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GEOLOGY OF THE LAC PETERS AREA (24M)

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(NTS 24M)

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Accompanies map
SI-24M-C2G-99J

Inukshuk, péninsule de l'Ungava.

2000

Québec

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ABSTRACT

The Lac Peters Area (NTS sheet 24M) is located in the southern part of the Douglas Harbour Domain (NE portion of the Minto Subprovince). It mainly consists of Archean rocks of the Superior Province. Early Proterozoic rocks of the Labrador Trough overlie the Archean craton in the easternmost part of the area. The contact between these two geological domains is characterized by an intense ductile deformation zone that formed under amphibolite-grade metamorphic conditions (sillimanite-muscovite schist). This deformation is attributed to the thrusting of Trough rocks onto the Archean craton.

Archean rocks in the area are subdivided into three lithodemic units: 1) the Troie Complex (TC) located in the south-central part, 2) the Qimussinguat Complex (QC) in the northwestern part and 3) the Faribault-Thury Complex (FTC) covering the rest of the area. On a map showing the total residual magnetic field, the TC and the QC are characterized by a high, irregular magnetic pattern, whereas the FTC corresponds to magnetic lows.

The FTC comprises large zones of intrusive rocks, generally gneissic or foliated, mainly composed of tonalite and trondhjemite. Amphibolite-grade volcano-sedimentary belts occur within these intrusive rocks. The most voluminous belts are informally named Faribault, Rivier, Tasiaalujjuaq, Hamelin, Curotte and Thury. These belts have variable dimensions. They can reach up to 5 km wide and over 20 km long.

The TC and the QC essentially consist of gneissic or foliated intrusive rocks composed of orthopyroxene and clinopyroxene-bearing tonalite or granodiorite. These intrusive rocks contain granulite-grade volcano-sedimentary belts that are generally smaller in size than those found in the FTC. Only one belt was informally named in each complex: the Peters West belt in the TC and the Gorribon belt in the QC. The thickness of belts observed in the TC and the QC varies between 500 m and 1.5 km, but locally reaches over 3 km. These belts are often folded and dislocated. Belt segments vary between 1 and 15 km in length.

Paragneisses in the FTC frequently contain a metamorphic assemblage composed of garnet + biotite ± sillimanite ± muscovite, whereas mafic volcanics consist of a hornblende + plagioclase ± quartz ± garnet assemblage. This mineralogy indicates amphibolite-facies regional metamorphic conditions. In the TC and the QC, the garnet + cordierite + spinel assemblage observed in paragneisses and the orthopyroxene + clinopyroxene + hornblende assemblage observed in plutons and volcanic rocks indicate that regional metamorphism reached the granulite facies.

Prior to this survey, no showing or lithogeochemical anomaly had been discovered in the Archean rocks forming the Lac Peters Area. A total of 350 assays from rock samples collected in gossans or sulphide-bearing mineralization in various geological environments led to the discovery of three showings mineralized in Au, Ag, Cu, Zn and Pb, and 15 lithogeochemical anomalies significant in terms of mineral exploration. These showings and anomalies occur in three distinct geological environments: volcano-sedimentary belts, sulphide-facies iron formations and synvolcanic or syntectonic mafic and ultramafic rocks.

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INTRODUCTION

Objectives

Archean rocks of the Superior geological Province in the northernmost part of Québec were mapped at a scale of 1:1,000,000 in the 1950s and 1960s (Eade, 1966; Stevenson, 1968). During the 1990s, mapping conducted by the Geological Survey of Canada improved the geological knowledge in certain areas such as the Rivière-aux-Feuilles area (Percival and Card, 1994). Other sectors with volcano-sedimentary sequences were the focus of more detailed mapping at 1:250,000 and 1:50,000 scale (Percival *et al.*, 1994, 1995, 1996, 1997a; Lamothe, 1997). The Lac Peters area (NTS 24M), which covers a portion of the Douglas Harbour Domain, is the focus of the present study. Mapping objectives are :1) to update the geological map at a scale of 1:250,000 and 2) to evaluate the mineral potential by identifying geological environments favourable to the discovery of mineral deposits.

Location and Access

The Lac Peters area is located in the northernmost part of the Province of Québec, in the Ungava Peninsula, south of the Arnaud River (Figure 1). This region, whose centre is located 200 km north of Kuujjuaq and 95 km northwest of Kangirsuk, is accessible by ski-equipped aircraft, from December to May, and by floatplane during the summer. The Arnaud River crosses the northern part of the area from east to west. Major lakes include: Lac Peters, Lac Tasiaalujjuaq and Lac Faribault. Topography is low and the altitude varies between 200 and 275 m above sea level, except in the SE sector, where some hills reach 400 m. The region is located north of the tree line. Outcrops are numerous but covered with lichen. They are generally large except in the eastern third of the map area, where glacial deposits dominate.

Methodology

Fieldwork conducted during the summer of 1998 consisted of geological mapping at a scale of 1:250,000, lithogeochemical sampling of lithodemic units, assay sampling of mineralized zones and geochronological sampling of nine units. Traverses averaging 10 km long were spaced every 8 km. Traverses were more closely spaced in interesting areas, such as the volcano-sedimentary sequences. Previously collected geoscientific data was integrated with newly collected information. The database is available through SIGÉOM (Québec's Geomining Information System).

Previous Work

Apart from 1:1,000,000 scale reconnaissance work conducted in the 1960s by the Geological Survey of Canada (Stevenson, 1968), no other mapping survey had been carried out on the Archean rocks of the Lac Peters area. However, rocks of the Labrador Trough, located in the eastern part of the map area, have been the focus of previous mapping surveys, more specifically in the Lac au Chien Rouge area (parts of 24M/01 and 24M/08; Freedman and Philpotts, 1958) and the Brochant River area (part of 24M/09; Bergeron, 1957). The region was also covered by a lake sediment geochemistry survey (MRN, 1998), a till survey (Bouchard *et al.*, 1993), a gravity survey with stations spaced every 10 km (GSC, 1994) and a regional aeromagnetic survey (Dion and Dumont, 1994).

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GENERAL GEOLOGY

The northeast Superior Province, which includes the Lac Peters area, is formed of the Minto Subprovince. It essentially consists of plutonic and gneissic rocks, but also includes volcano-sedimentary belts, all Archean in age. These rocks are typically metamorphosed to the amphibolite facies or the granulite facies. The overall NNW orientation of major lithological assemblages in the subprovince is clearly outlined on regional maps showing the magnetic gradient and the total magnetic field. The Minto Subprovince is bounded by Early Proterozoic rocks of the Labrador Trough to the east and of the Ungava Trough to the north.

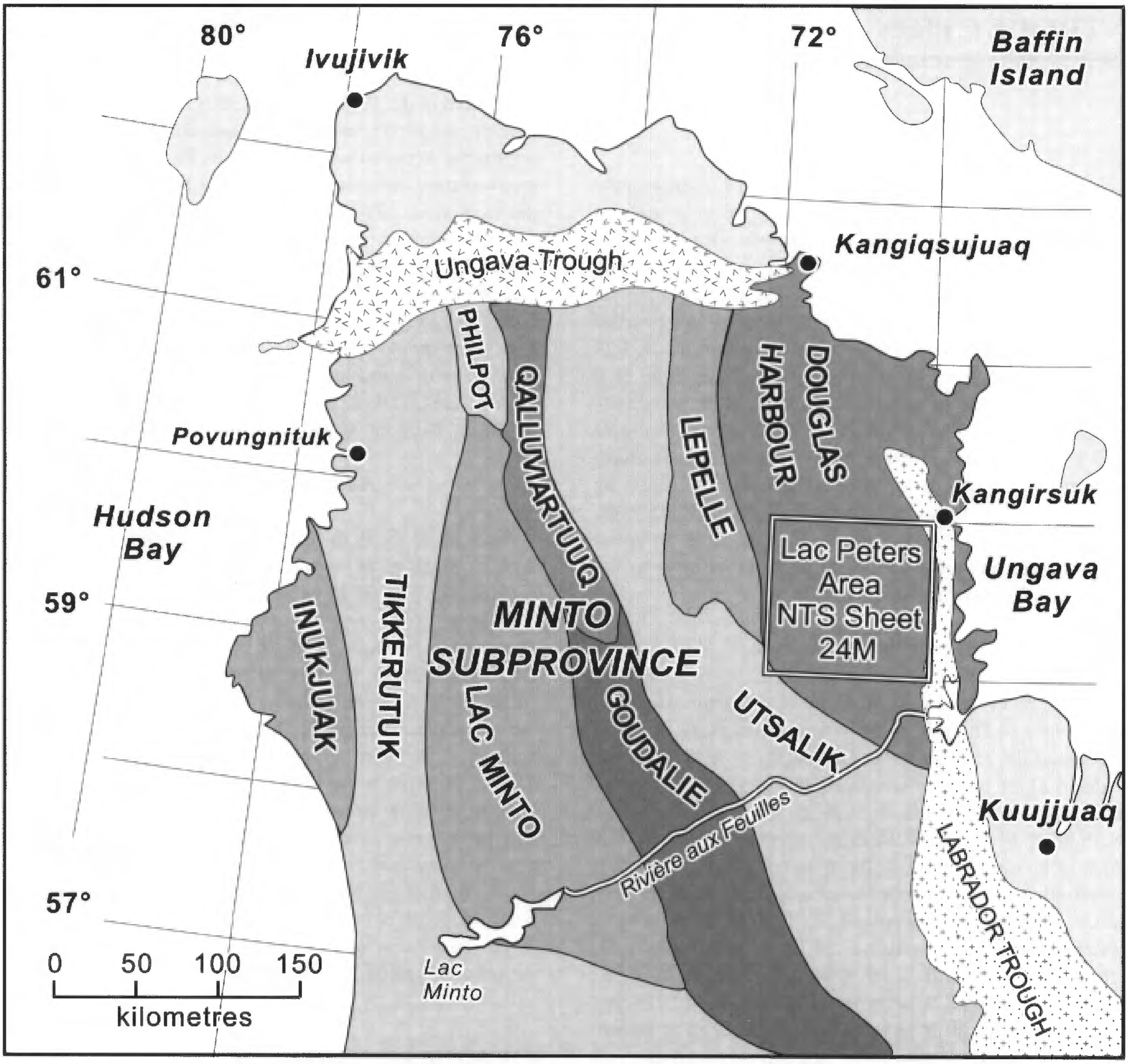

FIGURE 1 - Location map of study area showing the distribution of lithotectonic domains (after Percival *et al.*, 1991; 1992; 1997b).

A preliminary subdivision of the Minto Subprovince into four lithotectonic domains was proposed by Percival et al. (1991) following their reconnaissance work along the Rivière-aux-Feuilles. Subsequent work extended this subdivision into six, then nine domains (Percival *et al.*, 1992 and 1997b). These domains are shown on Figure 1. The *Inukjuak Domain* is formed of plutonic rocks containing metasedimentary enclaves. The *Tikkerutuk Domain* consists of plutonic rocks (2707 - 2693 Ma). The *Lac Minto Domain* comprises calc-alkaline granodiorite (2780 - 2693 Ma), peraluminous granodiorite (2725 - 2696 Ma), monzogranite (2690 Ma) and dominantly sedimentary supracrustal rocks including the Kugaluk volcano-sedimentary belt (~ 2760 Ma). The *Goudalie Domain* consists of tonalite (3010 - 2900 Ma) and volcano-sedimentary belts including the Vizien belt (2700 Ma), interpreted by Skulski and Percival (1996) as an assemblage of oceanic and continental arc fragments. The *Philpot Domain* is composed of gneissic and intrusive rocks (2755 Ma), the *Qalluviartuuq Domain*, of intrusive rocks and evolved volcanic rocks (~ 2800 Ma), the *Lepelle Domain*, of intrusive rocks and the *Utsalik Domain*, of calc-alkaline granodiorite and granite (2755 - 2725 Ma). Up until very recently, the *Douglas Harbour Domain* was considered as a lithological assemblage composed exclusively of plutonic rocks (2880 - 2780 Ma). However, the Lac Peters survey, which covers a portion of the Douglas Harbour Domain, identified several volcano-sedimentary belts.

Domain boundaries within the Minto Subprovince are essentially based on the extrapolation of reconnaissance work using aeromagnetic data. The geological nature of the various domains is mainly assumed from the aeromagnetic signature of each domain. As a general guide, positive aeromagnetic anomalies correspond to two pyroxene-bearing plutonic rocks, and to granulite-facies metamorphism. Negative aeromagnetic anomalies correspond to remnants of supracrustal rocks metamorphosed to the amphibolite facies and intruded by tonalitic plutons. However, this correlation is not always accurate, and a better understanding of the Minto Subprovince requires new field programs followed by geochemical, mineralogical and geochronological studies.

Despite their restricted volume and a higher regional metamorphic grade, volcano-sedimentary belts in the Minto Subprovince display several features similar to other Archean belts renowned for their gold and base metal ore deposits, such as the Abitibi (NW Québec), the *Yilgarn Block* (W Australia) and the Barberton District (South Africa). All these belts form narrow bands within larger-scale plutonic terrains.

STRATIGRAPHY

A large portion of the area covered by the survey is underlain by Archean rocks of the Superior Province (Minto Subprovince). In the easternmost part of the map area, Early Proterozoic rocks of the Labrador Trough are in structural contact with the Archean craton. The contact between these two geological domains is characterized by an intense ductile deformation zone, attributed to the thrusting of Trough rocks onto the Superior craton during the New Québec orogeny. This report focusses on the Archean rocks of the Lac Peters area, as Early Proterozoic rocks of the Labrador Trough have already been described in previous geological reports by Bergeron (1957), and Freedman and Philpotts (1958).

Archean rocks in the Lac Peters area are subdivided into three lithodemic units : 1) the Troie Complex (TC) located in the south-central sector, 2) the Qimussinguat Complex (QC) in the northwest and 3) the Faribault-Thury Complex (FTC) which borders the other two units. On a map showing the total residual magnetic field, the TC and the QC are characterized by a high and irregular magnetic signature, whereas the FTC is found in magnetic lows. The TC and the QC are essentially composed of granulite-facies assemblages whereas the FTC comprises amphibolite-facies rocks. Intense ductile deformation zones, observed in certain areas, separate amphibolite-grade and granulite-grade lithological assemblages. The three complexes are mainly composed of plutonic rocks and orthogneiss that host several segments of volcano-sedimentary belts. These segments may reach a maximum of five kilometres in width over several tens of kilometres in length, however most of them are relatively small. They have undergone several folding events, and have been tectonically dismembered. The relationship between volcano-sedimentary belts and adjacent rocks is ambiguous. Field observations suggest that the volcano-sedimentary belts were tectonically transposed with intrusive country rocks and that their contacts are sheared. Monzonitic and gabbronoritic intrusions, mainly found in the TC, cross-cut other plutonic rocks and orthogneisses. All Archean units are cut by Early Proterozoic mafic dykes.

Archean

FARIBAULT-THURY COMPLEX (Afth)

The Faribault-Thury Complex is a new lithodemic unit referring to an assemblage formed of large zones of generally gneissic or foliated intrusive rocks and narrow volcano-sedimentary belts metamorphosed to the amphibolite facies, which occur within the intrusive zones. The most voluminous belts were informally named Faribault, Rivier, Tasiaalujjuaq, Hamelin, Curotte and Thury (Figure 2). The size of the belts is quite variable. They can be fairly small (< 1 km2), or may reach up to 5 km wide by over 20 km long. Although the Faribault-Thury Complex coincides with a magnetic low on the total residual magnetic field map (Figure 3), some belts included in the complex, such as the Rivier belt, coincide with very localized magnetic highs, whereas other belts have no magnetic expression.

Biotite Granite (Afth5)

This unit outcrops in the western part of the map area. The granite is weakly-deformed, homogeneous, and locally displays a tectono-metamorphic foliation. This granite cross-cuts adjacent units. It contains biotite (~3 %) as well as traces of apatite and zircon. Plagioclase is partially sericitized and epidotized. Other granitic masses, too small to be represented on the map, contain biotite, muscovite, minor garnet, but no oxides. The granite exhibits evidence of metamorphic recrystallization but idiomorphic magmatic feldspar crystals are locally preserved. However, more deformed samples display a granoblastic texture, and contain relics of ribbon quartz.

Tonalite and Trondhjemite (Afth4)

This is by far the most widespread unit in the Faribault-Thury Complex. It is mainly composed of tonalite and trondhjemite, in equal proportions and uniformly distributed throughout the map area. This unit also contains minor proportions of quartz diorite, diorite, gabbro and granodiorite, which form intrusive stocks 10 metres to one kilometre in diameter, and numerous dykes of pink granitic pegmatite. This lithological assemblage is a typical example of an Archean *TTG suite* (tonalite-trondhjemite-granite) (see Ridley and Kramers, 1990; Martin, 1994; Rudnick, 1995; Berger and Rollinson, 1997).

The tonalite, trondhjemite and granodiorite are commonly migmatized with local diatexite. These migmatites contain <1 to 15% trondhjemitic, leucotonalitic or granitic mobilizate (locally up to 60%). Enclaves typically consist of tonalite, diorite or granodiorite. The tonalite and the trondhjemite almost always exhibit a gneissocity or a foliation with schlieren enriched in mafic minerals. In some cases, the deformation is weak, but generally, even the most homogeneous rocks are deformed and display a linear fabric (L-tectonite) and very well developed quartz ribbons. On outcrop, the hinges of metre-scale folds display a chaotic aspect where folded and displaced enclaves lie in a leucocratic mobilizate. Along fold limbs, the general fabric is more homogeneous and the gneissocity or foliation is well-defined.

Most samples from this unit display a granoblastic texture in thin section. Observed microfabrics indicate variable degrees of deformation. Least deformed samples sometimes exhibit idiomorphic antiperthitic plagioclase grains that were preserved from deformation and recrystallization. The most deformed rocks have a mylonitic foliation that was partially obliterated by static recrystallization.

