K-feldspar, the abundance of which varies according to the degree of "granitization". The rock contains 10 to 20% ferromagnesian minerals, represented by brown or green biotite and green hornblende, in equal proportions or dominated by hornblende. Biotite is variably altered to chlorite, whereas hornblende is altered either to chlorite alone, or to an assemblage of chlorite, epidote and calcite. Alteration of ferromagnesian minerals generally increases in conjunction with the sericitization of plagioclase. Magnetite, apatite, sphene and epidote are commonly associated with the mafic minerals. Small zircon grains occur isolated or as inclusions in biotite. A few samples contain isolated allanite grains. Recrystallization textures in quartz were observed in samples from strongly deformed areas associated with regional fault zones.

Loups Marins Complex (Alma)

The Loups Marins Complex was defined in the Lacs des Loups Marins area (Figure 1; Gosselin *et al.*, 2002) to describe an assemblage of clinopyroxene and orthopyroxene-bearing intrusive and metamorphic rocks. Rocks of this complex were also identified in the Bienville (Gosselin *et al.*, 2004) and Montrochand (Roy *et al.*, 2004) areas (Figure 1). In the Lac à l'Eau Claire area, clinopyroxene and orthopyroxene units mainly consist of intrusive rocks with a minor proportion of metamorphic rocks. Thus, it would be more appropriate to use the term "suite" rather than "complex" to describe these rocks. However, clinopyroxene- and orthopyroxene-bearing intrusive rocks in this area are petrographically similar to those assigned to the Loups Marins Complex in adjacent areas. Therefore, in this report, we have maintained the use of the term "Loups Marins Complex". Issues concerning the nomenclature of this unit will need to be addressed during regional synthesis work.

In the Lac à l'Eau Claire area, the Loups Marins Complex covers an important surface area on either side of the Nastapoca Deformation Zone and in the southeastern part of the area, near Lac à l'Eau Claire (Figure 2). It includes a clinopyroxene unit (Alma1) and an orthopyroxene unit (Alma2), similar in many ways to those recognized in the Lacs des Loups Marins area (Gosselin *et al.*, 2002), the Lac Bienville area (Gosselin *et al.*, 2004) and the Lac Montrochand area (Roy *et al.*, 2004). The Loups Marins Complex broadly corresponds to areas of high magnetic susceptibility on the regional total magnetic field map.

Clinopyroxene Unit (Alma1)

Unit Alma1 was defined in the Lacs des Loups Marins area (Figure 1; Gosselin *et al.*, 2002). Subsequent work by Gosselin *et al.* (2004) in the Lac Bienville area led to the subdivision of this clinopyroxene unit into three sub-units comprising: 1) tonalite (Alma1a), 2) granodiorite (Alma1b), and 3) megaphyric granodiorite and granite (Alma1c). All these sub-units are exposed in the Lac à l'Eau Claire area. A sample of clinopyroxene-bearing granite (Alma1c) from the Bienville area yielded an age of 2709±2 Ma, whereas a sample of clinopyroxene-bearing tonalite (Alma1a) from the Lac à l'Eau Claire area yielded an age of 2712±4 Ma.

In addition to the omnipresence of clinopyroxene, rocks of the clinopyroxene unit (Alma1) also share a few other common characteristics. These rocks generally show a high magnetic susceptibility. They contain reddish biotite and salmon pink or burgundy plagioclase, which give the rock a pinkish or purplish aspect. In many locations and especially near contact zones between units Alma1 and Alma2, clinopyroxene-bearing rocks exhibit a greenish tinge attributable to the green colour of plagioclase grains. It then becomes difficult to tell them apart from greenish orthopyroxene-bearing rocks of unit Alma2. Fine-grained amphibolite and diorite enclaves were observed in all clinopyroxene sub-units. These cm-scale to m-scale enclaves generally represent between 1 and 10% of the total volume of the rock. They are foliated with a well-developed granoblastic texture.

Clinopyroxene-Bearing Tonalite and Diorite (Alma1a)

Sub-unit Alma1a covers a vast surface area in the northern half of the study area (Figure 2). It is the most widespread clinopyroxene sub-unit in unit Alma1. This sub-unit is composed of tonalite with minor diorite and quartz diorite. All these rocks are massive or foliated and medium to coarse-grained. They contain 5 to 25% mafic minerals, occurring in cm-scale aggregates often elongated along the foliation direction. Colour variations in the rock, from medium grey to pinkish grey, purplish grey or greenish grey, are related to variations in the colour of plagioclase. Salmon pink or burgundy-coloured plagioclase crystals from 1 to 10 mm in size are typical of sub-unit Alma1a.

Tonalites in sub-unit Alma1a are mainly composed of plagioclase (55 to 70%) and quartz (20 to 30%). The K-feldspar content is generally low (0 to 5%) except in certain samples where it represents nearly 10% of the volume of the rock. Plagioclase crystals are weakly to strongly altered to sericite. They contain fine reddish inclusions that appear to be responsible for the salmon pink or burgundy colour of the plagioclase. Antiperthitic textures are commonly observed. Quartz occurs as homogeneous grains with undulatory extinction, or as fine-grained mosaics around coarser-grained plagioclase. Strongly deformed rocks related to the Nastapoca Deformation Zone exhibit a mylo-nitic fabric. The tonalite contains 3 to 10% mafic mineral aggregates, composed of partially chloritized reddish brown biotite (2 to 9%) and minor clinopyroxene (1 to 2%) variably altered to hornblende. Certain samples also contain a few hornblende crystals. Fine-grained xenomorphic magnetite, which may represent up to 1% of the volume of the rock, is either disseminated or associated with the mafic minerals. Its presence explains the high magnetic susceptibility of this sub-unit. Epidote, allanite, sphene, apatite and zircon are the most common accessory minerals. Diorites and quartz diorites in sub-unit Alma1a contain a greater proportion of mafic minerals (10 to 25%) than tonalites in this sub-unit. The clinopyroxene content is also greater (3 to 10%).

Clinopyroxene-Bearing Granodiorite (Alma1b)

Sub-unit Alma1b consists of clinopyroxene-bearing granodiorite. It covers a small surface area in the eastern part of the map area, where it forms restricted bands (Figure 2). The granodiorite in sub-unit Alma1b is visually similar to the tonalite in sub-unit Alma1a. Its colour, generally purplish grey to pinkish grey, varies locally according to the colour of plagioclase. It is massive or foliated and medium to coarse-grained. It contains 1 to 2% isolated K-feldspar phenocrysts from 1 to 4 cm long. Ferromagnesian minerals (5 to 20%) form cm-scale aggregates variably stretched along the foliation direction.

The granodiorite is composed of plagioclase (45 to 65%), quartz (20 to 35%), and K-feldspar (10 to 20%). A few rare samples have a granitic composition with 35 to 40% K-feldspar. Perthitic and myrmekitic textures are commonly observed. As described in tonalites of sub-unit Alma1a, several plagioclase crystals contain fine reddish needles that appear to be responsible for the salmon pink or burgundy colour of the plagioclase. Quartz occurs in homogeneous grains, or, in strongly deformed rocks, as fine-grained mosaics between plagioclase and K-feldspar crystals. The granodiorite contains 2 to 5% mafic minerals, predominantly reddish biotite with a minor proportion of clinopyroxene. A few hornblende crystals were observed in certain samples. The rock also contains minor amounts of magnetite, sphene, apatite, allanite and zircon.

Clinopyroxene-Bearing Porphyritic Granodiorite and Monzodiorite (Alma1c)

Porphyritic rocks in sub-unit Alma1c form bodies of variable dimensions located in the eastern half of the area (Figure 2). These bodies are mainly composed of granodiorite, with minor amounts of monzodiorite and quartz monzodiorite. These rocks were initially assigned to the Lussay Suite (Gosselin *et al.*, 2002) in the Lacs des Loups Marins area. This nomenclature was subsequently modified following work by Gosselin *et al.* (2004) in the Lac Bienville area, and clinopyroxene-bearing porphyritic granodiorites were eventually assigned to the Loups Marins Complex. Since there seems to be a spatial association between clinopyroxene-bearing rocks of unit Alma1 and clinopyroxene-bearing porphyritic granodiorites, it was deemed preferable to include the latter in the Loups Marins Complex (sub-unit Alma1c) rather than in the distinct Lussay Suite.

Granodiorites and monzodiorites exhibit a porphyritic texture due to the presence of 10 to 25% K-feldspar phenocrysts from 1 to 4 cm long. These phenocrysts are variably aligned along the foliation direction. The rock is pinkish grey, greenish grey or greenish brown. It is generally homogeneous and ranges from medium to coarse-grained. It shows a strong magnetic susceptibility, like all other units in the Loups Marins Complex. The rock is composed of plagioclase (45 to 60%), quartz (5 to 25%), and K-feldspar (10 to 30%). It contains 5 to 20% mafic mineral aggregates, composed of red biotite (4 to 10%), clinopyroxene (1 to 4%) and minor amounts of hornblende. Orthopyroxene is rarely observed; it is altered to serpentine, carbonate and talc. Xenomorphic magnetite grains (1 to 2%) are associated with the mafic minerals. The rock also contains trace amounts of zircon and apatite.

Orthopyroxene Unit (Alma2)

Unit Alma2 was introduced in the Lacs des Loups Marins area (Gosselin *et al.*, 2002). Geochronology results from hypersthene diorite samples of unit Alma2 collected in the Lacs des Loups Marins (Gosselin *et al.*, 2002) and Lac Bienville (Gosselin *et al.*, 2004) areas yielded respective ages of 2694±3 Ma and 2720±2 Ma.

Unit Alma2 covers an important surface in two distinct parts of the study area (Figure 2). The first is located north of the Nastapoca Deformation Zone, and the second is located south of the latter, near Lac à l'Eau Claire (Figure 2). Unit Alma2 consists of enderbite, hypersthene quartz diorite, hypersthene diorite, with minor opdalite and charnockite observed locally. All these rock types show a strong magnetic susceptibility. Enderbite and diorite outcrops are fine to medium-grained and range from massive (Photo 3 in appendix) to strongly foliated. The rocks are greenish to brownish, generally darker for intermediate rocks, and weathered surfaces are brownish grey to golden brown.

They may contain burgundy-coloured plagioclase, especially near contact zones with unit Alma1. Rocks in unit Alma2 contain 3 to 20% ferromagnesian minerals, clustered in cm-scale aggregates that are either subrounded or stretched along the foliation plane. Mafic minerals are more abundant in diorites, where they may represent up to 30% of the volume of the rock. All lithological assemblages in unit Alma2 contain enclaves from 5 cm to 1 m long, generally stretched along the foliation direction. The enclaves are composed of dark grey to blackish, fine-grained, foliated amphibolite and diorite. These rocks contain orthopyroxene and exhibit a well-developed granoblastic texture. The enclaves represent 1 to 10% of the volume of outcrops, but may locally reach more than 50%. Generally, as the percentage of enclaves increases, so does the proportion of mafic minerals in the rock.

In thin section, enderbites, hypersthene quartz diorites and hypersthene diorites of unit Alma2 are composed of plagioclase (55 to 80%), quartz (2 to 35%) and ferromagnesian minerals (3 to 30%). Minor amounts of K-feldspar (<2%) were observed in a few samples. Mafic minerals are represented by variable proportions of red biotite (1 to 15%), clinopyroxene (1 to 10%) and orthopyroxene (1 to 5%) with minor green hornblende locally. Orthopyroxene is weakly to strongly altered to talc, carbonate, serpentine and chlorite. Xenomorphic magnetite grains (1 to 3%) are associated with the mafic minerals. Apatite and zircon are the most commonly observed accessory minerals. The rock displays a variably developed equigranular texture, except in deformation zones where quartz forms mosaics of recrystallized grains between plagioclase crystals.

Desbergères Suite (Adeb)

The Desbergères Suite was introduced in the Maricourt area (Simard *et al.*, 2002) to describe a unit of biotite-hornblende granodiorite. This unit was later recognized in the Lacs des Loups Marins area (Gosselin *et al.*, 2002), the Lac Bienville area (Gosselin *et al.*, 2004) and the Lac Montrochand area (Roy *et al.*, 2004) (Figure 1). A U-Pb age of 2683+4/-2 Ma was obtained in the Maricourt area, and ages of 2714±12 Ma and 2711±4 Ma were respectively obtained in the Lacs des Loups Marins and Lac à l'Eau Claire areas. Simard *et al.* (2002) reported a close link between the presence of granites and granodiorites of the Desbergères Suite and the intensity of the "granitization" phenomenon affecting tonalitic units in the area. This relationship was also observed in all other areas where the Desbergères Suite was identified.

In the Lac à l'Eau Claire area, the Desbergères Suite was subdivided into two units. The first mainly consists of biotite-hornblende granodiorite and granite (Adeb1), whereas the second is composed of biotite granite and granodiorite (Adeb2). These two units cover a significant proportion of the study area, especially to the south of the Nastapoca Deformation Zone (Figure 2).

Biotite-Hornblende Granodiorite and Granite (Adeb1)

Unit Adeb1 consists of massive to weakly foliated biotite-hornblende granodiorite and granite. Granodiorite is the dominant lithology. Both the granodiorite and granite are medium to coarse-grained and pinkish grey to light pink. They contain 2 to 15% mafic minerals occurring in cm-scale aggregates. These rocks show a high magnetic susceptibility attributable to the presence of magnetite grains associated with the mafic minerals. K-feldspar phenocrysts from 1 to 5 cm in length are commonly observed, although they generally account for less than 5% of the rock. Locally, the rock exhibits a porphyritic texture with more than 25% K-feldspar phenocrysts. Enclaves are heterogeneously distributed within the unit. Several areas are completely devoid of them, whereas elsewhere, they constitute 10 to 20% of outcrops. The enclaves are cm-scale to m-scale and mainly consist of fine-grained foliated amphibolite and diorite with a well-developed granoblastic texture.

Granodiorites and granites of unit Adeb1 are composed of 30 to 65% plagioclase, 20 to 30% quartz, and 10 to 35% K-feldspar. The mafic mineral content ranges from 2 to 15%. The latter form aggregates of brown or green biotite and green hornblende, in equal proportions or dominated by biotite. Mafic minerals are variably altered; biotite is altered to chlorite and hornblende is altered to chlorite or chlorite-epidote-calcite. Intense alteration of mafic minerals is generally accompanied by a strong sericitization of plagioclase crystals. Magnetite, sphene, allanite, epidote, zircon and apatite are the most commonly observed accessory minerals. They are often associated with the mafic mineral aggregates. Rocks in this unit display myrmekitic, perthitic and antiperthitic textures. Recrystallization textures consisting of fine-grained mosaic quartz were observed in strongly deformed rocks, namely along the Nastapoca Deformation Zone and in the westernmost part of the area, near the contact with Proterozoic rocks.

Porphyritic Biotite-Hornblende Granodiorite, Granite and Monzodiorite (Adeb1a)

Porphyritic rocks in sub-unit Adeb1a occur in gradual contact with granodiorites and granites of unit Adeb1. Other than their porphyritic texture, rocks in sub-unit Adeb1a generally show compositional and petrographic characteristics similar to granodiorites and granites of unit Adeb1. The porphyritic rocks generally have a granodioritic composition, rarely granitic or monzodioritic. They range from medium to coarse-grained and contain 15 to 35% K-feldspar phenocrysts from 1 to 5 cm long. They show a high magnetic susceptibility. Mafic minerals, which account for 8 to 10% of the total volume of the rock, occur in cm-scale aggregates, composed of roughly equal proportions of brown or green biotite and green hornblende. Magnetite grains and a few sphene and apatite crystals are associated with the mafic minerals. The porphyritic rocks are homogeneous. They contain rare 10-cm enclaves of fine-grained, foliated and granoblastic diorite.

Biotite Granite and Granodiorite (Adeb2)

Unit Adeb2 consists of biotite granite and granodiorite, which are difficult to distinguish in the field. However, K-feldspar staining, thin section studies and lithogeochemistry results indicate that the granitic composition is largely predominant. These rocks are medium to coarse-grained and pinkish grey to light pink, with a whitish grey colour in many locations. In the latter case, it becomes difficult to tell them apart from tonalitic units, given the whitish colour of the K-feldspar phase. Biotite granites and granodiorites are massive or weakly foliated, except in deformation zones related to regional faults, where mylonitic and cataclastic textures are observed. Rocks of unit Adeb2 contain 3 to 8% biotite, disseminated throughout the rock or clustered in aggregates. K-feldspar phenocrysts from 1 to 5 cm long are common but generally represent less than 5% of the total volume of the rock. In certain locations, the granite and granodiorite occur in gradual contact with phenocryst-rich rocks (more than 25%). Granites and granodiorites of unit Adeb2 contain variable proportions of whitish biotite tonalite restite (Photo 4 in appendix) similar to Favard Suite tonalites. These consist of pockets or lenses a few centimetres to a few metres long, of tonalitic material with diffuse blurry contacts, which give the rock a heterogeneous aspect. Enclaves of amphibolite, diorite, minor gabbro and rare ultramafic rocks generally account for less than 2% of outcrops, although they may locally reach 15%. The enclaves are cm-scale to m-scale and are generally stretched along the regional foliation direction. They are foliated or banded, fine to medium-grained and exhibit a granoblastic texture. The mafic mineral content of the granite increases near the enclaves. The overall texture of the granite and granodiorite may rapidly change from homogeneous to heterogeneous due to an increase in the proportion of enclaves and of tonalitic restite.

