RG 2000-02

GEOLOGY OF THE KOROC RIVER AREA AND PART OF THE HEBRON AREA (NTS 24I AND 14L)

Énergie et Ressources naturelles
Québec

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(NTS 24I AND 14L)

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Accompanies maps
SI-24I-C2G-00A and SI-14L-C2G-00A

A View of the Lake Harbour paragneisses in the Baudan River valley.

2001

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ABSTRACT

The Koroc River area (sheet 24I and part of 14L) lies within the eastern part of the Churchill Province. The Churchill consists of a number of Archean cratonic blocks and Early Proterozoic mobile zones, where the peak of metamorphism and deformation occurred at about 1.8 Ga. In northeastern Québec and northern Labrador, the Churchill comprises all Archean and Early Proterozoic rocks located between the Superior and Nain provinces. Their deformation is attributed to the Early Proterozoic Trans-Hudson Orogeny. The Churchill in NE Québec is composed of: the New Québec Orogen (Labrador Trough) in the west, the SE extension of the Rae Province, which we have called the Far North craton, in the central part, and the Torngat Orogen in the east, which links the Far North craton and the Nain Province further east, and which formed during the collision between the two cratons.

The Koroc River area straddles the eastern margin of the Far North craton and the Torngat Orogen, which contains reworked terrains of the Far North craton and the Nain, as well as a variety of para- and orthogneisses of uncertain affinity wedged between the two cratons.

The Far North craton is divided into four lithodemic and lithostratigraphic units: 1) the **Kangiqsualujjuaq Complex** (new term), formed during the Early Proterozoic, and composed of a series of tonalitic and granitic orthogneisses cross-cut by Archean granitoid dykes and plutons; 2) the **Baudan Complex** (new term), also Early Proterozoic in age, composed of Archean granitic gneiss and diatexite, as well as wedges of paragneiss probably correlated to the Lake Harbour Group; 3) the **Lake Harbour Group**, an Early Proterozoic sequence of paragneiss, quartzite, calcitic and dolomitic marble, calc-silicate rock and metabasalt; 4) the **Nuvulialuk mafic Suite** (new term) composed of Early Proterozoic metamorphosed gabbroic and ultramafic dykes and sills intruding the Lake Harbour Group and the metamorphic complexes. All these units are metamorphosed to the upper amphibolite facies.

The Torngat Orogen comprises, from west to east: the **Sukaliuk Complex** (new term), a deformed assemblage of tonalitic, enderbitic and charnockitic orthogneisses, paragneiss, quartzite and ultramafic rocks metamorphosed to the granulite facies, which probably correspond to reworked equivalents of units in the Far North craton; the **Lomier Complex**, composed of anorthositic, enderbitic, mangeritic and charnockitic orthogneisses, with bands and enclaves of paragneiss, granitoid rock and metagabbro; the **Tasiuyak Gneiss**, a strongly deformed assemblage of granitic gneiss and Early Proterozoic paragneiss; and the **Iberville Complex** (new term), formed of orthogneiss of the AMCG suite, located east of the Tasiuyak Gneiss.

The Torngat Orogen and the rocks of the Far North craton are cross-cut by late mafic dykes that we have assigned to the **Falcoz Diabase**.

In the Koroc River area, the Far North craton displays an intense foliation, oriented NE-SW and dipping about 20° SE, as well as a strong tectono-metamorphic lineation that plunges 18° to the SE on average, both attributed to the Trans-Hudson Orogeny (Torngat). An early foliation (Archean?) is namely observed in mafic enclaves in the tonalitic gneiss. Contacts between stratigraphic units are defined by reverse faults that are parallel to the main foliation. Dextral and sinistral shear zones oriented NW-SE (such as the Falcoz zone) are interpreted as riedel shears related to major N-S strike-slip faults observed in the Torngat Orogen. Within the Torngat Orogen, the presence of a strong subvertical N-S foliation and a subhorizontal N-S lineation, in addition to predominantly sinistral kinematic indicators are associated with an intense shearing event. Brittle faults parallel to the ductile shear zones are the result of late tectonic activity.

Two tonalitic gneiss units in the Kangiqsualujjuaq Complex (SP-4044A1 and A2) represent lithologies from a Middle Archean (2.9 and 2.76 Ga) basement, reworked during a Late Archean tectono-thermal episode (2.623±0.004 Ga). An age of 1.85 Ga, obtained in an amphibolite, is interpreted as the age of emplacement for this lithology. It most likely indicates the tectonic juxtaposition of the Proterozoic amphibolite with the Archean tonalitic gneisses. A granitic dyke, with an emplacement age of 1.828±0.002 Ga, represents a magmatic event related to the tectono-thermal peak widely recognized in the entire Trans-Hudson Orogen, and which precedes the period of terrain exhumation. Samples from the Baudan Complex granitic gneisses helped pinpoint the occurrence of a Late Archean magmatic event at about 2.6 Ga, which represents both the emplacement of new material and the remobilization of older terrains. Ongoing studies on samples of the Falcoz zone have not yet revealed relevant information concerning the development of the shear zone.

The proposed sequence of events for the Koroc River area is as follows:

- the formation of an Archean tonalitic basement with remnants of supracrustal rocks (mainly amphibolites) between 2.920 Ga and 2.76 Ga;
- the intrusion of granitic rocks during the Archean (2.60 Ga – 2.623±0.004 Ga), accompanied by granulite-facies metamorphism and ductile deformation;

(continues on the next page)

(Abstract continued)

- the erosion of a magmatic arc and the emplacement of sediments and lavas of the Lake Harbour Group and the Nuvulialuk intrusive Suite (1.90 – 1.85 Ga), in a fore-arc basin;
- the Trans-Hudson Orogeny : metamorphism and remobilization of basement and supracrustal rocks to form the Baudan and Kangiqsualujjuaq complexes (1.82 – 1.828 Ga); granulitization at depth (Sukaliuk and Lomier complexes and Tasiuyak Gneiss). Deformation in an E-W compressional regime (Nain – Churchill and Churchill – Superior collisions) to generate N-S oriented folds, then transport of units from east to west (development of recumbent folds and thrust zones), thereby bringing rocks from deeper structural levels close to the surface;
- Evolution of the deformation from a compressional to a transpressional regime, generating N-S and NW-SE shear zones (ex: Lac Daniel fault, Falcoz zone), which cut and refold earlier N-S folds. Emplacement of syn- to post-transpressive deformation granite and granitic pegmatite dykes and veins.
- Intrusion of Falcoz Diabase.

CONTENTS

INTRODUCTION

Objectives

The mapping of the Koroc River area is part of an ambitious project undertaken by the Ministère des Ressources naturelles du Québec whose objective, over a period of a few years, is to map at a scale of 1:250,000 and to evaluate the mineral potential of Québec's Far North region, a vast territory located north of the 55th parallel. This project, initiated in 1997 with a lake sediment geochemical survey completed in conjunction with partners from the private sector, continued in 1998 with four regional mapping projects.

The objectives of the Koroc River area project are to define the main metallogenic environments of this part of the Churchill Province and the Torngat Orogen, to add more detail to the existing geological map, and to test regional tectonic models proposed as a result of seismic surveys conducted in Ungava Bay and the Labrador Sea in the LITHOPROBE program (ECSOOT project). Prospecting and geophysical surveys by mining companies, as well as a Quaternary geology study undertaken by the Geological Survey of Canada, were carried out concurrently with our geological survey.

Location

The Koroc River area is situated between longitudes 63°30' and 66°00' west and latitudes 58°00'and 59°00' north, in the Province of Québec. It covers most of topographic sheet NTS 24I and a small part of adjacent sheet 14L (Figure 1). It represents a surface area of nearly 10,000 km^2 between Ungava Bay to the west and the Labrador border to the east. This territory is under the jurisdiction of the Nunavik regional administration, and under the authority of the Kangiqsualujjuaq municipality, the only village in the area, located at the mouth of the George River, along the coast of Ungava Bay, 125 km northeast of Kuujjuaq. The 1998 base camp was located on Big Cariboo Lake (this name does not appear on topographic maps) 35 km northeast of Kangiqsualujjuaq.

The Koroc River area is a region of highlands that culminate in the east with the Torngat mountain range, where the highest peaks (Mont Iberville being the highest) tower at over 1,500 m of altitude. The eastern part of the area is characterized by alpine topography, with sharp peaks and ridges, and glacial valleys and cirques. The western part forms a plateau gouged by deep valleys, which starts at a maximum altitude of 900 m and gradually goes down to sea level. The main rivers in the area, the George River, which flows from south to north, and the Koroc River, which drains the Torngat Mountains from east to west, are important rivers, with a rapid and elevated rate of flow over most of their path. Their tributaries, the main ones being the Grenier River and the Sukaliuk Creek for the Koroc River and the Ford River for the George River, create a relatively dense drainage pattern, with encased valleys and steep slopes. A multitude of small and medium-sized lakes are scattered throughout the area. The most important are Daniel Lake, in the centre of the area, and Tasirlaq Lake in the south. The coastline of Ungava Bay is cut by fjords and deep bays that display exceptional outcrops at low tide.

With the exception of the main valley bottoms, where we find a sparse forest composed of epicea, tamarack, birch, rhododendrons and other shrubs, the forest cover is absent. Soil cover is rare, and most of the area consists of lichen-covered rock outcrops or fields of blocks alternating with mossy, grassy or flowery zones. The area hosts a variety of animals including caribou, black bears, occasionally polar bears, wolverines, arctic fox, lemmings, hares, as well as numerous species of birds such as the Canada goose, several species of duck, snowy owls, other birds of prey and the rock ptarmigan. Aquatic species include salmon, trout and arctic char.

Kangiqsualujjuaq is currently accessible via regular flights between Montréal and Kuujjuaq, where a local flight acts as a shuttle two or three times a week between the villages in the area. Chartered flights on floatplane in the summer, or ski-equipped aircraft in the winter season, provide access to certain lakes. During the course of our survey (1998), a landing strip for Twin Otters was accessible at Big Cariboo Lake; another landing strip exists southwest of Mont Iberville. Of course, it is possible to land nearly anywhere by helicopter, but sudden and extreme weather variations and very steep topography call for very cautious use of this type of aircraft.

Previous Work

The first geological study of the Koroc River area consisted of a cursory reconnaissance survey of coastline outcrops by Low (1896 and 1899) at the turn of the century. He identified a very ancient series of granitic gneisses, grey gneisses and mafic gneisses. The first complete geological map dates back to the late 1960s when Taylor (1969 and 1979) published the results of his fieldwork covering all of northeastern Québec and northern Labrador. During the 1980s, regional mapping jointly conducted by the Geological Survey of Canada and the Geological Survey of Newfoundland and Labrador in Labrador, and by the ministère des Ressources naturelles du Québec in northeastern Québec, led to the publication of several 1:100,000 scale maps, and to the elaboration of several tectonic models for the entire Hudsonian Orogen (Hoffman, 1988, 1990 a and b; Wardle, 1983, 1998; Rivers *et al.*, 1996; Girard, 1990a), and in particular, of a global review published in a special

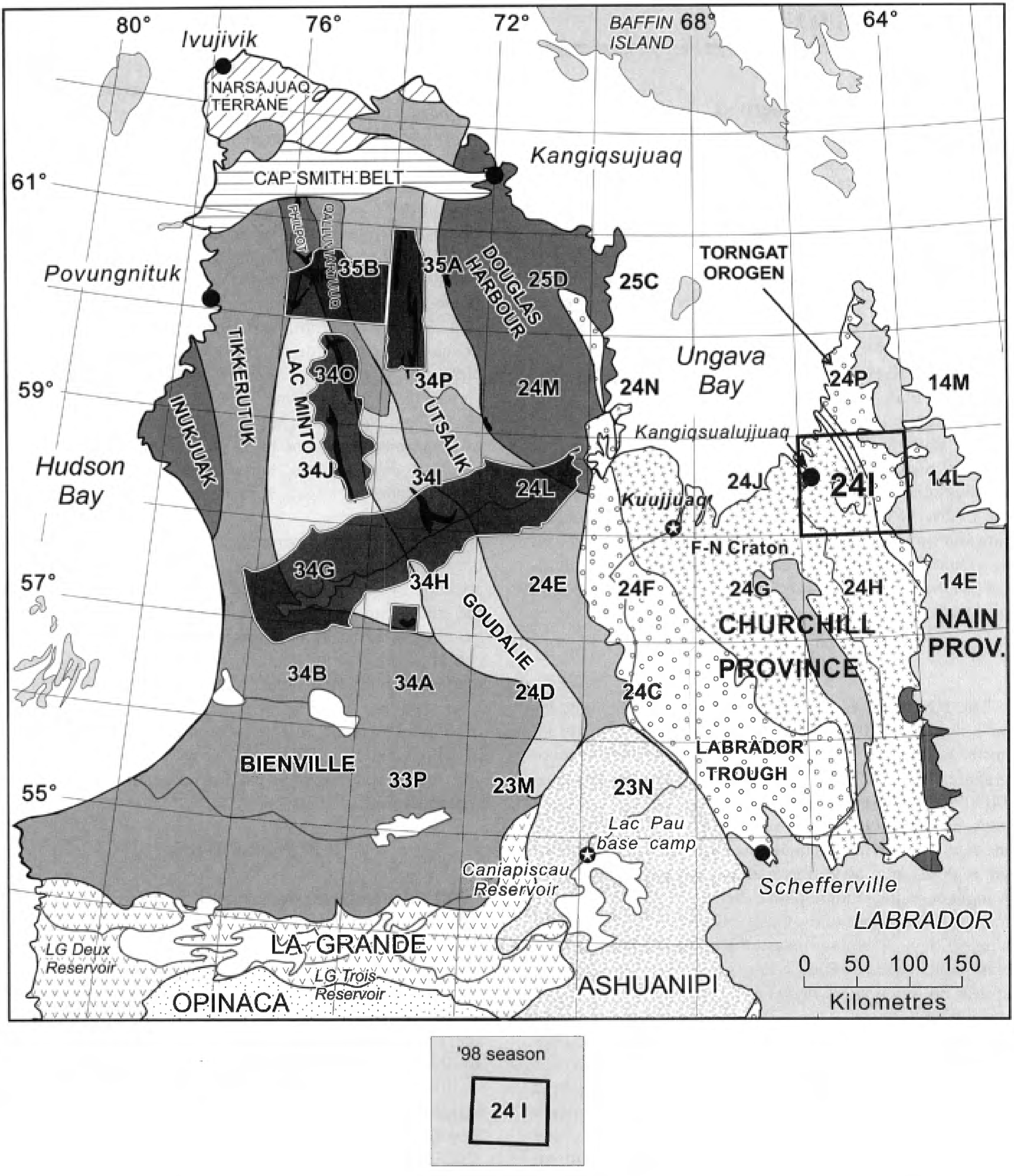

FIGURE 1 – Location map of the study area, showing the principal geological domains in Québec's Far North.

edition of Geoscience Canada (1990, volume 17, number 4). A second wave of work conducted in the 1990s took advantage of the results of a deep seismic survey (LITHOPROBE program ECSOOT survey) carried out in 1992 offshore of Ungava Bay and the Labrador Sea (Hall *et al.*, 1995). This seismic data, as well as concurrent studies in isotope geochemistry (Dunphy and Skulski, 1994, 1996; Isnard *et al.*, 1998), geochronology (Scott, 1998) and structural geology (Wardle and van Kranendonk, 1996; St-Onge *et al.*, 1997 and 1998) resulted in a more complete interpretation of the New Québec and Torngat orogens and of the affected "basement" (or basements).

Several Quaternary studies of the area were published; the latest (Parent and Paradis, 1999) was carried out at the same time as our field mapping. We refer the reader to this study to obtain a complete bibliography of the work performed in the area. Parent and Paradis (1999) identified three successive episodes of regional glacial flow: the first and oldest is NNE and NE directed; the second is attributed to the last glacial episode, related to the ENE movement of the Laurentide Ice Sheet, and the third final movement to the NW, which affected only the western part of the area. Preliminary data suggest that glacial dispersion axes associated with the last glaciation, i.e. to the ENE (2nd system) and to the NW (3rd system) are likely to form geochemical dispersion patterns which could be recognized within the framework of high-resolution geochemical surveys (sampling stations spaced closer than 13 km^2) to identify base and precious metal targets of economic interest (Parent and Paradis, 1999).

The area has been the focus of relatively numerous geophysical surveys. A regional magnetic survey covers the entire area (Dion and Dumont, 1994). It allows us to trace numerous contacts between structural or stratigraphic units. Recent seismic reflection and seismic refraction work (ECSOOT project), conducted in Ungava Bay, the Labrador Sea and across the Ungava Peninsula, have led to a reinterpretation of the structural evolution of this part of the Churchill Province. Gravity surveys carried out by the Geological Survey of Canada and UQAM also cover the entire region, although the spacing is quite large.

Finally, the MRN, along with partners from the mining industry, conducted in 1997 a lake bottom sediment survey (MB 98-01). In 1998, a few companies carried out prospecting work on several staked properties.

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The 1998 survey is the result of an intense collaboration involving numerous individuals. We wish to thank all our collaborators: geologists Geneviève Boudrias, Louis Caron and Youcef Larbi; geological assistants Jean-François Alix, Félix Gervais, Louis-Martin Guénette, Sophie Lafontaine, Gabrièle Lemieux and Weena Vachon; our excellent cook, Luc Therrien, who took on many tasks; Tunu Saviadjuk who assisted us in the field and who maintained a clean and functional environment in our camp; helicopter pilots Daniel Martin and Jacques Galichon, who flew in precarious weather conditions to bring us back to camp safe and sound, and their outstanding mechanics Sylvain Ouellette and Martin Chartrand. We also wish to thank Normand Goulet (UQAM), Dick Wardle (Geological Survey of Newfoundland) and Alain Simard (Service géologique de Québec) who, during their respective field visits, participated in field data acquisition and made constructive comments very useful to the realization of the survey. We extend our gratitude to the Groupe de soutien administratif et matériel, who somehow overcame numerous logistical problems, and finally, we wish to thank Nelson Leblond and his collaborators, who assured the integration of our data into SIGÉOM.

REGIONAL GEOLOGY

The Koroc River area lies within the eastern part of the Churchill Province, as defined by Stockwell (1964). The boundaries of the Churchill in this area were established by Taylor (1972) and Hoffman (1988, 1990a and b). The Churchill consists of a number of Archean cratonic blocks, partially remobilized during the Early Proterozoic, and of Paleoproterozoic mobile zones where the peak of metamorphism and deformation occurred at about 1.8 Ga. The Churchill forms the northern, eastern and western margins of the Superior Province "craton", and separates it from other Archean cratons, such as the North Atlantic craton (Hoffman, 1988), which includes the Nain Province. In NE Québec and Labrador, the Churchill includes all Archean and Paleoproterozoic rocks located between the Superior and Nain provinces (Figure 1). Their deformation is attributed to the Paleoproterozoic Trans-Hudson Orogeny (Hoffman, 1988, 1990a and b). Hoffman (1988, 1990a and b) abandoned the term Churchill, and subdivided the terrains previously defined as such into a series of structural provinces, each of which corresponds to an Archean craton or to one of the mobile zones that bind them together. In NE Québec and Labrador, he identified, from west to east, 1. the New Québec Orogen (Labrador Trough), developed on the northeastern margin of the Superior during the accretion of an Archean craton (Rae Province or Far North craton) located to the east; 2. the Far North craton (new term), which forms the southeastern extension of the Rae Province, and whose western margin represents the internal zone of the New Québec Orogen whereas the eastern margin represents the foreland of the Torngat Orogen; 3. the Torngat Orogen, which joins the Rae Province and the Nain Province to the east, and is the result of a collision between the two cratons (Figure 2). More recently, this part of the Rae Province, renamed Core zone (James and Dunning, 1996; James *et al.*, 1996), has been assigned a lithotectonic affiliation with the

Superior, which had already been suggested as a result of structural, petrological, geochronological and geochemical studies (Goulet and Ciesielski, 1990; Machado *et al.*, 1989). However, the name Core zone is currently being questioned as it erroneously refers to the term metamorphic core complex. This is why we have introduced in this report the term Far North craton, using the name of the wildlife reserve that covers a large part of the area, to designate these rocks.

Previously proposed tectonic models for the area suggest that the Far North craton is a microcontinent that may have separated from the Superior through rifting at the end of the Archean or the beginning of the Paleoproterozoic, and whose accretion to the Superior craton at about 1.84 Ga produced the New Québec Orogen. Almost at the same time, the Far North craton was hit by the Nain and in turn acted as foreland for the Torngat Orogen.

The New Québec Orogen is a volcano-sedimentary and magmatic belt, folded and thrusted to the southwest, and transported onto the Superior craton during the Paleoproterozoic (Clark, 1994; Hoffman, 1988, 1990a and b). Terrains in the eastern part of the orogen are far more metamorphosed, and contain slices of Archean basement imbricated with the volcano-sedimentary sequences. The De Pas Batholith is interpreted as an Early Proterozoic magmatic arc intrusive, injected into the Far North craton and related to the New Québec Orogeny (Figure 2).

The Far North craton is composed of an assemblage of tonalitic and granitic gneisses, which were subjected to several phases of deformation during the Archean and the Paleoproterozoic. These gneisses contain remnants of metasediments, amphibolites and ultramafic rocks of uncertain ages, but which probably represent tectonic slices that originated from the Paleoproterozoic supracrustal cover sequence. The Far North craton, particularly its eastern part, is locally overlain by quartzite, paragneiss and metavolcanic units intruded by metagabbro dykes and sills. In certain areas such as the coastal regions located north of our map area, this Paleoproterozoic supracrustal sequence unconformably overlies the basement (Goulet and Ciesielski, 1990). In the Koroc River area however, the contact is tectonic over most of the area. The Far North craton is subdivided into two tectonic zones separated by the George River shear zone (see Clark, 1994): the Kuujjuaq zone to the west, and the George River zone to the east. The Kuujjuaq zone represents the internal zone of the New Québec Orogen. The George River zone is also subdivided into domains separated by shear zones, namely the Falcoz shear zone which forms the northern boundary of the Lac Henrietta domain (Ermanovics and van Kranendonk, 1998).

The Trans-Hudson Orogeny is the Early Proterozoic tectonic event that deformed and metamorphosed the eastern margin of the Far North craton and the western margin of the Nain during their collision 1.8 Ga ago. The term Torngat Orogen is used in this report to designate the lithotectonic assemblage that was completely remobilized during the orogeny and which constitutes the suture zone between the two cratons. It is therefore formed of two cratonic margins, deformed and injected with synorogenic intrusions, and of an assemblage of strongly deformed and highly metamorphosed gneisses of uncertain affinity, called the Tasiuyak Gneiss (Figure 3). The western portion of the orogen is formed of tectonic wedges imbricated to the west, whereas in the east, the thrusts are east verging. A major ductile shear zone, the Abloviak shear zone, has reoriented original structures on its path to a N-S direction. We have grouped several units in the Torngat Orogen, namely the Lomier Complex, formed of remobilized Archean rocks and deformed Early Proterozoic intrusions including anorthosites; the Tasiuyak Gneiss, formed of granulite-facies paragneisses and granitoids; the Iberville Complex (new term), which also includes an abundance of rocks of the anorthosite – mangerite – charnockite (AMC) assemblage; and granulite facies rocks that were not named, but that probably belong to the Four Peaks Domain, or the Saglek Gneiss, a reworked segment of the Nain Province (Figures 2a and 3).

The Nain is an Archean tectonic province, with older rocks than those found in the Far North craton. It occupies the coast of Labrador and part of South Greenland. This province consists of Middle Archean granitic and tonalitic gneiss, intruded by Paleoproterozoic mafic dykes, and overlain by an Paleoproterozoic volcano-sedimentary sequence whose western part, the Ramah Group (Figure 3), is involved in the Torngat Orogen.

STRATIGRAPHY

The Koroc River area contains two of the principal structural elements that make up NE Québec and Labrador: the eastern margin of the Far North craton and the Torngat Orogen, which comprises reworked Churchill and Nain terrains, as well as a series of para- and orthogneisses of uncertain affinity wedged between the two reworked cratons (Figure 3).

