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GEOLOGY ALONG THE CENTRAL PART OF THE UGJOKTOK RIVER, (NTS 13N/5 AND PARTS OF 13M/8 AND 13N/6) LABRADOR

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ABSTRACT

The central part of the Ugjoktok River is underlain by early Precambrian polydeformed gneisses, granitoid and volcanic sedimentary rocks, which are intruded by Middle Proterozoic mafic to felsic plutonic massifs. Pyroxene- and amphibole-bearing tonalite orthogneiss of the Nain Province Archean Hopedale block has been metamorphosed to upper amphibolite−granulite facies during the Archean and/or Proterozoic orogenic events. Garnet-, sillimanite-, and cordierite-bearing quartzofeldspathic paragneiss of suspected Aphebian age has been deformed and metamorphosed to upper amphibolite grade during the Hudsonian Orogeny. The paragneiss is in contact with the orthogneiss along a folded, 0.5-km-wide zone, consisting of intensely mylonitized rocks of the latter unit. Paragneiss is intruded by foliated garnet and hypersthene-bearing porphyritic granodiorite. Westward, paragneiss and porphyritic granodiorite are interlayered with a series of amphibolite- to granulite-grade plutonic and gneissic rocks of the Churchill Province. These rocks have been intensely deformed and mylonitized during the Hudsonian Orogeny, to form a sequence of northerly trending straight belts.

Several kilometres east of the paragneiss−orthogneiss boundary, deformed Aphebian mafic to intermediate volcanic and sedimentary rocks (containing clasts of both the volcanic rocks and the basement gneisses), form the Ingrid group. Rocks of the Ingrid group have been folded and flattened during the Hudsonian Orogeny, and are in part thrust eastward over basement orthogneiss and in part lie unconformably upon it.

Fresh, igneous-textured leucogabbro, gabbronorite and anorthosite, intruded by porphyritic to equigranular, igneous-textured olivine-bearing monzonite, quartz monzonite and syenite, are found in both the Harp Lake and Nain igneous complexes. A locally rapakivi-textured variant of porphyritic olivine-bearing monzonite is found only within the Harp Lake complex. These undeformed, Paleohelikian rocks form extensive massifs that intrude orthogneiss, paragneiss and straight belts of granitoid gneiss along sharp, well-defined contacts. Although reported to the north of the Ugjoktok River area, no extensive, widespread metamorphic aureoles were defined in this study in the basement gneisses surrounding the massifs. A number of late Paleohelikian?, subhorizontal, olivine-bearing pyroxene gabbro to pyroxene diabase sills, both intrude and lie upon rocks of the Harp Lake complex as well as the basement gneisses and granitoids. Associated with these are hypabyssal or volcanic fragmental flow rocks. These sills are undeformed and exhibit pristine igneous textures. Neohelikian peralkaline granite and quartz−feldspar porphyry of the Flowers River Igneous Suite comprise the youngest rocks found in the area. Dykes and small bodies of peralkaline granite and quartz−feldspar porphyry, the latter probably as xenoliths or small roof pendants, occur within felsic granitoid rocks of the Nain igneous complex.

INTRODUCTION

This report discusses the results of a fill-in mapping project undertaken in a small area that was omitted earlier, during the course of three other regional mapping projects. The study area encompasses NTS sheet 13N/5 and the northern parts of sheets 13M/8 and 13N/6, which are located along the Ugjoktok River, approximately 255 km north-northwest of Goose Bay, Labrador (Figure 1). Final publication from this mapping project is intended to be at 1:100,000 scale. West and south of this area, a major regional study on the Harp Lake complex was carried out by Emslie (1980). Hill (1982) mapped the Flowers River and Nain igneous complexes to the north and to the east, Korstgård and Ermanovics (1984), Grant *et al.* (1983), Knight *et al.* (1981), Taylor (1979), Ermanovics and Raudsepp (1979), Ermanovics (1980), Ermanovics and Korstgård (1981) and Ermanovics *et al.* (1982) have reported on rocks of the Archean Hopedale block. Mapping of the intervening area had the additional objective of integrating these earlier surveys. The field component was carried out from June 20th to August 17th, and involved ground traversing, helicopter-borne reconnaissance as well as limited boat work. In addition, a geochronological program carried out under the direction of Urs Scharer at the Université du Québec à Montréal, resulted in the collection of seven samples from key lithostratigraphic units, to determine U−Pb zircon dates.

Regional Geology

The central Ugjoktok River area straddles the boundary between the Nain and Churchill provinces (Figure 1), and is underlain by a crystalline terrain consisting of

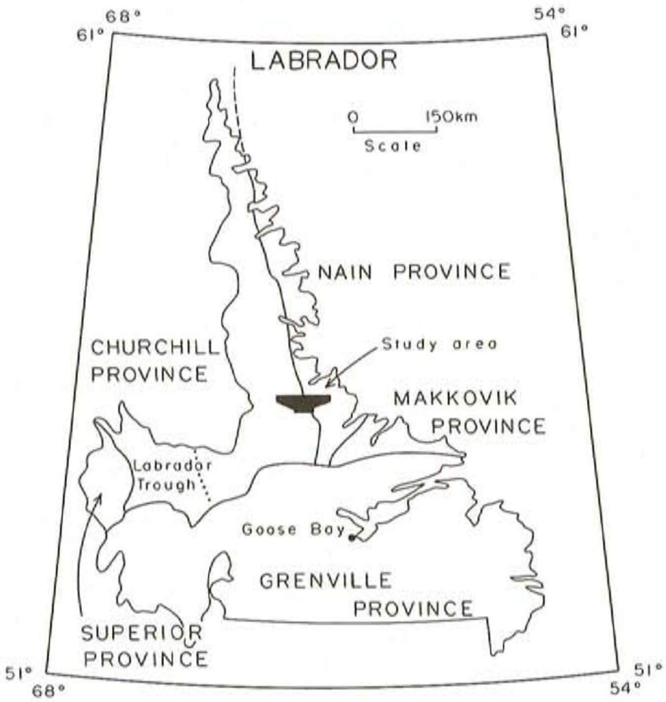

Figure 1. *Location of central Ugjoktok River map area (structural province divisions after Taylor, 1971; Wardle, 1983; and modified from Smyth and Greene, 1976).*

approximately sixty percent igneous rocks and forty percent amphibolite- to granulite-grade gneissic rocks. Beyond the map area to the northwest, are Proterozoic amphibolite- to granulite-grade migmatitic and agmatitic gneisses of the central core of the Churchill Province. Rocks in the northeastern part of the map area are continuous with the Paleohelikian pyroxene–amphibole granites and gabbroid plutons of the Nain igneous complex, which range in age between 1200 Ma and 1400 Ma (Hill, 1982), as well as the Neohelikian peralkaline volcanics and granite of the Flowers River Igneous Suite that are about 1270 Ma old (Hill, 1982). To the east and southeast, the Archean Hopedale block consists of amphibolite to granulite facies, granitic to tonalitic gneisses, migmatites, granitic intrusive rocks, greenstone belts and amphibolite. Extending to the west, southwest and south of the Ugjoktok River area, for up to 120 km, are granitic, anorthositic and gabbroic rocks of the Harp Lake complex, dated at 1450 $\pm$ 25 Ma (Emslie, 1980).

Paleohelikian and Neohelikian igneous rocks surrounding the map area are essentially undeformed and occur as large, roughly circular massifs. Proterozoic gneissic and granitic rocks of the Churchill Province are polydeformed, and have a predominantly northerly to north-northwesterly trend. The Archean Hopedale block lithologies are also polydeformed, exhibiting several trends, the most predominant being northeasterly.

