Geological Report GR80-9

Geology of the Cochrane and Seal Rivers Area

D.C.P. Schledewitz

Manitoba
Energy and Mines
Geological Services

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By D.C.P. Schledewitz

Winnipeg, 1986

Energy and Mines

Hon. Wilson D. Parasiuk
Minister

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Deputy Minister

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COCHRANE AND SEAL RIVERS AREA: GEOGRAPHIC NAMES AND LOCATIONS

To assist the reader in locating features described in the text, the following list has been prepared. As a few lake names were changed during preparation of this report, old names are included, in brackets, because they appear on some maps in references and in assessment files. A few of the lake names do not appear on the geological maps GR80-9-1 to 8, but the lakes can be located from their coordinates.

	Map Area	Latitude	Longitude
Albert Lake	64 J/9	58°43′	98°01′
Askey Lake	64 O/10	59°39′	98°42′
Bain Lake	64 J/14	58°54′	99°14′
Bangle Lake	64 O/10	59°43′	98°54′
Belsham Lake	64 J/14	58°49′	99°05′
Big Sand Lake	64 G/12	57°45′	99°42′
Blackfish Lake	64 O/4	59°10′	99°32′
Blevins Lake	64 O/15	59°52′	98°50′
Booth Lake	64 O/5	59°23′	99°36′
Burnie Lake	64 K/16	58°55′	100°26′
Caribou Lake	64 P/8	59°21′	96°10′
Cavaghan Lake	64 P/2	59°02′	96°57′
Chatwin Lake	64 K/15	58°54′	100°48′
Chekask Lake	64 N/12	59°45′	102°00′
Clifton Lake	64 J/11	58°43′	99°13′
Colbeck Lake	64 N/3	59°09′	101°19′
Coll Lake	64 I/10	58°42′	96°41′
Commonwealth Lake	64 P/14	59°55′	97°14′
Copeland Lake	64 O/2	59°00′	98°45′
Corbett Lake	64 O/11	59°35′	99°18′
Duddles Lake	54 L/12	58°42′	95°46′
Duffin Lakes	64 P/4	59°03′	97°43′
Egenolf Lake	64 O/4	59°03′	100°00′
Eppler Lake	54 L/13	58°53′	95°52′
Esaruk Lake	64 K/12	58°42′	101°53′
Fergus Lake	64 J/12	58°40′	99°40′
Fort Hall Lake	64 N/6	59°16′	101°29′
Greening Lake	64 O/2	59°03′	98°33′
Grimes Lake	64 J/12	58°34′	99°35′
Kasmere Lake	64 N/11	59°34′	101°10′
Koona Lake	64 N/10	59°44′	100°37′
Lezun Lake	64 N/14	58°53′	101°12′
Lofthouse Lake	54 L/7	58°28′	94°58′
Long Lake	54 M/6	59°26′	95°27′
MacLeod Lake	64 P/4	59°11′	97°35′
Marie Lake	64 K/10	58°43′	100°40′
McGill Lake	64 K/14	58°56′	101°03′
Meades Lake	64 N/1	59°04′	100°12′
Minuhik Lake	64 K/13	58°53′	101°40′
Munroe Lake	64 O/2	59°13′	98°35′
Nejanilini Lake	64 P/12	59°33′	97°48′
Nichol Lake	64 I/9	58°40′	96°15′
Nicklin Lake	64 J/3	58°52′	99°48′
North Knife Lake	64 I/3	58°05′	97°05′
Nowell Lake	54 L/10	58°43′	94°56′
Nueltin Lake	64 O/13	60°00′	99°50′
Omand Lake	64 I/16	58°47′	96°27′
Overby Lake	64 J/16	58°55′	98°25′
Pangman Lake	64 K/9	58°40′	100°15′
Poulsen Lake	64 O/2	59°08′	98°53′
Putahow Lake	64 N/15	59°54′	100°40′
Reindeer Lake (See Birch Bay)	64 F/5	57°20′	102°00′
Round Sand Lake	64 P/15	59°46′	96°38′
Rutledge Lake	64 K/14	58°54′	101°12′
Ryan Lake	64 J/10	58°35′	98°46′
Seddon Lake	64 J/15	59°00′	98°38′
Shetanei Lake	64 I/13	58°48′	97°50′
Snyder Lake	64 N/5	59°22′	101°40′
South Knife Lake	64 I/1	58°10′	96°28′
Spruce Lake	64 P/2	59°03′	96°44′
Stony Lake	64 J/15	58°51′	98°40′
Tadoule Lake	64 J/9	58°36′	98°20′
Thuycholeeni Lake (northern part of former 'Sandy Hill Lake')	64 K/16	58°30′	101°11′
Tice Lake	64 N/14	59°47′	101°03′
Topp Lake	64 N/7	59°16′	100°45′
Veal Lake	64 N/13	59°48′	101°43′
Whiskey Jack Lake	64 K/5	58°23′	101°55′
Widlake Lake	64 N/15	59°52′	100°35′
Wilkie Lake	64 J/11	58°40′	99°20′
Wither Lake	64 I/15	58°53′	96°48′
Wolochatiuk Lake	64 P/1	59°01′	96°21′
Zadworny Lake	64 I/16	58°45′	96°21′