Churchill Province (Far North Craton)

The Far North craton of the Churchill Province is represented in this area by four different lithodemic and lithostratigraphic units (Figure 3 and Table 1): 1) the **Kangiqsualujjuaq Complex** (new term), formed during the Paleoproterozoic, but consisting largely of Archean tonalitic and granitic orthogneiss, cut by Archean and Proterozoic granitoid dykes and plutons; the complex contains enclaves of Archean amphibolite as well as bands of amphibolitized mafic rocks, paragneiss (probable equivalents of the Lake Harbour Group) and meta-ultramafic rocks; 2) the **Baudan Complex** (new term), also Paleoproterozoic in age, composed of Archean foliated granitic gneiss and Paleopro-

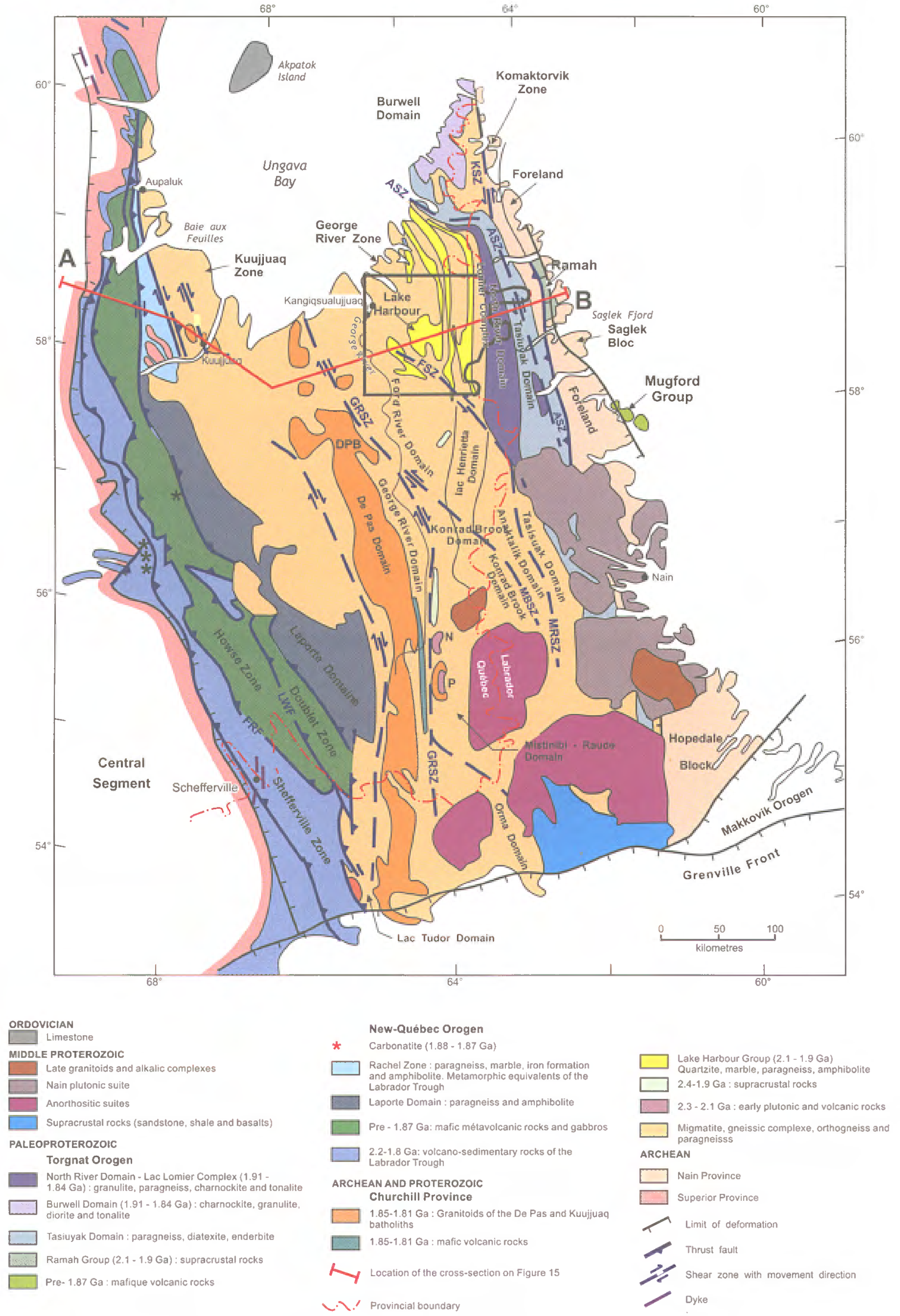

FIGURE 2 a – Lithotectonic map (adapted from Wardle *et al.*, 1990). Section AB indicates the location of the cross-section shown in Figure 15. The box indicates the perimeter of the study area.

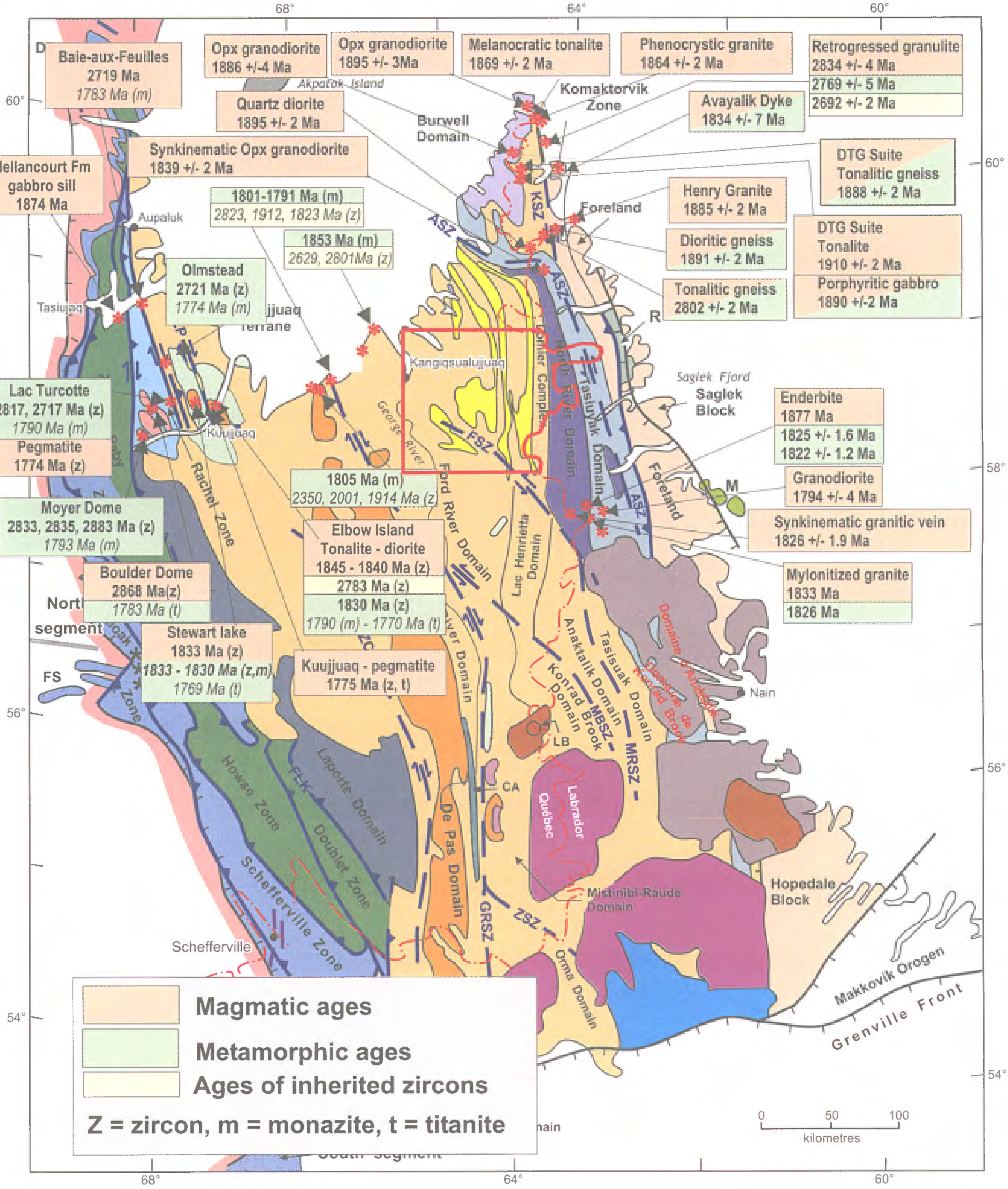

FIGURE 2 b – Geochronological data for the Churchill Province and the New Québec and Torngat orogens. U-Pb data are from Machado *et al.* (1989), Bertrand *et al.* (1993), van Kranendonck and Wardle (1996), Bardoux *et al.* (1998), David, J., personal communication (1998) and Scott *et al.* (1998). Unless specified by an abbreviation, the ages are from zircons (Compilation by Serge Perreault).

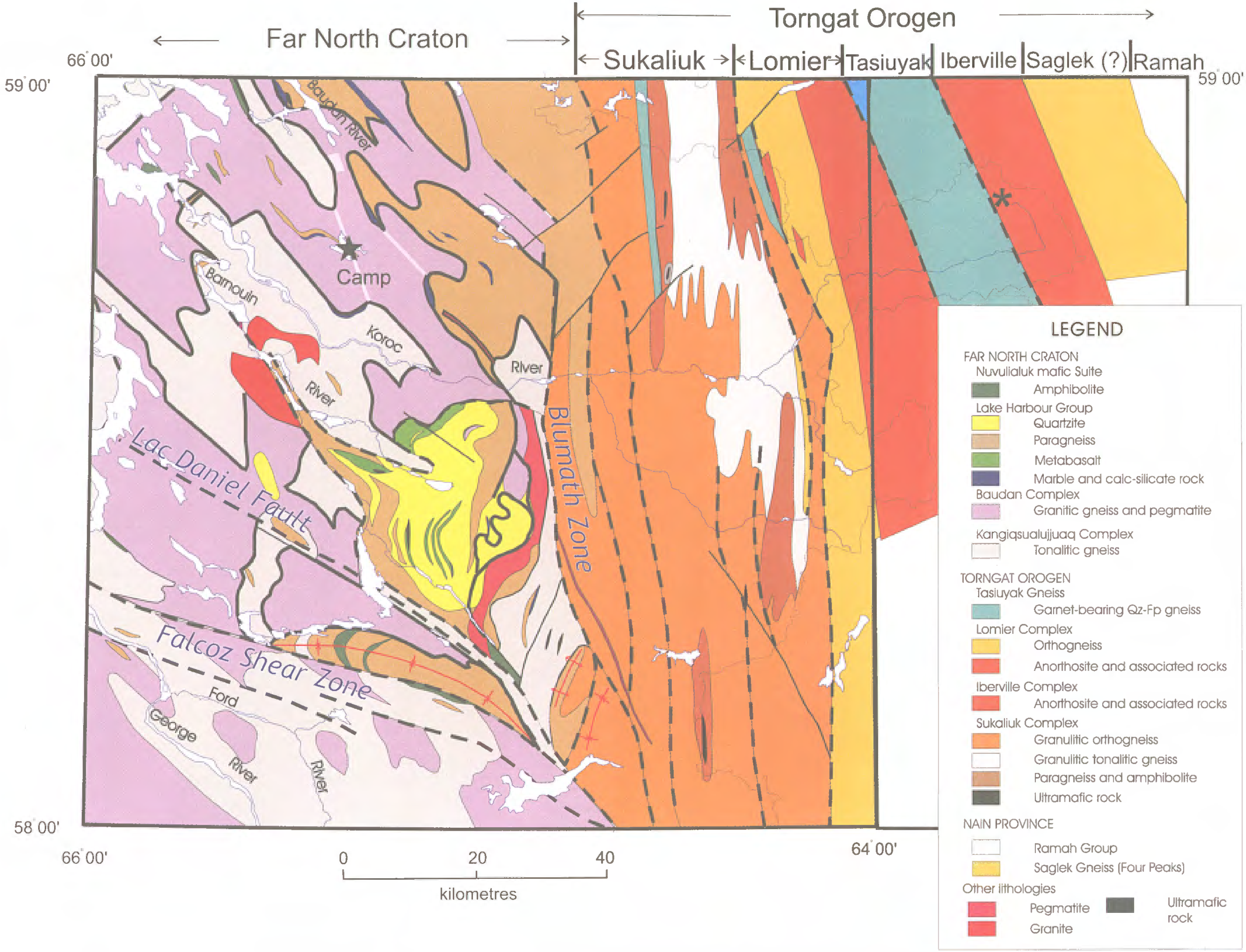

FIGURE 3 – Simplified geology of the Koroc River area (map 24I) and part of the Hébron area (map 14L).

terozoic diatexite, as well as paragneiss wedges that are probable stratigraphic equivalents of metasediments of the Lake Harbour Group; 3) the **Lake Harbour Group** (Jackson and Taylor, 1972), an Paleoproterozoic sequence of paragneisses, quartzites, calcitic and dolomitic marbles, calc-silicate rocks and metabasalts; 4) the **Nuvulialuk mafic Suite** (new term) composed of Paleoproterozoic metamorphosed gabbroic and ultramafic dykes and sills, injected in the Lake Harbour Group and the metamorphic complexes.

All these units are metamorphosed to the middle to upper amphibolite facies, with relic zones of granulite-facies rocks.

Kangiqsualujjuaq Complex

The Kangiqsualujjuaq Complex is a new unit that designates a strongly tectonized assemblage of Archean tonalitic gneiss and amphibolite, also including remnants of paragneiss, quartzite, amphibolite and locally, marble, ultramafic rock, calc-silicate rock and iron formation. The remnants most likely represent tectonic wedges of the Lake Harbour Group and the Nuvulialuk mafic Suite. Tonalitic dykes and pegmatitic granitoids locally cross-cut the gneisses, but have nevertheless been assigned to the complex. The mouth of the George River, near the village of Kangiqsualujjuaq, constitutes the type locality for the unit. The rocks have generally undergone retrograde metamorphism to the middle to upper amphibolite facies, but granulite facies zones that resisted the retrograde metamorphism have been observed locally.

Tonalitic Gneiss

The tonalitic gneiss accounts for about 60% of the complex. It is grey, medium-grained, with heterogranular to granoblastic textures, and is generally well foliated. The constituent minerals are: plagioclase + quartz + biotite ± hornblende ± microcline; accessory minerals include: epidote (pistachite), allanite, sphene, zircon, apatite, magnetite and sulphides. The most commonly observed texture consists of a mortar texture. Most feldspar grains exhibit microcrystals developing along grain boundaries. Microcline is interstitial or occurs in antiperthite in the plagioclase. The biotite is brown to brown-red and the hornblende is olive green. Epidote grains sometimes contain allanite cores, although the mineral is often developed on biotite and plagioclase grains. Rare pyroxenes, garnet, graphite and magnetite have also been observed. In local granulitic pockets located in the NW part of the map area, which are affected by intense deformation zones, garnet is generally associated with pyroxenes. These pockets are probably wedges from deeper, granulitized crustal levels, imbricated with the tonalitic gneiss. Granulite-facies rocks will be described in more detail in the section dealing with the Sukaliuk Complex.

The tonalitic gneiss displays various degrees of migmatization (Appendix, Photo 1). The resulting mobilizate is pink to whitish, granitic in composition and coarse to very coarse-grained. This migmatization phenomenon is represented in spectacular fashion along the eastern coast of Ungava Bay. The relative proportions of plagioclase and potassic feldspar are quite variable in the mobilizate.

The tonalitic gneiss also includes a more dioritic phase, characterized by a greater amphibole and biotite content and a lower content (or even absence) of quartz and potassic feldspar. This rock type is also granoblastic.

The tonalitic gneiss also contains bands and boudins of amphibolite that make up 10 to 30% of the rock (Appendix , Photo 1). This amphibolite is probably Archean, and therefore different from those classified as belonging to the Nuvulialuk Suite. Bands or wedges of paragneiss and amphibolitized mafic rocks, 100 metres wide on average, are intercalated with bands of tonalitic gneiss (Appendix, Photo 7). Metasedimentary bands are compositionally very similar to those of the Lake Harbour Group, whereas mafic and ultramafic rocks resemble those of the Nuvulialuk mafic Suite. The description of these rocks will therefore be included in the descriptions of the Lake Harbour Group and the Nuvulialuk mafic Suite. The larger bands were mapped as Lake Harbour and Nuvulialuk wedges. Finally, a garnetite band, associated with an amphibolite band, was observed near the Koroc River, SSE of our base camp. This garnet-rich rock also contains ribbon quartz, biotite and magnetite.

Baudan Complex

The Baudan Complex is a new unit that designates an assemblage of granitic gneiss to which we have assigned a structural position between the tonalitic gneisses of the Kangiqsualujjuaq Complex and the Lake Harbour Group supracrustal rocks. The granitic gneisses could represent a more deformed and migmatized phase of the supracrustal sequence, however in certain cases, they rather seem to belong with the tonalitic gneisses. The Baudan Complex also includes enclaves of metasediments and amphibolite and numerous intrusions of granitic pegmatite and anatectic granitoids. It is metamorphosed to the middle to upper amphibolite facies.

Granitic Gneiss

The granitic gneiss is a greyish pink to pink rock, foliated to strongly foliated and even mylonitic (Appendix, Photo 2). It is generally medium to coarse-grained, locally nearly pegmatitic. In the field, the granitic gneiss is associated both with the tonalitic gneiss and the paragneiss. It is therefore quite possible that more than one generation of granitic gneiss exists, each related to a remobilization episode, one Archean and one Proterozoic.

TABLE 1 – Principal diagnostic mineral assemblages for Early Proterozoic metamorphic rocks.

LAKE HARBOUR GROUP AND PARAGNEISS REMNANTS IN THE KANGIQSUALUJJUAQ AND BAUDAN COMPLEXES

PARAGNEISS

Muscovite + garnet + biotite + plagioclase + quartz ± microcline
Sillimanite + garnet + biotite + quartz + plagioclase ± muscovite ± granitic mobilizate
Cordierite + anthophyllite + quartz + biotite ± garnet
Garnet + sillimanite + biotite + quartz + plagioclase + orthoclase
Garnet + sillimanite + biotite + cordierite + plagioclase + quartz ± orthoclase

MAFIC ROCKS

Hornblende + plagioclase + biotite ± garnet ± quartz
Hornblende + clinopyroxene + plagioclase ± quartz ± biotite

CARBONATE AND CALC-SILICATE ROCKS

Calcite + olivine + chondrodite + phlogopite + diopside + titanite ± quartz (tremolite)
Calcite + garnet + tremolite + titanite ± diopside ± olivine
Diopside + biotite + plagioclase + titanite + quartz ± microcline ± amphibole ± calcite
Calcite + diopside + scapolite + plagioclase + titanite ± microcline ± biotite (±amphibole ± epidote)

ULTRAMAFIC ROCKS

Olivine + orthopyroxene + clinopyroxene + spinel + hornblende + cummingtonite + tremolite + serpentine
Hornblende + cummingtonite + clinopyroxene + magnetite + serpentine/iddingsite

Sukaliuk complex

Orthopyroxene + hornblende + plagioclase + orthoclase + quartz ± biotite
Hornblende + plagioclase + quartz + orthoclase + biotite
Garnet + sillimanite + biotite + plagioclase + quartz

TASIUYAK GNEISS

Garnet + sillimanite + plagioclase + quartz + perthitic orthoclase ± biotite ± rutile
Orthopyroxene + garnet + perthitic orthoclase + quartz + plagioclase
Orthopyroxene + clinopyroxene + plagioclase ± garnet ± quartz ± hornblende

LOMIER COMPLEX AND IBERVILLE COMPLEX

Orthopyroxene + clinopyroxene + hornblende + plagioclase ± biotite
Orthopyroxene + clinopyroxene + hornblende + plagioclase ± biotite ± garnet
Garnet + orthopyroxene + clinopyroxene + quartz + magnetite

The mineralogy of the granitic gneiss is very similar to that of the tonalitic gneiss, the main difference being that microcline (or orthoclase) is clearly more abundant than plagioclase. The constituent minerals are: microcline + orthoclase + plagioclase + quartz + brown-green biotite and rare hornblende. Accessory minerals are: muscovite ± apatite ± zircon ± allanite ± epidote ± sphene. Sulphides and magnetite are rarely present. The rock is generally heterogranular, and sometimes exhibits microcystals developing along grain boundaries, or else is clearly mortar-textured. Ribbon quartz is very common in intense deformation zones, and an augen texture was observed in several areas. Muscovite generally appears on sericitized plagioclase grains or in association with biotite.

Granulite-facies granitic gneisses were not observed in the Baudan Complex.

Pegmatites

Pegmatites have two modes of occurrence: as dykes and veins cross-cutting the granitic gneiss, paragneiss and mafic rocks, or as metre-scale to kilometre-scale masses, namely in the area between the supracrustal rock sequence of the Lake Harbour Group and the granulitic terrains to the east.

In the field, we also noted that the paragneiss-related pegmatites are generally white, whereas those that cut the granitic and tonalitic gneisses are pink. In certain areas, the pegmatites are easily mistaken for quartz veins. Certain pegmatites are even foliated and folded.

In thin section, the pegmatites are rich in plagioclase and quartz, with interstitial microcline or antiperthite in locally sericitized plagioclase. Muscovite is associated with biotite. Accessory minerals include epidote, zircon, rutile, magnetite and sulphides.

Granite

A few kilometre-scale granitic plutons were outlined. The granite may be distinguished from other granitoids by its massive or weakly foliated texture and its fairly coarse grain size. It locally displays a porphyritic or rapakivi texture (Appendix, Photo 3). The constituent minerals are: microcline (orthoclase) + plagioclase + quartz ± biotite ± hornblende; accessory minerals are: epidote ± muscovite ± chlorite ± zircon ± allanite ± apatite ± sphene ± magnetite ± sulphides ± leucoxene. Myrmetitic textures are frequently observed, and perthites, mesoperthites and antiperthites have also been noted.

The relationship between the granitic plutons and other lithologies in the complex remains ambiguous, as the contacts of these intrusions were never observed in the field.

Lake Harbour Group

The Lake Harbour Group was originally defined by Jackson and Taylor (1972) to designate a sequence of Paleoproterozoic (Aphebian in their text) metasediments that formed part of the Dorset fold belt, found on Baffin Island and northeastern Québec and Labrador. Taylor (1979) reused the term, bringing the unit to the rank of formation with the sole objective of respecting the North American stratigraphic code in use at that time. Hoffman (1988) grouped these metasediments under the informal heading "Koroc River sediments", while acknowledging their affiliation with the Lake Harbour Group. Girard (1990a, 1990b and 1990c) used the term Koroc River Group, which was also used by Clark (1994). We wish to abandon the term Koroc River Group as it offers no clear advantage, in our opinion, and because it was preceded by the term Lake Harbour Group, which should therefore have precedence. As the unit occupies a large surface area, and since it is composed of several mappable lithofacies, we prefer to maintain the rank of group rather than formation introduced by Taylor. We have chosen to include certain isolated metasedimentary bands that had not been included by Taylor (1979) in the group, as they are compositionally identical. However, more detailed age dating may modify these correlations in the event that Archean metasediments would be discovered among the wedges imbricated in the tonalitic or granitic gneiss.

In the Koroc River area, the Lake Harbour Group comprises a sequence of quartzites, paragneisses, calcitic or dolomitic marbles, calc-silicate rocks and metabasalts with an apparent thickness of about one kilometre. The stratigraphic boundaries of the group are not exposed and even its sedimentary polarity remains uncertain. The lower contact in the northern part of the area, near the Baudan River, is a ductile shear zone, if not a detachment zone. Marbles found at the "base" of the sequence in this area could also represent a more ductile horizon where deformation was concentrated. Pink pegmatites between one and three metres thick were observed in several locations, at the contact between the Archean gneisses and the Proterozoic marbles. Everywhere else, the lower contact consists of a fault in a ductile shear zone. The upper contact was never observed.

Paragneiss

The group is represented, for the most part, by a fine- to medium-grained, dark grey to black paragneiss that alters to a rusty brown colour. Beds are generally thick to very thick. In a sequence NE of Lac Daniel, underneath a thick quartzite sequence, the paragneiss outcrops in one to ten-metre thick beds alternating with quartzite beds. Elsewhere, it is the predominant unit in supracrustal sequences (Appendix, Photos 4, 5 and 6). A strong foliation, marked by ribbons of quartz-rich mobilizate, is generally present.