General Geology of the Ugjoktok River Area

The map area is divided into twenty-one lithological types (Figure 2). The oldest rock present is amphibolite- to granulite-grade tonalite orthogneiss (subunit 1a), which is tentatively correlated with the Archean Maggo gneiss of Ermanovics *et al.* (1982). The tonalite gneiss is predominantly exposed in a block, north and east of the Ugjoktok River on map sheets 13N/5 and 13N/6 (Figure 2), where it can be traced into continuity with the Maggo gneiss to the east. Along its northwestern boundary, the tonalite gneiss is in contact with garnet paragneiss of Unit 3. The contact is marked by mylonite approximately 250- to 500-m wide, and consists of mainly tectonized tonalite orthogneiss (subunit 1b). Both the mylonite zone and the southwestern boundary of the tonalite gneiss are truncated by intrusive rocks of the Harp Lake complex.

Foliated pyroxene–hornblende–biotite granite (Unit 2) intrude the tonalite gneiss in the northern part of NTS 13N/6, but was not examined in detail.

Sillimanite and hypersthene-rich garnet paragneiss (Unit 3) correlate with an extensive unit of quartz, feldspar, garnet mylonitic gneiss located along the Nain–Churchill Province boundary in northern Labrador (Ryan *et al.*, 1983), and is known as the Tasiuyak gneiss (Wardle, 1983, 1984; Korstgård *et al.*, 1987). It underlies an 18-km-wide north–south-trending belt along the northern parts of 13N/5 and 13M/8 map sheets, and covers roughly the same area as the tonalite gneiss. South of Sarah Lake (Figure 2), several deformed quartz diorite to dioritic bodies (Unit 4) intrude the garnet paragneiss, possibly in the core of folds.

Throughout its area of exposure, garnet paragneiss is interlayered with garnet and hypersthene-bearing porphyritic granodiorite (Unit 5). Granodiorite is weakly to moderately foliated, intrusive into the garnet paragneiss, and in zones of intense local deformation, forms augen gneiss. Deformed plutonic and gneissic rocks of generally granitic, syenitic and dioritic compositions occur as relatively narrow north–south-trending bands (Units 6 to 12), in the northwestern part of map sheet 13M/8 (Figure 2). These rocks are continuous with those of the Churchill Province granitoid–gneiss belt of Hill (1982) in the adjoining Flowers River area to the north. Units 3 to 12, supposedly of Aphebian age and associated with some possible Archean component(s), all terminate against later intrusive rocks belonging to the Nain and Harp Lake complexes.

A supracrustal sequence of mafic to intermediate volcanic and derived sedimentary rocks, termed the Ingrid group (Unit 14) by Ermanovics and Korstgård (1981), unconformably overlies tonalite orthogneiss along the eastern edge of map sheet 13N/5. Although the group was originally subdivided into five units (Ermanovics and Korstgård, 1981; Knight *et al.*, 1981) for simplicity, the upper three have been combined and an additional one added. (It is noted here that these rocks were not remapped during this study). Collectively, the rocks of the group are overturned to the east, are presumed by Ermanovics and Korstgård (1981) to be Aphebian in age and lie unconformably upon the underlying Archean gneisses.

The Ingrid group is abruptly truncated at its northern end by a large igneous massif belonging to the Nain igneous complex, which underlies a deeply incised, barren highland plateau dominating the northeastern part of the map area (Figure 2). Leucogabbro and gabbronorite (subunit 15a) as well as subordinate anorthosite (subunit 15b) are intruded by later, areally dominant monzonite, quartz monzonite and syenite (Unit 16). These rocks have a well-defined, intrusive contact with tonalite gneiss of subunit 1a, but no intense, widespread metamorphic aureole was recognized. Rocks of both the massif and the Nain igneous intrusive bodies are continuous in the Flowers River area to the north, which yield Paleohelikian ages (Hill, 1982) of emplacement.

The southwestern and western parts of the map area are underlain solely by rocks of the Harp Lake complex, which forms a barren highland igneous massif, similar to that in the northeastern part of the area. It contains leucogabbro–gabbronorite (subunit 17a) and anorthosite (subunit 17b), intruded by monzonite to quartz monzonite (Unit 18). Rocks of this massif also intrude older lithologies including Units 1 through 13 (Figure 2), but show little evidence of contact metamorphism away from the contact. The Harp Lake complex was emplaced during the Paleohelikian (Emslie, 1980).

Unique within the Ugjoktok River map area is either a single or series of subhorizontal to horizontal pyroxene gabbro–diabase sill(s) (subunit 19c), which intrude(s) garnet paragneiss (Unit 3), quartz diorite (Unit 4), garnetiferous porphyritic granodiorite (Unit 5) and Harp Lake complex monzonite to quartz monzonite rocks (Unit 18). Fragmental (hypabyssal?) mafic flow rocks (subunits 19a and 19b) are closely associated, typically along the margins of the sill(s) (Figure 2), and contain some clasts from lithologies unrecognized within the map area. The Unit 19 gabbroic–diabasic rocks exhibit fresh intrusive or volcanic igneous textures, are undeformed and therefore inferred to be Paleohelikian.

Peralkaline granite (Unit 21) of the Neohelikian Flowers River Igneous Suite of Hill (1982), occurs in two places within the northeastern Nain igneous complex massif. It is closely associated with gabbronorite at the easternmost locality, and contains angular fragments of quartz–feldspar porphyry of Unit 20 at the locality north of the Ingrid group. The quartz–feldspar porphyry (Unit 20) is suspected of having peralkaline chemistry, and therefore, has been also assigned to the Flowers River Igneous Suite.

Gneissic and deformed granitoid rocks within the Ugjoktok River map area have undergone two known orogenic events. Tonalite orthogneiss (Unit 1) has been subjected to an Archean orogenic event, and at least north of the Ugjoktok River, has been reworked during the Proterozoic Hudsonian event. Both garnet paragneiss (Unit 3) and garnetiferous porphyritic granodiorite (Unit 5) have undergone Hudsonian deformation. In addition, the rocks of Units 6 through 13 have also been tectonized during the Hudsonian Orogeny but may contain Archean remnants affected by pre-Hudsonian tectonism.

Tonalite Orthogneiss (Unit 1)

Tonalite orthogneiss (subunit 1a) is well banded, but may be locally migmatitic or agmatitic. Banding may be regular and planar, or irregular and contorted (Plate 1), and consist of leucosome mobilizate layers ranging up to 5 cm in width, separating much wider (up to tens of metres) melanosome restite layers. Tonalite orthogneiss weathers grey to greenish-grey, is grey–green on fresh surface and consists of quartz, K-feldspar, plagioclase, orthopyroxene, green amphibole, brown biotite $\pm$ garnet $\pm$ magnetite $\pm$ chlorite $\pm$ epidote. The rock exhibits a fine- to medium-grained equigranular, polygonal, granoblastic texture and has a grain size up to 2 or 3 mm. Garnet occurs as fine-grained crystals within the matrix. The gneiss contains amphibolite bands up to tens of metres in width and is intruded by basic dykes, some of which are layer parallel and have been metamorphosed and recrystallized, others of which are fresh and cross-cut the gneissic banding. The cross-cutting dykes, which are generally narrow ($<$ 1 m) and trend northeasterly, may belong to the Harp dyke swarm of Emslie (1980).

