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THE ARCHEAN HUNT RIVER GREENSTONE BELT, HOPEDALE BLOCK, EASTERN LABRADOR (NTS 13N/7 AND 13N/10): GEOLOGY AND EXPLORATION POTENTIAL

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ABSTRACT

The Archean Hunt River greenstone belt, Hopedale Block, southern Nain Province, is a north-northeast-striking amphibolite-facies belt of supracrustal rocks consisting of mainly amphibolite, derived from mafic volcanic rocks, and lesser amounts of ultramafic rocks, pelitic and quartzofeldspathic metasedimentary rocks. It includes minor amounts of amphibolite derived from gabbro and inferred to represent subvolcanic mafic intrusions, and rare occurrences of felsic volcanic rocks and banded chert–magnetite iron formation. In the northern part of the belt, there are two occurrences of quartzite associated with ultramafic rocks.

The ultramafic rocks, which have the potential to host Kambalda-type Ni–Cu sulphide mineralization, occur either as thin (10 to 30 m) units that can be traced for several kilometres, or as lens-shaped units that are several hundred metres long. The ultramafic rocks are commonly associated in the field with sulphitic metasedimentary rocks and local felsic volcanic rocks; also, they contain a single occurrence of spinifex textures. This suggests that they probably represent ultramafic flows; the continuous units representing widespread sheet flows, and the lens-shaped units representing narrow channelized flows. Hand specimens of massive sulphide, hosted by ultramafic rocks in the southern part of the belt, contain 4.3% Cu and 0.57% Ni.

A contact between tonalite gneiss and a 50-m-thick unit of quartzofeldspathic metasedimentary rocks, which locally form the basal unit of the greenstone belt, is interpreted as a preserved basement–cover contact. The contact itself is a 30-cm-thick schistose metaconglomerate(?) and is also marked by several, very thin ultramafic layers. These relationships, and the fact that quartzites occur locally, suggest that the Hunt River greenstone belt was deposited on a basement of continental crust. Subaerial exposures of the basement rocks provided detritus for the quartzofeldspathic metasedimentary rocks and quartzites in the belt.

INTRODUCTION

The Archean Hunt River greenstone belt in the Hopedale Block, southern Nain Province, eastern Labrador (Figures 1 to 3), is a northeast-striking and lenticular-shaped belt consisting mainly of mafic volcanic rocks and lesser amounts of sedimentary and mafic intrusive rocks. It is intruded and encompassed by Archean granitoid plutons and orthogneiss units of several ages. Rocks in the Hunt River greenstone belt are metamorphosed to amphibolite facies; hence it is not a true greenstone belt. However, it is geologically similar to the better preserved and lower-grade Florence Lake greenstone belt, which occurs to the south of the study area (*see* Figure 3; Ermanovics, 1993; James *et al.*, 1996a).

Detailed geological mapping and prospecting (e.g., McLean, 1991), regional-scale geological mapping (Jesseau, 1976; Ermanovics, 1993) and geochemical surveys (Hornbrook and Friske, 1988) suggest that the Hunt River greenstone belt has potential for komatiite-associated nickel–copper sulphide mineralization and mesothermal gold (Swinden *et al.*, 1991). In view of the mineral potential and the need for an updated bedrock geology map, parts of the belt were mapped at 1:25 000 scale in 1996 (*see* Figures 4 to 6); a preliminary report of the 1996 field season is given by James (1996). The Hunt River greenstone belt is presently contained within one of the Exempt Mineral Lands areas (*see* Figure 7).

Mapping in the Hunt River greenstone belt represents one component of the Hopedale Multidisciplinary Project; a review and assessment of the geology and mineral potential of greenstone belts in the Hopedale Block. In 1995, the project focused principally on the Florence Lake greenstone belt and included 1:25 000-scale bedrock mapping (James *et al.*, 1996a, b, c, d), detailed mapping and sampling of known and newly discovered sulphide mineralization (Miller, 1996),

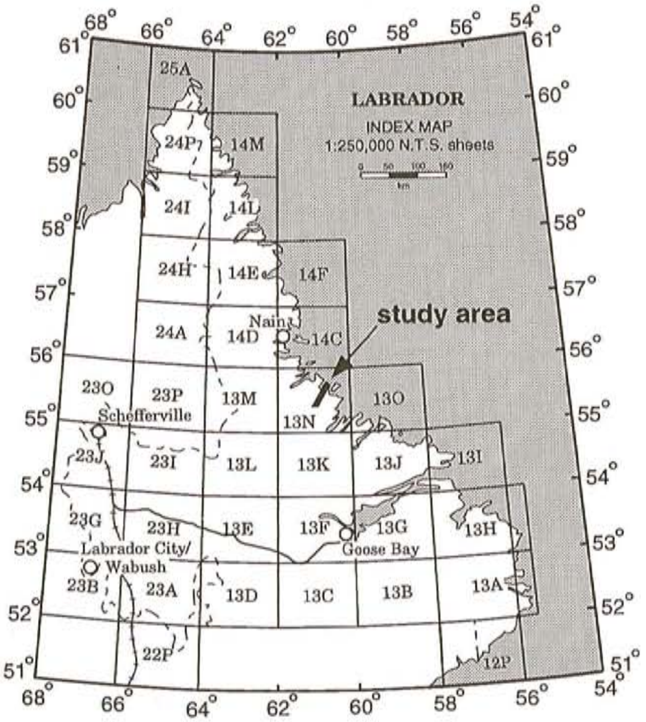

Figure 1. *NTS index map of Labrador showing location of the study area.*

a soil and stream water ± sediment geochemical sampling program (McConnell, 1996) and Quaternary mapping (Batterson, 1996). Data collected from the Hopedale Multidisciplinary Project will be combined with non-confidential mineral-industry data (e.g., detailed airborne geophysical data, mineral occurrences, drillhole data) currently held in the Newfoundland Department of Mines and Energy assessment files. The project will ultimately be delivered to clients as a fully integrated GIS package. The compilation work and assessment-file research is being conducted by G. Kilfoil, L. Nolan, A. Hogan and L. Crisby-Whittle of the provincial Geological Survey.

PREVIOUS WORK

The northern parts of Hopedale Block including the Hunt River greenstone belt were first mapped at 1:250 000 scale by Taylor (Taylor, 1972, 1977, 1979). However, a report by Low (1896) of "greenschists" in the Jack Lane Bay[1] (Big Bay) area is the first reference to the metavolcanic rocks that were later defined as the Hunt River greenstone belt. Subsequent to Taylor's mapping, the Hunt River greenstone belt was mapped at 1:50 000 scale by Jesseau (1976) as part of a M.Sc. thesis project at Memorial University of Newfoundland, and at 1:50 000 scale by Ermanovics (1981, 1993).

There are very few reports of prospecting and exploration work in the Hunt River greenstone belt. Falconbridge (McLean, 1991) did some detailed mapping, prospecting and sampling in 1990 and 1991, and held the only claims ever made in the belt.

PRESENT INVESTIGATION

This report is based on 1:25 000-scale bedrock mapping carried out mainly in NTS map areas 13N/7 and 13N/10. Mapping was conducted by a two-person traversing team, and was mainly boat-supported from three camps (Figures 4 to 6); some of the work was helicopter-supported from the camp at Big Bay. The focus was on subdividing the greenstone belt into mappable units, examining the stratigraphic and structural relations between units, and evaluating the mineral potential of the belt. Contacts between the greenstone belt and encompassing granitoid plutons and orthogneisses were mapped, although the plutons and orthogneiss units were not examined in any detail.

REGIONAL FRAMEWORK

The Archean Nain Province (Stockwell, 1964) is divided into the Hopedale and Saglek blocks in the south and north, respectively (Taylor, 1971, 1977, 1979). Generally, the Hopedale Block contains crust ranging between 3.3 and 2.8 Ga (Ermanovics, 1993) in contrast to the Saglek Block, which contains crust between 3.8 and 2.5 Ga (Schiøtte *et al.*, 1993; Connelly and Ryan, 1994). The blocks are separated by a zone containing voluminous Mesoproterozoic intrusions of anorthosite, troctolite and associated granite belonging to the 1340 to 1290 Ma Nain Plutonic Suite (Connelly and Ryan, 1994; Krogh and Davis, 1973), and perakaline volcanic and plutonic rocks of the ca. 1271 Ma Flowers River Igneous Suite (Hill, 1982; Brooks, 1982). The Hopedale Block is tectonically bound by Paleoproterozoic shear zones that separate it from reworked Archean and Paleoproterozoic rocks in the southeastern Churchill and Makkovik provinces (Figure 3). Locally, Archean rocks in Hopedale Block are unconformably overlain by deformed and metamorphosed Paleoproterozoic volcanic and sedimentary rocks belonging to the <2200 Ma Moran Lake Group (southwest) and the Ingrid Group (northwest), whose maximum age is constrained at <1900 Ma (Wasteneys *et al.*, 1995). The Mesoproterozoic Harp Lake Complex intrudes the southwestern margin of Hopedale Block (*see* Wardle, 1993).

The Hopedale Block is a granite–greenstone terrane consisting of northeast-striking and lenticular-shaped, mainly greenschist- to amphibolite-facies volcanic belts that are

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[1] (Note: Jack Lane Bay was renamed Big Bay).