Essential minerals are: quartz + biotite + plagioclase ± garnet ± sillimanite, with local microcline. Accessory minerals are: cordierite, zircon, apatite, graphite, allanite, rutile, sulphides, magnetite and tourmaline. Garnet is poikiloblastic or occurs as small grains. Garnet porphyroblasts may contain inclusions of quartz, biotite, plagioclase, sillimanite, cordierite, zircon, magnetite and graphite, which indicates that garnet is a late phase in the paragenesis of the paragneiss. Sillimanite and fibrolite, a fibrous variety, form mm- to cm-scale nodule-shaped lenses in association with muscovite. Locally, these nodules also contain small garnets. They could represent relics of unstable garnet. Graphite is also a characteristic mineral of the paragneiss unit.

The paragneiss often contains mm- to cm-scale bands of quartzofeldspathic mobilizate, which replaces the protolith in variable proportions. The mineralogy of the mobilizate is: microcline and orthoclase + plagioclase + quartz ± garnet ± sillimanite (fibrolite) ± muscovite ± biotite ± graphite. Plagioclase and potassic feldspar also form porphyroblasts with inclusions of quartz, feldspar, magnetite, graphite, biotite, etc. The mobilizate has also been affected by a variable degree of deformation in several locations, and has been transformed into protomylonite and even mylonite.

The simultaneous presence of garnet, cordierite and sillimanite frequently coincides with the presence of abundant, locally massive sulphides.

Quartzite

Quartzites are most commonly observed in the Barnouin River area, where they form the apparent top of the group (Appendix, Photo 4). They also occur in lesser quantities as dirty (impure) quartzites intercalated with the paragneiss.

Quartz constitutes at least 75 to 80% of the rock, but biotite is nearly ubiquitous. It is locally replaced by muscovite. Plagioclase and microcline have also been observed. Tourmaline is fairly common, sometimes accompanied by apatite, zircon and graphite. Quartzites, much like paragneisses, may also contain sulphides and magnetite.

Quartz grains are either lens-shaped, ribbon-shaped or display serrate grain boundaries. Micaceous minerals sometimes give a lepidoblastic texture to the rock, especially obvious in thin section, but which also gives the quartzite a bedded aspect on occasion. The quartzite is frequently cut by quartz veins and veinlets.

Marble and Calc-Silicate Rock

The marble forms thin sequences, generally observed at the base of the group in the northwest part of the map area. The marble is generally calcitic, although dolomitic marble has also been observed. It is also associated with calc-silicate rocks, and may contain quartzite beds. It is less frequently intercalated with paragneiss sequences (Appendix, Photo 5). Marbles and calc-silicate rocks are medium- to coarse-grained, strongly deformed and display a granoblastic texture. A low-temperature deformation episode produced a mylonitization, which resulted in a grain size reduction of certain marbles.

The principal minerals observed are: carbonates ± phlogopite ± tremolite ± olivine ± diopside ± scapolite. Olivine is variably altered to serpentine and iddingsite, and certain crystals have been partially replaced by chondrodite. The marble also contains a wide variety of accessory minerals: sulphides, apatite, graphite, sphene, garnet, epidote, zircon, tourmaline, quartz and feldspar. The marble may be equi- or heterogranular, and is generally well foliated. It is locally strongly deformed and sometimes occurs as cm- to m-scale boudins within calc-silicate rocks or paragneiss units.

Certain olivine and spinel-bearing carbonate rocks associated with ultramafic rocks will be discussed in a later section dealing with the ultramafic rocks.

Calc-silicate rocks are generally related to the marbles, and have more or less the same field distribution. Their mineralogy is very different however. In addition to carbonates, diopside, tremolite, epidote, scapolite, plagioclase, quartz and sphene form the constituent minerals for these rocks. Diopside has been observed as the dominant mineral in two outcrops. Hornblende, apatite, olivine, phlogopite, plagioclase, garnet, spinel, chlorite, zircon and allanite are also present locally. Where present, olivine is rimmed by clinopyroxene, and it is often serpentinized.

Marbles and calc-silicate rocks frequently occur at the contact between paragneisses of the Lake Harbour Group and tonalitic gneisses of the Kangiqsualujjuaq Complex. As several of these contacts are tectonic, it is possible that the marbles and calc-silicate rocks may have served as ductile material that facilitated movement along shear planes.

Metabasalt

A metabasalt unit was recognized in an escarpment south of the Barnouin River, intercalated with quartzite and paragneiss, near the basal tectonic contact between the Lake Harbour Group and the Baudan Complex. It is fine-grained to aphanitic, dark green to black, and forms massive, pillowed or brecciated flows. However, it is impossible to determine its topping direction or true thickness, as it is too strongly deformed.

The metabasalt is essentially composed of hornblende, plagioclase, opaque minerals and local clinopyroxene. Hornblende gives a nematoblastic texture to the rock, whereas plagioclase is rather granoblastic. The hornblende is locally altered to biotite. The most common opaque minerals are sulphides, with minor oxides. Sphene, apatite and magnetite are scattered throughout the rock. Epidote appears as an alteration phase of plagioclase and mafic minerals. Quartz, a very minor phase, is either interstitial or occurs as globules in hornblende grains.

Garnetite

Garnetite has been observed in three outcrops (99-DB-3046, 99-GB-6090 and 99-SP-4007) within the Lake Harbour Group, always associated with paragneiss. Two of these occurrences contain diopside and sphene with or without calcite, plagioclase, epidote, magnetite and sulphides. The third (99-GB-6090), which occurs within paragneisses of the Falcoz zone, also contains quartz, apatite, sulphides, red biotite, magnetite and monazite. This garnet- and quartz-rich rock contains cm-scale bands formed of a well crystallized mineral and of phosphorus-rich colloform minerals that were identified by microprobe. The well crystallized mineral is harrisonite, a calcium and iron silico phosphate. This is the second known occurrence of this mineral in the world. Up until now, it had only been recognized in a sample collected on Arcedeckne Island, in the District of Franklin in the Canadian Arctic (Roberts *et al.*, 1993). The description given by Roberts *et al.* (1993)

leads us to believe that the geological context is the same for both known occurrences, i.e. a metasedimentary host rock in a highly metamorphosed environment. In the Koroc River area, microprobe analyses also revealed the presence of several colloform phases most likely produced by the alteration of harrisonite and sulphides during the Cretaceous era. These minerals consist of iron and alumina-rich hydrated sulfophosphates. To our knowledge, minerals with this type of composition have never been documented. The rock also contains disseminated pyrite, pyrrhotite, chalcopyrite, apatite, ilmenite and monazite with traces of interstitial gypsum. A detailed mineralogical study of this locality will by published by Cimon *et al.* (in preparation).

Nuvulialuk Mafic Suite

The Lake Harbour Group is cut by amphibolitized mafic rocks, sometimes accompanied by ultramafic rocks (dunite, peridotite, pyroxenite), which we interpret as differentiated metagabbros injected as sills and dykes (Appendix, Photo 4). These mafic rocks also occur as bands imbricated within the gneissic complexes (Appendix, Photo 7). Several of these mafic and ultramafic rocks have kept their primary mineralogy, and contain primary magmatic pyroxene and olivine. This is an important feature as it indicates that they were emplaced after the peak of metamorphism, which occurred in the Early Proterozoic (1.8 Ga). Certain wedges were however metamorphosed to the amphibolite facies. This also suggests that they cannot be contemporaneous with metabasalts of the Lake Harbour Group.

Metagabbro

The mineralogy of metagabbros is essentially the same as for metabasalts: hornblende, plagioclase and opaque minerals, with biotite. They are coarser-grained and have a more massive aspect compared to the metabasalts, despite a ubiquitous foliation. In certain areas, clinopyroxene and orthopyroxene relics have been observed, mainly in the central portion of gabbroic bands. Near the contacts, where fluids were able to circulate more freely, gabbros are completely amphibolitized. Minor garnet has also been observed locally.

Meta-Ultramafic Rock

Four ultramafic rock types were identified, based on the relative proportions of olivine, pyroxene and amphibole; hornblendite, pyroxenite, peridotite and dunite.

The dunite is essentially composed of olivine with minor pyroxene. Undeformed dunite is equigranular, much like a cumulate rock. It is also characterized by the presence of abundant dark green to brownish green spinel, as inclusions in olivine or interstitial. Clino- and orthopyroxene, phlogopite and magnetite are present between olivine crystals. Deformation and metamorphism have resulted in variable serpentinization (and iddingsitization) of olivine, and by the formation of randomly oriented acicular tremolite and clinochlore crystals.

As the pyroxene content increases, the rock becomes a peridotite composed of large olivine, orthopyroxene and clinopyroxene crystals (Appendix 1, Photo 8). In these rocks, the effects of deformation and metamorphism are also outlined by the serpentinization of olivine and the formation of tremolite and clinochlore. Serpentinization is accompanied by the formation of iddingsite, but without magnetite, which emphasizes the high magnesium content of olivine grains. Small olivine inclusions were noted in the pyroxenes. Disseminated spinel and magnetite are also present, as well as local disseminated sulphides. Rare epidote has been observed, developing on amphibole and chlorite grains. Locally, late fractures in the rock contain carbonates, prehnite and epidote.

Certain thin sections of carbonate rocks associated with the ultramafic rocks are characterized by the abundance of olivine, pyroxene and spinel crystals along with the carbonates. Similar rocks in the Gaspé area were interpreted as altered and metamorphosed products of ultramafic rocks (Beaudin, 1980). These altered rocks are called listwaenites (Belhumeur and Valiquette, 1993; P. Gosselin, 1999, personal communication).

The pyroxenite is formed of large clino- and orthopyroxene crystals, with minor olivine. During deformation and metamorphism, a fair portion of these pyroxenes was transformed into granoblastic aggregates of pyroxene and amphibole in variable proportions, accompanied by minor clinochlore. Spinel appears at the triple junctions within these aggregates. Even the large pyroxene crystals are transformed into amphibole, which occurs as pockets within the grains or at the periphery. These rocks are well foliated. In intense deformation zones, the rock is transformed into tremolite-chlorite schist, with a strongly nematoblastic texture. Accessory minerals include magnetite, rutile, sulphides and apatite.

The hornblendite is a medium to coarse-grained equigranular rock composed of hornblende, tremolite, actinolite, biotite, chlorite and local interstitial plagioclase. Accessory minerals are apatite, magnetite and sulphides. These rocks could represent metamorphosed pyroxenites and even peridotites.

We would like to highlight the fact that certain orthopyroxene-bearing ultramafic rocks, in intrusions or as tectonic slices within the gneiss and paragneiss, occur in amphibolite-facies environments. However, the ultramafic rocks do not represent granulite-facies rocks, nor do they display any evidence of amphibolitization. It is therefore possible that these rocks were emplaced rather late in the history of the area, i.e. after the thermal peak of the latest orogenic event.

Torngat Orogen

The Torngat Orogen comprises the following units, from west to east: the Sukaliuk Complex, the Lomier Complex, the Tasiuyak Gneiss and the Iberville Complex. The orogen is characterized by intense deformation, with a strongly developed N-S trending subvertical foliation and tectonic layering, as well as a strong subhorizontal lineation that affects all the rocks.

Sukaliuk Complex

The Sukaliuk Complex is a new term that we have introduced to designate a series of granulite-facies supracrustal rocks (paragneiss, quartzite, marble), orthogneisses, and mafic and ultramafic rocks. Sometimes included in the Lomier Complex (Girard, 1990 a, b, c), these rocks are most frequently associated with the Far North craton (see Wardle and van Kranendonk, 1996, for a review). However, the degree of metamorphism and the nature of the intense deformation clearly indicate that they belong to the Torngat Orogen. The Sukaliuk Complex contains the following lithologic assemblages: tonalitic and granitic gneisses related to those of the Kangiqsualujjuaq and Baudan complexes, granulitic gneisses of unknown origin, remnants of paragneiss, marble and calc-silicate rocks equivalent to those of the Lake Harbour Group, amphibolite remnants possibly equivalent to the Nuvulialuk mafic Suite and ultramafic rocks of unknown affinity.

Undifferentiated Granulitic Gneiss

The granulitic gneisses include rocks of granitic to tonalitic composition that could not be differentiated in the field. These rocks often form sequences with rapid successions of granitic gneiss (rich in potassic feldspar), tonalitic gneiss (rich in plagioclase) and cm- to m-scale bands of mafic rocks and paragneiss (Appendix, Photo 9). The entire compositional spectrum between the granitic and tonalitic end members is represented in this unit. The widely variable mineral composition of these granulitic gneisses suggests that they are not part of a charnockitic suite (mangerite – charnockite – enderbite).

The granulitic gneisses are composed of variable proportions of plagioclase, microcline-orthoclase and quartz, with orthopyroxene, clinopyroxene, hornblende and biotite. Potassic feldspar grains are micro- to mesoperthitic. Garnet, as porphyroblasts or small grains, is not always present but is nevertheless fairly common. Accessory minerals include apatite, magnetite, zircon, sulphides and carbonates. These carbonates appear in the interstices between the constituent mineral phases and as alteration products of feldspars. Rock textures vary from heterogranular to granoblastic.

We have also included in this unit garnet-bearing quartzofeldspathic gneisses that appear to be strongly related to the Tasiuyak Gneiss. These gneisses, which outcrop in the eastern part of the map area, will be described in a later section.

Granulitized Tonalitic Gneiss

The granulitized tonalitic gneiss constitutes the second most abundant lithology in the Sukaliuk Complex. This gneiss generally does not contain microcline, however its mineralogy is otherwise identical to that of the undifferentiated granulitic gneiss. Furthermore, it displays the same textures and minerals as the tonalitic gneisses previously described, with the addition of clino- and orthopyroxene and red, orange red or red brown biotite. Garnet has also been observed.

Paragneiss with Quartzite, Amphibolite, Ultramafic Rock, Marble and Calc-Silicate Rock

Paragneiss, quartzite, amphibolite, ultramafic rock, marble and calc-silicate rock units encountered in the Sukaliuk Complex are similar to those already described in the units west of the Blumath shear zone, in the Lake Harbour Group and Nuvulialuk mafic Suite. However, the degree of deformation is higher, and the paragneiss units in this complex are associated with granulitic rocks.

Lomier Complex

The term Lomier Complex was introduced by Girard (1990). In the type locality south of the Koroc River area, the complex comprises an undifferentiated portion composed of granulitic gneisses of enderbitic, charnockitic, tonalitic and granitic composition, and of a magmatic suite called the Courdon intrusive Suite (Girard, 1990) (this suite has not been identified in our map area), which includes enderbite, tonalite, opdalite, granodiorite, gabbro and ultramafic rock. These rocks are Proterozoic in age, as they cross-cut the Lake Harbour Group. They also cross-cut the Tasiuyak Gneiss. The Lomier Complex in the type locality is also characterized by a high total magnetic field and a high magnetic gradient.

In the Koroc River area, rocks assigned to the Lomier Complex include an assemblage of tonalitic granulitic gneisses and an assemblage of granulitic orthogneisses that belong to an anorthosite-mangerite-charnockite-granite (AMCG) suite. It is possible that the tonalitic gneisses may belong to the same suite. Orthogneisses of the AMCG suite could be correlated to magmatic rocks of the Courdon intrusive Suite recognized by Girard (1990).

Enderbite, Mangerite and Charnockite

Orthogneisses of the Lomier Complex consist of orthopyroxene-bearing granitoids of variable composition. The different phases were not differentiated on the map. The main field characteristics of these rocks are their uniform mineral composition, their fairly constant texture over wide surface areas and the apparent absence of intensive remobilization during their deformation. It is possible that these orthogneisses represent an orthopyroxene-bearing intrusive suite associated with anorthositic rocks found in the same complex. The weakly remobilized aspect of these orthogneisses, combined with the strong magnetic anomaly that characterizes the Lomier, distinguish this unit from granulitic rocks of the Sukaliuk Complex.

The constituent minerals, present in variable proportions in the orthogneisses, are: plagioclase, microcline-orthoclase (most commonly mesoperthitic) and quartz, generally in ribbons, with orthopyroxene, and sometimes clinopyroxene and biotite. Accessory minerals are zircon, allanite and apatite. The texture of these rocks is generally heterogranular to granoblastic, but it becomes mylonitic in several locations, as several faults and deformation zones run across the complex.

Anorthosite and Gabbroic Anorthosite

This lithologic unit is reported for the first time in the Lomier Complex west of the Tasiuyak Gneiss, although Goulet and Ciesielski (1990) did signal the presence of anorthosite remnants near the western margin of the Tasiuyak Gneiss in the Abloviak shear zone, in the fjord that bears the same name. We have assigned the anorthositic unit to the Lomier Complex, since the transition from this anorthosite to the orthogneissic unit described above is gradual.

The anorthosite is grey-white and foliated, sometimes even mylonitized. It is essentially composed of plagioclase and aggregates of clinopyroxene-orthopyroxene-hornblende ± biotite, with zircon, apatite, magnetite and sulphides as accessory minerals. Garnet, sphene and rutile are localy observed. Anorthosites display granoblastic, mortar and porphyroclastic textures. These rocks often contain veinlets of ribbon quartz. In intense deformation zones, anorthosites and gabbroic anorthosites become fine to medium-grained with a well developed granoblastic texture. Most plagioclase grains are polygonized, and primary porphyroclasts are sometimes visible. Pyroxenes form streaks composed of polygonal crystals accompanied by rare pyroxene porphyroclasts. Garnet is poikiloblastic or occurs as small grains. Rarely, thin sections show plagioclase grains being transformed into scapolite, indicating late hydrothermal alteration of these rocks.

Garnetites locally occur within these anorthositic horizons as one to ten-metre thick bands composed of strongly poikilitic garnet with inclusions of deformed quartz, magnetite, zircon and diopside. Accessory minerals include apatite, magnetite and zircon.

Amphibolite

Amphibolites in the Lomier Complex are similar to those in other previously described units. The reader is referred to the description of amphibolites of the Sukaliuk Complex.

Tasiuyak Gneiss

The Tasiuyak Gneiss was formally named by Wardle (1983). In our map area, the unit mainly outcrops in the Hébron area (NTS sheet 14L). A narrow portion was also observed in the NE corner of the region in NTS sheet 24I (Koroc River). The term Tasiuyak Gneiss designates a very characteristic assemblage of strongly deformed garnet-bearing quartzofeldspathic gneiss. In the map area, the unit is very homogeneous. It forms a N-S band 8 to 12 km in width, bounded to the west by granulitic orthogneisses of the Lomier Complex and to the east by anorthositic gneisses of the Iberville Complex.

Garnet-Bearing Quartzofeldspathic Gneiss

This unit is easy to identify on a regional scale, thanks to the following field characteristics: whitish to light pink colour, very leucocratic nature, ubiquitous pink-mauve to reddish garnets and intense deformation represented by a very strong subhorizontal lineation (Appendix, Photo 10).

The gneiss is composed of plagioclase, potassic feldspar, quartz, biotite, garnet, orthopyroxene, sillimanite and minor clinopyroxene. The potassic feldspar is either orthoclase or microcline with meso- and microperthite. The feldspars are generally polygonal, thereby defining an impressive granoblastic texture. In thin section, quartz almost always occurs as thin monocrystalline to polycrystalline ribbons. On outcrop, quartz forms thin rods that define the very well developed omnipresent lineation. Garnet is poikiloblastic. It is often elongated parallel to the foliation, and sometimes forms sigmoid figures which nearly always indicate a sinistral movement. Textural evidence suggests that the garnet formed during a very late phase of mylonitic deformation. Accessory minerals are: zircon, rutile, graphite, apatite, magnetite and sulphides.

Garnetite (map sheet 14L)

Along the eastern margin of the unit, near the contact with the anorthosites, outcrops a garnetite unit different from those in the Lomier Complex. About 10 metres thick, it contains garnet, clino- and orthopyroxene, as well as quartz, apatite, magnetite or ilmenite, zircon, sphene and graphite as accessory minerals. Garnet is poikiloblastic and contains inclusions of pyroxene, quartz and apatite. The granoblastic texture is very well developed. Pyroxenes occupy the interstices between quartz grains, which form large poikilitic crystals in optical continuity. Epidote is also present between quartz grains.

We cannot reject the hypothesis that this garnetite is associated with anorthosites of the Iberville Complex, which also contains one to ten-metre thick bands of dark coloured, strongly oxidized rocks very similar to the unit described here (Appendix, Photo 11). In the field, these very dark rocks strongly contrast with the lighter-coloured anorthosite.

Iberville Complex (sheet 14L – Hébron area)

The Iberville Complex is a new unit that we have introduced to designate the series of anorthositic and granulitic gneisses that outcrop to the east of the Tasiuyak Gneiss. The anorthositic part of the complex could be correlated with the Hutton anorthositic suite observed further north by van Kranendonk and Wardle (1993). Isotopic studies performed on the Hutton anorthositic suite were inconclusive; it could be Late Archean or Early Proterozoic in age. In the map area, the Iberville Complex appears to be in structural contact with the Tasiuyak Gneiss.

Lithology descriptions are brief. Very few outcrops were visited during our field mapping program.

Anorthosite and Gabbroic Anorthosite

Anorthosites in the Iberville Complex are petrographically identical to those of the Lomier Complex. They are strongly deformed and recrystallized. They often contain narrow and elongate mafic bands, which gives the appearance of straight gneisses (Appendix, Photo 12).

Granulites

Granulites basically share the same mineralogy and texture as the granulitic gneisses of the Sukaliuk Complex.

Nain Province (sheet 14L – Hébron area)

Saglek Gneiss (Four Peaks Domain)

The Saglek Gneiss, in the Four Peaks Domain (Figure 2), designates an assemblage of Archean granulitic gneisses affected by the Torngat Orogen and which could represent reworked rocks of the Nain. This gneiss appears to be cross-cut by a diabase dyke in one of the outcrops we visited.

The Ramah Group, a Proterozoic metasedimentary sequence that unconformably overlies the Saglek Gneiss, outcrops only in Labrador, and is not described in this report. The Ramah Group may be contemporaneous with the Lake Harbour Group.

Late Intrusions

Falcoz Diabase (sheet 24I)

The term Falcoz Diabase was introduced by Girard (1990) to designate late dykes in the Lac Courdon area, southeast of our map area. The Falcoz Diabase in our study area comprises a series of undeformed and unmetamorphosed gabbro and diabase dykes that cross-cut all other units. They have been observed both in the Torngat Orogen and in the Far North craton.

The most important dyke is located in the south-central part of the area, southeast of Lac Blumath, where it is discontinuously injected in a NW-SE-trending fracture. It reaches up to 50 m thick, and is medium-grained. All other dykes and sills are generally one metre thick and nearly aphanitic.

It is possible that the diabase dykes in the area belong to more than one intrusive suite. Only detailed geochemical and geochronological studies will allow us to clarify their origin.

The mineralogy of the ophitic-textured diabase is fairly constant: plagioclase + olivine ± clinopyroxene ± orthopyroxene ± spinel ± magnetite. Hornblende and biotite sometimes appear as alteration products of pyroxene. In certain dykes, olivine and plagioclase seem to have gone through two phases of crystallization, one that produced phenocrysts and the other to form the groundmass. Locally, skeletal plagioclase crystals, a rapid cooling texture, have been observed.

Two types of diabase have been noted. The first features thin rims of clinopyroxene or green or blue hornblende around olivine crystals in contact with plagioclase, whereas this coronitic texture is absent in the second type. Olivine grains often contain inclusions of opaque minerals similar to those found in the pyroxene grains, and which form schiller textures. Where olivine grains come in contact with clinopyroxene, the corona is absent. In coronitic diabase, the magnetite is also rimmed by finely crystalline reddish biotite. Magnetite crystals sometimes display a skeletal texture due to rapid cooling. Plagioclase and clinopyroxene sometimes exhibit zoning.

METAMORPHISM

The central and western portions of the map area are underlain by rocks at the middle to upper amphibolite facies, with remnants of granulite-facies rocks. South of the Koroc River and east of Lac Daniel, in the Lake Harbour Group, mineral assemblages indicate middle amphibolite facies conditions. The eastern part of the map, underlain by the Torngat Orogen, is characterized by mineral assemblages indicative of granulite-facies conditions with zones at the middle to upper amphibolite facies. Locally, along ductile and brittle shear zones, retrograde metamorphic conditions have been observed to the greenschist facies.

Previous studies on the metamorphism of the map area include Taylor (1979) who described the main characteristics of the metamorphism of the study area. Van Kranendonk (1996), Mengel and Rivers (1991) and Rivers *et al.* (1996) described the metamorphism of adjoining regions northward and eastward. They describe in detail the tectono-metamorphic evolution of the Torngat Orogen.