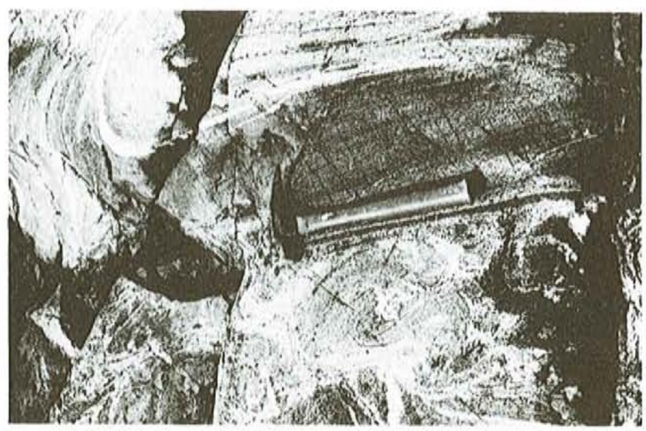

Plate 1. *Irregular, contorted banding in tonalite orthogneiss belonging to Unit 1.*

Mylonitic tonalite orthogneiss (subunit 1b), (Figure 2) is extremely fine-grained, recrystallized and dissected by numerous chlorite-filled fractures. In addition, it is locally brecciated and/or strewn with rounded feldspar porphyroclasts, up to 0.5 cm in diameter. On the weathered surface it is rusty pink and on the fresh surface it is greenish-red. The mylonitization may be due to a single fault, or may represent the root of a higher level fault zone. The subunit 1b orthogneiss zone is itself folded, and therefore probably represents a relatively early structure.

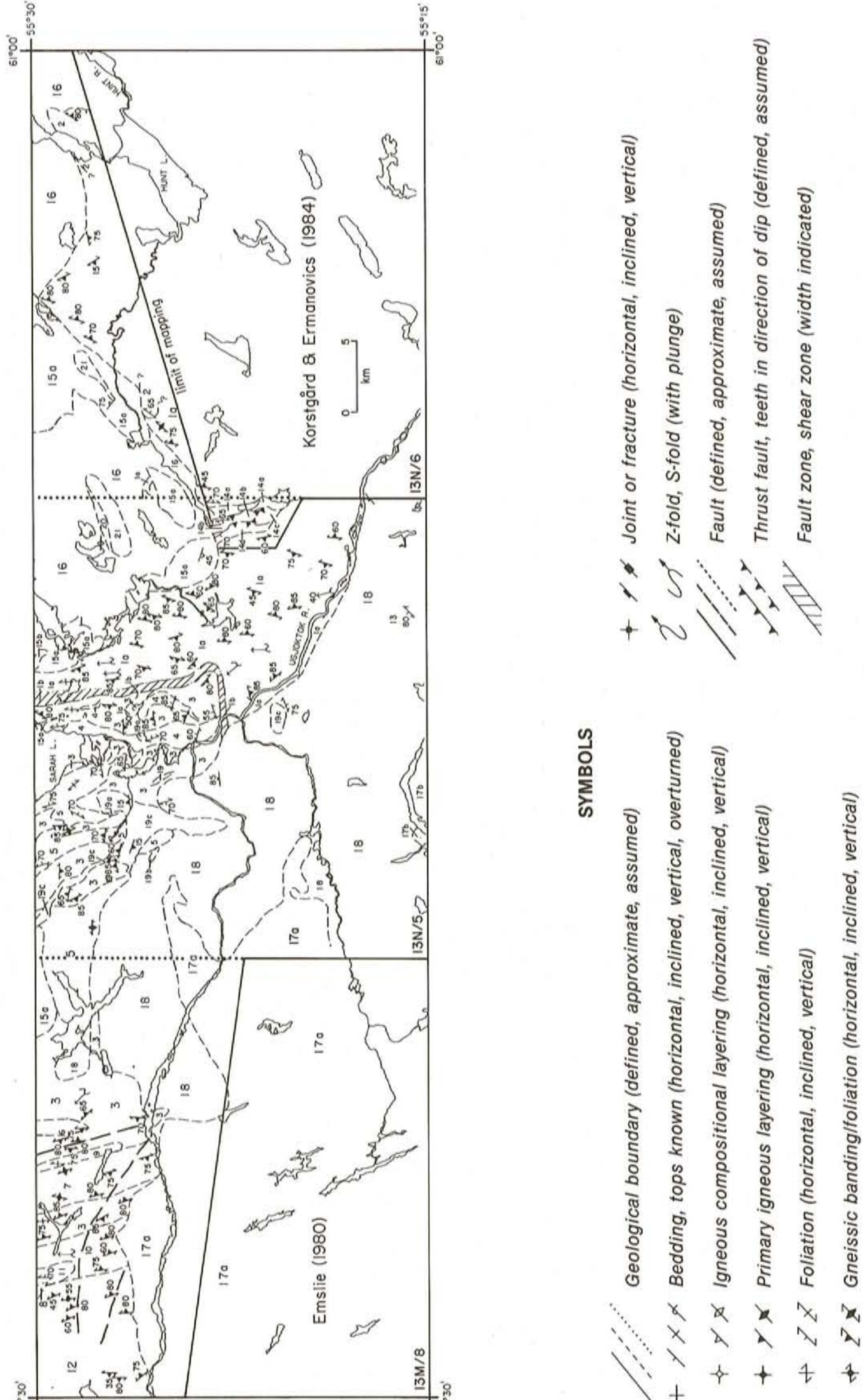

Figure 2. *Geology along the central part of the Ugjoktok River, Labrador.*

LEGEND

NEOHELIKIAN

FLOWERS RIVER IGNEOUS SUITE

21 *Peralkaline granite*

20 *Quartz, feldspar porphyry*

PALEOHELIKIAN

19 19a, *Fragmental flow rock (consists of angular fragments of a variety of lithologies in a matrix of amygdule-rich hypabyssal mafic rock:* 19b, *fragmental flow rock similar to subunit 19a, but containing large quantities of graphite;* 19c, *pyroxene gabbro to pyroxene diabase*

HARP LAKE COMPLEX

18 *Monzonite, quartz monzonite (commonly rapakivi textured)*

17 17a, *Leucogabbro, gabbronorite;* 17b, *anorthosite*

NAIN IGNEOUS COMPLEX

16 *Monzonite, quartz monzonite, syenite*

15 15a, *Leucogabbro, gabbronorite;* 15b, *anorthosite*

APHEBIAN

INGRID GROUP

14 14a, *Mafic to intermediate lavas, mafic conglomerate, sandstone, siltstone;* 14b, *mafic to intermediate lavas, porphyritic basalt, mafic conglomerate sandstone, siltstone;* 14c, *mafic volcanic conglomerate, felsic polymictic conglomerate, sandstone siltstone, grit, mudstone;* 14d, *mylonitized and tectonically intercalated rocks of Unit 1 and Ingrid group*

APHEBIAN and/or ARCHEAN

13 *Foliated equigranular granite*

12 *Granitic orthogneiss*

11 *Foliated hornblende, pyroxene granite*

10 *Foliated biotite, amphibole diorite to monzodiorite*

9 *Foliated quartz syenite*

8 *Amphibolite, includes minor bands of diorite, tonalite gneiss and schist*

7 *Granitic gneiss intermixed with tonalite gneiss and quartz syenite*

6 *Porphyritic granitic gneiss*

5 *Garnet, hypersthene-foliated porphyritic granodiorite to augen gneiss*

4 *Quartz diorite, diorite*

3 *Garnet paragneiss with or without sillimanite and hypersthene*

ARCHEAN

2 *Foliated hornblende, biotite granite*

1 1a, *Tonalite orthogneiss;* 1b, *mylonitic tonalite orthogneiss*

The type and homogeniety of mineralogy over large expanses of the tonalite gneiss, suggest a dioritic to quartz dioritic igneous protolith. The gneiss has had a complicated tectonometamorphic history and has attained upper amphibolite to granulite facies conditions, and hence may be as old as Archean.