The tonalite and the trondhjemite contain equal proportions of quartz and plagioclase. Quartz generally occurs as polycrystalline ribbons. Plagioclase crystals are often sericitized and contain small grains of secondary epidote and calcite. Less than 10% potash feldspar, typically as interstitial microcline, was observed in the tonalite and the trondhjemite. Locally, the potash feldspar content exceeds 10%, and the rock becomes granodioritic. The tonalite generally contains between 10 and 40% ferromagnesian minerals whereas the trondhjemite contains less than 10%. Biotite and hornblende are the most frequently observed mafic minerals. Metamorphic muscovite and garnet are locally observed. Accessory minerals include oxides (magnetite, ilmenite), zircon, sphene (<8%), apatite, and local magmatic allanite and epidote. Magmatic epidote (<1 to 5%) is idiomorphic but exhibits partial resorption textures. The presence of magmatic epidote indicates that crystallization began at a pressure of 0.8 GPa (Zen and Hammarstrom, 1984). Resorption phenomena suggest subsequent decompression in the magmatic state. Diorite layers related to the tonalite and the trondhjemite are mainly composed of plagioclase, hornblende and biotite. They also contain pyroxene relics that have generally been replaced by hornblende, magnetite and ilmenite.

Amphibolitic Metavolcanic Rocks (Afth3)

Volcanic rocks constitute the main lithological unit of supracrustal belts. They are mafic or intermediate in composition, although small volumes of ultramafic volcanics have been observed, and are metamorphosed to the amphibolite facies. On a macroscopic scale, these rocks display a penetrative foliation, outlined by cm-scale layering. Locally, they are clearly massive, but primary structures and textures such as pillowed flows, crystal tuff, lapilli tuff and blocky tuff have been recognized.

Thin sections of mafic and intermediate volcanic rocks of the Faribault-Thury Complex are typically fine-grained (~ 0,5 to 1 mm) and display a polygonal granoblastic texture. In many cases, prismatic hornblende crystals are oriented parallel to the foliation and the lineation and define a nematoblastic texture. The main mineral phases are: green hornblende (55 to 75%) and plagioclase (20 to 45%). Minor phases include biotite (<5%), which is locally partially chloritized, quartz (<5%), epidote (<1 to 10%), sphene (<1 to 5%), garnet (<1 to 3%) and locally, clinopyroxene relics almost completely replaced by hornblende.

Ultramafic rocks are spatially related to the mafic volcanics. They are generally heterogeneous, strongly metamorphosed and altered. They locally appear massive and relatively fine-grained, and probably represent komatiitic lavas. More frequently, they are medium- to coarse-grained (5 to 15 mm) and are essentially composed of pyroxenite, peridotite and minor dunite. The pyroxenite and peridotite units are either intrusive, or represent cumulates derived from overlying massive flows, as suggested by their relationship with supracrustal rocks. Ultramafic rocks are mainly composed of variable proportions of clinopyroxene, orthopyroxene and olivine pseudomorphs. Locally, these minerals are fresh but olivine grains are generally replaced by iddingsite and serpentine. The most frequently observed secondary minerals include anthophyllite, clinochlore (magnesian chlorite), epidote and talc.

Paragneiss (Afth2)

Paragneiss units form thin (1 to 10 m) horizons, which extend laterally for a few kilometres. They display a tectono-metamorphic layering and are migmatized. Rare marble and calc-silicate rocks are intercalated with the paragneiss. Tourmaline and garnet-bearing pegmatite dykes are associated with the paragneiss.

The paragneiss consists of a granoblastic quartzo-feldspathic matrix. Biotite (15 to 30%) and garnet (1 to 5%) are commonly observed in these rocks, along with variable proportions of sillimanite, graphite, muscovite, rutile and tourmaline. Garnet porphyroblasts are often poikilitic, and contain small inclusions of biotite, sillimanite, quartz, plagioclase or graphite. Biotite is locally replaced by chlorite.

On a macroscopic scale, marble occurrences consist of 1-metre to 10-metre thick layers parallel to the general fabric. These layers have a negative relief relative to adjacent lithologies. In thin section, static recrystallization has affected all the minerals that form the marble unit. The average size of neoblasts is about 2 mm but may reach

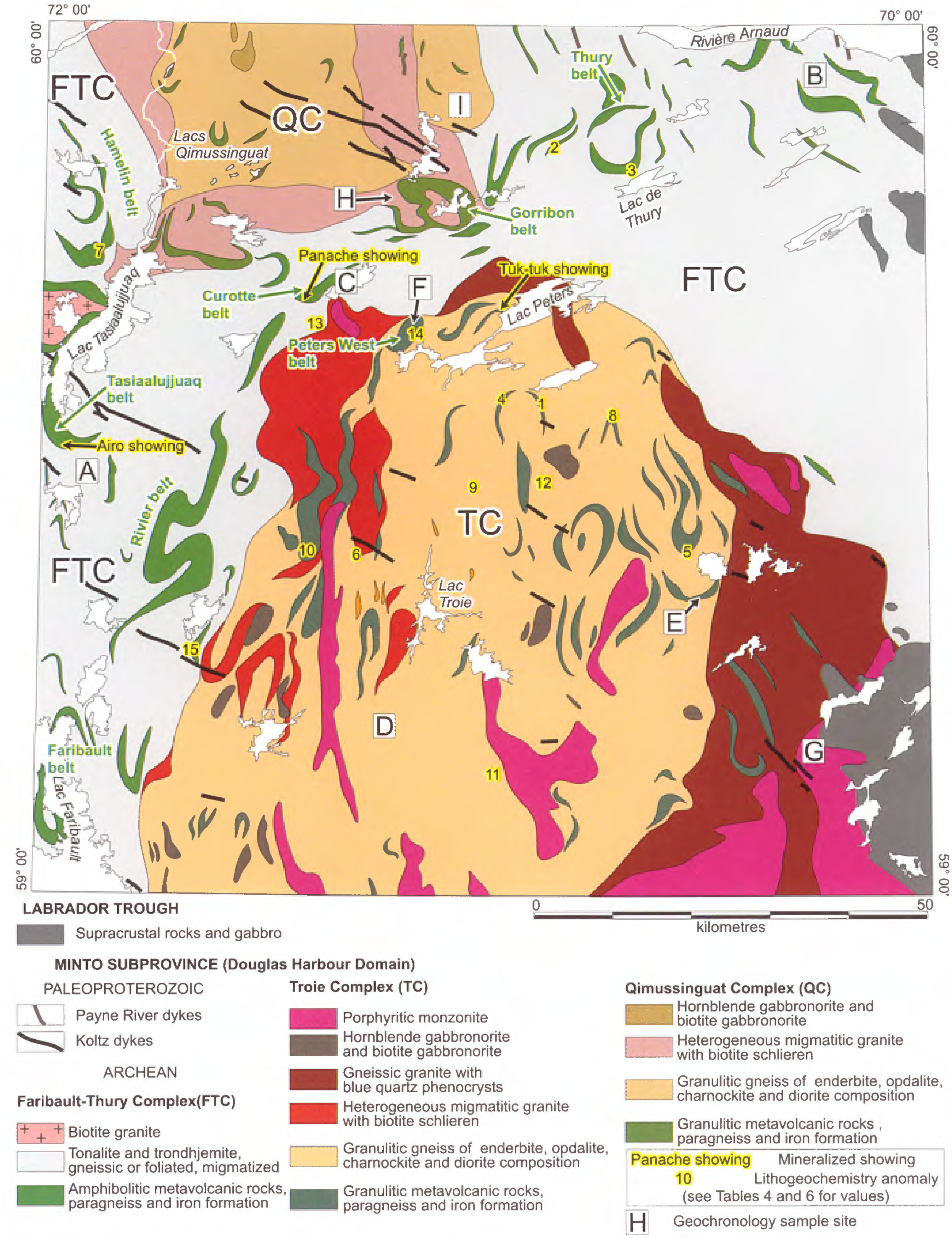

FIGURE 2 - Simplified geological map of the Lac Peters Area (NTS 24M).

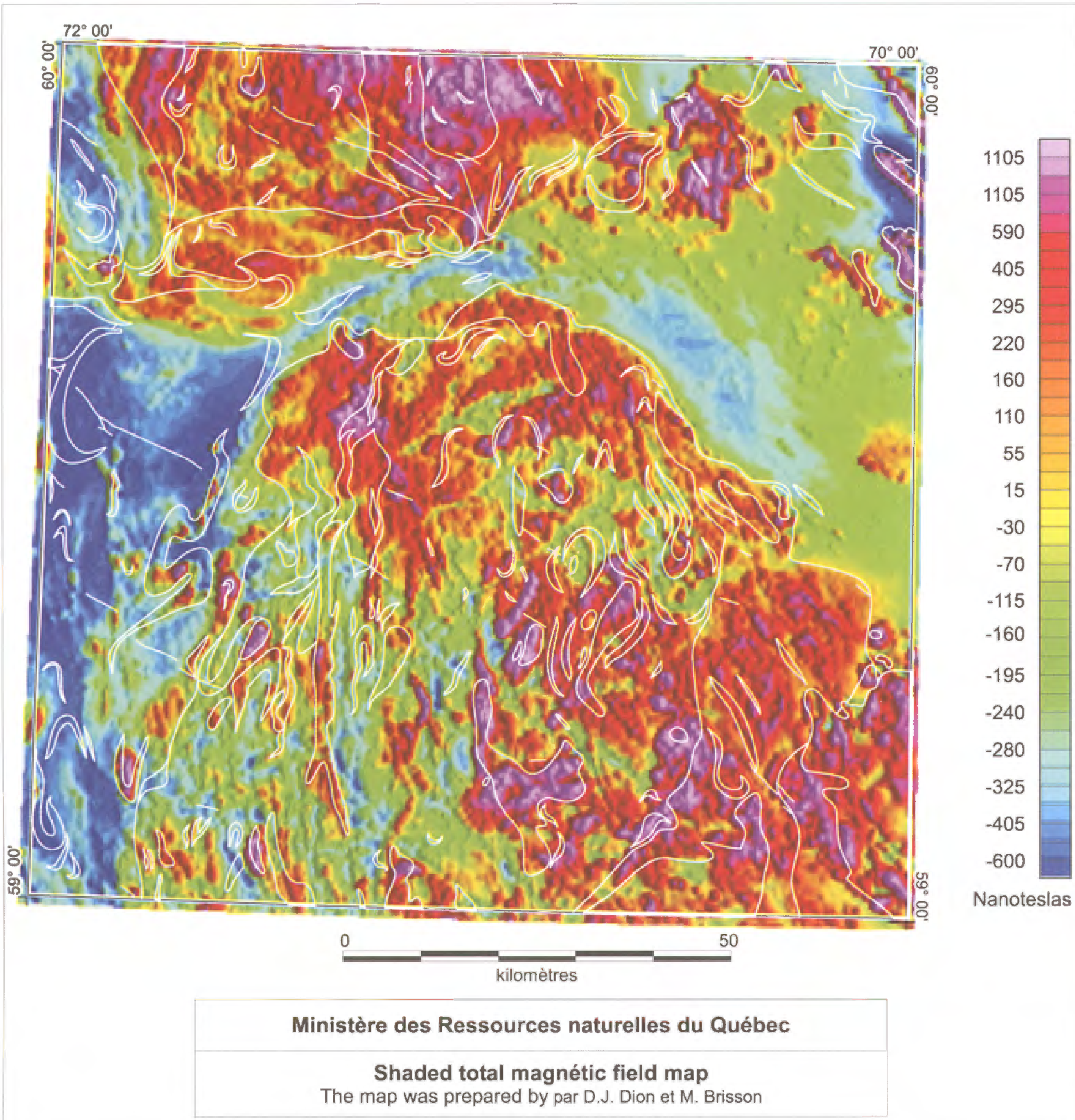

FIGURE 3 - Shaded total magnetic field map, NTS sheet 24M. White lines correspond to geological contacts shown in Figure 2.

10 mm. The marble is essentially composed of calcite or dolomite and contains about 15% accessory minerals such as diopside, forsterite (magnesian olivine), sphene and minerals of the humite group. These minerals are concentrated in mm- to cm-scale bands that define the tectono-metamorphic layering.

Very few calc-silicate rocks were identified in the field. The rare samples observed in thin section display a mm-scale tectono-metamorphic layering and a granoblastic texture. Grain size varies between 0.5 mm and 2 mm. These rocks contain diopside, calcite, scapolite, sphene, quartz, plagioclase and hornblende. Mineral proportions vary from one layer to the next. Locally, epidote and hornblende surround scapolite crystals. Rare idiomorphic tourmaline crystals have also been observed.

Iron Formation (Afth1)

Iron formation units occur as 1-metre to 10-metre thick horizons, although bands over 50 m thick have also been observed. Iron formation units may occur on their own, or in contact with orthogneiss and intrusive rocks, or intercalated with metasedimentary and volcanic rocks. Hydrothermal

alteration zones are frequently observed in the vicinity of iron formation units.

The iron formations are metamorphosed. Thin sections reveal a well developed granoblastic texture. They are generally banded but can also occur as homogeneous or foliated units. Their composition is quite variable. Two facies were recognized: the *silicate facies*, essentially composed of iron silicates and quartz, and the *oxide facies*, composed of magnetite and quartz.

Silicate-facies iron formation units are essentially composed of garnet and quartz concentrated into thin (mm- to cm-scale) layers. Less frequently, this facies is dominated by grunerite and quartz-rich rocks. Silicate-facies iron formation units also contain minor proportions of magnetite, hornblende, biotite, calcite and pyrite, with traces of apatite and zircon.

Oxide-facies iron formations are characterized by alternating magnetite and quartz laminae (mm-scale). Locally, magnetite forms cm-scale elongate polycrystalline masses parallel to foliation. The oxide facies locally contains grunerite, garnet and apatite.

TROIE COMPLEX (Atie) AND QIMUSSINGUAT COMPLEX (Aqim)

The Troie and Qimussinguat Complexes constitute two new lithodemic units with similar lithological assemblages. Both complexes consist of orthopyroxene and clinopyroxene-bearing migmatitic quartzofeldspathic orthogneiss. Rare massive and homogeneous units are locally preserved. Theselithological assemblages also contain granulite-facies volcano-sedimentary belts. Supracrustal sequences found in the Troie and Qimussinguat complexes are generally smaller than those in the Faribault-Thury Complex. Two of these were informally named: the Peters West belt in the Troie Complex and the Gorribon belt in the Qimussinguat Complex (Figure 2). The average thickness of supracrustal belts in these two complexes varies from 0.5 to 1.5 km, but it can reach more than 3 km. The belts are generally folded and dismembered, and their length is generally less than 15 km.

On a map showing the total residual magnetic field (Figure 3), the Troie and Qimussinguat complexes are outlined by two large zones with a high and irregular magnetic field. The zone that corresponds to the Troie Complex is oval-shaped. It covers a fair portion of NTS sheet 24M and continues south onto map sheet 24L. The zone corresponding to the Qimussinguat Complex forms a band about 60 km wide that begins in the northern part of NTS sheet 24M and extends towards the NNW over a distance exceeding 140 km.

Porphyritic Monzonite, Quartz Monzonite and Monzodiorite (Atie9)

Monzonitic rocks were observed only in the Troie Complex where they form a suite of intrusions. Evidence of magma mixing between biotite gabbronorites of unit Atie8 and monzonitic rocks was observed in certain outcrops, indicating that the two magmas were emplaced contemporaneously.

Monzonitic rocks (as well as biotite gabbronorites) are among the least deformed lithologies in the area. These intrusions are probably late-tectonic, and followed major N-S-trending regional structures. They generally form elongate bodies covering 5 km2 to over 100 km2. Their average thickness is 5 km and they can reach up to 40 km in length.

Typically, monzonitic rocks display a porphyritic texture. They are sometimes deformed, with a foliation defined by the alignment of phenocrysts, but are locally massive. The composition of this unit varies from quartz monzonite to monzonite to quartz monzodiorite. Monzonitic rocks contain between 25 and 50% idiomorphic orthoclase phenocrysts that are locally microperthitic. They also contain smaller plagioclase phenocrysts (2 to 35%) that are generally sericitized. More differentiated facies also contain idiomorphic quartz phenocrysts. The matrix consists of quartz (5 to 20%), green hornblende (<1 to 10%) and biotite (5 to 15%). Hornblende and biotite are locally chloritized. Accessory minerals include apatite, sphene, epidote and zircon. Between 1 and 3% oxide minerals (magnetite and ilmenite) occur as small grains disseminated throughout the rock or lodged in the cleavage planes of biotite crystals. Biotite and hornblende sometimes form symplectites with quartz. Monzonitic rocks display neoblastic textures along feldspar grain boundaries and within large quartz grains. The preferred orientation of quartz neoblasts indicates that recrystallization occurred during an episode of ductile deformation (dynamic recrystallization).

Hornblende Gabbronorite and Biotite Gabbronorite (Atie8 and Aqim6)

Small gabbronorite intrusive stocks less than 20 km2 in size are found throughout the Troie Complex (Atie) and the Qimussinguat Complex (Aqim). These rocks commonly occur within granulitic gneiss units (Atie4 and Aqim4), as m-scale enclaves surrounded by felsic mobilizate, thus defining an agmatitic texture. In the Troie Complex, gabbronorite dykes and small stocks have also been observed in the vicinity or within monzonitic intrusives (Atie9) described in the previous section. Petrographic and geochemical observations allow us to identify two types of gabbronorite: hornblende-bearing and biotite-bearing. The two types are found in the same geological environments and are therefore not differentiated on the map.

In thin section, gabbronorites display a heterogranular granoblastic texture where the grain size varies between 1 and 5 mm. Relics of subophitic textures are locally observed, although primary igneous textures are most frequently replaced by recrystallization textures. Gabbronorites are mainly composed of clinopyroxene

(10 to 35%), orthopyroxene (5 to 30%) and plagioclase (40 to 55%). Hornblende gabbronorites contain between 15 and 30% green hornblende, which partially replaces both pyroxene phases, and a small quantity of biotite (1 to 5%). This first type of gabbronorite is generally deformed and displays a well developed foliation. Biotite gabbronorites contain 5 to 15% biotite and less than 5% hornblende. This second type of gabbronorite is less deformed than the first, and locally forms dykes which exhibit an igneous porphyritic texture. These dykes cross-cut monzonitic units. Plagioclase sometimes occurs as idiomorphic, zoned and locally antiperthitic phenocrysts in the biotite gabbronorite. Accessory minerals observed in both types of gabbronorite include apatite (1 to 3%) and quartz (1 to 2%). These rocks also contain 5 to 15% opaque minerals, mainly magnetite and ilmenite, disseminated throughout the rock.