The Kangiqsualujjuaq and Baudan Complexes

The tonalitic gneiss of the Kangiqsualujjuaq Complex and the granitic gneiss of the Baudan Complex are characterized by several phases of metamorphism, as shown by the complex migmatization process that affected both the tonalitic and granitic gneiss, by the presence of remnants of granulite-facies rocks in the tonalitic gneiss, and by the presence of several zircon overgrowths of various ages. These rocks were metamorphosed to the middle to upper amphibolite facies (Table 1) and to the granulite facies during the Archean and Paleoproterozoic.

Locally, remnants of granulite-facies tonalitic gneiss were observed in the northern part of the area. They are characterized by the presence of orthopyroxene or clinopyroxene (Table 1). However, the orthopyroxene and clinopyroxene are locally replaced to a variable extent by hornblende and other alteration products. The granulite facies was also reached in certain amphibolite horizons and boudins that contain pyroxene in tonalitic and granodioritic leucosomes. The presence of hornblende coronas around the orthopyroxene crystals suggests that these rocks underwent one or several episodes of retrograde metamorphism at the amphibolite facies.

The high degree of migmatization, the great structural complexity observed in the tonalitic gneiss, the presence of diatexite in the Baudan Complex, the preserved zones of granulite-facies rocks and the development of middle to upper amphibolite-facies mineral assemblages overprinting granulite-facies assemblages indicate that the Kangiqsualujjuaq and Baudan complexes underwent at least two tectono-metamorphic events; an initial prograde event during the Archean, and the other prograde and retrograde during the Paleoproterozoic. This conclusion is confirmed by results of the isotopic study described in Chapter 7.

The Lake Harbour Group

Contrary to rocks of the Kangiqsualujjuaq Complex, the Lake Harbour Group is characterized by a single major metamorphic event. This high-grade event occurred during the Paleoproterozoic.

South of the Koroc River and east of Lac Daniel, rocks of the Lake Harbour Group are characterized by diagnostic mineral assemblages indicating middle to upper amphibolite facies conditions (Table 1). In a few paragneiss thin sections, prograde muscovite disappears and is replaced by sillimanite. One thin section also contains a cordierite + anthophyllite assemblage. The presence of prograde muscovite, the weak degree of migmatization of paragneiss units and the presence of cordierite reflect metamorphic conditions qualitatively estimated between 550 and 600°C and below six kilobars (0.6 GPa) for this portion of the Lake Harbour Group.

In the north and west portions of the map, the Lake Harbour Group and the paragneiss remnants within the Kangiqsualujjuaq and Baudan complexes are characterized by metamorphic assemblages typical of the middle to upper amphibolite facies, and locally up to the granulite facies (Table 1). Muscovite is absent from the paragneiss assemblages, which are migmatized. Garnet occurs in both pelitic and mafic assemblages. Cordierite is frequently observed in pelitic assemblages. Locally, orthopyroxene has been observed in quartzofeldspathic gneisses associated with graphitic paragneiss. Clinopyroxene is locally observed in quartz-free amphibolites. In carbonate units, olivine is common in marbles, whereas diopside and scapolite occur mainly in calc-silicate units, and more rarely in marble units. Based on the various petrogenetic grids for pelitic rocks, metamorphic conditions are qualitatively estimated between 600 and 750°C and between five and eight kilobars (0.5 to 0.8 GPa).

The Torngat Orogen

Rocks in the Saglek Gneiss, Iberville Complex, Tasiuyak Gneiss and Lomier and Sukaliuk complexes are metamorphosed to the granulite facies, with the exception of a few zones in the Sukaliuk Complex where middle to upper amphibolite-facies zones were observed. Table 1 presents the main diagnostic assemblages encountered in these geologic units.

Rivers *et al.* (1996) and van Kranendonk (1996) determined the metamorphic conditions for the Tasiuyak Gneiss in the Saglek area and in the North River area in Labrador. In the Saglek area (Labrador), maximum pressure and temperature conditions are estimated between 10 and 12 kbars (1.0 and 1.2 GPa) and about 850°C. Pressure conditions of 6 to 7 kbars (0.6 to 0.7 GPa) and temperatures of 650 to 750°C, measured in the Abloviak deformation zone, are associated with retrograde metamorphism due to uplift. In the North River area, southeast of our map area, maximum pressure and temperature conditions reached 9.5 kbars (0.95 GPa) and 950°C; however, mineral assemblages were re-equilibrated at 7 kbars (0.7 Gpa) and 750°C (van Kranendonk, 1996). In the Lomier Complex, van Kranendonk (1996) believed pressure conditions were lower than those in the Tasiuyak Gneiss and Iberville Complex, given the absence of clinopyroxene and garnet in mafic rocks. Estimated pressure and temperature conditions are 6.8 to 7.7 kbars (0.68 to 0.77 GPa) and around 800°C. Both van Kranendonk and Taylor (1979) observed a reduction of the metamorphic grade westward.

Our field observations lead us to conclude that this westward decrease in metamorphic grade is not gradual. In the Sukaliuk Complex, we mapped rectilinear bands of granulite-facies rocks alternating with amphibolite-facies rocks, most frequently tonalitic gneiss. These bands, generally on the order of one kilometre thick, are bounded by ductile to brittle shear zones.

Retrograde Metamorphism

Late brittle faults and deformation zones are characterized by chloritization, epidotization and sericitization of the country rocks. These alterations, typical of the greenschist facies, are mostly visible along fault planes, along fractures and microfractures and in the vicinity of these structures. In thin section, these alteration patterns are characterized by the development of chlorite and epidote in replacement of mafic minerals, by the sericitization and saussuritization of plagioclase and by the development of hematite veinlets. In mineralized zones, pyrite and pyrrhotite are often associated with these retrograde alterations, probably caused by hydrothermal fluid circulation.

STRUCTURAL GEOLOGY

Structural Domains

The Far North craton of the Koroc River area and of surrounding terrains is subdivided into several structural domains with a relatively complex nomenclature (see Clark, 1994). As a general guide, the Far North craton is divided into two structural domains: the western Kuujjuaq domain and the eastern George River domain, separated by the sinistral George River shear zone (Figure 2).

In the Koroc River area, the George River domain extends southward to the Falcoz zone, south of which begins the Ford River domain, and northward and eastward to the Torngat Orogen (Figure 2). The Far North craton is separated from the Torngat Orogen by the 5 to 10 km wide Blumath deformation corridor (Figure 3), composed of several faults and shear zones, and where amphibolite and granulite-grade rocks alternate. This zone contains a very large number of pegmatitic intrusions. Shallow east and southeast dips in the Far North craton rapidly become subvertical and N-S oriented east of the Blumath deformation corridor, in the Torngat Orogen. Likewise, the metamorphism abruptly changes from the amphibolite facies in the west to the granulite facies east of the Blumath deformation zone.

For the purposes of structural analysis, we subdivided the Koroc River area into six structural domains, bounded by major faults and shear zones (Figure 5).

The Far North craton is characterized by an intense NE-SW striking foliation that dips at about 20° SE, as well as a strong tectono-metamorphic lineation that plunges 18° SE on average, attributed to an early episode of the Trans-Hudson Orogeny (Torngat)(Figure 6). An earlier, probably Archean, foliation is namely observed in mafic enclaves within tonalitic gneiss. Contacts between stratigraphic units occur along reverse faults parallel to the main foliation (N040°/20°). Dextral and sinistral shear zones oriented NW-SE and steeply dipping, (such as the Falcoz zone) are interpreted as riedel shears related to major N-S strike-slip faults observed in the Torngat Orogen. This shearing produced an important NW-SE striking foliation (N251°/50°), which affected the first NE-SW foliation (Figure 6). In the south part of the Far North craton, where the Falcoz shear zone occurs, this foliation is even more pronounced. Only the Lake Harbour East domain (LHE) exhibits foliations and lineations intermediate between those of the Lomier and Lake Harbour West (LHW) domains (Figure 6).

In the Torngat Orogen, a strong subvertical N-S striking foliation, a subhorizontal N-S trending lineation and dominantly sinistral kinematic indicators reveal the presence of intense shearing (Figure 6). Brittle N-S faults parallel to ductile shear zones attest to late tectonic activity.

Shear Zones

Several ductile deformation zones or corridors cut across the area, in three main orientations: WNW-ESE, N-S and NE-SW.

WNW-ESE faults and shear zones are restricted to the Far North craton. The most important WNW-ESE zone is the Falcoz zone. It consists of a 5 to 7 km wide deformation corridor that contains several faults which display both dextral and sinistral movements, indicating a very complex history. A bit further north, the Lac Daniel fault exhibits both brittle fracture features and ductile structure characteristics. Its zone of influence, about 100 metres wide, is narrower than that of the Falcoz zone. Still further north, on the Barnouin River, the extent and intensity of deformation suggest the presence of an important shear zone 2 to 3 km wide, which joins up with the one that borders the Lake Harbour Group to the south. Finally, several other zones oriented NW, the largest located just north of the Baudan River, reactivate and fold NE-SW oriented thrust faults.

The Blumath deformation zone, oriented N-S, crosses the area and separates the Far North craton from the Torngat Orogen. This important zone also marks the transition between the amphibolite facies in the west and the granulite facies in the east. In the southern part of the area, in the Lac Tasirlaq sector, the Blumath and Falcoz zones join up to form a single corridor that extends southward. To the east, several other N-S shear zones and faults generally display sinistral kinematic indicators. Some of these faults have a brittle aspect: the rock is brecciated and contains pseudo-

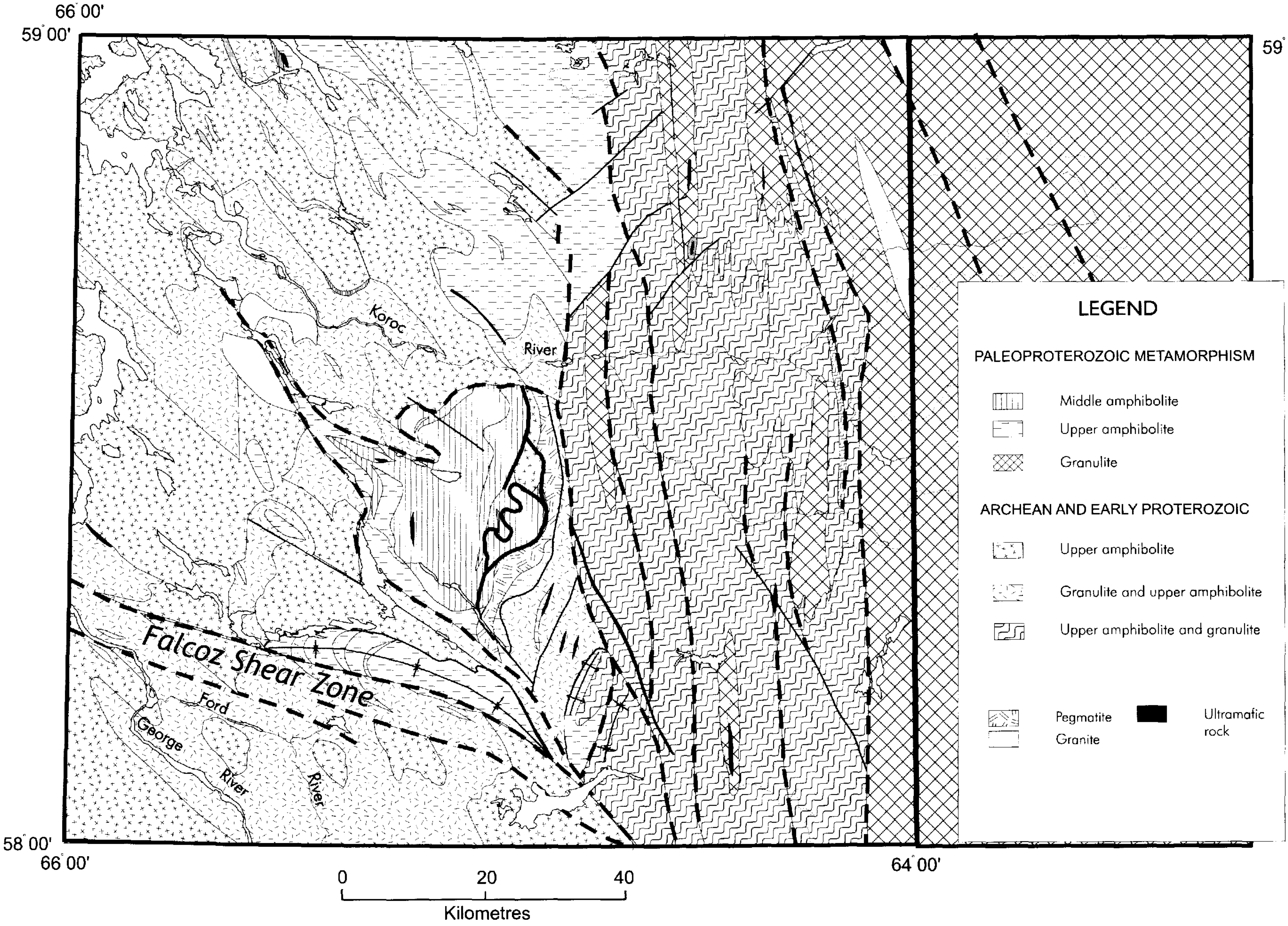

FIGURE 4 – Simplified regional geology with metamorphic domains.

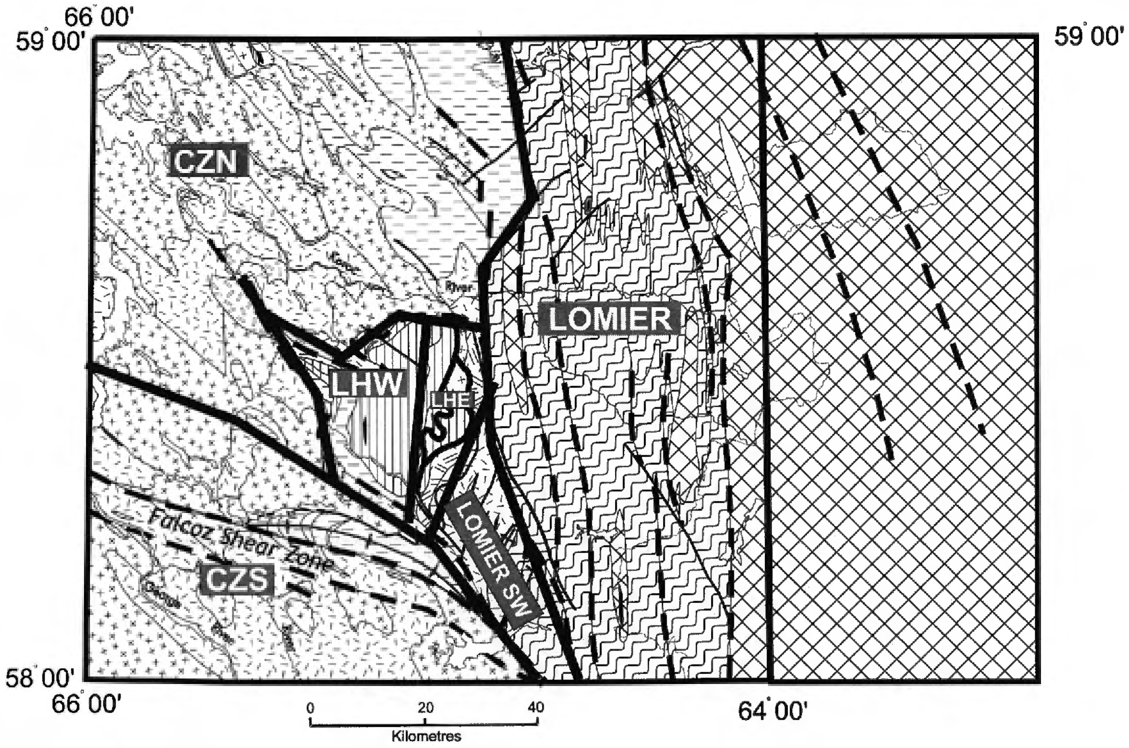

FIGURE 5 – Simplified regional geology with structural domain boundaries. CZN : north part of the Far North craton; CZS : south part of the Far North craton; LHE : east part of the Lake Harbour Group; LHW : west part of the Lake Harbour Group (see Figure 4 for legend).

tachylites, namely along the contact between the Sukaliuk Complex and the Lomier Complex. The influence of these N-S faults and shear zones on the NW-SE faults is rather ambiguous. NW-SE faults seem to converge towards the Blumath zone, which suggests that this N-S zone is late relative to NW-SE structures. However this zone may have been reactivated more than once. An early episode of movement may even have preceded the formation of these structures. NW-SE zones could be contemporaneous with NE-SW structures, as they seem to form a conjugate pattern.

NE-SW oriented faults are mainly thrust faults. The presence of recumbent folds with similar orientations and NW vergence is suspected.

Structural Evolution

Based on presently available data, the following tectonic history is proposed:

- Ductile deformation of the rocks of the Far North craton during the Archean;
- In the Paleoproterozoic, deformation in an E-W compressional regime (collision between the Nain and the Churchill in the east and between the Churchill and the Superior in the west) to generate N-S oriented folds, then thrusting of units from east to west (development of recumbent folds and thrust zones), thereby bringing rocks from deeper structural levels close to the surface; this is when the Lomier was accreted onto the Far North craton;
- Evolution from a compressional to a transpressional deformation system, generating N-S and NW-SE shear zones (ex: Lac Daniel fault, Falcoz zone), which cut and refold earlier N-S folds.

LITHOGEOCHEMISTRY

A total of 196 rock samples collected over the entire study area were analyzed. Of these, 63 were sent for whole rock analysis and 133 for the determination of base and precious metals. All the samples were analyzed at the Centre de recherche minérale du Québec. Analytical results and sample locations were integrated into Géologie Québec's SIGÉOM database, available at the Ministère des Ressources naturelles. Table 2 contains analytical results of a few representative samples of igneous rocks in the area. The following section is based only on the samples that were submitted for whole rock analysis. Samples analyzed for base and precious metals will be dealt with in the chapter entitled "Economic Geology".

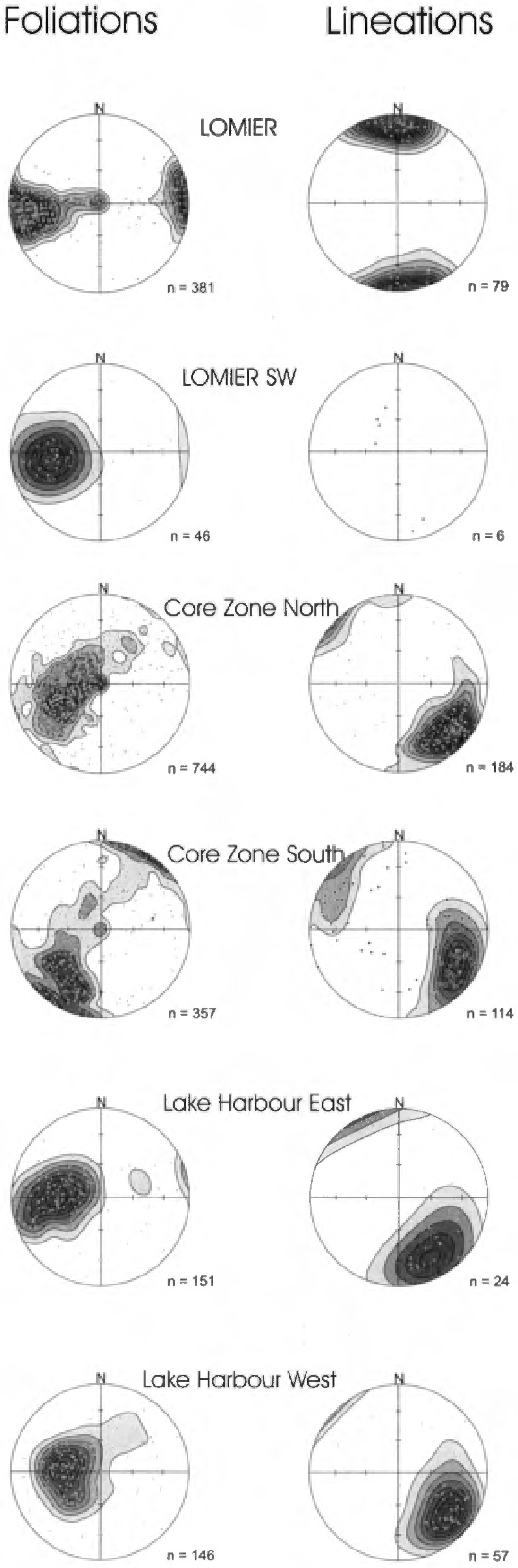

FIGURE 6 – Equal area stereographic projection of the poles of foliation planes and of stretching lineations in various structural domains. Contours are traced using the method proposed by Robin and Jowett (1986). n=number of measurements.

Mafic and felsic rocks will be discussed separately, as their mode of occurrence and their affinities are markedly different (Figure 7e).

Felsic Rocks

Felsic rocks in the area are all subalkalic and have a calc-alkaline affinity (Figures 7a and 7b). They form two distinct compositional groups: tonalites (tonalitic gneiss : see the legend on figure 7) and granites (granitic gneiss). The granites are slightly enriched in silica and alkalis (Figure 7a). Their MgO (Figure 7c), Al_2O_3, CaO and Na_2O contents are lower, however K_2O (not represented) is higher. Granitoid rock analyses were plotted on a QAP diagram, used for the classification of granitoid rocks. Their distribution in the various fields of the diagram confirms the validity of our field classification (Figure 7d).

Trace element contents are fairly uniform for the various types of granitoids. However, granitic gneisses have higher concentrations. The distribution of trace elements and rare earth elements (REE) lead us to conclude that these rocks have diverse origins. Thus, chondrite-normalized rare earth diagrams (Figure 8), as well as the Zr/Y vs Zr diagram (Figure 7f) identify two families of granites: tonalitic gneiss samples form a pattern typical of rocks derived from partial melting of crustal material, whereas granitic gneiss samples follow a pattern typical of rocks produced by fractional crystallization in addition to partial melting. The absence of europium anomalies in both granite and tonalite samples may be explained by the fact that the fractional crystallization mechanism was not the dominant process in the genesis of these rocks.

Mafic and Ultramafic Rocks

On Figures 7 and 8, we divided mafic and ultramafic rocks into four groups: metagabbros, ultramafic rocks, metabasalts and diabases.

Before we begin comparing the various mafic rocks, it is important to provide additional information on how the samples were processed. Analyzed mafic rocks are generally fine to medium-grained, homogeneous samples. We assumed that, as a general rule, the geochemical behaviour of gabbros would be similar to that of mafic volcanic rocks. The same diagrams, originally designed for volcanic rocks, were used for both intrusive rocks and for metabasalts. Ultramafic rocks, however, had to be dealt with separately. The high degree of recrystallization affecting some of these samples makes it difficult to distinguish cumulate rocks from those that formed from a magmatic liquid.

Mafic rocks, much like felsic rocks, are subalkalic (Figure 7a), and they fall within the tholeiitic field on the AFM diagram (Figure 7b). Ultramafic rocks and diabases have clearly different compositions compared to other mafic rocks; ultramafic rocks are depleted in alkalis, titanium and phos-

TABLE 2 – Chemical analyses of representative samples of igneous rocks and paragneisses of the Koroc River area. Trace elements and rare earth elements are in ppm, except for gold, which is in ppb.