Hornblende–Biotite Granite (Unit 2)

Rocks belonging to the two limited exposures of granite on map sheet 13N/6, are moderately to strongly foliated, having patches of gneissic texture developed in the easternmost exposure. They weather buff-white to pink, are pink–white on fresh surface and comprise quartz, K-feldspar, plagioclase, biotite, amphibole and orthopyroxene. The rocks of Unit 2 appear to intrude the tonalite orthogneiss of Unit 1, however, both these rock types have undergone at least one common deformational event.

Garnet Paragneiss (Unit 3)

Quartzofeldspathic paragneiss (Plate 2) weathers white, is grey–green to grey on fresh surface and exhibits medium to coarse polygonal granoblastic texture. It is well banded, having cordierite, biotite, minor muscovite, hypersthene?, fine-grained subhedral to euhedral garnet, magnetite and/or ilmenite and commonly associated with coarse prismatic sillimanite confined to melanocratic restite bands. These bands vary in width from 2 to 10 cm. Leucocratic mobilizate bands contain quartz, feldspar and large (up to 2 cm) euhedral to subhedral garnet porphyroblasts (Plate 2). In general, leucocratic bands are much wider than their melanocratic counterparts, quite commonly occurring on a scale of one to two metres. Banding in the gneiss may be regular or contorted, but generally represents polyphase deformation. Mushroom structures and chevron folds, as well as transposition structures such as hook folds, are common throughout the unit.

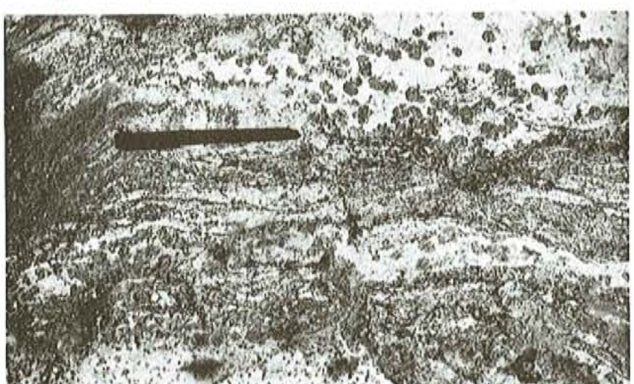

Plate 2. *Garnet porphyroblasts in quartzofeldspathic garnet paragneiss of Unit 3.*

The presence of abundant sillimanite suggests that the protolith was a pelitic sediment. Both the protolith and deformation within the gneiss are considered to be Proterozoic, the latter being due to the Trans-Hudson Orogen. Pending the results of a comprehensive geochronological program, for which samples from this unit were collected, the possibility of parts or all of the paragneiss being as old as Archean is not yet discounted.

Quartz Diorite–Diorite (Unit 4)

The quartz diorite to dioritic rocks of Unit 4 consist of medium-grained, recrystallized quartz, plagioclase, hypersthene, amphibole, biotite and magnetite and/or ilmenite. In the cores of the two large bodies, south of Sarah Lake (Figure 2), relict medium- to coarse-grained igneous textures prevail, whereas polygonal, granoblastic textures are typical in the small body southeast of the lake, as well as in the margins of the larger bodies. These rocks are intrusive into Unit 3 paragneiss, however, both their absolute age relationship and tectonic history with respect to the gneiss are uncertain.

Garnet–Hypersthene Porphyritic Granodiorite (Unit 5)

As with garnet paragneiss, porphyritic granodiorite weathers white and is buff-white or white on fresh surface. It exhibits a characteristically coarse porphyritic texture (Plate 3) containing euhedral to subhedral, elongate K-feldspar crystals up to 5 cm long in a medium-grained quartz, plagioclase, orthopyroxene and amphibole matrix. Coarse subhedral to rounded garnet and/or orthopyroxene? porphyroblasts up to 1.5 cm in diameter are ubiquitous throughout the rocks of this unit (Plate 4). Porphyritic granodiorite is strongly foliated to gneissic and the feldspar phenocrysts show marked tectonic alignment. Locally, the rocks of Unit 5 are migmatitic and are almost everywhere intruded by criss-crossing dykes and veins of felsic aphanitic material.

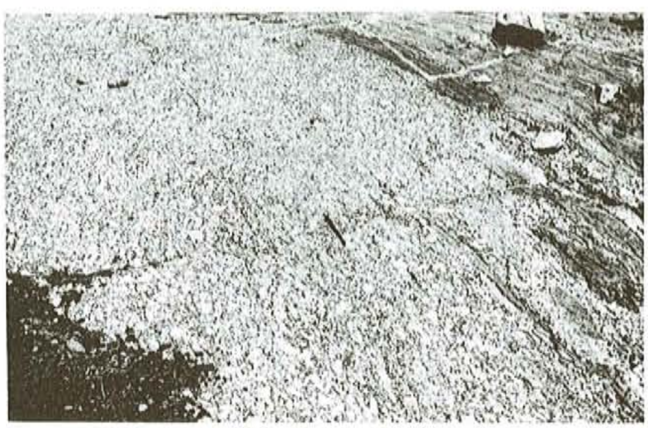

Plate 3. *Coarse porphyritic texture in foliated garnet, hypersthene granodiorite of Unit 5; note contact of granodiorite with Unit 3 paragneiss at upper right.*

Porphyritic granodiorite has been metamorphosed under conditions of amphibolite to granulite facies. It is itself deformed, but also intrudes previously deformed Unit 3 paragneiss (Plates 3 and 5), indicating either a late syntectonic

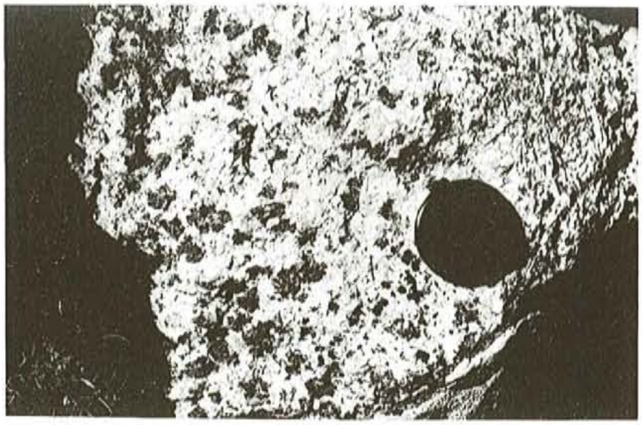

Plate 4. *Closeup of garnet porphyroblasts within Unit 5 garnet, hypersthene granodiorite.*

Plate 5. *Xenolith of deformed Unit 3 paragneiss surrounded by Unit 5 granodiorite.*

origin with respect to deformation in the paragneiss, or posttectonic intrusion, if subsequently deformed.

Churchill Province Straight Granitoid–Gneiss Belts (Units 6 to 12)

These lithologies include porphyritic granite gneiss (Unit 6), amphibolite (Unit 8), quartz syenite (Unit 9), diorite–monzodiorite (Unit 10) and granitic orthogneiss (Unit 12), as well as several other minor granitoid and gneiss units. Two features link all these units: 1) the upper amphibolite to granulite facies metamorphic mineral assemblages, and 2) the occurrence of variously developed mylonitic fabrics. The mineralogy of the rocks within these units, comprises quartz, K-feldspar, plagioclase, orthopyroxene, clinopyroxene, amphibole, biotite, garnet, sillimanite and chlorite. Orthopyroxene (hypersthene?) is present in approximately seventy percent of the felsic gneissic and granitic rocks. Chlorite is a minor retrograde alteration product of amphibole, garnet and pyroxene.

Fifteen of seventeen samples examined in thin section showed moderately to strongly developed mylonitic textures, including highly strained and intensely recrystallized quartz and feldspar. This sequence of Churchill Province rocks is monotonous and was examined in detail by Hill (1982).