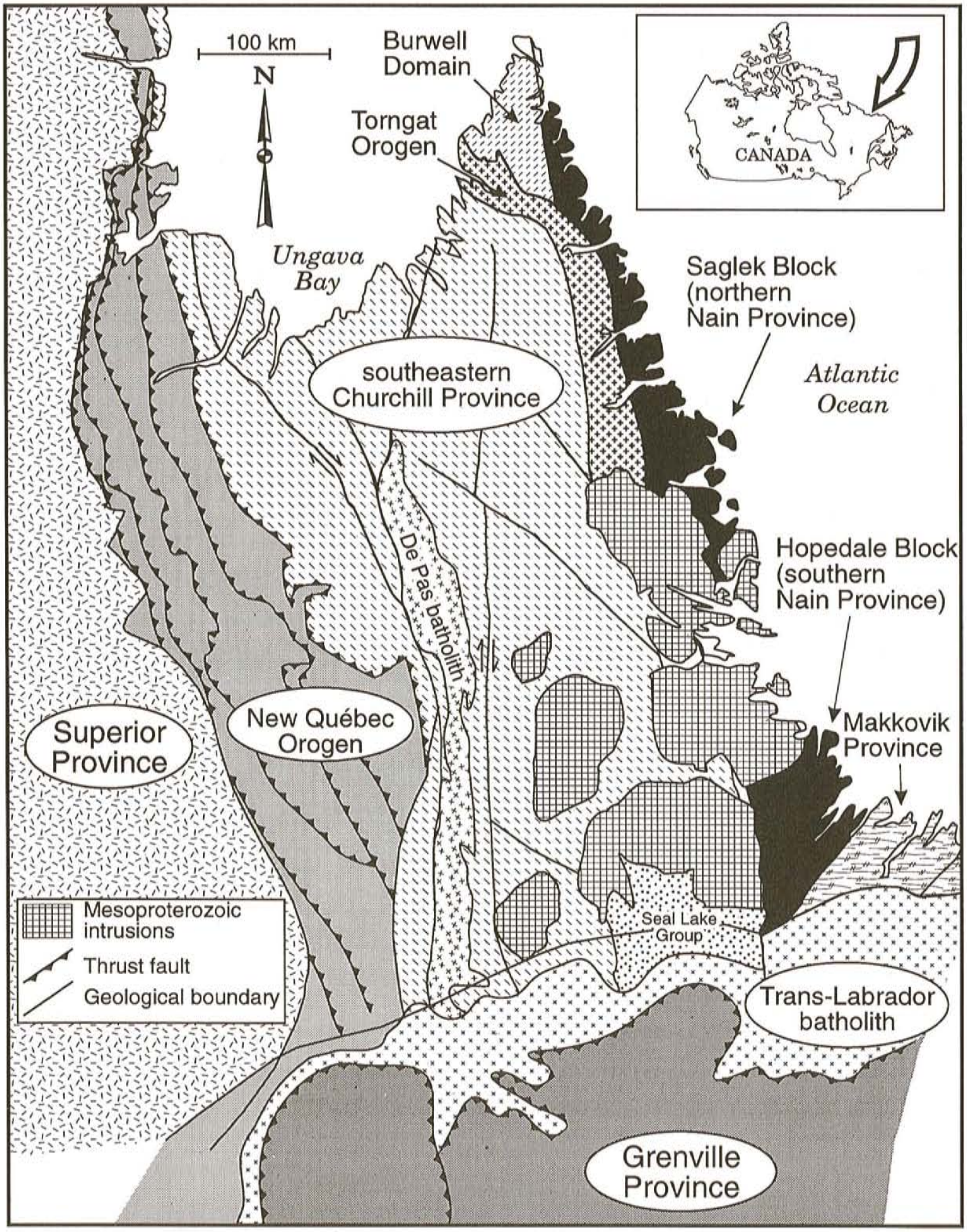

Figure 2. *Principal tectonic elements of northeastern Laurentia in northern Labrador and adjacent northeastern Quebec.*

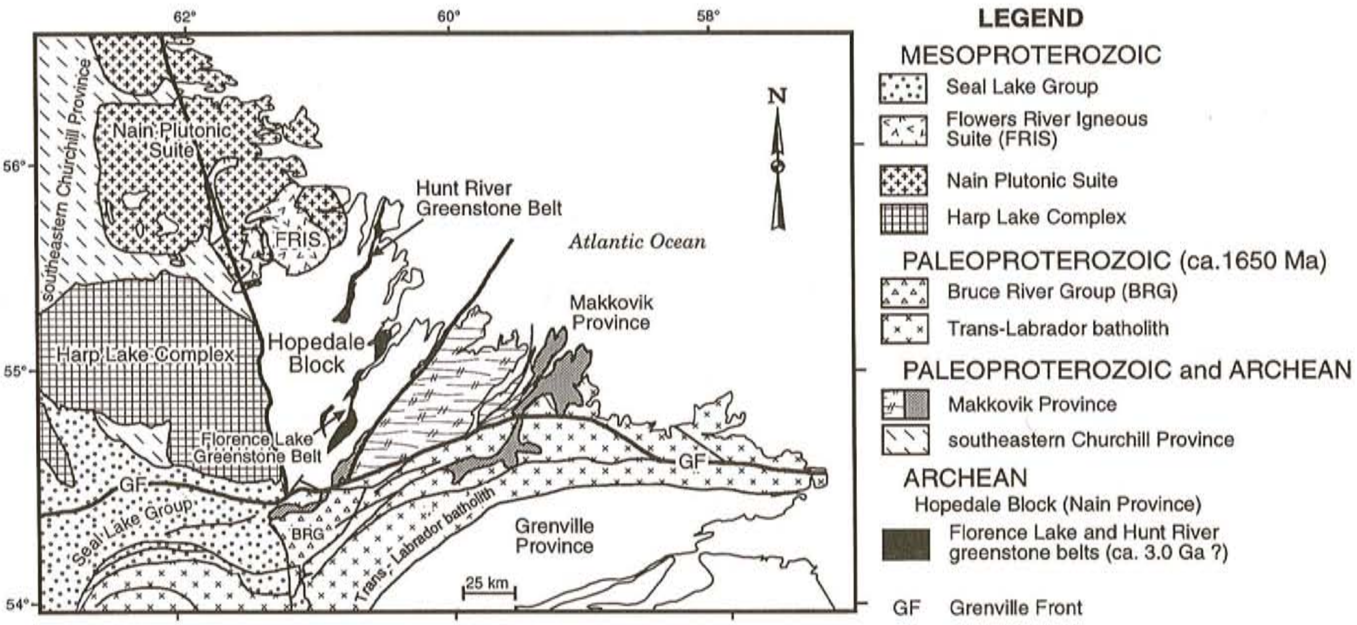

Figure 3. *General geology of eastern Labrador.*

enveloped by Archean granitoid plutons and orthogneiss units of several ages. Based principally on field relationships, Ermanovics (1993) suggested that the Hopedale Block contains evidence of two volcanic–plutonic episodes, each followed by a period of metamorphism and concomitant deformation (Table 1). The first metamorphic and deformation event, termed Hopedalian, is marked by upper amphibolite- and local granulite-facies metamorphism and north-northwest-trending structures, in contrast to the second event, termed Fiordian, which is marked by greenschist- to amphibolite-facies metamorphism and northeast-trending structures (Ermanovics, 1993). A sample of felsic volcanic rock from the Florence Lake greenstone belt, inferred to be one of the younger volcanic sequences, has been dated at 3002 ± 2 Ma (Wasteneys *et al.*, 1995). However, volcanic rocks from the Hunt River greenstone belt, inferred to be an older sequence, have not been dated. The age of the Hunt River greenstone belt is only constrained to be older than a ca. 2875 Ma monzodiorite pluton that intrudes it (Wasteneys *et al.*, 1995). The youngest metamorphism of Hunt River greenstone belt rocks probably occurred at ca. 2550 Ma based on a sphene age from an amphibolite (Wasteneys *et al.*, 1995). (Two samples of felsic volcanic rocks from the Hunt River greenstone belt are currently being processed for U–Pb geochronological studies.)

The Hunt River and Florence Lake greenstone belts are intruded by ca. 2830 Ma plutons ranging in composition from tonalite to granite prior to Fiordian metamorphism and deformation (Ermanovics, 1993). However, the ages of granitoid intrusions and Fiordian metamorphism are not tightly constrained by U–Pb geochronology. Furthermore, mapping by James *et al.* (1996a) has shown that granitoid plutons intruding the Florence Lake greenstone belt have different states of strain and degrees of recrystallization suggesting that they have a wide range in intrusive ages. The plutons may include ca. 3.0 Ga subvolcanic intrusions, pre-metamorphic intrusions and late-syn to post-metamorphic intrusions. The Florence Lake greenstone belt is also in contact with two granitoid orthogneiss units. One is in tectonic contact with volcanic rocks and may represent pre-volcanic basement equivalent to the ca. 3105 Ma Maggo gneiss (Loveridge *et al.*, 1987; Ermanovics, 1993) based on correlation of rock types. In contrast, the other orthogneiss is clearly intrusive into volcanic rocks. These complexities demonstrate that a lot more detailed work needs to be done toward understanding the timing of deposition of supracrustal sequences, and metamorphic, structural and intrusive events in Hopedale Block.

UNIT DESCRIPTIONS

MAFIC VOLCANIC ROCKS–AMPHIBOLITE (UNIT 1)

The Hunt River greenstone belt mainly consists of amphibolite defined as Unit 1 (Figures 4, 5 and 6). The rocks are black- to grey-weathering and are composed of variable proportions of hornblende and plagioclase, and local, minor amounts of garnet, biotite and quartz. Minor amounts of these rocks are amphibolites composed almost entirely of hornblende; some rocks having coarse-grained hornblende porphyroblasts. Metamorphic textures in these rocks are ubiquitous, although there are rare occurrences of relict volcanic features including pillows and pillow breccia (Plate 1). The rocks are typically fine to medium grained and variably foliated, and often occur as massive to weakly