	Kangiqsualujjuaq Complex			Baudan Complex				Nuvulialuk mafic Suite		
Lithology	M3 (I1D)	M3 (I1D)	M3 (I1D)	M3 (I1B)	M3 (I1B)	M3 (I1B)	I1B	I3A (M16)	I3A (M16)	I3A (M16)
Sample	5053a	3255b	1147a	1013a	5069b	4097a	4049a	2004b	4087a	6040a
Element										
SiO_2 (%)	69,0	71.9	67.6	73.9	71.6	73.9	69.1	41.8	47.8	48.3
TiO_2	0.37	0.29	0.44	0.13	0.26	0.35	0.71	1.37	1.93	0.58
Al_2O_3	16.1	15.6	16.6	13.4	14.4	12.6	14,00	13.6	14.2	13.5
Fe_2O_3T*	2.75	2.47	3.51	1.35	2.49	2.82	4.14	11.1	15.7	9.69
MnO	0.05	0.02	0.04	0.01	0.03	0.04	0.08	0.2	0.23	0.16
MgO	1.36	0.75	1.24	0.49	0.87	0.51	0.54	11.5	6.47	9.69
CaO	3.07	2.6	3.21	0.19	1.88	0.72	2.1	14.7	10.6	14.3
Na_2O	4.45	4.06	4.33	2.35	3.24	2.46	3.21	1.54	1.24	2.1
K_2O	1.19	2.23	1.97	7.28	3.93	5.83	4.9	1.1	0.99	0.49
P_2O_5	0.05	0.1	0.13	0.04	0.08	0.09	0.28	0.18	0.2	0.04
LOI	1.36	0.43	0.72	0.41	0.48	0.32	0.28	2.1	1.02	0.88
TOTAL (%)	99.75	100.45	99.79	99.55	99.26	99.64	99.34	99.19	100.38	99.73
Ba (ppm)	170	790	380	700	1300	1000	1700	130	130	50
Rb	50	80	92	327	143	293	181	8	23	6
Sr	345	421	384	109	291	114	288	91	246	78
Ga	19,00	19,00	22,00	15,00	17,00	19,00	20,00	20,00	22,00	13,00
Ta	0.1	0.3	0.5	0.4	0.2	1.8	b.d.	0.3	1,0	0.5
Nb	2,00	2,00	5,00	2,00	2,00	27,00	14,00	6,00	14,00	2,00
Hf	2.6	4.1	4.3	4.5	3.3	11,0	b.d.	3.1	3.2	0.7
Zr	75	168	152	119	97	265	328	104	120	26
Y	5	4	7	8	3	48	41	24	26	10
Th	0.88	6.9	22,00	48,00	9.2	43,00	12,00	2.2	1.4	0.2
U	0.7	1,0	1.9	27,0	0.8	7.3	1.8	0.7	0.7	0.5
Cr	20	20	20	20	20	20	20	110	110	400
Ni	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	36,00	68,00	n.a.
Co	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	17,00	n.a.	n.a.
Sc	11,0	3.8	8,0	3.1	5.1	6,0	9.1	41,0	41,0	53,0
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	230	290	n.a.
Cu	4	3	5	2	15	1	2	32	3	n.a.
Pb	1	3	2	45	15	14	11	1	n.a.	n.a.
Zn	59	44	63	18	32	46	84	45	99	n.a.
Ag	2	2	2	2	2	2	2	0.2	2	n.a.
Au (ppb)	2	2	2	2	2	4	2	50	2	n.a.
As	0.5	0.5	0.5	0.5	0.5	0.5	0.5	b.d.	2.7	n.a.
La	14	40	52	20	33	94	n.a.	10	14	3
Ce	23	59	96	44	55	210	n.a.	23	34	8
Nd	9	17	25	4	19	61	n.a.	9	17	5
Sm	1.9	2.2	4.3	1.1	2.7	10,0	n.a.	3.4	5.1	1.5
Eu	0.7	0.6	0.8	0.5	0.8	1.6	n.a.	1,0	2,0	0.5
Tb	0.1	0.1	0.3	0.3	0.1	1.2	n.a.	0.6	0.7	0.3
Ho	0.5	b.d.	0.8	2,0	0.5	1.9	n.a.	0.9	b.d.	0.5
Tm	0.2	b.d.	b.d.	0.2	0.2	0.3	n.a.	0.3	0.4	0.2
Yb	0.2	0.5	1,0	0.6	0.2	4.2	n.a.	2.9	2.2	1.3
Lu	0.05	b.d.	0.07	0.1	0.05	0.64	n.a.	0.36	0.31	0.2

* Fe_2O_3T = Total iron oxides expressed as Fe_2O_3

b.d. = below detection limit

n.a. = not analyzed

TABLE 2 – Continued.

	Nuvulialuk mafic Suite			Lake Harbour Group				Lomier	Falcoz Diabase	
Lithology	I4	I4	I4	V3A	V3A	V3A	M4	I3G	I3B	I3B
Sample	3145A	4104a1	4073k	3066a	4080a	6009a	6032b	1110c	1059b	4039c
Element										
SiO_2 (%)	40.6	50.9	43,0	51.7	49.8	49,0	72.5	57,0	50.8	49,0
TiO_2	0.06	0.57	1.19	1.31	1.18	1.16	0.48	0.82	2.39	2.58
Al_2O_3	3.39	15.8	8.17	12.9	14.4	14.3	12.9	17.5	14.4	14.9
Fe_2O_3T	11,00	13.2	13.1	14.5	13.6	12.5	4.3	7.55	16,00	15.9
MnO	0.14	0.19	0.18	0.21	0.27	0.19	0.02	0.12	0.2	0.18
MgO	34.4	7.33	20,00	5.71	8.05	7.61	1.14	3.44	4.89	5.29
CaO	0.6	9.05	8.11	9.39	11.2	12,00	2.97	7.24	7.82	7.41
Na_2O	0.1	1.86	0.37	1.97	1.37	2.06	2.98	3.8	2.44	2.65
K_2O	0.05	0.45	0.13	0.99	0.43	0.12	1.2	1.05	1.03	0.94
P_2O_5	0.03	0.05	0.11	0.14	0.1	0.09	0.1	0.32	0.42	0.39
LOI	8.65	0.38	4.9	0.8	0.67	0.71	1.31	0.59	-0.58	0.3
TOTAL	99.02	99.78	99.26	99.62	101.07	99.74	99.9	99.43	99.81	99.54
Ba (ppm)	50	250	50	140	50	50	280	1200	550	580
Rb	3	7	3	23	6	3	47	3	21	15
Sr	3	237	119	138	152	152	190	694	320	327
Ga	3,00	17,00	12,00	18,00	17,00	17,00	14,00	23,00	23,00	23,00
Ta	0.1	0.2	0.5	0.2	0.2	0.2	0.5	0.5	0.95	0.6
Nb	2,00	2,00	5,00	4,00	2,00	2,00	8,00	3,00	8,00	7,00
Hf	0.2	1.1	1.8	2.6	1.5	1.4	5.2	4.1	5.8	409,0
Zr	9	50	69	90	56	49	169	139	206	191
Y	3	12	15	29	20	17	16	28	37	34
Th	0.05	0.56	0.52	1.4	0.59	0.36	15,00	0.2	2.6	1.8
U	0.5	0.5	0.7	0.5	0.5	0.5	3.9	0.5	0.6	0.6
Cr	5300	96	1600	100	340	320	44	41	100	68
Ni	1400,00	n.a.	800,00	48,00	110,00	n.a.	n.a.	22,00	12,00	13,00
Co	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	na	na	na
Sc	15,0	36,0	28,0	45,0	46,0	45,0	12,0	19,0	40,0	33,0
V	42	n.a.	190	300	240	n.a.	n.a.	110	160	170
Cu	1	51	110	150	240	n.a.	28	28	19	24
Pb	n.a.	1	n.a.	n.a.	n.a.	n.a.	8	n.a.	n.a.	n.a.
Zn	30	130	59	95	70	n.a.	60	72	130	120
Ag	2	2	2	2	2	n.a.	1	2	n.a.	2
Au	2	3	2	2	3	n.a.	50	2	n.a.	2
As	0.5	0.5	2.9	0.9	1,0	n.a.	b.d.	0.7	n.a.	0.5
La	0.5	7.1	6.3	10	6.4	3.5	50	n.a.	30	25
Ce	2	14	18	23	16	10	95	n.a.	60	55
Nd	b.d.	8	9	11	9	3	37	n.a.	28	27
Sm	0.16	2,0	2.8	3.8	2.7	2.1	6.8	n.a.	8.1	6.3
Eu	0.1	0.9	1,0	1.3	1.1	0.8	1.5	n.a.	1.4	2.3
Tb	b.d.	0.3	0.4	0.8	0.3	0.3	0.2	n.a.	1.2	1,0
Ho	b.d.	b.d.	0.5	0.7	b.d.	0.5	0.9	n.a.	2,0	1,0
Tm	b.d.	b.d.	0.2	0.6	0.5	0.2	0.8	n.a.	0.2	0.5
Yb	0.2	1.3	1.5	2.6	2,0	1.9	2.2	n.a.	4.3	3.2
Lu	0.068	0.14	0.18	0.39	0.32	0.22	0.3	n.a.	0.6	0.46

* Fe_2O_3T = Total iron oxides expressed as Fe_2O_3

b.d. = below detection limit n.a. = not analyzed

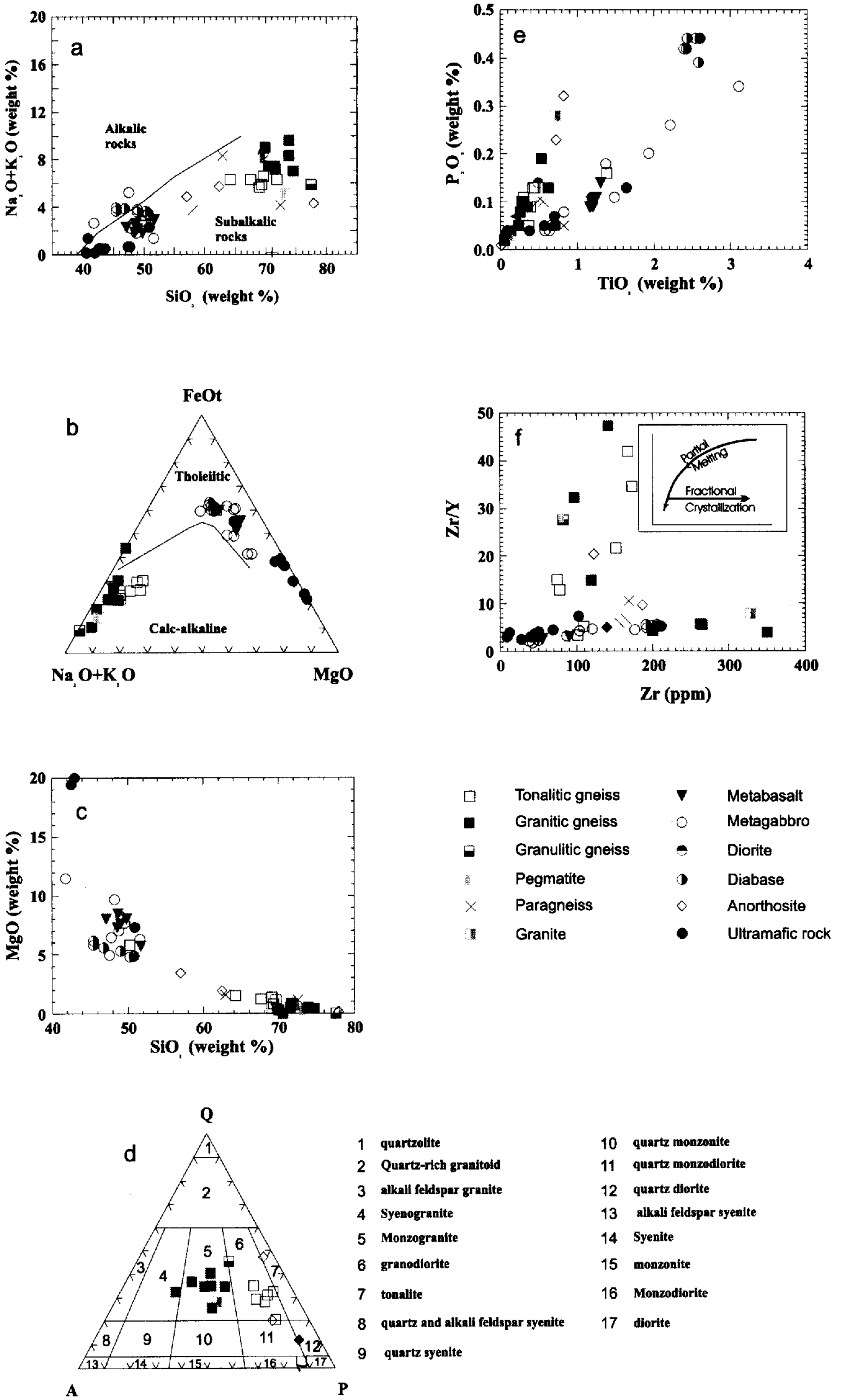

FIGURE 7a - Binary diagram Na_2O+K_2O versus SiO_2, showing the tholeiitic and calc-alkaline fields as defined by Irvine and Baragar (1968) for igneous rocks and paragneisses. **7b** – Ternary AFM diagram by Irvine and Baragar (1968) for igneous rocks and paragneisses. **7c** – Binary diagram MgO versus SiO_2 for felsic igneous rocks and paragneisses.**7d** - Ternary diagram Quartz (Q) – Albite (P) – Orthoclase (A), using CIPW normative minerals for felsic igneous rocks.**7e** - Binary diagram P_2O_5 versus TiO_2 for igneous rocks and paragneisses. **7f** - Zr/Y versus Zr diagram for igneous rocks. This diagram is used to identify magma evolution patterns characteristic of partial melting and fractional crystallization processes.

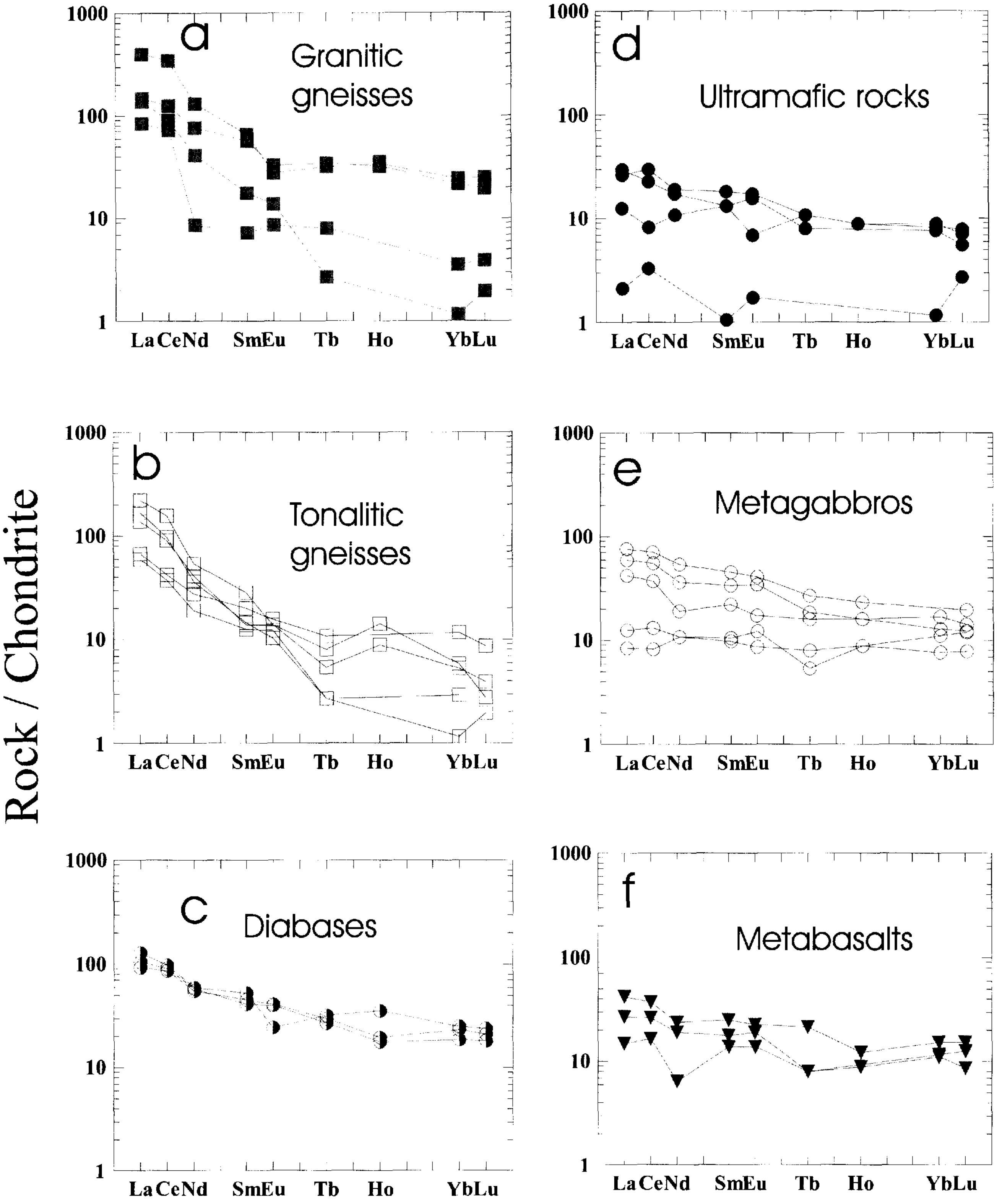

FIGURE 8 – Chondrite-normalized rare earth element concentration diagrams (Sun and McDonough, 1989) for felsic (a and b) and mafic (c,d,e and f) igneous rocks.

phorus relative to other mafic rocks, whereas diabases are enriched in these elements (Figure 7a and 7e). Metabasalts form a single coherent group, whereas metagabbros have a random distribution, which is nevertheless distinct from that of diabases and ultramafic rocks.

Among mafic rocks, diabases are most enriched in trace elements and REE (Figure 8c and 10c). This enrichment is probably the result of contamination during their emplacement in an older thicker crust. Ultramafic rocks, mainly peridotites, dunites and pyroxenites, have komatiitic compositions. These are generally coarse-grained rocks that probably represent cumulates. Except for one sample, REE distribution patterns are constant and probably represent a source slightly enriched in light rare earth elements (Figure 8d).

Metagabbros seem to form two mafic suites, one slightly enriched in light rare earths (La/Yb~ 4), the other with La/Yb ratios ~ 1. One of these suites, the least enriched in light rare earths, could be related to the metabasalt suite. The latter features compositional characteristics intermediate between the two gabbroic suites (Figures 8e and f). The presence of two metagabbroic suites in the area could be explained by the presence of an Archean metagabbroic suite, penecontemporaneous with the tonalitic or granitic gneisses, and a Proterozoic metagabbroic suite. These Proterozoic metagabbros could be contemporaneous with Lake Harbour metabasalts or with ultramafic rocks containing primary olivine and orthopyroxene.

Lithogeochemistry and Tectonic Environment

It has become fairly common to use the chemical affinity of igneous rocks to characterize the tectonic environment of genesis and emplacement. A series of diagrams were designed by various authors for granitoid and basaltic rocks, in which tectonic domains were defined based on analyses of igneous rocks from recent (Cenozoic) environments. We have plotted some of our analyses on these diagrams, keeping in mind that the diagrams were designed for recent environments, whereas rocks of the Koroc River area are Archean to Proterozoic in age and that they have been subjected to intense deformation and high-grade metamorphism. However, observed trends are not random, and are not caused only by alteration processes. It is therefore possible to draw certain conclusions from these diagrams.

Granitoids

Figure 9 shows four diagrams used to discriminate tectono-magmatic environments for granitoid rocks of the Koroc River area. The diagram A/CNK versus A/NK (Maniar and Picolli, 1989) indicates that the granitoids are essentially peraluminous. Their composition falls at the boundary between S-type granites (formed from the melting of sedimentary or supracrustal rocks) with an A/CNK ratio greater than 1.1, and I-type granites (from an igneous mantle source) with A/CNK ratios < 1.1. All the diagrams show tonalitic gneiss samples within the field of island arc granites. We can therefore assume that the Archean crust of the Far North craton formed in a collisional environment. The granitic gneiss, which may be Proterozoic or Archean in age, shows chemical affinities with volcanic arc granites and intraplate granites (Figure 9). This double affinity may indicate that there were several protoliths with diverse sources for these gneisses. Some of these granites are compositionally similar to the tonalitic gneisses, whereas others are completely different.

Mafic Rocks

Metagabbros (?) and metabasalts (?) have compositions comparable to mafic magmas slightly enriched in trace elements and rare earths. Certain metagabbros are chemically similar to normal MORB (mid-oceanic ridge basalt), whereas other metagabbros as well as all metabasalts are more comparable to enriched tholeiites such as E-type MORB or island arc tholeiites such as back-arc basalts (Figure 10).

Ultramafic rocks (?) are abnormally enriched in trace and light rare earth elements (Figure 8); in fact, their trace element content is very similar to that of mafic rocks. Therefore, they cannot represent the source of the mafic rocks in a fractional crystallization process. Consequently, we can suggest possible sources such as a magma issued from a trace element and REE undepleted mantle, or a magma originating in the upper mantle that would have been contaminated by crustal material.

Diabases (half-open circles) often fall outside of defined tectono-magmatic domains, in various diagrams. In the Ti-Zr-Y diagram by Pearce and Cann (1973) and TiO_2-MnO-P_2O_5 by Mullen (1983), diabases are compositionally similar to intraplate basalts (Figures 10b and d). This was to be expected, given the fact that the diabases are late, and were emplaced in a stable crust environment.

Conclusion

The geochemistry of granitoids confirms our field identifications. Tonalitic and granitic gneisses do in fact have different mineral and geochemical compositions. However, tonalitic gneisses form a fairly coherent chemical group, whereas the composition of granitic gneisses is quite variable, which suggests they probably belong to more than one intrusive suite. Similar observations were made for mafic rocks: the metagabbros form at least two suites, whereas metabasalts, with a more coherent composition, form a single suite. The composition of ultramafic rocks is difficult

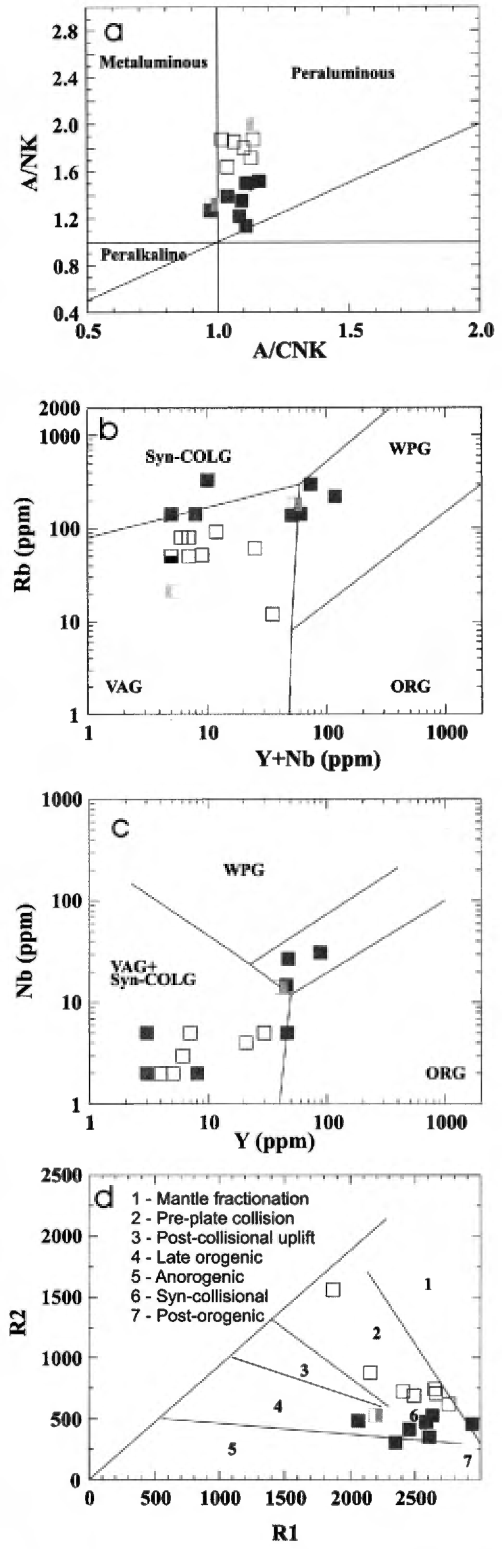

FIGURE 9 – Tectonic environment discrimination diagrams for felsic rocks of the Koroc River area. a) A/NK (Al_2O_3/Na_2O+K_2O) versus A/CNK ($Al_2O_3/CaO+Na_2O+K_2O$) granitoid classification diagram; b) ln Rb vs ln (Y+Nb); SYN-COLG = syn-collisional granite; VAG = volcanic arc granite; ORG = oceanic-ridge granite; AORG = anomalous oceanic ridge granite; WPG = within-plate granite; c) ln Nb vs ln Y by Pearce *et al.* (1984) for granitoids; d) binary diagram R2 [4Si-11(Na+K)-2(Fe+Ti)] versus R1 (6Ca+2Mg+Al) by Batchelor and Bowden (1985).