In thin section, the rock is composed of plagioclase (15 to 60%), quartz (20 to 35%), and K-feldspar (15 to 60%). Myrmekitic, perthitic and antiperthitic textures are frequently observed. The rock contains less than 5% mafic minerals, essentially brown or green biotite that is partially to completely chloritized. Biotite occurs as isolated flakes or in aggregates with minor epidote and opaque minerals. Several samples contain a few coarse crystals of sphene and allanite. Apatite, zircon and muscovite complete the accessory minerals. The granites and granodiorites are medium-grained and show an equigranular texture. In strongly deformed samples, quartz is recrystallized and forms a fine-grained mosaic around coarser plagioclase and K-feldspar grains. This recrystallization texture is particularly common in the southwestern part of the area, near the Lamain Deformation Zone (Figure 7). It is generally accompanied by a strong chloritization of biotite and intense sericitization of plagioclase.

Porphyritic Biotite Granite and Granodiorite (Adeb2a)

A number of biotite granite and granodiorite intrusions with a porphyritic texture were observed in transitional contact with rocks of unit Adeb2 of the Desbergères Suite. Those large enough to be shown on the geological map were included in sub-unit Adeb2a. They are all located in the northwestern part of the area (Figure 2). The composition of these porphyritic rocks (Adeb2a) is mainly granitic. The porphyritic texture is due to the presence of 20 to 35% K-feldspar phenocrysts from 1 to 5 cm long, although this proportion may locally exceed 50%. The porphyritic rocks are massive or weakly foliated. Their magnetic susceptibility is slightly stronger than for granites and granodiorites of unit Adeb2. Overall, the porphyritic rocks are homogeneous and contain very few enclaves or tonalitic restite.

All samples observed in thin section show a granitic composition, with 25 to 40% quartz, 20 to 25% plagioclase, and 35 to 45% K-feldspar. They also contain less than 3% mafic mineral aggregates, composed of weakly chloritized brown or green biotite, associated with magnetite, sphene, allanite, epidote and apatite in minor amounts. Myrmekitic and perthitic textures are commonly observed. All samples show recrystallization textures in quartz, albeit to variable degrees, attributable to the influence of the Nastapoca Deformation Zone.

Qullinaaraaluk Suite (Aluk)

The Qullinaaraaluk Suite (Aluk) was introduced further north in the Lac Vernon area (Parent *et al.*, 2003) to describe a series of late mafic to ultramafic intrusions. It was also recognized to the west of the latter, in the Rivière Innuksuac area (Simard *et al.*, 2004). The discovery in 2000 of an important Ni-Cu-Co-PGE zone hosted in an ultramafic intrusion assigned to this suite revealed its economic potential. This showing is located near Lac Qullinaaraaluk (NTS 34G; Parent *et al.*, 2003; Labbé *et al.*, 2001), to the north of the study area.

In the Lac à l'Eau Claire area, the Qullinaaraaluk Suite was subdivided into two units in order to distinguish mafic facies from facies dominated by ultramafic rocks. The first unit is primarily composed of ultramafic intrusions (Aluk1), generally associated with a few mafic intrusions. The second unit is exclusively composed of mafic intrusions (Aluk2) similar to those occasionally found in unit Aluk1. A U-Pb analysis conducted on a leucocratic gabbro sample from unit Aluk1 yielded an age of 2700±3 Ma.

Mafic and ultramafic intrusions of the Qullinaaraaluk Suite (Aluk1 and Aluk2) are fairly widespread throughout the area (Figure 2). They consist of small homogeneous and massive intrusions. They are commonly cut by whitish tonalitic or granitic injections from 1 to 10 cm thick, which give the rock a brecciated aspect (Photo 5 in appendix). Several of these intrusions are located along the margins of the Nastapoca Deformation Zone, as well as in the vicinity of Lac à l'Eau Claire (Figure 2).

Ultramafic Intrusions (Aluk1)

Ultramafic intrusions are composed of hornblendite and pyroxenite with minor peridotite. The rocks are dark green to blackish grey with a brownish grey to dark brown weathered surface. They are medium to coarse-grained, and several intrusions display cumulate textures. The rock commonly contains 5 to 15% hornblende phenocrysts from 1 to 3 cm in size, which give the rock a mottled aspect. Unit Aluk1 also comprises gabbros and gabbronorites in sharp or transitional contact with the ultramafic rocks, such that some of these plutons may represent differentiated mafic to ultramafic intrusions. These gabbros and gabbronorites are similar to those in unit Aluk2.

In thin section, the hornblendite is heterogranular and mainly composed of green hornblende, some of which occurs as cm-scale poikilitic crystals. It also contains <10% clinopyroxene, partially replaced by green hornblende, <5% brown biotite, which is partially to strongly chloritized, and <5% interstitial plagioclase. Orthopyroxene, albeit strongly to completely altered to talc, serpentine, carbonate, chlorite and magnetite, was observed in a few samples. Magnetite and pyrite are the main accessory minerals. Zircon is present in minor amounts. Pyroxenites are composed of pyroxene (50 to 85%), green hornblende (10 to 40%) and interstitial plagioclase (<5%). Clinopyroxene and orthopyroxene occur in variable proportions, although clinopyroxene is usually predominant. Orthopyroxene is fresh or weakly altered to serpentine and talc. Clinopyroxene is partially to completely replaced by green hornblende. Hornblende also occurs as xenomorphic grains between pyroxene grains, or as coarse poikilitic crystals. The rock contains a few reddish flakes of biotite or phlogopite. Magnetite forms up to 1% of the total volume of the rock. Several ultramafic samples from unit Aluk1 exhibit a partial, weakly developed granoblastic texture indicating the onset of recrystallization.

Mafic Intrusions (Aluk2)

Mafic intrusions consist of leucocratic to melanocratic, medium to coarse-grained gabbro and gabbronorite. The rock is greenish grey to blackish grey with a brownish, greenish or whitish grey weathered surface. Similar to ultramafic rocks, the gabbros and gabbronorites contain 5 to 15% green hornblende phenocrysts from 1 to 3 cm long, which give the rock a mottled aspect.

A petrographic study reveals a variety of compositions for mafic intrusions in unit Aluk2, despite similar field characteristics. The unit includes many different types of gabbro, namely with hornblende-biotite, hornblende-biotite-clinopyroxene, hornblende-biotite-clinopyroxene-orthopyroxene, and clinopyroxene-orthopyroxene-biotite assemblages. All these gabbros contain 30 to 70% plagioclase, which is variably sericitized. Biotite is reddish and weakly altered. However, pyroxenes are generally unstable. Orthopyroxene is partially to strongly altered to talc, serpentine, carbonate and chlorite, whereas clinopyroxene is partially to completely replaced by green hornblende. The magnetite content varies from one sample to the next, reaching up to 3% in certain cases. This petrographic diversity suggests the Qullinaaraaluk Suite may contain mafic intrusions from distinct magmatic series. However, more detailed work is needed to characterize the various types of gabbro observed in this unit. Similar to ultramafic rocks in unit Aluk1, the different gabbros of unit Aluk2 frequently exhibit a partially developed granoblastic texture.

Bourdel Syenite (new unit, Abol)

A nepheline syenite intrusion some 6 km long, the Bourdel Syenite (Abol), was observed in the vicinity of Lac Bourdel, in the northeastern part of the area (Figure 2). It consists of a homogeneous, medium to coarse-grained rock with a well-developed magmatic foliation. Nepheline crystals from 0.5 to 2 cm diameter weather to a medium grey colour and appear in positive relief on outcrops, giving the whitish syenite a mottled aspect (Photo 6 in appendix). The rock contains 5 to 10% mm-scale to cm-scale biotite flakes aligned parallel to the magmatic foliation. The rock shows a high magnetic susceptibility.

Only one sample was observed in thin section. It is a nepheline monzosyenite composed of 35% nepheline, 15% plagioclase (albite), and 45% K-feldspar with strong albite exsolution textures. The rock also contains 5% fresh brown biotite flakes aligned along the primary foliation. Fine subrounded carbonate grains are disseminated throughout the rock. A reaction rim formed of radiating cancrinite is observed along the contacts between carbonate and nepheline grains. Apatite, zircon and allanite are the main accessory minerals.

Proterozoic

Proterozoic rocks are represented by two volcano-sedimentary sequences, as well as several thin diabase dykes that cut Archean rocks. Volcano-sedimentary rocks belong to the Richmond Gulf and Nastapoka groups (Chandler, 1988), both exposed in the westernmost part of the area, near Hudson Bay. These rocks, shallowly dipping to the west, form magnificent cuestas along the western shore of Lac Guillaume-Delisle (see photo on cover page). The emplacement of these units was controlled by the opening of the Aphebian Richmond Gulf Graben (Chandler and Schwarz, 1980; Chandler, 1988). These Proterozoic volcano-sedimentary rocks were not studied in detail during this geological survey. Thus, the information provided below is taken from the work of Chandler (1988).

Richmond Gulf Group (pPgr)

The Richmond Gulf Group covers an important surface in the southwestern part of the study area (Figure 2). It consists of volcano-sedimentary rocks overlying the Archean basement along a faulted contact or an angular unconformity. The group is composed of three formations (not identified on the geological map enclosed with this report), namely from the base to the top: the arkosic Pachi Formation, the basaltic Persillon Formation and the arkosic Qingaaluk Formation (Chandler, 1988). The Pachi Formation is 0 to 500 metres thick. It is mainly composed of cross-bedded arkosic sandstone. It also contains minor conglomerate and red sandstone units at the base as well as discrete units of thinly bedded lacustrine sandstone and pelite. The Persillon Formation, reaching up to 70 metres in thickness, is composed of a series of subaerial basalt flows. The flows have a massive, amygdaloidal or rarely pillowed base and an amygdaloidal top. The basalt, generally black or green, becomes reddish in the upper part of the unit. The basalts are overlain by a 1-m-thick conglomerate that constitutes the base of the Qingaaluk Formation. In addition to this basal conglomerate, the latter formation contains a unit of sandstone and red mudstone, a unit of red arkose, subaerial basaltic flows with columnar jointing and an upper unit of grey sandstone. The total thickness of the Qingaaluk Formation exceeds 500 metres. According to Chandler (1988), rocks of the Richmond Gulf Group were deposited in an alluvial plain setting with a few hills and shallow lakes. Paleocurrent studies suggest sediment transport took place from the west to the east. The Richmond Gulf Group also contains a mafic intrusive unit, the Wiachuan Sill, mainly injected within the Pachi Formation. It consists of very fine-grained gabbro, with petrographic characteristics fairly similar to certain coarser-grained basalts in the Persillon Formation.

Nastapoka Group (p*Pn*s)

The Nastapoka Group is located in the westernmost part of the area, along the coast of Hudson Bay (Figure 2). It consists of a relatively thin volcano-sedimentary sequence (0 to 160 m) overlying rocks of the Richmond Gulf Group and Archean rocks along an angular unconformity. The sedimentary sequence of the Nastapoka Group comprises a wide variety of facies indicating a marine transgression (Chandler, 1988). The sequence was subdivided into 9 informal members by Chandler (1988). The base of the sequence consists of conglomerates, rhythmic sequences of calcareous turbidites and a cross-bedded quartz arenite. These rocks are overlain by several carbonate units formed of algae mats that namely contain stromatolitic horizons, ooliths, submarine oolithic dunes and laminite breccias. The sequence hosts several pyrite-rich stromatolitic horizons; the most impressive is brecciated and hosts lead-zinc mineralization. The carbonate rocks are capped by a cross-bedded quartzitic or feldspathic sandstone. The top of the Nastapoka Group consists of columnar basalt flows conformably overlying the sedimentary sequence.

Diabase Dykes

Proterozoic diabase dykes intrude Archean units in many outcrops in the Lac à l'Eau Claire area. They are particularly abundant in the southwestern part of the map area, near Proterozoic sequences of the Richmond Gulf and Nastapoka groups. However, their small size makes it impossible to represent them on the geological map at the 1:250,000 scale.

Diabase dykes in the Lac à l'Eau Claire area follow two dominant orientations, namely an E-W to WNW-ESE trend and a N-S to NNW-SSE trend (Figure 3). A third orientation, NW-SE, is much less common. The last two orientations respectively correspond to the Maguire (about 2230 Ma) and Minto (1998±2 Ma) swarms studied by Buchan *et al.* (1998) along the Rivière aux Feuilles. However, the association of diabase dykes observed in the Lac à l'Eau Claire area with these two swarms has yet to be confirmed. The E-W to WNW-ESE orientation, on the other hand, does not seem to be associated with any other swarm documented in the northeastern Superior Province. It represents a new swarm, called the Richmond Swarm, concentrated along the extension of the main E-W rift valleys associated with the Richmond Gulf Graben. E-W to WNW-ESE-trending dykes are the most widespread and outcrop throughout the map area. N-S to NNW-SSE dykes are mainly located along the eastern margin of the Proterozoic basin surrounding Lac Guillaume-Delisle in the western part of the study area. Finally, NW-SE dykes were only observed locally. Close to

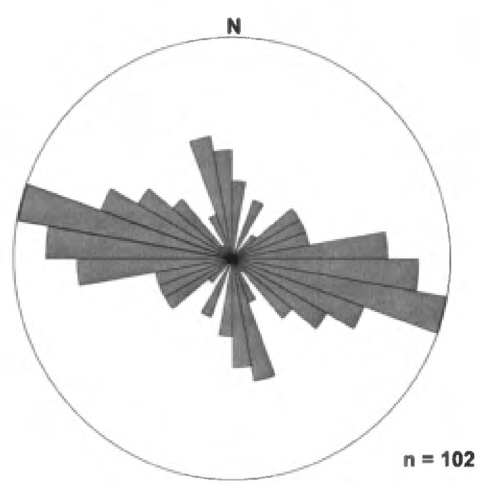


FIGURE 3 - Stereographic projection of diabase dykes in the Lac à l'Eau Claire area (n = number of measurements).

fifty samples of diabase dykes from the three major groups were the object of a petrographic study or were analyzed for major and trace elements. Unfortunately, field observations, petrographic studies and lithogeochemistry results (see section entitled "Lithogeochemistry") are not sufficient to differentiate these dykes based on their orientation.

Diabase dykes in the Lac à l'Eau Claire area range from 10 cm to more than 30 m in thickness. They are generally aphanitic, fine-grained or medium-grained and exhibit a dark grey-green to black colour. Their magnetic susceptibility varies from weak to strong. Certain coarser-grained dykes are light grey and strongly magnetic. In thin section, aphanitic and fine-grained dykes are composed of thin laths of twinned plagioclase and mm-scale microphenocrysts (5-20%) of sericitized plagioclase embedded in a fine-grained groundmass of mafic minerals, which are often chloritized. Rounded amygdules (1-3%) filled with greenish chloritized material are also observed. Trace amounts of epidote overprint plagioclase grains. These dykes also contain finely disseminated oxides (magnetite, ilmenite, hematite) and sphene, as well as rare sulphides in trace amounts. Coarser-grained dykes exhibit an ophitic to subophitic texture composed of fresh plagioclase and pyroxene. Certain dykes are sericitized and carbonatized. These alteration patterns are accompanied by the replacement of pyroxene by amphibole and chlorite and by the saussuritization of plagioclase.

Diabase dykes in the western part of the Lac à l'Eau Claire area were compared to volcanic rocks of the Richmond Gulf Group by Labbé and Lacoste (2004). According to these authors, most dykes in this area are geochemically and petrographically similar to volcanic rocks of the Richmond Gulf Group, suggesting the two may be genetically related.

Pennsylvanian

Lac à l'Eau Claire Complex (Plec)

The two subrounded depressions forming the eastern and western sections of Lac à l'Eau Claire resulted from a double meteorite impact (Beals *et al.*, 1956, 1960). The remains of this impact form a ring of islands located in the centre of the western section of Lac à l'Eau Claire (Figure 2). There, an assemblage of allochthonous rocks, displaced by the impact, form a deposit estimated at some 160 metres thick prior to erosion (Rondot *et al.*, 1993). These impact-related rocks were dated using three different methods, namely K-Ar (Bostock, 1969), Rb-Sr (Reimold *et al.*, 1981), and Ar-Ar (Bottomley *et al.*, 1990). The results yielded Pennsylvanian ages of about 280 Ma. Rondot *et al.* (1993) conducted a detailed study of rocks exposed on the islands in the western section of Lac à l'Eau Claire. The following descriptions are taken from this work. More recently, a study was undertaken on the various lithological units exposed on these islands within the scope of a Bachelor's thesis at Université Laval (Guilmette *et al.*, 2001).

On all the islands in Lac à l'Eau Claire, Pennsylvanian rocks overlie the variably fractured Archean basement. The presence of maskelynite (vitrified plagioclase) in the Archean rocks is the result of high-grade shock metamorphism at pressures estimated between 25 and 30 GPa (1 GPa = 1 million kilopascals) at the centre of the impact. In various locations, the Archean rocks are cut by Proterozoic diabase dykes that also underwent the effects of this shock metamorphism. Ordovician limestones were observed as enclaves in impactites and as isolated unmetamorphosed and unaltered blocks in unconsolidated deposits found on the islands. The presence of these limestones suggests that a partial cover of Ordovician rocks was probably present at the time of the impact.

The allochthonous impact-related rocks deposited during the Pennsylvanian were divided into four informal units by Rondot *et al.* (1993), namely: a basal breccia, impactite and mylolisthenite dykes, impact-ignimbrite and impactite. The basal breccia (0 to 30 m) is composed of 80% lithic clasts (1 mm to 1 m) and minerals poorly cemented by a clayey matrix. One per cent of these clasts consist of boulders from 1 to 10 m in diameter of Archean basement. The Archean basement and the impact breccia are cut by brick red impactite dykes from 1 to 10 cm thick, composed of cryptocrystalline material with a minor proportion of small clasts. A grey or greenish breccia dyke called a mylolisthenite, much less widespread, was also identified in drill core. The basal breccia is overlain by a subhorizontal layer of 18 to 20 m of impact ignimbrite, which is a breccia where the clasts (20%) are welded by melted material. It is visually similar to a volcanic ignimbrite. The impactite, overlying the impact ignimbrite along a sharp contact, contains less than 10% clasts, embedded in a purple, beige or grey crystalline matrix. The latter is fine to medium-grained and exhibits a diabasic or subophitic texture. This rock is fairly similar to a diabase or an intrusive rock. The impactite, exposed over 85 metres, represents the partially eroded top of the Pennsylvanian sequence.

