RG 2003-03

Geology of the Rivière Innuksuac area (34K and 34L)

Martin Simard
Martin Parent
Jean David
Kamal N. M. Sharma

Volcanic sequence in the Porpoise Cove belt dated at 3825 ±16 Ma.

2004

Québec

Geology of the Rivière Innuksuac area (34K and 34L)

Martin Simard
Martin Parent
Jean David
Kamal N.M. Sharma

RG 2003-03

Abstract

This report deals with the results of a geological survey at 1:250,000 scale carried out during the summer 2001 in the Rivière Innuksuac area (NTS 34K and 34L). This area is located in Québec's Far North, more specifically near the small community of Inukjuak. The area is underlain by Archean rocks, with the exception of a few Proterozoic diabase dykes and a sequence of sedimentary and basaltic rocks of the Hopewell Group. Archean volcano-sedimentary rocks assigned to the Innuksuac Complex (Ainn) are the oldest units in the area (3825±16 Ma). They form km-scale bands enclosed in felsic intrusions and metamorphosed to the amphibolite facies and the granulite facies. Tonalitic units belong to three distinct suites: the Boizard Suite (Aboz), which consists of heterogeneous tonalite with abundant mafic enclaves, the Qamanirjuaq Suite (Aqam), composed of biotite leucotonalite, and the Qilalugalik Suite (Aqil) composed of clinopyroxene-biotite tonalite with burgundy plagioclase, greenish orthopyroxene tonalite (enderbite) and biotite tonalite with burgundy to red plagioclase. These rocks have undergone a regional "granitization" process, which may have been triggered by the emplacement of granodiorite and granite intrusions of the Voizel Suite (Avoi). Other granitic units are represented by the Gabillot Suite (Agab) and the Corneille Suite (Acrn). The Gabillot Suite is characterized by a megaphyric texture. The Corneille Suite (*ca.* 2691 Ma), exclusively found in the westernmost part of the area, consists of white granite and whitish tonalite. All Archean units are cross-cut by foliated gabbronorite and hypersthene diorite intrusions assigned to the Cheminade Suite (Acmd) as well as by massive gabbronorite and ultramafic intrusions of the Qullinaaraaluk Suite (Aluk).

The structural interpretation of the Innuksuac area outlines six phases of ductile and brittle deformation. The first two phases (D1 and D2) were observed in supracrustal rocks only. Phase D3 represents the main deformational event responsible for the NNW-SSE-striking regional structural trend. Phase D4 is represented by tight to open F4 folds with NW-SE-trending axial traces. Phase D5 produced ductile shear zones oriented NW-SE to NNE-SSW and more rarely E-W. NNE-SSW structures occur within two distinct corridors. Finally, phase D6 is responsible for a network of late brittle faults oriented E-W.

This geological survey led to the discovery of several sites of economic interest and mineralized zones associated with: 1) early volcano-sedimentary sequences, 2) late mafic to ultramafic intrusions, and 3) quartz-carbonate-sulphide veins. Occurrences associated with volcano-sedimentary rocks correspond to rusty zones from 10 cm to 1 m in thickness, with disseminated or semi-massive pyrite often accompanied by pyrrhotite or chalcopyrite. Several samples collected in these mineralized zones yielded anomalous Cu, Zn, Au, Ag, Co and Ni grades, including several assays greater than 0.1% for Cu and Zn. The Porpoise Cove belt contains horizons of anthophyllite-cordierite-garnet schist interpreted as metamorphosed hydrothermal alteration zones, considered prospective for volcanogenic deposits. Sites of economic interest associated with late mafic and ultramafic intrusions contain rusty zones from 1 to 10 m wide, with fine disseminated pyrite often associated with pyrrhotite or magnetite. The discovery of the Qullinaaraaluk Ni-Cu-Co-PGE showing by the MRN in the summer 2000 generated renewed interest for this type of intrusion. The Qullinaaraaluk showing is located 75 km to the southeast of the study area. Finally, mineralization hosted in quartz-carbonate veins consists of sporadic pockets of chalcopyrite locally accompanied by galena and sphalerite.

DOCUMENT PUBLISHED BY GÉOLOGIE QUÉBEC

Director
Alain Simard

Head of the Service géologique de Québec
Pierre Verpaelst

Head of geoscience inventories
Robert Marquis

Document accepted for publication on the 02/05/06

Critical review
Alain Leclerc
Pierre Lacoste

Translation
Michelle Mainville

Edition and page setting
Jean-Pierre Lalonde

Computer assisted drawing
Martin Parent
Martin Simard
Christian Garneau
Nathalie Drolet

Coloured map preparation
Joanne Nadeau
Nelson Leblond

Technical supervision
Charlotte Grenier

Dépôt légal – Bibliothèque nationale du Québec
ISBN : 2-551-22437-3

CONTENTS

INTRODUCTION

Mapping conducted during the summer of 2001 was carried out within the scope of the Far North project launched in 1997 by the Ministère des Ressources naturelles du Québec. The objectives of this survey are to build a regional geological framework at 1:250,000 scale, to acquire new geoscience data and to attract mineral exploration in this vast yet little known territory located north of the 55th parallel. The geological survey, carried out in the Rivière Innuksuac area, covers NTS sheets 34K and 34L (Figure 1). This survey follows in the wake of previous mapping conducted in the Lac Vernon area (NTS 34J; Parent *et al.*, 2002) and covers the structural and aeromagnetic extension of the Lacs des Loups Marins area (NTS 34A; Gosselin *et al.*, 2001; Figure 2), located further south. Mapping in these areas helped establish the overall lithostratigraphic, structural and metallogenic setting. Lithological characteristics observed in these areas helped define the western part of Québec's Far North corresponding to the Tikkerutuk Domain (Percival *et al.*, 1991, 1992).

Location and Access

The Rivière Innuksuac area is located in Nunavik, at the westernmost edge of the Ungava Peninsula (Figure 1). It corresponds to NTS sheets 34K and 34L, bounded by latitudes 58°00' and 59°00' North and longitudes 76°00' and 78°35' West. Its surface area covers about 14,000 km^2. The centre of the area is located roughly 45 km east of Inukjuak, a village on the coast of Hudson Bay (Figure 1). Several lakes provide ready access to many parts of the area by floatplane from Puvirnituq, located 160 km to the north. Most lakes in the area are free of ice by mid-June. No landing strips for short-airlift aircraft (Twin Otter-type) are present in the study area, except for a landing strip at Inukjuak airport.

Methodology

The fieldwork was carried out by a team of seven geologists, and took place over a period of 11 weeks, from early June to late August. Mapping crews, each composed of a geologist and an assistant, were transported to the field via helicopter from the base camp, located to the northeast of Lac Qamanirjuaq. Traverses ranging from 8 to 12 km in

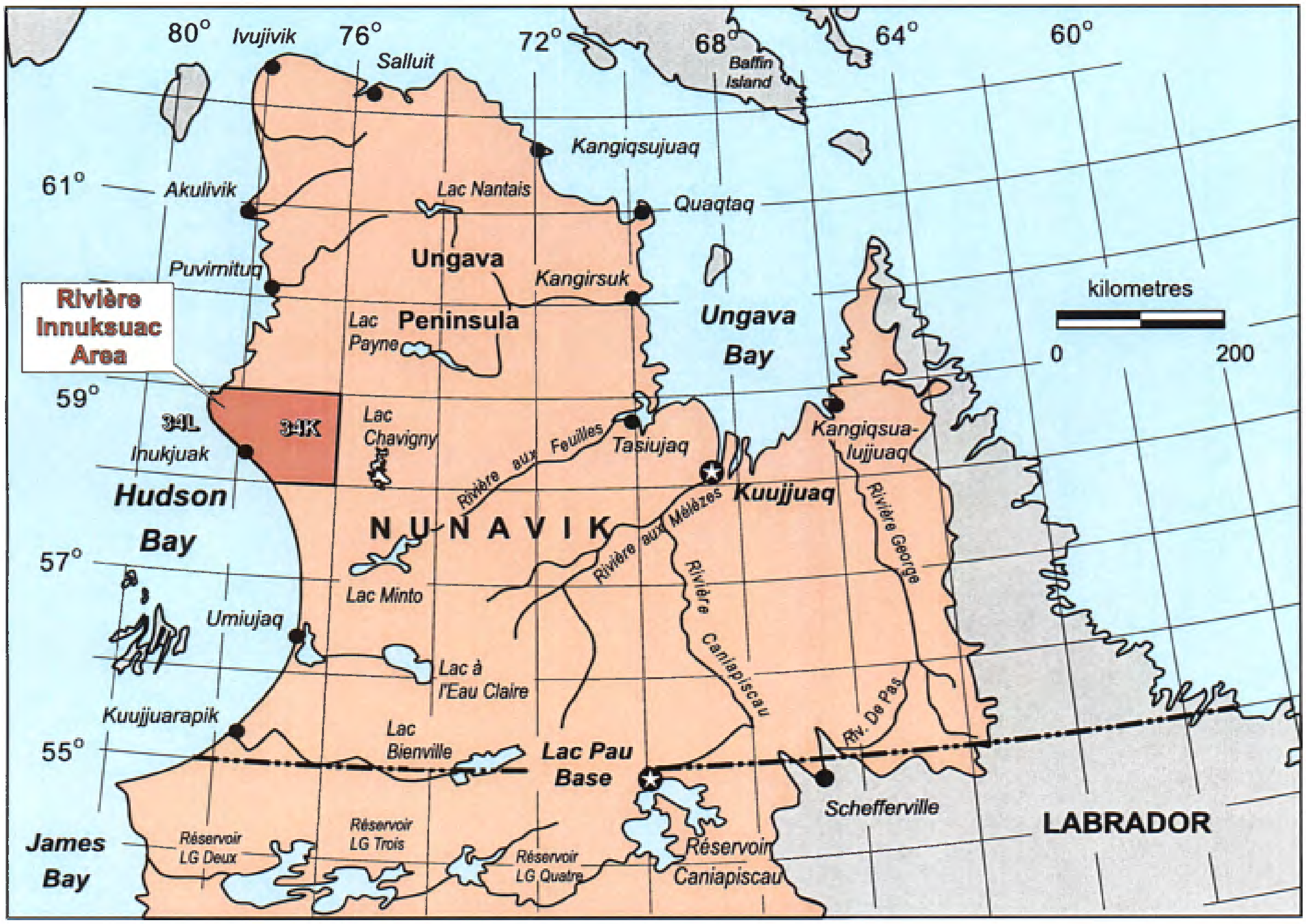


FIGURE 1 - Location of the Rivière Innuksuac area (34K and 34L).

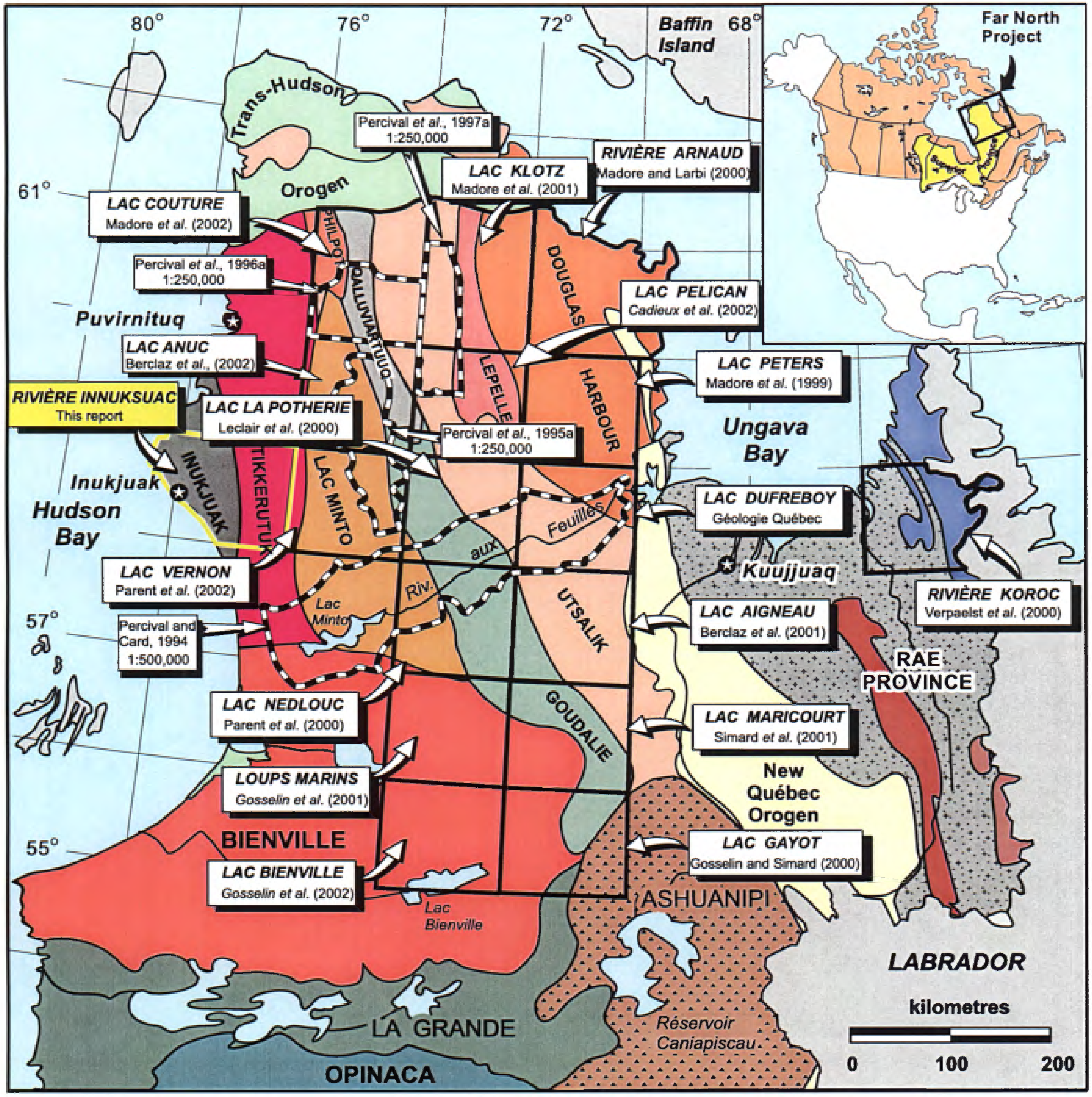


FIGURE 2 - Lithotectonic subdivisions of the northeastern Superior Province (modified after Card and Ciesielki, 1986 and Perceval *et al*., 1992, 1997b) and location of recent geological mapping projects in Québec's Far North.

length were spaced every 4 to 10 km, depending on the geological complexity and the density of outcrops. On average, a dozen traverses were carried out in each 1:50,000 scale NTS sheet. Isolated spot checks on a hundred or so outcrops reached by helicopter completed the mapping coverage. Several representative samples were collected in the different lithological units and mineralized zones for geochemical analyses, magnetic susceptibility readings and thin sections. Seven samples were collected for geochronological purposes. These samples were processed by Jean David (Géologie Québec) at the GÉOTOP research centre of the Université du Québec à Montréal. Geological maps and related field data as well as analytical results were integrated to the geomining information system (SIGÉOM) operated by the Ministère des Ressources naturelles du Québec.

Previous Work

The first geological survey carried out in the Rivière Innuksuac area was conducted by Lee (1965), who mapped a surface area of 480 square miles along the coast of Hudson

Bay, including part of the Hopewell Islands. A few years later, a 1:1,000,000 scale reconnaissance geological survey (Stevenson, 1968) and regional aeromagnetic (Dion and Lefebvre, 2000) and gravity (GSC, 1994) surveys provided a geoscience database for the entire northeastern Superior Province. During the 1990s, the Geological Survey of Canada conducted a 1:500,000 scale geological survey along the Rivière aux Feuilles (Percival and Card, 1994), and three geological surveys at 1:250,000 scale in areas further north (Percival *et al.*, 1995a, 1996a, 1997a; Figure 2). In 1997, the Far North project began with an extensive lake sediment geochemistry survey (MRN 1998), and from 1998 on, continued with 16 new geological surveys carried out at 1:250,000 scale to cover the entire northeastern Superior Province (Figure 2). Finally, no exploration work appears yet to have been conducted in the Rivière Innuksuac area.

Acknowledgements

We thank all the members of our field crew for their efficient work and their enthusiasm throughout the summer. The team included, in addition to authors Martin Simard and Martin Parent, geologists Robert Thériault, Julie Fredette, Marie-Line Tremblay, Xuan Hoang Truong, and geological assistants Carl Bilodeau, Gaëlle Carrier, Caroline Dumas, Louis Grenier, Pierre Nadeau, Claude Pilote, Marie-Andrée Vézina and Jobie Weetaluktuk. Among these, we are particularly grateful to Robert Thériault for his considerable involvement in planning the project logistics. Jolyn Hébert once again confirmed his talents as camp manager by carrying out quality work. Our cook, André Monette, made a significant contribution to our team spirit thanks to his excellent cuisine. The authors benefited from discussions in the field with Laurent Godin, Jean-Yves Labbé, Pierre Lacoste, Alain Leclair, Ross Stevenson and Pierre Verpaelst. The pilots, François Degagné and Christian Mazeron, and mechanics, Richard Vlieghe, Étienne Chassé and Stephane Ouellet, of Canadian Helicopters Ltd. provided safe and efficient transportation. Digital geological maps were produced thanks to the indispensable technical assistance of Christian Garneau and Nelson Leblond. Marc Beaumier prepared unpublished maps showing lake sediment geochemical anomalies to guide our fieldwork. Aeromagnetic maps were produced by Denis-Jacques Dion. The Service des applications géospatiales (MRN) supplied regional spatiomaps based on Landsat images. Finally, we thank Alain Leclair and Pierre Lacoste of Géologie Québec, who provided a critical review of the first draft of this report.

REGIONAL GEOLOGY

The northeastern Superior Province is essentially composed of various Archean plutonic rocks that enclose relics of deformed and metamorphosed supracrustal rocks. The different metamorphic assemblages encountered in these rocks indicate high-temperature metamorphic conditions ranging from the upper greenschist facies to the granulite facies (Bégin and Pattison, 1994; Percival and Skulski, 2000). The northeastern Superior Province is characterized by a regional structural trend oriented NNW-SSE, marked by high-relief aeromagnetic anomalies (Card and Ciesielski, 1986; Percival *et al.*, 1992; Figure 3). This structural trend contrasts with the E-W orientation of major geological assemblages in the southern Superior Province. Overall, granitic and charnockitic plutonic rocks are associated with vast (40-100 km wide) positive aeromagnetic anomalies, whereas supracrustal belts are commonly enclosed within tonalitic suites, which coincide with narrow (10-20 km wide) weakly magnetic bands.

The northeastern Superior Province appears to be the result of a succession of episodes of crustal growth and recycling of earlier terrains spanning over 300 Ma (Leclair *et al.*, 2002). The oldest reported geological elements are the remains of a Mesoarchean protocraton (3.1-2.9 Ga) identified by the presence of inherited and detrital zircons. These early terrains, difficult to identify, were largely recycled by tectono-magmatic processes (2.89 and 2.66 Ga). However, the oldest reported units consist of dismembered remnants of volcano-sedimentary sequences enclosed in tonalite-trondhjemite units (2.88-2.87 Ga). The geographic distribution of these oldest rocks coincides with the presence of the oldest inherited zircons, which suggests that early lithologies are spatially associated with dismembered and recycled protocratons (Leclair *et al.*, 2002). A second episode of crustal growth is marked by tholeiitic volcanism and tonalitic-trondhjemitic plutonism, bracketed between 2.84 and 2.80 Ga. An early phase of deformation (D_1), dated at 2.81 Ga, may be related to an episode of tectonic accretion of early terrains (Percival and Skulski, 2000). Subsequently, large-scale magmatic activity took place in a diachronous fashion (2.79-2.74 Ga) with the emplacement of tonalite-trondhjemite and the production of both tholeiitic and calc-alkaline volcanic rocks. This event is outlined by the emplacement of syenite and carbonatite intrusions. Later on, the appearance of granite, granodiorite and granitic mobilizate (2.735 and 2.725 Ga) marks the onset of potassic magmatism generated by an episode of intracrustal melting, possibly due to the juxtaposition of various terrains (Leclair *et al.*, 2001b; Leclair *et al.*, 2001c). In the wake of this potassic magmatism comes an important production of enderbite, tonalite, granodiorite and tholeiitic and calc-alkaline volcanic rocks (2.725 and 2.69 Ga). This extended period of intracrustal magmatism contributed to the onset of high-temperature metamorphism, responsible for the partial melting (2.698 and 2.675 Ga) and recycling of older lithologies. The presence of late to post-tectonic zircons and monazites (2.68-2.62 Ga) is attributed to regional-scale hydrothermal activity. Finally, several fault networks channelled late to post-metamorphic hydrothermal fluids (2.68-2.62 Ga) and may have played a

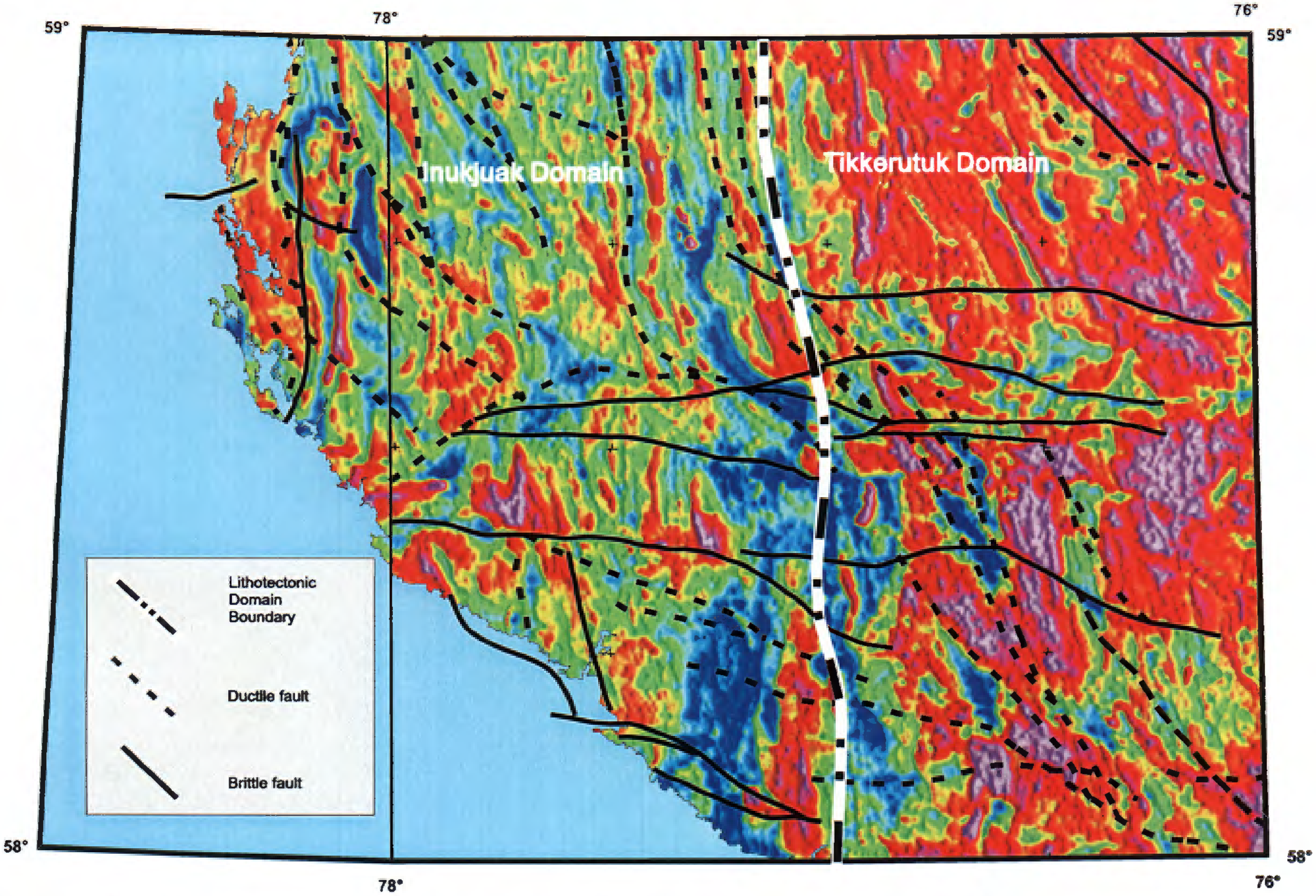


FIGURE 3 - Shaded total residual magnetic field map on which can be observed the lithotectonic domain boundaries as defined by Percival *et al.* (1992, 1997b). The aeromagnetic data was taken from Dion and Lefebvre (2000).

role in the emplacement of syenite, carbonatite, diabase and lamprophyre intrusions.