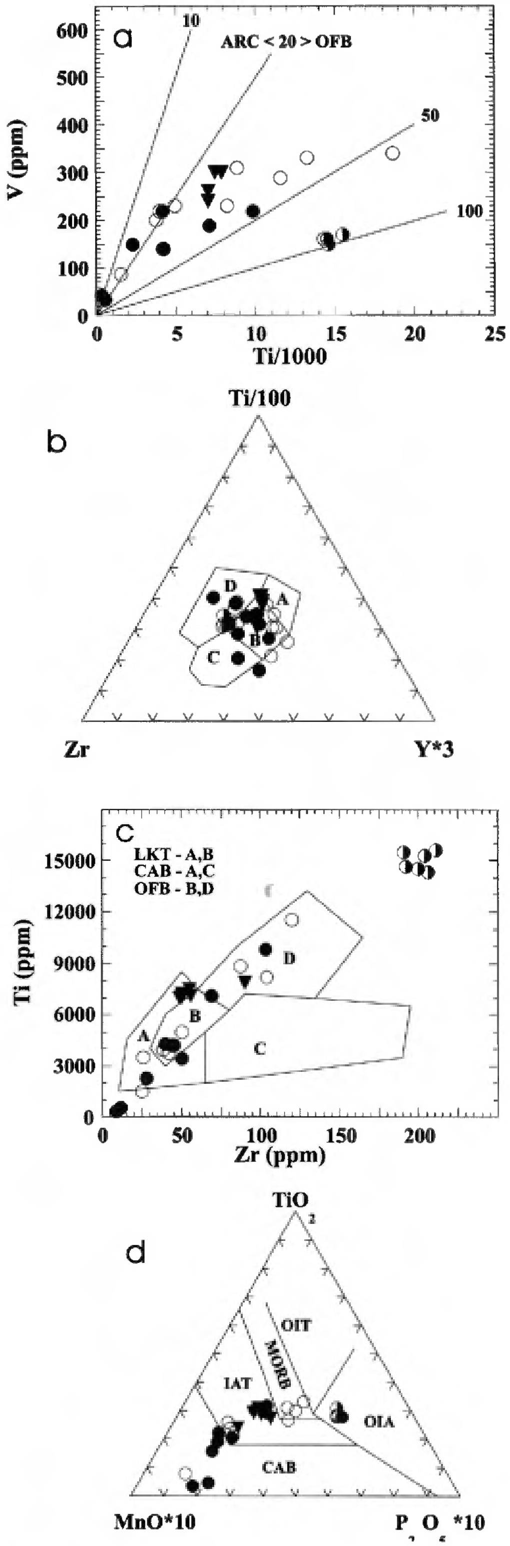

FIGURE 10 – Tectonic environment discrimination diagrams for mafic rocks of the Koroc River area. a) V vs Ti by Shervais (1982), ARC = island arc tholeiites; OFB = oceanic floor basalts; the lines and the numbers at the end of the lines indicate V/Ti ratios; b) Ti-Y-Zr (Pearce and Cann, 1973), fields A and B: K_2O-poor tholeiites, field B: oceanic floor basalts; fields B and C: calc-alkaline basalts; field D: intra-plate basalts. c) Ti vs Zr (Pearce and Cann, 1973); d) MnO-TiO_2-P_2O_5 (Mullen, 1983), OIT = oceanic island tholeiites; MORB = mid-oceanic ridge basalts; IAT = island arc tholeiites; CAB = calc-alkaline basalts; OIA = oceanic island andesites.

to interpret, due to the probable presence of cumulates, however three of the samples form a distinct suite. Diabase samples are nearly identical.

Mafic and felsic rocks appear to have different sources, even though they were emplaced in similar tectonic environments. Granitoids were mainly formed from the partial melting of a heterogeneous crust. Various degrees of partial melting generated compositionally different granitoids. Granitic gneisses underwent a phase of fractional crystallization, in addition to partial melting.

The interpretation of tectono-magmatic diagrams for granitoids and mafic rocks suggests an island arc environment, with a calc-alkaline affinity for granitoids and a tholeiitic affinity enriched in trace elements for mafic rocks, particularly for the Lake Harbour metabasalts. These volcanic rocks occur in an important sedimentary basin. This association could indicate that they were emplaced during the construction of an island arc, in a back-arc basin, or on a continental arc. Metagabbros display characteristics from two environments: island arc and oceanic ridge. Finally, diabases typically fall in the intra-plate basalt field.

We compared Lake Harbour basalts to those of the Mugford Group, a sequence of Early Proterozoic supracrustal rocks unconformably overlying the Nain Province craton in Labrador (Hamilton, 1994). The mafic volcanic rocks from both groups have similar major element contents. However, Lake Harbour basalts are not as enriched in incompatible elements such as Zr, Y, Nb and REE (these elements are concentrated in the residual liquid during the crystallization of minerals whose structure is too compact to include them), and have lower La/Yb ratios than Mugford Group basalts, which are interpreted as plume-type oceanic ridge tholeiites (Hamilton, 1994). We cannot infer a common origin for these two units without more detailed studies such as isotopic studies. Nevertheless, we cannot reject a correlation hypothesis, given the basalt/sediment association of both groups.

GEOCHRONOLOGY

(Chapter prepared in collaboration with Hélène Isnard, Clément Gariépy and Ross Stevenson)

U-Pb

A geochronological study was undertaken on eight samples of the Far North craton in order to determine the age of the lithologies, identify the nature of their source, and understand the respective evolution of the Kangiqsualujjuaq and Baudan complexes. Four samples were collected in the Kangiqsualujjuaq Complex, in a restricted sector in the northwestern corner of the map area where we were able to establish the lithological and structural relationships between the various units. The dominant lithology in this area is a migmatized and intensely deformed tonalitic gneiss. Despite the fact that it contains numerous leucosome phases, only the protolith was sampled (98-SP-4044A1). This unit is in contact with a second tonalitic gneiss (98-SP-4044A2), slightly more felsic and probably associated with a different structural level. This gneiss is also migmatized but does not contain as many leucosome phases as the first one, and is not as intensely deformed. The second tonalitic gneiss (98-SP-4044A2) hosts granulite-facies mafic enclaves, in addition to a 10 m-wide amphibolite band, which was sampled in an intermediate horizon (98-DB-3099). With the exception of a penetrative foliation, the degree of deformation is much less intense in the amphibolite relative to the tonalitic gneiss. The last sample was collected in a weakly deformed, albeit foliated granitic dyke (98-SP-4044C) that cross-cuts the first three lithologies.

Figure 11 summarizes the distribution of ages obtained in this project. It allowa a comparison of these ages with other ages obtained from rocks in the area. Analytical results yielded the following U/Pb and Pb/Pb ages: zircons from the 98-SP-4044A1 gneiss sample belong to two morphological populations that yielded respective ages of 2.920±0.040 Ga and 2.76 Ga. Tonalitic gneiss 98-SP-4044A2 contained three zircon populations that yielded Pb/Pb ages of 2.80, 2.60 and 1.82 Ga. The amphibolite sample (98-DB-3099) yielded only small hypidiomorphic to xenomorphic zircon crystals, more difficult to characterize. Nevertheless, analytical results indicate the presence of two families: a few ages of about 1.90 Ga were obtained from very rounded grains and relatively consistent ages of 1.85 Ga from prismatic crystals. Zircon grains from dyke 98-SP-4044C are mainly brown-red uranium-rich crystals; three analyses yielded identical and concordant ages of 1.828±0.002 Ga.

Four samples from the Baudan Complex were taken on three distinct outcrops. A porphyritic granitic gneiss (98-SP-4049C) comes from the central part of the Far North craton, and belongs to a regionally extensive lithology. Despite the presence of a tectonic fabric, field observations do not lead us to believe that this lithology was affected by the same intensity of deformation as that observed in the gneisses of the Kangiqsualujjuaq Complex. A second granitic gneiss (98-SP-4079A) was sampled in the Falcoz shear zone. In this area, the gneiss is mylonitized and cut by a pegmatite (98-SP-4079B). The gneiss and the pegmatite are respectively associated with synkinematic and late kinematic phases in the development of the shear zone. Finally, a garnet-bearing granite (98-PV-1011) was sampled at the contact between the Far North craton and the Torngat Orogen in order to precisely determine the age of the collision between these two entities.

A single homogeneous zircon population is present in the porphyritic gneiss (98-SP-4049C), and four U/Pb analyses yielded an emplacement age of 2.623±0.004 Ga. Zircons contained in gneiss 98-SP-4079A differ, but preli-

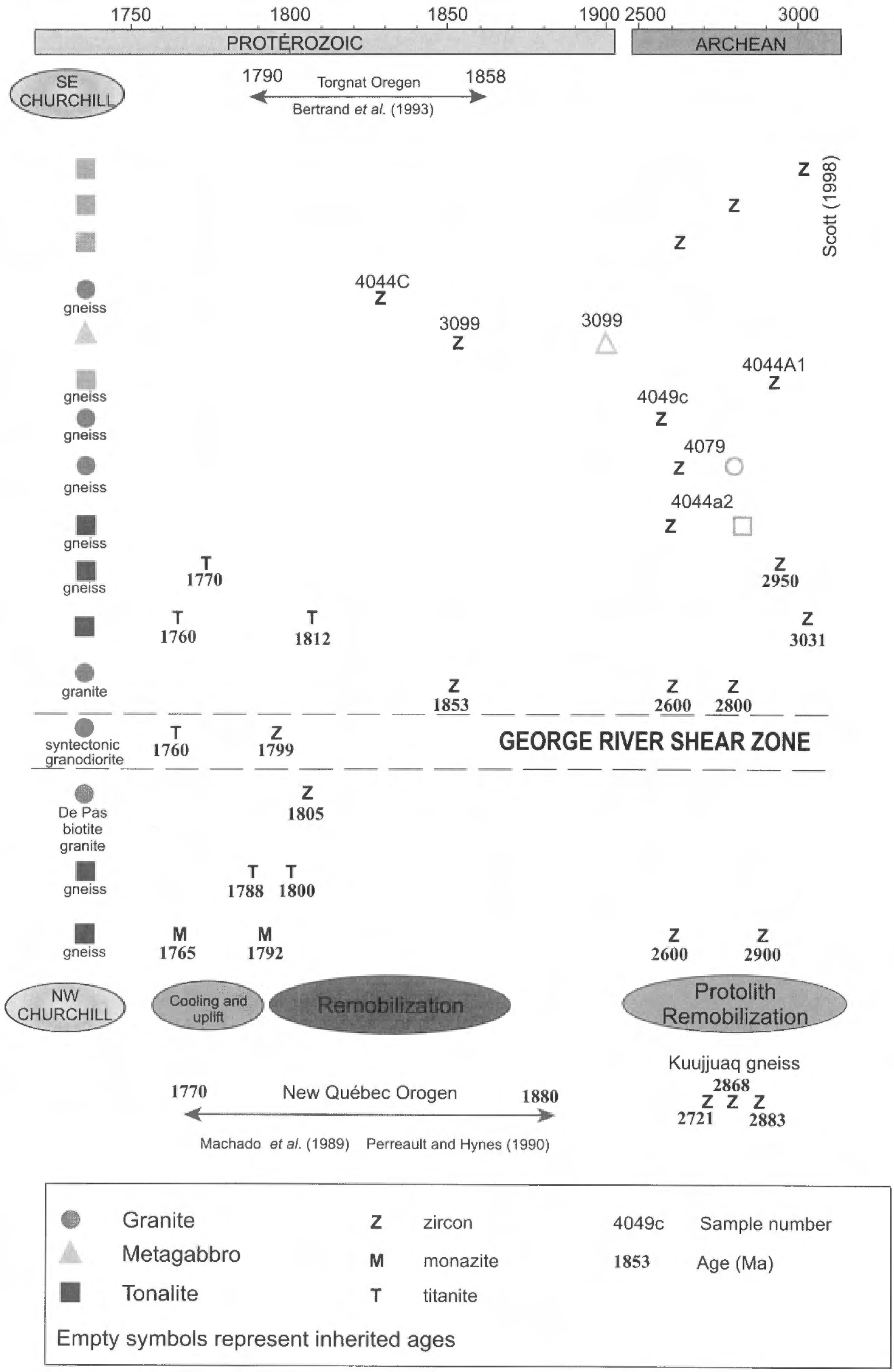

FIGURE 11 – Distribution of ages determined within the framework of this project and by others in the Churchill Province and the New Québec and Torngat orogens.

minary results indicate two Pb/Pb age groups at about 2.60 Ga and 2.70 Ga.

In conclusion, the two tonalitic gneisses in the Kangiqsualujjuaq Complex (98-SP-4044A1 and A2) represent lithologies from a Middle Archean basement (2.9 and 2.76 Ga) reworked during a Late Archean tectono-thermal episode (2.623±0.004 Ga). The 1.85 Ga age obtained for amphibolite 98-DB-3099 is interpreted as an emplacement age for this lithology, which suggests that the amphibolite was most likely tectonically juxtaposed with the tonalitic gneisses during a Proterozoic deformation event. It could therefore represent a dyke belonging to the Nuvulialuk Suite. Granitic dyke 98-SP-4044C, whose emplacement age is 1.828±0.002 Ga, was produced during a magmatic event linked to the tectono-thermal peak. This event preceded the period of exhumation of these terrains. Granitic gneiss samples from the Baudan Complex allow us to add that a Late Archean magmatic event occurred at about 2.60 Ga. This event represents both the emplacement of new material and the remobilization of older terrains. Work under way on samples from the Falcoz zone has not yet allowed us to determine the age of the development of the shear zone.

Sm-Nd

The Sm-Nd system is used as a tracer and a dating tool in this project. In order to use it as a tracer, we use the "ε Nd " parameter, which is the range between the ^{143}Nd/^{144}Nd ratio measured in the sample relative to the value defined by the isotopic evolution of chondrites. Positive values generally indicate a juvenile source, whereas negative values identify a source from an older reworked basement. In the Sm-Nd system, we use the concept of model ages obtained from the ε Nd value of the sample relative to an evolution trend for the depleted mantle or for the crust (see de Paolo, 1988; Vidal, 1994).

Kangiqsualujjuaq and Baudan Complexes

Preliminary analytical results using the Sm-Nd method on whole rocks are as follows: six tonalitic gneisses of the Kangiqsualujjuaq Complex and one granitic gneiss of the Baudan Complex yielded ε Nd values of –16 and –12 (calculated at 1.8 Ga, the minimum age for the peak of regional metamorphism). These results correspond to model ages on the order of 2.8-3.1 Ga for the protolith of these gneisses, indicating that the gneisses represent Archean material reworked during the Proterozoic, at 1.8 Ga. These ages coincide with other Archean gneisses located on the south shore of Ungava Bay.

A garnet-bearing granite sampled at the contact between the Far North craton and the Torngat Orogen, and a granitic dyke sampled at the western edge of the area yielded slightly more radiogenic ε Nd values at about –10; the involvement of Archean material in the genesis of this rock is formal and in accordance with major and trace element data for granitoids in the area which indicate an emplacement in an island arc environment.

Finally, a pegmatite cross-cutting all other lithologies yielded a ε Nd value of –7, similar to the De Pas Batholith (Kerr *et al.*, 1994, Dunphy and Skulski, 1996), where the involvement of Archean material in the genesis was demonstrated (see also Isnard *et al.*, 1999).

Lake Harbour Group

Analyses from five metasedimentary samples of the Lake Harbour Group yielded negative ε Nd values between –12 and –13.5 with model ages on the order of 2.7-3.1 Ga. These negative values clearly indicate an Archean origin for these metasediments. Furthermore, the values obtained coincide with those obtained in the gneisses of the Far North craton. The Archean basement that constitutes the Far North craton in the area is therefore considered to be the dominant source for these sediments.

Nuvulialuk Suite

Metagabbros and ultramafic rocks of the Nuvulialuk Suite found in the Far North craton were also included in this isotopic study. Their ε Nd signatures vary between 0 and +4, the positive signatures indicating a much more juvenile origin than the gneisses. They probably come from a juvenile mafic source and were emplaced at about 1.8 Ga. These rocks display evidence of contamination, which occurred during their emplacement or during the subsequent metamorphism.

Two samples of the Nuvulialuk Suite were taken in the Torngat Orogen: a metagabbro with a ε Nd value of –5 and a hornblendite with a εNd value of –1. The two are either intrusive or imbricated in the Sukaliuk Complex. The Sm-Nd system allows us to obtain model ages of about 2.8 and 2.3 Ga respectively. These two samples contrast with other mafic rocks with their higher rare earth contents and lower Sm/Nd ratios. Their origin has not yet been established and remains ambiguous.

These geochronological data support certain stratigraphic relationships established in the field. They allow us to define the geological history of the area in more detail. The very old age of tonalitic gneisses and their remobilization during the Proterozoic metamorphic event constitute solid milestones in the genesis of the map area, relative to the rest of the Churchill Province in Québec (Figure 11). The juvenile nature of gabbros, amphibolites and even ultramafic rocks is also confirmed. Therefore, these do not simply represent enclaves within the gneiss but actual tectonic

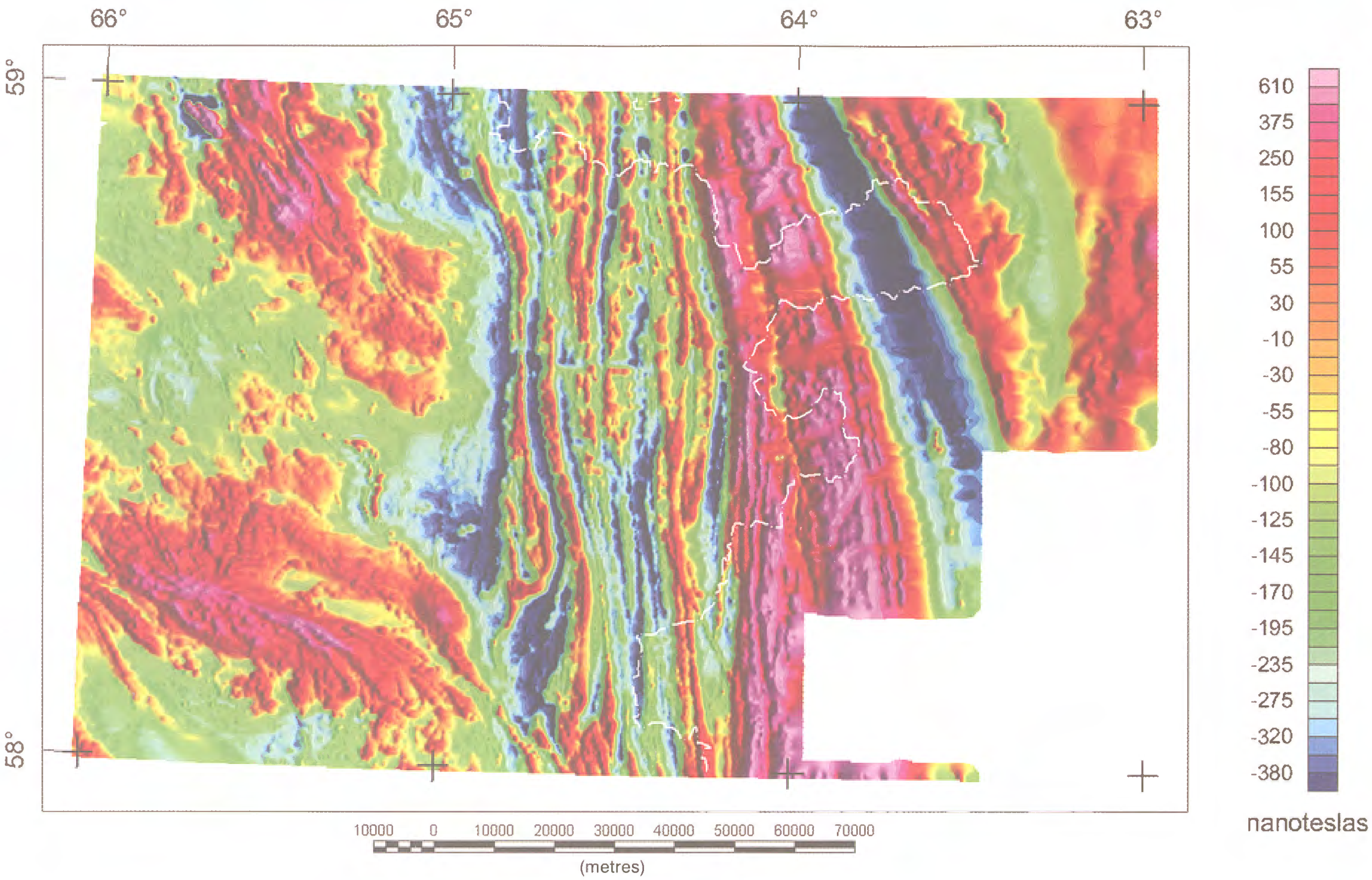

FIGURE 12 – Total residual magnetic field for the Koroc River area.

slices tectonically imbricated in the gneiss during the Trans-Hudson Orogeny.

Sukaliuk and Lomier Complexes

Two samples from the Lomier Complex, an orthopyroxene-bearing tonalite and a pegmatite yielded ε Nd values of about −7. The involvement of Archean material in the genesis of these rocks is formal.

One hypothesis being considered is that the Sukaliuk and Lomier complexes are metamorphosed and deformed equivalents of the Kangiqsualujjuaq and Baudan complexes and of the Lake Harbour Group. The value obtained for the enderbite (99-SP-4109A) is more radiogenic (ε Nd = -7) than those obtained for the tonalitic and granitic gneisses of the Far North craton (-16<ε Nd<-12). Given our current understanding of the area and in light of results obtained further south by Thériault and Ermanovics (1997) in the Lomier Complex, isotopic geochemistry has not yet allowed us to confirm this hypothesis.

GEOPHYSICS

Figure 12 shows the results of a magnetic survey carried out with readings taken at an altitude of 300 m and a spacing of 800 m between flight lines. Total residual magnetic field data presented in this figure were interpolated at a lateral spacing of 200 m (Dion and Dumont, 1994). The regional magnetic pattern highlights the principal lithological units identified in the field. The Far North craton is characterized by a medium intensity regional anomaly (between 0 and 200 nT) probably generated by the high sulphide (mainly pyrite) and oxide (magnetite) content of the tonalitic and granitic gneisses. Within this regional anomaly, bands of high magnetic intensity correspond either to paragneisses, which often contain pyrrhotite, or metagabbros or metabasalts that contain sulphides and magnetite. Ultramafic rocks were also encountered in the NW part of map sheet 24I. Another strong anomaly, oriented WNW-ESE and located in the SW quarter of the area, occurs along the Falcoz zone. It essentially coincides with a granitic gneiss unit, and remains unexplained given our current understanding of the area. A sharp contrast occurs eastward, as strongly magnetic bands oriented N-S alternate with less magnetic bands. This domain corresponds to the granulite-facies Sukaliuk Complex, composed of granitic and tonalitic gneisses, with 100-metre wide bands of paragneiss and metagabbro. The weakly magnetic bands in this domain seem to correspond to paragneiss horizons. Further eastward, another sharp change can be observed going into the Lomier Complex, a strongly magnetic unit throughout. This unit contains anorthosites, gabbroic anorthosites (leucogabbronorite) (lom2) and rocks of the charnockitic suite (lom1) that can generate strongly positive anomalies. Finally, at the NE edge of map 24I and in the NW part of map 14L, a corridor that corresponds to a magnetic low about 15 km wide coincides with the Tasiuyak Gneiss. All the contacts between these domains are sharp, which indicates they are most likely subvertical. Within the Far North craton however, contacts between variably magnetic zones are more gradual, which supports the shallower dips noted in the field. We can also suspect the presence of important magnetic bodies under a weakly magnetic cover.

All units east of the Far North craton are metamorphosed to the granulite facies. At this grade, amphiboles are frequently transformed into pyroxenes and magnetite. This metamorphic transformation could explain the presence of stronger magnetic anomalies in the eastern part of the area.

LAKE SEDIMENT GEOCHEMISTRY

The lake bottomsediment geochemical survey of the Far North program, carried out in 1997 and covering the Far North region, highlighted several anomalies in Cu, Ni, Cr, Co, U, As and Au. Based on the location of these geochemical anomalies, certain mining companies acquired several exploration permits in the Koroc River area and other adjacent areas. Certain sites are characterized by strong multi-element anomalies whereas others are represented by an isolated anomaly involving only one element (Figure 13 or map of lake bottom sediment geochemistry anomalies).