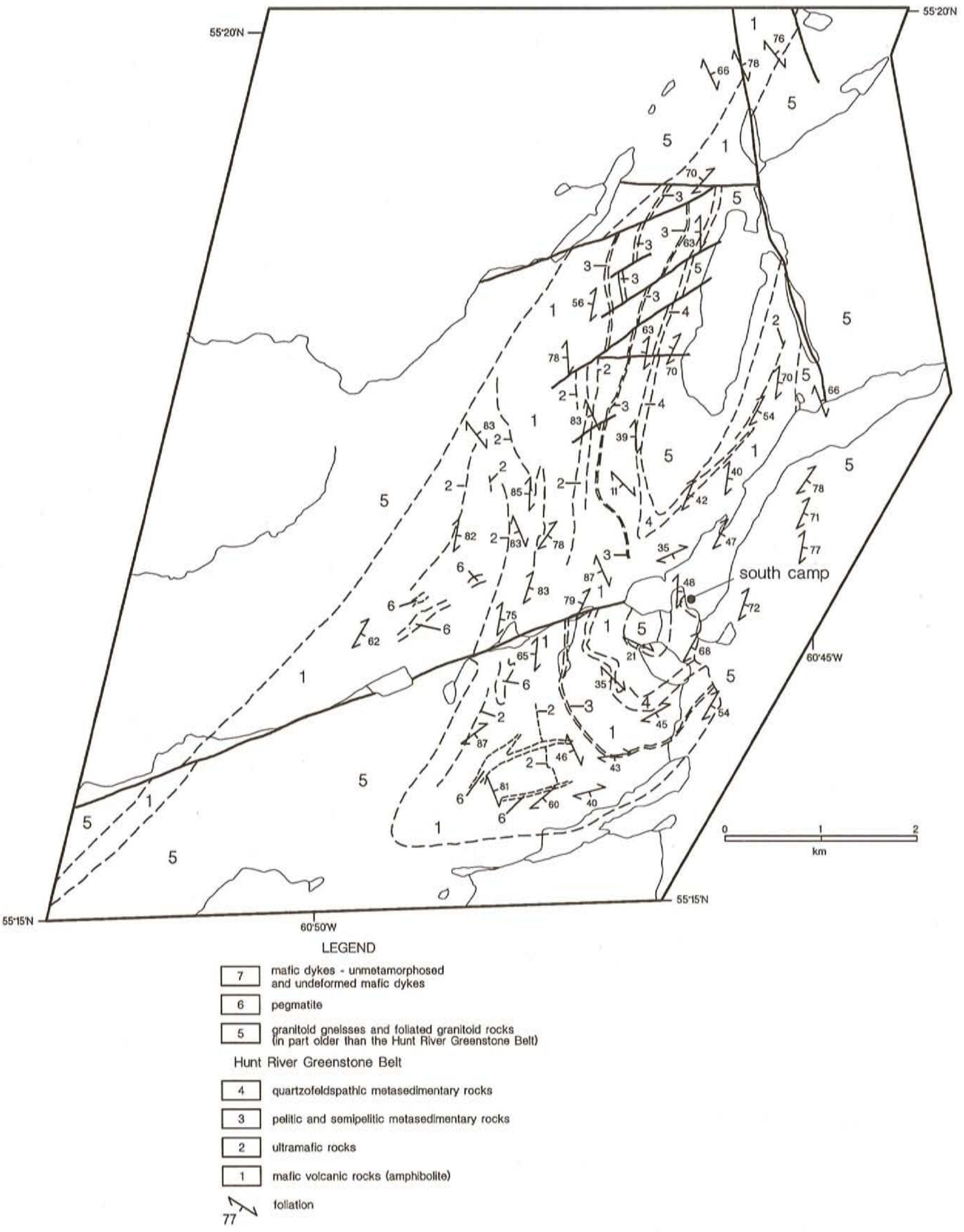

Figure 4. *Geology of the southern part of the Hunt River greenstone belt.*

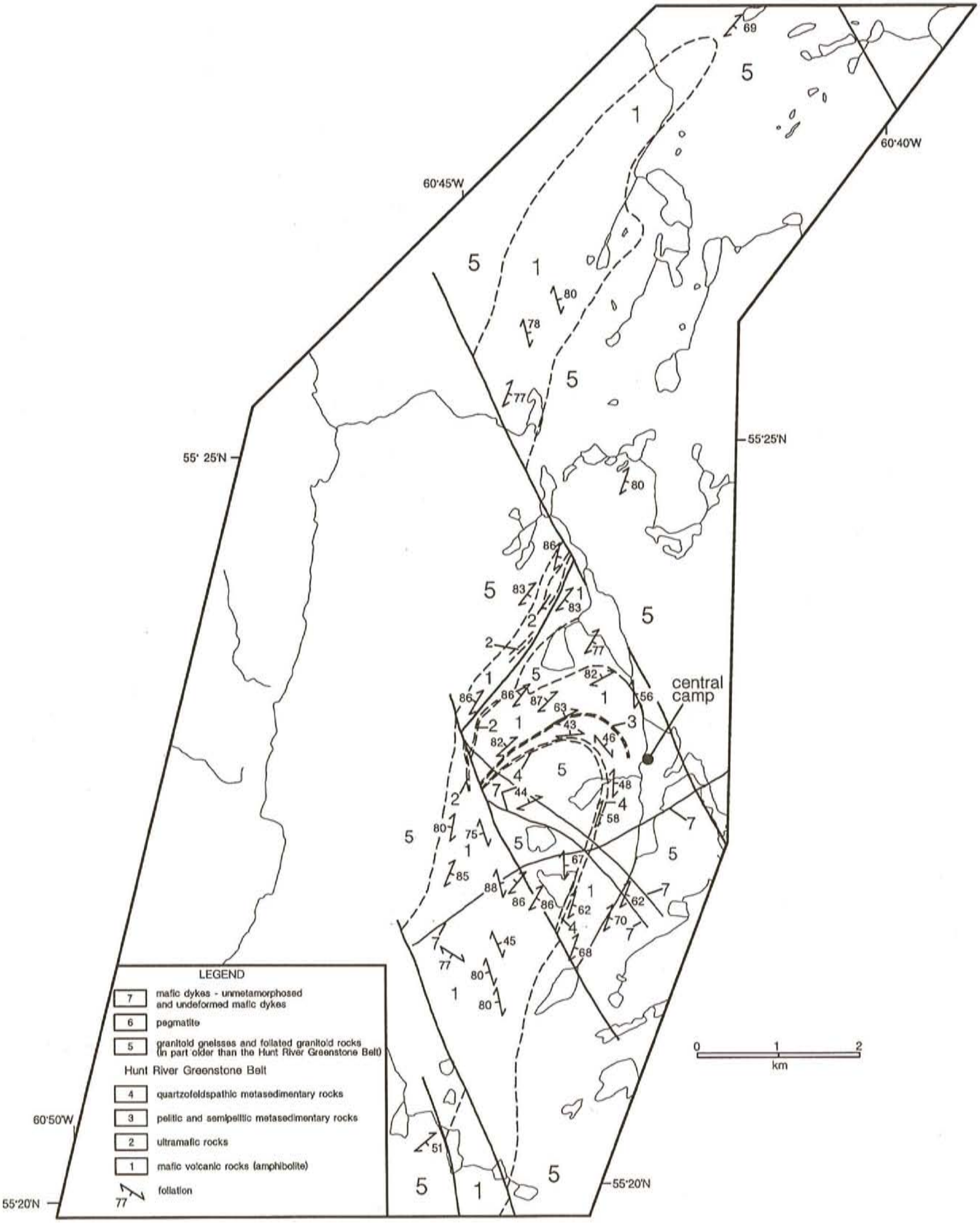

Figure 5. *Geology of the central part of the Hunt River greenstone belt.*

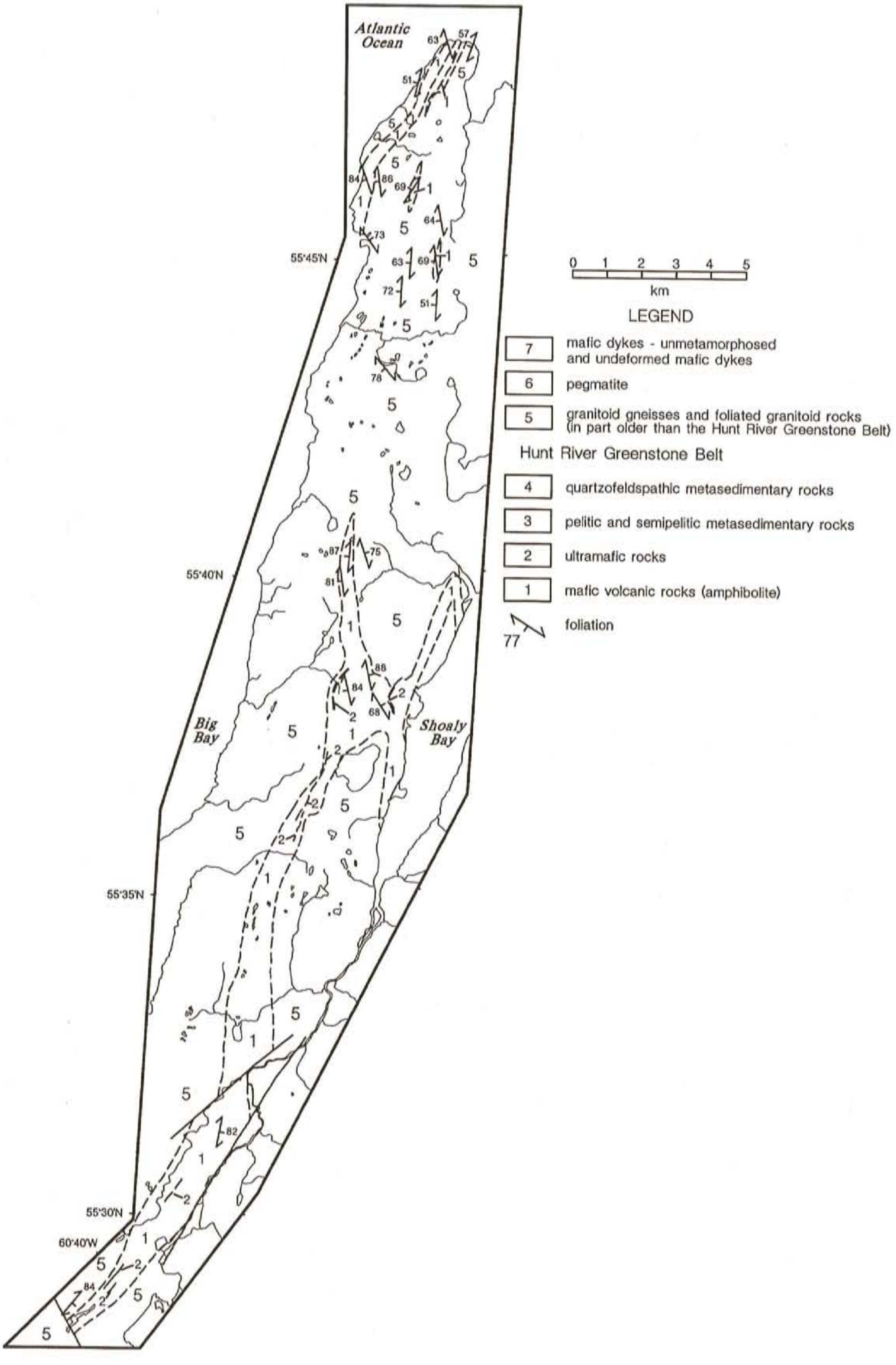

Figure 6. *Geology of the northern part of the Hunt River greenstone belt.*

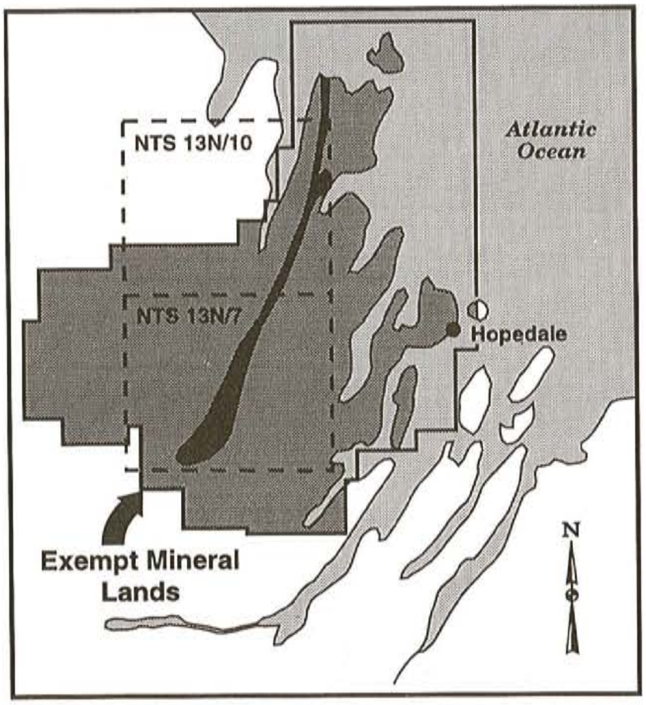

Figure 7. *Sketch showing the position of the Hunt River greenstone belt (solid black) and the Exempt Mineral Lands areas west of Hopedale.*