Lithotectonic Subdivision

Percival *et al.* (1992, 1997b) proposed a subdivision of the northeastern Superior Province into different lithotectonic domains based on aeromagnetic, lithological and structural criteria (Figure 2). 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. Subsequent work further north (Percival *et al.*, 1995b, 1996b, 1997b) led to the definition of the Philpot, Qalluviartuuq and Lepelle domains. Subsequently, the boundaries of all these domains were extrapolated province-wide, based on the extension of the various aeromagnetic anomalies. These domains may extend over several hundred kilometres parallel to the dominant NW-SE structural trend (Figure 2).

Recent work carried out by the MRN has uncovered many problems however concerning the boundaries and relationships between certain domains. The boundaries remain uncertain, mainly due to the absence of observable structural limits and the presence of numerous intrusive suites that cross domain boundaries. Mapping conducted in the Rivière Innuksuac area confirms the difficulty of recognizing the nature and the boundaries of lithotectonic domains proposed by Percival *et al.* (1992). According to the latter, the boundary between the Tikkerutuk and Inukjuak domains runs across the central part of the Innuksuac area in a N-S direction. Our work failed to identify a contact zone between these two domains, despite a few lithological differences observed between the eastern and western parts of the area. The sharp magnetic contrast that had originally been used to trace the boundary between the two domains (Figure 3) does not correspond to a noticeable lithological or structural variation. Nevertheless, recent geological surveys conducted within the scope of the Far North Project (this report; Gosselin *et al.*, 2001; Parent *et al.*, 2002) outline certain features that suggest the Tikkerutuk Domain may extend southeastward into the Loups Marins area (Figure 2). This hypothesis is based on similarities observed in terms of lithological assemblages, U/Pb age dating analyses and a continuity in the regional aeromagnetic signature.

LITHOSTRATIGRAPHY

The Rivière Innuksuac area is mainly composed of Archean intrusive and volcano-sedimentary units intruded by a few narrow Proterozoic diabase dykes. It also contains some Proterozoic sedimentary and basaltic rocks in the westernmost part of the area. The rocks in the area were grouped into lithodemic suites and complexes in accordance with the North American stratigraphic code (MRN, 1986). These units were sometimes subdivided into informal sub-units, in order to outline the specific nature of certain mappable zones. The legends in Figure 4 and on the geological maps show all the units encountered in the Rivière Innuksuac area. The stratigraphic order was established based on cutting relationships observed in the field and U-Pb ages available at the time of writing this report.

Archean volcano-sedimentary units are the oldest units in the area. They are not abundant, and occur as small elongated and lenticular bands. The dominant lithological units are paragneisses and mafic to ultramafic rocks. The Porpoise Cove belt, located along the coast of Hudson Bay, is the best-exposed Archean volcano-sedimentary sequence. All Archean volcano-sedimentary rocks in the area were assigned to the Innuksuac Complex (Ainn).

Tonalitic units cover the largest surface area within the study area. They belong to three suites: the Boizard Suite (Aboz), composed of heterogeneous tonalite with a gneissic aspect and abundant mafic enclaves, the Qamanirjuaq Suite (Aqam), composed of biotite leucotonalite, and the Qilalugalik Suite (Aqil) composed of clinopyroxene tonalite with burgundy plagioclase, greenish enderbite and biotite tonalite with burgundy to red plagioclase. Tonalitic rocks in the area have undergone a "granitization" process of variable intensity, marked by the presence of a heterogeneous granitic phase erratically distributed within the tonalitic phase.

Monzodioritic to granitic units are assigned to the Voizel (Avoi), Gabillot (Agab) and Corneille (Acrn) suites. The Voizel Suite, the most widespread, consists of homogeneous, massive to foliated biotite granite and granodiorite. These rocks form irregular and elongate bodies. The Gabillot Suite (Agab) is represented by a few small monzodioritic to granitic plutons that exhibit a characteristic megaphyric texture. Finally, the Corneille Suite (Acrn), mainly composed of whitish hololeucocratic granite, exclusively outcrops in the westernmost part of the area.

Several small ultramafic to intermediate intrusions cut the other Archean units in the area. The Cheminade Suite (Acmd) consists of dykes or small foliated bodies elongated parallel to the regional foliation direction, composed of gabbronorite, hypersthene diorite and hypersthene quartz diorite. The Qullinaaraaluk Suite (Aluk) is composed of massive and undeformed mafic to ultramafic rocks. These rocks occur as small plutons, largely found in the eastern half of the area. The economic potential of this unit was outlined by the discovery of a showing hosted in an ultramafic intrusion near Lac Qullinaaraaluk (Parent *et al.*, 2002).

A sequence of Proterozoic sedimentary and basaltic rocks belonging to the Hopewell Group (Php) (Lee, 1965) is well exposed on the Hopewell Islands in the westernmost part of the area. This sequence consists of sedimentary rocks at the base, unconformably overlain by a unit of columnar basalts. Rocks of the Hopewell Group appear to overlie the Archean bedrock along an angular unconformity (Lee, 1965).

Volcano-Sedimentary Units

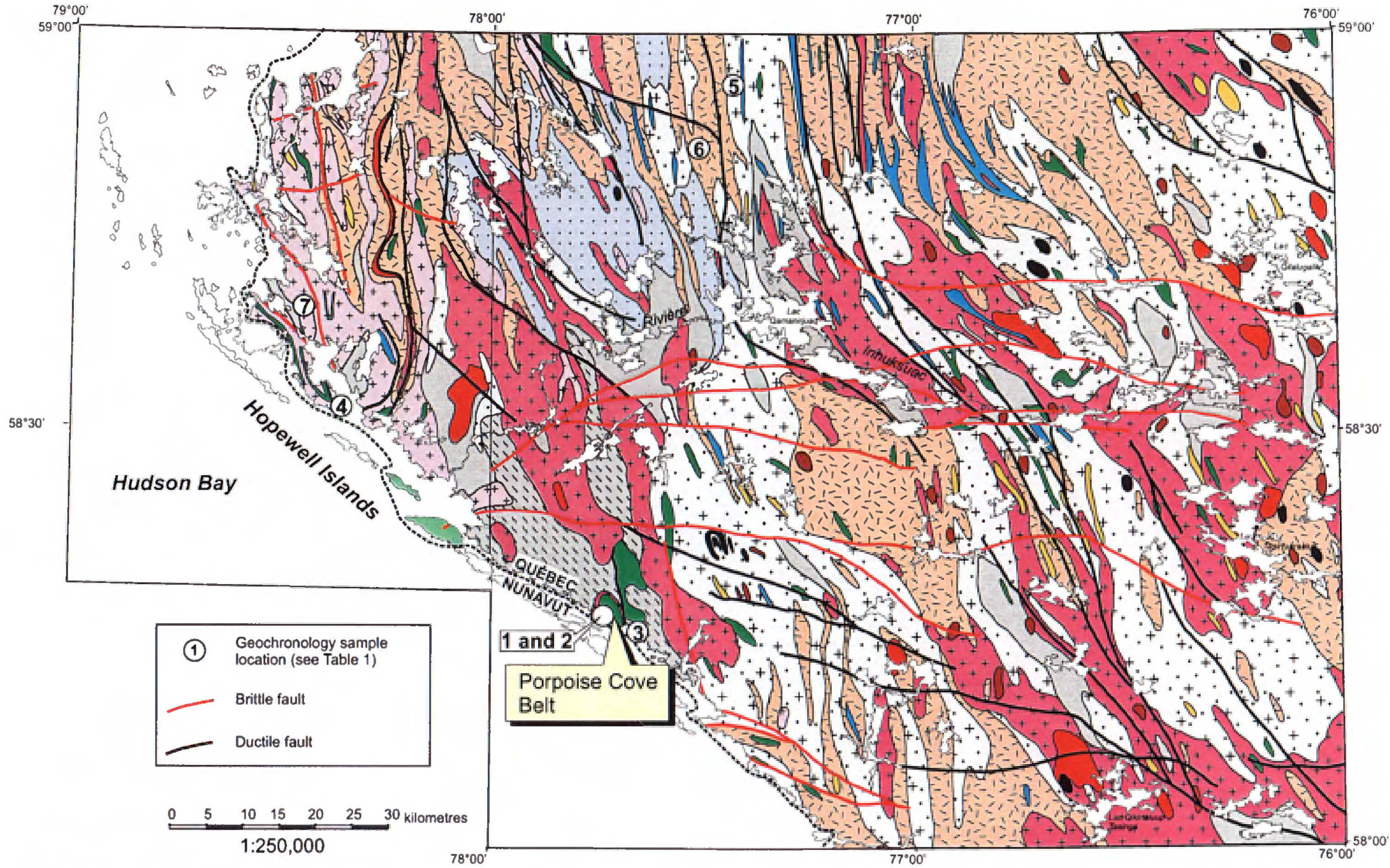
Innuksuac Complex (New unit, Ainn)

Archean volcano-sedimentary units are the oldest units in the area. They are not abundant and form small lenticular bands enclosed in a sea of granitoids. Among these bands, the Porpoise Cove belt contains the best-preserved supracrustal sequence. All Archean volcano-sedimentary rocks were grouped under a single new unit, the Innuksuac Complex (Ainn). This complex was subdivided into two sub-units, to take into account dominant lithologies. The first sub-unit (Ainn1) consists of various lithological facies dominated by mafic and ultramafic rocks. The second (Ainn2) is mainly composed of paragneiss, associated with intermediate rocks of uncertain origin. Supracrustal rocks of the Innuksuac Complex are intruded by younger granitoids.

Mafic and Ultramafic Rocks (Ainn1)

The best-preserved supracrustal sequence in the area is the Porpoise Cove belt, located along the coast of Hudson Bay (Figure 4). It contains several lithologies affected by polyphase tectonics that produced complex deformation patterns. Supracrustal rocks of sub-unit Ainn1 outside of this belt form fairly restricted bands (Figure 4) generally injected and partially assimilated by surrounding granitoids. These bands mainly consist of dark greenish grey amphibolite and mafic gneiss with a brownish weathered surface. The intrusive or effusive origin of these lithologies is difficult to ascertain given the intense metamorphic recrystallization in these rocks. Outcrops generally show alternating massive and banded layers a few metres in thickness, with a fine to coarse grain size. This variation in composition and texture suggests that amphibolites and mafic gneisses are derived from a variety of different volcanic facies. Mafic sequences also contain 1 to 10 m-thick horizons of ultramafic rock and a few beds of migmatitic garnet paragneiss, locally associated with silicate or oxide-facies iron formations a few metres in thickness.

In thin section, amphibolites exhibit a very well developed granoblastic texture consisting of polygonal grains of twinned plagioclase, hornblende, orthopyroxene and clinopyroxene in variable proportions. Mafic minerals and



PROTEROZOIC

Hopewell Group

(*Php*) Sedimentary sequence unconformably overlain by a columnar basalt unit

ARCHEAN

ULTRAMAFIC TO INTERMEDIATE UNITS

Qullinaaraaluk Suite

(Aluk2) Massive gabbronorite

(Aluk1) Massive ultramafic rocks and massive gabbronorite

Cheminade Suite

(Acmd) Foliated gabbronorite, hypersthene diorite and hypersthene quartz diorite

MONZODIORITIC TO GRANITIC UNITS

Corneille Suite

(Acrn) White granite and white tonalite; variety of enclaves

Gabillot Suite

(Agab) Megaphyric monzodiorite to granite

Voizel Suite

(Avoi) Biotite-chlorite granite and granodiorite

TONALITIC UNITS

Qilalugalik Suite

(Aqil4) Biotite tonalite with burgundy to red plagioclase

(Aqil3) Enderbite and orthopyroxene quartz diorite; charnockite and opdalite

(Aqil1) Clinopyroxene tonalite and quartz diorite with burgundy plagioclase

Qamanirjuaq Suite

(Aqam) Biotite leucotonalite

Boizard Suite

(Aboz) Heterogeneous tonalite with a gneissic aspect

VOLCANO-SEDIMENTARY UNITS

Innuksuac Complex

(Ainn2) Migmatitic paragneiss; intermediate rocks of undetermined origin; iron formation

(Ainn1) Amphibolite and mafic gneiss; ultramafic rocks; paragneiss; iron formation; anthophyllite-cordierite schist; garnetite; conglomerate; rare felsic horizons.

FIGURE 4 - Simplified geology of the study area (map sheets 34K and 34L).

plagioclase are generally weakly altered. A few samples display a well-developed foliation defined by the alignment of mafic minerals. Amphibolite samples commonly contain magnetite in disseminated grains or associated with mafic minerals. Reddish biotite and apatite were observed in a few samples. Most amphibolite samples are fine-grained, although a few samples show a coarser grain size.

Porpoise Cove Belt

The Porpoise Cove belt is exposed on a number of large outcrops with good observation surfaces, especially those located directly along the coastline of Hudson Bay. In fact, two of these outcrops were selected for a detailed study within the scope of a Master's thesis (Nadeau, 2002). The Porpoise Cove belt consists of a number of lithologies affected by complex polyphase tectonics. Amphibolite is the dominant lithology in the belt. It forms sequences several hundred metres in thickness, made up of bands from 0.1 to 1.0 m in thickness that show a variety of textures. These horizons are massive or banded, more rarely brecciated or amygdaloidal, and their grain size is variable. These amphibolites may represent former basalt sequences that were intruded by gabbro dykes or sills. The amphibolites are composed of elongate grains of green hornblende that define foliation planes; between the latter, small polygonal plagioclase grains are fairly saussuritized and sericitized. Several ultramafic horizons from 1 to 10 m thick are intercalated in the amphibolite sequences. These are blackish, fine to medium-grained rocks with a characteristic brownish weathering rind. In thin section, two dunite samples are composed of altered olivine crystals separated by acicular tremolite grains. M-scale layers of garnetite (90% garnet) and anthophyllite ± cordierite ± garnet schist are intercalated with the mafic and ultramafic rocks. These layers are interpreted as metamorphosed hydrothermal alteration zones. Supracrustal rocks of the Porpoise Cove belt also include migmatitic garnet paragneisses, silicate-facies and oxide-facies banded iron formations from 1 to 10 m thick, a few felsic volcanic units (lavas or tuffs) and m-scale beds of polygenic conglomerate (Appendix 1, Photo 1). The latter contain about 40% felsic clasts from 1 to 8 cm long, stretched in the foliation direction. M-scale whitish pegmatite dykes injected at an angle relative to the foliation are also observed.

Paragneisses and Intermediate Rocks (Ainn2)

Sub-unit Ainn2, observed throughout the area, is particularly well represented in the north-central part of the map area (Figure 4), where it occurs in lenticular bands a few kilometres wide by several kilometres long. These bands mainly consist of migmatitic paragneiss, alternating with intermediate rock layers of uncertain origin. Locally, iron formations are also intercalated in the paragneiss sequence. Rocks in this sub-unit are easily spotted from the air given their rusty weathered surfaces.

Paragneiss is the dominant lithology in sub-unit Ainn2. It occurs in layers from a few metres to a few hundred metres in thickness that form banded sequences often disturbed by isoclinal folding. The paragneiss is fine-grained, with a medium grey colour and a yellowish grey to rusty brown weathered surface. In several locations, it is affected by migmatization, marked by the presence of 1 to 10 cm bands of whitish to pinkish granitic mobilizate parallel to the foliation, which enhance the rock's banded aspect. This mobilizate, which forms 5 to 40% of the rock, may locally reach up to 80%. Garnet grains of mm to cm-scale are abundant in the paragneiss, as well as in the mobilizate bands. A few m-scale paragneiss horizons contain more than 80% garnet.

In thin section, the paragneiss exhibits a well-developed granoblastic texture mainly defined by polygonal plagioclase grains. It contains 2 to 20% quartz, occurring as thin ribbons or elongate bands parallel to the foliation. The foliation, often folded, is defined by the alignment of reddish biotite, which represents 10 to 30% of the total volume of the rock. A few samples also contain 5 to 10% orthopyroxene. Garnet occurs as mm-scale to cm-scale sub-rounded poikilitic grains. Cordierite and spinel (10%) are locally observed, and a few grains of andalusite and corundum were noted in a paragneiss sample. The mobilizate associated with the paragneiss is tonalitic to granitic in composition. It contains less than 2% mafic minerals, mainly biotite in the form of stretched aggregates or small mm-scale bands. The mobilizate may also contain minor orthopyroxene and garnet.

Intermediate rocks form horizons from 1 to 10 m thick, intercalated in the paragneiss sequences. They consist of dark grey rocks that weather to a brownish grey colour. They are fine to medium-grained and display a well-developed granoblastic texture. These rocks are massive or foliated and locally banded on outcrop. They are composed of plagioclase (55 to 70%) and mafic minerals (20 to 40%), represented by variable proportions of red biotite, clinopyroxene and orthopyroxene, with less than 5% green hornblende locally, or brown hornblende even more rarely. Xenomorphic magnetite grains (up to 3%) are generally associated with the mafic minerals. The rock contains isolated mm-scale to cm-scale garnet grains.

Iron formations are not abundant, and occur in association with the paragneisses. They generally consist of thinly banded silicate-facies iron formations, often strongly folded, occurring in beds from 1 to 30 m thick. Exceptionally, they may reach up to 300 m in thickness. Silicate-facies iron formations consist of alternating bands from 0.1 to 10.0 cm thick, composed of quartz, grunerite, magnetite and garnet.

Tonalitic Units

Tonalitic units cover a considerable proportion of the study area (Figure 4). They are subdivided into three lithodemic units: the Boizard Suite (Aboz), the Qamanirjuaq Suite (Aqam) and the Qilalugalik Suite (Aqil).

The Boizard Suite (Aboz) is a new unit encountered near the Porpoise Cove belt. It is composed of tonalite, which contains numerous stretched and partially assimilated mafic enclaves that give the tonalite a gneissic aspect. The Qamarnirjuaq Suite (Aqam) consists of leucotonalite that contains less than 10% biotite. The Qilalugalik Suite (Aqil) comprises a sub-unit of clinopyroxene tonalite with burgundy plagioclase (Aqil1), a sub-unit of heterogeneous enderbite, opdalite and charnockite (Aqil3), and a sub-unit of biotite tonalite with burgundy to red plagioclase (Aqil4). All the tonalitic units in the area host enclaves of diorite and amphibolite. Cross-cutting relationships between rocks of the Boizard, Qamanirjuaq and Qilalugalik suites were not observed in the field.

All the tonalitic rocks in the area underwent an extensive "granitization" process of variable intensity at a regional scale. The "granitization" translates into the presence of a pinkish grey, medium to coarse-grained granodioritic to granitic phase, which constitutes 10 to 60% of the total volume of the rock. It occurs in more or less continuous bands from 1 to 10 cm thick, with diffuse contacts, giving the rock a banded and heterogeneous aspect. It also occurs as pockets or lenses of variable dimensions, with diffuse and transitional contacts with the tonalitic phase (Appendix 1, Photo 2). In several locations, the "granitization" has generated cm-scale K-feldspar crystals, isolated or clustered in aggregates within the tonalite. The K-feldspar distribution is heterogeneous on a regional scale, on outcrop and even in hand sample. The "granitization" phenomenon is often more intense near the contacts with granodiorite bodies of the Voizel Suite (Avoi), which suggests a link between the emplacement of these plutons and the "granitization" of tonalitic rocks in the area. However, the processes involved are poorly understood.

Bozard Suite (New unit, Aboz)

The Boizard Suite (Aboz) is a new unit encountered only in the southwestern part of the area, in the vicinity of the Porpoise Cove volcano-sedimentary belt (Figure 4). This suite is composed of heterogeneous tonalite, commonly banded and with a gneissic aspect. The heterogeneity of the unit is due to the significant "granitization" of the tonalite, to rapid variations in grain size, to an irregular distribution of mafic minerals, and to the presence of numerous stretched mafic to ultramafic enclaves largely assimilated by the tonalite (Appendix 1, Photo 3). Abundant late injections of fine to coarse-grained granite, conformable or not relative to the foliation, enhance the heterogeneity of this unit.

The tonalite is pale grey to medium grey, and exhibits a heterogeneous grain size that rapidly changes from fine to coarse. Mafic minerals, irregularly distributed, represent 5 to 25% of the total volume of the rock. In several locations, they form schlieren from 1 to 10 cm thick, derived from the partial assimilation of mafic enclaves. Enclaves represent 10 to 35% of the rock, but may exceed 50% in certain locations. They mainly consist of cm-scale to m-scale enclaves stretched along the regional foliation direction. They are composed of amphibolite and rare ultramafic rock (Appendix 1, Photo 3). Locally, the amphibolites also form bands a few tens of metres thick. The mafic mineral content in the tonalite commonly increases near enclave borders. This increase is caused by the partial assimilation of enclaves by the tonalite. The foliation is generally well developed in the tonalite, and the presence of stretched enclaves and mafic mineral aggregates produces a banded to gneissic aspect. Folding affects all at once the foliation, the enclaves and the mafic mineral aggregates. The enclaves also exhibit an early internal foliation, folded by the regional foliation, adding to the complexity of this unit's deformation pattern.

In thin section, most samples of the Boizard Suite (Aboz) exhibit a well-developed foliation and a heterogeneous grain size. The rock has a tonalitic composition, with 25 to 35% quartz, 50 to 70% plagioclase and less than 5% K-feldspar. It contains 3 to 15% mafic minerals, aligned parallel to the foliation or concentrated in mm-scale to cm-scale bands, which give the rock a banded aspect. These mainly consist of chloritized brown biotite and green chlorite, with rare green hornblende. The rock also contains epidote, often associated with chlorite, sub-rounded apatite grains, xenomorphic magnetite grains and sphene. Several samples contain coarse allanite grains rimmed with epidote (pistacite) as well as automorphic zoned zircon grains. Certain tonalite samples, more massive and more homogeneous, contain less than 5% mafic minerals, represented by small disseminated chlorite flakes and partially to strongly chloritized brown biotite. This tonalite is similar to tonalites assigned to the Qamanirjuaq Suite (Aqam).

Qamanirjuac Suite (New Unit, Aqam)

Tonalites of the Qamanirjuaq Suite (Aqam) cover an extensive surface area in the central part of the map area (Figure 4). This new unit consists of pale grey and sometimes slightly pinkish, weakly to strongly foliated, locally massive tonalite with a fine to coarse grain size. The tonalite contains less than 8% mafic minerals, often accompanied by a few small grains of magnetite. The unit hosts abundant cm-scale to m-scale enclaves of amphibolite, diorite, gabbro, as well as rare paragneiss and ultramafic rock. These enclaves are generally fine-grained, strongly foliated and exhibit a well-developed granoblastic texture. The proportion of enclaves varies considerably within the unit (0 to 40%). In certain locations, zones with a high proportion of enclaves form corridors a few tens of metres wide. The enclaves, stretched along the regional foliation direction, are strongly assimilated by the tonalite, and form in many locations, elongate aggregates of mafic minerals similar to schlieren encountered in diatexites. A 1 to 10 cm-thick reaction rim of hornblende or pyroxene is also observed at the contact between enclaves and tonalite. Locally, garnet is observed within the enclaves. The presence of stretched enclaves, coupled with the "granitization" phenomenon that affects the tonalite, gives this unit a heterogeneous aspect.

The unit also comprises some tonalite and quartz diorite that contain 10 to 35% mafic minerals, mainly biotite and hornblende. These rocks form horizons a few tens of metres wide, too small to appear on the map at 1:250,000 scale. The leucotonalite intrudes the tonalite and quartz diorite, indicating it is younger than the latter.