Gneissic Granite with Blue Quartz Phenocrysts (Atie6)

The gneissic granite with blue quartz phenocrysts was only observed in the eastern and northern parts of the Troie Complex. On a regional scale, the *Atie6* unit is heterogeneous and various rock types may be observed on outcrop. This unit is characterized by the abundance of granitic material with blue quartz phenocrysts, containing <1 to 20% enclaves of various compositions. The granite is generally medium-grained (1 to 3 mm), homogeneous, gneissic or foliated. Certain heterogeneous sectors, characterized by a diatexite texture, contain over 10% enclaves in addition to biotite schlieren. The enclaves vary from one cm to a few tens of cm in size. They may consist of biotite schist, tonalite, granodiorite, diorite or metabasite. This unit also contains a significant proportion of gneissic or foliated and generally migmatitic tonalite, which sometimes contains relics of orthopyroxene. These tonalites are comparable to those in unit *Atie4*, which is described in an upcoming section.

In thin section, the gneissic granite with blue quartz phenocrysts commonly displays an igneous texture with idiomorphic feldspar crystals. Neoblastic phenomena are observed along feldspar grain boundaries and within large quartz grains, which are formed of subgrains in a checkerboard pattern. In this granite unit, plagioclase is sericitized and contains small grains of secondary epidote and calcite whereas orthoclase grains are generally fresh. The granite also contains biotite (1 to 10%), apatite (<1%), and 2 to 10% opaque minerals (mainly magnetite), with traces of zircon and sphene.

Heterogeneous Migmatitic Granite (Atie5 and Aqim5)

Units *Atie5* and *Aqim5*, respectively found in the Troie Complex and the Qimussinguat Complex, are comparable to the blue quartz granitic unit (*Atie6*). These two units are more heterogeneous than *Atie6*, and migmatitic textures are omnipresent. They are characterized by the presence of relatively homogeneous masses composed of granite with biotite schlieren, which contain <1 to 20% enclaves of various compositions. These units also include a gneissic or foliated tonalite, which locally contains orthopyroxene relics. These tonalitic rocks have a migmatitic texture, and contain between 30 and 60% granitic mobilizate.

Granulitic Gneiss (Atie4 and Aqim4)

Units *Atie4* (Troie Complex) and *Aqim4* (Qimussinguat Complex) are essentially formed of orthogneiss and felsic to intermediate foliated igneous rocks. These granulitic rocks are characterized by the presence of orthopyroxene. They have various compositions: enderbite (hypersthene tonalite), opdalite (hypersthene granodiorite) as well as charnockite (hypersthene granite) and diorite in lesser proportions. They are generally migmatized and contain between 10 and 60% two pyroxene-bearing felsic mobilizate. Outcrops where migmatization is more intense may contain over 85% mobilizate.

In thin section, the orthogneiss and the two pyroxene-bearing intrusive rocks frequently display a polygonal granoblastic texture, and vary from fine (0.5 to 1 mm) to medium-grained (1 to 3 mm). These rocks are essentially composed of quartz, plagioclase, potash feldspar and ferromagnesian minerals in proportions that vary according to the lithology. Mafic minerals include brown-red biotite, clinopyroxene, orthopyroxene and hornblende. Quartz often forms polycrystalline ribbons. Secondary hornblende generally occurs in contact with pyroxene grains, and locally surrounds them. Biotite occurs as idiomorphic porphyroblasts. Between 5 and 20% opaque minerals, mainly magnetite, are disseminated throughout the rock. The most commonly observed accessary minerals are apatite and zircon.

Granulitic Metavolcanic Rocks (Atie3 and Aqim3)

The most abundant supracrustal rock type in the Troie and Qimussinguat complexes consists of mafic metavolcanic rock. These rocks are generally mafic, locally intermediate. A few ultramafic bodies were identified in the two complexes, although they are volumetrically restricted. On a macroscopic scale, metavolcanic rocks are either banded (cm-scale layers) or massive. They are metamorphosed to the granulite facies.

Under the microscope, metavolcanic rocks are fine-grained (~ 0,5 to 1 mm) and display a polygonal granoblastic texture. They are mainly composed of plagioclase (5 to 35%), orthopyroxene (10 to 25%) and green hornblende (5 to 30%), with minor proportions of biotite and quartz. Magnetite and other opaque minerals form 1 to 10% of the rock and occur as small disseminated grains. Criteria used to distinguish volcanic rocks from their intrusive equivalents either in the field or in thin section include their fine-grained nature, their homogeneity and their association with paragneiss or iron formation units. However, a geochemical study is necessary to characterize these rocks.

Ultramafic rocks in the Troie and Qimussinguat complexes are comparable to those observed in the Faribault-Thury Complex (see *Afth3*). They are spatially related to mafic volcanic rocks, however certain bodies form small isolated outcrops within the granulitic gneiss unit (*Atie4* and *Aqim4*). These rocks essentially consist of pyroxenite, peridotite and minor dunite. Pyroxenites and peridotites may represent either intrusive bodies or cumulate flows.

Paragneiss (Atie2 and Aqim2)

Paragneiss units are rarely observed in the Troie and Qimussinguat complexes. They form thin (one to ten metres thick) horizons whose lateral extension rarely exceeds a few hundred metres. They are generally comprised of strongly migmatized quartzofeldspathic paragneiss with a strong tectono-metamorphic layering. Granitic mobilizate may constitute more than 60% of the rock. Thin beds of marble or calc-silicate rock are sometimes found intercalated with the paragneiss, volcanic rocks or iron formation.

The paragneiss is essentially composed of a granoblastic quartzofeldspathic matrix, and generally contains between 15 and 30% reddish brown biotite, along with variable proportions of cordierite, garnet, spinel and sillimanite. Marble and calc-silicate layers observed in the supracrustal sequences of the Troie and Qimussinguat complexes are very similar to those in the Faribault-Thury Complex (see *Afth2*). Marble is essentially composed of carbonate (calcite or dolomite) with about 15% accessory minerals such as diopside, forsterite (magnesian olivine), humite-group minerals and sphene. Calc-silicate rocks are formed of diopside, calcite, scapolite, sphene, quartz and plagioclase.

Iron Formation (Atie1 and Aqim1)

Iron formation units between 1 and 10 m thick are observed in the Troie and Qimussinguat complexes. These rocks are found either as isolated outcrops, in contact with orthogneiss or foliated intrusions of units *Atie4* and *Aqim4*, or intercalated with paragneiss and metavolcanic rocks. The iron formation units are commonly banded. Two facies were identified: the silicate facies and the oxide facies.

Iron formation units are metamorphosed and exhibit a well developed granoblastic texture in thin section. Silicate-facies iron formation is essentially composed of garnet and quartz. Orthopyroxene and clinopyroxene have been observed locally, and probably replace grunerite. These minerals are generally concentrated in separate layers to form mm to cm-scale banding. Locally, hornblende partially replaces pyroxene grains. Silicate-facies iron formation units also contain small magnetite grains and biotite porphyroblasts disseminated throughout the rock in minor proportions. Oxide-facies iron formation is mainly composed of magnetite and quartz. Locally, magnetite forms cm-scale, elongate polycrystalline masses parallel to foliation. They also contain minor clinopyroxene (partially replaced by hornblende), biotite and apatite.

Early Proterozoic

PAYNE RIVER DYKES (PPPAY) AND KOLTZ DYKES (PPKTZ)

Archean rocks of the Lac Peters area are cross-cut by Early Proterozoic mafic dykes. These dykes are 15 to 100 m thick and are generally undeformed and weakly metamorphosed, with the exception of dykes that outcrop in the eastern part of the map area, where Proterozoic deformation strongly affected these rocks. The dykes belong to two distinct dyke swarms: the Payne River dyke swarm, oriented NNW-SSE, and the Koltz dyke swarm, oriented NW-SE (Fahrig *et al.*, 1985; Buchan *et al.*, 1998). In this report, the terms " Payne River Dykes " (pPpay) and " Koltz Dykes " (pPKtz) are used to designate two lithodemic units that correspond to the dyke swarms that bear the same name. *Payne River Dykes* are observed in the northern part of the map area, along the Arnaud River whereas *Koltz Dykes* are found throughout the entire map area (Figure 2). Two samples collected in the chilled margins yielded K-Ar ages of 1875 and 1790 Ma for the Payne River Dykes, which suggests an emplacement age slightly older than 2000 Ma (Fahrig *et al.*, 1985). A sample from the Koltz Dykes yielded a U-Pb age of 2209 Ma (Buchan *et al.*, 1998).

Payne River Dykes and Koltz Dykes are composed of ophitic gabbro. The grain size varies from medium to coarse-grained within each dyke. The rocks consist of idiomorphic plagioclase crystals surrounded by a matrix composed of clinopyroxene and local orthopyroxene. Fe-Ti oxides, minor quartz and biotite have also been observed. The dykes have chilled margins about 10 cm thick that contain idiomorphic microcrystals of plagioclase and augite, aligned parallel to the dyke margins. The dykes are locally altered and ferromagnesian minerals may be partially replaced by chlorite and amphibole, whereas sericite and epidote are associated with plagioclase grains.

METAMORPHISM

The Lac Peters area is formed of two granulitic " domes " corresponding to the Troie and Qimussinguat complexes. These domes are surrounded by amphibolite-grade terrains (Faribault-Thury Complex). With the exception of late, low-grade retrograde metamorphism restricted to the internal boundary of the granulitic complexes, all observed mineralogical assemblages suggest prograde metamorphic conditions. In the western portion of the map area, ductile shear zones juxtapose granulite-grade rocks with amphibolite-grade rocks. This situation probably also prevails in the eastern part of the map, although the transition from granulite-grade to amphibolite-grade rocks appears to be more gradual.

In the Faribault-Thury Complex, paragneiss units commonly contain a metamorphic assemblage of garnet + biotite ± sillimanite ± muscovite and locally, staurolite. Mafic volcanics contain an assemblage of hornblende + plagioclase ± quartz ± garnet. These mineralogical assemblages attest to mid-amphibolite facies regional metamorphic conditions. Metamorphic assemblages observed in the paragneiss units are the most distinctive. They limit the temperature conditions between ~ 5500C and 6500C, and the pressure conditions between ~ 0.4 Gpa and 0.6 GPa (Figure 4).

In the Troie and Qimussinguat granulitic complexes, orthogneiss, foliated intrusions and felsic mobilizates frequently contain orthopyroxene, clinopyroxene and hornblende. Paragneiss units generally contain biotite. Variable proportions of garnet, cordierite, sillimanite and hercynite (dark green spinel) are also found in these rocks. Mafic volcanic rocks generally contain an assemblage of orthopyroxene + clinopyroxene + hornblende. The presence of a cordierite + garnet ± hercynite assemblage, and the relatively widespread distribution of sillimanite, observed in paragneiss, suggest that the regional metamorphism in the two granulitic domes reached conditions of high temperature (~ 9500C) and moderate pressure (<0.8 GPa).

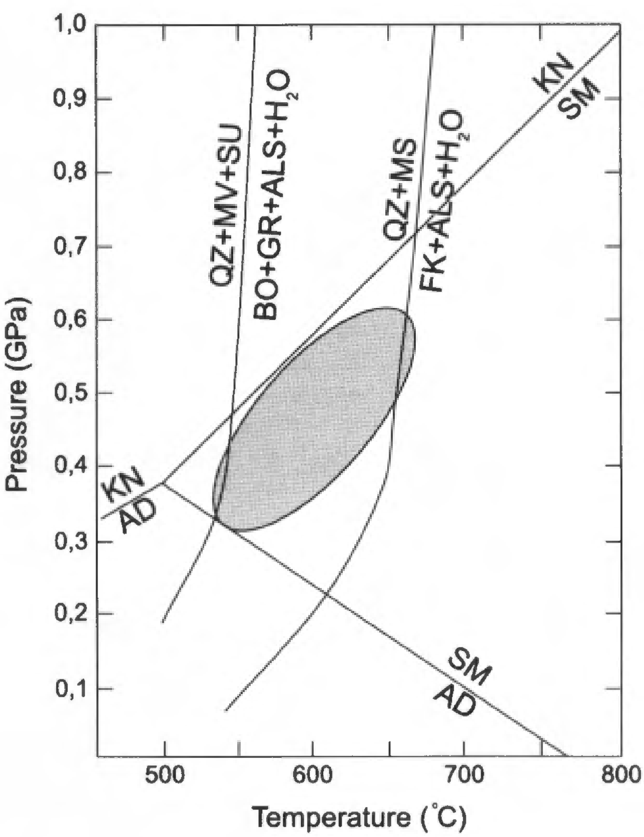

FIGURE 4 - Petrogenetic grid (from Yardley, 1989). The shaded zone corresponds to metamorphic pressure and temperature conditions observed in the Faribault-Thury Complex.
AD = andalusite, ALS = aluminosilicates, BO = biotite, GR = garnet, FK = potash feldspar, KN = kyanite, MV = muscovite, QZ = quartz, SM = sillimanite, SU = staurolite.

STRUCTURAL GEOLOGY

The study area has been affected by complex folding events of variable intensity, followed by brittle deformation characterized by the development of a major network of lineaments, many of which exceed 40 to 50 km in length. This fracture network is particularly well developed in the Troie Complex, where numerous lineaments oriented NNE-SSW, NE-SW and NW-SE control the hydrographic network of the central and south-central portions of the map area. Epidote and hematite alteration are observed in the vicinity of these major brittle faults.

The style of deformation is closely linked to the nature of lithological assemblages that make up the three complexes. Figure 5 is a simplified map of structural patterns obtained by analyzing aerial photographs, magnetic field maps and planar structural data collected in the field.

Lithological units of the Troie Complex are characterized by the presence of an older foliation or gneissocity, reworked by large N-S-oriented regional folds. These folds are generally tight, overturned to the E and have an amplitude of one to several kilometres (Figure 6). The style of deformation is very similar in lithological assemblages of the Qimussinguat Complex, where the regional planar fabric shifts slightly towards the NNW. Tectono-metamorphic lineations in the two complexes plunge steeply to the W and NW (Figure 7, a and b).

The style of deformation undergoes major changes in the Faribault-Thury Complex. In the SW part, lithological assemblages are characterized by the development of an intense subvertical planar fabric, oriented N-S. A few major shear zones, also oriented N-S, juxtapose amphibolite-grade tectonic slices of several metres to several kilometres (Faribault-Thury Complex) with granulite-grade slices (Troie Complex). The geometry of the Rivier and Hamelin belts -also attests to the complex folding deformation (non-planar folding) that affected all supracrustal lithological units in this complex. Tectono-metamorphic lineations are generally well developed, and plunge moderately to steeply to the NE (Figure 7c).

In the eastern part of the Faribault-Thury Complex, the structural pattern is dominated by an intense NNW-trending planar fabric, moderately to steeply-dipping towards the NE. In this area, the contact zone with the Troie Complex is not exposed, and its nature remains unknown. However, the transition from the granulite facies (Troie Complex) to the amphibolite facies (Faribault-Thury Complex) seems to be more gradual in the eastern portion of the map area compared

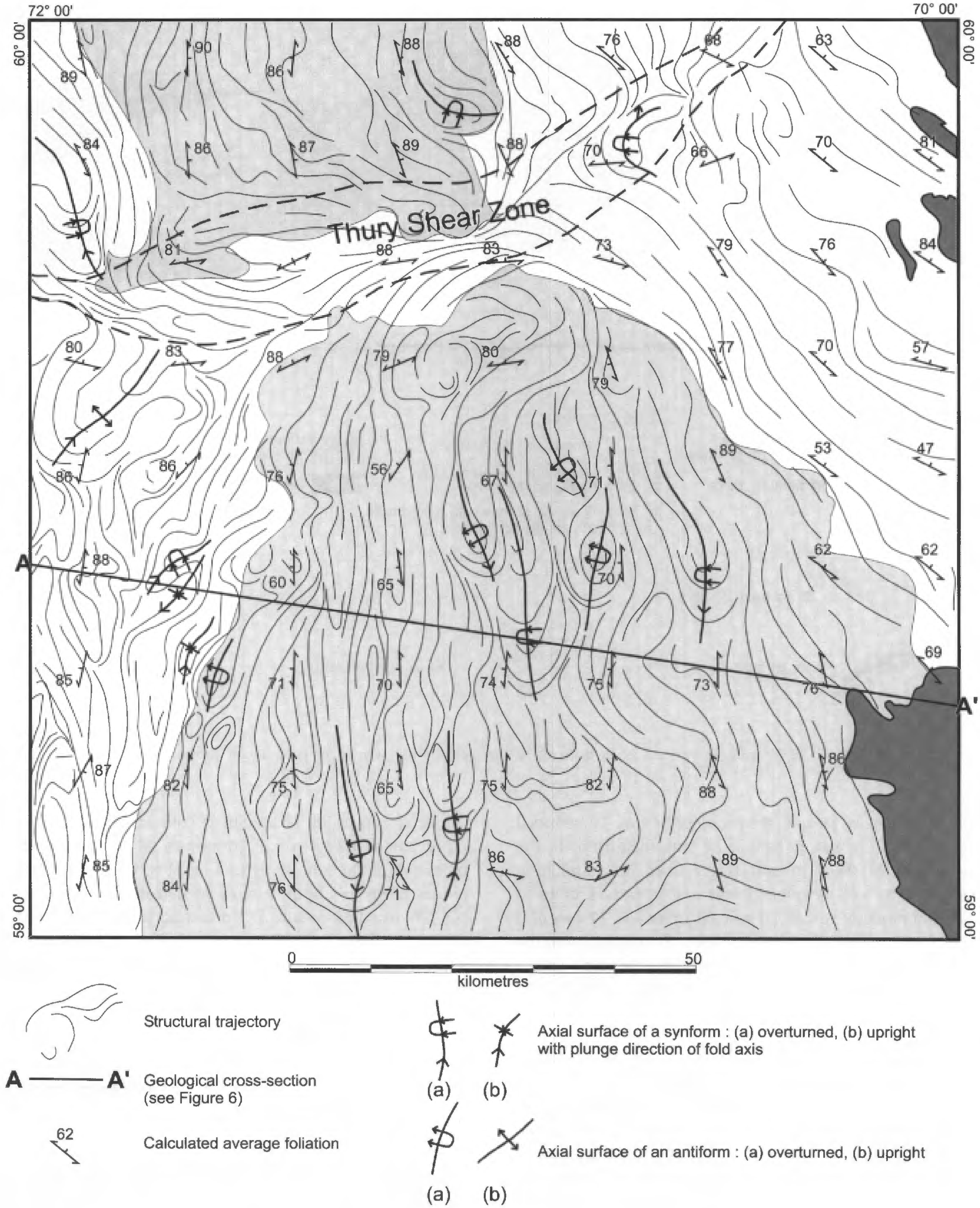

FIGURE 5 - Simplified map of structural trajectories in the Lac Peters Area.