GEOCHRONOLOGY

A geochronology study was undertaken in conjunction with the geological survey in the Lac à l'Eau Claire area. Six samples of various stratigraphic units were collected for this purpose (Figure 2) and analyzed for uranium and lead isotopes in the GEOTOP-UQAM-McGill laboratories using two different methods, namely isotopic dilution - thermal ionization mass spectrometry (TIMS) and *in situ* laser ablation - multiple collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS). Geochronology results are listed in Table 1.

TABLE 1 - Results of U-Pb analyses conducted on samples from the Lac à l'Eau Claire area. Sample locations are shown in Figure 2.

Site no. and analytical method	Location UTM (Nad83)	Sample number (field)	Stratigraphic unit	Age of crystallization	Secondary inherited age	Lithology
1 (LA-MC-ICP-MS)	494710 E 6284336 N	MP-02-1000	Amel1 Natwakupaw Belt	2741±4 Ma	2.78-2.80 Ga	Felsic volcanic rock
2 (LA-MC-ICP-MS)	483152 E 6296515 N	DM-02-5027	Afav1	3020-3040 Ma		Biotite leucotonalite
3 (LA-MC-ICP-MS)	440006 E 6302915 N	GL-02-7037	Alma1a	2712±4 Ma	2800 Ma and 2950 Ma	Clinopyroxene tonalite with burgundy plagioclase
4 (LA-MC-ICP-MS)	479642 E 6223971 N	MP-02-1091	Adeb1	2711±4 Ma		Biotite-hornblende granodiorite
5 (LA-MC-ICP-MS)	463899 E 6299089 N	MS-02-52	Aluk1	2700±3 Ma		Massive leucogabbro at the Flipper showing
6 (TIMS)	544502 E 6219340 N	GR-02-6232	Abol	2675±1 Ma		Nepheline syenite

U-Pb isotope analytical methods:
TIMS: isotopic dilution and thermal ionization mass spectrometry
LA-MC-ICP-MS: in situ laser ablation and multiple collector inductively coupled plasma mass spectrometry

Melvin Complex – Felsic Rock from the Natwakupaw Belt (Amel1)

A fine-grained felsic rock (Amel1), most likely representing a lava flow or a tuff, was collected in the Natwakupaw Belt (site 1, Figure 2 and Table 1). This belt forms an elongated band within the Nastapoca Deformation Zone. Isotopic analyses by laser ablation (LA-MC-ICP-MS) conducted on some twenty zircons yielded an age of emplacement of 2741±4 Ma. The sample also contains xenocrysts inherited from an earlier source with an age of about 2.78-2.80 Ga. To date, no other age similar to that of 2741±4 Ma was encountered in volcanic rocks within the northeastern Superior Province. This age generally corresponds to the age of emplacement of tonalitic units encountered in the southern half of the area covered by the Far North Project. In reference, the closest volcanic sequence, assigned to the Dupire Complex in the Nedlouc area (Parent *et al.*, 2001), yielded an age of 2787±4 Ma from a sample of felsic tuff.

Favard Suite (Afav)

Leucotonalites of the Favard Suite were dated in various locations in recent years. Two trondhjemite samples from the Lac Gayot and Maricourt areas yielded respective ages of crystallization of 2.73 Ga (Gosselin and Simard, 2001) and 2749±4 Ma (Simard *et al.*, 2002). A sample of "granitized" trondhjemite collected in the Lac Bienville area (Gosselin *et al.*, 2004) yielded an age of 2741±4 Ma, interpreted as the age of emplacement for the trondhjemite, and a younger age of 2713±2 Ma corresponding to the age of crystallization of the granitic phase associated with the "granitization" phenomenon. These results appear to indicate that leucotonalites and trondhjemites of the Favard Suite were emplaced between 2.73 Ga and 2749±4 Ma.

A sample of biotite leucotonalite assigned to unit Afav1 of the Favard Suite was collected in the Lac à l'Eau Claire area. This sample comes from a sequence of homogeneous tonalite exposed within the Nastapoca Deformation Zone, a few kilometres north of the Natwakupaw volcano-sedimentary Belt (site 2, Figure 2 and Table 1). Isotope analyses by laser ablation (LA-MC-ICP-MS) conducted on twenty automorphic to subautomorphic zircon)crystals form a cluster to yield an imprecise age of about 3020-3040 Ma. This age represents the best estimate for the emplacement of the leucotonalite. This result shows that some early leucotonalites with features identical to those of Favard Suite leucotonalites were included in this unit. However, field data collected during this survey is currently insufficient to constrain the extent of these early tonalites.

Loups Marins Complex – Clinopyroxene Units (Alma1a, Alma1b and Alma1c)

Two ages were obtained from clinopyroxene-bearing samples in areas adjacent to the Lac à l'Eau Claire area. In the Lac Bienville area, a granite assigned to sub-unit Alma1b yielded an age of 2709±2 Ma (Gosselin *et al.*, 2004). In the Lacs des Loups Marins area, a clinopyroxene-bearing porphyritic granodiorite of the Lussay Suite, equivalent to sub-unit Alma1c, yielded an age of 2713±3 Ma (Gosselin *et al.*, 2002). Further north in the Lac Vernon area, a clinopyroxene-bearing tonalite with burgundy plagioclase of the Qilalugalik Suite, most likely equivalent to sub-unit Almа1a of the Loups Marins Complex, yielded an age of crystallization of 2709±3 Ma and an inherited age of 2780±8 Ma from an earlier lithology (Parent *et al.*, 2003). These results suggest that clinopyroxene-bearing rocks assigned to the Loups Marins Complex or to equivalent units were all emplaced at about 2710 Ma.

In the Lac à l'Eau Claire area, a sample of clinopyroxene-bearing tonalite with burgundy plagioclase was collected in sub-unit Alma1a of the Loups Marins Complex (site 3, Figure 2 and Table 1). Isotopic analyses by laser ablation were conducted on 16 zircon crystals. All the crystals consist of elongated prisms characterized by an internal magmatic zoning pattern. They yielded $^{207}Pb/^{206}Pb$ ages ranging from 2800 to 2950 Ma. However, analytical results from two light brown and more homogeneous zircon crystals and one overgrowth yielded identical ages of crystallization of 2712±4 Ma, interpreted as the age of emplacement for the intrusion. This age is equivalent to other results obtained from samples collected in clinopyroxene units in adjacent areas.

Desbergères Suite (Adeb)

Granodiorites of the Desbergères Suite were dated in the Maricourt and Lacs des Loups Marins areas. U-Pb zircon isotope analyses yielded respective ages of crystallization of 2683 +4/-2 Ma (Simard *et al.*, 2002) and 2714 ±12 Ma (Gosselin *et al.*, 2002).

In the Lac à l'Eau Claire area, a sample of biotite-hornblende granodiorite from unit Adeb1 (site 4, Figure 2 and Table 1) yielded an age of crystallization of 2711±4 Ma, *i.e.* similar to the age obtained in the Lacs des Loups Marins area. These results suggest the emplacement of granodioritic intrusions of the Desbergères Suite took place in several episodes. Note that the age obtained for the Desbergères Suite granodiorite is equivalent to the age of the granitic phase (2713±2 Ma) in the "granitized" tonalite sample of the Favard Suite from the Lac Bienville area (Gosselin *et al.*, 2004). This result supports the hypothesis that a link exists between the emplacement of plutons of the Desbergères Suite and the regional granitization phenomenon that affects tonalitic units.

Qullinaaraaluk Suite (Aluk)

In the Lac à l'Eau Claire area, an age dating analysis was conducted on a sample of massive leucogabbro from unit Aluk1 of the Qullinaaraaluk Suite, collected near the Flipper showing discovered by Falconbridge Nickel (site 5, Figure 2 and Table 1). Zircons recovered from this sample mainly consist of clear colourless to light brown fragments. A few crystals resemble subautomorphic prisms that exhibit magmatic zoning patterns. Analyses by *in situ* laser ablation (LA-MC-ICP-MS) conducted on 14 grains are practically all concordant and yield an age of crystallization of 2700±3 Ma. This age is relatively early for this type of intrusion. In contrast, Parent *et al.* (2003) in the Lac Vernon area, and Simard *et al.* (2004) in the Rivière Innuksuac area, considered intrusive rocks of the Qullinaaraaluk Suite as late, based primarily on the massive and undeformed nature of these intrusions. Furthermore, in the vicinity of the Qullinaaraaluk showing, Labbé *et al.* (2001) mentioned that in certain locations, the long axis of mafic intrusions is at an angle relative to the regional structural trend, suggesting these intrusions are post-tectonic. It is therefore possible that the Qullinaaraaluk Suite may in fact group mafic and ultramafic intrusions related to magmatic events of different ages.

Bourdel Syenite (Abol)

A sample was collected in the nepheline syenite intrusion located near Lac Bourdel (site 6, Figure 2 and Table 1), in the northeastern part of the study area. Baddeleyite is a zirconium oxide (ZrO_2) typically encountered in alkaline lithologies. It represents a primary mineral related to magmatic crystallization. Analyses by isotopic dilution (TIMS) of three baddeleyite fractions yielded concordant results that helped establish the age of emplacement at 2675±1 Ma. The Bourdel Syenite is therefore the youngest Archean unit in the Lac à l'Eau Claire area.

LITHOGEOCHEMISTRY

Most intrusive suites observed in the Lac à l'Eau Claire area were previously identified in adjacent areas (Gosselin and Simard, 2001; Simard *et al.*, 2002; Gosselin *et al.*, 2002; Parent *et al.*, 2003). To facilitate their lithogeochemical characterization, lithodemic suites of the Lac à l'Eau Claire area were subdivided into three groups, namely: 1) felsic to intermediate intrusive rocks, 2) mafic to ultramafic intrusive rocks and volcanic rocks, and 3) diabase dykes.

A total of 170 rock samples from the various lithostratigraphic units were analyzed for major elements and a series of trace elements. Analyses were performed at Acme Analytical Laboratories in Vancouver by inductively coupled plasma emission spectrometry (*ICP-ES*; major elements and S, C, Ba, Ni, Sc, Sr, Y, Zr) and by inductively coupled plasma mass spectrometry (*ICP-MS*; Au, Ag, As, Ba, Bi, Cd, Co, Cs, Cu, Ga, Hf, Hg, Mo, Nb, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, Tl, U, V, W, Zn, Zr, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu). Analytical results and sample locations are available from the Department via SIGÉOM (Québec geomining information system) databases. Average

TABLE 2 - Average composition, with minimum and maximum concentrations for felsic to intermediate intrusive rocks of the Lac à l'Eau Claire area.

Rock type Unit	Granite/granodiorite (Adeb1, Adeb2)		Leucotonalite (Afav1)		Tonalite (Acou2)		Diorite/quartz diorite (Acou1)		Tonalite/diorite (Alma1a)		Granodiorite (Alma1b. Alma1c)		Enderbite/OX diorite (Alma2)	
n	43		10		8		3		7		4		5	
variables	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**
SiO_2 (%)	70.71	63.80-74.78	69.51	63.29-74.8	64.6	60.52-69.38	52.32	49.70-54.16	58.39	49.93-70.68	67.82	66.72-68.49	60.73	53.82-67.52
TiO_2	0.28	0.11-0.59	0.34	0.13-0.54	0.49	0.36-0.70	1.77	1.15-2.84	1.05	0.54-2.26	0.48	0.43-0.60	0.62	0.45-0.87
Al_2O_3	14.35	13.03-16.20	15.34	13.43-19.93	15.88	14.39-16.79	16.15	14.06-18.10	16.84	15.51-18.82	15.34	14.97-15.74	17.02	15.06-18.85
Fe_2O_3t	2.65	1.06-5.06	3.02	1.59-4.68	4.88	3.53-6.55	11.12	10.62-12.05	7.65	2.46-12.41	3.7	3.35-4.19	6.22	4.66-9.58
MnO	0.03	0.01-0.08	0.04	0.02-0.07	0.08	0.05-0.13	0.12	0.11-0.13	0.08	0.04-0.14	0.05	0.04-0.05	0.08	0.04-0.12
MgO	0.93	0.29-2.68	0.96	0.43-1.93	1.98	1.16-3.05	3.87	3.51-4.30	2.65	0.85-4.50	1.1	0.96-1.26	3.08	1.57-6.21
CaO	1.96	0.64-3.94	3.18	1.83-4.69	4.13	3.32-5.32	7.02	6.22-7.82	5.72	3.79-7.69	3.05	2.94-3.20	5.52	3.08-6.82
Na_2O	3.41	2.53-4.08	4.5	3.57-5.98	4.11	3.51-4.62	3.57	3.45-3.75	4.15	3.38-4.46	3.7	3.46-4.06	4.04	3.32-4.71
K_2O	4.22	2.80-6.12	1.71	0.80-3.00	2.2	1.43-3.03	1.66	0.96-2.34	1.76	1.17-2.39	3.34	2.76-3.74	1.57	0.88-2.07
P_2O_5	0.08	0.01-0.24	0.09	0.01-0.17	0.16	0.08-0.23	0.5	0.38-0.63	0.47	0.10-1.02	0.17	0.13-0.27	0.3	0.09-0.82
Ba (ppm)	1015	469-2559	376	87-755	538	288-972	616	338-978	655	232-990	871	729-1235	663	330-813
Rb	135	86-263	66	36-113	97	50-137	75	23-135	69	41-98	101	67-131	44	10-64
Cs	1.07	0.1-4.4	0.8	0.3-2.6	1.1	0.2-2.1	0.4	0.2-0.8	0.5	0.1-1.1	0.3	0.1-0.5	0.1	0.1-0.2
Th	18,0	0.9-51.9	20.1	2.9-74.6	13	6.2-40.9	3.5	0.9-7.5	2.9	1.5-7.7	4,0	1.7-5.7	1.1	0.3-2.3
U	1.6	0.1-6.4	1.3	0.3-3.3	1.4	0.3-2.7	0.6	0.3-1.0	0.6	0.1-1.4	0.3	0.1-0.7	0.2	0.1-0.4
Ta	0.4	0.1-1.8	0.4	0.1-0.7	0.6	0.2-1.5	0.7	0.4-1.3	0.5	0.2-1.0	0.2	0.1-0.2	0.3	0.1-0.6
Nb	5.5	1.3-16.0	5.5	2.3-13.1	8.3	5.4-12.5	14.1	8.2-21.6	10,0	2.8-24.2	5,0	4.7-5.9	6.1	3.7-10.4
Sr	370	176-645	426	269-753	464	272-649	637	433-840	653	451-864	478	359-627	584	410-772
Zr	138	83-301	173	119-279	122	78-175	231	120-289	279	114-501	175	118-251	178	98-250
Hf	4.3	2.5-8.9	5	1.7-7.6	3.8	2.2-5.2	6,0	3.1-7.9	7.2	3.0-12.0	5.3	3.5-6.8	4.8	2.5-6.9
Y	8.7	1.5-29.2	8.8	2.0-18.6	18.3	8.5-32.8	27.9	24.4-30.6	20.6	4.9-40.7	8.6	7.0-10.5	13.5	5.9-18.9
La	39.2	7.0-85.0	41.9	10.0-83.5	33.9	18.2-50.4	43,0	28.9-60.9	49.9	22.0-78.9	44.4	29.4-70.7	39.2	17.2-66.7
Ce	69.7	10.4-147.6	73.2	17.2-148.7	63.7	43.5-92.6	98.4	66.9-135.6	103.2	38.9-182.1	79.1	53.4-130.5	75.1	30.8-139.0
Nd	24.5	3.2-55.4	26.8	7.1-48.0	30.7	21.5-38.8	54.4	42.6-67.6	52.5	14.8-105.0	31.2	22.5-52.5	33.6	12.0-65.3
Sm	3.6	0.5-9.4	3.7	1.2-6.6	5.5	3.4-8.4	10.9	9.4-12.0	9.1	2.4-18.1	4.8	3.6-7.9	5.7	2.1-10.2
Eu	0.8	0.4-1.5	0.9	0.4-1.6	1.1	0.7-1.6	2.4	1.9-2.7	1.8	0.8-3.8	1.1	0.9-1.6	1.3	0.7-1.9
Yb	0.8	0.2-2.6	0.8	0.3-1.7	1.6	0.6-3.2	2.1	1.7-2.4	1.7	0.4-3.2	0.6	0.6-0.7	1.2	0.6-1.7
Lu	0.1	<0.1-0.4	0.1	<0.1-0.3	0.2	0.1-0.4	0.3	0.3-0.3	0.2	<0.1-0.4	0.1	0.1-0.1	0.2	0.1-0.3
V	34	6-91	33	10-47	74	42-123	212	138-250	129	25-203	54	41-65	88	63-127
Ni	6	2-16	7	4-14	13	8-18	15	10-23	15	7-36	7	4-10	24	8-71
Co	5	1-12	5	2-9	11	6-18	30	29-32	19	6-31	7	6-9	18	10-34
Mg#	0.36	0.19-0.49	0.34	0.21-0.43	0.39	0.33-0.46	0.36	0.32-0.39	0.36	0.31-0.41	0.32	0.30-0.36	0.44	0.35-0.51

n = number of analyzed samples
Mg# = MgO/(MgO+$Fe^{2}O^{3}$t*1.1111) (mole %)

TABLE 3 - Average composition, with minimum and maximum concentrations for mafic to ultramafic intrusive rocks and felsic volcanic rocks of the Lac à l'Eau Claire area.