In thin section, the leucotonalite is composed of 25 to 30% quartz, 60 to 75% plagioclase and 0 to 8% K-feldspar. K-feldspar occurs as an interstitial phase between other grains, or as isolated crystals. Certain strongly "granitized" samples may contain up to 25% K-feldspar, randomly distributed or occurring in bands or aggregates. The leucotonalite contains 1 to 8% mafic minerals, including partially to strongly chloritized brownish biotite and greenish chlorite, disseminated or in aggregates associated with epidote. A few rare green hornblende crystals were observed in a few samples. One sample collected in the westernmost part of the area contains a few mm-scale grains of garnet. Apatite and magnetite are the most widespread accessory minerals, whereas muscovite, sphene and zircon are locally observed. Plagioclase grains often show antiperthitic textures. They are partially altered to sericite, except in areas affected by regional faults, where intense alteration of plagioclase grains is accompanied by the complete chloritization of biotite.

Qilalugalik Suite (Aqil)

The Qilalugalik Suite was introduced by Parent *et al.* (2002) in the Lac Vernon area, where it comprises three sub-units: a sub-unit of hornblende-clinopyroxene tonalite with burgundy plagioclase (Aqil1), a sub-unit of hornblende ± clinopyroxene granite (Aqil2) and a sub-unit of heterogeneous enderbite (Aqil3). In the Rivière Innuksuac area, the hornblende-clinopyroxene granite sub-unit (Aqil2) was not observed. The Qilalugalik Suite (Aqil) in our study area does includes however a sub-unit of clinopyroxene tonalite with burgundy plagioclase (Aqil1), as well as a sub-unit of heterogeneous enderbite (Aqil3), which respectively correspond to sub-units Aqil1 and Aqil3 in the Lac Vernon area. It also includes a new sub-unit, composed of biotite tonalite with burgundy to red plagioclase (Aqil4).

Clinopyroxene Tonalite with Burgundy Plagioclase (Aqil1)

The clinopyroxene tonalite with burgundy plagioclase sub-unit (Aqil1) is fairly widespread within the map area, except in the western part where it is much less common (Figure 4). The sub-unit contains, in addition to tonalite, some quartz diorite, which displays similar characteristics to the tonalite. The fine to medium-grained tonalite and quartz diorite are weakly to strongly foliated. They exhibit a distinctive purplish grey colour caused by the burgundy colour of the plagioclase (Appendix 1, Photo 4). The distribution and proportion of burgundy plagioclase is quite variable. In several locations, m-scale layers or lenses from 0.1 to 1.0 m in thickness with diffuse contacts contain a high proportion of burgundy plagioclase. In many areas, blackish plagioclase is seen to coexist with burgundy plagioclase in variable proportions. Plagioclase grains in these locations are zoned, with a blackish core surrounded by a burgundy-coloured rim. Another important characteristic of sub-unit Aqil1 is the presence of clinopyroxene. The tonalite in this sub-unit contains 3 to 10% mafic minerals, but this proportion may reach 25% in areas where enclaves are more abundant. Enclaves from 0.1 to 1.0 m in size of amphibolite, diorite and rare paragneiss represent 5 to 15% of the total volume of the rock. They are sub-rounded in areas where the tonalite is massive to weakly foliated, and stretched where the foliation appears to be more strongly developed. The enclaves occasionally exhibit a folded internal foliation enhanced by the presence of mm-scale to cm-scale whitish mobilizate. In certain locations, bands from 0.01 to 1.00 km in size of amphibolite or mafic gneiss were mapped. Overall, outcrops in this sub-unit range from homogeneous to heterogeneous over short distances. The heterogeneity is caused by variations in grain size, in "granitization" intensity, in the proportion of mafic enclaves and in mafic mineral and burgundy plagioclase content.

Rocks of sub-unit Aqil1 are composed of 10 to 30% quartz, 55 to 75% plagioclase and 0 to 8% K-feldspar. Samples affected by "granitization" may contain up to 20% K-feldspar. Plagioclase crystals are weakly to strongly altered to sericite. They contain fine reddish inclusions, which appear to be responsible for the burgundy colour. Antiperthitic textures are fairly common within plagioclase crystals. K-feldspar occurs as interstitial grains or as hypidiomorphic crystals disseminated throughout the rock. Plagioclase and K-feldspar crystals are generally surrounded by aggregates of quartz grains with dendritic grain boundaries, or by a fine groundmass composed of recrystallized quartz grains. The tonalite generally contains 3 to 10% mafic minerals occurring in aggregates composed of partially chloritized brown biotite with minor amounts of clinopyroxene and rare hornblende. Clinopyroxene crystals are partially to almost entirely replaced by hornblende. Hornblende crystals are altered to chlorite, epidote and carbonate. In samples collected near regional fault zones, biotite is completely replaced by chlorite. This chloritization of biotite is accompanied by a strong sericitization of plagioclase. Xenomorphic magnetite grains are disseminated throughout the rock or are associated with mafic minerals. Magnetite may represent more than 1% of the total volume of the rock. Rare epidote grains are generally associated with chlorite. Apatite, allanite, sphene and zircon are the most common accessory minerals. Muscovite was observed in a few samples.

The contact between tonalites with burgundy plagioclase (Aqil1) and heterogeneous enderbites (Aqil3) is transitional. It is marked by the appearance of orthopyroxene and by a change in the color of plagioclase grains, grading from burgundy to green, which gives the rock a distinctive greenish tinge. In transition zones between the two sub-units, colour variations are frequently observed over a few metres in width. In these zones, the tonalite contains both burgundy and green plagioclase, as well as a dark red biotite and a few isolated grains of orthopyroxene. The contact between the two sub-units is based on the appearance of orthopyroxene, which characterizes the heterogeneous enderbite sub-unit (Aqil3).

Heterogeneous Enderbite (Aqil3)

Similar to sub-unit Aqil1, sub-unit Aqil3 was mapped in many locations throughout the area (Figure 4). It mainly consists of enderbite and orthopyroxene quartz diorite, with minor opdalite and charnockite. These lithologies are difficult to distinguish in the field, but feldspar staining, thin section examinations and lithogeochemistry indicate that enderbites are largely predominant. The colour of these rocks, which grades from greenish grey to green to honey brown, is attributable to the greenish tinge of plagioclase and the brownish tinge of smoky quartz. These rocks are massive to foliated. Their grain size ranges from medium to coarse, they are slightly porphyritic and display a high magnetic susceptibility. They may contain burgundy plagioclase grains, especially near contact zones with sub-unit Aqil1. Rocks in sub-unit Aqil3 contain 3 to 10% mafic minerals. Orthopyroxene is ubiquitous; it often occurs as disseminated cm-scale crystals with a distinctive brownish weathered surface. Overall, sub-unit Aqil3 hosts 2 to 5% sub-rounded or stretched enclaves of amphibolite, diorite or migmatitic paragneiss. The proportion of enclaves increases near volcano-sedimentary bands that reach a few hundred metres in thickness. This increase in the proportion of enclaves is generally accompanied by an increase in the mafic mineral content of country rocks. Similar to sub-unit Aqil1, outcrops of sub-unit Aqil3 vary from a homogeneous to a heterogeneous aspect over short distances, as a function of the "granitization", the grain size and the percentage of enclaves and mafic minerals.

Thin sections show that orthopyroxene-bearing quartz diorites represent a fairly widespread lithology. These rocks contain 10 to 15% quartz, whereas enderbite samples contain 20 to 30% quartz. The plagioclase content of enderbites and orthopyroxene-bearing quartz diorites ranges from 60 to 80%. The K-feldspar content is generally lower than 5%, but increases with the degree of "granitization". Plagioclase grains are partially altered to sericite, and exhibit an antiperthitic texture in many samples. Fine reddish inclusions were observed in burgundy plagioclase grains. Mafic minerals range from 1 to 8% in enderbites, and from 10 to 15% in quartz diorites. In both cases, these minerals occur as mm-scale to cm-scale aggregates disseminated throughout the rock. Biotite and orthopyroxene are predominant in the enderbites, whereas clinopyroxene and orthopyroxene represent the dominant mafic phases in quartz diorites. Hornblende was observed in a few samples. Biotite is always dark red, and commonly aligned parallel to the foliation direction. Orthopyroxene occurs as automorphic to hypidiomorphic crystals, occasionally surrounded by clinopyroxene. Orthopyroxene is partially to completely altered to talc, serpentine, carbonate and iddingsite such that, in certain samples, only these alteration products remain. Clinopyroxene is commonly retrograded to green hornblende or altered to carbonate, chlorite and epidote. The rock contains nearly 1% xenomorphic magnetite, occurring as disseminated grains or associated with the mafic minerals. Sub-rounded apatite grains as well as small often-zoned zircon grains were observed in all samples. The foliation is defined by the alignment of mafic minerals and the stretched nature of quartz grains. In certain samples, quartz, plagioclase and pyroxene grains exhibit a granoblastic texture. Opdalites and charnockites contain less than 5% mafic minerals, composed of red biotite, orthopyroxene, clinopyroxene and local hornblende. The petrographic characteristics of these rocks are comparable to those observed in enderbite and orthopyroxene-bearing quartz diorite samples.

Biotite Tonalite with Burgundy to Red Plagioclase (new unit, Aqil4)

Sub-unit Aqil4 covers a small surface area in the northwestern part of the map area (Figure 4). In the field, the tonalite in this sub-unit contains plagioclase with a burgundy to red colour, which often gives the rock an appearance similar to the clinopyroxene tonalite with burgundy plagioclase assigned to sub-unit Aqil1. However, tonalites in sub-unit Aqil4 are characterized by the absence of clinopyroxene and the slightly more reddish tinge of plagioclase grains.

In thin section, quartz, plagioclase and K-feldspar proportions are similar to those of tonalites with burgundy plagioclase in sub-unit Aqil1. The same textures are also observed, as well as the fine reddish inclusions within plagioclase grains. The tonalite in sub-unit Aqil4 contains 1 to 5% mafic minerals, represented by partially chloritized biotite. This tonalite contains no clinopyroxene or hornblende. In fact, except for the reddish or burgundy colour of the plagioclase, tonalites in sub-unit Aqil4 are fairly similar to biotite leucotonalites of the Qamanirjuaq Suite (Aqam).

Monzodioritic to Granitic Units

Monzodioritic to granitic rocks in the area belong to three distinct lithodemic suites. The Voizel Suite (Avoi), the most extensive, consists of homogeneous, massive or foliated biotite granodiorite and granite. Rocks in this unit are similar to those of the granitic phase associated with the "granitization" that affects tonalitic units. A link may exist between the "granitization" of tonalitic units and the emplacement of the Voizel Suite. The Gabillot Suite (Agab) consists of small bodies of biotite-clinopyroxene monzodiorite and granite, characterized by a megaphyric texture. The Corneille Suite (Acrn) is found exclusively in the westernmost part of the area. It mainly consists of hololeucocratic granite and tonalite. These rocks exhibit a characteristic white colour.

Voizel Suite (New unit, Avoi)

The Voizel Suite (Avoi) covers an important surface area in the Rivière Innuksuac area (Figure 4). It is composed of homogeneous granodioritic to granitic rocks. The rocks in this suite are medium-grained and range from pinkish grey to pale pink. In several locations, the granite and granodiorite have a whitish grey colour. It then becomes difficult to differentiate them from tonalitic units given the whitish colour of the K-feldspar phase. The granodiorite and granite are also difficult to distinguish from one another in the field. However, K-feldspar staining, thin section examinations and lithogeochemical analyses indicate that granitic compositions are largely predominant. The rock is massive or weakly foliated, except in deformation zones related to regional faults, where cataclastic and mylonitic textures are observed. The granite and granodiorite generally exhibit a high magnetic susceptibility. They contain 3 to 8% mafic minerals, disseminated throughout the rock or clustered in aggregates. K-feldspar phenocrysts from 1 to 4 cm long are common, but generally represent less than 5% of the total volume of the rock. They may however reach 25% in certain locations. The rocks often contain burgundy plagioclase grains similar to those typically observed in tonalites of the Qilalugalik Suite (Aqil). These are particularly abundant in the southeastern part of the area. Intermediate to mafic enclaves generally represent less than 2% of the total outcrop surface, with local exceptions reaching up to 15%. These consist of cm-scale to m-scale enclaves generally stretched along the regional foliation direction, composed of amphibolite, gabbro, diorite, and rare gabbronorite and orthopyroxene diorite. These rocks are foliated or banded, fine to medium-grained and commonly exhibit a granoblastic texture. The mafic mineral content in the granite increases near the enclaves.

In thin section, the rock is composed of quartz (20 to 35%), plagioclase (5 to 60%) and K-feldspar (15 to 50%). Myrmekitic, perthitic and antiperthitic textures are widespread. The rock contains 1 to 8% mafic minerals, represented by brown biotite, often chloritized, and hypidiomorphic chlorite crystals. These minerals occur as isolated grains or in aggregates with epidote and opaque minerals. Samples of granite with burgundy plagioclase contain 2 to 3% green hornblende in addition to biotite and chlorite. Small reddish brown acicular inclusions were observed in burgundy-coloured plagioclase grains. Granites and granodiorites of the Voizel Suite (Avoi) also contain minor apatite, sphene, zircon and a few allanite grains.

Gabillot Suite (New unit, Agab)

The Gabillot Suite (Agab) is a new unit introduced to describe small bodies (less than 10 km in diameter) of megaphyric rocks, mainly exposed in the eastern half of the area (Figure 4). These rocks range from a monzodioritic to a granitic composition. They are characterized by the presence of 10 to 50% K-feldspar phenocrysts from 1 to 5 cm in length. The rock is pinkish grey to dark pink, and varies from medium to coarse-grained. It contains 5 to 15% mafic minerals, generally occurring in aggregates. The rocks are massive, although a weak foliation may be defined by the alignment of K-feldspar phenocrysts and mafic minerals. This foliation is stronger in deformation zones related to regional faults. The rock exhibits a high magnetic susceptibility. Amphibolite or gabbro enclaves represent less than 2% of the total volume of outcrops. These enclaves range from a few centimetres to a few decimetres in size. A fine-grained syenite was observed in the southeastern part of the area. It may represent a border facies included within a megaphyric monzodiorite intrusion.

The few samples observed in thin section reveal monzodioritic and quartz monzodioritic compositions. These rocks consist of quartz (10 to 15%), plagioclase (40 to 55%) and K-feldspar (20 to 35%). They contain 8 to 15% mafic minerals, mainly clinopyroxene, reddish brown biotite, green hornblende and rare orthopyroxene. Clinopyroxene is partially replaced by green hornblende, whereas biotite is partially altered to chlorite. The presence of 1 to 2% xenomorphic grains of magnetite, generally associated with the mafic minerals, explains the strong magnetic susceptibility of these rocks. Apatite is ubiquitous, and generally occurs as hypidiomorphic grains. Epidote, sphene and zircon are the other commonly observed accessory minerals. Myrmekitic textures are very widespread and a mortar texture is locally observed. These rocks show a heterogeneous grain size, consisting of medium to coarse grains surrounded by a fine groundmass.

Corneille Suite (New unit, Acrn)

The Corneille Suite (Acrn) is a new unit, exclusively found in the western part of the area (Figure 4). It primarily consists of whitish and rarely greenish granite, which contains distinctive bluish grey quartz grains. The granite is generally massive or weakly foliated, except in deformation zones where ribbon quartz and mylonitic textures are observed. It shows a heterogeneous grain size, ranging from medium to coarse over short distances. This heterogeneity is further enhanced by the presence of 1% K-feldspar phenocrysts from 1 to 2 cm in length. The granite generally contains less than 2% chlorite and less than 1% small mm-scale garnet grains. The unit also includes a whitish tonalite, with characteristics and textures broadly comparable to those of the white granite. Nevertheless, feldspar staining and thin sections reveal that granite is more abundant than tonalite. The whitish granite forms large plutons covering many square kilometres. It also occurs as dykes and injections that cut all earlier units encountered in the westernmost part of the area.

The Corneille Suite (Acrn) contains 10 to 25% elongate enclaves of migmatitic paragneiss, amphibolite, diorite, gabbro, and minor tonalite and enderbite. These enclaves range from a few centimetres to a few tens of metres in length. The proportion of enclaves may exceed 50% in certain horizons generally about 10 m in width. Stretched enclaves, partially assimilated and injected by the granite, give the unit a heterogeneous aspect. Mafic mineral schlieren were observed in many locations within the granite. Samples from mafic enclaves show a well-developed granoblastic texture. These mafic enclaves are mainly composed of plagioclase, clinopyroxene, orthopyroxene and brown hornblende. Migmatitic paragneiss enclaves contain red biotite, garnet and orthopyroxene.

The granite is composed of 25 to 50% quartz, 5 to 25% plagioclase and 30 to 60% K-feldspar. In thin section, the rock shows evidence of internal deformation that contrasts with its massive aspect on outcrop. This deformation is illustrated by the undulating extinction of quartz grains, curved twins in plagioclase and K-feldspar grains as well as the presence of a mortar texture and a mylonitic texture. Mesoperthitic textures are abundant in K-feldspar grains, indicating the granite formed at high temperatures. Myrmekitic textures are also very common. Plagioclase grains are moderately to strongly altered to sericite, epidote, chlorite and calcite. Mafic minerals (less than 2%) are represented by chlorite, which forms aggregates with epidote. Garnet, biotite, white mica and zircon were also observed in a few samples.

The only difference between the tonalite and the granite is the plagioclase and K-feldspar content. All the textures observed in the granite are also present in the tonalite.

Ultramafic to Intermediate Units

Archean units in the area are cut by small younger intrusions ranging from ultramafic to intermediate compositions. These intrusive rocks belong to two distinct suites: the Cheminade Suite (Acmd) and the Qullinaaraaluk Suite (Aluk). The Cheminade Suite (Acmd) consists of gabbronorite, hypersthene diorite and hypersthene quartz diorite. Rocks in this suite have recorded a phase of deformation marked by the presence of a weak foliation. The Qullinaaraaluk Suite (Aluk) is mainly composed of massive intrusions of hornblende pyroxenite and gabbronorite.

Cheminade Suite (New unit, Acmd)

The Cheminade Suite (Acmd) is a new unit introduced to describe mafic to intermediate intrusions characterized by the presence of orthopyroxene. These intrusions are observed throughout the map area (Figure 4). They consist of dykes or bodies of gabbronorite, hypersthene diorite and hypersthene quartz diorite, elongated parallel to the regional structural trend. These intrusions, less than one kilometre wide, may extend for several kilometres in length. On outcrop, gabbronorite and hypersthene diorite are difficult to differentiate from one another, whereas the greater quartz content that characterizes the hypersthene-bearing quartz diorite is easily observed in the field. Based on petrographic observations, hypersthene diorite is more widespread than gabbronorite. All these rocks exhibit a high magnetic susceptibility. They are fine to medium-grained, with local cm-scale plagioclase phenocrysts. They are greenish grey to dark green, with a brownish to beige weathered surface. Weathered surfaces look spotty, given the presence of stretched cm-scale aggregates formed of blackish mafic minerals that outline the foliation. In several locations, elongate cm-scale to m-scale enclaves composed of diorite, amphibolite and rare ultramafic rock are observed. These fine-grained enclaves exhibit a granoblastic texture.

Intrusive rocks of the Cheminade Suite are mainly composed of plagioclase (58 to 83%), mafic minerals (15 to 35%) and less than 2% interstitial quartz, except for a few samples of quartz diorite where the quartz content ranges from 6 to 10%. These rocks do not contain any K-feldspar. Mafic minerals consist of weakly altered, xenomorphic to hypidiomorphic crystals of red biotite (3 to 27%), green hornblende (0 to 18%), clinopyroxene (0 to 7%) and orthopyroxene (1 to 12%). They are clustered in aggregates broadly elongated parallel to the foliation. These rocks also contain nearly 1% xenomorphic magnetite, associated with the mafic minerals. Hypidiomorphic grains of apatite are abundant, whereas zircon and sphene are fairly rare.

Qulinaaraaluk Suite (Aluk)

The Qullinaaraaluk Suite (Aluk) was defined by Parent *et al.* (2002) as a series of late mafic to ultramafic intrusions encountered in the Lac Vernon area. The discovery of a significant Ni-Cu-Co-PGE showing revealed the economic potential of this type of intrusion. This mineralized zone, hosted in ultramafic rocks, is located near Lac Qullinaaraaluk (Parent *et al.*, 2002; Labbé *et al.*, 2000).

In the Rivière Innuksuac area, the Qullinaaraaluk Suite was subdivided into two sub-units in order to distinguish mafic facies from facies dominated by ultramafic rocks. The first sub-unit is mainly composed of ultramafic intrusions (Aluk1), generally associated with a few mafic intrusions. The second sub-unit is exclusively composed of mafic intrusions (Aluk2), similar to those found in sub-unit Aluk1. Most intrusions assigned to the Qullinaaraaluk Suite (Aluk1 and Aluk2) are only exposed in the eastern half of the area (Figure 4).

Intrusions of the Qullinaaraaluk Suite form well-constrained bodies a few hundred metres to a few kilometres in diameter. These intrusions cut all Archean lithological units in the area, and do not appear to be affected by regional Archean deformation or metamorphism. In the Lac Vernon area, the long axis of some ultramafic intrusions is at an angle relative to the regional structural trend, suggesting they are post-tectonic (Labbé *et al.*, 2000). Certain intrusions encountered in the Rivière Innuksuac area are transected by small local fault zones. These faults zones, injected with epidote veins, are probably Proterozoic in age.

Ultramafic Intrusions (Aluk1)

Ultramafic intrusions mainly consist of pyroxenite with minor hornblendite and peridotite. These rocks are dark green or blackish grey, with a brownish grey to dark brown weathered surface. They are massive and range from fine to medium-grained. They are commonly cut by whitish tonalitic to granitic injections from 1 to 10 cm wide, which give the rock a brecciated aspect (Appendix 1, Photo 6). These rocks commonly contain 10 to 25% blackish hornblende phenocrysts from 1 to 4 cm long, giving them a spotty appearance. The ultramafic rocks occur in sharp or transitional contact with gabbronorites similar to those in unit Aluk2, to which they are associated.

In thin section, observed ultramafic rocks consist of hornblende pyroxenite, mainly composed of pyroxene (50 to 85%) and green hornblende (10 to 40%), with minor interstitial plagioclase. The pyroxene phase is represented by variable proportions of clinopyroxene and orthopyroxene, with clinopyroxene as the dominant phase. Orthopyroxene grains are fresh or slightly altered to serpentine and talc. Clinopyroxene grains are partially or completely replaced by green hornblende, and more rarely so, by another lighter-coloured fibrous amphibole, probably from the tremolite-actinolite series. Clinopyroxene grains commonly exhibit aligned inclusions of fine-grained opaque minerals along cleavage planes. Hornblende occurs as an interstitial phase between pyroxene grains, and as coarse (cm-scale) poikilitic grains that host clinopyroxene and orthopyroxene inclusions. The rock also contains a few flakes of biotite or reddish phlogopite. Olivine crystals (2%) were observed in a single sample. Magnetite accounts for roughly 1% of the rock, except in the olivine-bearing sample, where it reaches 5%.

Mafic Intrusions (Aluk2)

Mafic intrusions consist of medium to coarse-grained, leucocratic to melanocratic hornblende gabbronorite. The rock shows a greenish grey, brownish grey or whitish grey weathered surface. Similar to ultramafic rocks, the gabbronorite is massive and cut by whitish injections that produce a brecciated texture. It also contains 10 to 25% green hornblende phenocrysts from 1 to 4 cm in length.

In thin section, the gabbronorite is composed of plagioclase (40 to 60%), orthopyroxene (15 to 20%), clinopyroxene (15 to 30%) and green hornblende (5 to 30%). Mafic minerals generally form clusters, separated by aggregates of fresh automorphic to hypidiomorphic plagioclase grains. Mafic minerals are similar to those observed in ultramafic rocks. Orthopyroxene grains are fresh, whereas clinopyroxene grains are partially or nearly completely replaced by green hornblende. Hornblende also occurs as an interstitial phase, or as cm-scale poikilitic crystals. Biotite and magnetite occur in minor amounts. A gabbronorite sample affected by a late fault shows evidence of complete saussuritization of plagioclase, accompanied by complete uralitization of clinopyroxene.

Proterozoic Rocks

Hopewell Group (Php)

The Hopewell Group (Php) was named by Lee (1965) to describe thick sequences of Proterozoic volcanic and sedimentary rocks found in the Hopewell Islands. Only two of these islands lie within Québec's borders, the remainder are located in Nunavut. Rocks of the Hopewell Group were not mapped in detail during this geological survey, and the following descriptions as well as the lithological names are primarily derived from Lee (1965). These rocks occur as undeformed sub-horizontal strata. They appear to overlie the Archean basement along an angular unconformity, although the contact between Proterozoic and Archean rocks is not exposed.