Other localities (selected)

	Map Area	Latitude	Longitude
Birch Bay (formerly named 'Perch Bay')	64 K/4	58°07′	101°49′
Cape Merry	54 L/16	58°47′	94°12′
Chipewyan Falls	64 K/11	58°33′	101°16′
Dechanhooledezay River	64 I/9	58°34′	96°01′
Eskimo Island	54 L/16	58°48′	94°13′
Mosquito Point	54 L/9	58°42′	94°12′
Teepee Falls	54 L/11	58°36′	95°06′

***NOTE:** Rb-Sr whole rock ages reported in this publication have been calculated using the ^{87}Rb decay constant of 1.42 $\times 10^{-11}$ yr^{-1}, ages cited from Weber, (Weber et al, 1975b) have been recalculated using this constant.

INTRODUCTION

LOCATION AND ACCESS

The area covered by the Cochrane and Seal Rivers Project (Fig. 1) is bounded on the east by the Hudson Bay shoreline and on the west by the Manitoba-Saskatchewan border, excluding the northwest corner of the area previously mapped as part of the Kasmere Project (Weber et al., 1975a). The southern limit of the mapping is latitude 58° and the northern extent latitude 60°, the Manitoba-Northwest Territories border. Access and service for this region is provided from the centres of Lynn Lake and Churchill. The information from the Kasmere Project has been incorporated in the 1:500 000 scale geological compilation of northern Manitoba north of latitude 58° (GR80-9-9), Whiskey Jack Lake map area (GR80-9-1) and the Cochrane River and Seal River Project Report (GR80-9). However, the area outlined by the Kasmere Project was not remapped and revisions of unit numbers have been made to accommodate a regional correlation. Re-interpretation of contacts and structures has been based on geophysical data and information from open assessment files. A gradiometer survey (Geological Survey of Canada Map C30,009G) in the area of Kasmere Lake and Fort Hall Lake contributed to a revised interpretation of the fault structures.

DRAINAGE AND TOPOGRAPHY

Elevations in the project area are between sea level and 450 m. The recently-released Manitoba Relief Map at a scale of 1:1 000 000 depicts a broad arcuate-shaped upland area extending east from the Manitoba-Saskatchewan border to the Nejanilini Lake area in the north and to South Knife Lake in the south of the region. The eastern edge of the arcuate zone coincides with the 900 foot (270 m) contour interval. To the east of this zone the land slopes gradually towards the shoreline of Hudson Bay. This easterly zone reflects the influence of the Hudson Bay basin.

The upland area itself has a step-like configuration (Fig. 2). The upper platform in the west ranges from 300 m to 432 m with the eastern edge marked by the 1,000 foot (300 m) contour interval. The second step or platform lies between the 1,000 foot (300 m) contour zone and the 850 to 900 foot (255 m to 270 m) contour zone.

The geomorphology of each of the platforms, depicted at a scale of 1:1 000 000, indicates a distinct pattern that can be attributed to bedrock structure. The upper platform has a very dominant northeast trend consistent with the structure of bedrock geology. The southern portion of the upper platform is molded under the influence of a more easterly-trending bedrock structure. This accounts for the "L" shape of the upper platform. The lower platform is highly dissected by a drainage pattern which reflects the complex network of folds, shear zones and fault zones (Fig. 2).