Rock type	Hornblendite/pyroxenite		Gabbro/gabbronorite		Gabbro/diorite		Amphibolite		Rhyodacite/dacite		Diabase (N-S)		Diabase (E-W)		Diabase (NW-SE)	
Unité	(Aluk1)		(Aluk2)		(Amel4)		(Amel2)		(Amel1)							
n	19		9		6		3		8		10		21		3	
variables	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**	**ave.**	**min.-max.**
SiO_2 (%)	50.05	42.87-55.01	47.97	44.17-52.47	54.28	48.60-68.01	49.99	47.40-54.51	65.98	61.17-68.80	45.18	33.20-51.44	49.18	46.25-53.26	49.4	45.87-51.76
TiO_2	0.61	0.29-1.50	1.58	0.68-3.79	1.27	0.54-2.21	1.14	1.04-1.21	0.46	0.33-0.61	1.86	0.88-2.62	1.69	0.77-2.85	1.62	1.04-2.36
Al_2O_3	14.35	13.03-16.20	14.48	8.34-17.69	15.55	13.86-16.95	15.27	14.55-16.35	16.03	14.91-16.77	14.88	12.19-16.79	14.05	12.30-16.70	15.56	15.15-15.89
Fe_2O_3t	12.25	8.90-19.82	13.1	9.72-16.26	11.08	5.62-16.16	13.35	9.88-17.37	4.84	3.41-6.31	12.54	6.22-17.32	12.51	4.95-16.49	10.36	8.44-11.60
MnO	0.18	0.11-0.25	0.15	0.10-0.20	0.16	0.08-0.29	0.22	0.12-0.37	0.06	0.03-0.07	0.15	0.06-0.25	0.16	0.04-0.23	0.14	0.06-0.19
MgO	13.66	5.98-24.25	7.04	4.52-12.35	4.8	3.43-7.31	5.89	5.01-7.59	1.36	0.81-2.85	9,00	5.88-12.88	6.76	4.24-10.68	7.99	4.11-10.67
CaO	10.76	4.71-15.00	8.87	5.63-14.10	6.91	2.74-8.65	8.37	6.94-9.61	3.16	2.44-4.33	6.38	1.07-12.64	7.69	0.78-11.57	5.57	2.39-8.21
Na_2O	1.41	0.54-3.15	2.79	1.48-4.14	3.4	2.44-4.45	3.26	2.72-3.76	3.91	3.22-4.29	1.9	0.17-2.88	2.31	0.97-4.85	2.87	1,89-3.75
K_2O	0.94	0.31-2.02	1.56	0.49-2.50	1.42	0.31-3.88	1.17	0.45-1.81	2.72	1.76-3.57	1.28	0.02-4.98	1.14	0.22-2.52	1.07	0.26-2.03
P_2O_5	0.16	0.02-0.64	0.39	0.06-1.50	0.39	0.04-1.08	0.07	0.04-0.10	0.15	0.11-0.23	0.23	0.06-0.34	0.22	0.06-0.44	0.27	0.10-0.55
Ba (ppm)	238	46-1010	455	212-962	742	87-2984	218	131-361	855	645-1266	252	30-764	678	42-4747	443	76-1074
Rb	37	7-116	58	6-107	63	4-175	32	13-71	99	56-136	43	8-128	38	3-121	30	4-47
Cs	0.57	0.1-3.5	0.6	0.1-1.5	1,0	0.1-3.4	0.5	0.1-0.8	5.8	2.1-20.7	1.2	0.1-3.6	0.5	0.1-3.2	0.3	0.1-0.5
Th	1.9	0.5-10.3	2,0	0.7-5.0	3.1	0.5-13.2	1.1	0.6-2.0	8.1	4.7-14.7	1.4	0.5-3.5	1.6	0.2-3.8	0.9	0.4-1.8
U	0.3	0.1-1.3	0.5	0.1-0.8	0.5	0.1-1.5	0.3	0.1-0.7	1.7	0.8-2.7	0.4	0.1-1.2	0.3	0.1-1.4	0.3	0.2-0.3
Ta	0.2	0.1-0.5	0.5	0.1-1.1	0.5	0.2-1.1	0.3	0.2-0.4	0.5	0.3-0.8	0.6	0.2-1.3	0.7	0.1-1.7	0.5	0.2-1.0
Nb	2.6	0.5-7.2	7.8	1.7-17.6	9.4	5.2-21.2	4.3	3.0-6.8	5.3	3.8-7.6	9.2	2.8-21.4	10.7	2.1-25.9	8.4	3.6-15.1
Sr	269	90-1424	601	286-908	462	118-1098	224	147-372	574	334-785	165	11-447	248	70-461	239	80-455
Zr	51	21-193	96	22-300	140	103-267	68	46-103	111	89-132	120	48-149	124	41-223	95	54-121
Hf	1.6	0.5-4.8	2.7	0.5-8.0	4,0	3.2-6.6	2.3	1.2-3.4	3.4	2.4-3.9	3.3	1.5-4.9	3.5	1.4-6.3	2.2	1.4-3.0
Y	16.1	8.4-31.3	19.1	5.6-32.8	26.5	11.3-39.3	22.8	14.9-28.7	11.2	6.0-14.6	29.5	12.6-50.3	31.8	13.6-52.0	24.1	20.0-26.3
La	17.9	4.2-60.8	28.1	6.9-86.1	31.7	8.9-50.9	11.7	5.9-19.2	24.6	6.0-39.7	14.1	4.3-22.5	17.8	5.3-35.7	18,0	6.1-30.0
Ce	41.6	12.3-130.2	62.9	16.5-182.6	67.8	21.1-118.3	24.7	14.6-40.2	44.9	10.0-72.1	29.5	5.7-48.9	38.1	11.7-69.6	36.8	14.4-60.2
Nd	24.1	9.2-60.6	35.2	8.3-93.1	36.9	15.3-68.3	15.2	9.6-24.5	19,0	3.4-30.3	17.9	3.1-27.2	22.4	8.3-36.5	22.4	10.5-34.1
Sm	5,0	2.2-10.2	6.9	1.8-15.9	7.5	3.6-12.5	3.3	2.6-4.3	3.2	0.9-4.9	4.2	0.9-7.6	5.1	2.1-8.4	4.5	2.8-5.9
Eu	1.1	0.5-1.8	1.7	0.6-2.9	1.8	0.8-3.2	1,0	1.0-1.2	0.8	0.5-1.2	1.2	0.2-2.2	1.6	0.8-2.4	1.7	0.9-2.4
Yb	1.5	0.7-3.2	1.7	0.6-2.9	2.4	1.1-4.6	2.5	1.3-3.1	1.1	0.6-1.6	3.1	1.8-4.4	3.1	1.4-5.5	2.3	1.9-2.7
Lu	0.2	0.1-0.5	0.2	0.1-0.4	0.3	0.2-0.6	0.4	0.2-0.4	0.2	0.1-0.2	0.5	0.3-0.7	0.5	0.2-0.8	0.4	0.3-0.4
V	251	112-931	294	133-506	188	101-234	270	139-370	81	42-120	349	267-476	323	167-471	253	199-311
Ni	157	32-1347	64	3-225	46	4-114	77	60-110	19	6-47	57	33-84	41	21-102	59	36-92
Co	74	40-139	50	31-68	32	24-38	48	35-59	11	6-20	52	35-81	46	25-60	51	41-65
Mg#[1]	0.64	0.43-0.75	0.46	0.32-0.65	0.41	0.25-0.52	0.41	0.32-0.49	0.31	0.19-0.42	0.53	0.35-0.75	0.46	0.31-0.75	0.55	0.37-0.67

n = number of analyzed samples

Mg# = MgO/(MgO+$Fe^{2}O^{3}$t*1.1111) (mole %)

compositions as well as minimum and maximum values for the different lithodemic units are listed in tables 2 and 3.

Felsic to Intermediate Intrusive Rocks

According to the distribution of analytical data on the normative classification diagram by O'Connor (1965), rocks of the tonalitic Favard (Afav1) and Coursolles (Acou) suites plot mainly in the field of tonalites (Figure 4a; left). Samples that plot in the field of granodiorites correspond to tonalites affected by the "granitization" phenomenon. Clinopyroxene-bearing tonalites and diorites as well as enderbites and orthopyroxene diorites, respectively assigned to units Alma1a and Alma2 of the Loups Marins Complex, also plot in the field of tonalites, whereas rocks from subunits Alma1b and Alma1c of the same complex are clustered in the field of granodiorites (Figure 4a, centre). Finally, rocks of the Desbergères Suite mainly plot in the field of granodiorites for unit Adeb1 and in the field of granites for unit Adeb2 (Figure 4a; right). As illustrated on the diagram showing the alumina saturation index (Figure 4b; Maniar and Piccoli, 1989), most of the felsic intrusive rocks in the area exhibit a peraluminous affinity. Samples with a metaluminous signature are mainly intermediate in composition. This difference may be explained by the greater proportion of calcium-rich ferromagnesian minerals (*e.g.* clinopyroxene, hornblende) in intermediate rocks. Note that several samples from the biotite granite and granodiorite unit of the Desbergères Suite (Adeb2) plot in the field of metaluminous rocks, near the boundary with peralkaline rocks. This is probably due to the high orthoclase content in these rocks, as illustrated in Figure 4a.

The diagram Rb versus Y+Nb by Pearce *et al.* (1984) (Figure 4c) is used to discriminate paleotectonic settings. Samples from the various units plot in the field of volcanic arc granitoids, except for samples from the biotite granite and granodiorite unit of the Desbergères Suite (Adeb2). In the latter case, these samples are primarily clustered in the field of syn-collisional granitoids. This suggests that the unit has a crustal component, which would explain its high K_2O content and higher LILE (large ion lithophile elements) values, namely for Rb, Ba, Th and U.

Figures 4d to 4g show variations of certain major elements relative to the silica content. Overall, rocks from the various intrusive suites show similar characteristics, namely a gradual decrease in MgO, CaO and TiO_2, and an increase in K_2O relative to SiO_2. These trends are typical of a magmatic differentiation process involving crystal fractionation of the main mineral constituents. Intermediate rocks of the Coursolles Suite (Acou1) and the Loups Marins Complex (Alma1a and Alma2) are systematically enriched in MgO, CaO and TiO_2 and depleted in K_2O, which demonstrates these rocks are not as fractionated as more felsic units. The biotite granite and granodiorite unit (Adeb2) of the Desbergères Suite, on the other hand, shows the highest degree of magmatic differentiation. Finally, the sample from the Bourdel Syenite (Abol) shows a chemical composition markedly different from the other magmatic rocks on binary diagrams in Figure 4, suggesting this intrusion likely has a distinct origin.

Mafic to Ultramafic Intrusive Rocks and Volcanic Rocks

Figure 5 shows a series of binary and ternary geochemistry diagrams used to characterize the various mafic to ultramafic intrusive rocks and the volcanic rocks of the Lac à l'Eau Claire area (Figure 5a to d), and interpret their paleotectonic environment (Figure 5e) and crystallization processes (Figure 5f to i).

On the discrimination diagram by Irvine and Baragar (1971) (Figure 5a), most rocks show a subalkaline affinity. However, this diagram makes an important distinction between ultramafic rocks and mafic rocks of the Qullinaaraaluk Suite (Aluk). All ultramafic samples plot in the field of subalkaline rocks, whereas most samples of mafic composition plot in the field of alkaline rocks. The classification diagram SiO_2 versus Zr/TiO_2 by Winchester and Floyd (1977) (Figure 5b) shows that most samples from mafic to ultramafic units plot in the field of basalts. It is interesting to note that mafic rocks of the Qullinaaraaluk Suite have lower Zr/TiO_2 ratios and SiO_2 contents than ultramafic rocks of the same intrusive suite. Felsic volcanic rocks of the Melvin Complex (Amel1) plot in the field of rhyodacites and dacites. On the AFM diagram (Figure 5c), mafic to ultramafic rocks of the Qullinaaraaluk Suite exhibit a tholeiitic signature, whereas felsic volcanic rocks of the Melvin Complex show a calc-alkaline affinity. Most diorite, gabbro (Amel4) and amphibolite (Amel2) samples from the Melvin Complex plot near the boundary between the tholeiitic and calc-alkaline fields. On a Jensen diagram (1976) (Figure 5d), ultramafic rocks of the Qullinaaraaluk Suite (Aluk1) plot in the field of basaltic komatiites. Mafic intrusive rocks of the Qullinaaraaluk Suite (Aluk2) and amphibolites of the Melvin Complex (Amel2) plot in the field of high-Fe tholeiites. Felsic rocks of the Melvin Complex are scattered in the fields of tholeiitic rhyolites and dacites, near the boundary with calc-alkaline rocks. This result differs from what the AFM diagram indicates. It is therefore difficult to interpret the affinity of these felsic rocks based on these geochemistry diagrams (Figure 5c and d).

The paleotectonic discrimination diagram by Pearce and Cann (1973) (Figure 5e) shows an important scatter of samples for all units, making it quite difficult to risk a coherent interpretation for their genetic environment. Most mafic to ultramafic rocks plot in the fields of ocean floor basalts and calc-alkaline basalts. Felsic rocks of the Melvin Complex generally plot outside of defined fields for specific paleotectonic settings; the same can be said for several mafic samples of the Qullinaaraaluk Suite.

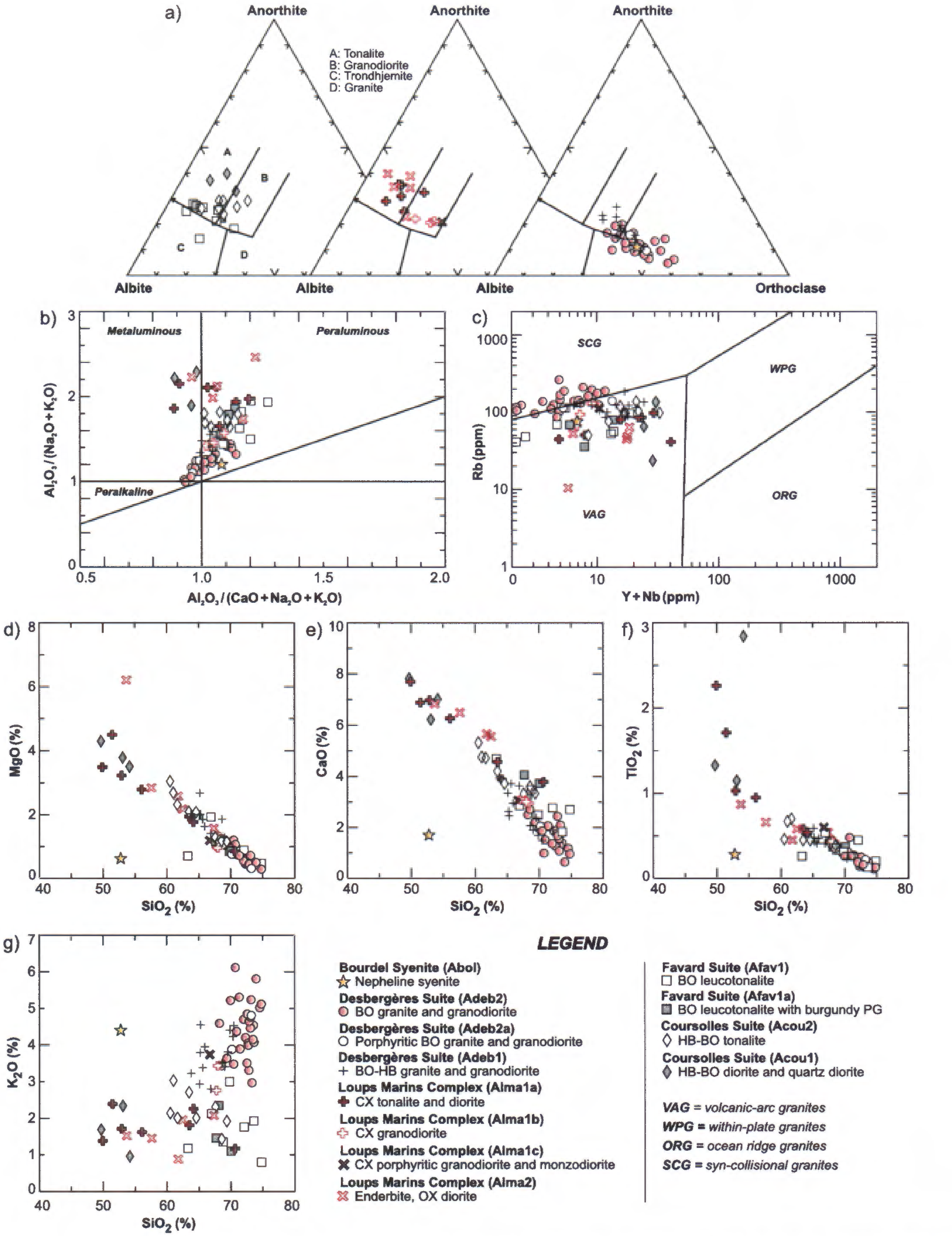


FIGURE 4 - Geochemistry diagrams showing the composition of felsic to intermediate intrusive rocks of the Lac à l'Eau Claire area: **a)** Normative albite-anorthite-orthoclase classification diagram by O'Connor (1965); **b)** Alumina saturation index by Maniar and Piccoli (1989); **c)** Binary discrimination diagram by Pearce *et al.* (1984); **d)** MgO versus SiO_2 binary diagram; **e)** CaO versus SiO_2 binary diagram; **f)** TiO_2 versus SiO_2 binary diagram; **g)** K_2O versus SiO_2 binary diagram. (BO = biotite; HB = hornblende; CX = clinopyroxene; OX = orthopyroxene; PG = plagioclase)