Lee (1965) reported that the Proterozoic supracrustal succession of the Hopewell Group (Php) is similar from one island to the other. The group consists of a sequence of sedimentary rocks, about 50 to 100 m thick, composed of alternating quartzite and quartzose sandstone, interbedded with slaty schist, chert and oolithic iron formation horizons. The top of the sedimentary sequence consists of a 3 to 8 m thick bed of black slaty schist. A diabase sill 3 to 10 m thick occurs immediately below the black schist. A 3 to 15 m flow of columnar basalt unconformably overlies the sedimentary rocks. The presence of oolithic iron formation, along with ripple marks and cross-bedding in quartzites and quartzose sandstones suggests a dynamic shallow depositional environment for these sediments (Lee, 1965).

Diabase dykes

Several Proterozoic diabase dykes were observed on 77 different outcrops. These are rectilinear and discontinuous bodies, ranging from a few decimetres to about 30 metres in thickness. The small size of these bodies makes it impossible to show them on a map a 1:250,000 scale. These dykes are locally affected by brittle deformation. The diabase is homogeneous and massive. It shows a greenish grey to dark green colour and a brownish weathered surface. Most diabase dykes are aphanitic or fine-grained. In certain cases, the grain size ranges from fine to medium from the edges toward the centre of the dyke. Dykes in the area show two preferential orientations: most dykes are oriented NW-SE, but a few dykes range from WNW-ESE to WSW-ENE. These orientations are respectively similar to those determined for the Minto Swarm (1998 ±2 Ma) and the Maguire Swarm (2230 Ma) by Buchan *et al.* (1998). Only three diabase dykes trending NE-SW were observed in the area. This orientation is related to the Ptarmigan Swarm (2505 ±2 Ma; Buchan *et al.*, 1998).

Carbonatite

A late dyke 3 to 4 m wide composed of a carbonatized rock of unknown origin was observed in only one location in the southwestern part of the area (Figure 9; tables 6 and 7). This is a massive, undeformed dyke trending NNE-SSW which cuts a white granite of the Corneille Suite (Acrn). Based on these field observations, the dyke may represent a Proterozoic intrusion, although no age dating analysis has been performed. The intrusion is formed of a medium-grained rock, composed of clasts of felsic intrusive rock rich in 0.5 to 1.0 cm-long K-feldspar crystals that stick out of the outcrop surface in positive relief. The carbonatite is light greenish grey in fresh surface, and shows a brownish tinge in weathered surface. It consists of a groundmass of polygonal carbonate grains, with 15 to 20% hypidiomorphic diopside crystals that often exhibit amoeboid crystal edges. Actinolite grains are commonly associated with the diopside. The rock contains nearly 2% mm-scale automorphic grains of brownish sphene, often zoned. Minor quartz and plagioclase fill interstices between carbonate grains. A few clasts exclusively composed of microcline infiltrated by carbonates may represent fragments derived from a syenite. Finally, allanite, epidote and scapolite are observed in minor amounts.

GEOCHRONOLOGY

A geochronology study was undertaken in conjunction with the geological survey of the Rivière Innuksuac area. Seven samples taken from different stratigraphic units were analyzed by Jean David (Géologie Québec) at the GÉOTOP laboratory at the *Université du Québec à Montréal*. Sampling locations are shown in Figure 4, and the results of U-Pb isotopic analyses by isotopic dilution and thermal ionization mass spectrometry (TIMS) and *in situ* laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) are listed in Table 1.

Innuksuac Complex – Porpoise Cove Belt

Two samples were collected in the Porpoise Cove belt: a felsic tuff and a late pegmatite. The first sample (site 1, Figure 4 and Table 1) comes from a felsic tuff horizon (MP-01-1091F) located along the limb of a fold that affects a sequence of mafic volcanic rocks (Appendix 1, Photo 5). The results of U-Pb isotopic analyses (TIMS) on zircons yielded an age of emplacement of 3825 ±16 Ma (David *et al.*, 2002). These results indicate that the Porpoise Cove belt (Innuksuac Complex – Ainn1) represents the oldest known volcanic sequence in the world, comparable to the Isua sequence (*ca.* 3.7-3.8 Ga) located in western Greenland (David *et al.*, 2002).

The second sample (site 2, Figure 4 and Table 1), located a few tens of metres north of the felsic tuff, was taken from a whitish pegmatite dyke (MP-01-1091G2). This pegmatite cuts the volcanic sequence as well as a bed of iron formation. U-Pb analyses (TIMS) conducted on monazite crystals yielded an age of 2688 ±2 Ma, interpreted as the age of emplacement for the pegmatite.

Boizard Suite

A tonalite sample (MP-01-1189) from the Boizard Suite (Aboz) was collected along the coast of Hudson Bay, east of the Porpoise Cove belt (site 3, Figure 4). U-Pb results (LA-ICP-MS) from 20 zircons yielded three distinct ages (site 3, Table 1); *ca.* 2722 Ma, 2750 ±5 Ma and 2789 ± 14 Ma. These ages are interpreted as follows: the age of crystallization is 2750 ±5 Ma, whereas 2789 ±14 Ma is an inherited age, and *ca.* 2722 Ma appears to represent a late event related to the emplacement of granitic phases ("granitization") that affects tonalitic units in the area.

Qamanirjuaq Suite

U-Pb analyses (TIMS) conducted on zircons recovered from a tonalite sample (MP-01-1188) of the Qamanirjuaq Suite (Aqam), collected in the westernmost part of the area, yielded an age of 2714 ±2 Ma (site 4, Figure 4 and Table 1), interpreted as the age of emplacement of the tonalitic magma.

Qilalugalik Suite

Based on field observations, clinopyroxene tonalites with burgundy plagioclase (Aqil1) and biotite tonalites with burgundy to red plagioclase (Aqil4) appear to be associated with enderbites of sub-unit Aqil3 of the Qilalugalik Suite. However, geochronology results reveal a much more complex history in terms of the relative timing of the different sub-units.

An age of crystallization of 2709 ±3 Ma was determined for a tonalite with burgundy plagioclase of sub-unit Aqil1,

TABLE 1 - Results of U-Pb age dating analyses conducted on samples of the Rivière Innuksuac area. Sample locations are shown in Figure 4.

Site no. (Figure 4) and analytical method	Location UTM (Nad83)	Stratigraphic unit	Age of crystallization	Secondary inherited age	Secondary "granitization" age	Lithology
1 (TIMS)	MP-01-1091F 339799 E 6462996 N	Ainn1 Porpoise Cove belt	3825±16 Ma			Felsic volcanic rock
2 (TIMS)	MP-01-1091G2 339730 E 6463036 N	Injection Porpoise Cove belt	2688±2 Ma (Monazite)			Pegmatite
3 (LA-ICP-MS)	MP-01-1189 343858 E 6461555 N	Aboz	2750±5 Ma	2789±14 Ma	Ca. 2722 Ma	Gneissic tonalite
4 (TIMS)	MP-01-1188 654121 E 6490978 N	Aqam	2714±2 Ma			Biotite leucotonalite
5 (LA-ICP-MS)	RT-01-4067 360102 E 6534551 N	Aqil1	2840±9 Ma	2941±5 Ma	2714±4 Ma	Greenish tonalite with burgundy plagioclase
6 (LA-ICP-MS)	RT-01-4183 354476 E 6526940 N	Aqil3	2732±1 Ma	2837±4 Ma		Enderbite
7 (TIMS)	JF-01-3283 648203 E 6503846 N	Acrn	2691±2 Ma	2715 Ma		White granite

TIMS : U-Pb isotopic analysis by isotopic dilution and thermal ionization mass spectrometry
LA-ICP-MS : in situ laser ablation and inductively coupled plasma mass spectrometry using multiple collectors

sampled in the Lac Vernon area (Parent *et al.*, 2002). A sample of greenish tonalite with burgundy plagioclase (RT-01-4067), from the Rivière Innuksuac area (site 5, Figure 4), was collected in the transition zone between sub-units Aqil1 and Aqil3. This sample, assigned to sub-unit Aqil1, yielded complex zircons, from which U-Pb analyses (LA-ICP-MS) established three distinct ages: 2714 ±4 Ma, 2840 ±9 Ma and 2940 ±5 Ma (Table 1). An interpretation of these results suggests that the tonalite was emplaced at 2840 ±9 Ma, and incorporated zircons from a lithology at 2940 ±5 Ma. Similar to the tonalite sample of the Boizard Suite, the timing of the regional "granitization" phenomenon is established at *ca.* 2714 Ma.

Zircons systematically exhibiting earlier cores were recovered from an enderbite sample (RT-01-4183) of unit Aqil3 (site 6, Figure 4). U-Pb analyses (LA-ICP-MS) conducted on about twenty grains yielded ages of 2732 ±1 Ma and 2837 ±4 Ma (Table 1). These ages respectively correspond to the age of crystallization of the enderbite and to an inherited age, which may correspond to the age of the previous tonalite in unit Aqil1 (site 5, Figure 4).

At the moment of writing, the relationship between tonalites of different ages within the Qilalugalik Suite remains obscure.

Corneille Suite

A sample of massive whitish granite (JF-01-3283) typical of the Corneille Suite (Acrn) was collected in the westernmost part of the area (site 7, Figure 4). Preliminary results of U-Pb zircon analyses (TIMS) yielded ages of 2691 ±2 Ma and 2715 Ma (site 7, Table 1), respectively interpreted as the age of crystallization and an age inherited from earlier lithologies. The age of crystallization of this granite is comparable to the age obtained for a whitish pegmatite dyke in the Porpoise Cove belt (site 2, Figure 4 and Table 1). As for the inherited age of 2715 Ma, it is comparable to the age of crystallization determined for the tonalite sample of the Qamanirjuaq Suite (site 4, Figure 4 and Table 1).

LITHOGEOCHEMISTRY

A lithogeochemistry study was performed in order to broadly characterize the composition of the main lithologies in the Rivière Innuksuac area. To do so, 138 rock samples were collected from the different lithodemic units and analyzed for major elements and certain trace elements. Analyses were conducted at the Consortium de Recherche minérale (COREM), by X-ray fluorescence (major elements and Ga, Ir, Nd, Ta, Rb, Sr, Y and Zr) and by neutron activation (Au, As, Ba, Br, Co, Cr, Cs, Mo, Ni, Sb, Sc, Se, Th, U, W). The results were integrated to the SIGÉOM database. Analytical results for major and trace elements will be discussed according to the five following categories: 1) early mafic and ultramafic rocks, 2) tonalitic rocks, 3) enderbites, 4) granodioritic and granitic rocks, and 5) late ultramafic to intermediate intrusions.

Early Mafic and Ultramafic Rocks

Analyzed samples of early mafic and ultramafic rocks come from the Porpoise Cove belt and a number of amphibolite bands of the Innuksuac Complex. The classification diagram by Winchester and Floyd (1977) (Figure 5c) shows that volcanic rocks of the Porpoise Cove belt (44.2 to 52.2% SiO_2; Table 2) and amphibolites in supracrustal bands (47.0 to 50.9% SiO_2; Table 2) have sub-alkaline basalt compositions. According to the AFM diagram by Irvine and Baragar (1971; Figure 5a), these rocks are tholeiitic. On the Jensen diagram (1976; Figure 5b), amphibolites plot in the magnesian tholeiite and iron tholeiite fields, whereas ultramafic rocks plot in the peridotitic komatiite field. The MgO content ranges from 6.5 to 9.6% (Table 2) in amphibolites from supracrustal bands, from 5.5 to 13.0% (Table 2) in mafic rocks of the Porpoise Cove belt, and from 26 to 30% in ultramafic rocks associated with the mafic volcanic rocks in the belt. Figure 5e shows that mafic rocks of the Porpoise Cove belt form two distinct groups. Most of the early mafic and ultramafic rocks in the area have Zr/Y ratios below 3, typical of tholeiitic rocks (Figure 5f). This ratio appears however to be higher than that observed in rocks of the Chavigny Complex where basalts show Zr/Y ratios from 1.8 to 2.4 (Parent *et al.*, 2002). The paleotectonic diagram by Pearce and Cann (1973; Figure 5d) indicates that all amphibolites in the area have signatures characteristic of ocean floor basalts. A single sample of felsic volcanic rock was analyzed. This sample, collected from a m-scale horizon intercalated in a mafic sequence of the Porpoise Cove belt, shows a calc-alkaline dacite composition (Figure 5a and 5b).

Tonalitic Rocks

Analyzed samples of tonalitic rocks come from the Qilalugalik (Aqil), Qamanirjuaq (Aqam), Boizard (Aboz) and Corneille (Acrn) suites. On the normative classification diagram by O'Connor (1965; Figure 6a), analytical results from these samples plot in the fields of tonalites, trondhjemites and granodiorites, except for samples of the Corneille Suite (Acrn), clustered in the field of tonalites.

TABLE 2 - Minimum, maximum and average geochemical composition of early supracrustal rocks (Ainn1).

unit	M16, Innuksuac Complex		M16, Porpoise Cove		M16, Porpoise Cove (low Mg)		M16, Porpoise Cove (high Mg)		Dacite Porpoise Cove		
n	16		7		4		3		1		
variable	min-max	ave.	min-max	ave.	min-max	ave.	min-max	ave.			
SiO_2	47.00-50.90	48.44	44.20-52.20	48.20	44.20-52.00	48.3	47.00-49.00	48.07		68.40	Weight %
TiO_2	0.60-1.19	0.89	0.67-1.55	0.99	0.67-1.55	1.08	0.72-1.06	0.87		0.36	
Al_2O_3	13.60-17.00	15.04	12.60-18.30	14.99	12.60-18.30	15.35	13.70-15.50	14.5		14.80	
Fe_2O_3t	10.80-14.70	12.86	11.00-20.70	15.44	12.00-20.70	17.45	11.00-14.40	12.77		3.70	
MnO	0.15-0.26	0.20	0.10-0.29	0.17	0.10-0.29	0.17	0.10-0.23	0.18		0.04	
MgO	6.52-9.62	7.91	5.50-12.70	8.06	5.54-7.29	6.06	9.51-12.97	11.50		2.27	
CaO	5.03-13.10	10.63	0.24-9.73	4.92	0.24-9.47	4.03	3.96-9.73	6.11		2.61	
Na_2O	1.28-3.27	2.43	0.10-2.46	1.09	0.10-1.85	0.61	0.91-2.46	1.72		4.1	
K_2O	0.15-1.72	0.74	0.67-3.61	1.80	0.67-3.61	2.30	0.92-1.44	1.15		1.85	
P_2O_5	0.01-0.05	0.03	0.01-0.12	0.05	0.01-0.12	0.07	0.02-0.03	0.02		0.12	
LOI		0.75		4.33		4.72		3.81		99.13	
total		100.02		100.09		100.17		99.98		0.87	
Mg#	0.50-0.63	0.55	0.35-0.64	0.50	0.35-0.48	0.41	0.59-0.64	0.62	0.35-0.64	0.50	
Ba	50.00-350.00	89.38	50.00-1400.00	301.43	50.00-1400.00	417.00	120.00-190.00	146.00		na	PPM
Rb	8.00-78.00	26.00	19.00-140.00	76.00	19.00-140.00	88.00	38.00-82.00	60.00		na	
Sr	37.00-117.00	87.00	2.00-144.00	52.00	2.00-144.00	45.00	44.00-78.00	61.00		na	
Zr	29.00-67.00	47.00	34.00-126.00	69.00	34.00-126.00	78.00	50.00-61.00	57.00		na	
Th	0.20-2.10	0.54	0.40-3.60	1.09	0.40-3.60	1.48	0.50-0.60	0.57		na	
Y	11.00-29.00	20.00	13.00-36.00	22.00	13.00-36.00	23.00	18.00-23.00	20.00		na	

M16: amphibolite
n: number of samples
na: not analysed
ave: average

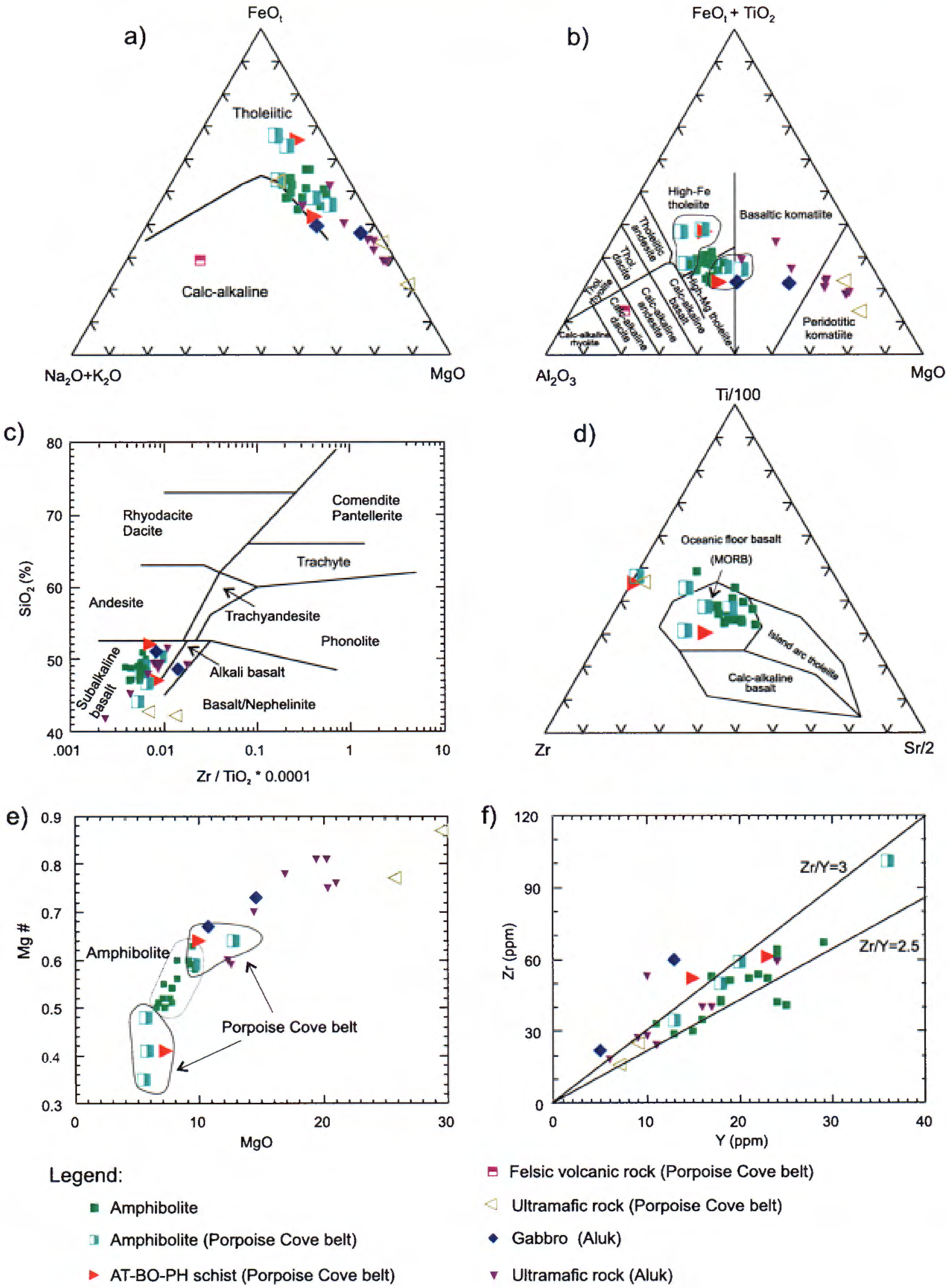


FIGURE 5 - Geochemical diagrams for early mafic and ultramafic rocks and late intermediate to ultramafic intrusions: **a)** AFM magmatic discrimination diagram by Irvine and Baragar (1971), **b)** AFM diagram by Jensen (1976), **c)** SiO_2 versus Zr/TiO_2 classification diagram (Winchester and Floyd, 1977), **d)** Ti-Zr-Sr paleotectonic diagram (Pearce and Cann, 1973), **e)** Mg number versus MgO diagram, **f)** Zr versus Y diagram. (AT = anthophylite; BO = biotite; PH = phlogopite)

Samples of the Qilalugalik Suite (Aqil1) show important variations in silica content (65.4 to 72.8% SiO_2; Table 3), as illustrated in all diagrams in Figure 7. This variation may be explained by the presence of quartz diorite, intimately related to the tonalite and difficult to distinguish in the field. A petrographic study reveals an important variation in the quartz content (10 to 30%), which gives the rock a composition ranging from a tonalite to a quartz diorite. The tonalite is however largely predominant within the sub-unit. Tonalites of the Qilalugalik Suite (Aqil1) show decreasing Al_2O_3, CaO, TiO_2, Fe_2O_3total and MgO contents with increasing SiO_2 (Figure 7b, d, e, g and h). This depletion is characteristic of a magmatic differentiation trend. Tonalites of the Qilalugalik Suite (Aqil1) are distinguished from other tonalites in the area thanks to their high Fe_2O_3total contents (2.71%). The latter may be related to the presence of small reddish inclusions within plagioclase grains, which may consist of hematite.

Biotite tonalites with burgundy plagioclase of the Qilalugalik Suite (Aqil4) stand out from other tonalitic rocks in the area given their lower average content in TiO_2 (0.18%), MgO (0.48%) and Fe_2O_3total (1.34%). SiO_2 contents (70.6%) for these tonalites are similar to those observed for all tonalites in the area however (Table 3, Figure 7). Low TiO_2, MgO and Fe_2O_3total values suggest that biotite tonalites with burgundy to red plagioclase (Aqil4) are derived from a slightly more evolved source than the one that generated tonalites with burgundy plagioclase in sub-unit Aqil1. Binary diagrams in Figure 7 indicate that tonalites of the Boizard (Aboz) and Corneille (Acrn) suites have major element contents similar to those of biotite tonalites with burgundy to red plagioclase of unit Aqil4.

The discrimination diagram by Maniar and Piccoli (1989) indicates that most tonalitic rocks in the area are hyperaluminous (Figure 6d), with the exception of a few samples from sub-unit Aqil1 that plot in the field of metaluminous rocks. All analyzed tonalitic samples have A/CNK (Al_2O_3/CaO+Na_2O+K_2O) ratios of less than 1.1, suggesting an igneous source (I-type) (White and Chappel, 1977). On the diagram by Batchelor and Bowden (1985), the tonalites are mainly clustered in the pre-collisional field, with another fairly important cluster in the field of mantle fractionation (Figure 6f). All tonalitic samples show compositions typical of volcanic arc granitoids (Figure 6e).

Enderbites

Samples of orthopyroxene-bearing intrusive rocks mainly come from the Qilalugalik Suite (Aqil3). Analyzed samples are almost exclusively enderbites, with a small number of opdalite samples. On the normative classification diagram by O'Connor (1965; Figure 6a), enderbite samples mostly plot in the field of tonalites, except for a few samples that plot in the field of granodiorites. Enderbites from unit Aqil3 have lower SiO_2 contents (67.12%) and higher TiO_2 (0.43%), Fe_2O_3total (3.71%), MgO (1.45%), CaO (4.25%) and P_2O_5 (0.09%) contents than tonalites in the area (Table 3; Figure 7). Furthermore, opdalites in this sub-unit have lower SiO_2 contents than other granodioritic and granitic rocks in the area. Several diagrams in Figure 7 show a geochemical similarity between enderbites (Aqil3) and SiO_2-poor tonalites with burgundy plagioclase of the Qilalugalik Suite (Aqil1).