The region is marked by two watersheds. In the southwest corner of the region the Cochrane River drains south to Reindeer Lake. The second main drainage, the Seal River System, follows a highly meandering easterly course acting as an arterial stream for an area of discontinuous drainage. The Seal River System comprises the North and South Seal and Seal Rivers. North Seal River joins with the north-flowing South Seal River east of Stony Lake, in

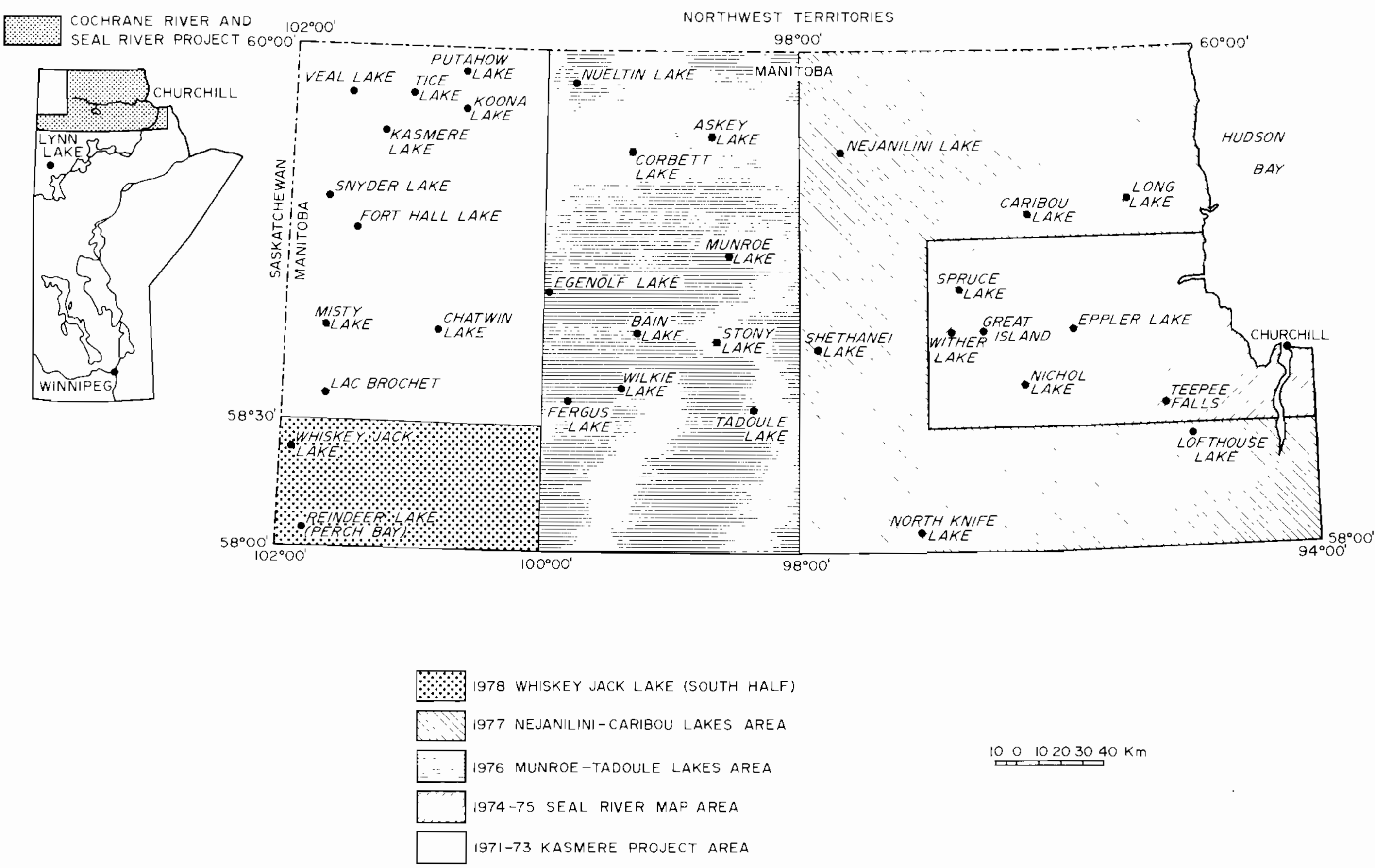


Figure 1: Location of Project Area and Kasmere Project.