foliated amphibolites and as very strongly foliated mafic schists. Localized occurrences of relict pillows and pillow breccia in association with interlayered pelitic metasedimentary rocks and local iron formation suggest that most of the amphibolites in this unit are derived from mafic volcanic rocks.

Some amphibolites are compositionally layered rocks consisting of alternating black-, tan- or brown-weathering rocks. Layering thickness varies from a few centimetres up to 1 m. The black rocks are amphibolites similar to those described earlier, whereas the tan- or brown-weathering rocks have a mafic to ultramafic composition, and mainly consist of tremolite, or diopside and plagioclase. Locally, layers consisting of >80 percent coarse-grained diopside occur. Layering is inferred to be a metamorphic accentuation of original compositional layering; the protolith being a layered sequence of mafic and ultramafic flows.

This unit also includes a subordinate amount of mainly medium-grained and massive to weakly foliated amphibolite that contains relict gabbroic textures. The metagabbroic rocks occur in well defined 1- to 3-m-thick layers, presumed to be relict dykes or sills, within the previously described amphibolites. They also occur in isolated outcrops, which could be parts of relatively small (1- to 5-m-thick) dykes or larger intrusive bodies of undefined dimensions. The metagabbroic amphibolites are inferred to represent subvolcanic mafic intrusions that are approximately the same age as the mafic volcanism. Gabbro dykes may have fed mafic flows that were higher in the volcanic sequence.

ULTRAMAFIC ROCKS (UNIT 2)

Ultramafic rocks occur throughout the Hunt River greenstone belt, although they are most common in the southern and central parts (Figures 4 and 5). They occur as 10- to 30-m-thick layers that can be mapped continuously for several kilometres or as lens-shaped units that can be traced for only a few hundred metres.

Generally, this unit consists of two types of ultramafic rocks distinguished on the basis of compositional and textural differences. The first and most common type is a tan- to darkish brown- to orange- to green-weathering rock that is typically black on the fresh surface. The rocks are massive to weakly foliated, very fine grained and are inferred to consist mainly of variable proportions of olivine, pyroxene, serpentine and minor amounts of magnetite. Commonly, they are extremely hard and the units stand out as prominent ridges. Locally, the rocks have a "layered" structure defined by 1- to 2-cm-thick tan or brown or black layers, or they have a structure defined by thin (1 to 2 cm) anastomosing tan- or grey-weathering zones. The "layering" and anastomosing structures are inferred to be a metamorphic feature produced during serpentinization. The second type of ultramafic rock present in the belt is a grey- to tan-weathering ultramafic schist. These rocks are very fine grained, foliated and are characteristically soft. These schistose subunits are recessive and commonly occur in narrow valleys or along the sides of valleys. The rocks consist mainly of tremolite or talc. Locally, thin (<1 m) layers of orange-weathering magnesite-rich rocks are contained in the ultramafic schists.

Metamorphic textures are ubiquitous and primary textures are obliterated everywhere in these rocks, with the exception of one outcrop from the southern part of the belt (UTM 639601E, 6125834N). It is a texturally heterogeneous outcrop of brown- to orange-weathering rocks consisting of three distinct parts: 1) a 3-m-thick zone of well-layered rocks having 1- to 5-cm-thick, brown-weathering layers separated by thin magnetite-rich(?) layers, 2) a 1-m-thick, fine-grained massive zone, and 3) a 1-m-thick zone having a bladed texture defined by thin (1 to 3 mm) and long (to 10 cm), curving acicular, black-weathering grains or aggregates of grains (Plates 2 to 4). This outcrop is interpreted to be part of a texturally composite ultramafic flow having a spinifex top; the spinifex texture represented by the curving acicular grains.

In the field, the ultramafic rocks are commonly associated with thin (1 to 2 m) sulphitic pelitic metasedimentary units; these are not indicated on the map because of their

Table 1. Major Archean units and events in the Hopedale Block (summarized and modified from Ermanovics, 1993)

Major Unit/ Event	Lithology
Fiordian event →	high-grade metamorphism and deformation
Kanairiktok Plutonic Suite ca. 2.84 Ga	pre-, syn- and post-Fiordian intrusions of granite, granodiorite and tonalite
intrusive contact	
Florence Lake greenstone belt ca. 3.0 Ga	mafic, ultramafic and felsic volcanic rocks, gabbroic intrusions, clastic sedimentary rocks, sub-volcanic granitoid intrusions
unconformity (inferred)	
Hopedalian event →	high-grade metamorphism and deformation
Hopedale dykes	
Maggo gneiss >3.1 Ga	granitoid orthogneisses
intrusive contact	
Weekes amphibolite	amphibolite, anorthosite, ultramafic rocks (in part equivalent to Hunt River volcanics?)
Hunt River greenstone belt	mafic and ultramafic volcanic rocks, gabbroic intrusions, clastic sedimentary rocks
pre-Hunt River?	pre-Hunt River granitoid intrusions?

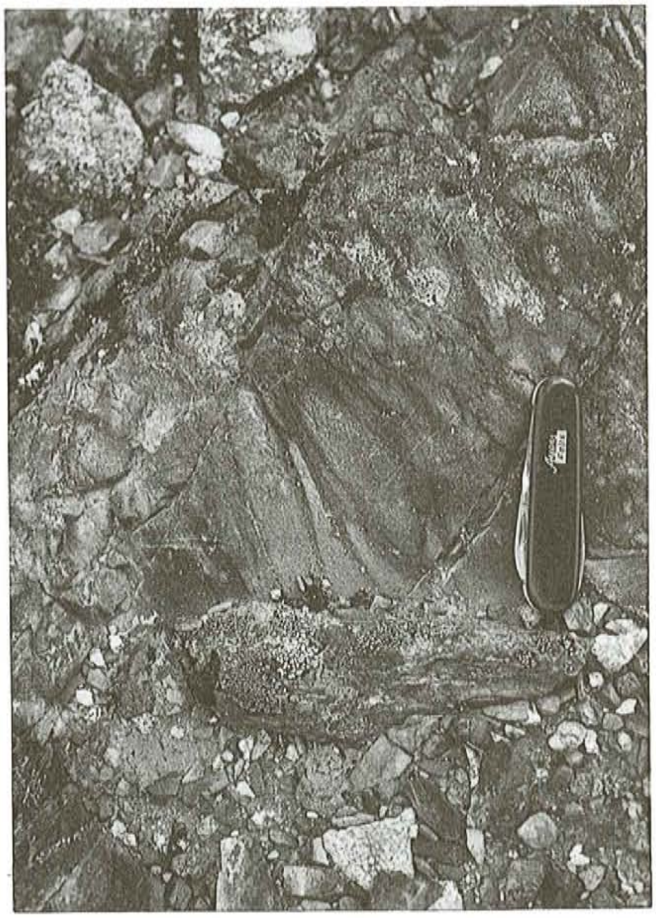

Plate 1. *Amphibolite containing relict pillow breccia.*

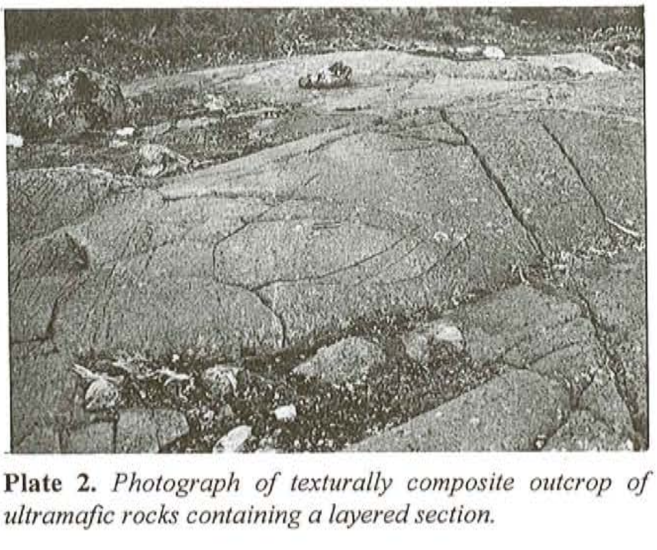

Plate 2. *Photograph of texturally composite outcrop of ultramafic rocks containing a layered section.*

Plate 3. *Photograph of texturally composite outcrop of ultramafic rocks containing a massive section.*

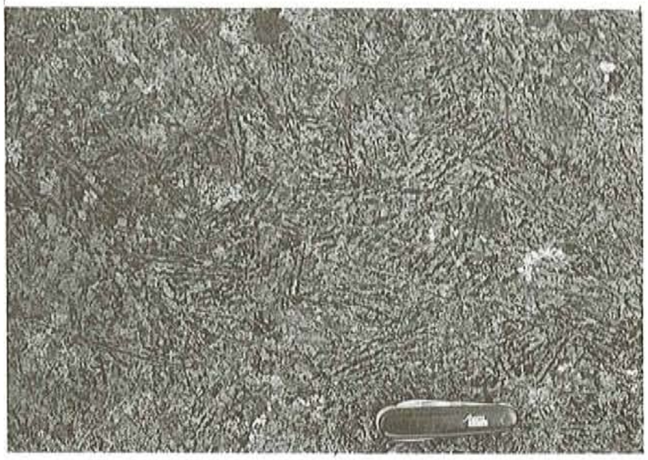

Plate 4. *Photograph of texturally composite outcrop of ultramafic rocks containing relict spinifex texture.*

small size. In addition, a few of the lens-shaped ultramafic units can be traced into sulphitic metasedimentary units, which themselves can be traced for several hundred metres and subsequently into the next lens-shaped ultramafic unit. The common field association between the ultramafic rocks and metasedimentary rocks, and the single occurrence of spinifex textures suggest the ultramafic rocks represent ultramafic flows. The continuous ultramafic units probably represent widespread sheet flows whereas the lens-shaped units may be restricted, channelized flows. A single occurrence of felsic volcanic rocks, which are interlayered with ultramafic rocks (Plate 5) in the southern part of the belt, is consistent with the flow model. The field relations also suggest that the volcanic belt may have formed as a series of volcanic cycles of at least local extent. Each of the cycles are dominated by mafic volcanic rocks and lesser amounts of ultramafic rocks; their terminations being marked by deposition of sulphitic pelitic sedimentary rocks that are in turn overlain by an ultramafic or mafic flow of the next cycle.