On the diagram by Batchelor and Bowden (1985; Figure 6f), enderbites mainly plot in the mantle fractionation and pre-collisional fields, whereas opdalites straddle the syn-collisional and pre-collisional fields. The discrimination

TABLE 3 - Minimum, maximum and average geochemical composition of the Qilalugalik (Aqil), Qamanirjuaq (Aqam) and Boizard (Aboz) suites.

unit	Qilalugalik (Aqil1) Tonalite, burgundy PG		Qilalugalik (Aqil3) Opdalite		Qilalugalik (Aqil3) Enderbite		Qilalugalik (Aqil4) Tonalite, red PG		Qamanirjuaq (aqam) Tonalite		Boizard (Aboz) Tonalite		
n	18		5		14		5		10		4		
variable	min-max	ave.	min-max	ave.	min-max	ave.	min-max	ave.	min-max	ave.	min-max	ave.	
SiO_2	65.40-72.80	69.56	65.50-71.50	67.4	61.70-72.60	67.12	69.10-72.50	70.56	68.30-73.50	71.18	69.20-71.40	70.15	Weight %
TiO_2	0.12-0.52	0.32	0.33-0.64	0.47	0.13-0.89	0.43	0.07-0.31	0.18	0.08-0.45	0.25	0.13-0.32	0.22	
Al_2O_3	14.30-17.30	15.67	15.00-16.50	15.66	14.00-18.80	16.03	15.90-17.40	16.52	13.60-18.70	15.69	16.10-16.60	16.33	
Fe_2O_3t	1.07-4.35	2.71	2.14-4.67	3.78	1.05-6.52	3.71	0.62-2.24	1.34	0.54-3.62	1.88	1.32-1.96	1.61	
MnO	0.01-0.06	0.03	0.03-0,07	0.05	0.01-0.10	0.05	0.01-0.02	0.01	0.01-0.07	0.03	0.01-0.03	0.02	
MgO	0.29-2.22	0.97	0.82-1.59	1.20	0.38-3.19	1.45	0.21-0.76	0.48	0.26-1.17	0.62	0.36-1.03	0.69	
CaO	2.15-4.48	3.28	2.62-3.65	3.26	3.01-6.03	4.25	3.00-4.04	3.51	2.06-4.07	3.11	2.68-3.92	3.14	
Na_2O	3.91-5.70	4.64	3.52-4.44	4.03	3.73-5.89	4.48	4.66-5.20	4.93	3.02-5.86	4.46	4.72-5.43	4.94	
K_2O	1.12-2.97	1.94	2.60-3.68	3.02	0.89-2.51	1.47	1.01-2.40	1.59	1.06-3.33	1.95	1.26-2.51	1.8	
P_2O_5	0.01-0.18	0.07	0.02-0.20	0.14	0.01-0.36	0.09	0.01-0.05	0.02	0.01-0.07	0.02	0.01-0.13	0.06	
LOI		0.65		0.66		0.49		0.68		0.56		0.61	
total		99.58		99.73		99.57		99.82		99.74		99.55	
Mg#	0.31-0.50	0.40	0.34-0.45	0.39	0.34-0.49	0.42	0.40-0.44	0.41	0.32-0.48	0.4	0.35-0.54	0.44	
Ba	210.00-1700.00	665.00	970.00-1600.00	1170.00	220.00-1000.00	610.00	330.00-760.00	597.00	140.00-1000.00	531.00	290.00-1100.00	595.00	PPM
Rb	21.00-86.00	49.00	62-113	76.00	9.00-59.00	29.00	16.00-77.00	39.00	16.00-93.00	55.00	39.00-65.00	50.00	
Sr	244.00-768.00	491.00	314-716	504.00	319.00-810.00	427.00	238.00-645.00	447.00	162.00-552.00	327.00	355.00-492.00	426.00	
Zr	88.00-155.00	115.00	101-206	155.00	88.00-460.00	152.00	16.00-171.00	79.00	48.00-238.00	118.00	73.00-508.00	198.00	
Th	0.20-17.00	5.41	0.3-5.0	1.70	0.20-31.00	4.83	0.20-18.00	5.93	0.20-50.00	8.94	0.20-6.50	3.15	
Nb	4.00-10.00	7.50	5.0-11	8.20	6.00-18.00	8.5	5.00-7.00	6.00	4.00-10.00	7.2	0.20-9.00	6.5	
Y	3.00-14.00	8.00	3.0-13	8.00	3.00-34.00	10.00	3.00-6.00	4.00	3.00-7.00	4.00	3.00-8.00	5.00	
U	0.50-0.70	0.51	0.5-0.8	0.56	0.50-0.60	0.52	0.50-0.50	0.50	0.50-1.50	0.68	0.50-0.70	0.55	
P	44.00-64.00	55.00	44-55	49.00	48.00-70.00	57.00	54.00-62.00	59.00	41.00-69.00	53.00	54.00-60.00	57.00	

n: number of samples
ave: average
PG: plagioclase

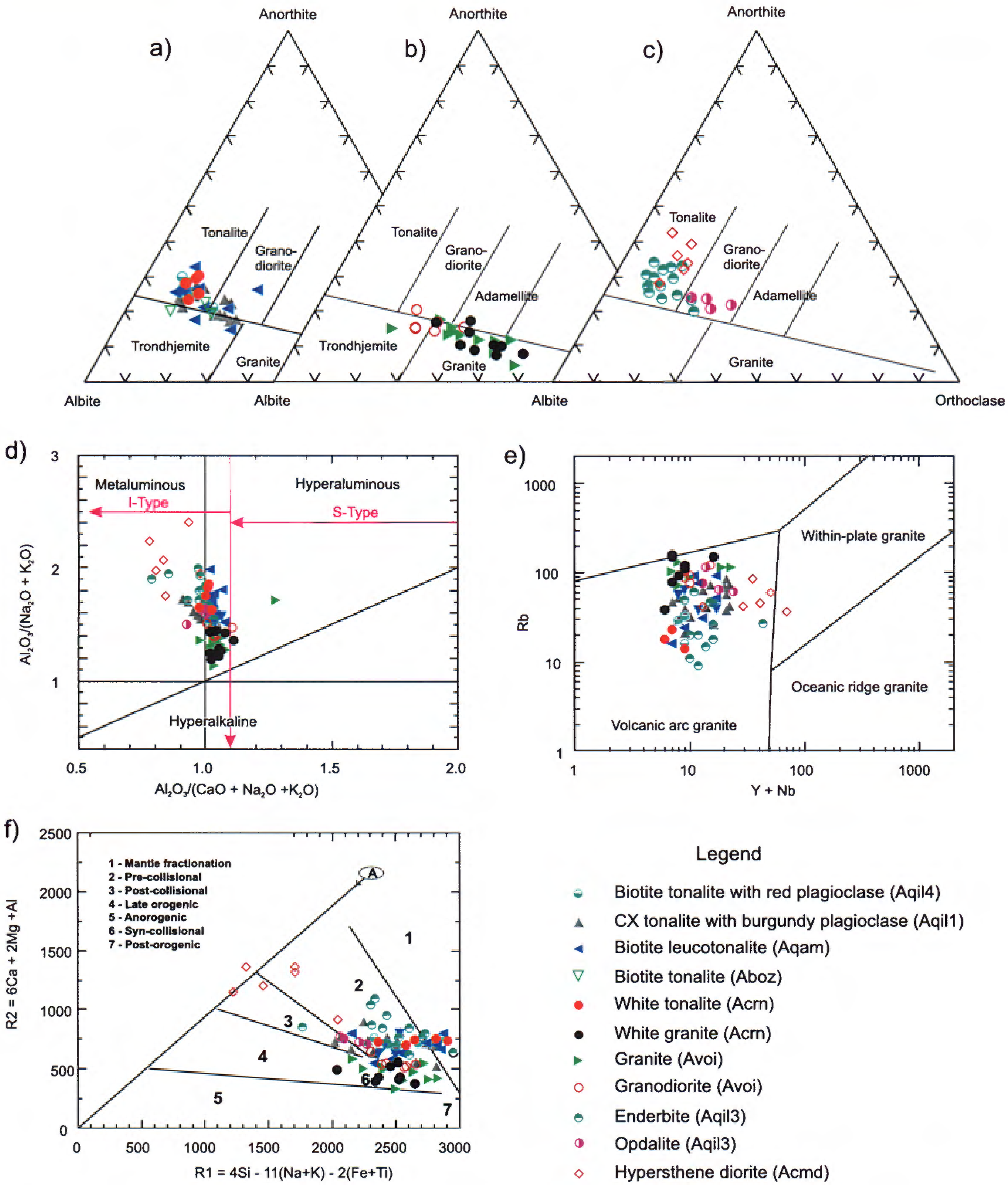


FIGURE 6 - Classification of the main intrusive suites in the Rivière Innuksuac area: **a)**, **b)** and **c)** Normative anorthite-albite-orthoclase diagrams by O'Connor (1965), **d)** $Al_2O_3/(Na_2O+K_2O)$ versus $Al_2O_3/(CaO+Na_2O+K_2O)$ discrimination diagram, showing metaluminous, hyperaluminous and hyperalkaline fields (Maniar and Piccoli, 1989) and I-type and S-type fields (White and Chappel, 1977), **e)** Tectonic discrimination diagram by Pearce *et al.* (1984), **f)** Discrimination diagram by Batchelor and Bowden (1985). (CX = clinopyroxene)

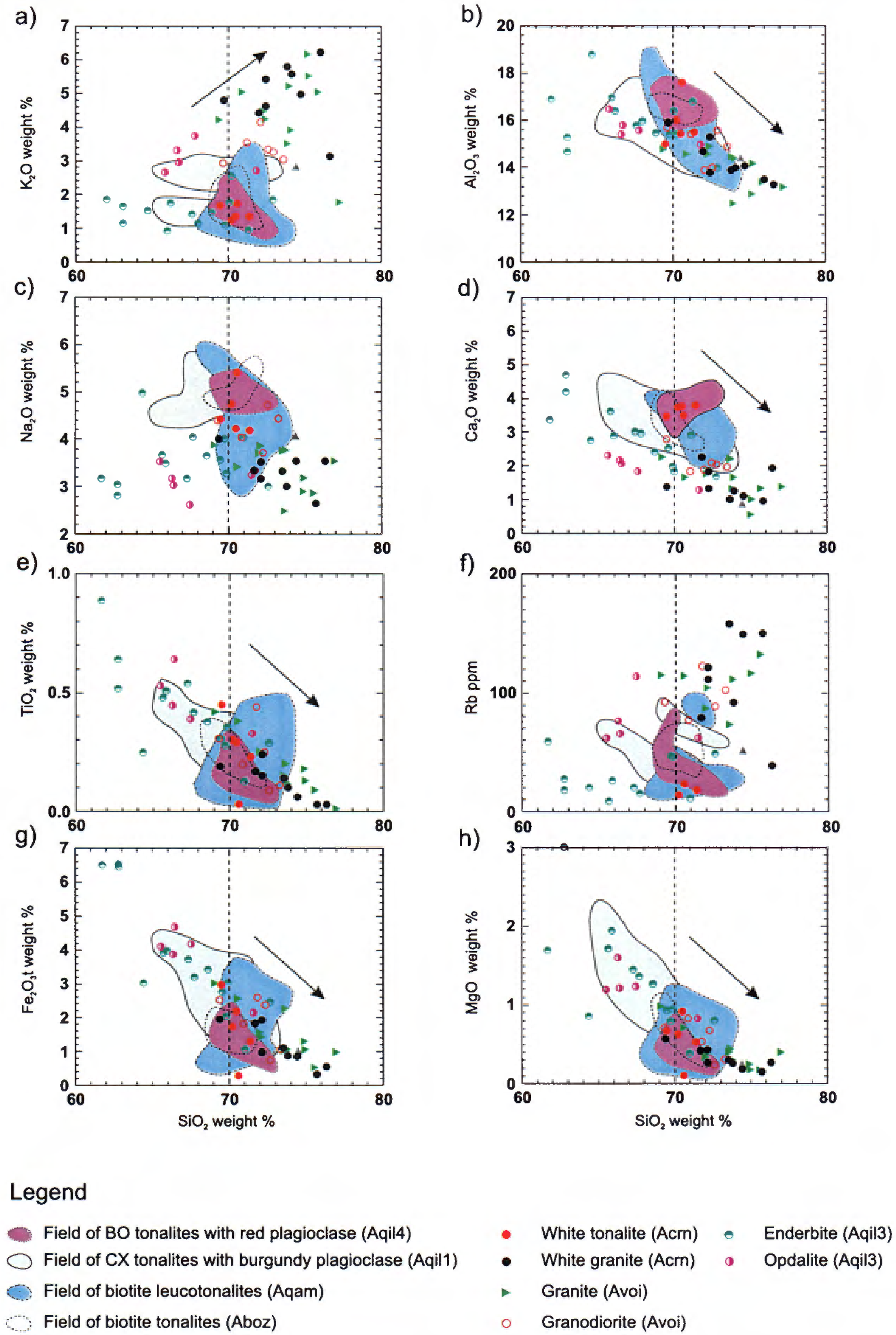


FIGURE 7 - Binary diagrams showing variations in a number of elements versus silica content. Arrows indicate trends characteristic of the differentiation process. (BO = biotite; CX = clinopyroxene)

diagram by Maniar and Piccoli (1989) (Figure 6d) indicates that opdalites and enderbites straddle the metaluminous and hyperaluminous fields (A/CNK ratio of about 1). All orthopyroxene-bearing samples from the Qilalugalik Suite (Aqil3) show compositions typical of volcanic arc granitoids (Figure 6e).

Granodioritic and Granitic Rocks

The main granodioritic and granitic lithological units in the area belong to the Voizel (Avoi) and Corneille (Acrn) suites. Petrographic observations and geochemical data indicate that the Voizel Suite (Avoi) is mainly composed of granitic rocks, with a few minor phases of granodiorite and trondhjemite (Figure 6b). Granites of the Voizel Suite show higher TiO_2 (0.21%), Fe_2O_3total (1.58%), MgO (0.41%) and P_2O_5 (0.3%) contents than granites of the Corneille Suite (Table 4, Figure 7). These geochemical criteria suggest that granites of the Voizel Suite are derived from a more weakly differentiated magma than that which produced the Corneille Suite. Moreover, granodiorites of the Voizel Suite show lower SiO_2 (71.7%) and K_2O (3.32%) contents, and higher Fe_2O_3total (1.84%) and MgO (0.54%) relative to granites of the same suite. With the exception of a greater K_2O (3.32%) and lower CaO (2.17%) content, granodiorites of the Voizel Suite show major element concentrations similar to tonalites of the Qamanirjuaq Suite (Aqam).

Granites and granodiorites of the Voizel (Avoi) and Corneille (Acrn) suites are hyperaluminous (1.1 > A/CNK < 1.0; Maniar and Piccoli, 1989) (Figure 6d). The paleotectonic discrimination diagram by Pearce *et al.* (1984) shows that all these rocks have compositions typical of volcanic arc granitoids (Figure 6e). On the diagram by Batchelor and Bowden (1985), analytical results from samples of the Voizel and Corneille suites plot in the syn-collisional field (Figure 6f).

Late Intermediate to Ultramafic Intrusions

Analyzed samples of late mafic and ultramafic intrusive rocks belong to the Qullinaaraaluk Suite (Aluk). Analyzed intermediate samples belong to the Cheminade Suite (Acmd). The AFM magmatic discrimination diagram (Irvine and Baragar, 1971; Figure 5a) shows that mafic and ultramafic rocks of the Qullinaaraaluk Suite (Aluk) have a tholeiitic signature, are magnesian and iron-poor. On the Jensen diagram (1976; Figure 5b), mafic intrusive rocks have basaltic komatiite compositions, whereas ultramafic rocks plot in the basaltic komatiite and peridotitic komatiite fields. The MgO content of gabbros ranges from 12 to 14%, and from 13 to 21% for ultramafic rocks.

Hypersthene diorites of the Cheminade Suite (Acmd) are characterized by low SiO_2 contents (54.16%) and very high TiO_2 (1.05%), Fe_2O_3total (8.61%), MgO (3.56%), CaO (8.61%), P_2O_5 (0.63%) and Y (25 ppm) contents (Table 4). On the discrimination diagram by Batchelor and Bowden (1985), orthopyroxene diorites plot along line A (Figure 6f), which

TABLE 4 - Minimum, maximum and average geochemical composition of the Voizel (Avoi), Corneille (Acrn) and Cheminade (Acmd) suites.

unit	Corneille (Acrn) tonalite		Voizel (Avoi) granodiorite		Voisel (Avoi) granite		Corneille (Acrn) white granite		Cheminade (Acmd) Ox diorite		
# samples	5		6		10		9		5		
variable	min-max	ave.	min-max	ave.	min-max	ave.	min-max	ave.	min-max	ave.	
SiO_2	69.50-71.40	70.44	69.30-73.30	71.70	69.10-75.60	73.03	69.40-76.30	73.22	53.20-55.40	54.16	Weight %
TiO_2	0.03-0.45	0.26	0.09-0.44	0.23	0.09-0.42	0.21	0.03-0.24	0.12	0.64-1.76	1.05	
Al_2O_3	15.00-17.60	15.90	13.90-15.70	14.92	12.50-14.90	14.08	13.35-15.9	14.28	15.00-17.60	15.90	
Fe_2O_3t	0.28-2.97	1.70	0.73-2.59	1.84	0.53-3.01	1.58	0.32-1.97	1.16	6.47-10.90	8.61	
MnO	0.01-0.05	0.02	0.01-0.02	0.02	0.01-0.04	0.02	0.01-0.02	0.01	0.07-0.14	0.10	
MgO	0.10-0.92	0.57	0.23-0.83	0.54	0.17-0.98	0.41	0.15-0.57	0.32	2.76-4.44	3.56	
CaO	3.46-3.79	3.65	1.91-2.87	2.17	0.60-2.30	1.61	1.00-2.31	1.50	6.13-10.90	8.61	
Na_2O	4.18-5.41	4.60	3.34-4.72	4,11	2.48-3.88	3.38	2.65-4.01	3.35	3.49-5.29	4.30	
K_2O	1.24-1.74	1.48	2.89-4.08	3.32	3.46-6.12	4.69	3.09-6.16	4,95	1.06-1.79	1.52	
P_2O_5	0.01-0.10	0.04	0.01-0.06	0.03	0.01-0.13	0.30	0.01-0.02	0.01	0.21-1.13	0.63	
LOI		0.71		0.68		0.64		0.62		0.64	
total		99.45		99.57		99.64		99.54		99.60	
#Mg	0.31-0.45	0.40	0.29-0.47	0.37	0.24-43.00	0.34	0.22-0.49	0.37	0.40-0.49	0.45	
Ba	260.00-760.00	450.00	540.00-880.00	744.00	630.00-2800.00	1303.00	100.00-2400.00	1362.00	430.00-1100.00	686.00	PPM
Rb	14.00-23.00	18.00	77.00-122.00	96.00	73.00-132.00	107.00	39.00-158.00	112.00	37.00-84.00	50.00	
Sr	455.00-480.00	469.00	206.00-519.00	352.00	94.00-492.00	325.00	35.00-371.00	267.00	515.00-961.00	743.00	
Zr	121.00-377.00	217.00	97.00-301.00	152.00	82.00-184.00	129.00	39.00-192.00	105.00	162.00-537.00	293.00	
Th	0.80-8.70	3.57	8.40-50.00	21.10	1.30-34.00	16.00	0.98-50.00	22.74	2.30-4.00	3.38	
Nb	3.00-6.00	4.30	6.00-9.00	6.60	5.00-8.00	5.50	3.00-6.00	4.40	4.00-18.00	12.20	
Y	3.00-3.00	3.00	3.00-6.00	4.00	3.00-17.00	6.00	3.00-12.00	4.00	9.00-55.00	25.00	
U	0.50-4.70	1.93	0.50-1.20	0.72	0.50-0.80	0.55	0.50-9.80	2.00	0.50-1.50	0.78	
P	54.00-63.00	57.00	38.00-51.00	46.00	27.00-43.00	37.00	27.00-41.00	36.00	66.00-4931.00	2282.00	

n: number of samples
ave: average

illustrates the evolution of primitive basaltic magmas along a line representing silica saturation and potassium and sodium enrichment as a result of feldspar crystallization. Hypersthene quartz diorites of the Cheminade Suite (Acmd) probably represent the least evolved intrusive rocks in the area, with the exception of those of the Qullinaaraaluk Suite (Parent *et al.*, 2002). The alumina saturation diagram by Maniar and Piccoli (1989) (Figure 6d) indicates that orthopyroxene diorites of the Cheminade Suite (Acmd) have metaluminous compositions.

METAMORPHISM

Rocks in the Rivière Innuksuac area show mineral assemblages that generally correspond to metamorphic conditions associated with the amphibolite and the granulite facies. Certain areas located near late fault zones have recorded secondary alteration corresponding to the greenschist facies.

Volcano-Sedimentary Rocks

Volcano-sedimentary units in the area contain the most useful mineral assemblages to characterize the various metamorphic facies. Samples collected in volcano-sedimentary bands of the Innuksuac Complex (Ainn) and enclaves enclosed in the various granitoid suites exhibit well-developed granoblastic textures. Mineral assemblages observed in these rocks reveal a regional metamorphism ranging from the amphibolite facies to the granulite facies. Metamorphic facies appear to be randomly distributed, and not related to the size of volcano-sedimentary bands, the composition of the rock or its regional distribution. Given the absence of granoblastic textures in intrusive rocks, it is likely that mineral assemblages and textures observed in supracrustal rocks correspond to a metamorphic event (M1) that pre-dates the emplacement of these intrusions. The granulite facies is represented by the following assemblages: orthopyroxene + clinopyroxene + hornblende + biotite in mafic rocks, and biotite + orthopyroxene + garnet ± cordierite in paragneisses. Mafic rocks and paragneisses metamorphosed to the amphibolite facies, on the other hand, respectively contain the following assemblages: hornblende ± clinopyroxene ± biotite and biotite + garnet ± cordierite ± spinel. In the north-central part of the area, a paragneiss sample also contains andalusite and corundum crystals.

All lithological units in the Porpoise Cove belt contain mineral assemblages typical of the amphibolite facies. Certain m-scale horizons observed in this belt display unusual mineral assemblages composed of anthophyllite, cordierite and garnet. These horizons are interpreted as hydrothermal alteration zones metamorphosed to the amphibolite facies. A fair proportion of the lithological units in the Porpoise Cove belt have also recorded retrograde alteration of biotite and hornblende into chlorite as well as strong saussuritization and sericitization of plagioclase. Cordierite is also occasionally intensely altered within metamorphosed hydrothermal alteration zones. Elsewhere, a partial transformation of sillimanite into sericite is locally noted in paragneisses.

Tonalitic Rocks

The regional metamorphism is much more difficult to interpret from mineral assemblages observed in tonalitic rocks. Mineral assemblages observed in these rocks may reflect initial emplacement conditions. Tonalites of the Boizard (Aboz) and Qamanirjuaq (Aqam) suites are composed of the following mineral assemblage: biotite + plagioclase + quartz ± hornblende ± muscovite ± epidote. The Qilalugalik Suite (Aqil) contains the assemblage biotite + plagioclase + quartz + clinopyroxene ± hornblende in sub-unit Aqil1 with burgundy plagioclase, and the assemblage biotite + plagioclase + quartz + orthopyroxene + clinopyroxene ± hornblende for the heterogeneous enderbite sub-unit (Aqil3). These assemblages indicate high pressure and temperature conditions that generally correspond to those of the upper amphibolite and the granulite facies. The absence of recrystallization textures suggests that these rocks were emplaced in an environment where such pressure and temperature conditions prevailed, and that they were not subjected to high-grade regional metamorphism after their emplacement. These rocks were also affected by a late alteration phenomenon that translates into a partial transformation of clinopyroxene into hornblende and by the alteration of orthopyroxene into serpentine, iddingsite, talc, carbonate and magnetite.

Rocks located near late fault zones underwent an important alteration process, most likely associated with the circulation of hydrothermal fluids. In highly affected zones, biotite and hornblende are strongly altered to green chlorite, whereas plagioclase grains are completely saussuritized and sericitized. Pyroxene grains are completely replaced by secondary minerals, making their identification difficult. Rocks in these zones exhibit a well-developed foliation defined by the alignment of chlorite.