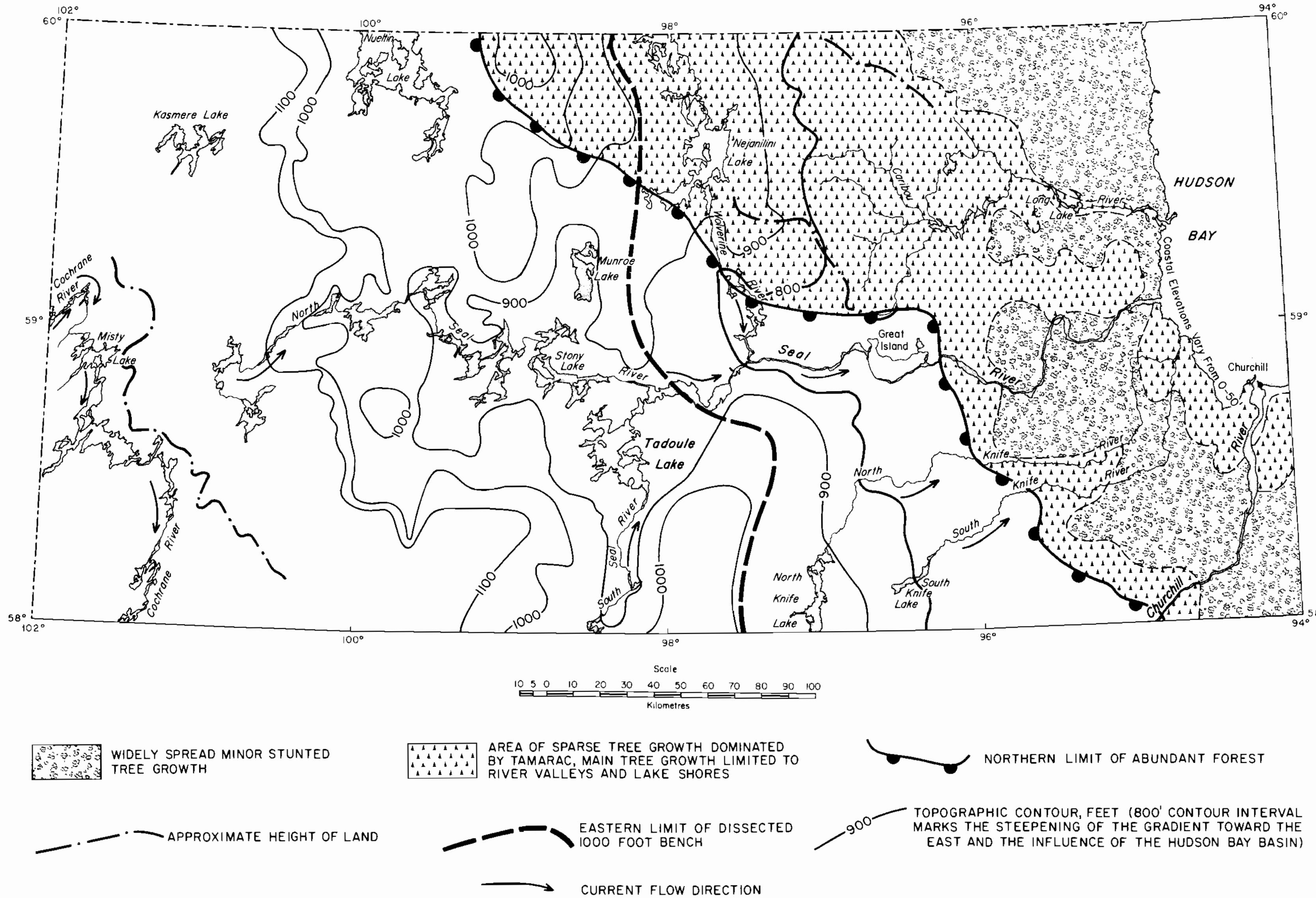


Figure 2: Topography and relief.

approximately the geographic centre of the project area. They join to form Seal River which follows a distinctly easterly course from Stony Lake, which is locally, deeply incised into the Pleistocene overburden. The flow of Seal River is further increased by the addition of water from Wolverine River which drains the Nejanilini Lake drainage basin. The gradient on the upper part of the Seal River System is modest, exceptions being the series of rapids on North Seal River at the east end of Stony Lake and the series of rapids on Seal River between Tadoule and Shethanei Lakes. However, from the confluence of the Seal and Wolverine Rivers the gradient becomes appreciable with a drop in elevation of 250 m over a distance of 152 km. Numerous sets of rapids occur between the west end of Great Island and the Seal River delta at Hudson Bay. Seal River is a much used route for white water canoeing enthusiasts who generally begin their trip with a flight by float-equipped aircraft from Lynn Lake into Big Sand Lake 128 km southwest of Tadoule Lake.

South of Seal River, North Knife River and the South Knife River are smaller rivers which interestingly mirror the course of the Seal River. The flow rate on South Knife River is very modest, and forms a narrow, shallow stream throughout much of its course. North Knife River has a much higher flow rate and has incised a deep square-shaped canyon from 9 to 16 m deep, through the Pleistocene overburden exposing bedrock along the floor and the lower part of the valley walls. This river valley provides the only zone of significant exposure in the extreme southeast corner of the map-area.