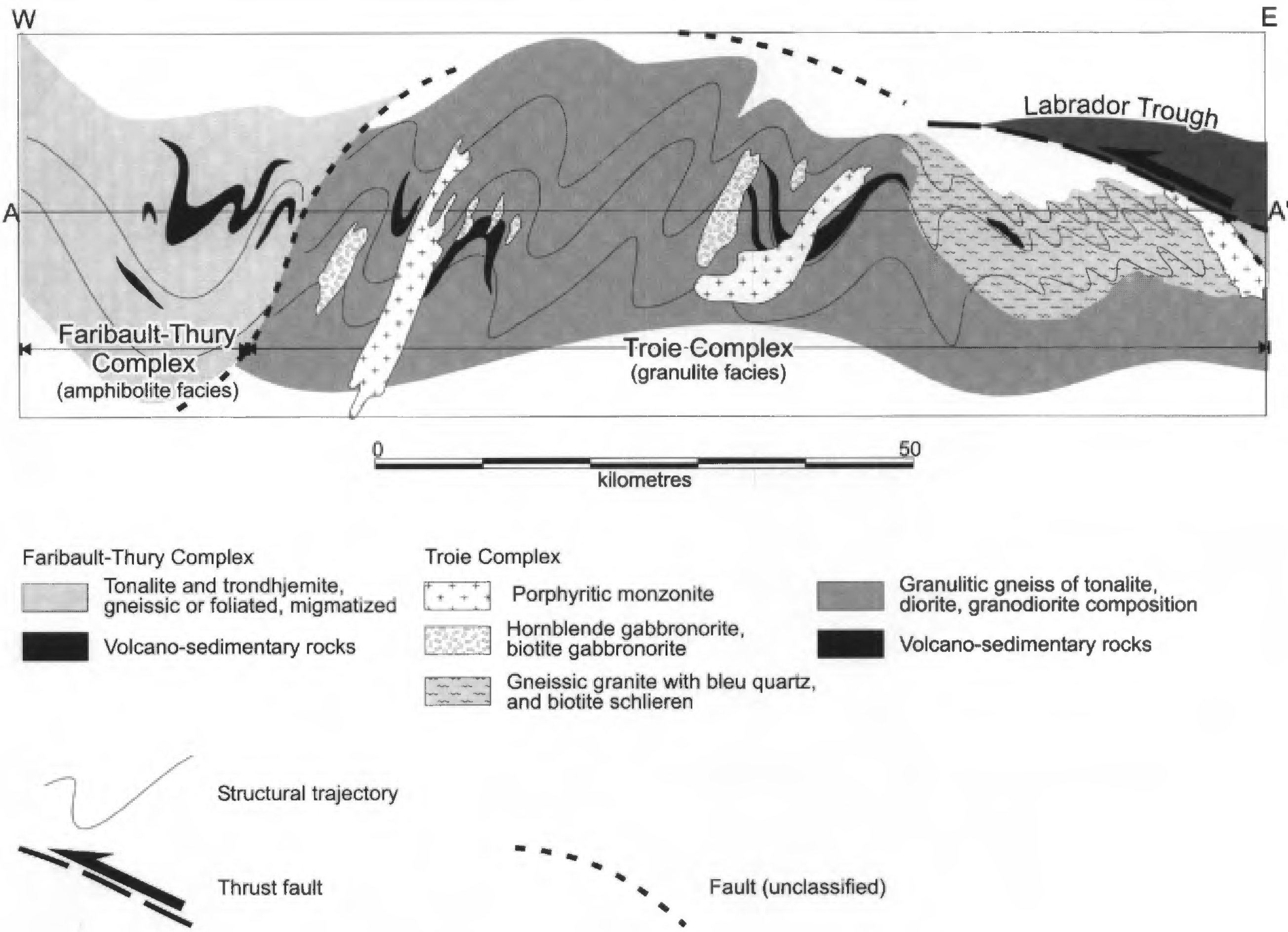

FIGURE 6 - E-W geological cross section through the Lac Peters area. The section location is shown in Figure 5.

to the western part. Despite the presence of a well developed planar fabric, no major shear zone was identified. In the eastern part of the Faribault-Thury Complex, stretching lineations are well-developed and consistently plunge to the NW at moderate to steep angles (Figure 7d). The regular planar fabric, dippind to the E (Figure 5) coupled with the systematic NW orientation of lineations suggest that a portion of the craton was affected by Proterozoic deformation associated with the Hudsonian orogeny. This hypothesis remains to be verified.

A major ductile shear zone, the *Thury Shear Zone* (Figure 5), crosses the northern part of the Lac Peters map sheet and separates the Troie and Qimussinguat complexes. This NE-SW-trending zone extends from the eastern tip of Lac De Thury to the west-central part of Lac Tasiaalujjuaq. An intense planar fabric, outlined by the tectonic transposition of lithological units, the development of a mylonitic layering and the dislocation of supracrustal belts characterize the structural style of this zone. All planar fabrics are reoriented ENE-WSW and dip steeply to the NW. Stretching lineations systematically plunge to the WSW (Figure 7e).

The effects of the Thury Shear Zone are particularly well represented over several kilometres along the southern boundary of the Qimussinguat Complex, where the regional planar fabric is abruptly reoriented from N-S-trending to NE-SW-trending (Figure 5). Furthermore, the structural style of the Gorribon belt, as well as other small belts near the southern margin of the Qimussinguat Complex, suggests tectonic dragging into the Thury Shear Zone.

LITHOGEOCHEMISTRY

The samples collected for this study were analyzed at the Centre de recherche minérale du Québec (CRM) and at the Québec Geoscience Centre (QGC). At the CRM, the minor group of elements constituted of Nb, Rb, Sr, Y and Zr war analyzed by X-ray fluorescence (XRF); Ni, Cu, Zn and V form the plasma-trace group; and rare earths and other trace elements were analyzed by neutron activation (INAA). At

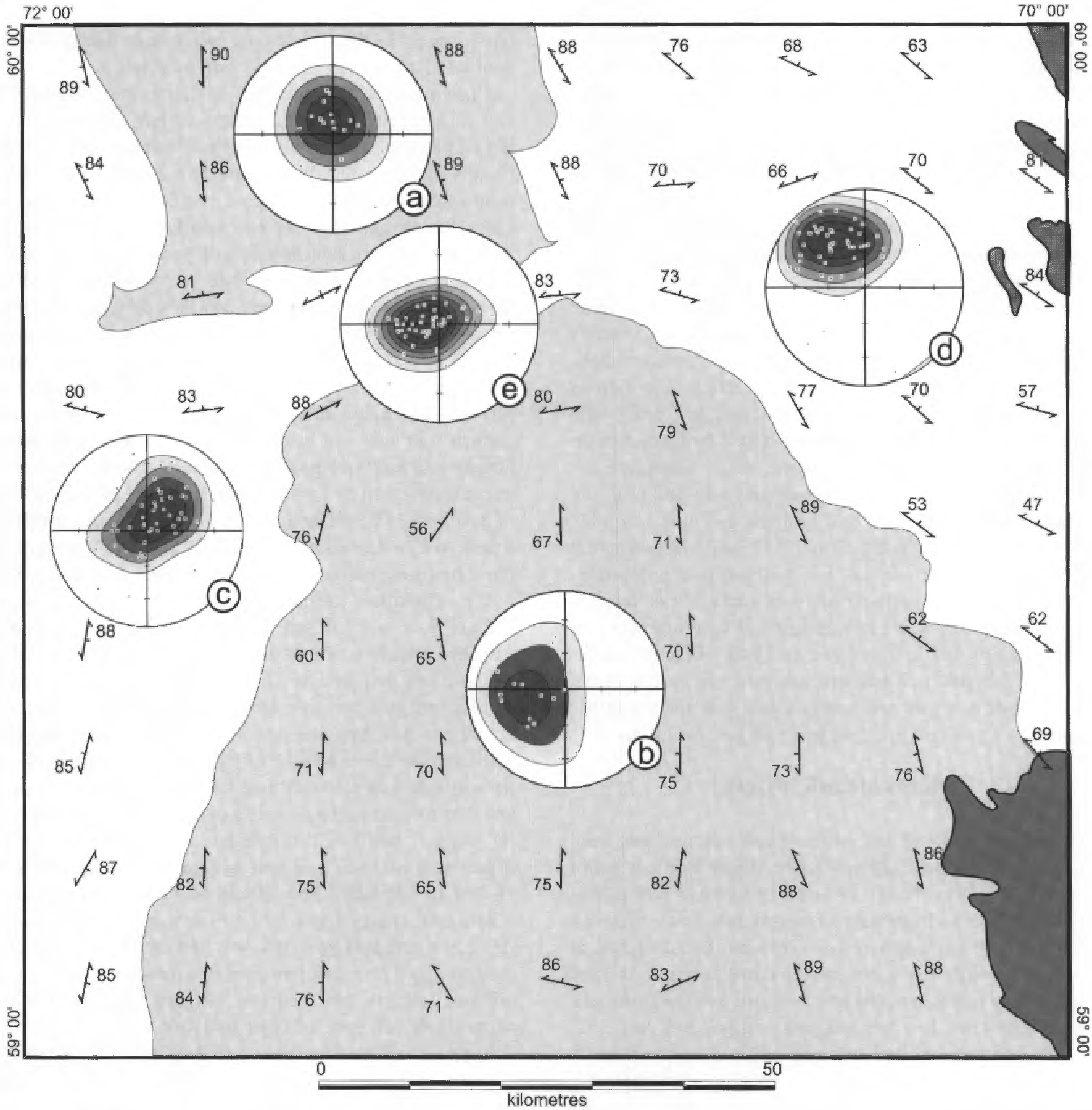

FIGURE 7 - Equal area stereographic projections of tectono-metamorphic lineations. Contours were traced using the method proposed by Robin and Jowett (1986) (N=number of observations) : (a) Qimussinguat Complex, N=17, (b) Troie Complex, N=16, (c) western part of Faribault-Thury Complex, N=56, (d) eastern part of Faribault-Thury Complex, N=52, (e) Thury Shear Zone, N=50. Planar structures shown on the map represent calculated average foliations.

Based on chondrite-normalized multi-element diagrams (Figure 10, a, b and c), the ultramafic rocks were divided into two families, depending on their trace element content relative to chondrites and MORBs : 1) trace element-depleted ultramafic rocks and 2) trace element-enriched ultramafic rocks.

Depleted ultramafic rocks (Figure 10a) show patterns nearly parallel to FTC tholeiitic metalavas, with small positive Th anomalies and negative Nb anomalies. We can assume a genetic relationship between the depleted ultramafics and the tholeiitic metalavas of the FTC, either through crystal fractionation, or through melting of a similar source. Strong Sr and Eu anomalies on different spectra suggest magmatic differentiation related to the coprecipitation of plagioclase and ferromagnesian minerals.

Enriched ultramafic rocks (Figure 10, b and c) have steeper patterns. They have higher Th and light rare earth contents than tholeiitic metalavas in the FTC, TC and QC. They also display strong negative Nb-Ta-Ti anomalies, which suggest either an arc-signature or the crustal contamination of the parent magma. However, the presence of negative Zr and Hf anomalies excludes the possibility of crustal the QGC, chemical analyses were performed by ICP-AES for major elements and conventional trace elements, and by ICP-MS for rare earths and low abundance trace elements. Analytical results for representative samples of felsic, mafic and ultramafic rocks are presented in Table 1 (Appendix). Analytical results from the CRM were integrated in the SIGÉOM database.

Geochemical data analysis is restricted to the geochemical characterization of mafic and felsic suites that form the metamorphic complexes of the Lac Peters area. This characterization allows for better correlation or subdivision of lithological units. It also serves as a basic tool to identify possible guides for mineral exploration in Archean rocks at high metamorphic grade. In this section, similarities and differences between granulite-grade rocks and amphibolite-grade rocks are emphasized. Among mafic suites, field data do not always allow us to determine the extrusive or intrusive origin of certain rocks found in the volcano-sedimentary belts of the Faribault-Thury Complex (FTC), and locally, in the Troie (TC) and Qimussinguat (QC) granulitic complexes. By comparing amphibolite-grade metavolcanics with problematic mafic rocks found in granulitic complexes, we were able to correlate and interpret (with the help of field observations) some of the granulite-grade mafic bands as volcano-sedimentary belts. However, certain types of mafic rocks only outcrop in the granulitic complexes. In this case, an intrusive origin was inferred.

Metavolcanic Rocks

Greenstone belts in the Minto Subprovince were long considered as isolated greenstone remnants lost in a sea of granite (Stevenson, 1968). We are beginning to realize that supracrustal rocks form belts of considerable size; they can reach 40 to 100 km long by 1 to 10 km wide. Our mapping, in conjunction with the geochemical correlations described below, imply that these belts are not limited to linear troughs characterized by low aeromagnetic signatures, but that they also outcrop within granulite-grade plutonic massifs characterized by strong positive aeromagnetic anomalies.

In order to provide an adequate basis for comparison, our first step in the geochemical analysis of metavolcanic rocks was performed on amphibolite-grade lavas of the Faribault-Thury Complex (FTC), where rare pillow relics and associations with paragneiss, metasandstone, iron formation and marble units left no doubts whatsoever as to their volcanic nature (see chapter on *Stratigraphy*). However, other than detailed sections carried out in the Hamelin and Curotte belts within the framework of a metallogenic study (Labbé *et al.*, 1998), the sampling of greenstone belt segments was done with an objective of general geochemical characterization. Nevertheless, much effort was placed on sampling only homogeneous and massive rocks, unaffected by migmatization. Certain samples contained thin felsic veinlets that were presumed to be *in situ* anatectic leucosomes. In these cases, we made sure that the sample contained a representative portion of veinlets.

Classification diagrams by Winchester and Floyd (1977) and Jensen (1976) indicate that the metavolcanic rocks of the Lac Peters area mainly consist of subalkaline tholeiitic basalts and ferrobasalts (Figure 8, a and b). Subordinate proportions of dacitic to andesitic tuff, ultramafic lavas and cumulates are also represented. Subalkaline tholeiitic basalts and ferrobasalts (iron tholeiites) represent metalavas with chemical compositions that form a continuous spectrum from 4.5 to 9% MgO and from 50 to 54% SiO_2, with moderate Cr and Ni contents (respectively <300 and <250 ppm). Cr and Ni values systematically decrease as MgO values decrease, suggesting the fractionation of chromite and olivine. Chemical analyses indicate an iron enrichment pattern that may be attributed to the coprecipitation of plagioclase and ferromagnesian minerals. Sc decreases only in the most evolved lavas, suggesting the late cosaturation of pyroxene. The differentiation of iron tholeiitic basalts is followed by a depletion in total FeO, TiO_2 and V, suggesting the saturation and fractionation of magnetite and ilmenite.

On chondrite-normalized multi-element diagrams (Figure 9, a, b, c, d and e), the most evolved metalavas display negative anomalies in Sr, Eu and Ti. This supports the hypothesis of coprecipitation of plagioclase and ferromagnesian minerals, as well as the fractionation of magnetite and ilmenite in iron tholeiites. These diagrams also indicate the existence of two types of metalavas : (1) tholeiitic metalavas with negative Nb anomalies (type I), and (2) tholeiitic metalavas with positive Nb anomalies (type II). *Type I metalavas* are clearly enriched in Th, La and depleted in Nb and Ta relative to chondrites (Figure 9, a and c) and to MORBs. This suggests either assimilation of continental crust (*Assimilation Fractional Crystallization; AFC*) or a parent magma that was generated in a subduction context. *Type II metalavas* display a more standard profile, without negative Nb anomalies (Figure 9, b and d), which suggests the absence of contamination.

Type I and II metalavas have fairly constant Zr/Y ratios of 2 to 4 (Figure 8e), with values typical of oceanic basalts, which excludes the occurrence of an open-system *AFC* process. Therefore, an arc-related signature is assumed for all the metavolcanic rocks. Furthermore, Ti-Zr-Y (Figure 8c) and Ti vs Zr (Figure 8d) paleotectonic diagrams indicate that most of the metavolcanics fall in the field of arc-related low-potassium tholeiitic basalts or of oceanic floor basalts.

Ultramafic rocks encountered within amphibolitic and granulitic metavolcanic assemblages are geochemically heterogeneous. Ultramafic lavas contain between 15 and 28% MgO, <3200 ppm Cr and <2300 ppm Ni, whereas peridotitic cumulates reach up to 42% MgO, 5840 ppm Cr and 2630 ppm Ni. On a Jensen cation plot (1976), ultramafic rocks of the Lac Peters area fall in the fields for komatiites (intraplate basalts) and komatiitic basalts (PK, BK; Figure 8b).