STRUCTURE

Phases of Deformation

The Rivière Innuksuac area is characterized by a structural trend broadly oriented NNW-SSE to N-S, which roughly corresponds to the distribution of lithological units. This distribution reflects a complex tectono-magmatic evolution that took place between 2810 and 2680 Ma (Leclair *et al.*, 2001a, b, c), marked by the combined action of tectonic stresses and magmatic processes. Although these authors indicate that syn- to late tectonic intrusive events controlled or modified the general aspect of the structural trend, most studies conducted in the northeastern Superior Province (Lin *et al.*, 1995 and 1996; Percival *et al.*, 1995b; Percival and Skulski, 2000; Parent *et al.*, 2000; Gosselin *et al.*, 2001; Berclaz *et al.*, 2001; Madore *et al.*, 2001; Leclair *et al.*, 2001a) associate the development of the regional foliation as well as the internal deformation of rocks to the effects of solid-state deformation. However, most of these authors also mention the existence of syntectonic magmatism. In the Lac du Pélican area, Cadieux *et al.* (2000) reported evidence of magmatic deformation in most intrusive rocks younger than 2732 Ma. It is therefore important to determine the nature of this deformation, since any new tectonic model must take into account the propagation setting of this deformation. We will attempt to determine the state (magmatic, "sub-magmatic" or solid) in which the rocks were deformed during the different phases of deformation, based mainly on field observations. More detailed studies are currently underway at Simon Fraser University in Vancouver, in order to assess the impact of "sub-magmatic" deformation versus solid-state deformation (Nadeau, 2002).

The structural interpretation of the Rivière Innuksuac area is based on the style and intensity of deformation, on the orientation of the different fabrics and on cutting relationships. It was used to update the regional structural framework already proposed in the Lac Vernon area, located to the east (Parent *et al.*, 2002). Within the study area, six phases of ductile and brittle deformation are defined. The first two phases of deformation (D1 and D2) are only observed in supracrustal rocks. Phase D3, marked by a NNW-SSE-striking foliation, represents the main deformational event responsible for the regional structural trend. The development of this deformation appears to have taken place largely in a magmatic or "sub-magmatic" state. The regional foliation (S3) is disturbed in the western part of the area by tight to open F4 folds with axial traces oriented NW-SE. Phase of deformation D5 produced ductile shear zones oriented NW-SE to NNE-SSW, and rarely E-W. Ductile NNE-SSW-trending structures are concentrated within two distinct corridors. Finally, phase of deformation D6 resulted in a network of E-W-trending late brittle faults that form important cataclastic zones, with associated hematization and epidotization. The different phases of deformation recognized in the Rivière Innuksuac area may be compared and correlated with those described in adjacent areas, namely the Lac Vernon (Parent *et al.*, 2002), Lac du Pélican (Cadieux *et al.*, 2002) and Lacs des Loups Marins (Gosselin *et al.*, 2001; Table 5) areas.

Phases of deformation D1 and D2

The first phase of deformation D1 is characterized by a well-developed planar fabric (S1) that occurs as a penetrative foliation, a gneissosity or migmatitic layering. This S1 fabric was solely observed in supracrustal rocks of the Innuksuac Complex (Ainn) and in enclaves of amphibolite, mafic gneiss and paragneiss enclosed in most granitoids. Mafic rocks locally exhibit compositional layering, outlined by the presence of orthopyroxene and clinopyroxene-bearing mobilizate. Furthermore, in contrast with granitoid rocks, most Archean volcano-sedimentary rocks exhibit a granoblastic texture. These observations suggest that the supracrustal rocks underwent at least one phase of deformation and recrystallization prior to the emplacement of plutonic rocks. This phase of deformation (D1) appears to correspond to the D1 phase described by Cadieux *et al.* (2002) in the Lac du Pélican area (Table 5). These authors also indicate that the S1 fabric only affects the oldest lithologies in their study area.

The S1 planar fabric is disturbed by tight to isoclinal F2 folds, generated during phase of deformation D2. Near F2 fold hinges, an S2 axial plane foliation is locally observed, weakly defined by the alignment of mafic minerals (biotite and hornblende). Outside of fold hinges and in the limbs of F2 folds, this S2 fabric is difficult to observe, since it is weakly developed and parallel to the S1 fabric. Isoclinal F2 folds affect the tectono-metamorphic layering (S1) present in amphibolites and paragneisses of the Porpoise Cove belt as well as in supracrustal enclaves, which confirms the existence of a phase of deformation that pre-dates phase D2 (Appendix 2, Photo 1). The lack of structural data makes it impossible to perform a coherent statistical analysis of S1 and S2 foliations and F2 folds. Furthermore, the latter were dismembered and reoriented during the emplacement of granitoid rocks. Phase of deformation D2, observed in the Rivière Innuksuac area, has no equivalent in the Lac Vernon, Lac du Pélican and Lacs des Loups Marins areas (Table 5).

Phase of deformation D3

Most authors recently involved in Québec's Far North (Lin *et al.*, 1995 and 1996; Percival *et al.*, 1995a; Percival and Skulski, 2000; Parent *et al.*, 2000; Leclair *et al.*, 2001a; Gosselin *et al.*, 2001; Berclaz *et al.*, 2001) interpret the main deformation and the regional metamorphism as being related to phase of deformation D2. However, the identification of two early phases of deformation in the map area lead us to assign the regional foliation (S3) responsible for the regional structural trend to phase of deformation D3. This foliation, generally oriented NNW-SSE, affects most intrusive rocks except those of the Qullinaaraaluk Suite (Aluk) and Proterozoic diabase dykes. This phase of deformation (D3) appears to be equivalent to phase D2 defined in the Lac Vernon (Parent

TABLE 5 - Structural correlations between the Rivière Innuksuac area and the Lac Vernon, Lac du Pélican and Lacs des Loups Marins areas. (BO = biotite; HB = hornblende; PX = pyroxene; SM = sillimanite)

Rivière Innuksuac area (34K-34L)	Phases	Lac du Pélican area (34P) (Cadieux *et al.*, 2002)	Lac Vernon area (34J) (Parent *et al.*, 2002)	Lacs des Loups Marins area (33A) (Gosselin *et al.*, 2001)
E-W brittle faults; epidote, chlorite, hematite -Fracturation cleavage (S6) -Cataclasite and pseudotachylite	**D6**	D6 WNW-ESE brittle faults associated with Payne River dykes -Estimated age: >2000 Ma D5 WNW-ESE, brittle faults associated with Klotz dykes -Maximum age: 2209 ±1 Ma	D6 E-W and NW-SE late faults, cataclasite and pseudotachylite -Chlorite, hematite and epidote-rich alteration zone	D5 ENE-WSW to NNE-SSW late faults, weakly developed, movement not determined
NW-SE to N-S mylonitic zones -Mylonitic fabric -L, L>S tectonites -Deformation corridors 1 and 2	**D5**	? D4 N-S to NNE-SSW brittle-ductile shear zones -Estimated age: 2691 ±6 Ma	D4 Brittle-ductile shear zones -Mylonitic fabrics -NNW-SSE, steeply dipping Shallow plunging stretching lineation -Transposes regional S2 foliation - L>S fabrics	D4 Network of anastomosing E-W faults, well developed mylonitic fabric D4 Network of anastomosing NW-SE faults, well developed mylonitic fabric
-Large amplitude folds (WNW-ESE to NW-SE) in supracrustal rocks -Tight folds affecting the magmatic fabric (S3) in granitoids -S4 fabric locally developed in F4 fold hinges	**D4**	D4 -N-S isoclinal F4 folds overturned to the east	D3 -Tight to isoclinal upright folds (WNW-ESE to NNE-SSW) -No axial plane fabric -Folded S2 foliation -Probably the result of a rheological contrast between different units	D4 -Open to tight F4 folds (WNW-ESE to NW-SE), dragged along NW-SE faults
Regional foliation (Magmatic to "sub-magmatic") -Alignment of mafic minerals -Alignment of enclaves -Schlieren and mafic mineral aggregates -Compositional layering (I1D, I1C, I1B, enclaves...) -Alignment of K-feldspar phenocrysts -Syn-magmatic I1B injections with diffuse contacts -Flow and turbulent flow textures	**D3**	D3 Primary foliation (magmatic) Tectonic foliation -Mylonite, gneissosity and mylonitic banding (N-S) Syn-magmatic F3 folds	D2 Penetrative foliation (NW-SE to N-S) -Preferential orientation (BO-HB-SM-PX). -Migmatitic layering, gneissosity -Aligned clasts in conglomerates -Elliptical structures with the main axis oriented parallel to the regional trend (syn-D2 doming effect)	D3 -Local presence of tight to isoclinal folds (ENE-WSW) D2 NNW-SSE regional S2 foliation and isoclinal F2 folds -Fabric intensity highly variable: weak alignment of mafic minerals to gneissosity -Obliterates or nearly completely parallels structures associated with D1
-Foliation/gneissosity (S1) folded by isoclinal F2 folds -Axial plane fabric (S2) locally developed -F2 observed in supracrustal rocks in enclaves	**D2**	D2 -Vertical S2 foliation (E-W) -Alignment of K-felspar phenocrysts (magmatic foliation) -P2 isoclinal folds		
-Foliation, gneissosity (S1) in supracrustal rocks -Granoblastic texture -Enclaves of foliated supracrustal rock in granitoids	**D1**	-Mylonitic banding, foliation, gneissosity (S1) in older lithologies	-Foliation/gneissosity (S1) in enclaves -Generally parallel to the S2 regional foliation	-Relics of an early foliation (S1) that predates the regional fabric (only in enclaves)

et al., 2002) and in the Lacs des Loups Marins (Gosselin *et al.*, 2001) areas, and to phases D2 and D3 in the Lac du Pélican area (Cadieux *et al.*, 2002; Table 5). Foliation S3 is namely defined by the preferential orientation of biotite flakes, hornblende crystals and aggregates of ferromagnesian minerals. This type of foliation may be related to deformation in a "sub-magmatic" or solid state. On the other hand, the following observations suggest that a fair portion of this deformation (D3) took place in magmatic to "sub-magmatic" conditions (Vernon, 2000); a) the presence of a diffuse layering defined by the heterogeneity of various granitoid phases and by the variation in mafic mineral content and the number of enclaves, b) the presence of previously deformed enclaves that are strongly aligned, without any evidence of such intense deformation within enclosing granitoids, c) the presence of mafic mineral schlieren produced by partial assimilation of enclaves, d) flow and turbulence structures around enclaves, e) the presence of certain granitoid horizons with a foliation defined by the alignment of K-feldspar phenocrysts (1 to 7 cm) suggesting magmatic flow textures.

Enclave-rich layers (> 20%) within granitoids generally have a gneissic or banded aspect, due to the presence of long mafic mineral schlieren and highly stretched enclaves. However, in thin section, the internal deformation of granitoid rocks is relatively weak. For this reason, we interpret this gneissic aspect as the result of a process in which enclaves were assimilated, reoriented and aligned by a magmatic current, or by flow in a sub-magmatic state, generated by tectonic stresses. The orientation of enclaves also depends on the intensity of the S3 foliation, which may be undulating, discontinuous and variably developed within a single unit. When granitoids possess a well-developed S3 foliation, enclaves are generally aligned and stretched parallel to this foliation. On the other hand, in weakly foliated or massive granitoids, enclaves are more angular, randomly distributed, and their long axis is generally at an angle relative to the foliation of the host rock. Vernon (1983; 2000) mentions that when enclaves are aligned by magmatic flow, the stretching ratio of enclaves is proportional to the intensity of the magmatic foliation in the host granitoid. The variation in deformation intensity observed within a single unit may be explained by changes in magmatic flow velocity, as well as by the viscosity of the material. Work by Paterson and Fowler (1993) and Paterson *et al.* (1998) outlines that magmatic fabrics recorded in granitoids generally represent the last phases of crystallization, when the viscosity of the magma is sufficiently high to preserve structures.

Phase of deformation D4

A D4 phase was recognized in the area, more specifically in the western part, where the regional foliation S3 is disturbed by tight to open F4 folds (Appendix 2, Photo 2) with axial traces ranging from NW-SE to NE-SW. These folds were observed at the outcrop scale as well as on aerial photographs and remote sensing images. The effects of this deformation are mainly obvious in the first 30 kilometres inland from the coast of Hudson Bay. At a few locations in granitoid rocks, a weak S4 axial plane foliation is observed, defined by the alignment of biotite. Moreover, in supracrustal rocks of the Porpoise Cove belt, open, large amplitude F4 folds are generally oriented N320° (Nadeau, 2002). In this location, a pegmatite (MP-01-1091G2) folded by F4 folds was dated at 2688 ±2 Ma (site 2, Figure 4 and Table 1), indicating the maximum age for phase of deformation D4. This D4 phase described in the Rivière Innuksuac area may be equivalent to the D3 phase identified in the Lac Vernon (Parent *et al.*, 2002) and the Lacs des Loups Marins (Gosselin *et al.*, 2001) areas, and to the D4 phase identified in the Lac du Pélican area (Cadieux *et al.*, 2002; Table 5).

Phase of deformation D5

The rocks in the area were affected by intense ductile shear zones attributed to phase of deformation D5. These shear zones are oriented NW-SE to NNE-SSW, and rarely E-W. They appear to be related to the same event that resulted in shearing associated to phase D4 in the Lac Vernon, Lac du Pélican and Lacs des Loups Marins areas (Table 5). Structural analysis and field observations reveal the presence of two corridors where ductile deformation associated with phase of deformation D5 is most intense (Figure 8). Within these corridors, the deformation is characterized by the development of abundant mylonitic fabrics and stretching lineations (L and L > S tectonites). Mylonitic fabrics also form wider zones from one to ten metres. This type of ductile structure also occurs, in a more discrete fashion, outside of these two deformation corridors.

Phase of deformation D6

The phase of brittle deformation D6 is responsible for the development of a network of late major faults that transect all units in the map area, as well as a few Proterozoic diabase dykes. These faults correspond to aeromagnetic and geomorphologic lineaments primarily oriented E-W. The most important are: the Sititalik, Innuksuac, Tasikutaaq, Kongut, Gagocdoar and Bartlett faults (Figure 8, stereogram K). These brittle structures have vertical or sub-vertical dips. They are well developed in the central part of the area, especially along the Rivière Innuksuac. They are locally accompanied by a conjugate set of fractures oriented NE-SW and NNW-SSE. Brittle faults from 1 to 10 m wide are characterized by the presence of cataclasites and alteration zones rich in hematite, chlorite and epidote.

The Kongut and Bartlett faults also affect Proterozoic rocks found on the Hopewell Islands (Figure 8). Kinematic indicators (displacement of islands) along the two faults suggest a dextral strike-slip movement for certain E-W-trending post-Archean faults. In the Lac du Pélican area, work by Cadieux *et al.* (2002) led to the identification of two fault sets coeval with the emplacement of Proterozoic diabase dykes. The first set, oriented WNW-ESE, is related to dykes of the Klotz Swarm (2209 ±1 Ma; Buchan *et al.*, 1998), whereas the second NW-SE-trending set is associated with the Payne River Swarm (> 2000 Ma; Fahrig *et al.*, 1986).

Statistical Compilation and Structural Analysis

Structural domains

Structural domain I, located in the northeastern part of the area, is characterized by a steeply dipping planar S3 fabric oriented NW-SE (Figure 8, stereogram A). In this domain, the orientation of the S3 fabric is relatively constant, and the fabric is only weakly folded. This indicates that the regional deformation in this area was not significantly affected by one or the other phases of deformation that postdate phase D3. Evidence of subsequent deformation is restricted to a few ductile structures (D5) and to minor late brittle faults (D6).

Structural domain II, however, is not as homogeneous, and shows a greater variation in the attitude of the S3 fabric. This domain lies in the western part of the area, and is subdivided into three zones: the northern, central and southern segments. In the northern segment, the orientation of the S3 fabric is fairly similar to that in domain I, with a relatively constant NW-SE strike and a steep dip (Figure 8, stereogram B). The foliation in the central and southern segments of domain II generally strikes NW-SE and is subvertical. Stereograms showing poles of foliation planes for these areas (Figure 8, stereograms C and D) reveal a greater variation in the attitude of the S3 fabric relative to the northern segment and domain I. This signals the presence of F4 folds associated with phase of deformation D4, observed in the central and southern segments of domain II.

Deformation corridors

A statistical analysis of structural data reveals the presence of two ductile deformation corridors associated

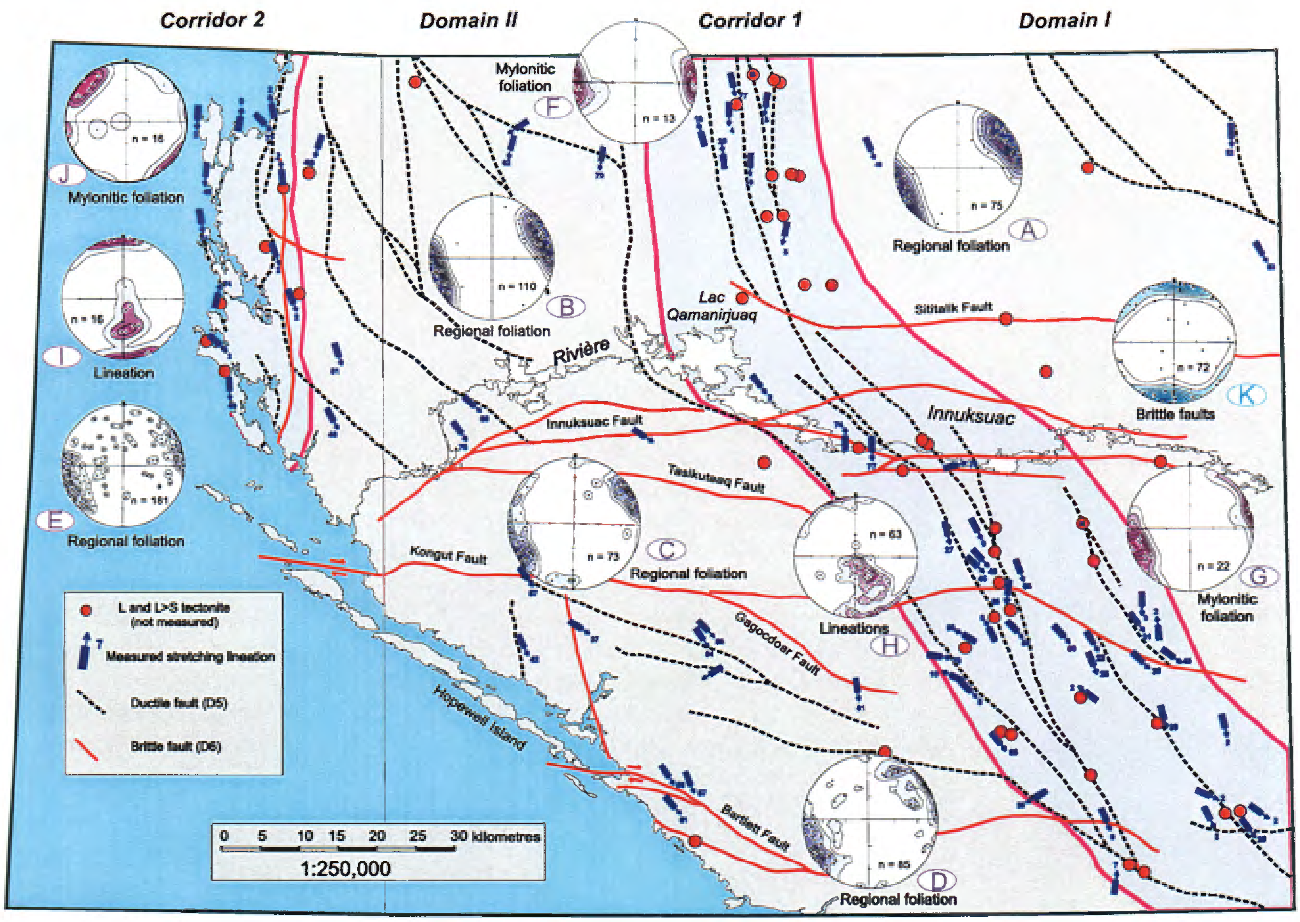


FIGURE 8 - Map of structural domains, deformation corridors and stereographic projections for the Rivière Innuksuac area (n = number of measurements).

with phase of deformation D5 (Figure 8). Corridor 1 consists of major regional faults that follow a sigmoid shape with N-S to ESE-WNW orientations. This corridor roughly corresponds to the boundary between the "Tikkeruktuk Domain" and the "Inukjuak Domain" proposed by Percival *et al.* (1997a). The deformation, characterized by the presence of mylonitic fabrics, ribbon quartz and L and L>S tectonites, is concentrated in a corridor about twenty kilometres wide. The orientation of mylonitic fabrics shifts from N-S in the northern part to NW-SE in the southern part (Figure 8, stereograms F and G). These fabrics are vertical to sub-vertical. Within this deformation corridor, the different lithologies form stretched bands transposed parallel to the mylonitic fabric. The regional S3 foliation and earlier fabrics (S1 and S2) are also transposed parallel to the mylonitic fabric. Lineations generally plunge towards the southeast, indicating a strike-slip movement outlined by sub-horizontal lineations as well as a thrust movement from the SSE towards the NNW, possibly associated with lateral ramps and marked by oblique to sub-vertical lineations (Figure 8; stereogram H) and by kinematic indicators (C/S fabrics, shear bands, etc.). The relative timing of the two movements has not been established.

Deformation corridor 2, at least ten kilometres wide, is located in the westernmost part of the area. Deformation within this corridor is marked by the presence of gneissic rocks, mylonitic fabrics (Appendix 2, Photo 3) and local L > S tectonites. The most important shear zones associated with this corridor are oriented NNW-SSE to N-S (Figure 8). However, stereogram J (Figure 8) indicates that several ductile structures of minor importance are oriented NNE-SSW. A few mylonite zones trending NW-SE, identical to those found in corridor 1, are also observed in a few locations. In several locations within mylonitic zones, white granite injections of the Corneille Suite (Acrn) appear to be coeval with the deformation, thereby creating a well developed banded texture. The distribution of the white granite appears to be controlled, at least in part, by ductile deformation (shearing) within corridor 2. Some stretching lineations are horizontal and oriented N-S, whereas others plunge southward at 47 to 80° (stereogram I). Most kinematic indicators reveal an apparent dextral strike-slip movement.

ECONOMIC GEOLOGY

Previous Work

Lee (1965) reported the presence of two mineral occurrences near the coast of Hudson Bay, where mineralized veins having a thickness of 30 to 60 cm are found. These veins extend over a maximum strike length of 70 m and cut a migmatitic granite. The mineralization, composed of chalcopyrite and galena, is concentrated along the contacts with the wall rock. Prior to our mapping survey, these two base metal showings were the only known occurrences in the Rivière Innuksuac area. Lee (1965) also reported the presence of siderite beds 15 to 60 cm thick on the Hopewell Islands, within a sequence of Proterozoic sedimentary rocks of the Hopewell Group.

An extensive lake sediment geochemistry survey (MRN, 1998), carried out by SIAL in 1997 within the scope of the Far North project, covered the entire Rivière Innuksuac area. This survey, funded by the MRN and five private industry partners, prompted exploration companies to acquire exploration licences in many areas of the Far North. No other exploration campaign was carried out, or at least had been reported in the area prior to our survey. However, a few small mining exploration licences (PEM) were in effect at the time of our field campaign.

Economic Results of the Field Campaign

Our work uncovered many interesting occurrences in the search for mineral substances in the Rivière Innuksuac area (Figure 9). These consist of rusty zones encountered during ground traverses or gossans visible from the helicopter. These mineralized zones were sampled to determine their base and precious metal content. They were classified into four categories: 1) occurrences associated with early mafic and ultramafic rocks, 2) occurrences associated with paragneisses, 3) occurrences associated with late mafic and ultramafic intrusions, and 4) quartz-carbonate-sulphide veins. The location of these sites of economic interest, numbered from 1 to 74, is shown in Figure 9 and their UTM coordinates (NAD83) are listed in Table 6. Occurrences which yielded the most interesting assay results or those of particular interest are shown by a star on Figure 9. They are briefly described in Table 7. Site number 74 in Figure 9 represents a 3 to 4 m-thick carbonatite dyke of unknown age and origin. A brief description of this carbonatite is provided in the section entitled "Lithostratigraphy".

Occurences Associated with Early Volcano-sedimentary Sequences

Most mineralized zones in the area are associated with early volcano-sedimentary sequences. On Figure 9 and in tables 6 and 7, these sites were subdivided into two categories, discussed below, namely occurrences associated with mafic to ultramafic rocks and occurrences associated with paragneisses.