Foliated Equigranular Granite (Unit 13)

Two small outcrops of foliated equigranular granite occur south of the Ugjoktok River as large xenoliths or possible roof pendants in monzonitic to quartz monzonitic rocks of the Harp Lake complex. This granite consists of quartz, microcline, orthoclase, amphibole and magnetite and/or ilmenite. Both its origin and absolute age are unknown.

Ingrid Group (Unit 14)

Detailed descriptions of rocks belonging to this unit have been given by Knight *et al.* (1981) and Ermanovics and Korstgård (1981), from which the following description is summarized. An overturned synform along the eastern edge of the group contains mafic to intermediate lavas, mafic volcanic conglomerate, sandstone and siltstone (subunit 14a). The lavas comprise mainly massive, or rarely, pillowed subaerial basalts and andesites, characterized by a fine-grained matrix of chlorite, epidote and actinolitic amphibole. Individual flows are not recognizable. The associated conglomerate contain clasts, which are derived from these mafic lavas.

The central part of the group is dominated by an overturned antiform, where, in the northern part, mafic to intermediate lavas, porphyritic basalt, mafic volcanic conglomerate, sandstone and siltstone are exposed (subunit 14b). The porphyritic basalt is characterized by irregularly distributed plagioclase phenocrysts up to 2 cm long, whereas mafic to intermediate lavas are identical to those in subunit 14a. Mafic conglomerate in this unit contain clasts derived from the porphyritic basalt, and include unsorted, poorly bedded rocks and angular fragments comprising basalt, gabbro and shale, as well as cobbles and boulders of the underlying Unit 1 orthogneiss.

Both the synform and antiform are overturned toward the east and bounded in part along their limbs by west-dipping thrust faults. The south-central section of the group contains mafic volcanic conglomerate, felsic polymictic conglomerate, sandstone, siltstone and grit and mudstone of the uppermost formation (subunit 14c). Clasts within this unit are also derived from volcanic and sedimentary rocks as well as basement gneiss. They include granodiorite, perthitic granite, diabase, sandstone, siltstone, shale, quartzite and limestone.

Subunit 14d along the western border of the Ingrid group, comprise mylonitized and tectonically intercalated rocks of Unit 1 basement gneiss and the group itself. The unit forms a 1-km-wide band along the edge of the group, and the contact with orthogneiss, *sensu stricto,* is gradational and obscured by mylonite. In this report, this unit is included within the group, but Ermanovics and Korstgård (1981) and Knight *et al.* (1981), mapped it as a separate lithological division outside of the group.

Conglomerates within the group are generally poorly sorted and the graded beds have indistinct gradational boundaries. Soft sediment slump structures, large isolated clasts in finer grained beds, and coarse unsorted detritus in beds of unsorted felsic sandstone are also common. Overall, these features suggest debris slide deposits indicative of an unstable depositional environment. Volcanic rocks intercalated with coarse polymictic detritus derived from both basement and underlying lavas, may be also indicative of volcanism in a tectonically unstable environment. The Ingrid group has been metamorphosed to the greenschist facies during the Hudsonian Orogeny.

Nain Igneous Complex (Units 15 and 16)

The plutonic rocks of this complex generally fall into two compositional groupings, namely 1) leucogabbroic to gabbronoritic and anorthositic rocks and, 2) monzonitic and syenitic rocks. Leucogabbro and gabbronorite (subunit 15a) are massive and exhibit well-developed, coarse-grained equigranular, ophitic to subophitic textures. These rocks weather grey—green and are grey or grey—white on fresh surface and have grain sizes up to 4 cm. They contain plagioclase, hypersthene and/or clinopyroxene, magnetite, ilmenite, apatite and locally olivine.

Anorthosite (subunit 15b), which is closely associated, spatially, with the leucogabbro and gabbronorite, also exhibits coarse-grained, equigranular igneous texture. Where examined, it comprises approximately eighty-five to ninety percent plagioclase with minor hypersthene and opaque minerals.

Unit 16 includes monzonite, quartz monzonite and syenite. The rocks are buff-white to pink and commonly exhibit both a rusty and red-coloured weathering. Exposed surfaces are deeply weathered, friable and associated with talus piles of grus. This latter characteristic is marked in some places, where entire outcroppings of rock have weathered *in situ* to give a crust consisting of piles of equant feldspar crystals. The rocks comprise quartz, perthite, plagioclase, ortho- and clinopyroxene, amphibole, olivine, deep brown biotite, iddingsite, apatite, chlorite, epidote, magnetite, ilmenite and pyrite. The syenite is characterized by a quartz-free, olivine-bearing assemblage. Feldspars exhibit string, vein and braid perthites and both micropegmatitic and myrmekitic textures are common. Coarse-grained, equigranular, plutonic igneous textures predominate in these rocks, and porphyritic textures are rare or absent.

Harp Lake Complex (Units 17 and 18)

The Harp Lake complex rocks are divided into two groupings, namely 1) leucogabbro, gabbronorite and anorthosite, and 2) monzonite and quartz monzonite. Leucogabbro and gabbronorite (subunit 17a) are massive, and like their counterparts in the Nain igneous complex, exhibit fresh, coarse-grained, equigranular, igneous textures and have the same colour and mineralogy.

Subunit 17b anorthosite is identical in character and mineralogy to subunit 15b anorthosite. Monzonite and quartz monzonite of Unit 18 differ mainly from that of Unit 16 in having a porphyritic texture, commonly with locally developed, rapakivi-textured perthite cores mantled by plagioclase rims (Plates 6 and 7). Plutonic rocks of Unit 18 comprise quartz, perthite, microcline, plagioclase, orthopyroxene, clinopyroxene, olivine, amphibole, minor brown biotite, iddingsite, minor chlorite, magnetite and ilmenite. Locally, the presence of numerous granitoid and intensely metamorphosed gneissic xenoliths (Plate 8), suggests that Unit 18 plutonic rocks may represent a high level of intrusion.

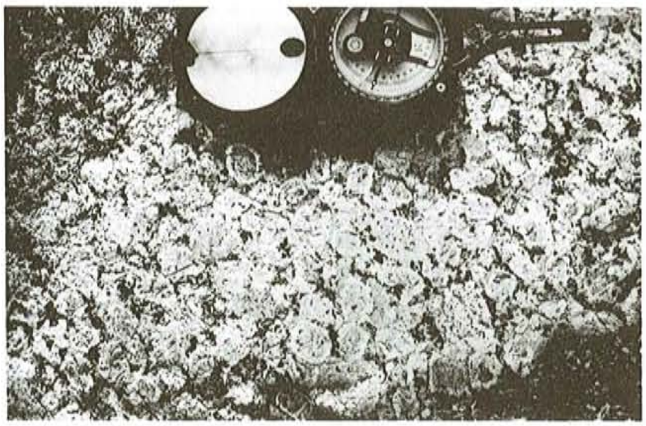

Plate 6. *Closeup of rapakivi texture in Harp Lake Complex quartz monzonite belonging to Unit 18.*

Plate 7. *Porphyritic, rapakivi-textured Harp Lake Complex quartz monzonite of Unit 18.*

Fragmental Flow Rock—Pyroxene Gabbro (Unit 19)

Subhorizontal to horizontal sills (Plate 9), southwest of Sarah Lake, contain mainly pyroxene gabbro to diabase, however, lesser amounts of hypabyssal or possibly volcanic flow rock occur along their margins.