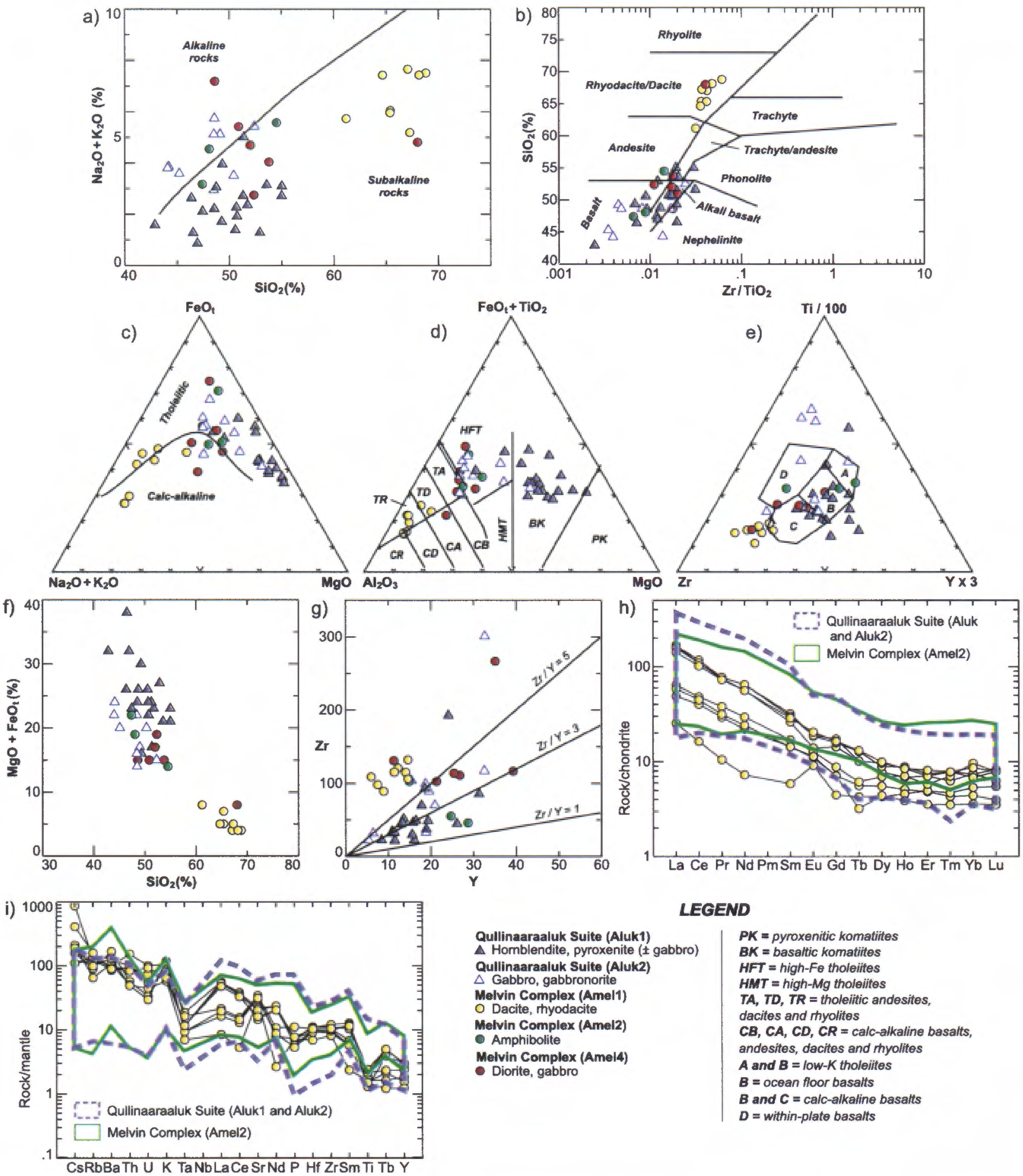


FIGURE 5 - Geochemistry diagrams showing the composition of mafic to ultramafic intrusive rocks and felsic volcanic rocks of the Lac à l'Eau Claire area: **a)** Binary discrimination diagram by Irvine and Baragar (1971); **b)** Binary classification diagram by Winchester and Floyd (1977); **c)** AFM ternary discrimination diagram by Irvine and Baragar (1971); **d)** Ternary discrimination diagram by Jensen (1976); **e)** Ternary discrimination diagram by Pearce and Cann (1973); **f)** MgO+FeOt versus SiO_2 binary diagram; **g)** Zr versus Y binary diagram modified after Neal *et al.* (1999); **h)** Chondrite-normalized rare earth element (REE) diagram by Sun and McDonough (1989); **i)** Mantle-normalized multi-element diagram by Wood *et al.* (1979).

Figures 5f and 5g show binary diagrams comparing major element variations ($MgO+FeO_t$ versus SiO_2) and trace element variations (Zr versus Y), respectively. On the diagram in Figure 5f, SiO_2 is plotted along the x-axis to determine the effects of crystal fractionation on the geochemical evolution of the various units. On this diagram, all units show a gradual decrease in $MgO+FeO_t$ relative to increasing silica. This trend is compatible with an evolution by crystal fractionation of ferromagnesian phases such as pyroxene, amphibole and mica. Furthermore, this diagram suggests that mafic and ultramafic rocks of the Qullinaaraaluk Suite are not comagmatic. On the diagram in Figure 5g, most ultramafic samples from the Qullinaaraaluk Suite (Aluk1), as well as amphibolites of the Melvin Complex (Amel4) possess Zr/Y ratios below 3, typical of tholeiitic rocks. Mafic rocks from the Qullinaaraaluk Suite (Aluk2) and intermediate to mafic rocks of the Melvin Complex (Amel4) have Zr/Y ratios generally between 3 and 5, whereas felsic rocks of the Melvin Complex (Amel1) show ratios greater than 5. On a rare earth element (REE) diagram normalized to chondrites (Sun and McDonough, 1989) (Figure 5h), mafic and ultramafic rocks of the Qullinaaraaluk Suite (Aluk2 and Aluk1) show patterns that are slightly more fractionated than those for amphibolites of the Melvin Complex (Amel2), with lanthanum values as high as about 350 and 200 times chondrites respectively. These are very high values for mafic to ultramafic rocks, which possibly indicates a source strongly enriched in incompatible elements (*e.g.* mantle plume). Note that the diorite and gabbro unit of the Melvin Complex (Amel4) contains average REE concentrations very similar to rocks of the Qullinaaraaluk Suite (Table 3). Felsic volcanic rocks of the Melvin Complex (Amel1) exhibit relatively steep patterns typical of fractionated rocks, with lanthanum values ranging from 25 to 175 times chondrite.

Figure 5i (Wood *et al.*, 1979) shows once again that mafic to ultramafic rocks of the Qullinaaraaluk Suite (Aluk2 and Aluk1) show patterns very similar to those of amphibolites of the Melvin Complex (Amel2). Positive Ba, K, La, Nd, Sm, and Tb anomalies are observed, associated with negative anomalies in U, Ta, Sr and Ti (±P). This pattern is typically observed in island arc rocks or mantle plume rocks. Felsic volcanic rocks of the Melvin Complex (Amel1) on the other hand, have much steeper profiles, although they follow roughly the same pattern as mafic to ultramafic rocks and amphibolites. This suggests a common source, but with a different degree of fractionation for these lithologies.

Diabase Dykes

Figure 6 shows analytical results from samples of Proterozoic diabase dykes collected in the Lac à l'Eau Claire area. These dykes follow three main orientations, namely N-S, E-W and NW-SE. The results were plotted on a series of binary and ternary diagrams (Figure 6). However, these diagrams fail to distinguish each family of dykes from a geochemical standpoint.

On the AFM diagram (Figure 6a), most of the diabase dykes exhibit a tholeiitic affinity. The Jensen diagram (1976) confirms this trend (Figure 6b), since most samples plot in the field of high-Fe tholeiites. The paleotectonic discrimination diagram by Pearce and Cann (1973) (Figure 6c) shows that most dykes plot in the field of ocean floor basalts. This trend is also observed on the V versus Ti/1000 discrimination diagram by Shervais (1982) (Figure 6d), where the diabase dykes plot in the field typically associated with MORB or back-arc basin basalts. Figures 6e and 6f show binary diagrams illustrating MgO and TiO_2 variations relative to SiO_2 content. In both cases, MgO and TiO_2 are widely variable whereas SiO_2 contents remain relatively constant.

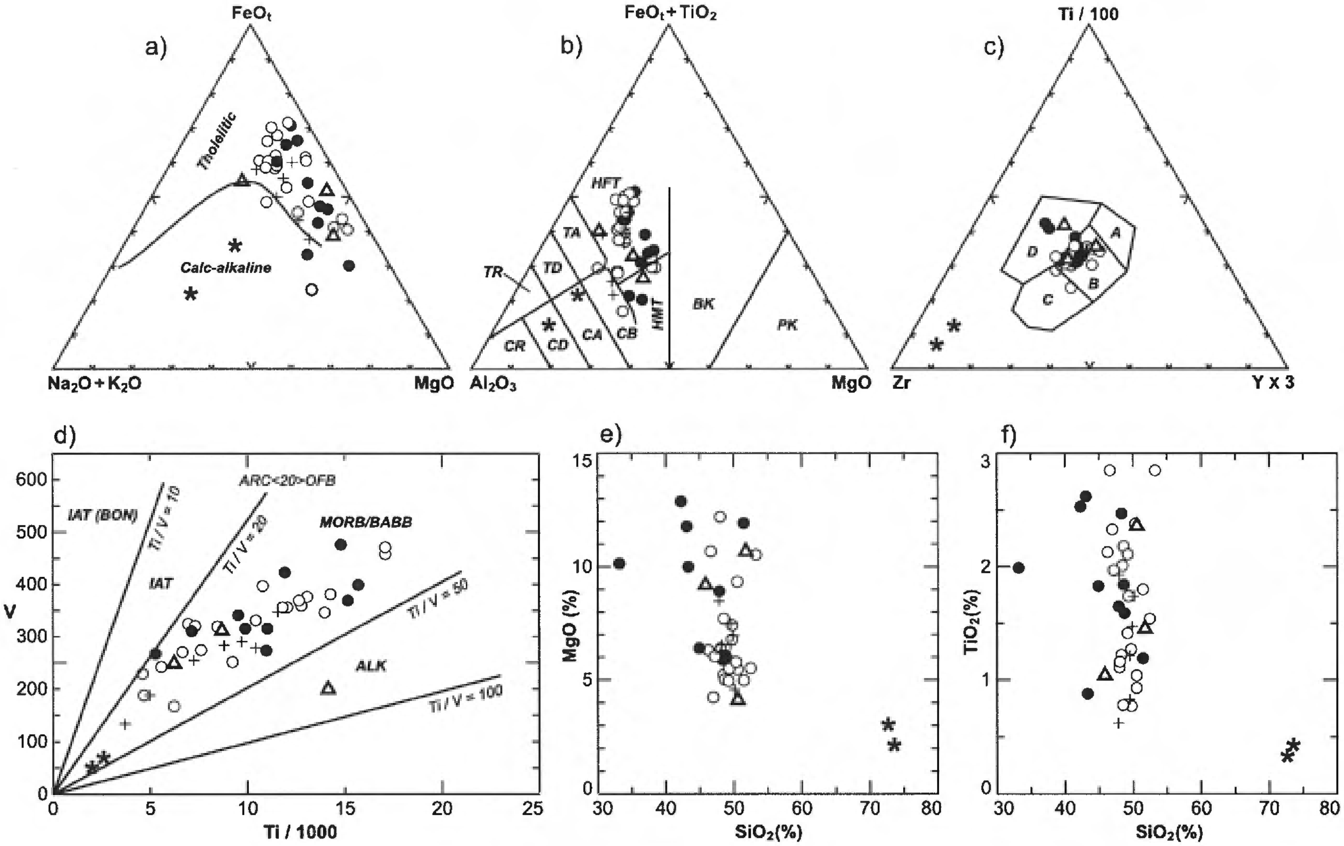
All diagrams in Figure 6 illustrate the distinct chemical composition of intrusive breccias (diatreme?) relative to diabase dykes. This suggests a different source and mode of emplacement.

METAMORPHISM

Volcano-sedimentary rocks contain the most diagnostic mineral assemblages to characterize the various metamorphic facies. The scarcity of these rock types in the Lac à l'Eau Claire area makes it difficult to interpret prevailing metamorphic conditions. Mineral assemblages observed in felsic intrusive rocks might reflect initial emplacement conditions rather than metamorphic conditions. The presence and identification of recrystallization textures in these rocks thus becomes an important element to estimate regional metamorphic conditions.

Volcano-Sedimentary Rocks

Mafic to intermediate volcanic and intrusive rocks from volcano-sedimentary bands of the Melvin Complex (Amel2 and Amel4) and from enclaves in various granitoid suites exhibit a well-developed granoblastic texture. Mineral assemblages observed in these rocks indicate metamorphic conditions ranging from the amphibolite facies to the granulite facies. Most of the samples that were examined were collected in the northeastern part of the area, where volcano-sedimentary rocks are most abundant. The amphibolite facies is represented by the assemblage hornblende + clinopyroxene + biotite + epidote (pistacite), whereas the granulite facies is represented by the assemblage orthopyroxene + clinopyroxene + hornblende + biotite. Felsic volcanic rocks of the Natwakupaw Belt (Amel1) generally contain the assemblage plagioclase + quartz + biotite ± epidote. Given the absence of granoblastic textures in the intrusive country rocks, mineral assemblages and textures observed in supracrustals rocks of the area may correspond to a tectono-metamorphic event that predates the emplacement of these intrusions. On the other hand,



LEGEND

- ● Diabase dyke (N-S trending)
- ○ Diabase dyke (E-W trending)
- △ Diabase dyke (NW-SE trending)
- + Diabase dyke (undetermined)
- ✱ Intrusive breccia (diatreme?)

PK = pyroxenitic komatiites
BK = basaltic komatiites
HFT = high-Fe tholeiites
HMT = high-Mg tholeiites
TA, TD, RT = tholeiitic andesites, dacites and rhyolites

CB, CA, CD, CR = calc-alkaline basalts, andesites, dacites and rhyolites
A and B = low-K tholeiites
B = ocean floor basalts
B and C = calc-alkaline basalts
D = within-plate basalts
MORB = mid oceanic ridge basalt

IAT (BON) = island arc tholeiites (boninitic affinity)
IAT = island arc tholeiites
BABB = back-arc basin basalts
ALK = alkaline rocks
OFB = ocean floor basalts
IA = island arc

FIGURE 6 - Geochemistry diagrams showing the composition of diabase dykes in the Lac à l'Eau claire area: **a)** AFM ternary discrimination diagram by Irvine and Baragar (1971); **b)** Ternary discrimination diagram by Jensen (1976); **c)** Ternary discrimination diagram by Pearce and Cann (1973); **d)** V versus Ti/1000 binary discrimination diagram by Shervais (1982); **e)** MgO versus SiO_2 binary diagram; **f)** TiO_2 versus SiO_2 binary diagram.

these assemblages and textures may also be the result of synmagmatic metamorphism related to higher temperatures associated with the emplacement of these felsic intrusions.

Felsic Intrusive Rocks

Overall, tonalitic, granodioritic and granitic units in the Lac à l'Eau Claire area exhibit a primary igneous texture characterized by the presence of tabular plagioclase crystals, coarse-grained xenomorphic to subautomorphic mafic minerals and interstitial quartz. In fact, granoblastic textures are rather uncommon. At the most, quartz occasionally displays undulatory extinction or forms a mosaic texture produced in part by deformation related to regional fault zones. With the exception of the Loups Marins Complex, the felsic intrusive rocks contain the mineral assemblage biotite + plagioclase + quartz ± hornblende ± muscovite ± epidote corresponding to amphibolite-grade conditions. However, the lack of granoblastic textures suggests this mineral assemblage reflects the initial conditions of emplacement for these rocks. Rocks of the Loups Marins Complex contain the assemblage biotite + plagioclase + quartz + clinopyroxene ± hornblende for clinopyroxene units (Alma1a, Alma1b and Alma1c) and biotite + plagioclase + quartz + orthopyroxene + clinopyroxene ± hornblende for the orthopyroxene unit (Alma2). These assemblages indicate high-temperature conditions equivalent to the upper amphibolite and the granulite facies. However, as for all other felsic intrusions in the area, the lack of internal deformation and recrystallization textures suggests these rocks were emplaced in an environment where such temperature conditions prevailed, and were not subjected to the effects of regional metamorphism and deformation after their emplacement. These rocks were also affected by late hydrothermal alteration, which translates into the partial transformation of clinopyroxene into hornblende and by the alteration of orthopyroxene into serpentine, iddingsite, talc, amphibole, chlorite, carbonate and magnetite.

Rocks located along late fault zones were strongly altered, most likely due to hydrothermal fluid circulation. This type of alteration also affects Archean rocks located near the contact with Proterozoic rocks of the Richmond Gulf Group, where a series of late E-W faults related to the formation of the Richmond Gulf Graben are found. In the most intense alteration zones, biotite and hornblende are strongly altered to green chlorite and pyroxenes and are completely replaced by secondary minerals. Mafic mineral alteration is accompanied by intense saussuritization and sericitization of plagioclase. The rocks in these zones display varied recrystallization textures with mosaic quartz, and also exhibit a strong foliation marked by the alignment of mafic minerals.

STRUCTURE

Phases of Deformation

The structural pattern of the Lac à l'Eau Claire area, generally oriented WNW-ESE to NW-SE, marks an important change in the structural make-up of the northeastern Superior Province. The Lac à l'Eau Claire area sits along the boundary between the southern Minto Subprovince, defined by a NNW-SSE structural trend, and the northern Bienville Subprovince, marked by a WNW-ESE trend. This change in the structural pattern reflects a complex tectonomagmatic evolution spanning the period between 3825 and 2680 Ma (David *et al.*, 2002; Leclair *et al.*, 2001 and 2002a) and marked by the combined action of tectonic constraints and magmatic events.