Occurrences Associated with Early Mafic to Ultramafic Rocks

Sites of economic interest associated with mafic to ultramafic rocks were mainly observed in small bands assigned to sub-unit Ainn1 of the Innuksuac Complex. A few mineralized zones are also associated with mafic rocks included in paragneiss sequences in sub-unit Ainn2. Although they occur in many different areas, sites of economic interest associated with mafic to ultramafic rocks are mainly clustered in the three following areas: 1) the northeastern part of the map area, 2) the westernmost part and 3) the southwestern part of the map area (Porpoise Cove belt) (Figure 9). These mineral occurrences correspond to rusty sulphide-rich zones a few decimetres to a few hundred metres wide. The mineralization generally consists of disseminated or semi-massive pyrite, to which pyrrhotite is commonly associated, and more rarely so, chalcopyrite. In several locations, the mineralized zones also contain oxide or silicate-facies iron formation horizons from 0.1 to 10.0 m in thickness (Appendix 2, Photo 4). Most samples taken from rusty zones yielded anomalous copper concentrations, often greater than 0.1% Cu (Table 7). Site 4 (Figure 9; tables 6 and 7), located in the northeastern part of the area, yielded the highest grade at 1.04% Cu. It consists of a rusty zone some 300 m thick, that contains small bands of massive pyrite. Moreover, several mineralized zones scattered throughout the area also contain anomalous Au, Ag, Co, Ni and Zn (Table 7). The best zinc content (0.41%) comes from a rusty zone located in the westernmost part of the area (site 23, Figure 9).

The Porpoise Cove belt represents a particularly interesting area. It hosts a number of mineralized zones associated with mafic and ultramafic rocks, as well as many iron formation horizons. Furthermore, anthophyllite-cordierite-garnet zones associated with mafic rocks are interpreted as metamorphosed volcanogenic hydrothermal alteration zones. The highest Au (330 ppb) and Ag (4.3 and 6.4 g/t) contents are associated with an anthophyllite-cordierite-garnet schist that hosts sulphide stringers (site 16, Figure 9). It also contains anomalous Cu grades (0.44 and 0.58%). Similar anthophyllite-cordierite-garnet schists were also recognized in volcanic sequences in the Lac Vernon area (Parent *et al.*, 2002), located to the east of our map area. In this geological setting, Labbé and Lacoste (2001) mentioned that the presence of altered basalts and

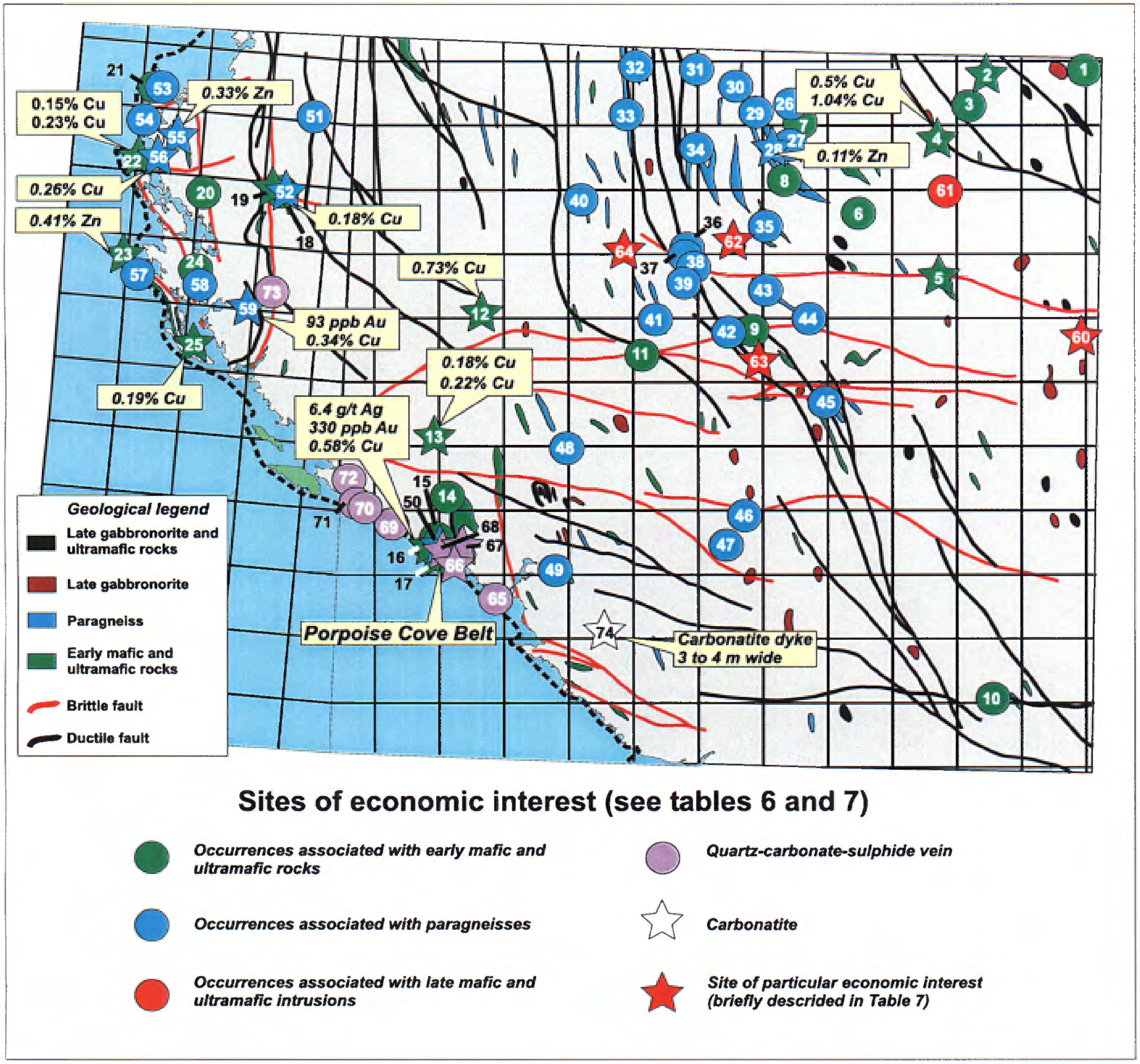


FIGURE 9 - Location of the main sites of economic interest in the Rivière Innuksuac area (34K and 34L).

base metal anomalies suggested a prospective environment for volcanogenic hydrothermal deposits.

Occurrences Associated with Paragneisses

Several mineral occurrences associated with paragneisses are located in the north-central part of the map area, where the vast majority of paragneiss bands assigned to sub-unit Ainn2 of the Innuksuac Complex (Figure 9) are found. The westernmost part of the area also contains this type of mineralization. Sites of economic interest associated with paragneisses generally correspond to km-long gossans from 50 to 200 m wide, clearly visible from the air (Appendix 2, Photo 5). The rusty colour of the rock is associated with the oxidation of fine disseminated pyrite and the alteration of biotite in paragneiss. The gossans contain oxide or silicate-facies iron formation horizons from 1 to 10 m thick, as well as m-scale reddish-brown garnet-rich bands (70 to 90%). Despite the extensive gossans associated with paragneisses in the north-central part of the area, analytical results from these zones yield disappointing concentrations. The most interesting was 0.11% Zn (site 28, Figure 9 and Table 7). However, no detailed work or systematic sampling was carried out on these mineralized zones. Mineralized zones located in the western part of the area host anomalous copper concentrations above 0.1% (sites 52, 56 and 59,

TABLE 6 - Sample number and UTM coordinates (NAD83) of mineral occurrences shown in Figure 9.

No. du site	**No. d'échantillon UTM (Nad 83)**	**No. du site**	**No. d'échantillon UTM (Nad 83)**	**No. du site**	**No. d'échantillon UTM (Nad 83)**
Minéralisations associées aux roches mafiques et ultramafiques anciennes					
1	MS-01-65 439571 E 6539965 N	10	MT-01-5275 426057 E 6440399 N	19	PN-01-2127 661846 E 6518736 N
2	RT-01-4057 424638 E 6538119 N	11	CP-01-7045 371934 E 6493991 N	20	XH-01-6257 650963 E 6517360 N
3	PN-01-2085 422358 E 6532994 N	12	JD-01-8045 346710 E 6501139 N	21	XH-01-6146 642339 E 6533243 N
4	PN-01-2055 416736 E 6527151 N	13	JF-01-3122 339599 E 6481165 N	22	RT-01-4157 639951 E 6521912 N
5	PN-01-2026 417615 E 6506123 N	14	MS-01-86 341675 E 6472251 N	23	MP-01-1186 639833 E 6506618 N
6	MS-01-62 405232 E 6516287 N	15	JY-01-9095 339856 E 6465582 N	24	PN-01-2063 650805 E 6505355 N
7	MT-01-5040 395911 E 6530138 N	16	MP-01-1078 339724 E 6464139 N	25	JF-01-3284 651451 E 6493513 N
8	MP-01-1065 393591 E 6521307 N	17	MP-01-1091 339736 E 6463046 N		
9	PN-01-2011 388253 E 6498083 N	18	PN-01-2126 662860 E 6518659 N		
Minéralisations associées aux paragneiss					
26	MT-01-5038 394620 E 6533415 N	38	MS-01-101 379310 E 6507572 N	50	MP-01-1079 340252 E 6464269 N
27	JF-01-3040 393774 E 6526827 N	39	MS-01-100 378206 E 6505541 N	51	XH-01-6164 666949 E 6530768 N
28	JF-01-3041 392288 E 6526672 N	40	RT-01-4036 362472 E 6518321 N	52	PN-01-2125 664047 E 6518023 N
29	MT-01-5033 389261 E 6532214 N	41	XH-01-6177 373682 E 6499700 N	53	XH-01-6145 643080 E 6533202 N
30	XH-01-6020 386273 E 6536084 N	42	MS-01-105 384954 E 6497701 N	54	XH-01-6149 641271 E 6527541 N
31	MP-01-1070 379940 E 6538757 N	43	MS-01-106 390807 E 6504320 N	55	MT-01-5165 646067 E 6525460 N
32	MS-01-079 370733 E 6539177 N	44	RT-01-4012 397802 E 6500073 N	56	MT-01-5161 643527 E 6522000 N
33	XH-01-6052 369256 E 6531724 N	45	MS-01-020 400058 E 6486461 N	57	JF-01-3282 642285 E 6503946 N
34	JF-01-3076 380346 E 6526532 N	46	JF-01-3101 387480 E 6469232 N	58	MT-01-5206 651971 E 6503210 N
35	MS-01-107 390916 E 6514498 N	47	JF-01-3098 384494 E 6464801 N	59	JF-01-3141 659685 E 6500273 N
36	MS-01-103 378596 E 6510708 N	48	XH-01-6111 359921 E 6479599 N		
37	MS-01-102 378291 E 6509602 N	49	MP-01-1084 358218 E 6460603 N		
Minéralisations associées aux intrusions mafiques et ultramafiques tardives					
60	MS-01-36 439787 E 6497107 N	62	PN-01-2037 386139 E 6511989 N	64	PN-01-2142 368959 E 6510331 N
61	PN-01-2078 418605 E 6519486 N	63	MP-01-1008 389718 E 6493186 N		
Veines de quartz-carbonate-sulfures					
65	JY-01-9092 348844 E 6456263 N	68	JY-01-9096 342181 E 6462824 N	71	JY-01-9089 327687 E 6470799 N
66	JY-01-9099 342197 E 6462506 N	69	JY-01-9091 332633 E 6468022 N	72	JY-01-9088 326569 E 6474757 N
67	JY-01-9098 342272 E 6462890 N	70	JY-01-9090 328120 E 6470565 N	73	XH-01-6188 662944 E 6502871 N
Dyke de carbonatite					
74	JF-01-3250 363668 E 6448126 N				

TABLE 7 - Brief description of sites of particular economic interest. These occurrences are represented by a star on Figure 9 and their UTM coordinates (NAD 83) are listed in Table 6.

Site number	Thickness	Description	Best contents
Occurrences associated with early mafic and ultramafic rocks			
2	30 m	Rusty amphibolite cut by disseminated to semi-massive sulphide zones (0.2 to 1.0 m).	45 ppb Au; 555 ppm Co; 959 ppm Cu; 835 ppm Zn
4	4 m	Rusty zone (4m x 300m) with local massive pyrite in an amphibolite sequence.	25 ppb Au; 1.04% Cu; 0.5% Cu
5	1 m	Rusty pyrite-pyrrhotite zones in ultramafic rocks associated with amphibolites.	63 ppb Au; 0.12% Cu; 354 ppm Ni; 522 ppm Zn
12	25 m	Rusty sulphide-rich zones associated with volcanic rocks.	34 ppb Au; 0.73% Cu
13	1 m	Rusty zones in early ultramafic rocks.	0.18% Cu; 0.22% Cu
16	A few m	Lenses of stringer sulphides in anthophyllite-cordierite-garnet schist.	330 ppb Au; 4.3 g/t Ag 6.4 g/t Ag; 0.44% Cu; 0.58 % Cu
17	500 m	Occurrences in different settings related to the Porpoise Cove belt. Iron formation, rusty zones, disseminated sulphides associated with mafic to ultramafic volcanic rocks. Pyritic conglomerates.	76 ppb Au; 0.18% Cu; 959 ppm Cu (in a conglomerate)
19	0.3 to 4.0 m	Early foliated and sheared ultramafic rocks with minor disseminated sulphides.	0.12% Cu; 246 ppm Ni
22	3 - 4 m	Several rusty zones with 5 to 25% pyrrhotite in a foliated granoblastic gabbronorite.	0.23% Cu; 0.15% Cu; 585 ppm Ni
23	10 m	Rusty zone in an amphibolite sequence.	581 ppm Cu; 599 ppm Zn; 0.41% Zn
25	1 - 5 m	Rusty sulphide-rich zones in mafic rocks.	0.19% Cu; 521 ppm Ni
Occurrences associated with paragneisses			
28	10 - 15 m	Rusty zone with disseminated sulphides in a paragneiss sequence.	0.11% Zn
50	5 m	Disseminated pyrite in quartzite.	130 ppb Au; 646 ppm Cu
52		Rusty siliceous zone with disseminated sulphides in paragneiss.	0.18% Cu; 367 ppm Ni
55	20 to 50 m	Rusty pyrite-rich zone in paragneiss.	0.33% Zn
56	100 m	Rusty zones in paragneiss with granitic injections.	0.26% Cu
59		Small rusty zones in paragneiss.	93 ppb Au; 0.34% Cu
Occurrences associated with late mafic and ultramafic intrusions			
60	2 m	Rusty pyrite-pyrrhotite zone in a late ultramafic intrusion.	0.17% Cu; 0.15% Ni
62	30 m	Rusty zone in a late ultramafic intrusion.	47 ppb Au; 0.11% Cu; 0.14 % Ni
63		Disseminated sulphides in late gabbroic and ultramafic intrusions.	846 ppm Co; 0.34% Cu; 0.52% Ni
64	Boulder	Erratic boulder of sulphide-rich ultramafic rock.	130 ppb Au; 0.51% Cu; 0.25% Ni
Quartz-carbonate-sulphide veins			
66	10 cm	Heterogeneous tonalite cut by quartz veins with minor sulphides. Some sulphides in the wall rocks.	120 ppb Au; 0.23% Cu
67	10 cm	Quartz-carbonate vein with minor sulphides including some chalcopyrite.	84 ppb Au; 0.46% Cu
68	15 cm	Quartz-carbonate vein with minor sulphides including some chalcopyrite.	220 ppb Au; 0.13% Cu; 0.29% Cu
Carbonatite dyke			
74	4 m	Carbonatite dyke (3 to 4 m thick) cutting a white granite.	

Figure 9). Furthermore, a sample from a rusty pyrite-rich zone yielded 0.33% Zn (site 55). A few rusty zones were also observed within thin layers of paragneiss intercalated in the mafic and ultramafic sequences of the Porpoise Cove belt. A sample of pyritic quartzite (site 50, Figure 9) from a 5 m-thick bed yielded anomalous Au (130 ppb) and Cu (646 ppm) contents. Finally, a sample of pyritic conglomerate yielded an anomalous Cu result of 959 ppm (site 17, Figure 9).

Occurences Associated with Late Mafic and Ultramafic Intrusions

In the study area, the presence of many small intrusions of late gabbronorite and ultramafic rocks of the Qullinaaraaluk Suite (Aluk1 and Aluk2; figures 4 and 9) offers promising potential for the discovery of Ni-Cu-Co-PGE deposits. The discovery of a massive sulphide zone hosted in a pyroxenite revealed the economic potential of these types of intrusions. This showing, located near Lac Qullinaaraaluk, was found and documented during a recent survey conducted by the MRN in the Lac Vernon area (Parent *et al.*, 2002; Labbé *et al.*, 2000). Analyses of massive sulphide samples yielded grades of 2.6% Ni, 1.8% Cu, 0.27% Co and 323 ppb Pt.

Mineralized zones associated with late gabbronorite and ultramafic intrusions were observed in the northeastern quadrant of the area (Figure 9). They consist of rusty zones from 1 to 10 m in size that contain fine disseminated pyrite, commonly associated with pyrrhotite and magnetite. Samples from these zones consistently contain more than 0.10% Cu and Ni. One sample yielded concentrations reaching up to 0.34% Cu and 0.52% Ni (site 63, Figure 9).

Moreover, a sample from an erratic boulder of mineralized ultramafic rock contains 103 ppb Au, 0.51% Cu and 0.25% Ni (site 64, Figure 9). No economic grades were encountered in late mafic to ultramafic intrusions within the study area. However, the discovery of the Lac Qullinaaraaluk showing has demonstrated that intrusions of this suite represent a choice exploration target for Ni-Cu-Co-PGE deposits.

Quartz-Carbonate-Sulphide Veins

Several quartz-carbonate-sulphide veins, similar to those described by Lee (1965) near the coast of Hudson Bay, were discovered. These mineralized veins are nearly all located in the southwestern part of the area, near the Porpoise Cove belt (Figure 9). They consist of late, rectilinear and undeformed veins about 10 cm wide, traced over a few hundred metres in length (Appendix 2, Photo 6). They cut Archean volcano-sedimentary and intrusive rocks located near the contact with the Proterozoic volcano-sedimentary sequence of the Hopewell Group. These mineralized veins may be Proterozoic in age or younger. The mineralization consists of pockets of chalcopyrite locally accompanied by galena and sphalerite. The vein walls may also be mineralized over a few centimetres. Given the discrete and erratic nature of the mineralization, samples of mineralized veins were not systematically analyzed for base metals. Among the few analyzed samples, the best contents in base and precious metals are in the order of 0.29% Cu, with anomalous gold at 220 ppb Au (site 68, Table 7).

CONCLUSION

The results of our work may be used to establish the geological framework at 1:250,000 scale and to define the stratigraphic, geochemical and structural setting of the Rivière Innuksuac area. A comparison of data collected in this area with that obtained in other adjacent areas has also outlined a few features that appear to characterize the western part of the Ungava Peninsula, roughly corresponding to the "Tikkerutuk Domain".

Units in the area are Archean, with the exception of a few Proterozoic rocks represented by diabase dykes and a sequence of sedimentary and basaltic rocks. This sequence is located in the westernmost part of the area. It is assigned to the Hopewell Group and appears to unconformably overlie the Archean rocks. Archean volcano-sedimentary rocks form restricted bands enclosed in granitoid intrusions. These bands were assigned to the Innuksuac Complex, which is the earliest unit in the area. They are dominated by mafic to ultramafic rocks or paragneisses. The Porpoise Cove belt, the best-preserved Archean supracrustal sequence, consists of a number of different lithological units, affected by a complex deformation pattern. A U-Pb zircon age obtained from a felsic tuff sample of this belt yielded an age of 3825 ±16 Ma, which makes it the oldest volcanic sequence in the world, with the Isua sequence in Greenland.

Tonalitic rocks cover a sizable proportion of the map area. They were subdivided into three lithodemic units: the Boizard Suite (2750 ±5 Ma), composed of heterogeneous tonalite with a gneissic aspect that contains abundant mafic enclaves, the Qamanirjuaq Suite (2714 ±2 Ma), composed of biotite leucotonalite, and the Qilalugalik Suite, which includes a sub-unit of clinopyroxene tonalite with burgundy plagioclase (2709 ±3 Ma and 2840 ±8 Ma), a sub-unit of heterogeneous enderbite (2732 ±1 Ma) and a sub-unit of biotite tonalite with burgundy to red plagioclase. The presence of early tonalites (2840 ±8 Ma), abundant mafic enclaves, volcano-sedimentary bands and inherited early zircons (2940 Ma) are indications of the complex history of the area, involving the presence of recycled early lithologies. Moreover, all tonalitic units in the area appear to have undergone a "granitization" process of variable intensity, which translates into the presence of a granitic phase, in pockets, lenses or bands, in transitional and diffuse contact with the tonalitic phase. This "granitization" is heterogeneously distributed on a local and regional scale.

An age of *ca.* 2714 Ma is interpreted for this "granitization" phenomenon, based on the identification of secondary zircons observed in a few tonalitic samples in the area.

Monzodioritic to granitic rocks in the area belong to the Voizel, Gabillot and Corneille suites. The Voizel Suite consists of biotite-chlorite granodiorite and granite. The emplacement of these rocks appears to have contributed to the "granitization" process. The Gabillot Suite is represented by a few small monzodioritic to granitic bodies with a characteristic megaphyric texture. These rocks appear to be younger than the tonalitic units and the granodiorites and granites of the Voizel Suite. Finally, the Corneille Suite is fairly widespread in the western part of the area. It mainly consists of a relatively young (*ca.* 2691 Ma) white granite, which was not recognized in adjacent areas.

The structural interpretation of the Innuksuac area outlined six phases of ductile and brittle deformation. The first two phases of deformation (D1 and D2) are ductile and characterized by an S1 foliation and tight to isoclinal F2 folds. These first two phases of deformation were exclusively observed in supracrustal rocks. Phase D3, marked by a NNW-SSE-striking foliation, corresponds to the main deformational event responsible for the attitude of the regional structural trend. The deformation attributed to D3 appears to have taken place largely in magmatic or "submagmatic" conditions. The regional foliation (S3) is affected, in the western part of the area, by tight to open F4 folds with NW-SE-trending axial traces. Phase D5 produced ductile shear zones oriented NW-SE to NNE-SSW and rarely E-W. NNE-SSW-trending ductile structures are concentrated within two distinct corridors. Finally, phase D6 resulted in a network of late brittle faults (E-W) that form important cataclastic zones, with associated hematization and epidotization.

Our work has led to the discovery of many mineralized zones and sites of economic interest, associated with early volcano-sedimentary sequences, late mafic and ultramafic intrusions and with quartz-carbonate-sulphide veins. Most occurrences are associated with early supracrustal bands composed of mafic to ultramafic sequences or paragneiss sequences. They consist of rusty zones from a few decimetres to a few hundred metres in thickness, that contain disseminated or semi-massive pyrite associated with pyrrhotite or chalcopyrite in many cases. These zones commonly contain oxide or silicate-facies iron formation horizons. Several samples from these mineralized zones yielded anomalous Cu, Zn, Au, Ag, Co and Ni results, with a number of Cu and Zn determinations above 0.1%. The highest Cu concentration is 1.04%. Moreover, the Porpoise Cove belt contains horizons of anthophyllite-cordierite-garnet schist, interpreted as metamorphosed hydrothermal alteration zones. The presence of these zones suggests a prospective environment for volcanogenic deposits. Several late gabbronorite and ultramafic intrusions contain rusty zones from 1 to 10 m wide, which host fine disseminated pyrite commonly associated with pyrrhotite or magnetite. Samples from these zones yielded anomalous concentrations up to 0.34% Cu and 0.52% Ni. The discovery of the Qullinaaraaluk showing by the MRN during the summer of 2000 revealed the economic potential for Ni-Cu-Co-PGE deposits hosted in this type of intrusion. The Qullinaaraaluk showing is located 75 km to the southeast of our study area. Our work has also uncovered a number of 10 cm-wide undeformed and rectilinear quartz-carbonate-sulphide veins. These veins, probably Proterozoic in age, are concentrated in the southwestern part of the area, near the contact between the Proterozoic sequence of the Hopewell Group and the Archean basement. The mineralization, hosted in veins and enclosing wall rocks, consists of disseminated pockets of chalcopyrite locally accompanied by galena and sphalerite. Mineralized samples yielded a few anomalous gold concentrations reaching up to 220 ppb Au.

REFERENCES

BATCHELOR, R.A. – BOWDEN, P., 1985 – Petrogenetic interpretation of granitoid rock series using multicationic parameters. Chemical Geology; volume 48, pages 43-54.