North of Seal River the main drainage is effected by the south- and east-flowing Caribou River and Little Seal River. The drainage in this area is very discontinuous and the water flow on these rivers is modest in comparison to the Seal River.

Bedrock exposures make up two per cent or less of the region. The area south of latitude 58°30' is particularly barren of exposure being overlain by fluvial and lacustrine deposits and along Hudson Bay by marine deposits derived by reworking of the Pleistocene overburden.

The most conspicuous Pleistocene deposits are eskers and boulder fields. The boulder fields constitute a felsenmeer which is common in the area between Nejanilini Lake and the Hudson Bay shoreline. Boulder examination can generally be used as a guide to the approximate location of geologic contacts except for linear boulder fields of highly rounded boulders left by the reworking of eskers, or the trains of boulders along the flanks of eskers.

AVAILABLE MAPS AND IMAGERY

Copies of Whiskey Jack Lake sheet (64K), Tadoule Lake sheet (64J), Shethanei Lake sheet (64-I), Churchill sheet (54L), Caribou River sheet (64-O) and Kasmere Lake sheet (64N) of the National Topographic series at a scale of 1:250 000 are available from the Manitoba Surveys and Mapping Branch, or from the Map Distribution Office in Ottawa.

Vertical aerial photographs at a scale of 1 inch equals 1 mile and one inch equals two miles are available through the Map Office/Air Photo Library, Manitoba Surveys and Mapping Branch, or from the National Photo Library. Landsat imagery is available from the Remote Sensing Centre, Surveys and Mapping Branch, Manitoba Department of Natural Resources.

Claim maps for the area can be obtained from the Mining Recording Section, Manitoba Department of Energy and Mines, Winnipeg and The Pas. Assessment information can be obtained from the Exploration Services Section, Manitoba Department of Energy and Mines, Winnipeg.

Aeromagnetic Series maps 7143G to 7151G at one inch to four miles and series maps 1061 to 1073G (64K) 666G, 667G; 669-671G, 721-723G, 725-732G (64J); 628-633G, 652-656G, 661G, 662G, 668G, 720G, 724G (64-I); 633-636G. 640-643G, 646-649G, 657-660G (54L); 1690-1692G, 1697-1699G, 1704-1706G, 1711-1713G (54M); 1686-1689G, 1693-1696G, 1700-1703G, 1707-1710G (64P); 1077-1092G (64-O); 1029-1041G (64N) at one inch to 1 mile, produced by the Geological Survey of Canada, cover the map area. Map 550G at a scale of one inch equals a half mile was produced from a special detailed airborne study in 1957 to cover a plus 10,000 gamma magnetic anomaly immediately north of Great Island.

An aeromagnetic gradiometer survey was conducted over parts of 64N-5, 6, 10, 11, 12, 15 in the Kasmere map area by the Geological Survey of Canada in 1977. The maps of the vertical gradient (Maps 40,032G - 40,048G) and total field (Maps 20,310G - 20,326G) at a scale of 1:25 000 and at I:125 000 (vertical gradient 45,003G and experimental colour composite C45,003G; total field 30,009G and C30,009G experimental colour composite), are available through the Manitoba Mineral Resources Division, Exploration Services Section.

ACKNOWLEDGEMENTS

The writer was assisted in the geological mapping in 1974 by P. Lenton, G. Southard, F. Saboo and B. Haig; in 1975 by R. Kasura, B. Newton and D. Yebleki; in 1976 by G. Clark, in 1977 by H.D.M. Cameron, J. Corkery, S. Benko, and R. Bell-Chambers, and by D. Lacey and B. Richards in 1978.

Supplies for the field party were arranged in Churchill by B. Martin of S & B Groceries in 1974, 1975, and were flown into the area by Lambair. During the summers of 1976, 1977 and 1978 supplies were obtained in Lynn Lake under the direction of N. Brandson and flown into the area by La Ronge Aviation Services Ltd., Parsons Airways Northern Ltd. and the Manitoba Government Air Division. A helicopter was chartered for support during each field season. A helicopter was provided by Gem Air Ltd., 1974, by Midwest Helicopters Ltd. in 1975, 1976; Aero Trades Ltd. in 1977 and Custom Helicopters Ltd. in 1978.