The ultramafic rocks in the Hunt River greenstone belt are similar in texture and composition and have broadly similar field associations as ultramafic rocks in the Florence Lake greenstone belt. Ultramafic units in the Florence Lake

Plate 5. *An example of field relations between ultramafic (left), felsic (centre) and mafic (right) volcanic rocks in the southern part of the Hunt River greenstone belt.*

greenstone belt are also interpreted as flows (James *et al.*, 1996a; Miller, 1996). However, plagioclase-phyric mafic flows, which commonly occur in association with ultramafic rocks in the Florence Lake greenstone belt, are extremely rare in the Hunt River greenstone belt.

PELITIC AND SEMIPELITIC METASEDIMENTARY ROCKS (UNIT 3)

Thin (1 to 5 m) units of pelitic and semipelitic rocks occur throughout the belt but are most common in the central and southern areas (Figures 4 and 5). The rocks are commonly rusty-weathering and consist of variable proportions of quartz, plagioclase, biotite, garnet, and local sillimanite or cordierite. Pyrite and magnetite are common accessory minerals. Relict bedding occurs locally and is defined by 5- to 10-cm-thick layers containing relatively high amounts of biotite alternating with biotite-poor quartzofeldspathic layers. These rocks are probably derived from wacke or wacke–mudstone turbidites.

In several locations, the unit includes rocks consisting of relatively high amounts of garnet, magnetite and pyrite (e.g., UTM 640889E, 6129692N). These rocks are interpreted to be metamorphosed silicate-sulphide facies iron formation.

Unit 3 also includes a 2-m-thick layer of felsic volcanic rocks that are interlayered with pelitic metasedimentary rocks in the southern part of the study area (UTM 641179E, 6131669N). The felsic rocks are white on both fresh and weathered surfaces, are extensively recrystallized and very fine grained, and foliated. The rocks do not contain relict volcanic textures. The felsic layer could be traced for several hundred metres.

QUARTZOFELDSPATHIC METASEDIMENTARY ROCKS (UNIT 4)

Quartzofeldspathic rocks, defined as Unit 4, occur locally along the contacts between mafic volcanic rocks (Unit 1) and granitoid gneisses (Unit 5), and as 20- to 30-m-thick units bound by mafic volcanic rocks (Figures 4, 5 and 6). The Unit 4 rocks are grey-weathering and composed of variable amounts of quartz, plagioclase, biotite, garnet and local hornblende. Layering in the rocks is defined by thin (1 to 2 cm) black layers, containing relatively high amounts of biotite and hornblende, alternating with 5- to 20-cm-thick quartzofeldspathic layers (Plate 6). The rocks are mainly fine grained and have granoblastic textures, although medium- to coarse-grained garnet porphyroblasts are common.

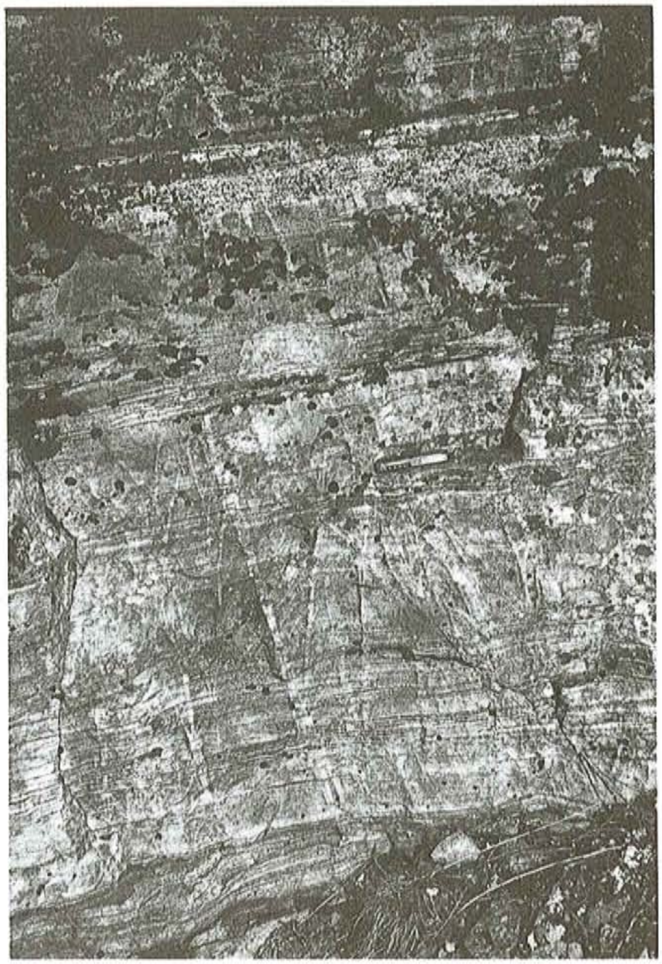

Plate 6. *Fine-scale compositional layering inferred to be relict bedding in quartzofeldspathic metasedimentary rocks (Unit 4).*

In several locations, these quartzofeldspathic rocks are interlayered with thin (<1 m), rusty-weathering pelitic layers. The pelitic rocks are similar to those of Unit 3, although one outcrop contains abundant muscovite and sillimanite. In the southern part of the belt, these rocks are associated with a 2-

m-thick ultramafic unit (e.g., at UTM 640768E, 6127241N), which occurs along the western contact between Unit 4 rocks and mafic volcanic rocks.

The origin of these quartzofeldspathic rocks is equivocal, although they are provisionally interpreted as being of sedimentary origin; that they are locally interlayered with pelitic metasedimentary rocks is consistent with this interpretation. Locally, these rocks occur along the contacts between mafic volcanic rocks and granitoid gneisses, thus, it is possible that in these places they represent metamorphosed sedimentary rocks that were deposited unconformably on a pre-volcanic basement. (A possible basement – cover contact is described and discussed on page 21.) However, it may also be possible that some of these quartzofeldspathic rocks could be derived from felsic volcanic rocks. Alternatively, some of the rocks occurring along the contact between the mafic volcanic rocks and the granitoid gneisses could be highly stained and extensively recrystallized equivalents of the granitoid gneisses (*see* Unit 5).

Other Metasedimentary Rocks

The belt includes several occurrences of quartzite, located at UTM 654620E, 6171547N and 655723E, 6168012N, but are not shown on the map because of their small size (<15 m thick) and because they could not be traced for more than 50 m due to poor outcrop exposure. The quartzites are white- or grey-weathering. They are extensively recrystallized, extremely fine grained, and consist of >90 percent quartz. The rocks commonly are massive, although they locally have layering defined by 2- to 10-cm-thick alternating grey- and white-weathering layers (Plate 7).

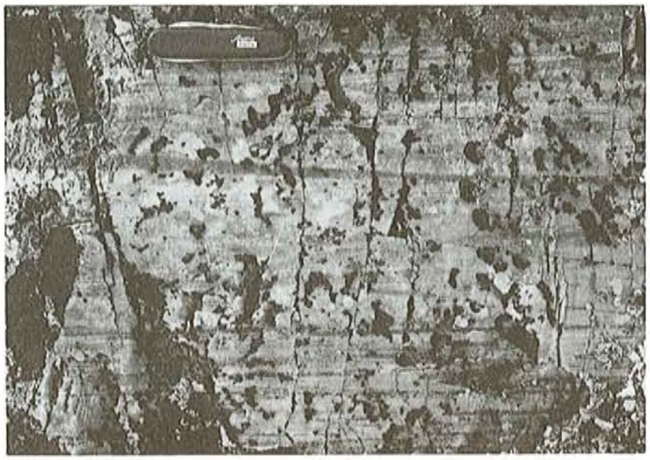

Plate 7. *Typical field aspects of quartzite that occurs with ultramafic rocks east of Big Bay.*

The quartzites are poorly exposed in the field and their field relationships are not well understood. In both locations they occur in contact with ultramafic rocks, although it does not appear that the quartzites occur along basement–cover contacts. To better understand the significance of these rocks they need to be mapped in greater detail.

Occurrences of quartzites and quartzite–ultramafic associations are not common in Archean greenstone belts, although they have been described elsewhere by Schau (1977) and their occurrences summarized by Ashton (1988).

The belt also includes several occurrences of chert–magnetite iron formation and associated cherty metasedimentary rocks. These rocks are also not shown on the map because they do not form mappable units. The iron formation consists of alternating 1 to 2 cm layers of grey- to white-weathering quartz (chert) and black-weathering magnetite. The associated cherty metasedimentary rocks are white- to tan-weathering, extremely fine grained and have layering defined by colour variations, and occur in 1- to 2-m-thick layers. Occurrences of iron formation and the cherty metasedimentary rocks are interlayered with mafic volcanic rocks (Unit 1).