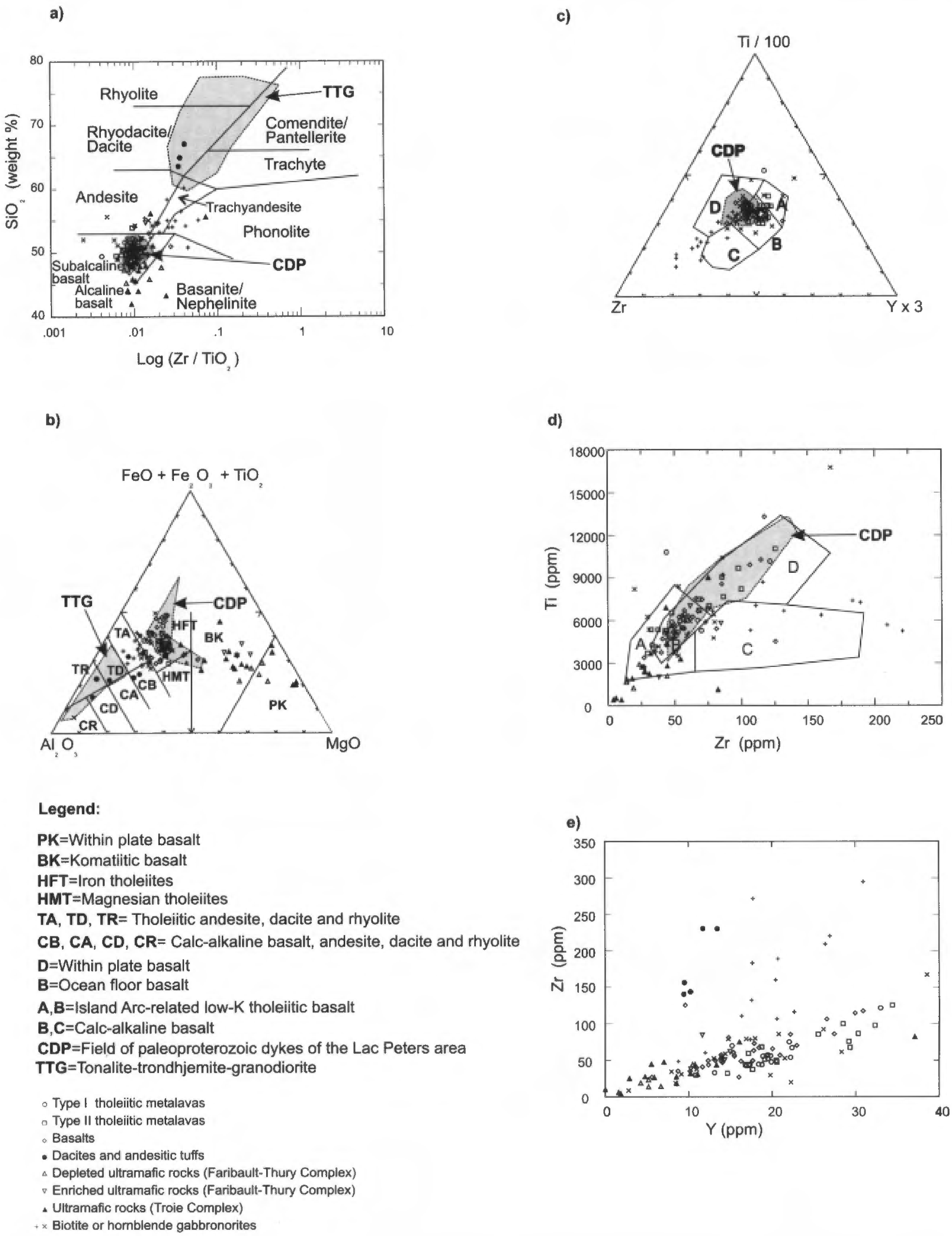

FIGURE 8 - a) SiO_2 vs Zr/TiO_2 classification diagram for volcanic rocks (Winchester and Floyd, 1977); b) Jensen cation plot (1976); c) Ti-Zr-Y paleotectonic diagram (Pearce and Cann, 1973); d) Ti vs Zr paleotectonic diagram (Pearce, 1975); e) Zr vs Y diagram for mafic rocks.

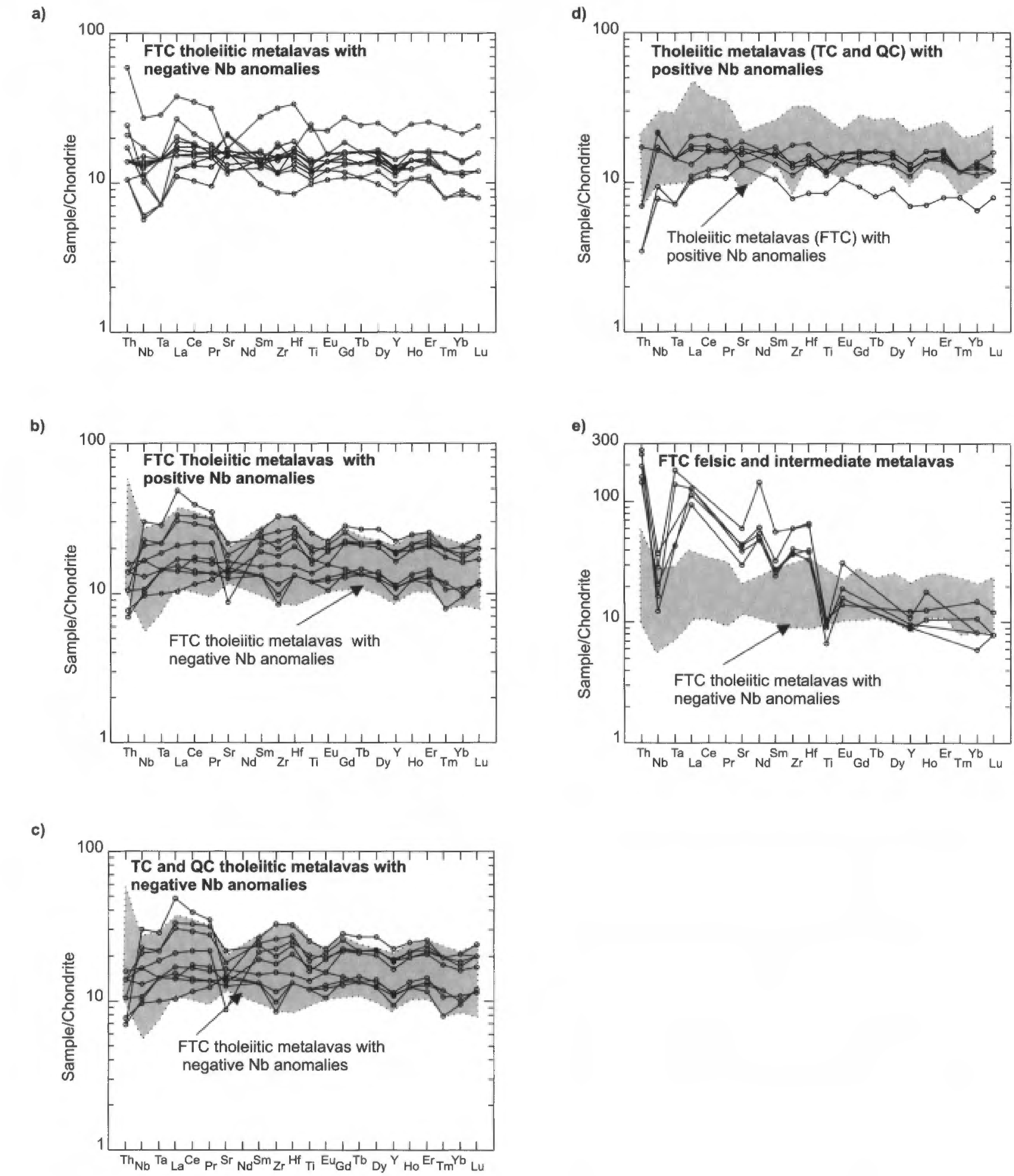

FIGURE 9 - Chondrite-normalized multi-element diagrams (Sun and McDonough, 1989) : a) and b) amphibolitic metavolcanic rocks of the Faribault-Thury Complex (FTC), c) and d) granulitic metavolcanic rocks of the Troie Complex (TC) and the Qimussinguat Complex (QC), e) felsic and intermediate metavolcanic rocks (or tuffs) of the Faribault-Thury Complex.

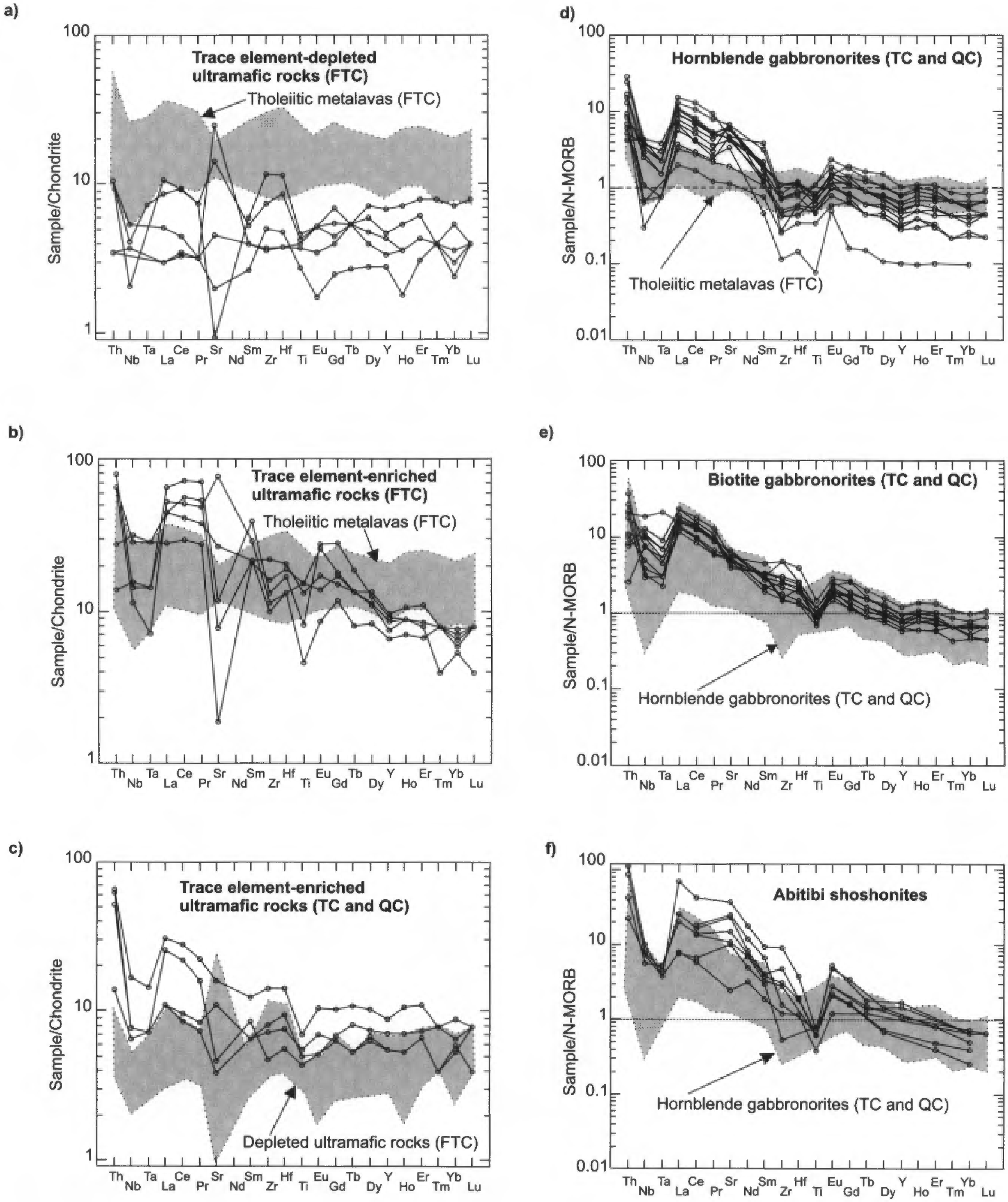

FIGURE 10 - Chondrite-normalized multi-element diagrams (Sun and McDonough, 1989) for depleted (a) and enriched (b and c) metavolcanic and intrusive ultramafic rocks. N-MORB-normalized multi-element diagrams (Sun and McDonough, 1989) for d) hornblende gabbronorites, e) biotite gabbronorites, f) shoshonites of the Abitibi greenstone belt. Shoshonite data is from Stern and Hanson (1992), and Wyman and Kerrich (1993).

contamination. Furthermore, strong negative Nb anomalies are not compatible with a mantle plume environment. We conclude that the geochemistry of both enriched and depleted ultramafic rocks suggests an island arc signature.

Dacites and andesitic tuffs (Figure 8b) have MgO contents between 1 and 5%, SiO_2 contents between 63 and 69%. The TiO_2 and FeO* depletion pattern suggests a calc-alkaline affinity. Chondrite-normalized multi-element diagrams (Figure 9e) are characterized by a strong enrichment in Th and La and pronounced negative Nb and Ti anomalies, which support the calc-alkaline affinity.

Macroscopic textures and structures that allow us to determine the volcanic origin of mafic rocks are rarely preserved at the granulite facies. Nevertheless, the common association with paragneiss and metasedimentary units lead us to believe that a strong proportion of mafic gneiss units (granulitic metavolcanics) found in the Troie and Qimussinguat complexes are indeed metalavas. When the geochemical data is analyzed, it is quite clear that a large number of these mafic gneisses have geochemical signatures comparable to those of tholeiitic metalavas of the Faribault-Thury Complex (Figure 9, a to d). A subordinate proportion of these volcanics is ultramafic in composition (Figure 8b). We conclude that the majority of mafic bands located in the granulitic complexes represent metamorphosed equivalents of supracrustal belts similar to those of the Faribault-Thury Complex.

However, certain ultramafic bodies located in the granulitic complexes (TC and QC) form small stocks (<25 km2) that cross-cut the tonalites. Rare tholeiitic dykes are also observed in the tonalites of the Faribault-Thury Complex (FTC). These basaltic and ultramafic dykes could represent intracrustal magmatic systems that served as feeders to a supracontinental volcanic episode.

Finally, a few gabbronorite intrusions scattered throughout the granulitic complexes have no equivalents in the supracrustal belts of the Faribault-Thury Complex. Two petrographically and geochemically distinct types were identified : hornblende gabbronorites and biotite gabbronorites (Figure 10, d and e). These are sometimes spatially related to tholeiitic metalavas and paragneiss, although many of them are not. We believe these spatial associations are fortuitous, and reflect the fact that ascending mafic magmas used rheological discontinuities.

Hornblende Gabbronorite

Geochemically, hornblende gabbronorites fall in the field of subalkaline basalts and andesites (Figure 8, a and b). Chemical analyses indicate MgO values between 5 and 15%, SiO_2 between 48 and 55%, K_2O between 1 and 2% and low compatible element contents (Cr <100 ppm, Ni <150 ppm). Binary diagrams showing MgO vs P_2O_5, TiO_2, FeO* and V exhibit inflexion points suggesting the precipitation of magnetite, ilmenite and apatite. On N-MORB-normalized multi-element diagrams (Figure 10, d and e), hornblende gabbronorites show a strong enrichment in light rare earths, moderate Th enrichment, and strong negative anomalies in Nb, Ta, Zr, Hf and Ti. Heavy rare earths are slightly depleted relative to N-MORBs and FTC tholeiitic metalavas. These characteristics confirm that the hornblende gabbronorites are distinct from tholeiitic metalavas in supracrustal belts and do not belong to the same evolution series. Their emplacement environment is ambiguous on paleotectonic diagrams (Figure 8, c and d). However, strong negative Nb anomalies suggest an island arc environment.

Biotite Gabbronorite

Biotite gabbronorites fall within the field of weakly alkaline and potassic trachyandesites or phonolites (Figure 8, a and b), with MgO values between 8.5 and 11%, SiO_2 between 51 and 60%, K_2O between 1.5 and 2.5% (maximum 4%). Binary diagrams of major oxides vs MgO do not show major differences between hornblende gabbronorites and biotite gabbronorites. On N-MORB-normalized multi-element diagrams (Figure 10e), biotite gabbronorites display a slightly more pronounced enrichment in Th, Zr and Hf relative to hornblende gabbronorites, and weak negative Nb and Ta anomalies. Paleotectonic diagrams (Figure 8, c and d) suggest an island arc environment for the emplacement of mafic parent magmas. The geochemical signature of hornblende gabbronorites and biotite gabbronorites is very similar to that of late-tectonic shoshonites in the Abitibi area (Figure 10f).

Tonalite - Trondhjemite - Granodiorite - Granite

Felsic intrusions in the Lac Peters area form a typical Archean TTG suite (tonalite-trondhjemite-granodiorite; Figure 8, a and b), dominated by tonalite and trondhjemite, with subordinate proportions of granodiorite and granite. Generally, enclaves (restite) are tonalitic, whereas the mobilizate is trondhjemitic, although the reverse situation was also observed in certain areas.

Tonalites and trondhjemites form a continuous suite, as shown on the normative classification diagram by O'Connor (1965) (Figure 12c), whereas granodiorites and granites, clearly richer in potassium, seem to form a distinct suite. Paleotectonic diagrams suggest that they are immature island arc granitoids (Figure 12d; Pearce *et al.*, 1984), as suggested by Stern et al. (1994). Compared to trondhjemites, tonalites are more primitive, with $SiO_2 < 70\%$, FeO* > 2.5%, TiO_2 > 0.3%, MgO > 1.5%, P_2O_5 >0.1%, Y >5 ppm and Yb >0.6 ppm. Very incompatible element contents are similar in both rock types. The granites are more evolved, and thus contain less FeO*, MgO, CaO and TiO_2. The geochemistry of the tonalite-trondhjemite-

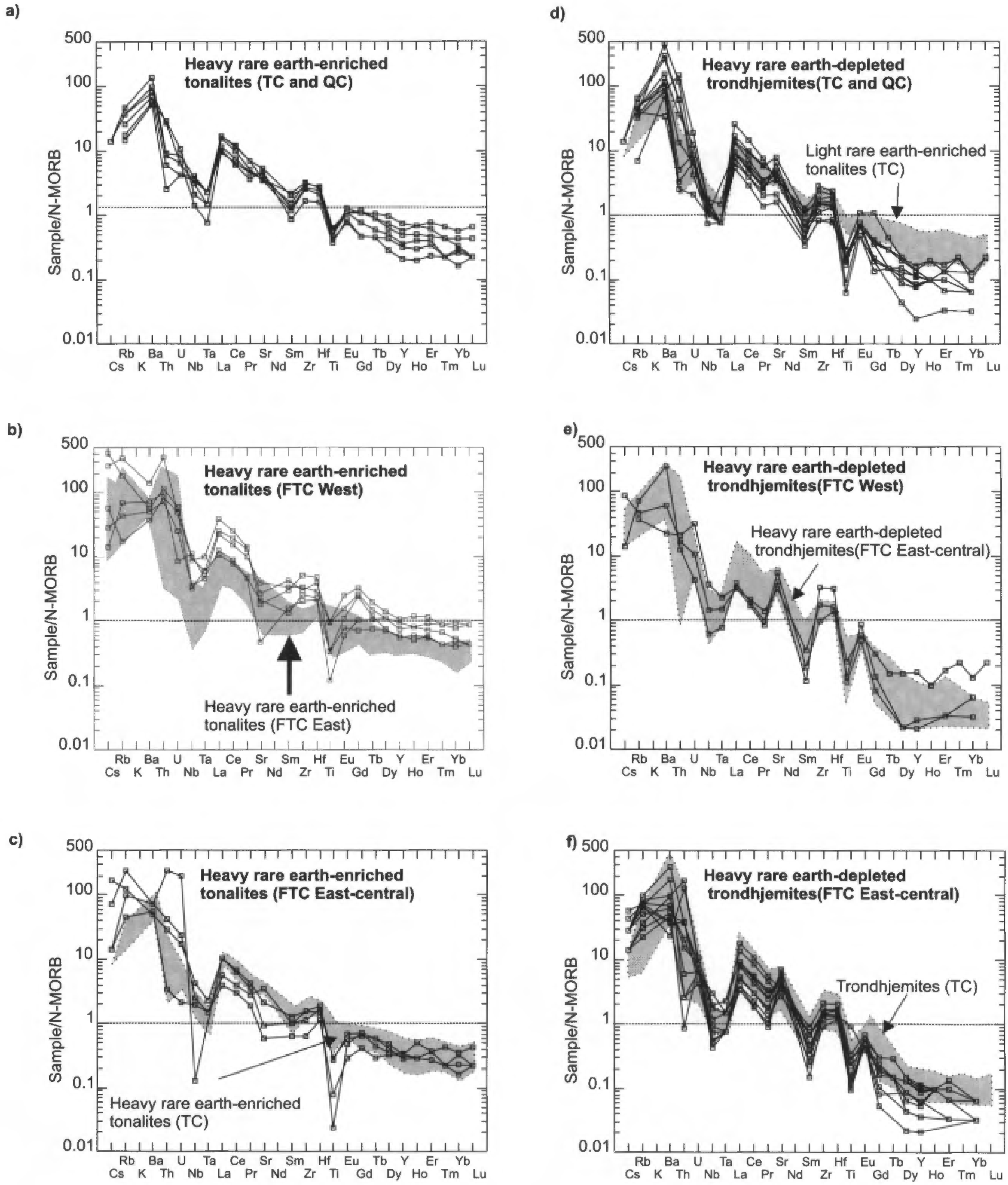

FIGURE 11 - N-MORB-normalized diagrams (Sun and McDonough, 1989) for heavy rare earth-enriched tonalites of the Troie Complex (TC) and Faribault-Thury Complex (FTC) (a, b and c), and for heavy rare earth-depleted trondhjemites of the TC and the FTC (d, e and f).