Fragmental flow rock (subunit 19a) is indicative of high levels of intrusion. It consists of a variety of angular fragments (Plate 10), in a fine-grained mafic matrix. Fragments, which

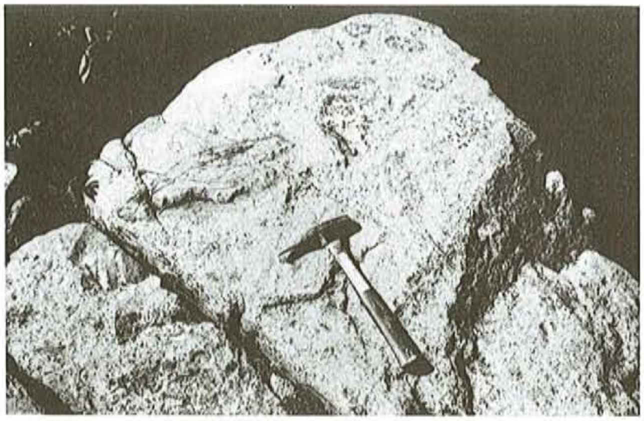

Plate 8. *Granitoid and gneiss xenoliths in high-level intrusive Unit 18 quartz monzonitic rocks belonging to the Harp Lake Complex.*

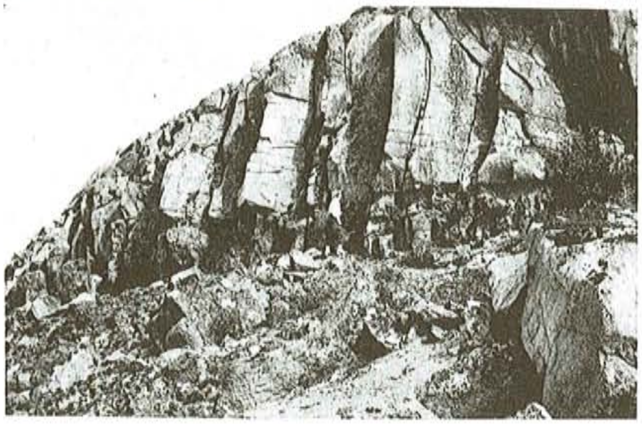

Plate 9. *Subhorizontal sill of subunit 19c pyroxene gabbro resting upon altered quartz monzonitic rocks belonging to Unit 18 of the Harp Lake Complex; note weathering and breakdown of rocks along the contact.*

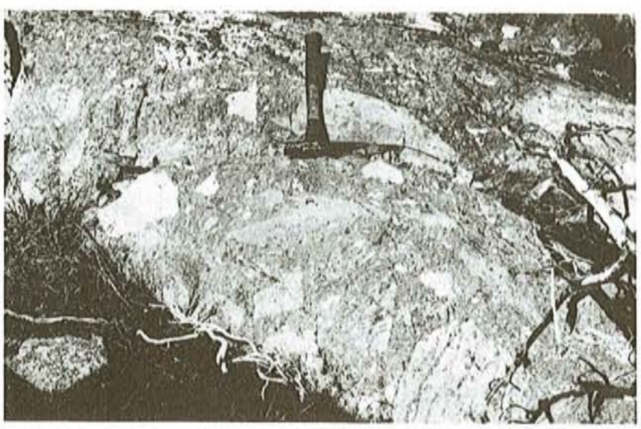

Plate 10. *Angular fragments of metaquartzite, gneiss and granitoids in a fine-grained mafic matrix; exposure is subunit 19a fragmental flow rock.*

range up to 0.5 m in diameter, consist of metaquartzite, felsic granitoid rocks and gneiss, are unsorted, and have a chaotic distribution suggestive of magmatic stoping. Parts of this unit are especially rich in fragments, almost to the exclusion of matrix material (Plate 11). Also present within the matrix are quartz and calcite-filled amygdules up to 1 cm in diameter. These are sparsely distributed and undeformed, with quartz commonly present as euhedral vug-filling crystals. The matrix of subunit 19a rocks is massive, exhibits a fresh pilotaxitic igneous texture, and consists of plagioclase laths in a groundmass of intersertal clinopyroxene, for the most part altered to chlorite and sericite. Locally, graphite and/or specular hematite and radiating clusters of zeolites? are also present. A chilled marginal contact (Plate 12) is locally exposed between fragmental flow rock (subunit 19a) and the country rocks.

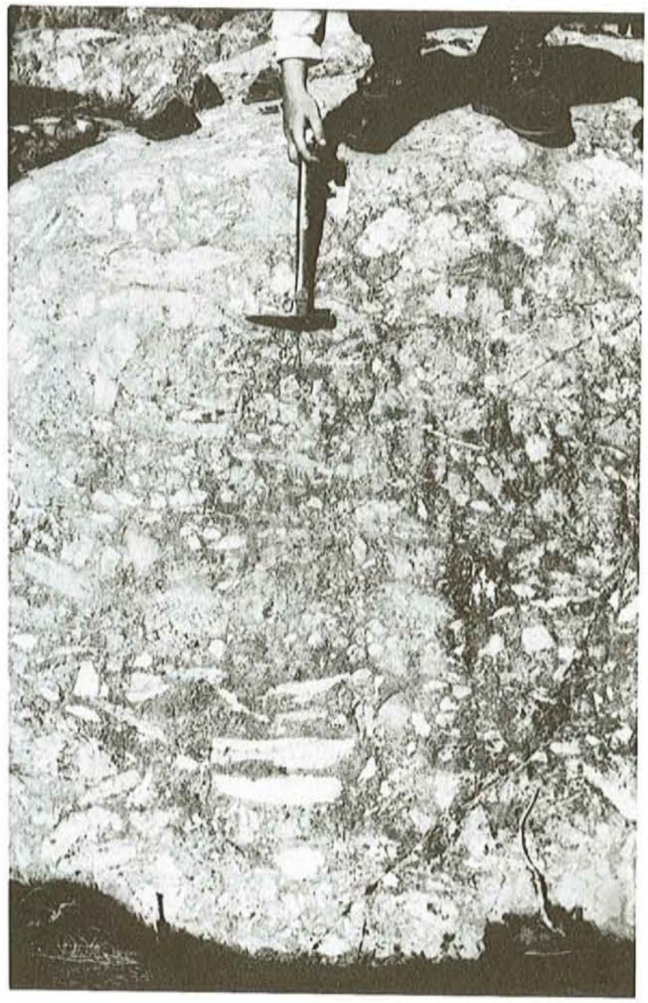

Plate 11. *Exposure is same area as that of Plate 10, showing close concentration of abundant fragments.*

A limited area of outcrop north of the western part of the Ugjoktok River consists of fragmental flow rock (subunit 19b) similar to that of subunit 19a, but contains large quantities

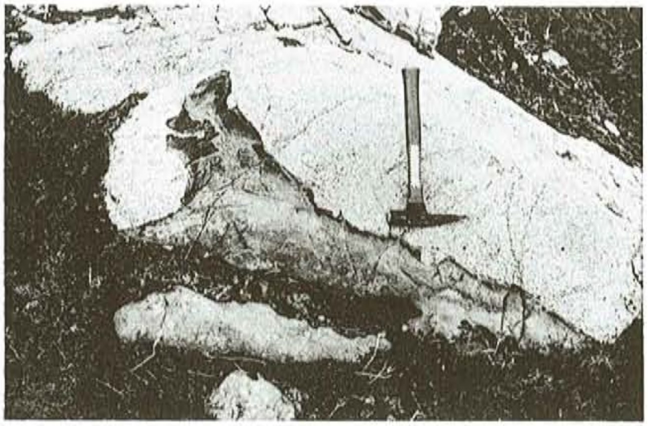

Plate 12. *Contact between fragmental flow rock of subunit 19a and quartz dioritic rock of Unit 4; note chilled margin of former against latter.*

Plate 13. *Subangular xenoliths of Unit 20 quartz, feldspar porphyry in Unit 21 peralkaline granite.*

of graphite and minor amounts of chalcopyrite and pyrite. In this unit, amygdules are not observed and the matrix texture may be in part detrital sedimentary. Therefore, although this rock is assigned to Unit 19, it may in actual fact be a raft of some earlier lithology, possibly correlative with the Ingrid group.