GRANITOID GNEISSES AND FOLIATED GRANITOID ROCKS (UNIT 5)

The study area contains several units of granitoid gneiss and foliated granitoid rocks (Figures 4, 5 and 6) that are not subdivided on the figures in this report. These units were given only a cursory examination in the field, although contacts between the greenstone belt and the granitoid units were mapped, as were granitoid outcrops in the vicinity of these contacts. Unit 5 is defined only for the purposes of preparing this report; it should not be considered as containing rocks of one type or age, and has no regional significance. Detailed mapping of the granitoid rocks that surround the Hunt River greenstone belt is outside the scope of this project. Four of the units that make up Unit 5 are described below.

In part, Unit 5 is made up of a compositionally and texturally heterogeneous division consisting of white- to grey-weathering granitoid gneiss and migmatite. These rocks comprise variable proportions of quartz, feldspar, biotite and hornblende. In general, they are medium grained and have granoblastic textures. Gneissosity is defined by mafic layers alternating with quartzofeldspathic layers, or by layers of white-weathering, medium- to coarse-grained leucosome. Locally, gneissic rocks are gradational into metamorphosed tonalite.

The rocks described above are derived from tonalite to granodiorite intrusions that have been metamorphosed to upper-amphibolite facies. They do not contain inclusions of Hunt River greenstone belt rocks, and no intrusive relations with the greenstone belt were observed; consequently they are provisionally interpreted to be older than the volcanic rocks.

However, the gneisses are themselves cut by abundant dykes of variably deformed, pink-weathering leucogranite, which may postdate the volcanic rocks. Samples of the gneiss have been collected for age dating (*in progress*).

Unit 5 also includes a white- to grey-weathering, foliated to gneissic tonalite containing biotite and hornblende. In contrast (to the aforementioned gneisses), these rocks contain unequivocal inclusions of Hunt River greenstone belt rocks, and therefore, must postdate volcanism.

The volcanic rocks are also cut by pre-metamorphic intrusions of grey-weathering quartz diorite to monzodiorite that contain hornblende and biotite. The rocks are medium grained, have granoblastic textures and are foliated. A sample of these rocks has been dated, by U–Pb zircon methods, at ca. 2875 Ma (Wasteneys *et al.*, 1995), which constrains the minimum age of volcanic rocks in the Hunt River greenstone belt.

In the northern part of the study area, the volcanic rocks are intruded by a unit of foliated and locally gneissic granodiorite to granite. Rocks are white- to tan-weathering, fine to medium grained and have granoblastic textures. Field relations and textures demonstrate that these rocks also represent pre-metamorphic intrusions.

PEGMATITE (UNIT 6)

Volcanic rocks in the southern part of the study area are cut by late syn- to post-metamorphic dykes of pegmatite that are up to 50 m thick. The pegmatite is white-weathering, medium to coarse grained and has a phaneritic texture. It consists of variable proportions of quartz and feldspar, and contains minor amounts of biotite; coarse-grained tourmaline occurs locally. The pegmatite dykes crosscut the principal foliation and metamorphic layering in the host volcanic rocks. However, some dykes have a weak foliation.

A POSSIBLE BASEMENT–COVER CONTACT

Several well-exposed outcrops in the central part of the study area (UTM 643779E, 6138197N) preserve evidence of a possible basement–cover contact between pre-volcanic granitic gneisses, which are included in Unit 5, and quartzofeldspathic metasedimentary rocks of Unit 4. The latter are inferred to make up the basal unit of the Hunt River greenstone belt at this location. The contact itself dips >60° to the east and is on the eastern limb of a gently northeast-plunging fold of the greenstone belt that is cored by granitoid gneiss.

The granitoid gneiss at the contact is a white- and grey-weathering tonalite gneiss containing 5- to 20-cm thick, grey, mafic layers. The rocks are fine grained and compositional layering defines a planar or straight structure (Plate 8). They do not appear to be highly strained, although they are more extensively recrystallized and have more of a "straight-layered" structure as compared to outcrops of gneiss that are several hundred metres from the contact.

Plate 8. *Tonalite gneiss (Unit 5) that occurs near the basement–cover contact discussed in the text.*

Where the contact is best exposed, it is marked by a 30-cm-thick, green- to brown-weathering rock that may be a relict metaconglomerate (Plate 9 and Figure 8). The rocks have a schistose matrix containing abundant biotite and chlorite, and granitoid "clasts" up to 15 cm long. The clasts could not be unequivocally identified as being derived from the underlying gneiss. The rocks also contain feldspar grains (≤ 2 cm) and quartz-rich fragments, in addition to abundant deformed and boudinaged quartz veins and lenses. Above the

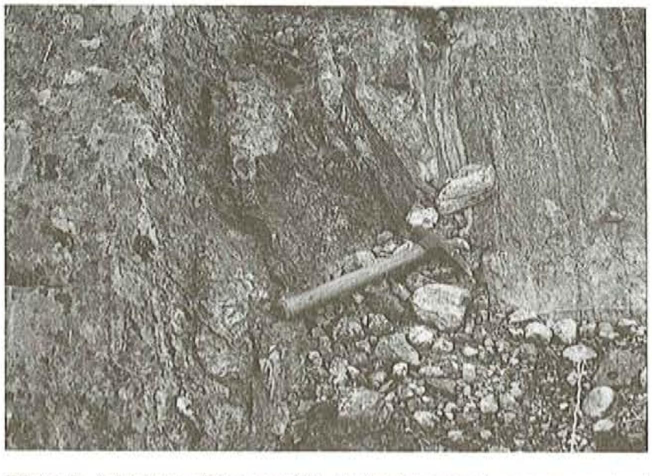

Plate 9. *Metaconglomerate(?) at the basement–cover contact. The layer of rock occurring below the hammer consists of a rusty-weathering schistose matrix and granitoid "clasts", and separates tonalite gneiss (left, and shown in Plate 8), from finely layered quartzofeldspathic metasedimentary rocks (right, and shown in Plate 10). Near the hammer-head is a thin (5 cm) layer of ultramafic schist (*see *also Figure 8).*

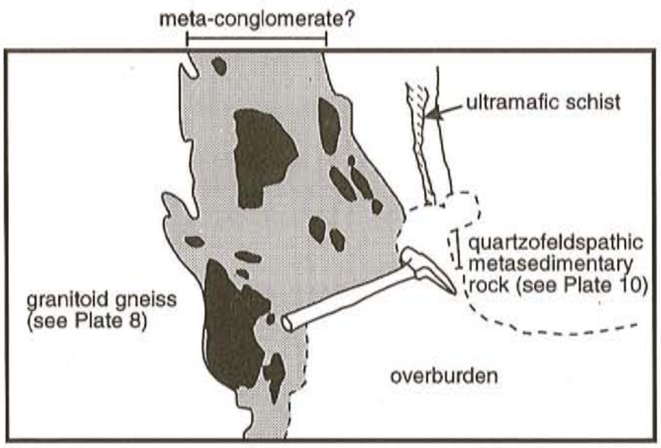

Figure 8. *Line drawing of outcrop shown in Plate 9 containing basement–cover contact. Biotite + chlorite schist zone (matrix) - stippled pattern; granitoid "clasts" - solid black.*

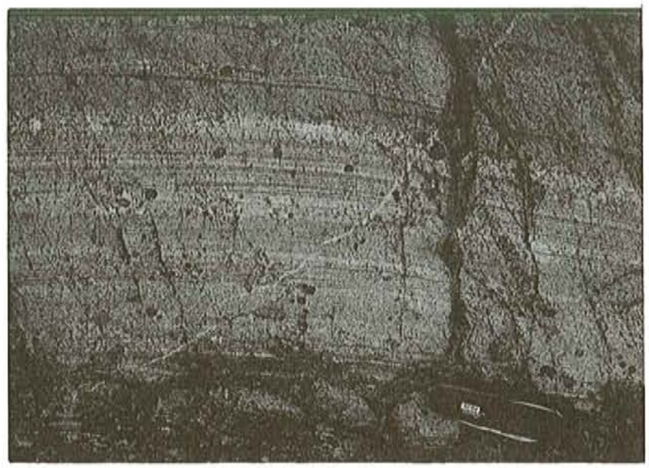

Plate 10. *Fine-grained and finely layered quartzofeldspathic metasedimentary rocks (Unit 4) occurring 10 m above the basement–cover contact discussed in the text.*

possible conglomerate are layers of chrome green-weathering ultramafic schist (ultramafic flows?) that are up to 10 cm thick; these being separated by layers of white-weathering, very fine-grained quartzofeldspathic rock of uncertain origin. The ultramafic schists are ubiquitous along the contact, although the metaconglomerate could only be traced for a few metres.

The rocks described in the preceding paragraph are overlain by a 50- to 70-m-thick unit consisting of white- to grey- to tan-weathering quartzofeldspathic rocks (Plate 10). The rocks are very fine grained and are remarkably finely layered; the layering defined by very thin (several millimetres) layers of a black mineral(s). The quartzofeldspathic rocks are inferred to be derived from sandstone. Interlayered with the quartzofeldspathic rocks are several 1-m-thick layers of rusty-weathering pelite containing coarse-grained garnet porphyroblasts. The pelite layers are citical because they argue against the interpretation of the quartzofeldspathic rocks as highly strained equivalents of the underlying granitoid gneisses. The quartzofeldspathic rocks are overlain by Unit 1 amphibolites.

These relations suggest that volcanic rocks of the Hunt River greenstone belt were deposited on a basement of pre-existing continental crust and that at least locally, mafic and ultramafic volcanism were preceded by deposition of sandstone. The latter were probably derived from areas of subaerially exposed basement. A model for the Hunt River greenstone belt involving the existence of pre-volcanic basement is consistent with occurrences of quartzite in the northern part of the belt. The quartzites must be derived from a pre-volcanic "granitic" crust.

STRUCTURE AND METAMORPHISM IN THE HUNT RIVER GREENSTONE BELT

Contacts between units in the greenstone belt and occurrences of primary compositional layering within units are overprinted and transposed by a variably developed northeast- to north-northeast-striking foliation (Figure 9) designated as S_1 and defined by alignment of the metamorphic minerals. Isoclinal closures (F_1) of unit contacts and primary compositional layering (i.e., pre-S_1 layering) are observed rarely. The S_1 foliation is deformed and folded into open to tight, northeast- and south-southwest-trending F_2 folds that are the main, map-scale folds in the belt. Superposition of F_2 folds on F_1 isoclinal closures of pre-S_1 layering produced local outcrop-scale Type II and Type III folds of the compositional layering. There does not appear to be a foliation associated with F_2 folding. The ages of F_1 and F_2 folds are unknown, although field relations suggest that both are approximately synchronous with the peak of metamorphism.