Certain sectors of the map area contain strong geochemical anomalies in Ni, Cr, and to a lesser degree, in Co. Exploration work conducted by mining companies failed to outline important mineralization that could explain these anomalies. All the anomalous sites are characterized by the presence of ultramafic rocks associated with supracrustal rock sequences occurring in the tonalitic gneiss, in the Lake Harbour Group and in the anorthositic rocks of the Iberville Complex and the Saglek Gneiss. These polymetallic anomalies in Ni, Cr and Co may be due to the presence of these ultramafic rocks. These rocks are generally characterized by very high Ni (between 100 and 800 ppm) and Cr (500 and 5300 ppm) contents.

A direct correlation may be drawn between the distribution of arsenic anomalies in lake sediments and supracrustal rocks of the Lake Harbour Group. The strongest anomalies occur in the south part of the Lake Harbour Group, and along a paragneiss horizon in the southern part of the Sukaliuk Complex. Elongate anomalous zones of lesser amplitude also occur along the southern portion of the Falcoz shear zone. These arsenic anomalies are not associated with known gold mineralization nor are they paired with lake bottom sediment anomalies in gold. However, they

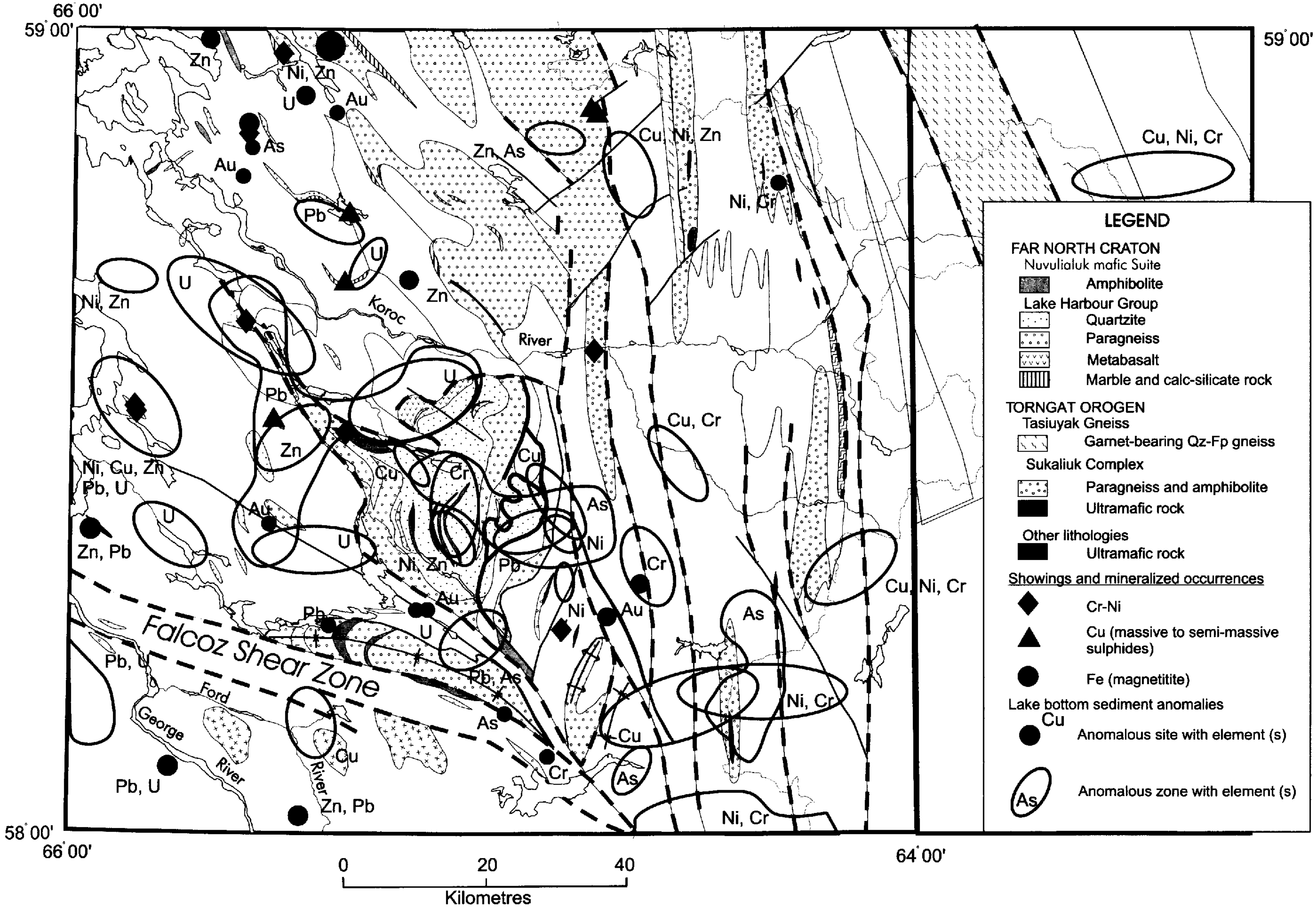

FIGURE 13 – Principal lake bottom sediment anomalies (zones and sites). Only units presenting an economic interest are represented to simplify the map. Mineralized occurrences are the same as those shown in Figure 14.

remain good exploration targets for gold, particularly the anomalies located in the vicinity of the Falcoz deformation zone.

The Koroc River area contains only weak gold anomalies in lake bottom sediments, located near the shear zones that form the boundaries of the Lake Harbour Group.

Isolated copper anomalies are associated with remnants of supracrustal rocks in tonalitic gneiss. Lead and zinc behave differently however, and anomalies for these two elements are often superposed. The majority of Pb-Zn anomalies are associated either with tectonic remnants of paragneiss characterized by the presence of marble and calc-silicate units in the tonalitic gneiss, or with rocks of the Lake Harbour Group. Lead anomalies correspond to the presence of late tectonic Archean granite. The presence of these Pb-Zn anomalous zones could not been explained however, as we did not detect any important mineralization. They could be due to a higher zinc and lead content in the paragneiss bands mineralized in pyrrhotite.

The George River area, located about 20 km south of the village of Kangiqsualujjuaq, is quite interesting in that it features an important polymetallic anomaly in Cu, Zn, Pb, U and Ni. This anomalous zone is located in a tectonic remnant of paragneiss and ultramafic rock in the tonalitic gneiss unit of the Kangiqsualujjuaq Complex. Other than minor sulphides observed in the ultramafic rocks and the paragneisses, as well as disseminated pyrrhotite in graphitic paragneiss, we were unable to identify any important mineralization that could represent the source of this anomaly.

Three uranium anomalies were observed in the NW quarter of map sheet 24I. One of these zones is located south of the Koroc River. It corresponds to the contact between the metasediments of the Lake Harbour Group and the tonalitic gneiss of the Kangiqsualujjuaq Complex. Another anomaly, located to the northwest, coincides with the Barnouin River, south of its mouth. This anomaly is more difficult to explain. Apart from a few pegmatite dykes observed locally, the source of this anomaly could be an Archean granite mapped in the southern part of the anomalous zone. The third uranium anomaly is associated with the important polymetallic anomaly mentioned previously.

ECONOMIC GEOLOGY

One of the first things that captures the attention of geologists mapping rocks of the Lake Harbour Group is the presence of gossans that extend as far as the eye can see. Apart from an iron showing discovered by Taylor (1979) and a mention of the presence of pyrrhotite in paragneiss units, economic geology studies of the area are very scarce. A nickel-graphite showing was the object of a Master's thesis by Bodycomb (1994) and the discovery in 1996 of a 1.5 mm diamond in a kimberlite along the shores of Abloviak Fjord (Digonnet *et al.*, 1999) encouraged the company Fjordland Minerals to acquire an exploration permit in this area and to conduct a heavy mineral survey in glacial sediments (till).

Five types of mineralization were recognized during our field campaign. These are: iron mineralization (magnetitite), massive sulphide mineralization (pyrrhotite) associated with paragneiss, chrome and nickel mineralization associated with ultramafic rocks, disseminated sulphide mineralization in the Tasiuyak Gneiss, and remobilized mineralization associated with ductile and brittle deformation zones.

Figure 14 shows the outcrops where mineralized samples were collected. Tables 3, 4 and 5 list analytical results from these samples.

Magnetitites (iron)

Taylor (1979) discovered a magnetite (Fe) showing about 10 kilometres east of the mouth of the Koroc River (NTS sheet 24I/13 and 24I/14, sites 99-PV-1004 and 99-SP-4115, Figure 14 and Table 3) in the Kangiqsualujjuaq Complex. This magnetite showing is part of a group of magnetite occurrences associated with deformed horizons of magnetitite distributed over a surface area of 10 km^2. These deformed horizons of magnetitite may be traced over several hundred metres, and their thickness varies from a few tens of centimetres to about 10 metres. Magnetitite horizons have conformable contacts with either granitic orthogneiss with potassic feldspar and biotite porphyroclasts, or tonalitic gneiss, or amphibolite or paragneiss. The magnetitite is composed of 50 to 80% magnetite, with variable proportions of quartz, augite, and cummingtonite. Accessory minerals are topaz, apatite, hematite and zircon.

Massive Sulphides

TABLE 3 – Chemical analyses of magnetitites.

Samples	99-SP-4098C	99-SP-4098C2	99-SP-4115D
Oxides	**(weight %)**		
Fe_2O_3	55.60	64,00	52.5
SiO_2	45.2	37.6	44.6
Al_2O_3	0.09	0.06	0.49
MgO	b.d.*	b.d.	1.90
Mn	0.05	0.13	0.17
CaO	b.d.	b.d.	1.29
TiO_2	b.d.	0.01	0.17
K_2O	0.03	b.d.	0.05
Na_2O	b.d.	b.d.	b.d.
P_2O_5	0.05	0.06	0.07

b.d. = below detection limit.

Sample 99-SP-4115D contains augite and traces of topaz.

Samples 99-SP-4098C and 99-SP-4098C2 are composed of magnetite and quartz.

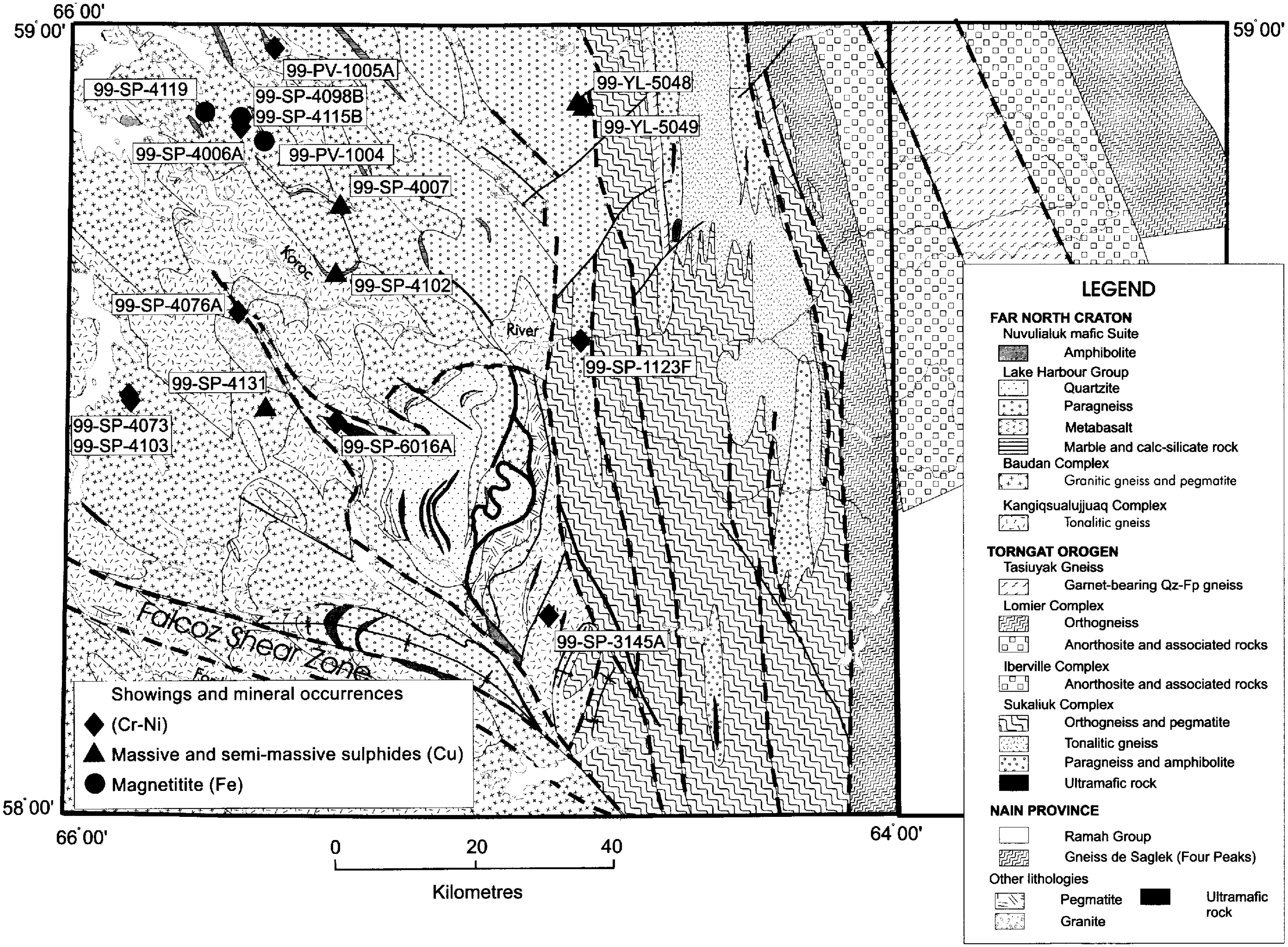

FIGURE 14 – Location map of lithogeochemical anomalies and mineralized occurrences.

TABLE 4 – Analytical results for elements with economic potential of samples from mineralized occurrences and showings encountered in paragneiss.

	UTM Coordinates		Elements with economic potential									
Sample	Easting	Northing	Cu	Ni	Co	Cr	Zn	Pb	Au	Ag	Mo	As
99-PV-1077C	364026	6524905	120	n.a.	n.a.	n.a.	31	9	b.d.	b.d.	58	n.a.
99-PV-1083A	388176	6459996	130	n.a.	n.a.	n.a.	86	7	b.d.	b.d.	16	n.a.
99-PV-1123D1	395624	6497343	163	185	63	b.d.	50	5	b.d.	b.d.	n.a.	2.3
99-PV-1123D2	395624	6497343	170	200	110	b.d.	37	2	b.d.	b.d.	n.a.	4
99-PV-1123D4	395624	6497343	520	110	20	b.d.	140	11	b.d.	b.d.	n.a.	2.9
99-LC-2086A	381156	6532315	170	n.a.	n.a.	n.a.	100	6	b.d.	b.d.	54	n.a.
99-LC-2215A4	365310	6516995	94	21	10	b.d.	45	6.00	6	b.d.	n.a.	2.6
99-LC-2215A5	365310	6516995	9	7	7	b.d.	55	1.00	12	b.d.	n.a.	n.a.
99-LC-2215A6	365310	6516995	61	26	10	b.d.	69	9.00	8	b.d.	n.a.	3.6
99-DB-3026A	372175	6481187	360	n.a.	n.a.	n.a.	900	23	b.d.	b.d.	84	n.a.
99-DB-3035A	367044	6478914	160	n.a.	n.a.	n.a.	570	28	b.d.	b.d.	9	n.a.
99-SP-4007E5	365310	6516995	300	290	79	b.d.	18	27	11	b.d.	n.a.	2.5
99-SP-4007E1	365310	6516995	390	n.a.	n.a.	n.a.	35	1	b.d.	b.d.	67	n.a.
99-SP-4007E2	365310	6516995	270	n.a.	n.a.	n.a.	n.a.	n.a.	17	2	100	n.a.
99-SP-4007E3	365310	6516995	500	n.a.	n.a.	n.a.	n.a.	n.a.	22	b.d.	n.a.	n.a.
99SP-4024D	346327	6462490	29	n.a.	n.a.	n.a.	280	b.d.	b.d.	b.d.	2	n.a.
99-SP-4024E	346327	6462490	33	n.a.	n.a.	n.a.	210	3	b.d.	b.d.	27	n.a.
99-SP-4081F	346105	6461712	210	160	42	670	91	b.d.	b.d.	b.d.	n.a.	0.6
99-SP-4087D	342399	6449515	130	210	52	b.d.	180	43	b.d.	b.d.	n.a.	2.1
99-SP-4087D2	342399	6449515	120	110	45	b.d.	110	b.d.	b.d.	b.d.	n.a.	2.2
99-SP-4091F1	366907	6527139	360	72	38	b.d.	47	2	3	b.d.	n.a.	0.5
99-SP-4091F2	366907	6527139	400	170	72	b.d.	33	b.d.	b.d.	b.d.	n.a.	n.a.
99-SP-4091F3	366907	6527139	100	28	16	b.d.	59	b.d.	3	b.d.	n.a.	1.7
99-SP-4100F	354436	6521879	1400	260		b.d.	18	3	3	b.d.	n.a.	n.a.
99-SP-4101D	354910	6521686	180	750	83	b.d.	180	19	b.d.	b.d.	n.a.	7.2
99-SP-4102F	364632	6507387	360	280	140	b.d.	20	b.d.	b.d.	b.d.	n.a.	1.8
99-SP-4102G	364632	6507387	130	28	19	b.d.	4	b.d.	4	b.d.	7	0.9
99-SP-4102G3	364632	6507387	930	n.a.	n.a.	n.a.	13	b.d.	5	b.d.	12	2.5
99-SP-4102H	364632	6507387	250	22	16	b.d.	13	b.d.	b.d.	b.d.	n.a.	n.a.
99-SP-4102I	364632	6507387	6000	28	17	b.d.	33	5	b.d.	b.d.	n.a.	n.a.
99-SP-4105C	453105	6810744	430	n.a.	n.a.	n.a.	140	b.d.	11	b.d.	6	2
99-SP-4116C	354929	6521257	670	n.a.	n.a.	n.a.	150	b.d.	24	b.d.	7	18
99-SP-4119E	345915	6529916	440	n.a.	n.a.	n.a.	3	b.d.	b.d.	b.d.	1	b.d.
99-YL-5006B	379512	6490618	410	n.a.	n.a.	n.a.	150	b.d.	b.d.	b.d.	15	n.a.
99-YL-5024C	375601	6495589	420	n.a.	n.a.	n.a.	19	b.d.	b.d.	b.d.	56	n.a.
99-YL-5025B	375478	6496399	600	n.a.	n.a.	n.a.	19	b.d.	b.d.	b.d.	21	n.a.
99-YL-5031A	368987	6475015	120	n.a.	n.a.	n.a.	39	3	b.d.	b.d.	22	n.a.
99-YL-5048A	399833	6528809	1300	n.a.	n.a.	n.a.	170	b.d.	b.d.	b.d.	20	n.a.
99-YL-5049A	398724	6528428	1700	n.a.	n.a.	n.a.	26	b.d.	b.d.	b.d.	75	n.a.
99-YL-5089B	352610	6504123	795	57	93	b.d.	103	3	b.d.	b.d.	n.a.	n.a.
99-YL-5146	458460	6521124	310	140	35	b.d.	260	5	26	b.d.	n.a.	b.d.
99-YL-5153A	390647	6480246	190	n.a.	n.a.	n.a.	27	3	b.d.	b.d.	50	n.a.
99-YL-5221C	385313	6465171	200	n.a.	n.a.	n.a.	19	5	b.d.	b.d.	95	n.a.
99-GB-6001A	365178	6515672	400	54	18	b.d.	49	33	b.d.	0.56	n.a.	n.a.
99-GB-6018C	367399	6483547	170	28	31	b.d.	92	b.d.	b.d.	0.2	n.a.	n.a.
99-GB-6020A	367708	6483146	160	67	15	b.d.	200	b.d.	b.d.	0.2	n.a.	n.a.
99-GB-6049B	347355	6471135	255	n.a.	n.a.	n.a.	256	b.d.	b.d.	b.d.	2	n.a.
99-GB-6090A1	363698	6458703	280	72	100	b.d.	55	5	b.d.	b.d.	n.a.	n.a.
99-GB-6202E	359618	6519679	160	n.a.	n.a.	n.a.	120	4	b.d.	b.d.	46	n.a.
All the results are in ppm except for Au which is in ppb.												

A bird's eye view of the Lake Harbour Group reveals that paragneiss units are characterized by a rusty colour, which contrasts with adjacent units. The majority of mineralized zones identified during the field campaign are associated with a quartzitic and graphitic paragneiss, and with horizons of quartz-rich, mineralized calc-silicate gneiss. These units are interbedded with biotite paragneiss, locally garnet-bearing, or with aluminous paragneiss (sillimanite ± garnet ± cordierite ± anthophyllite), or occur within carbonate sequences (marble and calc-silicate rocks). In certain areas, amphibolite horizons are in contact with the mineralized zones; these amphibolites are themselves locally interbedded with the paragneiss sequence. Table 4 lists analytical results of samples collected from various mineralized occurrences. Only one sampled mineralized site fits the criteria that define a showing. The Naksaluk showing (site 99-SP-4102; 0.6 % Cu, Figure 4), located 3 km south of Naksaluk creek, features lenticular horizons of semi-massive to massi-

TABLE 5 – Analytical results for elements with economic potential of samples from mineralized occurrences and showings encountered in mafic and ultramafic rocks.

Sample	Easting	Northing	Cu	Ni	Co	Cr	Zn	Pb	Au	Ag	As
PV-1123F2	395624	6497343	32	1110	89	4800	34	8	b.d.	b.d.	14
PV-1123H2	395624	6497343	56	340	68	2200	180	4	b.d.	b.d.	b.d.
DB-1345 A	394265	6457466	b.d.	1400	n.a.	5300	30	n.a.	b.d.	b.d.	b.d.
SP-4006E*	355340	6521586	10	900	n.a.	2800	140	n.a.	23	b.d.	490
SP-4073K	403204	6430548	110	800	n.a.	1600	59	n.a.	b.d.	b.d.	2.9
SP-4076A2	347705	6506471	57	1600	n.a.	5800	90	n.a.	3	b.d.	1.1
SP-4076B**	347705	6506471	780	13	71	b.d.	29	5	13	b.d.	b.d.
SP-4079	365532	6454445	120	180	39	1500	120	b.d.	b.d.	0.23	6.3
SP-4103A	334128	6489819	10	830	n.a.	2300	51	n.a.	b.d.	b.d.	2.7
SP-4104A	334407	6490410	4	360	n.a.	1700	47	n.a.	b.d.	b.d.	2.6
GB-6010C	373276	6488970	711	74	37	350	53	2	b.d.	b.d.	n.a.
GB-6013C	370852	6482518	217	57	82	900	83	2	b.d.	b.d.	n.a.
GB-6013E	370852	6482518	160	57	37	830	57	2	b.d.	b.d.	n.a.

All the samples are ultramafic rocks except for one gabbro (*) and one amphibolite (**).

All concentrations are in ppm except for Au. which is in ppb.

The heading "99" which precedes each sample number has been omitted in this table.

ve sulphides, with a brecciated texture, conformable to locally cross-cutting relative to the regional gneissosity. Other mineralized sites yielded up to 1700 ppm Cu, 750 ppm Ni and 900 ppm Zn. Gold is lower than 30 ppb (Table 4). The mineralization is associated with a quartz-rich calc-silicate gneiss, with diopside, scapolite, biotite, graphite and plagioclase. The mineralization consists of pyrrhotite, pyrite, locally chalcopyrite, and graphite and contains cm-scale subrounded to subangular fragments of biotite paragneiss, polycrystalline quartz vein material and rounded quartz grains. Pyrite is developed in replacement of pyrrhotite along fractures and grain boundaries. Late pyrite veinlets, and locally pyrite + chalcopyrite veinlets are also present.

Cr-Ni Associated with the Nuvulialuk Suite

This mafic to ultramafic igneous suite is composed of metagabbro, peridotite, dunite, pyroxenite and hornblendite. It is not associated with any important mineralization. These rocks contain high Ni and Cr contents, which partially explains certain lake sediment anomalies; these rocks are present in the watershed of lakes where the anomalies occur. Table 5 lists the base metal (Ni, Cr, Cu, etc.) contents commonly observed in these rocks.