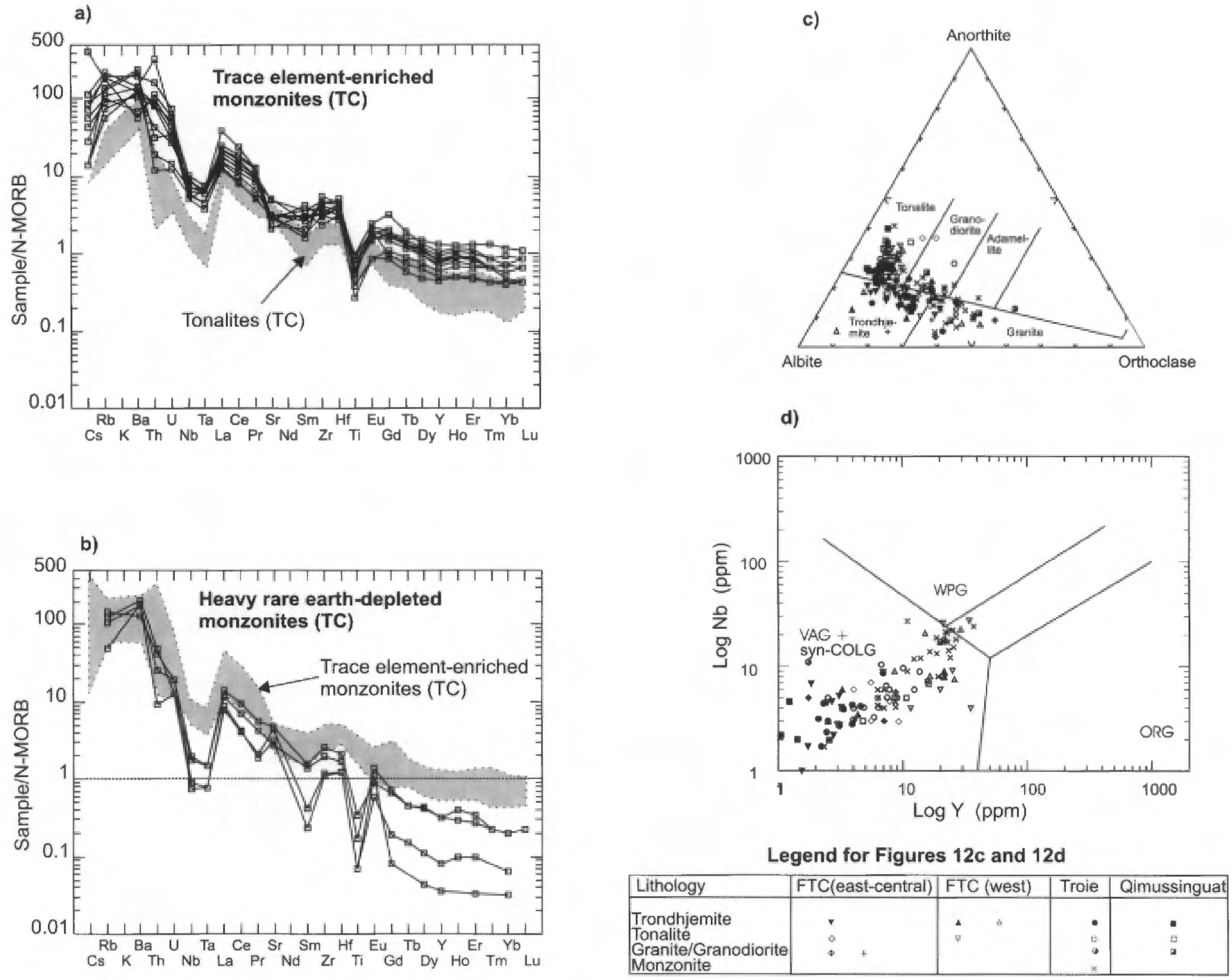

FIGURE 12 - N-MORB-normalized diagrams (Sun and McDonough, 1989) for monzonites of the Troie Complex, a) enriched in trace elements, b) depleted in heavy rare earth elements; c) normative anorthite-albite-orthoclase diagram (O'Connor, 1965) for felsic rocks; (d) paleotectonic diagram for felsic rocks (Pearce *et al.*,1984).

granodiotite-granite suite resembles that of island arc plutons or cordillera-type plutons.

On N-MORB-normalized multi-element diagrams, all tonalites and trondhjemites in the Troie and Qimussinguat granulitic complexes show well-fractionated trace element patterns, with Rb and Ba maxima, strong negative Nb, Ta and Ti anomalies as well as weak positive Zr and Hf anomalies (Figure 11, a and d). Trondhjemites are typically more depleted in heavy rare earths and Y relative to the tonalites (Figure 11, d, e, f and 12d), with distinctive positive Sr and Eu anomalies. Tonalites and trondhjemites of the Troie and Qimussinguat complexes are geochemically similar, which suggests that the two complexes probably represent tectonically separated equivalents.

When the tonalites and trondhjemites of the Faribault-Thury amphibolitic Complex (FTC) are compared to those of the Troie (TC) and Qimussinguat (QC) granulitic complexes, subtle differences may be noted. Tonalites and trondhjemites from the central and eastern portion of the Faribault-Thury Complex (FTC east-central; Figure 11, c and f), trondhjemites of the western sector (FTC west; Figure 11e) and a sub-set of tonalites in the western sector (Figure 11b) are almost identical to their granulitic equivalents. The main difference consists in the fact that granulite-facies rocks are slightly depleted in Cs+Rb+Th+U+Ta. These differences may reflect the loss of volatile elements present in amphiboles during the transition from the amphibolite facies to the granulite facies. The loss of Ta would be the result of the replacement of sphene by Ti oxides. This implies that there was no marked difference at the onset between the TTG suite of the amphibolitic complex and that of the granulitic complexes. The same may be said for the supracrustal belts.

Tonalites and trondhjemites located in the western sector of the Faribault-Thury Complex (FTC) may be divided into three types : 1) heavy rare earth-depleted trondhjemites (Figure 11e), 2) heavy rare earth-enriched tonalites (Figure 11b), and 3) tonalites and trondhjemites clearly enriched in lithophile elements and with negative Ti and Sr anomalies. Heavy rare earth-enriched tonalites, located in the western part of the FTC, are very similar to tonalites and trondhjemites located in the east-central part of the FTC.

Granites are rare in both granulitic complexes (TC and QC). They are distinguished from the tonalites by higher Cs, Rb, K, Ba, Th and U contents, slightly less enriched light rare earth element contents, flatter heavy rare earth patterns and stronger negative anomalies in Nb, Ta, Sr, Zr, Ti and Eu.

Monzonite

Monzonites form a slightly different evolution series than the TTG suite described above. They contain more K2O and P2O5, and are classified as granodiorites and granites in the diagram by O'Connor (1965) (Figure 12c).They fall either in the island arc granitoid domain or halfway between intraplate granitoids and island arc granitoids in the diagram by Pearce et al. (1984) (Figure 12d). This suite is late to post-tectonic. Samples from this suite form a tight cluster on normalized diagrams. The geochemistry of monzonites closely resembles that of enriched tonalites in the western part of the Faribault-Thury Complex (Figure 11b). However, subtle differences exist between heavy rare earth-enriched monzonites (Figure 12a) and certain depleted monzonitic facies (Figure 12b).

Early Proterozoic Mafic Dykes

These mafic dykes are subalkaline to alkaline ferrobasaltic or more evolved in composition (PD; Figure 8, a and b). Using paleotectonic discrimination diagrams (PD; Figure 8, c and d), it is possible to assume that these rocks may have formed in an anorogenic environment. They show enriched multi-element patterns, generally without negative Nb and Ta anomalies, but with pronounced negative anomalies in Sr and Eu, implying plagioclase fractionation.

GEOCHRONOLOGY

A geochronological study was undertaken in the GÉOTOP laboratories of the Université du Québec à Montréal for the Ministère des Ressources naturelles du Québec. Nine samples (A to I, Figure 2), from the Faribault-Thury (FTC), Troie (TC) and Qimussinguat (QC) complexes were analyzed. Preliminary results of U-Pb isotopic analyses (isotopic dilution and thermal ionization mass spectrometry : "TIMS") and Pb isotope analyses (*in situ* analyses by laser ablation and plasma ionization mass spectrometry : "LA-ICP-MS") make it possible to establish the ages of emplacement, inheritance and metamorphism. U-Pb analytical results are presented with a confidence interval of 2? whereas Pb-Pb analytical results are presented with an interval of 1?. In the latter case, the precision (not mentioned in the text) is evaluated at *ca.* ±1%. U-Pb analytical work is under way, and will eventually allow us to define more accurate ages of emplacement.

Faribault-Thury Complex (FTC)

Two tonalites and one quartz and feldspar porphyry were sampled in the Faribault-Thury Complex. A first sample of foliated tonalite from unit *Afth4* was taken in the western part of the complex (site A, Figure 2; UTM coordinates NAD83, Z19: 334298E, 6596838N). Zircons in this sample form a relatively homogeneous population of clear and uncoloured stubby prismatic crystals or ovoid crystals with hexagonal sections. Statistical analysis of Pb-Pb analytical results yields a first order mode at 2.90 Ga and a second order mode at 2.85 Ga. Preliminary U-Pb results yielded minimum ages between 2880 and 2891 Ma. Ongoing studies will allow us to establish if 2.85 Ga corresponds to the age of emplacement or to a remobilization event that affected the zircons after the crystallization of the granitic unit.

A second sample of gneissic tonalite was also taken in unit *Afth4* (site B, Figure 2; UTM coordinates, NAD83, Z19: 434038E, 6647775N) in the northeastern part of the Faribault-Thury Complex. Two zircon morphologies were observed: light brown acicular crystals with square sections and light brown to uncoloured xenomorphic crystals. Despite the relatively simple appearance of zircon grains, Pb-Pb analytical results revealed a variety of older ages related to the presence of inclusions in the zircons. Four modes were identified. The main mode is at *ca.* 2.61 Ga, the second at *ca.* 2.69 Ga, and the other two of lesser importance, at *ca.* 2.76 Ga and *ca.* 2.81 Ga. A quartz and feldspar porphyry (site C, Figure 2; UTM coordinates, NAD83, Z19: 367246E, 6620976N) was sampled in the Curotte volcano-sedimentary belt (unit *Afth3*). The porphyry appears conformable to tuff beds and is interpreted as synvolcanic. Collected zircons form a single homogeneous population. These uncoloured to brownish zircons occur as elongate prisms. This simple morphology is characteristic of effusive rocks. Pb-Pb analyses performed on individual grains revealed similar ages (*ca.* 2.78 Ga), interpreted as the age of emplacement.

Troie Complex (TC)

Four samples were collected in the Troie Complex: a granulitic gneiss (*Atie4*), a gabbronorite (*Atie3*), a calcitic marble (*Atie2*) and a porphyritic monzonite (*Atie9*). The granulitic gneiss of enderbitic composition from unit *Atie4* (site D, Figure 2; UTM coordinates, NAD83, Z19

: 374675E, 6565340N) was taken in a seemingly homogeneous area. Recovered zircons are characterized by a single morphological population composed of dark brown euhedral equant crystals. Some of these zircons exhibit evidence of magmatic zonation. Pb-Pb analyses reveal only one first order mode indicating an age of *ca.* 2.74 Ga. It is however possible to detect a second, less important mode (2.80 - 2.83 Ga) which suggests the presence of older inclusions. Preliminary U-Pb analyses yielded discordant results with ages varying between 2683 and 2721 Ma. Regression calculations yielded an age of 2740 +11/-8 Ma, most likely the age of emplacement of the intrusion. U-Pb analyses were also performed on three monazites. These yielded an age of 2707 ± 3 Ma, interpreted as a metamorphic age.

A sample of coarse-grained homogeneous gabbronorite from unit *Atie3* (site E, Figure 2; UTM coordinates, NAD83, Z19 : 411440E, 6579927N) was taken in a small volcano-sedimentary belt segment in the east-central part of the complex. All zircon grains in this sample consist of large fragments (>120 µm), which made it impossible to characterize morphological populations. On the other hand, the fragments systematically originate from pinkish brown to dark brown crystals with well-developed crystal faces. Pb-Pb analyses yielded ages with a restricted variability (2.73-2.78 Ga) which are distributed around a single mode at ca. 2.75 Ga. Considering the uncertainty inherent to the analytical procedure (analytical mass bias), the age is evaluated at 2.73 Ga with a precision of 0.05 %, and is interpreted as the age of emplacement.

In order to define the maximum age of sedimentation in the Peters West volcano-sedimentary belt, a calcitic marble from unit *Atie2* (site F, Figure 2; UTM coordinates, NAD83, Z19 : 379247E, 6615309N) was sampled. The presence of olivine, diopside and quartz indicate that the marble originally contained siliciclastic material from which detrital zircons were recovered. The majority of dark brown zircons are well rounded and yield Pb-Pb ages between 2.70 Ga and 2.75 Ga. Statistical analysis of our results, corrected for the analytical mass bias, produced a single mode at *ca.* 2.73 Ga. A second type of zircon was also analyzed. These zircons consist of dark brown elongate prisms and sometimes show light brown cores or overgrowths. Five modes were defined by statistical analysis. This either indicates that the zircons recorded several crystallization events or that they are formed of older cores from different sources. The main mode corresponds to the youngest age (*ca.* 2.70-2.71 Ga), probably recorded from overgrowths. Four other secondary modes yield ages of *ca.* 2.79 Ga, 2.84 Ga, 2.89-2.91 Ga and 2.96 Ga.

The porphyritic monzonite from unit *Atie9* (site G, Figure 2; UTM coordinates, NAD83, Z19 : 426769E, 6560157N) was taken in the southeast part of the complex. Recovered zircons form golden brown elongate prisms with asymmetrical ends. The homogeneity of zircons is reflected in the Pb-Pb analytical results, which are confined between 2.68 Ga and 2.72 Ga. The average is 2.69 Ga with a relative standard deviation of 0.05 %. This age represents our best estimate for the emplacement of the monzonite. Four out of 20 analyzed grains suggest the presence of older inclusions whose ages vary between *ca.* 2.72 Ga and 2.73 Ga.

Qimussinguat Complex (QC)

A migmatitic biotite tonalite (site H, Figure 2; UTM coordinates, NAD83, Z19 : 377500E, 6628437N) was sampled in unit *Aqim5*. This tonalite is typically gneissic, and is cut by granodioritic to tonalitic mobilizate. In order to determine both the age of the protolith and the age of remobilization, the restite and the mobilizate were sampled separately. Recovered zircons in both samples are very heterogeneous and difficult to group into specific populations. Pb-Pb analyses on about 30 zircons yield ages between 2.66 Ga and 3.01 Ga. Two modes distinctly stand out from statistical analysis of the results. The main mode is at *ca.* 2.75-2.76 Ga and the second at *ca.* 2.71 Ga. Three other modes are observed at *ca.* 2.84-2.87 Ga, *ca.* 2.92 Ga and *ca.* 3.02 Ga. The dates recorded in these rocks reveal a complex history, and the interpretation of these results could only be speculative at this point.

A granulitic gneiss from unit *Aqim4* (site I, Figure 2; UTM coordinates, NAD83, Z19 : 381005E, 6645671N) was sampled in order to compare it to granulitic gneisses (*Atie4*) from the Troie Complex. Recovered zircons are comparable to those extracted from the granulitic gneiss in the Troie Complex (site D). Pb-Pb analytical results are divided into two distinct modes. The first mode corresponds to an age of 2.73 Ga whereas the second poorly defined mode suggests ages *ca.* 2.80-2.81 Ga. Three U-Pb analyses yielded slightly discordant (<0.8%) results and ages between 2729 Ma and 2733 Ma. Regression calculations yielded an age of 2734 ± 27 Ma. Despite the lack of precision, this age corroborates Pb-Pb analytical results and represents a preliminary estimate for the age of emplacement of these rocks.

LAKE SEDIMENT GEOCHEMISTRY

The ministère des Ressources naturelles initiated the Far North program by conducting, in collaboration with *Cambior*, *Falconbridge*, *Noranda*, *SOQUEM* and *Virginia Gold Mines*, an important geochemical survey now available to the public (MRN, 1998). This survey comprises more than 26,000 samples of lake bottom sediments, collected at a spacing of 1 sample per 13 km2. Samples were analyzed at the *Centre de Recherche Minérale*. Results from this survey are available in digital format in SIGÉOM under the project heading 1997-520.

Background and Geochemical Domains Defined by Lake Sediment Geochemistry

The geochemical background for a given element is considered to be the geometric average for a given region whose surface area exceeds 100 km2. "Geochemical domains", as proposed by Kauranne et al. (1992), are defined within these surface areas. They correspond to specific geochemical environments.