The study area also contains several syn- to late synmetamorphic high-strain zones that occur locally along the contacts between the greenstone belt and surrounding Unit 5 granitoid rocks. The shear zones overprint the S_1 foliation in the volcanic rocks and deform thin (<10 m?), pink- to white-weathering granite sheets, which are included in Unit 5. The granite postdates gneissosity in the host rocks. The shear zones are narrow (<10 m), and their kinematics and significance are unclear.

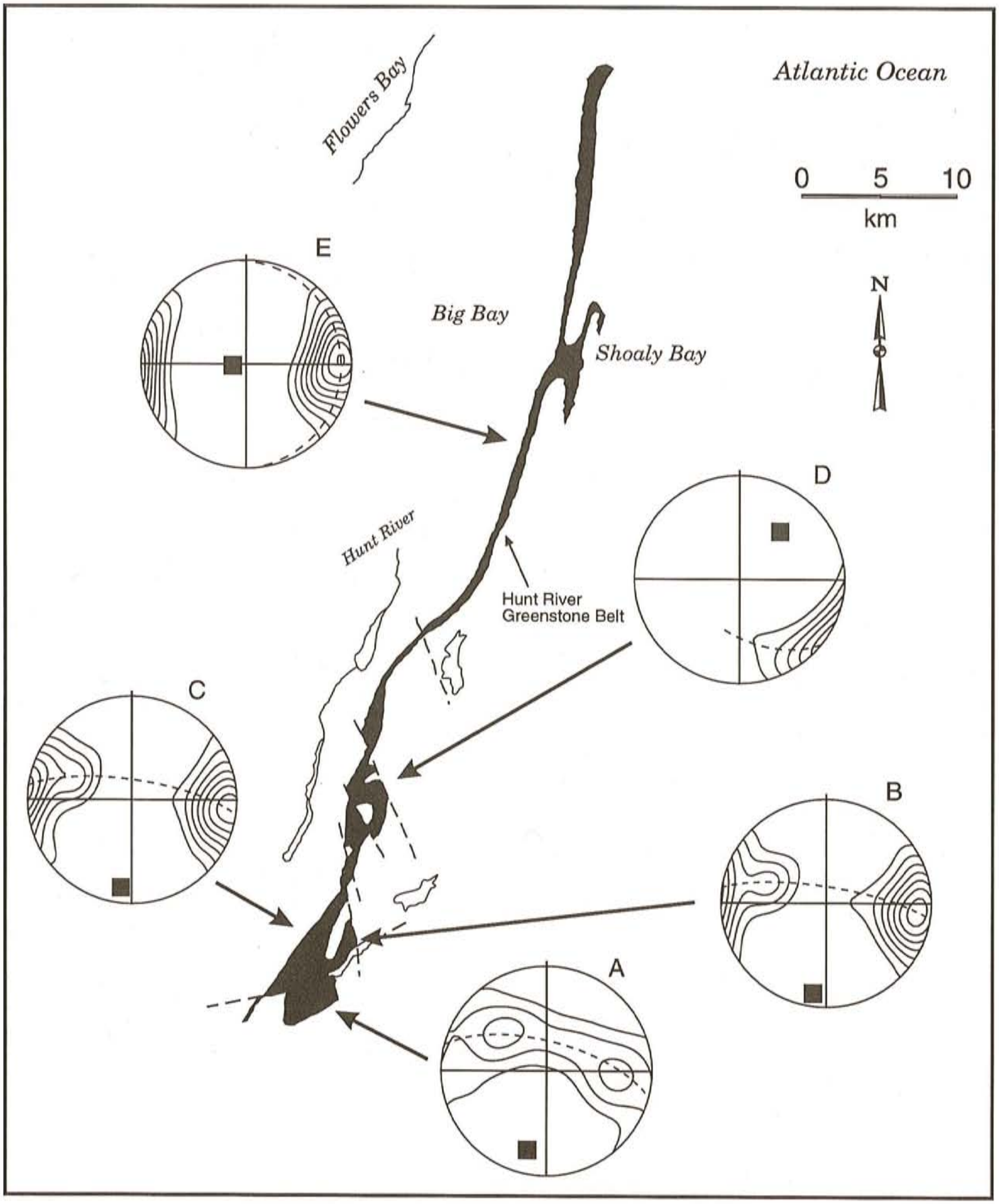

Figure 9. *Contoured, lower hemisphere equal-area projections of poles to* S_1 *foliation in volcanic and sedimentary rocks, Hunt River greenstone belt. (Contours are in increments of 2σ, π girdles - dashed lines, β axis - black square) A - n=54, σ=1.29; B - n=71, σ=1.33; C - n=98, σ=1.37; D - n=41, σ=1.23; E (all volcanic rocks in the northern part of the study area) - n=67, σ=1.32.*

The greenstone belt may contain pre- to syn-S_1, layer-parallel contractional faults that could duplicate or excise greenstone belt stratigraphy. These structures have not been mapped, although the possibility that they occur should not be discounted. Some of the thin and strike-continuous ultramafic or metasedimentary units, which are highly schistose and incompetent relative to bounding mafic volcanic rocks, could be the locus for such faults. Detailed mapping and chemostratigraphic tests might assist in determining if these structures exist. Pre-metamorphic faulting along the basement–cover contact is also possible.

North-northwest- and east-northeast-striking faults deform the greenstone belt and surrounding granitoid units. The faults are mainly unexposed and are inferred from offsets of granitoid–greenstone belt contacts and topographic lineaments. Mylonitic granite and highly strained amphibolite occur along one of the north-northwest-striking faults, demonstrating that at least some of these structures are ductile high-strain zones, which were formed contemporaneous with amphibolite-facies metamorphism.

The greenstone belt is everywhere metamorphosed to amphibolite facies. Mafic rocks contain the assemblage hornblende, plagioclase, garnet and biotite. Clinopyroxene occurs locally in mafic rocks. Pelitic metasedimentary rocks contain garnet, biotite and sillimanite or cordierite; muscovite occurs locally. Although metamorphic assemblages are consistent throughout the belt, rocks in the northern areas are more pervasively recrystallized and are somewhat coarser grained than those in the southern and central areas. Primary volcanic features are completely obliterated in the northern parts of the belt. These differences may be due to the fact that the northern part of the belt is principally a narrow septum encompassed by syn- to late-syn metamorphic granitoid intrusions, which may have locally elevated temperatures and produced slightly different metamorphic textures than seen in southern and central areas. Metamorphism in the Hunt River greenstone belt probably occurred at ca. 2550 Ma based on sphene ages in two samples from the belt (Wasteneys *et al.*, 1995).

EXPLORATION POTENTIAL AND MINERALIZATION

The Hunt River greenstone belt is similar, in most geological aspects, to the Florence Lake greenstone belt. They have similar rocks, chemistry, field relations between units (e.g., the common field association of ultramafic flows and sulphitic metasediments) and are interpreted to have formed in a similar environment. The belts are also suspected to be similar in age. These gross similarities suggest that the Hunt River greenstone belt may have similar exploration potential and mineralization as the Florence Lake greenstone belt. This potential is highlighted by recent drillhole and assay results from the Baikie nickel showing in the Florence Lake greenstone belt (including 2.35% Ni over 5.15 m; Tapestry Ventures, press release, November 18, 1996). These results should enhance the exploration profile of all greenstone belts in the Hopedale Block.

The Baikie showing is considered as an example of komatiite-associated or Kambalda-type nickel sulphide mineralization (Brace, 1990; James, 1996; Miller, 1996). There is good potential for this type of mineralization in the Hunt River greenstone belt. The Kambalda-type mineralization occurs in the Archean greenstone belts of Western Australia (Marston *et al.*, 1981; Gresham and Loftus-Hills, 1981; Groves and Lesher, 1982; Lesher *et al.*, 1984; Lesher and Groves, 1986; Marston, 1984), and from where it derives its name, in the Abitibi greenstone belt in Canada (Naldrett and Gasparrini, 1971; Coad, 1979; Naldrett, 1981; Jensen, 1986), and also from Zimbabwe (Williams, 1979; Hammerbeck, 1984). Komatiite-associated nickel sulphide deposits contain about 25 percent of the world total identified nickel resource (Lesher, 1989).

Falconbridge held the only claims ever made in the Hunt River greenstone belt (McLean, 1991). They reported and sampled several gossans, although the highest nickel (2100 to 2400 ppm), copper (up to 5350 ppm) and gold (up to 160 ppb) values (McLean, 1991) were apparently not promising enough to warrant additional exploration.

Mapping in 1996 revealed numerous gossans and two occurrences of massive sulphide associated with Unit 2 ultramafic rocks. One occurrence of massive sulphide (UTM 642368E, 6129848N) occurs within a 2-m-thick ultramafic unit and contains 4.30% Cu, 0.57% Ni, 0.05% Co and 2.5 ppm Ag. The second massive sulphide occurrence is along the contact between an ultramafic unit and structurally underlying sulphitic metasedimentary rocks (UTM 640834E, 6131061N) and contains 0.10% Ni, 0.02% Cu, 0.01% Co and 0.4 ppm Ag. The sulphitic metasedimentary rocks may be critical for the formation of mineralization as they provide a source of sulphur, which is scavenged during thermal erosion by overlying ultramafic flows.

Gossanous rocks also occur throughout the amphibolites (Unit 1) and the pelitic metasedimentary rocks (Unit 3). These gossans can generally be attributed to several percent disseminated pyrite and are not thought to have significant exploration potential. The pelitic rocks may have some potential for mesothermal gold mineralization in areas where they contain silicate–sulphide-facies iron formation (magnetite–garnet–pyrite rocks) and abundant quartz veins (e.g., UTM 640889E, 6129692N).

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REFERENCES

Ashton, K.E.
1988: Precambrian geology of the southeast Amer Lake area (66H/1), near Baker Lake, N.W.T. A study of the Woodburn Lake Group, an Archean orthoquartzite-bearing sequence in the Churchill Structural Province. Unpublished Ph.D. thesis, Queen's University, Kingston, Ontario, Canada, 335 pages.

Batterson, M.
1996: Quaternary geology of parts of the central and southern Hopedale Block, Labrador. *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 96-1, pages 1-10.

Brace, T.D.
1990: Geology, geochemistry and metallogeny of the Archean Florence Lake Group and associated ultramafic and trondhjemitic rocks, Nain Province, Labrador. Unpublished M.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland.