Three Cr mineralized occurrences are associated with this ultramafic suite. The ultramafic rocks form horizons, locally deformed and one to tens of metres thick, in the Lake Harbour Group paragneisses, and in paragneiss remnants of the Sukaliuk Complex. The margins of the peridotite are amphibolitized. Lenses one to ten centimetres in size and veinlets containing pyrrhotite and traces of chalcopyrite are present in the amphibolitized margins (Table 5, site 99-SP-4076A2 and B, Figure 14). No economic grades were obtained in these mineralized zones.

Random samples collected in the central portions of these ultramafic horizons yielded high Cr values and anomalous Ni values (Table 5, SP-4076B, DB-3145A, PV-1123 F2, Figure 14). Cr varies from 0.1 to 0.58% and Ni from 0.05 to 0.16%. These values are explained by the presence of chromite and of traces of pyrrhotite and pentlandite associated with magnetite. Oxide phases form small interstitial pods between olivine and pyroxene grains.

Disseminated Sulphides Associated with the Tasiuyak Gneiss

A few mineral occurrences were observed in paragneiss units of the Tasiuyak Gneiss. Within the map area, the Tasiuyak Gneiss is characterized by its rusty colour, which strongly contrasts with adjacent units. This rusty colour is caused by the alteration of pyrrhotite, an accessory phase of the gneiss.North of the map area, in the Abloviak Fjord region, Ni-Cu and graphite mineralizations are associated with garnet-sillimanite paragneisses. This nickeliferous and graphitic mineralization forms cm- to m-scale lenticular horizons that are conformable with the mylonitic foliation observed in the host rock. Locally, these mineralized zones are observed along the margins of boudined metagabbro horizons in contact with the paragneiss.

In the sector mapped in 1998, mineral occurrences observed in the Tasiuyak Gneiss are composed of disseminated pyrrhotite hosted in garnet-sillimanite paragneiss or as pyrrhotite veins with traces of chalcopyrite that brecciate the hosting paragneiss. The veins are fairly narrow, from a few cms to a few tens of cms, and are late tectono-metamorphogenic, i.e. they formed later than the ductile deformation and the peak of metamorphism that affected the Tasiuyak Gneiss. No economic grades were obtained in these mineralized zones.

Sulphides Associated with Ductile and Brittle Deformation Zones and Post-Tectonic Remobilization

In certain ductile deformation zones, such as site 99-SP-4119 (Figure 14, Table 4), pyrite forms hypidioblastic grains and veinlets parallel to the mylonitic foliation observed in a quartz-rich sillimanite and cordierite-bearing paragneiss. Pyrite veinlets are composed of idiomorphic and hypidioblastic pyrite crystals in the paragneiss, and partially truncate the mylonitic foliation. These textures suggest a late kinematic and late metamorphic development of the mineralization. No Au grades, or other metals, were reported. Similar mineral occurrences were observed in the Falcoz deformation corridor. In the latter, remobilized mineralized zones, composed of disseminated pyrrhotite and pyrrhotite and pyrite veins, are associated with amphibolite and paragneiss units. Pyrrhotite occurs as elongate pods oriented along the mylonitic foliation plane whereas pyrite occurs as grains. No economic grades in Au or other metals were reported.

Industrial Minerals

Dolomitic marble horizons from carbonate units of the Lake Harbour Group, particularly those located near the seashore, are good exploration targets for dolomite. We noted that the thickness of dolomitic marble units is quite variable in the carbonate sequence, from a few centimetres to several metres. Horizons are folded and frequently lenticular. We also noted the presence of thin paragneiss horizons, as well as quartz veins. Field observations and thin section studies of these dolomitic marbles allowed us to identify, in several locations, appreciable quantities of phlogopite, diopside and tremolite. The most promising horizons are located along Kéglo Bay, just north of our study area, and near Baudan Bay. As the Kangiqsualujjuaq area is very distant from large urban centres, and that there are no port installations near the dolomite occurrences, any type of dolomite production from this area would only be viable for use in a local market.

Diamonds

The Abloviak Fjord area, located about 50 km north of the northernmost limit of the area mapped in 1998, was the focus of diamond exploration in 1997. This exploration was initiated following the discovery of a gem-quality diamond of 1.5 mm in a phlogopite-bearing hypabyssal kimberlite dyke of Cambrian age (Digonnet, 1997). The diamondiferous kimberlite dyke is part of a suite of ultramafic dykes, whose thickness does not exceed a few metres. This unit was emplaced during the Cambrian (544 ± 12 Ma, Ar/Ar method on phlogopite grains), in a Riedel system associated with an en echelon shearing movement related to the reactivation of the Abloviak deformation corridor (Digonnet, 1997). This reactivation in the brittle domain is attributed to the opening of the Iapetus Ocean between 620 and 550 Ma. Based on lithogeochemistry data, Digonnet (1997) concluded that the ultramafic dykes could be classified as lamproites and that certain dykes have affinities with kimberlites.

The map area includes the western margin of the Abloviak deformation corridor. Diabase dykes were identified in this region.

Mineral Potential of the Koroc River Area

Despite the presence of numerous mineralized occurrences and spectacular gossans that extend as far as the eye can see, no economic grades or significant values were obtained from the analysis of these mineral occurrences, other than the Naksaluk showing and of chrome mineralization associated with the Nuvulialuk Suite.

Mineralizations observed in paragneiss units of the Lake Harbour Group have certain affinities with stratiform copper deposits, Besshi-type massive sulphide deposits, SEDEX Zn-Pb-Ag deposits, and most of all, Broken Hill-type Pb-Zn-Ag deposits. The Naksaluk showing displays several characteristics that resemble the Broken Hill-type, both regarding the geological context and the type of mineralogical and lithological assemblages. However, we were unable to uncover any important Pb, Zn or Ag mineralization.

As for the ultramafic rocks, their potential seems limited to Cr. Observed Ni values can be explained by the mere crystallization of olivine and Ni-rich pyroxene. The presence of chromite was noted in some of these rocks. However, the presence of chromiferous horizons remains to be verified in the field. The nature and mode of emplacement of the ultramafic rocks differs from those of the Ungava and New Québec orogenic belts. The Ungava orogenic belt hosts the important Raglan Ni-Cu-PGE deposits with a total tonnage of 22 Mt at 3.08% Ni and 1.67% Cu. Ultramafic and mafic rocks in these two belts were emplaced in an oceanic context or at the ocean-continent transition, whereas those of the Koroc River area are associated with a late-orogenic mode of emplacement. On the other hand, it is not excluded that certain tectonic slices of ultramafic rocks may be associated with the formation of an oceanic crust. Thus, the absence of important Ni mineralization associated with the ultramafic rocks of the Koroc River area could be linked to the difference in the mode of emplacement relative to rocks of the Ungava and New Québec orogenic belts.

The origin of magnetitite horizons is speculative. These rocks could be associated with Kiruna-type mineralization. Given the absence of U-Cu mineralization, it is difficult to compare these magnetitites with the Olympic Dam deposit in Australia. Moreover, these rocks are partially hosted in a pyrrhotite-bearing paragneiss which also contains massive pyrrhotite lenses. This close relationship between the two units indicates that these magnetitites could also represent iron formation horizons associated with Besshi-type mineralization.

TECTONIC MODEL

A compilation of previous work and of our own field data as well as our petrographic, structural, geochemical and isotopic studies have allowed us to elaborate a summary geological history of the Koroc River area. The sequence of events is summarized as follows:

1. Formation during the Archean of a tonalitic basement and of supracrustal rocks (mainly amphibolites) (2.920 – 2.76 Ga);
2. Emplacement of granitoids during the Archean (2.60 – 2.623 ± 0.004 Ga), granulite-facies metamorphism and ductile deformation;
3. Intrusion of rocks of the AMCG suite, and rifting of the eastern margin of the Far North craton (2.2 Ga);
4. Collision Nain-Far North craton, and subduction of the Nain margin beneath the Far North craton, injection of granitoids in the margin of the Far North craton (an eastward subduction model is also plausible);
5. Erosion of the magmatic arc and emplacement of sediments and lavas of the Lake Harbour Group, and of the Nuvulialuk intrusive Suite (1.90 – 1.85 Ga), in a back-arc basin (ex: tholeiitic island arc basalts and metagabbros);
6. Trans-Hudson Orogeny: metamorphism and remobilization of the basement and Early Proterozoic supracrustal rocks to generate the Baudan and Kangiqsualujjuaq complexes (1.82 – 1.828 Ga). Granulitization at depth (Sukaliuk and Lomier complexes and Tasiuyak Gneiss). E-W compressional deformation (collision Nain – Churchill ? Churchill - Superior) to generate N-S oriented folds, then transport of units from east to west (development of recumbent folds and thrust zones), thereby bringing rocks from deeper structural levels closer to the surface;
7. Evolution of the deformation from a compressional regime to a transpressional regime, generating N-S and NW-SE shear zones (ex: Lac Daniel fault, Falcoz zone), that cut and refold earlier N-S folds. Possible intrusion of anorthosites in the suture zones when the stresses changed direction (alternative to step 3). Emplacement of syn- to post-transpressive deformation dykes and veins of granite and granitic pegmatite;
8. Reactivation of major N-S ductile structures, with development of cataclasite, pseudotachylite and brittle deformation;
9. Intrusion of the Falcoz Diabase.

The schematic structural cross-section in Figure 15 illustrates the final result of the tectonic evolution of the area, based on newly acquired field data and on results of seismic and gravity surveys conducted during the ECSOOT project as part of the LITHOPROBE program (Funk and Louden, 1998; Hall *et al.* 1995).

CONCLUSIONS

Geological mapping of the Koroc River area has made it possible to redefine the boundaries of a stratigraphic unit, the Lake Harbour Group, and to define new lithodemic units that had not yet been differentiated. These are: two lithodemic units in the Far North craton of the Churchill Province, the Kangiqsualujjuaq and Baudan complexes, two lithodemic units in the Torngat Orogen, the Sukaliuk and Iberville complexes, and a lithodemic unit that is widespread throughout the area, the Nuvulialuk mafic Suite.

It has also allowed us to identify at least three phases of deformation:

1) An initial Archean phase, contemporaneous with the first granulite-facies metamorphic event, during which remobilization and migmatization of tonalites and supracrustal rocks occurred to generate granites;

2) During the Proterozoic, the first compressional phase of the Trans-Hudson Orogeny generated N-S folds and shear zones. These shear zones are important enough to have brought to the surface deeper structural levels and juxtapose amphibolite-grade and granulite-grade domains;

3) This compressional phase then evolved into a transpressive deformation phase, generating N-S shear zones with subhorizontal sinistral strike-slip movement and NW-SE shearing. These deformation features cut and refold earlier N-S folds.

Preserved zones of granulite-grade rocks, and the development of mineral assemblages typical of the middle to upper amphibolite facies at the expense of those of the granulite facies indicates that the Kangiqsualujjuaq and Baudan complexes underwent at least two tectono-metamorphic events, one during the Archean and one in the Early Proterozoic. Metamorphic conditions vary from one area to the next for the Lake Harbour Group: east of Lac Daniel, they are semi-quantitatively estimated between 550

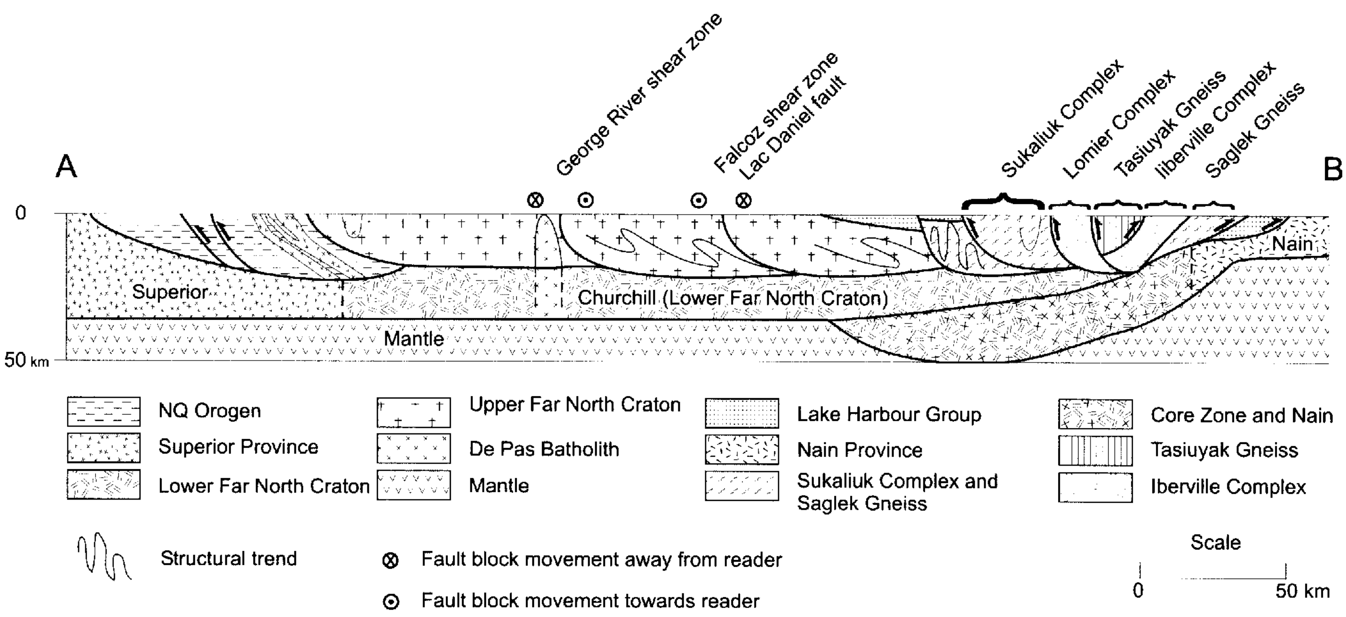

FIGURE 15 – Simplified geological cross-section of the northern Churchill Province, cutting across units mapped in the Koroc River area. The cross-section was interpreted from seismic, gravimetric and geological data. The location of the cross-section is shown in Figure 2.

and 600 °C and lower than 6 kilobars (0.6 GPa); in the northwest portion of the map area, metamorphic conditions are estimated between 600 and 750 °C and from 5 to 8 kilobars (0.5 to 0.8 GPa). It is possible that Proterozoic thrust faults may have brought underlying structural levels of the Lake Harbour Group up to the surface. The study of metamorphic assemblages observed in the Torngat Orogen leads us to conclude that the transition from the granulite facies observed in the Torngat Orogen to the amphibolite facies in the Far North craton is not gradual. It is contained within a deformation corridor, the Blumath zone, marked by the presence of ductile and brittle faults and deformation zones.

Geochemical studies confirm the distinctions made in the field between the various granitoid rocks. Granites probably form more than one suite. Metagabbros seem to form at least two suites, whereas metabasalts form a single coherent suite. Ultramafic rocks are a bit more difficult to decipher due to the possible presence of cumulates, however three of the samples analyzed belong to a distinct suite. The diabase samples are all nearly identical. Granitoids seem to represent the products of various degrees of partial melting of a relatively heterogeneous crust. Granitic gneisses, in addition to partial melting, are partly issued from a fractional crystallization process. Tectono-magmatic diagrams for the granitoids (Archean) and mafic rocks (Proterozoic) suggest an island arc environment, with a calc-alkaline affinity for granitoids (Archean) and a trace element-enriched tholeiitic affinity for mafic rocks (Proterozoic), particularly for metabasalts of the Lake Harbour Group. These volcanic rocks are associated with an important sedimentary basin. This association could indicate emplacement during the construction of an island arc in a back-arc basin or on a continental arc. Gabbros display characteristics typical of two environments: island arc and oceanic floor. Finally, diabase samples are typical of intra-plate basalts.

Preliminary results from the isotopic study of rocks in the area lead us to conclude that the tonalitic gneisses are probably Middle Archean in age, as most of the gneisses analyzed elsewhere in the Far North craton. This basement would then have undergone a Late Archean tectono-thermal episode, represented by the granitic gneisses. Certain metamorphosed gabbros were emplaced during the Proterozoic and are probably contemporaneous with Lake Harbour metabasalts. A granitic dyke also yielded a Proterozoic age, and represents a tectono-thermal event widely recognized throughout the Trans-Hudson Orogen.

Five types of mineralization were observed during the field campaign. These are: iron mineralization (magnetitite), massive sulphide mineralization (pyrrhotite) associated with paragneiss, chrome and nickel mineralization associated with ultramafic rocks, disseminated sulphide mineralization in the Tasiuyak Gneiss, and remobilized mineralization, associated with ductile and brittle deformation zones.

Despite the presence of numerous mineral occurrences and spectacular gossans that extend as far as the eye can see, the mineral potential of the map area appears limited, apart from the Naksaluk showing and the chrome mineralization associated with the Nuvulialuk Suite. However, mineralizations observed in the paragneiss sequences of the Lake Harbour Group display certain affinities with stratiform copper deposits, Besshi-type massive sulphide deposits, SEDEX-type Zn-Pb-Ag deposits, but most of all with Broken Hill-type Pb-Zn-Ag deposits.

Unfavourable weather conditions somewhat hampered our field work during the summer of 1998. This lack of field observation led us to develop a more detailed interpretation of remote sensing data (aerial photographs, Landsat images, aeromagnetic maps). Certain interesting features were highlighted by these studies, which merit further evaluation:

- The Baudan and Kangiqsualujjuaq complexes form entities that cover a very extensive surface area, and which are probably even more « complex » than would appear on the geological map. There are probably several generations of granitic gneiss and several generations of amphibolitized metagabbro, which we were unable to differentiate in the field.
- Paragneisses of the Lake Harbour Group contain numerous gossans that could not be examined systematically; a more thorough examination is warranted. The most interesting area is the NW quarter of map sheet 24I, which requires more detailed mapping than our 1:250,000 scale.
- From a structural standpoint, the site where the Falcoz zone and the Blumath zone converge is very complicated. It may hold the key to understanding the sequence of tectonic events that affected the area.
- An isotopic study of rocks of the Sukaliuk and Lomier complexes could confirm or refute the hypothesis that these complexes are formed of the same rocks, at a higher metamorphic grade and degree of deformation, than those of the Far North craton.
- Finally, an isotopic study of the anorthosites of the Lomier Complex and the Iberville Complex would be very useful, as these lithologies occupy the presumed suture zone between the Nain and Churchill provinces, on either side of the Tasiuyak Gneiss. They could help us clarify the age of this suture.

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Appendix

PHOTOS 1 TO 12

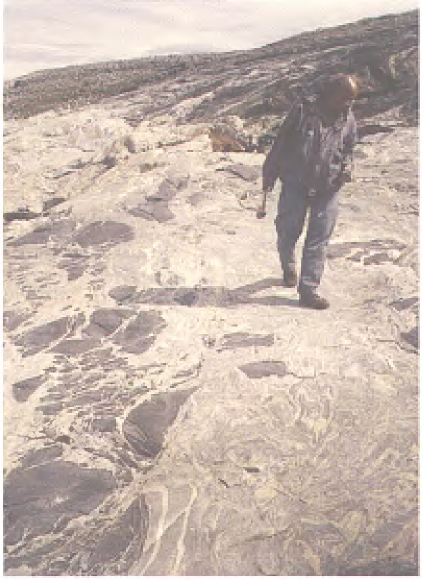

PHOTO 1 – Tonalitic gneiss with amphibolite enclaves in the Kangiqsualujjuaq Complex.

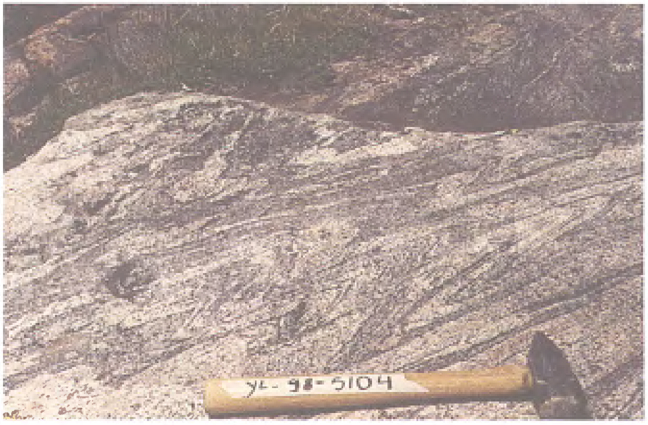

PHOTO 2 – Microfolded granitic gneiss of the Baudan Complex.

PHOTO 3 – Granite with feldspar phenocrysts (Baudan Complex).

PHOTO 4 – Quartzite (light-coloured) sequence of the Lake Harbour Group with metagabbro sills of the Nuvulialuk mafic Suite. The thickest sill is about 50 metres thick.

PHOTO 5 – Marble bands intercalated with paragneisses of the Lake Harbour Group.

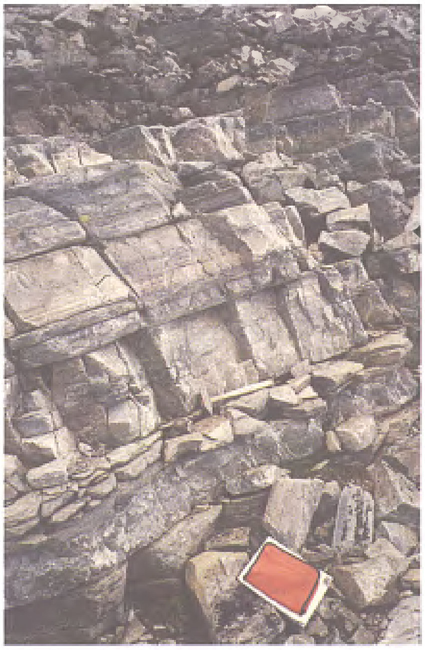

PHOTO 6 – Alternating quartzite and paragneiss near the base of the Lake Harbour Group.

PHOTO 7 – Tonalitic gneiss (upper unit) thrust upon a metagabbro of the Nuvulialuk mafic Suite.

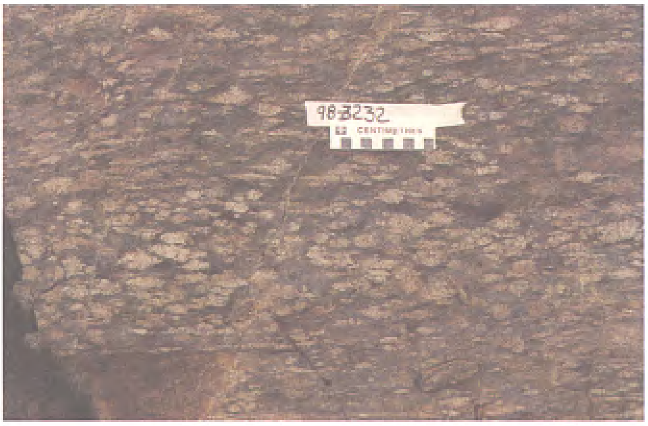

PHOTO 8 – Peridotite with orthopyroxene phenocrysts (Nuvulialuk mafic Suite).

PHOTO 9 – Biotite garnet paragneiss with cm-scale bands of quartzite and quartz-rich gneiss (Sukaliuk Complex).

PHOTO 10 – Quartz feldspar garnet gneiss (Tasiuyak Gneiss) exhibiting a strong subhorizontal lineation. The waterfall is about two metres high.

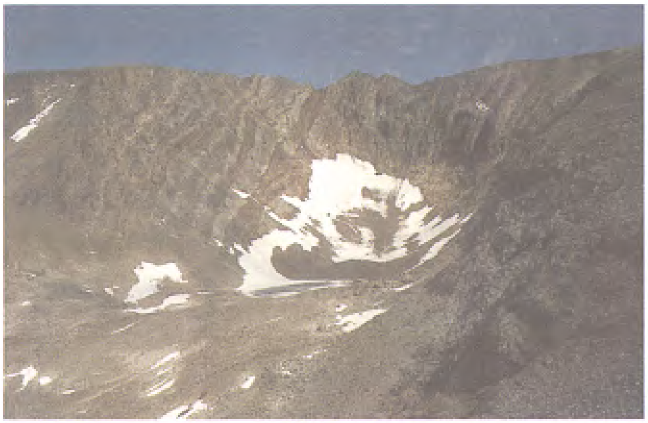

PHOTO 11 – Anorthositic layers alternating with darker garnetite layers in the Iberville Complex, Mont Iberville. The dark band left of the ice is about 30 metres thick.

PHOTO 12 - Strongly foliated anorthosite with 10-cm thick amphibolite bands in the Iberville Complex.

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