The structural interpretation of the Lac à l'Eau Claire area is based on the style and intensity of deformation, on the orientation of various fabrics and on cutting relationships. Four phases of ductile deformation (D1 to D4) are recognized, as well as a phase of brittle deformation (D5). The first phase of deformation (D1) is only observed in supracrustal bands and intermediate to mafic enclaves enclosed in granitoids. Phase D2 is marked by a regional foliation generally trending WNW-ESE to NW-SE. The development of this fabric appears to have taken place at least in part in a submagmatic state. Phase D3, weakly developed in the Lac à l'Eau Claire area, is responsible for F3 folds that locally affect the regional foliation (S2). Phase of deformation D4 produced ductile shear zones oriented E-W to WNW-ESE, responsible for the reorientation of the regional structural trend. Finally, phase of deformation D5 produced a set of late brittle faults oriented E-W, forming important cataclastite zones where hematite and epidote alteration are ubiquitous.

Phase of Deformation D1

The first phase of deformation (D1) is characterized by a well-developed planar fabric (S1) occurring either as a penetrative foliation, gneissosity or migmatitic layering. This S1 fabric was observed in supracrustal bands and in enclaves of amphibolite and mafic to intermediate gneiss enclosed in most granitoid units. Locally, rocks in supracrustal bands exhibit a compositional layering enhanced by the presence of mobilizate. Furthermore, as opposed to the granitoid rocks, most Archean supracrustal rocks display a granoblastic texture. These observations suggest that the supracrustal rocks underwent at least one phase of deformation and recrystallization prior to the emplacement of the plutonic rocks. The lack of structural data makes it impossible to conduct a coherent statistical analysis of foliation S1. This phase of deformation is poorly documented and its impact on the regional structural evolution is difficult to ascertain.

Phase of Deformation D2

Most authors of recent studies conducted in Québec's Far North (Lin *et al.*, 1995, 1996; Percival *et al.*, 1995a; Percival and Skulski, 2000; Parent *et al.*, 2001, 2003; Leclair *et al.*, 2002b; Gosselin *et al.*, 2002, 2004; Berclaz *et al.*, 2002) interpret the main foliation as related to phase of deformation D2.

In the Lac à l'Eau Claire area, the regional foliation (S2) affects Archean supracrustal and intrusive rocks, except the Bourdel Syenite (Abol) and mafic and ultramafic intrusions of the Qullinaaraaluk Suite (Aluk). However, certain intrusions of the Qullinaaraaluk Suite exhibit recrystallization textures indicating they have undergone the effects of deformation and high-grade metamorphism. Phase of deformation D2 in the Lac à l'Eau Claire area appears to be equivalent to phase D2 defined in the Lacs des Loups Marins area (Gosselin *et al.*, 2002) and the Lac Bienville area (Gosselin *et al.*, 2004). In granitoid rocks, the intensity and expression of foliation S2 is variable. It often appears as a discrete, poorly defined fabric that is difficult to detect. Foliation S2 is defined by the preferential orientation of biotite and hornblende grains and ferromagnesian mineral aggregates. It may also be marked by stretched quartz and plagioclase grains, and by the alignment of K-feldspar phenocrysts in porphyritic intrusions. Foliation S2 is enhanced by the alignment of mafic to intermediate enclaves which, as they are assimilated to variable degrees, produce a discontinuous banding or generate trains of mafic minerals or biotite schlieren. Furthermore, the "granitization" phenomenon that affects tonalitic units produces cm-scale bands of granitic material parallel to the foliation. These bands are wavy, discontinuous and in diffuse contact with the tonalitic phase. In the southern part of the area, the presence of tonalitic restite in the granitic bodies also enhances the regional S2 foliation.

The following observations suggest that at least part of deformation D2 took place in "submagmatic" conditions (Vernon, 2000): a) the presence of diffuse banding defined by the heterogeneity of the various granitoid phases,

b) the presence of pre-deformed strongly aligned enclaves with no evidence of equivalent deformation within the enclosing granitoids, c) the presence of mafic mineral schlieren produced by the partial assimilation of enclaves, and d) the presence of a foliation defined by the alignment of K-feldspar phenocrysts (1 to 5 cm) in porphyritic intrusions, suggesting flow in plastic-state conditions.

Phase of Deformation D3

Phase of deformation D3 is not widespread in the Lac à l'Eau Claire area. A few mesoscopic NE-SW folds were locally observed on the scale of the outcrop. The presence of certain folds related to this phase may also be interpreted from aerial photographs and Landsat remote sensing images. The limited amount of detailed structural data collected in the field prevents us from adequately documenting phase D3. The effects of this phase of deformation are more important eastward in the Lacs des Loups Marins (Gosselin *et al.*, 2002), Lac Gayot (Gosselin and Simard, 2001) and Maricourt (Simard *et al.*, 2002) areas.

Phase of Deformation D4

The rocks in the study area were affected by ductile shear zones oriented E-W to WNW-ESE, attributable to phase of deformation D4. Most of these structures are concentrated within the Nastapoca Deformation Zone (Figure 7). This zone, roughly 15 to 20 km in width, is made up of several major regional ductile faults from 10 m to 1 km in width. The most important faults may reach up to 5 km wide and are characterized by the presence of protomylonitic to blastomylonitic fabrics. The orientation of these ductile structures shifts from E-W in the western part of the Nastapoca Zone to WNW-ESE along its eastern segment (Figure 7). The intensity of deformation gradually increases from the outside to the centre of the Nastapoca Zone. The first indications of deformation consist in the appearance of a fabric parallel to the zone, defined by the preferential orientation of biotite and incipient stretching in quartz and feldspar. The deformation rapidly progresses to a subvertical to vertical mylonitic fabric. The regional S2 foliation and previous fabrics (S1) are transposed parallel to this mylonitic fabric. Within the Nastapoca Zone, the various lithologies form bands stretched and transposed parallel to ductile faults. In the centre of the zone, the deformation is characterized by a well-developed mylonitic fabric (mylonite to blastomylonite), which contains quartz ribbons and feldspar porphyroclasts. Lineations are rarely observed, however kinematic indicators such as rotated porphyroclasts and C/S fabrics suggest uplift of the north block coupled with an apparent sinistral movement (Grenier, 2003).

On the scale of the map, the Nastapoca Deformation Zone corresponds to a major lithological change between tonalitic units to the north and granitic and granodioritic units to the south. It also marks a change in the direction of the structural trend between the Minto Subprovince, located to the north and characterized by a structural pattern oriented NNW-SSE, and the southern part of the Superior Province largely characterized by an E-W to WNW-ESE-trending structural pattern. These lithological and structural variations therefore suggest that the Nastapoca Deformation Zone marks the boundary between the Bienville Subprovince and the Tikkerutuk domain of the Minto Subprovince.

Phase of Deformation D5

The phase of brittle deformation (D5) is responsible for the development of a network of late E-W-trending subvertical to vertical major faults. Most of these faults are located in the southern half of the area (Figure 7). They correspond to aeromagnetic and geomorphological lineaments. These structures most likely represent the extension of Proterozoic rifts related to the formation of the Richmond Gulf Graben. Faults that were active during the period of sedimentation controlled at least in part the distribution of sedimentary units of the Richmond Gulf Group (Chandler, 1988). They transect Archean units as well as certain Proterozoic diabase dykes. The Archean rocks affected by these faults are strongly hematized, epidotized and locally exhibit a cataclastic texture. The degree of alteration increases near the contact with Proterozoic rocks, despite the existence of an angular unconformity as the contact.

Statistical Compilation and Structural Analysis

The area was subdivided into five structural domains (Figure 7) based on the intensity of deformation and the orientation of the regional foliation (S2). Stereograms depicted in Figure 7 illustrate the average orientation of foliation S2 within each domain.

Domain I covers the area to the northeast of the Nastapoca Deformation Zone (Figure 7). It is characterized by a subvertical foliation trending NW-SE. This orientation coincides with the regional foliation (S2) observed in areas to the north. Intrusive rocks in domain I are generally only weakly deformed, except those located near the Nastapoca Zone. In thin section, the intensity of deformation is seen to increase going toward the zone. The deformation begins with a strongly developed undulatory extinction in quartz, followed by the progressive recrystallization of quartz grains and eventually to the formation of a mylonitic fabric.

Domain II corresponds to the Nastapoca Deformation Zone itself. It was subdivided into two sub-domains corresponding to the western segment (IIa) and the eastern segment (IIb) (Figure 7). The internal foliation of the zone is roughly E-W in sub-domain IIa and WNW-ESE in sub-domain IIb. The mylonitic fabric that characterizes this zone has transposed the regional S2 foliation as well as all other

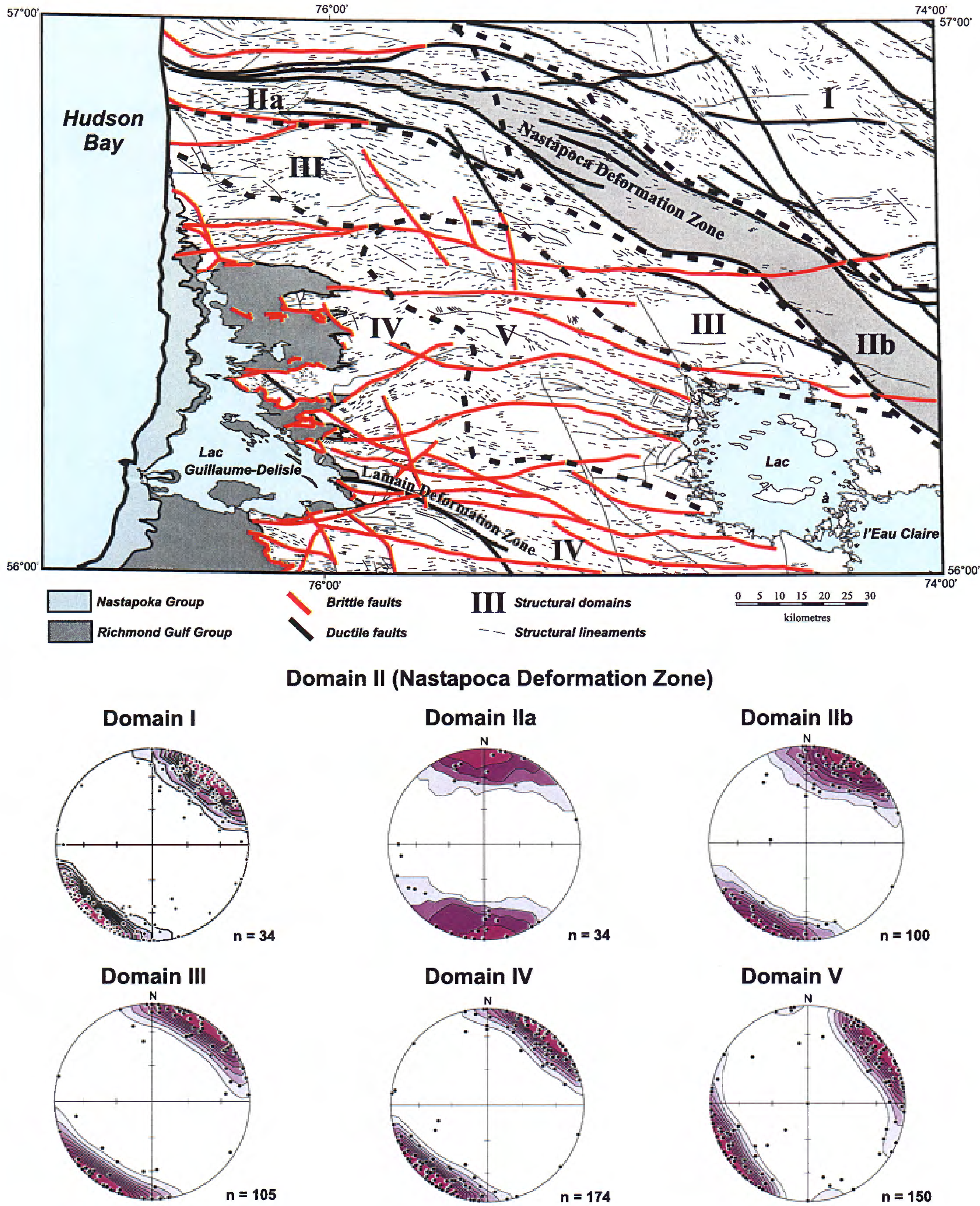


FIGURE 7 - Structural domains in the Lac à l'Eau Claire area and stereographic projections of regional foliation S2 using method by Schmidt. (n = number of measurements)

prior structures. It is within the Nastapoca Deformation Zone that Archean rocks of the Lac à l'Eau Claire area show the most intense deformation. In thin section, they exhibit recrystallization textures that commonly result in a mylonitic fabric.

Domain III is located just south of the Nastapoca Deformation Zone (Figure 7). The stereogram shows the S2 foliation is widely scattered, with a cluster giving an average NW-SE orientation, which indicates the foliation in this domain is broadly parallel to the general orientation of the Nastapoca Zone. In thin section, rocks in this domain are characterized by recrystallization textures, namely mosaic quartz surrounding coarser-grained plagioclase as well as K-feldspar phases.

Domain IV is located in the southern and southwestern parts of the Lac à l'Eau Claire area (Figure 7). This domain comprises all Archean rocks in contact with Proterozoic units of the Richmond Gulf and Nastapoka groups. Archean rocks in this domain are particularly affected by late brittle faults associated with phase of deformation D5. The stereogram in Figure 7 shows a steeply dipping average foliation oriented NW-SE. This foliation does not appear to have been affected by late E-W faults. Rocks in this domain exhibit internal deformation textures similar to those observed in rocks of domain III. The degree of deformation increases near the contact with Proterozoic rocks as well as in the southwestern part of the area, where a major deformation zone is located. This zone was also recognized to the south, in the Lac Montrochand area by Roy *et al.* (2004), where it was referred to as the Lamain Deformation Zone.

Domain V covers the central part of the area (Figure 7). In this domain, foliation S2 trends roughly NNW-SSE, similar to the regional structural trend of areas further north. This area was therefore not affected by phase of deformation D4 related to the Nastapoca and Lamain deformations zones which reoriented the regional foliation along a WNW-ESE direction. However, similar to domain IV, rocks in domain V are fairly affected by late E-W faults associated with phase D5. In domain V, lineaments interpreted from Landsat remote sensing images do not correspond to the orientation of the regional foliation. Instead, they correspond to late E-W fractures related to the formation of the Richmond Gulf Graben. In thin section, rocks in this domain do not display recrystallization textures. They contain primary igneous textures similar to those observed in most rocks from domain I.

ECONOMIC GEOLOGY

Previous Work

Most of the previous work in prospecting and mineral exploration carried out in the Lac à l'Eau Claire was focused on the Proterozoic rocks in the western part of the area. The first lead-zinc deposits hosted in carbonate horizons of the Nastapoka Group were found in the mid-18th century. The Hudson's Bay Company extracted a few tonnes of ore from these deposits (Marcoux, 1983). In the 1930s, Cominco performed work on the deposits, but the results are unavailable. From 1946 to 1949, Gulf Lead Mines launched an important exploration campaign on these mineralized horizons, including over 40,000 m of drilling (Moffat, 1946; Almond, 1947; Almond *et al.*, 1947; Harwood, 1949). This work led to the delineation of three ore deposits totalling 900,000 t at nearly 2% lead-zinc (Robinson, 1950). Only one of these deposits, the Monte Lake deposit, is located within the study area (Figure 8). The concession was abandoned by Gulf Lead Mines in 1959 and then taken up again by the Hudson Bay Syndicate in 1961. Southern Exploration and Development obtained an adjacent concession in 1964, and in the same year, Mokta Exploration Canada signed an option for the two properties (Velaine, 1965). The latter conducted an exploration campaign on the two concessions and eventually dropped the option in 1965 due to disappointing results. In 1968, Penarroya Canada conducted an ore deposit study covering the same properties (Darcy, 1968). Finally, the concessions were permanently abandoned in the early 1970s (Marcoux, 1983).

The Proterozoic sequences in the area once again attracted the attention of mining companies during the late 1970s following the discovery of U-Th anomalies by the Geological Survey of Canada. From 1977 to 1979, Uranerz Exploration and Mining performed a variety of airborne and ground exploration surveys, focussing mainly on the contact between fluvial sequences of the Richmond Gulf Group and the Archean basement (Madon, 1980). This work led to the discovery of a few uranium occurrences hosted in brecciated zones in the Archean granitic basement. The best grades obtained from grab samples were on the order of 1.3% U_3O_8 and 0.2% U_3O_8. The project was abandoned in 1979.

The launch of the Far North Project by the Department in 1997 jump-started mineral exploration in northern Québec. An extensive lake sediment geochemistry survey (MRN, 1998), for which SIAL completed the sampling phase, covered the entire Lac à l'Eau Claire area. This survey, funded by the Department and five partners from the private sector, prompted mining companies to acquire exploration licences in many areas of the Far North. The discovery of a Ni-Cu-PGE showing associated with an ultramafic intrusion in the Lac Qullinaaraaluk area (NTS 34G) by the Department during the summer of 2000 (Parent *et al.*, 2003; Labbé *et al.*, 2001) rekindled interest for this type of mineralization. During the summer of 2002, Falconbridge uncovered two showings in a similar setting within the Lac à l'Eau Claire area. Finally, the Department conducted, during the summer of 2002, a study of copper-silver occurrences associated with volcanic rocks of the Richmond Gulf Group in the Lac Guillaume-Delisle area (Labbé and Lacoste, 2004).