Brooks, C.
1982: 3rd report on the geochronology of Labrador (pertaining to sub-project 1:09). Report to Newfoundland Department of Mines and Energy, Mineral Development Division. Open File Lab (519), 38 pages. [1062-1068, 2000-2001]

Coad, P.R.
1979: Nickel sulphide deposits associated with ultramafic rocks of the Abitibi Belt and economic potential of mafic – ultramafic intrusions. Ontario Geological Survey Study 20, 84 pages.

Connelly, J.N. and Ryan, B.
1994: Late Archean and Proterozoic events in the central Nain craton. *In* Eastern Canadian Shield Onshore - Offshore Transect (ECSOOT), Transect Meeting (December, 1993). R. J. Wardle and J. Hall (compilers). The Université du Québec at Montréal, Report 36, pages 53-61.

Ermanovics, I.F.
1981: Geology, Hunt River map-area, Labrador, Newfoundland (parts of 13N/7, 9, 10, 15, 16). Geological Survey of Canada, Open File 778.

1993: Geology of the Hopedale Block, southern Nain Province, and the adjacent Proterozoic terranes, Labrador, Newfoundland. Geological Survey of Canada, Memoir 431, 161 pages.

Gresham, J.J. and Loftus-Hills, G.D.
1981: The geology of the Kambalda nickel field, Western Australia. Economic Geology, Volume 76, pages 1373-1416.

Groves, D.I. and Lesher, C.M.
1982: Regional geology and nickel deposits of the Norseman–Wiluna Greenstone Belt, Western Australia, Publication 7. University of Western Australia, Department of Geology and Extension Service, Perth, 234 pages.

Hammerbeck, E.C.I.
1984: Aspects of nickel metallogeny of Southern Africa. *In* Sulphide Deposits in Mafic and Ultramafic Rocks. *Edited by* D.L. Buchanan and M.J. Jones. Proceedings of International Geological Correlation Program Projects 161 and 91, Third Nickel Sulphide Field Conference, Perth, Western Australia, Institution of Mining and Metallurgy, London, pages 130-140.

Hill, J.D.
1982: Geology of the Flowers River-Notakwanon River area, Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-6, 140 pages.

Hornbrook, E.H.W. and Friske, P.W.B.
1988: National geochemical reconnaissance lake sediment and water geochemical data, eastern Labrador (parts of 13I, 13J, 13K, 13N and 13O). Geological Survey of Canada, Open File 1636.

James, D.T.
1996: Geological mapping in the Archean Hunt River greenstone belt, Hopedale Block, southern Nain Province, Labrador. *In* Report of Activities. Department of Mines and Energy, Geological Survey, pages 62-64.

James, D.T., Miller, R.R., Patey, R.P. and Thibodeau, S.
1996a: Geology and mineral potential of the Archean Florence Lake greenstone belt, Hopedale Block (Nain

Province), eastern Labrador. *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 96-1, pages 85-107.

James, D.T., Miller, R.R. and Patey, R.P.
1996b: Geology of the Florence Lake greenstone belt, Hopedale Block, Nain Province, eastern Labrador (Parts of NTS areas 13K/15 and 13K/10). Newfoundland Department of Mines and Energy, Geological Survey, Open File Map 96-23, scale 1:25 000.

1996c: Geology of the Florence Lake greenstone belt, Hopedale Block, Nain Province, eastern Labrador (Parts of NTS areas 13K/15 and 13N/2). Newfoundland Department of Mines and Energy, Geological Survey, Open File Map 96-24, scale 1:25 000.

1996d: Geology of the Florence Lake greenstone belt, Hopedale Block, Nain Province, eastern Labrador (Parts of NTS areas 13N/1 and 13N/2). Newfoundland Department of Mines and Energy, Geological Survey, Open File Map 96-25, scale 1:25 000.

Jensen, L.S.
1986: Mineralization and volcanic stratigraphy in the western part of the Abitibi subprovince. *In* Volcanology and Mineral Deposits. *Edited by* J. Wood and H. Wallace. Ontario Geological Survey Miscellaneous Paper 129, pages 69-87.

Jesseau, C.W.
1976: A structural – metamorphic and geochemical study of the Hunt River supracrustal belt, Nain Province, Labrador. Unpublished M.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 211 pages.

Krogh, T.E. and Davis, G.L.
1973: The significance of inherited zircons on the age and origin of igneous rocks - an investigation of the ages of the Labrador adamellites. Annual Report Geophysics Laboratory, Carnegie Institute, Washington, Yearbook, Volume 72, Number 1630, pages 610-613. [2126, 2127, 2129, 2132]

Lesher, C.M.
1989: Komatiite-associated nickel sulphide deposits. *In* Ore Deposition Associated with Magmas. *Edited by* J. Whitney and A.J. Naldrett. Reviews in Economic Geology, Volume 4, pages 45-101.

Lesher, C.M., Arndt, N.T. and Groves, D.I.
1984: Genesis of komatiite-associated nickel sulphide deposits at Kambalda, Western Australia: A distal volcanic model. *In* Sulphide Deposits in Mafic and Ultramafic Rocks. *Edited by* D.L. Buchanan and M.J. Jones. The Institute of Mining and Metallurgy, pages 70-80.

Lesher, C.M. and Groves, D.I.
1986: Controls on the formation of komatiite-associated nickel-copper sulphide deposits. *In* Geology and Metallogeny of Copper Deposits. *Edited by* G.H. Friedrich, A.D. Genkin, A.J. Naldrett, J.D. Ridge, R.H. Sillitoe and F.M. Vokes. Springer-Verlag, Berlin, pages 43-62.

Loveridge, W.D., Ermanovics, I.F. and Sullivan, R.W.
1987: U-Pb ages on zircon from the Maggo Gneiss, the Kanairiktok Plutonic Suite and the Island Harbour Plutonic Suite, coast of Labrador, Newfoundland. *In* Radiogenic Age and Isotopic Studies: Report 1. Geological Survey of Canada, Paper 87-2, pages 59-65.

Low, A.P.
1896: Map of Labrador Peninsula, northeast sheet. Geological Survey of Canada, Map 588.

Marston, R.J.
1984: Nickel mineralization in Western Australia. Geological Survey of Western Australia, Perth, Mineral Resources Bulletin 14, 271 pages.

Marston, R.J., Groves, D.I., Hudson, D.R. and Ross, J.R.
1981: Nickel sulphide deposits in Western Australia: A review. Economic Geology, Volume 76, pages 1330-1363.

McConnell, J.
1996: Preliminary report of the soil- and stream-geochemical surveys of the Florence Lake greenstone belt, eastern Labrador. *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 96-1, pages 191-192.

McLean, S.
1991: Report on mapping and sampling surveys on mapped staked licences 368M, 369M, 370M, 371M, 372M, NTS areas 13N/7 and 13N/10, Labrador. [Lab 013N/0042]

Miller, R.R.
1996: Ultramafic rocks and Ni – Cu mineralization in the Florence Lake – Ugjoktok Bay area, Labrador. *In* Current Research. Newfoundland Department of Natural Resources, Geological Survey, Report 96-1, pages 163-174.

Naldrett, A.J.
1981: Nickel sulphide deposits: Classification, composition and genesis. *In* Seventy-Fifth Anniversary Volume. *Edited by* B.J. Skinner. Economic Geology Publishing Company, El Paso, pages 628-685.

Naldrett, A.J. and Gasparrini, E.L.

1971: Archean nickel sulphide deposits in Canada: Their classification, geological setting and genesis with some suggestions as to exploration. *In* The Archean Rocks, Proceedings of the First Symposium on Archean Rocks, Special Publication 3. *Edited by* J.E. Glover. Geological Society of Australia, Adelaide, pages 331-347.

Schau, M.

1977: "Komatiites" and quartzites in the Archean Prince Albert Group. *In* Volcanic Regimes in Canada. *Edited by* W.R.A. Baragar, L.C. Coleman and J.M. Hall. Geological Association of Canada Special paper 16, pages 341-354.

Schiøtte, L., Hansen, B.T., Shirey, S.B. and Bridgwater, D.

1993: Petrological and whole-rock isotopic characteristics of tectonically juxtaposed Archean gneisses in the Okakh area of the Nain Province, Labrador: relevance for terrane models. Precambrian Research, Volume 63, pages 293-323.

Stockwell, C.H.

1964: Fourth report on structural provinces, orogenies, and time classification of rocks of the Canadian Precambrian Shield. Geological Survey of Canada, Paper 64-17, pages 1-21.

Swinden, H.S., Wardle, R.J., Davenport, P.H., Gower, C.F., Kerr, A., Meyer, J.R., Miller, R.R., Nolan L., Ryan, A.B. and Wilton, D.H.C.

1991: Mineral exploration opportunities in Labrador: a perspective for the 1990's. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 91-1, pages 349-390.

Taylor, F.C.

1971: A revision of Precambrian structural provinces in northeastern Quebec and northern Labrador. Canadian Journal of Earth Sciences, Volume 8, pages 579-584.

1972: Reconnaissance geology of a part of the Precambrian Shield, northeastern Quebec, northern Labrador. Geological Survey of Canada, Paper 71-48.

1977: Geology, Hopedale, Newfoundland. Geological Survey of Canada, Map 1443A, scale 1:250 000.

1979: Reconnaissance geology of a part of the Precambrian Shield, northeastern Quebec, northern Labrador and Northwest Territories. Geological Survey of Canada, Memoir 393, 99 pages.

Wardle, R.J.

1993: Geology of the Naskaupi River region, central Labrador (13NW), scale 1:500 000. Newfoundland Department of Mines and Energy, Geological Survey Branch, Map 93-16.

Wasteneys , H., Wardle, R.J., Krogh, T. and Ermanovics, I.

1995: Preliminary U – Pb geochronology of the Ingrid Group and basement rocks in the Hopedale Block in the vicinity of the southern Nain craton/Torngat Orogen boundary. *In* Eastern Canadian Shield Onshore - Offshore Transect (ECSOOT), Transect Meeting (November 1994). R.J. Wardle and J. Hall (compilers). The University of British Columbia, LITHOPROBE Secretariat, Report 45, pages 206-216.

Williams, D.A.C.

1979: The association of some nickel sulphide deposits with komatiitic volcanism in Rhodesia. Canadian Mineralogist, Volume 17, pages 337-349.

Note: Geological Survey file numbers are included in square brackets.