Pyroxene gabbro to pyroxene diabase (subnit 19c) is fresh, exhibits a massive igneous texture, and at several localities near the base of the sills has well-developed igneous layering. In general, there is a fining of grain size toward the lower margin of the sills, with the gabbroic textures at higher levels, giving way to diabasic textures along a chilled marginal contact. The basal contact of one prominent sill (Plate 9) is marked by a 1.5-m-thick band of altered, iron-stained pyrite, pyrrhotite-rich, fine-grained rock, which is quite noticeable from a great distance, and can be mapped easily from the air. Subunit 19c gabbro–diabase contains plagioclase, orthopyroxene, clinopyroxene, olivine, red–brown biotite, magnetite and/or ilmenite and, where altered, minor chlorite, iddingsite, serpentine and calcite.

Flowers River Igneous Suite (Units 20 and 21)

Quartz-feldspar porphyry (Unit 20) occurs in a narrow, 1.5-km band northeast of the Ugjoktok River. It weathers to a rusty-buff colour and is reddish-green on fresh surface. The rock is massive, fresh and contains mainly euhedral to subhedral K-feldspar and subordinate quartz phenocrysts up to 1 cm across, in a groundmass of fine-grained polygonal quartz, K-feldspar, plagioclase, clinopyroxene, amphibole, olivine? and magnetite and/or ilmenite. K-feldspar phenocrysts are zoned and clinopyroxene crystals are commonly embayed and resorbed. At present, it is considered that the quartz–feldspar porphyry is peralkaline, as the clinopyroxene is suspected to be aegirine. In addition, the porphyry is intruded by suspected peralkaline granite (Plate 13).

Peralkaline granite (Unit 21), closely associated, spatially, with the quartz–feldspar porphyry, is massive and fresh, exhibiting a coarse plutonic igneous texture. One suspected occurrence of this rock type is as a small elongate body in Nain igneous complex rocks north of the Ingrid group, however, it is more commonly found as narrow dykes at localities widespread throughout the complex. Peralkaline granite weathers buff-white or pink–white, is medium- to coarse-grained and contains quartz, perthite, plagioclase, aegirine and arfvedsonite and/or riebeckite.

Structure

Rocks within the Ugjoktok River map area are divided into three structural groups: 1) those that are undeformed, 2) those deformed during the Hudsonian Orogeny, and 3) those deformed during the Hudsonian and/or earlier (Archean) events. Apart from some localized shearing and mylonitization, igneous rocks belonging to the Nain igneous complex, Harp Lake complex and Flowers River Igneous Suite are essentially undeformed. No evidence was observed to suggest faulting of any great magnitude.

It is suspected that rocks of the Ingrid group are Aphebian and therefore, were deformed during the Hudsonian Orogeny. Knight *et al.* (1981) and Ermanovics and Korstgård (1981) interpret the regional structure of the group as resulting from an originally gently flexed anticline, subsequently folded and faulted along steep, west-dipping thrust faults. These would have most likely occurred by slippage along the limbs of overturned large-scale regional folds.

Basement gneisses deformed during the Hudsonian Orogeny are separated into two groups. Churchill Province gneisses of map sheet 13M/8, within the northwestern part of the area, are flattened and straightened, exhibiting an intense, regular, steep-dipping, north-trending gneissic banding and/or foliation (Figure 3b). These northwestern

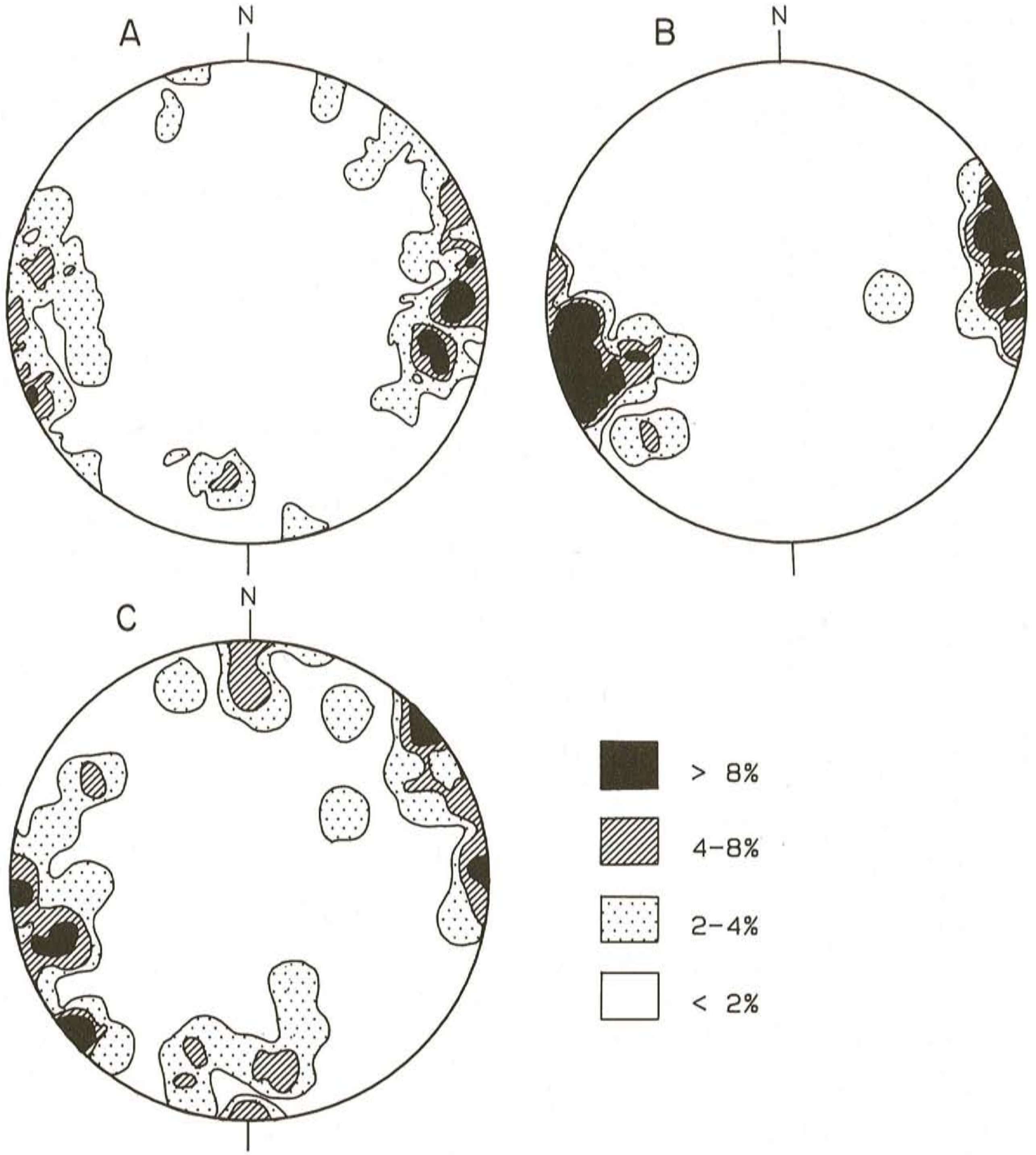

Figure 3. *Contoured stereographic plots of poles to gneissic banding–foliation planes for, a) the central gneisses; b) the northwestern gneisses; and c) the foliation planes for central granitoid rocks; plots are based on 80, 30 and 36 data points respectively; contour intervals are in percent of poles per one percent area of the stereonet.*

gneisses are polydeformed, and both mesoscopic and megascopic folds are closed, isoclinal structures, with the observed folds being flattened and occasionally recumbent. At one locality in the extreme northwestern part of the area, gneissic banding is nearly horizontal on the vertical face of an outcrop, and nearly vertical on the top of the same outcrop. It is possible that either two limbs of a fold are being observed, or that at this locality, an intense subvertical foliation overprints a flat-lying gneissic banding. For the amount of time spent examining the northwestern gneisses, it was not possible to determine a detailed breakdown into structural events and or domains.