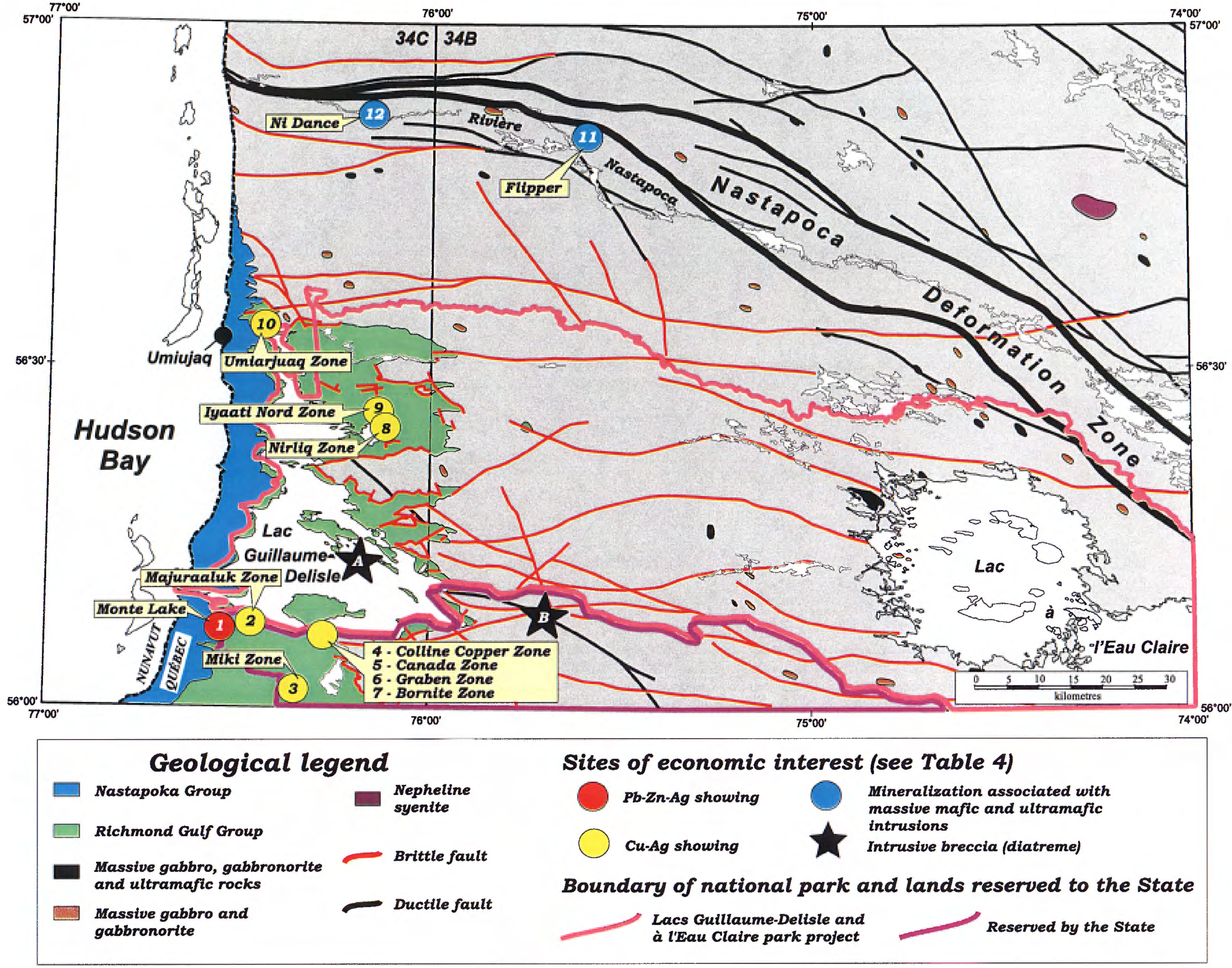


FIGURE 8 - Location of main sites of economic interest in the Lac à l'Eau Claire area (NTS 34B and 34C).

TABLE 4 - A brief description of sites of economic interest. Site locations are plotted on Figure 8.

Site no.	Name of showing	Location UTM (nad83)	Thickness	Host rock	Mineralization	Tonnage or grade	Notes
Pb-Zn occurrences in Proterozoic rocks of the Lac Guillaume-Delisle area							
1	Monte Lake	404547 E 6220311 N	3.05 m	Stromatolitic dolomite	Pyrite, galena and sphalerite	120,000 t at 1.75% Pb	The mineralization is hosted in a stromatolitic dolomite unit enclosed in siliceous dolomites.
Cu-Ag occurrences in Proterozoic rocks of the Lac Guillaume-Delisle area							
2	Majuraaluk	410053 E 6220141 N	n.a.	Basalt	Chalcocite and trace bornite	1.49% Cu and 17.3 g/t Ag	Aphanitic rock, weakly amygdaloidal; sulphides are finely disseminated.
3	Miki	413566 E 6208713 N	n.a.	Volcanic rock	Chalcocite, bornite and trace pyrite	0.60% Cu and 5 g/t Ag	Massive, non-hematized rock; sulphides are disseminated and concentrated in thin stringers.
4	Colline Copper	419919 E 6219550 N	n.a.	Amygdaloidal basalt	Chalcocite and bornite	2.84% Cu and 12.9 g/t Ag	Hematized amygdaloidal rock; sulphides are disseminated.
5	Canada	419748 E 6219040 N	n.a.	Hematized basalt	Chalcocite and bornite	3.21% Cu and 16.9 g/t Ag	Fractured and hematized rock; disseminated sulphides appear to be associated with fractures.
6	Graben	419829 E 6218488 N	n.a.	Gabbro and sediment	Bornite, digenite and trace chalcocite	1.15% Cu and 29.2 g/t Ag	Massive, non-hematized rock; sulphides are finely disseminated.
7	Bornite	421723 E 6218328 N	n.a.	Amygdaloidal basalt	Chalcocite, bornite and trace digenite and covellite	4.46% Cu and 48.2 g/t Ag	Highly fractured, non-hematized rock; sulphides are disseminated or in fracture-filling veinlets.
8	Nirliq	431318 E 6252165 N	n.a.	Basalt	Chalcocite, bornite and trace digenite and covellite	11.43% Cu and 81.9 g/t Ag	Massive non-hematized rock, no amygdules; sulphides are finely disseminated.
9	Iyaati Nord	429407 E 6254059 N	n.a.	Amygdaloidal basalt	Chalcocite and trace bornite	4.29% Cu and 26.4 g/t Ag	Strongly hematized rock; sulphides are concentrated in and around amygdules.
10	Umiarjuaq	411677 E 6268524 N	n.a.	Hematized basalt	Chalcocite	0.72% Cu and 5.7 g/t Ag	Massive, hematized and amygdaloidal rock; sulphides are concentrated in thin fractures.
Ni-Cu-PGE occurrences in mafic and ultramafic intrusions of the Qullinaaraaluk Suite							
11	Flipper	463899 E 6299089 N	roughly 10 m	Massive gabbronorite	Pyrite	1% Cu, 1.3% Ni, 200 ppb PGE and 149 ppb Au	Strongly altered rusty shear zone.
12	Ni Dance	429268 E 6303440 N	roughly 100 m	Massive gabbronorite	Pyrite, pyrrhotite and minor chalcopyrite	1% Cu, 2.5 g/t PGE and 295 ppb Au	Several m-scale rusty pyrite-rich zones; extensive gossans.
Diamond potential - intrusive breccia (diatreme)							
A	Breccia A	423781 E 6229690 N	20 m	Proterozoic sedimentary rocks	no mineralization		Intrusive breccia (diatreme).
B	Breccia B	454654 E 6219813 N	15 to 20 m	Archean granite	no mineralization		Intrusive breccia (diatreme).

n.a. = not available

Economic Potential of Proterozoic Sequences

Pb-Zn-Ag Showings

Exploration work by Gulf Lead Mines, carried out from 1946 to 1949 (Moffat, 1946; Almond, 1947; Almond *et al.*, 1947; Harwood, 1949) led to the delineation of three lead-zinc deposits including the Monte Lake deposit (120,000 t at 1.75% Pb; site 1, Figure 8 and Table 4) located in the Lac à l'Eau Claire area. The other two deposits, namely Ruby Lake (525,000 t at 1.07% Pb and 1.26% Zn) and Nancy Island (267,000 t at 0.72% Pb and 2.15% Zn) are located just south of the map area. All three deposits are hosted in the same stromatolitic limestone horizon of the Nastapoka Group. This prospective horizon extends for more than 80 kilometres along the eastern slope of cuestas bordering Lac Guillaume-Delisle. The lead-zinc mineralization in these three deposits is interpreted as Mississippi-Valley-type (Leach and Sangster, 1993; Sangster, 1996).

The Monte Lake deposit is located about 2 km south of Lac Guillaume-Delisle (site 1, Figure 8). In this location, the mineralized stromatolitic horizon is 2 to 3 metres thick. It is enclosed in a unit of siliceous dolomite roughly 10 metres thick, traced over a strike length of a few kilometres. The dolomitic country rock is light grey and granular. The mineralized horizon contains 5 to 10% sulphides (galena, sphalerite, pyrite), occurring either disseminated in small pockets or infilling thin veinlets. Other than the main mineralized horizon, the siliceous dolomite also contains mm-scale disseminated pyrite grains, concentrated in certain layers.

It is quite likely that the stromatolitic limestone horizon may host other lead-zinc occurrences. However, the topographic relief in this area is such that exploration conditions are difficult. Furthermore, the mineralized sedimentary units are subhorizontal and for the most part overlain by a unit of columnar basalt.

Cu-Ag Showings

Several copper-silver showings were discovered in 2000 by a crew from the Nunavik Mineral Exploration Fund (NMEF) near the shores of Lac Guillaume-Delisle (NTS 34C/01). The showings are hosted in Proterozoic rocks of the Richmond Gulf Group (Figure 8), more specifically in basalt units of the Persillon Formation, except for the Graben occurrence, found in gabbros assigned to the Wiachuan Sill and in sandstones of the Pachi Formation. A study was conducted by Labbé and Lacoste (2004) of the Department on this type of Cu-Ag mineralization during the 2002 and 2003 field seasons. Figure 8 (sites 2 to 8) shows the location of showings examined by the two authors and Table 4 lists the main elements of information. The following descriptions are taken from their work. The seven following showings were named by the NMEF team in 2001: Iyaati Nord (site 9), Nirliq (site 8), Majuraaluk (site 2), Colline Copper (site 4), Canada (site 5), Graben (site 6), and Bornite (site 7). The Umiarjuaq (site 10) and Miki (site 3) showings were discovered during reconnaissance work carried out by Labbé and Lacoste (2004) during the summer of 2002.

In most of l the showings, the mineralization is composed of chalcocite, digenite and bornite, infilling amygdules or disseminated throughout the rock. Trace amounts of covellite were locally observed and the presence of chalcopyrite is sporadic. Mineralized samples are characterized by discreet malachite alteration. Copper-silver showings of the Lac Guillaume-Delisle area all share the same characteristics typical of redbed copper deposits (Kirkham, 1996), namely copper-silver occurrences hosted in subaerial volcanic rocks in oxidizing conditions, disseminated and amygdule-filling copper sulphides, strongly hematized volcanic units, association with sedimentary redbeds, low-grade metamorphism and lack of ore-related alteration. This type of deposit is commonly encountered in continental rift settings, within plateau basalt sequences.

All the Cu-Ag showings hosted in Proterozoic rocks of the Lac Guillaume-Delisle area were discovered by prospecting and sampling. As opposed to iron sulphide occurrences, which often display clearly visible rusty surfaces, copper-silver occurrences are difficult to detect given the lack of visible surface alteration. This area therefore offers great potential to discover new Cu-Ag occurrences via ground prospecting. However, certain showings as well as an important proportion of the prospective units are located within the boundaries of the Lacs-Guillaume-Delisle-et-à-l'Eau-Claire park project (Figure 8).

Ni-Cu-PGE Occurrences in Mafic and Ultramafic Intrusions of the Qullinaaraaluk Suite

Small late intrusions of gabbronorite and ultramafic rocks of the Qullinaaraaluk Suite (Aluk1 and Aluk2) offer an interesting potential for the discovery of Ni-Cu-PGE occurrences. The economic potential of these intrusions in Québec's Far North was revealed by the discovery of a pyroxenite-hosted massive sulphide zone, the Qullinaaraaluk showing. This showing, located near Lac Qullinaaraaluk (NTS 34G/10), was discovered and documented during recent work performed by the Department in the Lac Vernon area (Parent *et al.*, 2003; Labbé *et al.*, 2001). Samples collected in the massive sulphide zone yielded assays reaching 2.6% Ni, 1.8% Cu, 0.27% Co and 323 ppb Pt.

Mafic and ultramafic intrusions of the Qullinaaraaluk Suite are fairly widespread throughout the Lac à l'Eau Claire area (figures 2 and 8). Two showings were found in these intrusions during the summer 2002. The two showings, exposed within exploration licences held by Falconbridge, are located in the northwestern part of the area (sites 11 and 12, Figure 8). They form gossans several metres wide easily identified from the air. The *Flipper* showing (site 11, Figure 8 and Table 4) is located on an escarpment along the side of a small hill (Photo 7 in appendix). It corresponds to a rusty, sheared and strongly altered zone some ten metres wide, hosted in a gabbronorite intrusion. The best grades reported from a grab sample are: 1% Cu, 1.3% Ni, 200 ppb PGE and 149 ppb Au. A U-Pb analysis conducted on a sample of leucocratic gabbronorite collected from this outcrop yielded an age of 2700±3 Ma. The *Ni Dance* showing (site 12, Figure 8 and Table 4) forms a gossan zone roughly one hundred metres wide on the top of a small hill (Photo 8 in appendix). In fact, it consists of several rusty pyrite-rich zones, a few metres wide each and spaced several metres apart, with rusty debris in between. The mineralization, hosted in massive gabbronorite, is composed of fine-grained disseminated pyrite associated with pyrrhotite and minor chalcopyrite. The best results from grab samples are: 1% Cu, 2.5 g/t PGE (212.5-788.5 ppb Pt; 217.3-1662.1 ppb Pd; 5.3-19.25 ppb Rh) and 295 ppb Au.

Since the discovery of the Qullinaaraaluk showing, massive ultramafic intrusions are a prime target for the discovery of new Ni-Cu-PGE occurrences in the western part of the Far North region. The discovery of the *Flipper* and *Ni Dance* showings, associated with massive gabbronorite intrusions, also highlights the potential of mafic intrusions for this type of mineralization.

Diamond Potential

Archean cratons have long been considered as the most favourable settings to search for diamond-bearing kimberlites. The latter are generally associated with alkaline intrusions occurring along major lineaments or major lithospheric fault zones (Dawson, 1964). Based on the presence of carbonatite, nepheline syenite, extension zones (rift), Proterozoic sedimentary basins and various structural lineaments, Moorhead *et al.* (1999; 2000) delineated several major structural zones favourable to diamond exploration in Québec. Two of these zones may have some economic interest in the Lac à l'Eau Claire area (Figure 9), namely the Allemand-Tasiat Structural Zone (ATZ) and the Richmond Gulf Structural Zone (RGZ).

The Allemand-Tasiat Structural Zone

The Allemand-Tasiat Structural Zone (Figure 9) is mainly defined based on the presence of a series of alkaline intrusions aligned along a NNW-SSE trending axis. These intrusions consist of diatreme, mafic and ultramafic carbonatitic volcanoclastic rocks, carbonatite, and nepheline syenite (Moorhead *et al.*, 1999). The presence of a nepheline syenite intrusion (Abol), mapped in the northeastern part of the area, leads us to sug-gest that the Allemand-Tasiat Zone

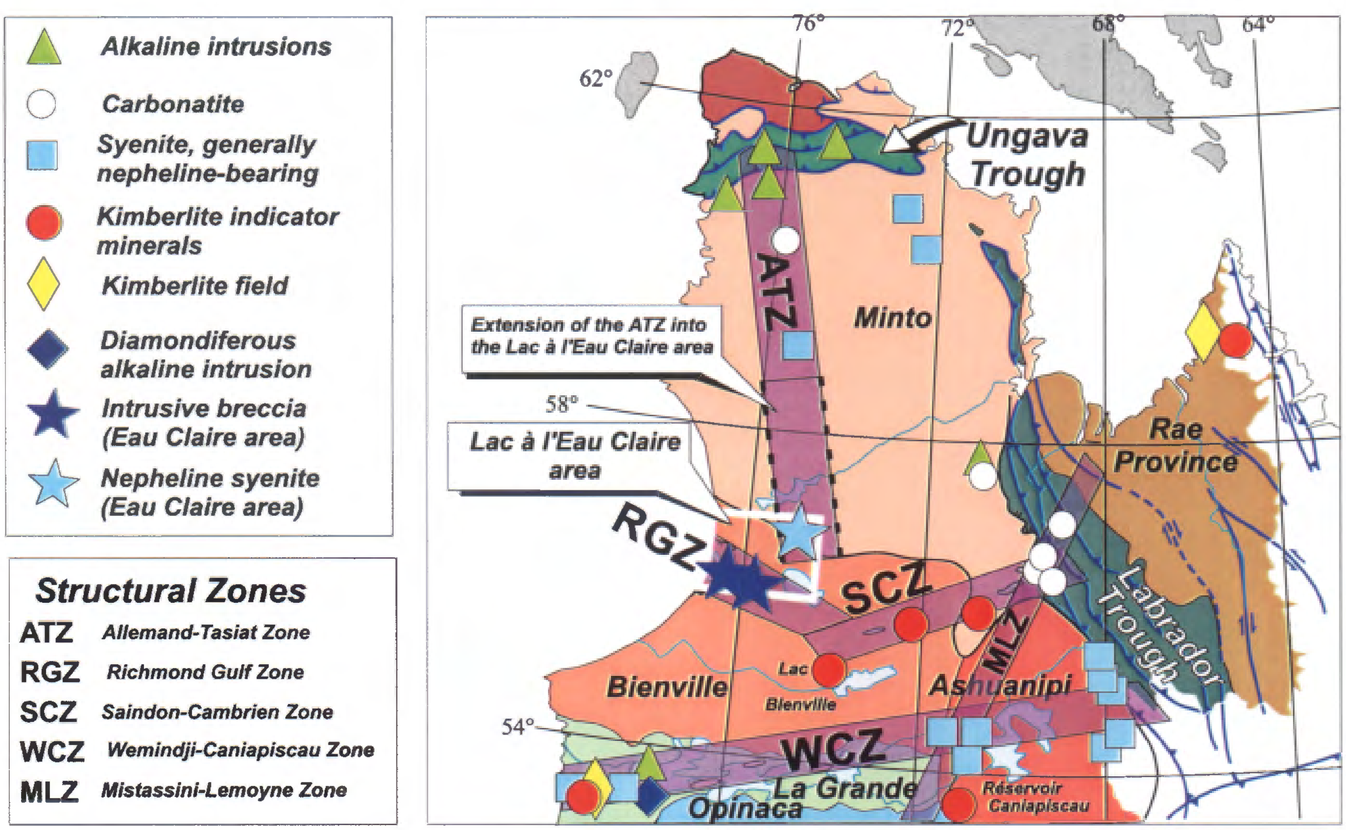


FIGURE 9 - Location of structural zones and indicators for diamond exploration (modified after Moorhead *et al.*, 2000).