For example, high nickel values are concentrated in the area underlain by the Troie Complex (TC), whereas high uranium values are mostly found in the area underlain by the Faribault-Thury Complex (FTC). High cerium values are observed in a portion of the Faribault-Thury Complex and in a portion of the Troie Complex. Thus, the distribution in the content of various elements, influenced by the composition of the underlying bedrock, makes it possible to identify spatially related sample populations that define geochemical domains.

Geochemical domains are represented in Figure 13. A good correlation exists between the Faribault Domain, where uranium values are high, and the western part of the Faribault-Thury Complex (Figures 13 and 14). This correlation seems to disappear towards the east. It is possible that allanite (uraniferous epidote), identified in several locations within tonalites in the western part of the Faribault-Thury Complex, is the source of high uranium values.

The area underlain by the Troie Complex contains five geochemical domains (Figures 13 and 14). In the north, the Peters West Domain is characterized by high U, Eu and Cu values and coincides with a volcano-sedimentary belt. Further south, the South Troie Domain is characterized by high Zr values as well as siderophile elements such as Cr and Ni. The Southeast Troie Domain displays a strong lithophile element signal (P, Eu, Ce, etc.) whereas the Southwest Troie Domain exhibits the strongest signal for Ni, Cr, siderophile elements (Fe, Ti, V), lithophile elements (Li, Ba) and rare earth elements (Ce, Th). The North Troie and Qimussinguat domains have no particular geochemical signature. The appearance of siderophile elements north of the Qimussinguat Domain defines the Arnaud Domain. However, the restricted extent of this domain hinders the production of meaningful statistical results. All other geochemical domains (Rivier, Tasiaalujjuaq, Hamelin, Gorribon and Thury) correspond to the various volcano-sedimentary belts. They are characterized by the presence of U, Eu and Cu.

Anomalous Threshold Values in Lake Sediments

Measured element contents in lake sediments vary considerably (by a factor of 25 in some cases) from one geochemical domain to the other. An average value (A) and an anomalous threshold value (T) were calculated for each geochemical domain as well as for the background zone (Table 2). The anomalous threshold value (T) for an element is obtained by adding the value of two standard deviations to the average value (A) for each geochemical domain (Table 2). Important differences exist between the anomalous threshold values of each geochemical domain. For example, the anomalous threshold values for uranium in the Tasiaalujjuaq and Qimussinguat domains are respectively 120 ppm and 5 ppm.

Exploration Targets

TARGETS FOR DIAMOND EXPLORATION

The small size (a few hundred metres in diameter) of kimberlitic intrusions and potentially diamondiferous rocks makes them particularly difficult to locate. Therefore, indirect methods are often used for diamond exploration. Glacial dispersion mechanisms are useful in that they widen exploration targets from a geological body of a few hundred metres in diameter to a dispersion area of several square kilometres.

Diamond exploration most frequently uses the presence of heavy mineral indicators (density >3.3 g/cm3) in till samples. The most commonly used heavy mineral indicators are pyrope, picro-ilmenite, chromian diopside, chromian phlogopite and zircon. Other methods such as biogeochemistry (ex. Dunn, 1993) or stream sediment geochemistry (ex. Gregory and Tooms, 1969) can also be useful.

Studies by Shao and Liu (1989) have demonstrated, using a kimberlite located near Fu Xian in China as an example, that the mobility of indicator elements in stream sediments may be observed up to 1.6 km downstream from the source. The main indicator elements used in this study were Cr, Ba, La, Nb, Ni, Zn, Co and Pb. The Guigues kimberlite, in the Témiscamingue area of Québec, is a notherexample where stream sediments contain anomalous levels of lithophile and rare earth elements (Al, Na, K, Ba, P, Ce, La, Y), siderophile elements (Fe, Ni, Cr, Mg) and uranium (U). Geochemical analysis of unconsolidated deposits thus seems to be a useful tool for the exploration of kimberlite and related rocks. Six sample sites for lake bottom sediments, located in the Lac Peters area (NTS 24M), show a geochemical signature comparable to those produced in stream sediments of Fu Xian and Guigues kimberlites. The location of these sites (UTM-NAD83 coordinates) as well as their Cr, Ni, Ba, K, Ce and Y contents are presented in Table 3.

TARGETS FOR GOLD EXPLORATION

In addition to numerous isolated sites with high Au values, a grouping of three successive sample sites in the northern part of the Rivier volcano-sedimentary belt (Figures 2 and 14) yielded anomalous gold values of

7, 10 and 15 ppb. Since the glacial dispersion pattern is known to be towards the NE, this succession leads to a magnetic high that coincides with the northern margin of the Rivier belt.

TARGETS FOR CU-MO PORPHYRY-TYPE EPIGENETIC MINERALIZATION

Samples collected in an area just north of the Thury volcano-sedimentary belt (Figures 2 and 14) yielded high Cu, Ce, Eu and Th values (Thury Domain, Figure 13). Elevated U and Mo values are observed in the periphery of this zone. This association of elements could correspond to the geochemical signature of a Cu-Mo *porphyry*-type epigenetic mineralization, or to Cu-U-Au-Ag-REE *Olympic Dam*-type mineralization. The anomalous zone is centred on a magnetic high.

TARGETS FOR CU-U-AU-AG-REE OLYMPIC DAM-TYPE MINERALIZATION

The sector located to the southeast of Lac Tasiaalujjuaq (Tasiaalujjuaq Domain, Figures 13 and 14) displays high Cu and Ni values compatible with a *magmatic*-type mineralization. However, further east, two anomalous sites yielded values of 175 and 212 ppm Cu along with high U and Ce values. This association of elements could correspond to a Cu-U-Au-Ag-REE *Olympic Dam*-type mineralization.

ECONOMIC GEOLOGY

The discovery of gold deposits in Archean iron formation units and in small, highly metamorphosed greenstone belts (e.g. Big Bell, Australia) has led us to re-evaluate the geology and metallogeny of the Minto Subprovince. Before the 1998 mapping program, no volcano-sedimentary belt and no lithogeochemical anomaly or mineralized showing had been discovered in the Archean rocks of the Lac Peters area (NTS sheet 24M). Surveys undertaken by the MRN led to the identification of several tectonically dismembered, amphibolite to granulite-grade volcano-sedimentary belts that include iron formation units. A total of 350 assays on samples collected in gossans or sulphide mineralization in various geological environments revealed the presence of three showings mineralized in Au, Ag, Cu, Zn and Pb, in addition to 15 lithogeochemical anomalies that are significant in terms of mineral exploration (Figure 2). Table 4 lists the emplacement and the grades of discovered showings. Table 5 lists lithogeochemical anomalous threshold values used in this study compared to those generally used in the Abitibi Subprovince (Descarreaux, 1973). Discovered showings and lithogeochemical anomalies sometimes coincide with lake sediment geochemical anomalies. However, none of the showings or anomalies has been the focus of a detailed study.

Mineralized showings and economically significant anomalies are related to three main geological environments: a) metavolcanic rocks or paragneiss sequences associated with metavolcanic rocks, b) Archean-age sulphide-facies iron formation units, and c) syntectonic or synvolcanic mafic-ultramafic intrusions.

Mineralization associated with Volcanic Rocks and Paragneiss

PANACHE SHOWING (AU-AG-ZN)

The Panache showing (Figure 2, Table 4) returned the following grades : Au=1.3 g/t, Ag=7.2 g/t, As=0.74 %, Zn=3.08 %, Pb=0.77%. The mineralized zone (>5% sulphides) forms a gossan in a paragneiss sequence of the Curotte volcano-sedimentary belt.

AIRO SHOWING (AG-ZN)

The Airo showing (Figure 2, Table 4) consists of several m-scale mineralized horizons that reach up to 1 km in length. Up to 30% disseminated to semi-massive sulphides (essentially pyrite) form discontinuous cm-scale bands. A randomly collected sample returned grades of 10 g/t Ag and 0.04% Zn. The mineralized zone is hosted in a locally silicified (> 90% quartz) paragneiss sequence, which forms part of the Tasiaalujjuaq volcano-sedimentary belt.

CU-AU-AG-ZN LITHOGEOCHEMICAL ANOMALIES

Cu-Au-Ag-Zn lithogeochemical anomalies are found in the Faribault-Thury and Troie complexes (sites 3and 8, Figure 2 and Table 6). They are related to mafic gneiss (metavolcanic rocks), or occur at the contact between paragneiss and ultramafic cumulates. The mineralization consists of disseminated to semi-massive chalcopyrite, pyrrhotite and pyrite.

CU OR CU-ZN LITHOGEOCHEMICAL ANOMALIES

Cu or Cu-Zn lithogeochemical anomalies represent by far the most frequently observed mineralization in the Lac Peters area (sites 4, 5, 9, 10, 11, 12, 13, 14, 15; Figure 2 and Table 6). Analytical results of surface samples often yield grades on the order of 0.3 % Cu and 0.2 % Zn. Encountered sulphides include chalcopyrite, bornite, pyrrhotite and pyrite. The mineralization often forms gossans, occasionally rich in garnet, and contain 1 to 20% sulphides either within metavolcanic rocks (essentially mafic gneiss), or wedged between a paragneiss unit and a metavolcanic unit. This type of mineralization has also been observed within paragneiss or amphibolites (possibly volcanic in origin).

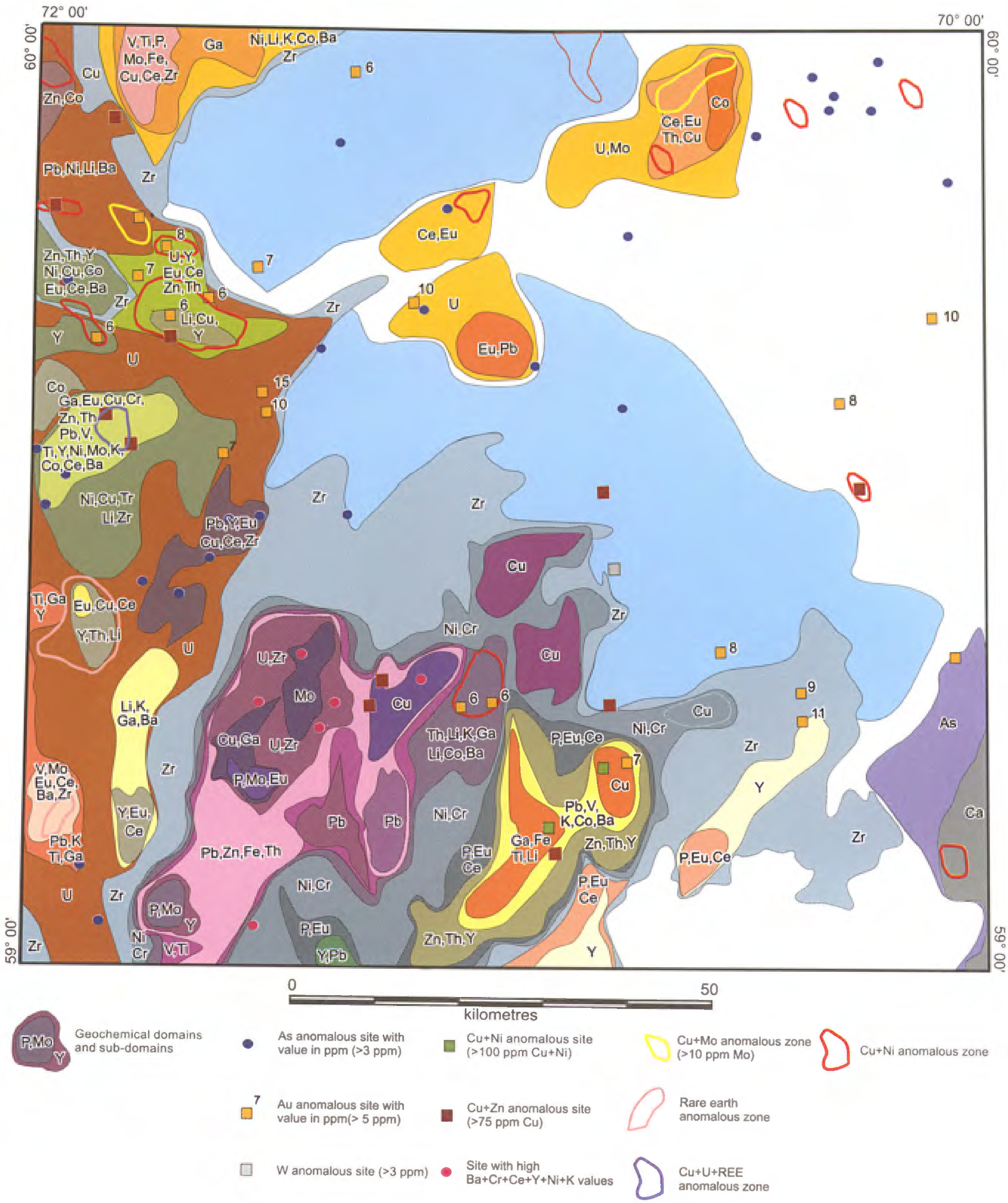

FIGURE 13 - Detailed map of lake sediment geochemistry (MRN, 1998) showing domains, sub-domains, anomalous zones and sites, Lac Peters area (NTS 24M).

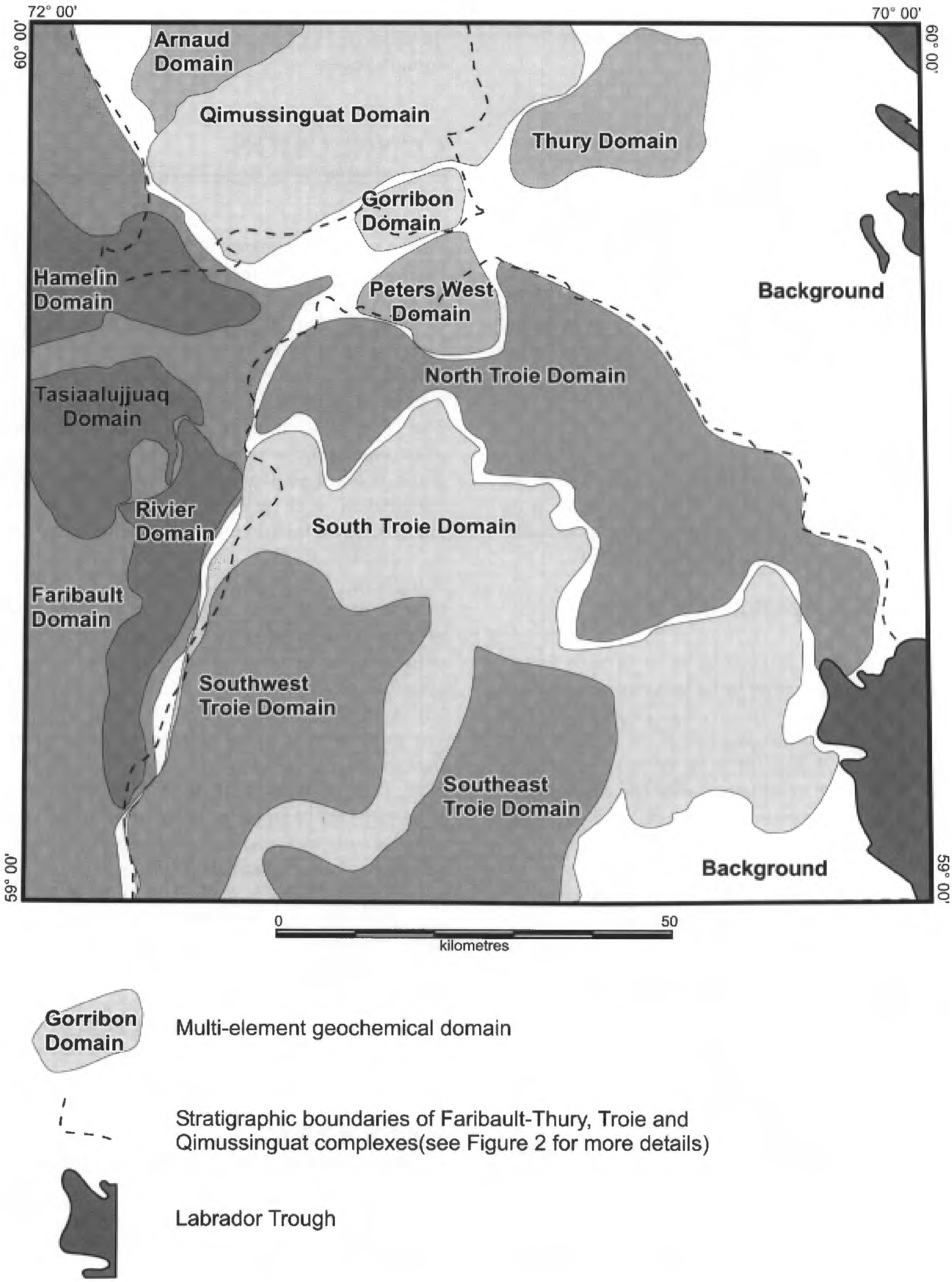

FIGURE 14 - Map of multi-element geochemical domains defined using lake sediment analytical results (MRN, 1998), Lac Peters area (NTS 24M).

Mineralization associated with Iron Formation

Au-Cu and Cu-Ag mineralization was observed in oxide-facies or silicate-facies iron formation units, whose dimensions may reach 50 m thick by 1 km long. Detailed sections in the Peters West and Hamelin belts indicate that these iron formations are often associated with carbonate layers, paragneiss sequences and metavolcanic rocks. The entire assemblage underwent at least two major phases of folding; the most important has a N-S-oriented axial plane. This assemblage suggests a shallow submarine environment, favourable for the formation of gold mineralization in Archean terrains.

TUK-TUK SHOWING (CU-AG)

The Tuk-Tuk showing (Figure 2 and Table 4), located in the southwest part of Lac Peters, contains Cu-Ag mineralization (0.63% Cu, 2 g/t Ag) hosted in a sulphide-facies iron formation associated with mafic gneiss.

AU-CU LITHOGEOCHEMICAL ANOMALIES

The Hamelin volcano-sedimentary belt is strongly folded. A sample taken from a sulphide-facies iron formation yielded grades of 0.13 g/t Au and 0.013 g/t Ag. This m-scale iron formation is associated with paragneiss and metavolcanic rocks (site 7; Figure 2 and Table 6). Observed sulphides essentially consist of disseminated pyrrhotite, chalcopyrite and pyrite. A similar environment was also observed in the Thury and Peters West belts.