Gneisses within the central part of the area exhibit greater structural diversity. As in the northwestern gneisses, gneissic banding and/or foliation in the central gneisses (Units 1 and 3) dip steeply east or west and trend north–south (Figure 3a), but is not as consistently flattened nor as tightly constrained to a north–south orientation. These characteristics are demonstrated by comparison of the stereoplots of Figures 3a and 3b. The pole maxima for the central gneisses are less intense than those for the northwestern gneisses. In addition, both pole maxima and pole girdles for the central gneisses are more dispersed, exhibiting a much wider variation in trend. Folding in the central gneisses is more open than in the northwestern gneisses. Regional, megascopic open to isoclinal F_2 folds plunge at moderate angles to the south or southeast, and refolded F_1 folds, such that the two become coaxial, with axial planes of both being vertical or subvertical. Gneissic banding and/or foliation were formed prior to, or during the of F_1 folding.

Deformed granitic rocks in the central part of the area exhibit foliation trends (Figure 3c) similar to the gneissic banding and/or foliation trends found within the surrounding gneisses. The major difference is the occurrence of a number of east–west trending, moderate to steep north- and south-dipping foliation planes, which are apparent on a stereoplot of the foliation data (Figure 3c).

Gneisses deformed during Hudsonian and/or earlier Archean events are confined to the southern and eastern parts of the map area. The tonalite orthogneiss (Unit 1) is believed to be of Archean age and to have primarily Archean structural features. West of the Ingrid group, and, according to Korstgård and Ermanovics (1984), east of the group for several kilometres, Hudsonian reworking has imparted a northerly trend to the gneiss. Farther to the east, near Hunt Lake in the region examined by Ermanovics and others, east and northeast late Archean trends (Ermanovics *et al.*, 1982) predominate. According to Korstgård and Ermanovics (1984), the eastern limit of Hudsonian deformation (and therefore the Churchill–Nain province boundary) is marked roughly by the Ingrid group and its nearby basement.

The (subunit 1b) mylonite zone may represent the root of a deep-seated thrust or reverse fault and constitute a more fundamental division between Proterozoic (Unit 3), and Archean (Unit 1) gneisses. A geochronological study, in progress, should define the Churchill–Nain province boundary more accurately in this area.

Several faults cut the northwestern gneisses and are marked by mylonite and deeply incised lineaments. Neither sense of movement nor age of these structures could be determined. Much of the northwestern gneiss terrain is mylonitic, having ribbon and strained quartz showing undulose extinction, fine-grained polygonal recrystallization and rotation features around rounded garnet; feldspar porphyroblasts are common. These Churchill Province gneisses have undergone associated extreme flattening.

Metamorphism

Apart from the local greenschist grade of late-stage deuteric alteration, rocks belonging to the Nain igneous complex, the Harp Lake complex, the Flowers River Igneous Suite and the fragmental flow rock and pyroxene and/or diabase of Unit 19, are essentially unmetamorphosed. The late-stage alteration is manifested by cross-cutting veinlets filled with chlorite, epidote, sericite and calcite and also by selective sericitization of plagioclase. Orthopyroxene and clinopyroxene are common mineral constituents of both gabbroid and granitoid plutons within these igneous complexes. Although these minerals are not in themselves of metamorphic origin, they indicate intrusion of the plutons under high-temperature anhydrous conditions. No obvious intense, widespread metamorphic aureole occurs about the igneous massifs, however, pyroxene exhibits retrograde alteration to amphibole at a number of localities in tonalite orthogneiss within several kilometres of the Nain igneous complex.

The occurrence of chlorite, epidote and actinolitic amphibole in rocks of the Ingrid group is indicative of greenschist facies metamorphism (Knight *et al.*, 1981; Ermanovics and Korstgård, 1981).

All other gneissic and deformed granitoid rocks within the map area exhibit amphibolite to granulite facies mineral assemblages. The northwestern gneisses have an upper amphibolite–granulite Hudsonian metamorphic mineral assemblage containing orthopyroxene, clinopyroxene, garnet and biotite with or without sillimanite and cordierite. An amphibolite facies retrograde overprint of unknown age is indicated by the partial alteration of pyroxene to amphibole.

Both orthogneiss and paragneiss from the central and eastern parts of the map area contain the granulite facies assemblage of orthopyroxene, clinopyroxene, biotite and garnet. In addition, paragneiss contains sillimanite as a stable phase. A greenschist to amphibolite retrogression is also apparent in these rocks, indicated by the presence of secondary amphibole, chlorite, sericite and minor epidote. Until results from the geochronology sampling program are received, no attempt is made to date the metamorphism other than to state that the northwestern gneisses are primarily Hudsonian, that the central gneisses are Hudsonian and/or late Archean?, and that the eastern gneisses are primarily late Archean.

Economic Geology

Igneous rocks belonging to both the Nain and Harp Lake complexes contain abundant coarse magnetite and ilmenite. Although no layered concentrations of ilmenite were observed anywhere, rich accumulations of ilmenite are present within subunit 15a gabbronorite, in the northeastern part of the area. Crystals in excess of 2-cm length were observed at several localities. Subunit 17a gabbronorite is also rich in coarse ilmenite crystals. Both the Nain and Harp Lake complexes are singled out as possible exploration targets for chromium and platinum group transition elements.

Peralkaline granite (Unit 21) of the Flowers River Igneous Suite is enriched in Zr, Ce, La and other rare-earth elements. Several Zr-rich samples have been collected by Hill (1982) from Flowers River Igneous Suite rocks to the north. One locality within the peralkaline granite body north of the Ingrid group gave a total count scintillometer reading of 700 to 1000 cps.

Stringer chalcopyrite, pyrite, pyrrhotite mineralization, along with abundant graphite, is present within subunit 19b fragmental rocks. Disseminated sulphide mineralization also occurs at numerous localities within the northwestern Churchill gneisses. A number of rusty mineralized zones occur to the west of Sarah Lake. Of those examined, only disseminated pyrite and rusty hematitic weathering products were found. Some localities were exceedingly difficult to sample due to the intensely weathered nature of the rocks.

DISCUSSION

The geological nature of the Churchill–Nain boundary in the region of the central Ugjoktok River is still uncertain. In the absence of constraining geochronological data, only generalizations can be made. The northwestern gneisses are continuous northward along a wide belt of known Hudsonian deformation and are by definition, part of the Churchill Province. The northwestern gneiss terrain and associated deformation, can be traced continuously into the gneisses within the central part of the map area. Throughout both of these areas, rocks are characterized by north–south gneissic banding and/or foliation and fold trends. Across the subunit 1b mylonite zone, north–south trends persist and continue as far as 5 km east of the Ingrid group. From there eastward, easterly to northeasterly late Archean trends dominate. Until the significance of both the subunit 1b mylonite zone and the associated transition across it, from equivalents of the Tasiuyak gneiss to equivalents of the Maggo gneiss can be determined, it is suggested that the Churchill–Nain province boundary in the Ugjoktok River region remain as defined by Korstgård and Ermanovics (1984).

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