(ATZ) may extend into the Lac à l'Eau Claire area (Figure 9). If this alignment of alkaline intrusions is not coincidental, this zone warrants a closer look from diamond explorationists.

The Richmond Gulf Structural Zone

The Richmond Gulf Structural Zone (RGZ) is based on the presence of a graben in which Proterozoic rocks of the Lac Guillaume-Delisle area were deposited (Chandler, 1988; Chandler and Schwartz, 1980). Normal faults associated with the formation of the graben are oriented E-W. Fahrig *et al.* (1986) suggested the aulacogen (aborted rift) be extended to the centre of the Superior Province (craton), based on the presence of E-W diabase dykes to the east of the Richmond Gulf Graben. Our mapping also outlined the presence of an important swarm of E-W-trending diabase dykes in the Lac à l'Eau Claire area. These dykes are concentrated along the extension of the main E-W rift valleys associated with the Richmond Gulf Graben. This E-W orientation is relatively uncommon for diabase dykes observed elsewhere in the northeastern Superior Province. Most E-W dykes are geochemically and petrographically similar to volcanic rocks of the Richmond Gulf Group, which suggests they may be genetically related to this volcanism (Labbé and Lacoste, 2004). Given the fact that diabase dyke swarms generally represent an episode of magmatism related to a crustal extension event, the presence of E-W dykes therefore suggests that the Superior craton underwent the effects of extensional deformation along the Richmond Gulf Zone. In an aborted rift setting, diabase dykes represent the only volcanic remains of an incipient continental break-up. Consequently, the Richmond Gulf Structural Zone should be considered as a prospective area for diamond exploration since extension zones represent weaknesses in the crust which may have served to channel uprising magma from greater depths.

The presence of two breccia units within the Richmond Gulf Zone is yet another feature that makes this area quite interesting for diamond exploration (Figure 8). Field observations suggest these breccias are associated with the emplacement of diabase dykes. The first breccia (site A, Figure 8 and Table 4), located on an island in Lac Guillaume-Delisle, cuts through sediments of the Richmond Gulf Group (Photo 9 in appendix). It contains clasts of arenite, mudstone, granitoid and volcanic rock (Photo 10 in appendix). It is bounded on either side by diabase dykes. The breccia matrix contains globular injections of mafic material. The breccia unit is roughly 20 metres wide and trends E-W. It was interpreted by Chandler (1988) as a clastic dyke. The second breccia (site B, Figure 8 and Table 4) was recognized during our mapping survey. It consists of a brecciated mafic dyke, locally carbonatized, which contains clasts of Proterozoic sedimentary rocks and volcanic glass as well as Archean granitoid clasts. The dyke is 15 to 20 metres wide and was traced over more than 2 km along strike. It cuts the Archean granitic country rock along a 345° axis. The breccia is composed of a very fine-grained matrix with subrounded to subangular polygenic fragments of various sizes (Photos 11 and 12 in appendix). In thin section, it mainly consists of subrounded grains of quartz, microcline, minor plagioclase and a few clasts of chloritized volcanic rock. In reflected light, rare disseminated grains of sphene and minor iron oxides (magnetite, ilmenite, hematite and chromite) are observed. The aphanitic matrix is strongly chloritized. At greater magnification, a thin brownish film a few microns thick is observed around quartz grains. These grains appear to have reacted with the matrix since their edges are commonly corroded. These observations suggest this is a diatreme breccia. The presence of Proterozoic sedimentary clasts in the breccia indicates the Proterozoic cover once extended much farther eastward into the Superior Craton. Several of these sedimentary clasts are from the Pachi Formation (< 2025 Ma; Chandler and Parrish, 1989), indicating the breccia was emplaced after the unit was deposited.

The extensional setting of the Richmond Gulf Zone is compatible with the presence of Proterozoic sedimentary basins of the Sakami Formation as well as numerous structural lineaments located along the Saindon-Cambrien Structural Zone (Figure 9). It is therefore possible that the Richmond Gulf Zone represents a branch of the Saindon-Cambrien Zone or a similar structure. Note that the diamond potential of the Saindon-Cambrien Zone was confirmed by the discovery of two chrome-rich picroilmenites in esker sediments of the Lac Bienville area (Parent *et al.*, 2002). The announcement of this indicator discovery attracted the attention of mining companies and led to the acquisition of over 500 exploration licences (Gosselin *et al.*, 2004).

CONCLUSIONS

The Lac à l'Eau Claire area is transected by a major E-W to WNW-ESE-trending deformation zone, the Nastapoca Zone. This regional deformation zone separates a domain primarily composed of tonalitic units to the north, from a domain essentially composed of granodioritic and granitic rocks to the south. The Nastapoca Deformation Zone may represent a regional-scale structure that marks the boundary between the Minto and Bienville subprovinces.

The Lac à l'Eau Claire area is mainly composed of Archean units intruded in many locations by Proterozoic diabase dykes. The Lac Guillaume-Delisle area, in the western part of the map area, comprises Proterozoic volcano-sedimentary sequences assigned to the Richmond Gulf and Nastapoka groups, overlying the Archean basement along an angular unconformity. The two subrounded depressions that form Lac à l'Eau Claire are the result of a double meteorite impact. The ring of islands in the centre of the western part of Lac à l'Eau Claire largely consists of Pennsylvanian impact-related rock units. This geological survey focused exclusively on the Archean rocks and Proterozoic diabase dykes. Archean units consist of intrusive rocks, namely tonalites, granodiorites and granites, clinopyroxene and orthopyroxene-bearing felsic rocks as well as mafic to ultramafic rocks. These intrusive units contain bands and enclaves of volcano-sedimentary rocks.

Volcano-sedimentary bands were assigned to the Melvin Complex. Most of these restricted bands are located in the northeastern part of the area, within the Nastapoca Deformation Zone itself and to the north of it. They are composed of felsic to mafic rocks with minor paragneiss. All these lithologies were metamorphosed to the amphibolite or the granulite facies. The Natwakupaw Belt, the best-preserved supracrustal sequence, consists of felsic rocks, most likely metamorphosed lava flows and tuffs. A felsic sample from this belt yielded a U-Pb age of 2741±4 Ma.

Tonalitic rocks belong to two prominent units, the Favard Suite and the Coursolles Suite. The most widespread is the Favard Suite, composed of biotite leucotonalite. A leucotonalite sample from the Lac à l'Eau Claire area yielded a U-Pb age of about 3020 Ma. This age is particular to the study area, since age dating analyses performed on other samples of the Favard Suite from adjacent areas indicate ages of emplacement ranging from about 2730-2749 Ma. The age obtained in the Lac à l'Eau Claire area demonstrates that early leucotonalites with characteristics identical to Favard Suite leucotonalites were incorporated into this unit. The Coursolles Suite consists of biotite-hornblende-bearing rocks. It comprises a diorite unit and a more widespread tonalite unit. The Coursolles Suite was not dated in the Lac à l'Eau Claire area. However U-Pb results obtained in adjacent areas suggest that two distinct magmatic episodes took place to produce Coursolles-type intermediate to felsic intrusions. The earliest is inferred to be at about 2750 Ma and the most recent at about 2718 Ma. Tonalitic units in the area underwent a "granitization" phenomenon, which translates into the presence of a granitic phase occurring in pockets, lenses or bands in diffuse contact with the tonalitic phase. This phase was dated at 2713±2 Ma in the Lac Bienville area.

The Loups Marins Complex comprises a unit of clinopyroxene-bearing rocks and a unit of orthopyroxene-bearing rocks. The clinopyroxene unit was subdivided into three sub-units, namely a tonalitic sub-unit, a granodioritic sub-unit and a sub-unit of porphyritic granodiorite. In addition to the omnipresence of clinopyroxene, these sub-units also exhibit a few common characteristics. They generally show a high magnetic susceptibility, they contain reddish biotite and salmon pink or burgundy plagioclase, which give the rocks a pinkish or purplish tinge. An age dating analysis performed on a tonalitic sample from the Lac à l'Eau Claire area yielded an age of crystallization of 2712±4 Ma. This result is similar to those obtained from clinopyroxene-bearing samples of the Loups Marins Complex in adjacent areas. The orthopyroxene unit is mainly composed of enderbite and orthopyroxene diorite, with minor opdalite and charnockite. This unit was not dated in the area. However, two geochronology analyses conducted on hypersthene diorite samples from other areas yielded ages of 2694±3 Ma and 2720±2 Ma.

Most granite and granodiorite intrusions in the study area belong to the Desbergères Suite. This is by far the most widespread unit in the area, particularly south of the Nastapoca Deformation Zone. The Desbergères Suite comprises a unit of biotite-hornblende granodiorite and granite and a unit of biotite granite and granodiorite. A U-Pb analysis conducted on a sample of biotite-hornblende granodiorite yielded an age of crystallization of 2711±4 Ma. The 2713±2 Ma age associated with the granitic phase from a tonalite sample in the Lac Bienville area supports the hypothesis that a link may exist between the emplacement of Desbergères Suite plutons and the regional "granitization" of tonalitic units.

Mafic and ultramafic rocks of the Qullinaaraaluk Suite form small, constrained, massive bodies. A U-Pb analysis conducted on a sample of leucocratic gabbro yielded an age of 2700±3 Ma. This is a relatively early age for these intrusions. In other areas where the Qullinaaraaluk Suite was identified, it was considered to be late, which suggests this suite may contain intrusions associated with a number of distinct magmatic events.

A nepheline syenite intrusion was identified in the northeastern part of the area. Dating analyses performed on baddeleyite crystals yielded an age of 2675±1 Ma, which makes it the youngest Archean unit in the area.

Proterozoic diabase dykes in the Lac à l'Eau Claire area follow three main orientations: E-W to WNW-ESE, N-S to NNW-SSE and NW-SE. However, field observations, petrographic studies and lithogeochemical analyses are insufficient to differentiate the dykes based on their orientation. E-W to WNW-ESE dykes appear to belong to a new swarm that had not yet been recognized elsewhere in the northeastern Superior Province. These dykes are concentrated along the extension of the main E-W rift valleys associated with the Richmond Gulf Graben.

Rocks in the Lac à l'Eau Claire area underwent five phases of deformation. Phase D1 was observed only in volcano-sedimentary bands and mafic enclaves enclosed in granitoids. Phase D2, marked by an S2 foliation generally oriented WNW-ESE to NW-SE, corresponds to the main deformation event responsible for the regional structural trend. This deformation appears to have taken place at least in part in a plastic state under magmatic to submagmatic conditions. A few NE-SW folds observed locally are associated with phase D3, which is only weakly developed in the Lac à l'Eau Claire area. Phase D4 produced major ductile shear zones oriented E-W to WNW-ESE, most of which are concentrated within the Nastapoca Deformation Zone. This zone, roughly 15 to 20 km wide, constitutes a major structure which may represent the boundary between the Minto and Bienville subprovinces. Finally, a phase of brittle deformation (D5) is responsible for the development of a network of late E-W-trending major faults that represent the extension of rift valleys associated with the formation of the Richmond Gulf Graben. Active faults during the period of sedimentation controlled, at least in part, the distribution of sedimentary units of the Richmond Gulf Group.

Prior to our field survey conducted in the summer of 2002, most of the prospecting and mineral exploration work in the area had focused on the Proterozoic sequences in the Lac Guillaume-Delisle area, where three Pb-Zn-Ag Mississipi-Valley type deposits are hosted in a stromatolitic limestone horizon of the Nastapoka Group. Among the three, only the Monte Lake deposit (120,000 t at 1.75% Pb) is located in the Lac à l'Eau Claire area. Several Cu-Ag showings associated with volcanic rocks of the Richmond Gulf Group were discovered in the 2001 and 2002 field seasons. The latter exhibit features typical of redbed copper deposits. Among Archean units, mafic to ultramafic intrusions of the Qullinaaraaluk Suite offer an interesting potential for the discovery of Ni-Cu-PGE occurrences. This potential was initially revealed in the summer of 2000 by the discovery of a massive sulphide zone in a pyroxenite intrusion located in the Lac Qullinaaraaluk area (NTS 34G/10). Two showings associated with gabbronorite intrusions of the Qullinaaraaluk Suite are located in the Lac à l'Eau Claire area, namely the *Flipper* showing (1% Cu, 1.3% Ni, 200 ppb PGE, 149 ppb Au) and the *Ni Dance* showing (1% Cu, 2.5 g/t PGE, 295 ppb Au). Finally, the Richmond Gulf Structural Zone is a graben environment where Proterozoic rocks of the Lac Guillaume-Delisle area were deposited. This extensional structure constitutes a zone of weakness which may have served to channel uprising magma from greater depths, and therefore represents a prospective zone for diamond exploration. The presence of two intrusive breccias, observed within the Richmond Gulf Structural Zone, is yet another feature that makes this area very attractive for diamond exploration.

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APPENDIX : PHOTOGRAPHS

PHOTO 1 - Primary layering in felsic volcanic rocks of the Natwakupaw Belt in the Melvin Complex (Amel1).

PHOTO 2 - Amphibolite of the Melvin Complex (Amel2) showing thin bands of whitish mobilizate with clinopyroxene and orthopyroxene crystals.

PHOTO 3 - Massive enderbite in the orthopyroxene unit of the Loups Marins Complex (Alma2).

PHOTO 4 - Leucotonalite restite in a granite from the biotite granite and granodiorite unit of the Desbergères Suite (Adeb2).

PHOTO 5 - Gabbronorite of the Qullinaaraaluk Suite (Aluk2). Note the lack of foliation and the presence of whitish injections that give the rock a brecciated aspect.

PHOTO 6 - Nepheline syenite of the Bourdel Syenite (Abol). Nepheline (greyish) stands out in positive relief and gives the rock a mottled aspect.

APPENDIX : PHOTOGRAPHS

PHOTO 7 - Flipper showing located along the side of a small hill. The best grades obtained from a grab sample collected in the rusty zone are: 1.0% Cu, 1.3% Ni, 200 ppb PGE and 149 ppb Au.

PHOTO 8 - Ni Dance showing located at the top of a small hill. The best results are: 1.0% Cu, 2.5 g/t PGE and 295 ppb Au from a grab sample.

PHOTO 9 - "Breccia A" cuts sedimentary rocks of the Richmond Gulf Group on an island in Lac Guillaume-Delisle.

PHOTO 10 - "Breccia A" consists of a variety of sedimentary and volcanic clasts.

PHOTO 11 - "Breccia B" consists of polygenic subrounded to subangular clasts of various sizes embedded in a fine-grained matrix.

PHOTO 12 - The size of clasts in "Breccia B" is highly variable.

ABSTRACT

This report presents the results of a geological survey carried out during the summer 2002 in the Lac à l'Eau Claire area (NTS 34B and 34C) at the 1:250,000 scale. This area is located in Québec's Far North, more specifically near the village of Umiujaq. Rocks in the area are mainly Archean in age, with the exception of a few Proterozoic diabase dyke swarms and a Proterozoic volcano-sedimentary sequence. Meteorite impact-related rocks of Pennsylvanian age are also present on islands in Lac à l'Eau Claire. Most Archean units consist of intrusive rocks, namely tonalites, granites and granodiorites, clinopyroxene and orthopyroxene-bearing felsic rocks as well as mafic and ultramafic rocks. These intrusive rocks contain small volcano-sedimentary bands metamorphosed to the amphibolite and the granulite facies. A nepheline syenite intrusion constitutes the youngest Archean unit (2675 ± 1 Ma). The area underwent five phases of ductile and brittle deformation (D1 to D5). Phase D2 is responsible for the regional structural trend oriented WNW-ESE to NW-SE. The area is cut by the Nastapoca Deformation Zone, a major E-W to ESE-WNW ductile deformation zone related to phase D4. Proterozoic rocks in the Lac Guillaume-Delisle area host Mississippi-Valley-type Pb-Zn-Ag occurrences as well as Cu-Ag showings that exhibit features typical of redbed copper deposits. Small mafic to ultramafic Archean intrusions offer good potential for the discovery of new Ni-Cu-PGE showings. Finally, the Richmond Gulf Structural Zone constitutes an interesting target area for diamond exploration.

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