BÉDARD, J., 2002 – Evidence for Regional-Scale, Pluton Driven, High-Grade Metamorphism in the Archaean Minto Block, Northern Superior Province, Canada. The Journal of Geology, in preparation.

BÉGIN, N.J. – PATTISON, D.R.M., 1994 – Metamorphic evolution of granulites in the Minto Block, northern Québec: extraction of peak P-T conditions taking account of late Fe-Mg exchange. Journal of Metamorphic Geology; volume 12, pages 411-428.

BERCLAZ, A. – CADIEUX, A.-M. – SHARMA, K.N.M. – DAVID, J. – PARENT, M., – LECLAIR, A., 2001 – Geology of the Lac Aigneau area (24E and 24F/04). Ministère des Ressources naturelles, Québec; RG 2001-05, 44 pages.

BERCLAZ, A. – MAURICE, C. – LACOSTE, P. – DAVID, J. – LECLERC, F. – SHARMA, K.N.M. – LABBÉ, J.-Y. – GOULET, N. – BÉDARD, J. – VALLIÈRES, J., 2003 – Géologie de la région du lac Anuc (SNRC 34O). Ministère des Ressources naturelles, Québec; RG 2002-14, 58 pages.

BUCHAN, K.L. – MORTENSEN, J.K. – CARD, K.D. – PERCIVAL, J.A., 1998 – Paleomagnetism and U-Pb geochronology of diabase dyke swarms of Minto block, Superior Province, Quebec, Canada. Canadian Journal of Earth Sciences; volume 35, pages 1054-1069.

CADIEUX, A.-M. – BERCLAZ, A. – LABBÉ, J.-Y. – LACOSTE, P. – DAVID, J. – SHARMA, K.N.M., 2002 – Géologie de la région du lac du Pélican (SNRC 34P). Ministère des Ressources naturelles, Québec; RG 2002-02, 49 pages.

CARD, K.D. – CIESIELSKI, A., 1986 – Subdivisions of the Superior Province of the Canadian Shield. Geoscience Canada; volume 13, pages 5-13.

DAVID, J. – PARENT, M. – STEVENSON, R. – NADEAU, P. – GODIN, L., 2002 – La séquence supracrustale de Porpoise Cove, région d'Inukjuak : un exemple unique de croûte paléoarchéenne (*ca.* 3.8 Ga) dans la Province du Supérieur. *In:*

L'exploration minérale au Québec, notre savoir, vos découvertes. 23e Séminaire d'information sur la recherche géologique, Programme et résumés. Ministère des Ressources naturelles, Québec, DV 2002-10.

DION, D.J. – LEFEBVRE, D.L., 2000 – Données numériques (profils) des levés aéromagnétiques du Québec. Ministère des Ressources naturelles, Québec; DP 99-01.

FAHRIG, W.F. – CHRISTIE, K.W. – CHOWN, E.H. – JANES, J. – MACHADO, N., 1986 – The tectonic significance of some basic dyke swarms in the Canadian Superior Province with special reference to the geochemistry and paleomagnetism of the Mistassini swarm, Quebec, Canada. Canadian Journal of Earth Sciences; volume 23, pages 238-253.

GEOLOGICAL SURVEY OF CANADA, 1994 – Gravity database. Natural Resources Canada, Ottawa, Ontario.

GOSSELIN, C. – SIMARD, M., 2000 – Geology of the Lac Gayot Area (NTS 23M). Ministère des Ressources naturelles, Québec; RG 200-03, 30 pages.

GOSSELIN, C. – SIMARD, M. – DAVID, J., 2001 – Geology of the Lacs des Loups Marins Area (34A). Ministère des Ressources naturelles, Québec; RG 2002-06, 40 pages.

GOSSELIN, C. – ROY, P. – DAVID, J., 2002 – Geology of the Lac Bienville area (33P). Ministère des Ressources naturelles, Québec; RG 2003-04, 38 pages.

IRVINE, T.N. – BARAGAR, W.R.A., 1971 – A guide to the chemical classification of the common volcanic rocks. Canadian Journal of Earth Sciences; volume 8, pages 523-548.

JENSEN, L.S., 1976 – A new cation plot for classifying subalkalic volcanic rocks. Ontario Department of Mines, Miscellaneous Paper 66.

LABBÉ, J.-Y. – LACOSTE, P. – LECLAIR, A. – PARENT, M., 2000 – The Qullinaaraaluk Ni-Cu-Co showing: A new type of mineralization in the Archean rocks of the Far North. Ministère des Ressources naturelles, Québec; PRO 2001-05, 12 pages.

LABBÉ, J.-Y. – LACOSTE, P., 2001 – Environnements propices aux minéralisations polymétalliques de type volcanogène dans le Grand-Nord québécois. Ministère des Ressources naturelles, Québec; MB-07, 85 pages.

LECLAIR, A.D. – PARENT, M. – DAVID, J. – DION, D.-J. – SHARMA, K.N.M., 2001a – Geology of the Lac La Potherie area (34I). Ministère des Ressources naturelles, Québec; RG 2001-04, 43 pages.

LECLAIR, A.D. – BERCLAZ, A. – DAVID, J. – PERCIVAL, J.A., 2001b – Regional geological setting of Archean rocks in the northeastern Superior Province. Geological Association of Canada; Program with Abstracts, page 84.

LECLAIR, A.D. – BERCLAZ, A. – DAVID, J. – GOSSELIN, C. – LABBÉ, J.Y. – LACOSTE, P. – LARBI, Y. – MADORE, L. – MAURICE, C. – PARENT, M. – ROY, P. – SHARMA, K.N.M. – SIMARD, M., 2001c – Le nord-est de la Province du Supérieur et son évolution géologique entre 3,0 et 2,6 Ga. Ministère des Ressources naturelles, Québec; DV 2001-08, page 11.

LECLAIR, A. – BERCLAZ, A. – DAVID, J. – PERCIVAL, J., 2002 – Les événements tectonomagmatiques du nord-est de la Province du Supérieur : 300 millions d'années d'évolution archéenne. *In:* Projet de cartographie du Grand-Nord - Rapport d'atelier. Ministère des Ressources naturelles, Québec; MB-2002-01.

LEE, S.M., 1965 – Inussuaq – Pointe Normand Area, New Québec. Ministère des Richesses naturelles du Québec. Geological Report 119, 143 pages.

LIN, S. – PERCIVAL, J.A. – WINSKY, P.A. – SKULSKI, T. – CARD, K.D., 1995 – Structural evolution of the Vizien and Kogaluc greenstone belts in Minto block, northeastern Superior Province, northern Quebec. *In*: Current Research 1995-C, Geological Survey of Canada; pages 121-130.

LIN, S. – PERCIVAL, J.A. – SKULSKI, T., 1996 – Structural constraints on the tectonic evolution of a late Archean greenstone belt in the northeastern Superior Province, northern Quebec (Canada). Tectonophysics; volume 265, pages 151-167.

MADORE, L. – BANDYAYERA, D. – BÉDARD, J.H. – BROUILLETTE, P. – SHARMA, K.N.M. – BEAUMIER, M. – DAVID, J., 1999 – Geology of the Lac Peters area (NTS 24M). Ministère des Ressources naturelles, Québec; RG 99-16, 43 pages.

MADORE, L. – LARBI, Y., 2000 – Geology of the Rivière Arnaud area (25D) and adjacent coastal areas (25C, 25E and 25F). Ministère des Ressources naturelles, Québec; RG 2001-06, 35 pages.

MADORE, L. – LARBI, Y. – SHARMA, K.N.M – LABBÉ, J-Y. – LACOSTE, P. – DAVID, J. – BROUSSEAU, K. – HOCQ, M., 2001 – Geology of the Lac Klotz (35A) and the Cratère du Nouveau-Québec (southern half of 35H) areas. Ministère des Ressources naturelles, Québec; RG 2002-05, 45 pages.

MADORE, L. – LARBI, Y. – LABBÉ, J-Y. – SHARMA, K.N.M – LACOSTE, P. – DAVID, J., 2002 – Géologie de la région du lac Couture (35B) et des lacs Nuvilik (35G, partie sud). Ministère des Ressources naturelles, Québec; RG 2002-04, 42 pages.

MANIAR, P.D – PICCOLI, P.M., 1989 – Tectonic discrimination of granitoids. Geological Society of American Bulletin; volume 101, pages 635-643.

MORTENSEN, J.K. – CIESIELSKI, A., 1987 – U-Pb zircon and sphene geochronology of Archean plutonic and orthogneissic rocks of the James Bay region and Bienville Domain, Quebec. *In*: Radiogenic Age and Isotopic Studies: Report 1. Geological Survey of Canada; Paper 87-2, pages 129-134.

MRN, 1986 – Code stratigraphique nord-américain. Ministère des Ressources naturelles, Québec; DV 86-02, 58 pages.

MRN, 1998 – Résultats d'analyses de sédiments de fond de lacs, Grand-Nord du Québec (données numériques). Ministère des Ressources naturelles, Québec; DP-98-01.

NADEAU, P., 2002 – Microstructural and Geochronological investigation of the Inukjuak domain, Northeast Superior Province, Northern Quebec. Master of Science Thesis Proposal, Simon Fraser University.

O'CONNOR, J.T., 1965 – A classification for quartz-rich igneous rocks based on feldspar ratios. United States Geological Survey; Professional Paper 525-B, pages 79-84.

PARENT, M. – LECLAIR, A. – DAVID, J. – SHARMA, K.N.M., 2000 – Geology of the Lac Nedlouc area (NTS 34H and 24E). Ministère des Ressources naturelles, Québec; RG 2000-09, 41 pages.

PARENT, M. – LECLAIR, A. – DAVID, J. – SHARMA, K.N.M. – LACOSTE, P., 2002 – Geology of the Lac Vernon area (34J). Ministère des Ressources naturelles, Québec; RG 2002-07, 40 pages.

PATERSON, S.R. – FOWLER, T.K., 1993 – Re-examining pluton emplacement processes. Journal of Structural Geology; volume 15, pages 191-206.

PATERSON, S.R. – FOWLER, T.K., – SCHMILD, K.L. – YOSHINOBU, A.S. – YUAN, E.S. – MILLER, R.B., 1998 – Interpreting magmatic patterns in plutons. Lithos, volume 44, pages 53-82.

PEARCE, J.A. – CANN, J.R., 1973 – Tectonic setting of basic volcanic rocks determined using trace element analysis. Earth and Planetary Sciences Letters; volume 19, pages 290-300.

PEARCE, J.A. – HARRIS, N.B.W. – TINDLE, A.G., 1984 – Trace element discrimination diagrams for the tectonic interpretation of granitic rocks. Journal of Petrology; volume 25, pages 956-983.

PERCIVAL, J.A. – CARD, K.D. – STERN, R.A. – BÉGIN, N.J., 1990 – A geologic transect of northeastern Superior Province, Ungava Peninsula, Québec: the Lake Minto area. *In*: Current Research, Part C, Geological Survey of Canada; Paper 90-1C, pages 133-141.

PERCIVAL, J.A. – CARD, K.D. – STERN, R.A. – BÉGIN, N.J., 1991 – A geologic transect of the Leaf River area, northeastern Superior Province, Ungava Peninsula, Québec. *In*: Current Research, Part C, Geological Survey of Canada; Paper 91-1C, pages 55-63.

PERCIVAL, J.A. – MORTENSEN, J.K. – STERN, R.A. – CARD, K.D. – BEGIN, N.J., 1992 – Giant granulite terranes of northeastern Superior Province; the Ashuanipi Complex and Minto Block. Canadian Journal of Earth Sciences; volume 29, pages 2287-2308.

PERCIVAL, J.A. – CARD, K.D., 1994 – Geology, Lac Minto – Rivière aux Feuilles. Geological Survey of Canada. Map 1854A, scale 1:500,000.

PERCIVAL, J.A. – SKULSKI, T. – CARD, K.D., 1995a – Geology, Rivière Kogaluc - Lac Qalluviartuuq region (parts of 34J and 34O). Geological Survey of Canada; Open File 3112.

PERCIVAL, J.A. – SKULSKI, T. – LIN, S. – CARD, K.D., 1995b – Granite-greenstone terranes of the northern Goudalie domain, northeastern Superior Province, Quebec. *In*: Current Research 1995-C, Geological Survey of Canada, pages 141-150.

PERCIVAL, J.A. – SKULSKI, T. – NADEAU, L., 1996a – Geology, Lac Couture, Quebec. Geological Survey of Canada; Open File 3315, scale 1:250,000.

PERCIVAL, J.A. – SKULSKI, T. – NADEAU, L., 1996b – Granite-greenstone terranes of the northern Minto block, northeastern Superior Province, Quebec. *In:* Current Research 1996-C, Geological Survey of Canada; pages 157-167.

PERCIVAL, J.A. – SKULSKI, T. – NADEAU, L., 1997a – Reconnaissance geology of the Pelican - Nantais belt, northeastern Superior province, Quebec. Geological Survey of Canada; Open File 3525, scale 1:250,000.

PERCIVAL, J.A. – SKULSKI, T. – NADEAU, L., 1997b – Granite-greenstone terranes of the northern Minto Block, northeastern Québec: Pélican-Nantais, Faribault-Leridon and Duquet belts. *In*: Current Research, 1997-C, Geological Survey of Canada; pages 211-221.

PERCIVAL, J.A. – SKULSKI, T., 2000 – Tectonothermal evolution of the northern Minto Block, Superior Province, Québec, Canada. The Canadian Mineralogist; volume 38, pages 345-378.

SIMARD, M. – GOSSELIN, C. – DAVID, J., 2001 – Geology of the Maricourt area (24D). Ministère des Ressources naturelles, Québec; RG 2001-07, 44 pages.

STEVENSON, I.M., 1968 – A geological reconnaissance of Leaf River Map-Area, New Quebec and Northwest Territories. Geological Survey of Canada; Memoir 356, 112 pages.

VERNON, R.H., 1983 – Restite, xenoliths and microgranitoid enclaves in granites (Clarke Memorial Lecture), Journal and Proceedings of the Royal Society of New South Wales; volume 116, pages 77-103.

VERNON, R.H., 2000 – Review of Microstructure Evidence of Magmatic and Solid-State Flow, Electronic Geosciences; 5:2.

VERPAELST, P. – BRISEBOIS, D.– PERREAULT, S. – SHARMA, K.N.M. – DAVID, J., 2000 – Geology of the Koroc River area and part of the Hébron area (NTS 24I and 14L). Ministère des Ressources naturelles, Québec; RG 2000-02, 59 pages.

WHITE, A.J.R. – CHAPPEL, P.A., 1977 – Ultrametamorphism and granitoid genesis. Tectonophysics; volume 43, pages 21-51.

WINCHESTER, J.A. – FLOYD, P.A, 1977 – Geochemical discrimination of different magma series and their differentiation products using immobile elements. Chemical Geology; volume 20, pages 325-343.

APPENDIX 1

PHOTO 1 - Metre-thick conglomerate bed in a volcanic sequence of the Porpoise Cove belt.

PHOTO 2 - Aspect of granitization produced by the mixture of a granitic phase in diffuse contact with a tonalitic phase.

PHOTO 3 - Heterogeneous tonalite of the Boizard Suite (Aboz) with mafic lava enclaves.

PHOTO 4 - Clinopyroxene tonalite with burgundy plagioclase of the Qilalugalik Suite (Aqil1).

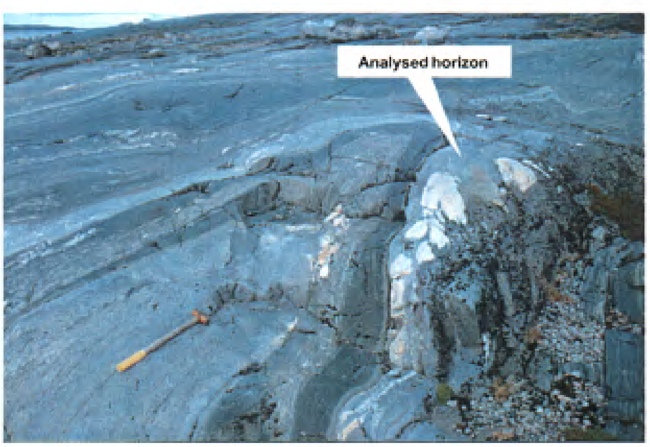


PHOTO 5 - Felsic tuff horizon dated at 3825±16 Ma located along the limb of a fold affecting a volcanic sequence of the Porpoise Cove belt.

PHOTO 6 - Massive pyroxenite of the Qullinaaraaluk Suite (Aluk) injucted with tonalitic material.

APPENDIX 2

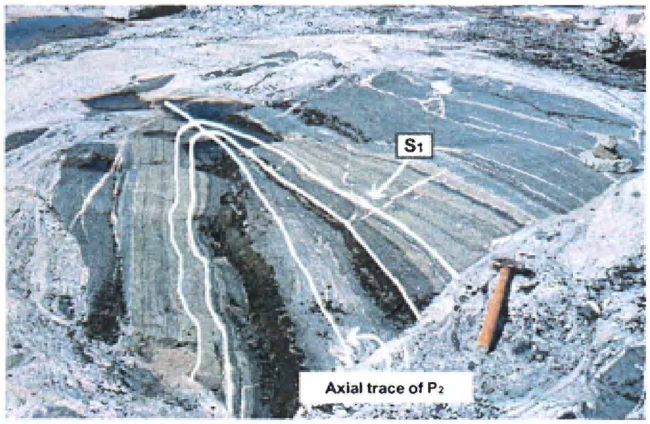


PHOTO 1 - Amphibolite enclave affected by a F2 fold.

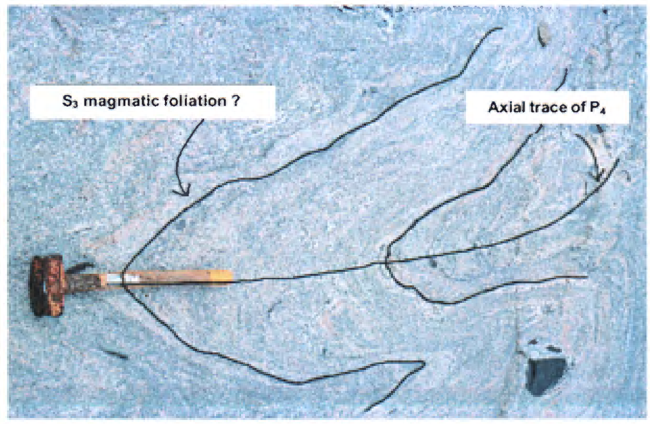


PHOTO 2 - Magmatic S3 foliation reworked by a F4 fold.

PHOTO 3 - Paragneiss and white granite (Acrn) affected by mylonitic zones in deformation corridor2.

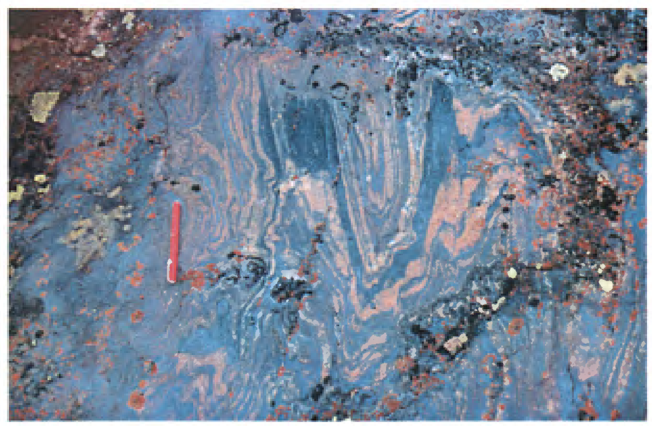


PHOTO 4 - Folded iron formation associated with volacanic rocks of the Porpoise Cove belt.

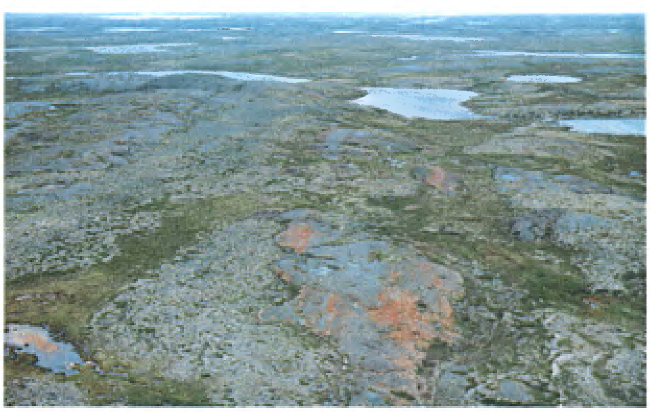


PHOTO 5 - Aerial view of a rusty paragneiss horizon.

PHOTO 6 - Decimetric quartz-carbonate-sulphide vein.

Abstract

This report deals with the results of a geological survey at 1:250,000 scale carried out during the summer 2001 in the Rivière Innuksuac area (NTS 34K and 34L). This area is located in Québec's Far North, more specifically near the small community of Inukjuak. The area is underlain by Archean rocks, with the exception of a few Proterozoic diabase dykes and a sequence of sedimentary and basaltic rocks of the Hopewell Group. Archean volcano-sedimentary rocks assigned to the Innuksuac Complex (Ainn) are the oldest units in the area (3825 ± 16 Ma). They form km-scale bands enclosed in felsic intrusions and metamorphosed to the amphibolite facies and the granulite facies. Tonalitic units belong to three distinct suites: the Boizard Suite (Aboz), which consists of heterogeneous tonalite with abundant mafic enclaves, the Qamanirjuaq Suite (Aqam), composed of biotite leucotonalite, and the Qilalugalik Suite (Aqil) composed of clinopyroxene-biotite tonalite with burgundy plagioclase, greenish orthopyroxene tonalite (enderbite) and biotite tonalite with burgundy to red plagioclase. These rocks have undergone a regional "granitization" process, which may have been triggered by the emplacement of granodiorite and granite intrusions of the Voizel Suite (Avoi). Other granitic units are represented by the Gabillot Suite (Agab) and the Corneille Suite (Acrn). The Gabillot Suite is characterized by a megaphyric texture. The Corneille Suite (ca. 2691 Ma), exclusively found in the westernmost part of the area, consists of white granite and whitish tonalite. All Archean units are cross-cut by foliated gabbronorite and hypersthene diorite intrusions assigned to the Cheminade Suite (Acmd) as well as by massive gabbronorite and ultramafic intrusions of the Qullinaaraaluk Suite (Aluk).

The structural interpretation of the Innuksuac area outlines six phases of ductile and brittle deformation. The first two phases (D1 and D2) were observed in supracrustal rocks only. Phase D3 represents the main deformational event responsible for the NNW-SSE-striking regional structural trend. Phase D4 is represented by tight to open F4 folds with NW-SE-trending axial traces. Phase D5 produced ductile shear zones oriented NW-SE to NNE-SSW and more rarely E-W. NNE-SSW structures occur within two distinct corridors. Finally, phase D6 is responsible for a network of late brittle faults oriented E-W.

This geological survey led to the discovery of several sites of economic interest and mineralized zones associated with: 1) early volcano-sedimentary sequences, 2) late mafic to ultramafic intrusions, and 3) quartz-carbonate-sulphide veins. Occurrences associated with volcano-sedimentary rocks correspond to rusty zones from 10 cm to 1 m in thickness, with disseminated or semi-massive pyrite often accompanied by pyrrhotite or chalcopyrite. Several samples collected in these mineralized zones yielded anomalous Cu, Zn, Au, Ag, Co and Ni grades, including several assays greater than 0.1% for Cu and Zn. The Porpoise Cove belt contains horizons of anthophyllite-cordierite-garnet schist interpreted as metamorphosed hydrothermal alteration zones, considered prospective for volcanogenic deposits. Sites of economic interest associated with late mafic and ultramafic intrusions contain rusty zones from 1 to 10 m wide, with fine disseminated pyrite often associated with pyrrhotite or magnetite. The discovery of the Qullinaaraaluk Ni-Cu-Co-PGE showing by the MRN in the summer 2000 generated renewed interest for this type of intrusion. The Qullinaaraaluk showing is located 75 km to the southeast of the study area. Finally, mineralization hosted in quartz-carbonate veins consists of sporadic pockets of chalcopyrite locally accompanied by galena and sphalerite.

Ressources naturelles
Québec