Mineralization associated with Mafic-Ultramafic Intrusions

NI-CU LITHOGEOCHEMICAL ANOMALIES

Mafic magmatic Ni-Cu mineralization was observed in ultramafic volcanic rocks (ultramafic lavas and associated cumulates), ultramafic intrusions (synvolcanic or syntectonic) and late mafic intrusions (norite, gabbro, gabbronorite) (sites 1 and 2; Figure 2 and Table 6). Although anomalous thresholds are very low for this type of mineralization, the geological context remains favourable for exploration. Geochemical and petrographic analyses reveal the presence of komatiitic lavas and ultramafic intrusions sometimes in association with paragneiss. The extent of these intrusions and the typology of the mineralization, which could include platinum group elements, is still unknown.

CU-ZN LITHOGEOCHEMICAL ANOMALIES

Gabbro and gabbronorite intrusions (sites 6 and 9; Figure 2 and Table 6) exhibit Cu-Zn mineralization, either disseminated in the mafic intrusion or at the contact with country rocks.

CONCLUSION

The geological mapping survey conducted in the Lac Peters area (NTS 24M) during the 1998 field season allowed us to define three lithodemic units : the Faribault-Thury Complex, the Troie Complex and the Qimussinguat Complex. The Faribault-Thury Complex designates a lithological assemblage essentially composed of gneissic or foliated tonalites and amphibolite-grade volcano-sedimentary belts. The Troie and Qimussinguat complexes essentially consist of two pyroxene-bearing gneissic tonalites and granulite-grade volcano-sedimentary belt segments. Rocks in the Lac Peters area generally exhibit a well-developed gneissocity or foliation. These planar fabrics are affected by complex folding events expressed as a series of non-planar folds (folds with curved axial planes). Intense ductile shear zones, located along the margins of the Troie and Qimussinguat complexes, locally obliterate previouslydescribed structures. They juxtapose granulite-grade rocks (Troie and Qimussinguat complexes) with amphibolite-grade rocks (Faribault-Thury Complex). The northern part of the map area is affected by a major ductile shear zone (Thury Shear Zone) where all planar fabrics are reoriented ENE-WSW with a steep NW dip.

During the mapping campaign, three mineralized showings and 15 economically significant lithogeochemical anomalies were identified (Tables 4 and 6). These sites occur in distinct geological environments: volcano-sedimentary belts, sulphide-facies iron formations and synvolcanic or syntectonic mafic and ultramafic rocks. The lake sediment survey led to the identification of exploration targets for diamond, gold, *porphyry*-type Cu-Mo and *Olympic Dam*-type Cu-U-Au-Ag-REE mineralization.

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APPENDIX : TABLES 1 TO 6

Table 1 - Chemical analyses of representative samples of major lithological units in the Lac Peters area.

	Troie Complex (TC)						Faribault-Thury Complex (FTC)					Qimussinguat Complex (QC)		
Sample	1046B	7132A	3258A	6022A	2050A	3002A	7033C	6075A	5058B	7177B	6193C	4072A	4113B	2146A
Lithology	Charnockite	Enderbite	Monzonite	Granite	Basalt	Gabbro	Tonalite	Granite	Basalt	Basalt	Ultramafic	Enderbite	Granite	Basalt
SiO_2	71,55	65,69	63,62	70,77	49,65	51,45	71,05	70,04	51,27	49,95	45,29	66,43	73,83	48,87
TiO_2	0,30	0,82	0,73	0,28	0,62	0,88	0,30	0,37	1,06	0,90	0,29	0,50	0,03	0,86
Al_2O_3	13,44	15,36	15,83	14,60	15,47	17,21	14,94	15,68	14,57	14,75	5,91	15,74	13,79	14,45
FeO*	3,26	4,71	4,40	1,61	9,51	9,34	2,81	2,47	11,18	11,72	10,10	4,22	0,81	11,48
MnO	0,06	0,07	0,07	0,02	0,15	0,11	0,04	0,03	0,20	0,20	0,17	0,05	0,04	0,21
MgO	1,71	2,32	1,35	0,81	9,72	5,50	0,82	1,00	7,59	7,38	26,68	1,93	0,19	7,41
CaO	3,00	3,71	3,32	2,02	12,63	9,88	3,37	3,52	10,88	10,81	6,45	4,62	1,25	13,17
Na_2O	3,76	4,53	3,81	4,77	1,29	3,28	4,47	4,71	1,16	2,59	0,15	4,64	2,93	2,21
K_2O	2,06	1,89	5,05	3,00	0,22	0,47	1,25	1,49	0,66	0,22	0,10	1,33	6,00	0,64
P_2O_5	0,03	0,26	0,21	0,11	0,07	0,36	0,08	0,09	0,06	0,07	0,02	0,12	0,02	0,05
LOI	0,87	0,64	1,62	2,01	0,74	1,57	0,87	0,59	1,37	1,40	4,83	0,84	1,11	0,76
Total	100,03	100,00	100,00	100,00	100,08	100,06	100,00	100,00	100,00	100,00	100,00	100,42	100,00	100,10
As	< 9.8	< 21.2	< 10.3	< 21.5	< 10.2	< 10.4	< 21	< 21.8	< 20	< 20.5	< 20.8	< 21.6	26,60	< 10.1
Cd	< 0.49	2,02	0,53	< 1.1	1,18	0,96	< 1	1,29	2,95	3,64	< 1	1,37	< 1.1	1,70
Co	12,50	< 26.4	< 12.9	< 26.9	70,50	48,60	< 26.2	< 27.3	58,20	42,70	115,60	< 26.9	< 27	59,10
Cr	57	40	< 15.4	< 32.2	313	31	< 31.4	< 32.7	275	240	2333	33	< 32.3	242
Ni	35	25	10	15	230	100			97	99	1151	27	12	143
Cu	< 0.49	30,18	8,36	11,30	86,99	60,60	14,30	27,65	75,07	87,30	77,56	36,31	12,24	45,90
Zn	49,80	94,40	30,40	45,60	36,30	58,70	56,50	68,10	78,75	95,40	72,50	60,80	< 5.4	66,40
Sc	5,60	10,07	8,12	1,72	30,10	19,82	3,52	7,45	44,34	45,83	24,42	12,01	3,49	42,33
V	34,10	81,80	71,60	20,40	189,70	230,90	26,10	33,00	289,55	269,90	121,10	74,30	< 5.4	300,30
Cs	0,04	0,07	0,11	0,06	< 0.03	< 0.03	0,59	0,09	1,04	0,06	0,09	0,18	0,46	< 0.029
Rb	22,89	25,87	77,15	37,68	0,65	2,71	26,70	25,64	14,23	1,61	1,17	19,81	134,39	2,66
Ba	214	874	1505	1929	24	216	386	340	61	15	11	408	456	105
Sr	147,82	326,58	296,44	710,51	93,16	605,79	283,05	311,38	120,70	150,59	32,49	411,95	83,90	125,34
Nb	3,89	8,91	13,28	3,09	1,94	2,46	3,44	4,60	3,08	3,41	0,95	5,01	0,31	2,30
Ta	0,14	0,27	0,61	0,09	0,10	0,11	0,16	0,16	0,18	0,17	0,04	0,15	0,02	0,14
Th	0,41	1,10	1,42	7,43	0,15	0,67	1,94	0,39	0,37	0,42	0,08	0,50	27,86	0,68
U	0,33	0,37	0,64	0,31	0,05	0,16	0,48	0,12	0,12	0,11	0,02	0,26	9,41	0,34
Zr	62,41	230,12	306,86	112,89	29,83	31,13	127,91	112,78	57,86	56,01	14,15	100,27	83,69	52,74
Hf	1,78	5,56	7,58	3,12	0,91	0,93	3,34	2,98	1,76	1,63	0,40	2,58	3,46	1,53
Y	3,35	13,70	18,87	4,02	10,92	9,16	4,37	7,90	19,63	19,01	6,70	10,73	9,38	19,62
La	13,43	24,12	37,60	35,93	2,38	14,03	7,91	13,84	3,65	3,63	0,74	22,97	25,63	4,51
Ce	21,85	49,24	77,16	69,57	6,66	31,62	16,05	29,12	9,21	9,48	2,10	53,57	46,42	10,23
Pr	1,81	6,06	8,97	7,65	1,00	4,02	1,75	3,60	1,44	1,47	0,35	6,10	4,67	1,34
Nd	6,08	22,55	37,71	25,58	5,10	17,34	6,18	13,95	7,25	7,15	1,85	24,34	16,24	6,64
Sm	0,87	3,95	6,89	3,14	1,56	3,25	0,92	2,72	2,21	1,99	0,62	4,27	2,72	2,13
Eu	0,53	1,14	1,70	0,76	0,61	1,16	0,58	0,65	0,77	0,83	0,26	1,01	0,53	0,70
Gd	0,50	4,40	5,52	1,53	1,86	2,70	1,05	2,33	2,98	2,98	0,94	4,23	2,59	2,91
Tb	0,06	0,55	0,76	0,18	0,32	0,35	0,13	0,35	0,53	0,52	0,18	0,48	0,28	0,52
Dy	0,62	2,85	4,37	0,93	2,26	2,07	0,71	1,85	3,74	3,49	1,18	2,48	1,64	3,73
Ho	0,12	0,51	0,80	0,14	0,45	0,38	0,14	0,31	0,74	0,73	0,24	0,46	0,34	0,81
Er	0,40	1,39	2,08	0,34	1,34	1,03	0,47	0,81	2,22	2,15	0,72	1,21	1,07	2,50
Tm	0,06	0,16	0,26	0,04	0,17	0,13	0,06	0,09	0,29	0,29	0,09	0,15	0,15	0,32
Yb	0,45	1,01	1,50	0,24	1,08	0,78	0,42	0,54	2,01	1,92	0,64	0,89	1,00	2,09
Lu	0,07	0,14	0,22	0,03	0,17	0,12	0,07	0,07	0,30	0,30	0,10	0,12	0,14	0,32

TABLEAU 2 - Teneurs moyennes (M) et seuils anomaux (S) des éléments analysés dans les sédiments de lacs pour les domaines géochimiques de la région du lac Peters (voir les figures 13 et 14).

Élément	Bruit de fond		Domaine de Qimussinguat		Domaine de Thury		Domaine de Gorribon		Domaine de Tasiaalujjuaq		Domaine de Faribault		Domaine de Rivier		Domaine de Peters-est		Domaine de Troie-Nord		Domaine de Troie-Sud		Domaine de Sud-est		Domaine d'Hamelin		Domaine de Sud-ouest	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
Ba	40	78	33	78	49	100	41	78	100	200	88	200	110	200	45	78	48	100	109	250	92	175	72	150	182	330
Ce	42	100	49	100	86	200	129	250	190	400	154	375	133	250	90	150	43	100	99	200	154	250	210	550	90	150
Co	4.6	10	3.9	10	8.3	25	4.3	5.0	11	25	8.6	15	8.8	15	5.6	10	5.7	10.0	10	20	10	20	7.8	15	13	25
Cu	24.9	75	30	75	53	150	43	100	83	175	63	150	80	150	41	75	28.6	75.0	54	100	59	100	70	150	53	100
Cr	14	30	11	25	11	25	10.8	20	30	60	20	50	20	30	14	20	18.5	35	34	65	40	75	20	35	36	60
Eu	.36	1.0	.37	1.0	.57	1.5	1.0	2.5	2.0	4.5	1.5	3.5	1.3	2.5	.8	1.5	.45	1.0	1.0	2.0	1.5	2.5	1.9	5	.9	1.5
La	31.7	75	35	75.0	56	120	70	130	136	300	109	250	94	150	59	120	33.7	75	68	130	87	150	145	350	70	115
Li	2.9	7	2.9	7	4.4	10	3.5	7.0	9.8	15	7.5	15	8.7	15	3.9	7	3.3	7	7.5	15	5.8	10	6.9	10	13	25
Mo	3.7	10	3.5	7	5.3	14	3.3	7.0	7.6	18	5.5	14	4.8	10	4.2	14	3.8	7	4.7	10	3.7	7	5.2	10	4.4	10
Ni	14.7	35	13	30	18	35	12.6	30	73	180	35	100	33	50	17	30	21	45	40.9	80	49.9	80	29	80	41	80
P	516	1000	557	1000	519	1000	615	1200	818	1300	750	1300	741	1300	670	1200	592	1000	880	1500	1073	1700	664	1100	886	1500
Pb	4	8	3.3	8	4.8	8	4.6	8.0	9.8	24	7.7	15	8.8	15	9.1	37	4.8	8	9.0	15	9.7	15	6.1	8	11.8	20
Th	4.9	11	4.2	11	8.3	15	8.3	11	13	25	11.7	25	12.7	20	8	15	5.7	11	14	25	16.4	30	14	30	18.5	30
Ti	268	550	255	550	325	550	300	500	695	1200	588	1200	707	1200	313	550	295	550	692	1400	627	1100	485	750	1112	2000
U	3.8	15	1.8	5	11	30	3.9	10	39	120	23	75	18	35	7.8	15	4.7	10	6.5	15	5.3	10	17.4	50	7.8	15
V	24	60	20	30	18	30	20	30	35	60	31	60	33	60	34	100	27	60	37	60	39	60	29	60	43	60
Y	8.4	20	7.0	15	9	20	14	25	42	100	32	75	28	50	16	30	11	25	20	35	25	40	37	100	19	30
Zn	61	120	55	120	78	120	58	120	127	230	114	200	126	200	73	120	74	150	133	230	149	230	121	230	150	230
Zr	2.4	6	2.3	6	3.3	6	2.7	6	7.1	11	6.0	11	6.8	11	3.6	6	3	6	5.3	11	5.3	11	6	11	6.0	11

Table 3 - Lake sediment samples of the Lac Peters area showing a geochemical signature similar to those produced in stream sediments by known kimberlites in other areas (see text).

Sample number	Location (UTM, NAD83) Easting	Northing	Cr	Ni	Ba	K	Ce	Y
41206	351978	6548232	46	57	286	10300	106	22
41272	356522	6574212	47	59	362	10500	106	22
42213	365650	6574011	56	60	330	12000	76	17
42216	361899	6579914	36	46	224	8500	62	15
42145	375890	6576567	69	79	358	8900	87	20
42212	363908	6570966	61	68	247	8700	62	12

Table 4 - Characteristics of mineralized showings in the Lac Peters area (NTS 24M). Showing locations are indicated in Figure 2.

Showing	Location (UTM NAD83)	Substance and Grade	Description
Panache	364 876 m E. 6 618 228 m N.	Au = 1.3 g/t Ag = 7.2 g/t As = 0.74 % Zn = 3.08 % Pb = 0.77 %	Rusty zone (>5% sulphides) in garnet-bearing paragneiss intercalated in a metavolcanic sequence (Curotte belt)
Tuk-Tuk	388 410 m E. 6 616 291 m N.	Cu = 0.63 % Ag = 2 g/t	Sulphide-facies iron formation
Airo	331 625 m E. 6 601 959 m N.	Ag = 10 g/t Zn = 0.04 %	Disseminated sulphides in silicified paragneiss (Tasiaalujjuaq belt)

Table 5 - Threshold values for mineralized showings and lithogeochemical anomalies.

Substance	Threshold values used for showings in the Lac Peters project	Threshold values used for anomalies in the Lac Peters project	Threshold values proposed for anomalies in the Abitibi mining camp
Au	1 g/t	0.080 g/t	0.050 g/t
Ag	5 g/t	3 g/t	2 g/t
Cu	0,5%	0,1%	0,05%
Ni	0,25%	0,2%	0,2%
Zn	0,75%	0,050%	0,03%
Pb	0,5%	0,050%	0,020%
Cr	1%	0,2%	0,2%
As	----	0,015%	0,005%

Table 6 - Characteristics of lithogeochemical anomalies. Anomaly locations are indicated in Figure 2.

Site number	Location (UTM NAD83)	Substance and Grade	Description
1	394 583 m E. 6 604 457 m N.	Ni = 0.19 % Cr = 0.43 %	Ultramafic metavolcanic rock
2	398 391 m E. 6 638 124 m N.	Ni = 0.21 % Cr = 0.28 %	Ultramafic metavolcanic rock from the Thury volcano-sedimentary belt
3	407 520 m E. 6 635 431 m N.	Cu = 0.26 % Au = 0.085 g/t Ag = 2 g/t	Metavolcanic rock (mafic gneiss) from the Thury volcano-sedimentary belt
4	393 173 m E. 6 608 904 m N.	Zn = 0.13 % Cu = 0.11 %	Small rusty amphibolite horizon (PO)
5	410 842 m E. 6 586 970 m N.	Cu = 0.15 %	PY-CP bearing rusty zone in metavolcanic rock (mafic gneiss)
6	371 372 m E. 6 587 087 m N.	Cu = 0.25 % Zn = 0.021 %	Sulphide zone at the contact between a granitic gneiss and a cross-cutting gabbro (CP, PY, PO)
7	336 763 m E. 6 625 273 m N.	Au = 0.13 g/t Cu = 0.013 %	Iron formation from the Hamelin volcano-sedimentary belt
8	403 280 m E. 6 602 190 m N.	Cu = 0.3 % Zn = 0.04 % Au = 0.062 g/t	Sulphide mineralization zone (CP, PY, PO) at the contact between a paragneiss and an ultramafic rock
9	381 801 m E. 6 590 977 m N.	Cu = 0.17 % Zn = 0.02 %	Disseminated sulphides in gabbronorite
10	364 535 m E. 6 579 783 m N.	Zn = 0.17 % Cu = 0.02 % Cr = 0.21 %	Paragneiss with 1 to 7% sulphides (PY, CP, PO) associated with metavolcanic rocks
11	387 111 m E. 6 558 485 m N.	Cu = 0.20 % Zn = 0.062 %	Mineralized amphibolite with 5% sulphides (PY, PO, CP)
12	393 511 m E. 6 595 700 m N.	Zn = 0.077 % Cu = 0.052 %	Garnet-rich rusty zone (PY, PO), associated with metavolcanic rocks (mafic gneiss)
13	363 695 m E. 6 615 507 m N.	Zn = 0.19 % Cu = 0.036 %	Rusty zone (10% sulphides) at the contact between a paragneiss and a metavolcanic rock
14	379 030 m E. 6 614 722 m N.	Cu = 0.18 %	Rusty zone in a metavolcanic rock (mafic gneiss) from the Peters West volcano-sedimentary belt
15	349 436 m E. 6 573 923 m N.	Cu = 0.11 %	Rusty zone (5% PY) in a metavolcanic rock

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