Chemical analyses were carried out by the Manitoba Mineral Resources Division analytical laboratory. Thin sections and stained slabs were prepared by the Mineral Resources Division rock preparation laboratory. J. Malyon, J. Peters and K. Albino identified several minerals by X-ray methods. G. Clark, University of Manitoba, determined several Rb-Sr ages.

The writer would like to thank K. Eade and L. Davison of the Geological Survey of Canada, J. Lewry of the Department of Geology, University of Regina, Regina, Saskatchewan; T. Sibbald, Saskatchewan Geological Survey, Regina, Saskatchewan, all of whom contributed to a broadening of perspective and the beginnings of an understanding of the regional geology. The writer's colleagues of the Manitoba Mineral Resources Division staff provided valuable discussion and guidance.

The writer also acknowledges the services of R. Sales, P. Buonpensiere, T. Franceschet, M. Timcoe, N. Barton and D. Bagwell in preparing the final maps and preparation of figures.

Special thanks are due to L. Chudy, B. Thakrar and D. Navitka who patiently and meticulously typed the numerous drafts and final manuscript.

TABLE 1. TABLE OF FORMATIONS

CENOZOIC	PLEISTOCENE AND RECENT	Sand-gravel, boulder fields, clay (glacial till, eskers, fluvioglacial boulder deposits, lake bottom sediments, abandoned marine beaches)	
		GREAT UNCONFORMITY	
PALEOZOIC	MIDDLE SILURIAN	Limestone and dolomite.	
PALEOZOIC	LATE TO EARLY ORDOVICIAN	Limestone variably bioclastic, thin basal sandstone	
		UNCONFORMITY	
PROTEROZOIC		33 Diabase	
PROTEROZOIC	HUDSONIAN IGNEOUS AND METAMORPHIC ROCKS	32 Pink porphyritic quartz monzonite a) Pink and/or white granite pegmatite b) Pink fluorite bearing quartz monzonite c) White fluorite bearing quartz monzonite d) Red granite coarse grained to pegmatitic + fluorite 31 Quartz monzonite medium to coarse grained massive to foliated + aplite + pegmatite zones a) Hybrid quartz monzonite b) Pink aplite + biotite + hornblende + magnetite granite gneiss d) Hybrid gneiss	
		INTRUSIVE CONTACT WITH ROCKS OF SEQUENCE I AND UNITS 22 AND 22a OF SEQUENCE II	
PROTEROZOIC	HUDSONIAN IGNEOUS AND METAMORPHIC ROCKS	30 White granite to trondhjemite medium grained cordierite bearing + tourmaline a) Porphyritic white granodiorite	
		INTRUSIVE CONTACT	
PROTEROZOIC AND/OR ARCHEAN		**SEQUENCE I** 20 Meta-arkose derived arkosic gneiss with metatexite 19 Feldspathic quartzite with *faserkiesel* of muscovite-sillimanite-quartz 18 Quartzite + andradite ± diopside + epidote 17 Calc silicate rock a) Marble + quartz + tremolite b) Albite pyroxene rock 16 Biotite psammite gneiss ± calc silicate lenses	PROTEROZOIC - APHEBIAN **SEQUENCE II** 29 Churchill quartzite **GREAT ISLAND GROUP** 28 Metasiltstone and meta-argillite 27 Metagreywacke 26 Garnet amphibolite schist (iron formation) + pyrrhotite + magnetite a) Black pyritic meta argillite + black acicular amphibole ± garnet 24 Dolomitic marble + quartz + clinochlore 22 Quartzite and interlayered pale green phyllite to biotite-muscovite schist + garnet a) Grey to grey green phyllite ± garnet + andalusite + biotite poikiloblasts 21a Conglomerate oligomictic 21b Conglomerate polymictic 27a (North Knife River) interlayered red and/or green metagreywacke and green phyllite 25 (North Knife River) Black meta-argillite with quartz pebbles 23 (Tadoule Lake) Metaconglomerate with muscovite-biotite-quartz siltstone matrix with quartzite clasts interlayered grey siltstone with pebble beds
		? ? ?	UNCONFORMITY
PROTEROZOIC AND/OR ARCHEAN		15 Metagabbro in part noritic metabasic rocks	Seal River Intrusive Rocks 14 Quartz porphyry 13 Pink to grey very fine grained feldspar porphyry 12 Ultramafic and serpentinite 11 Gabbro 10 Granodiorite to porphyritic quartz diorite
		INTRUSIVE CONTACT	
PROTEROZOIC AND/OR ARCHEAN		**SEQUENCE I** 6 Semi pelitic paragneiss to metatexite + muscovite + cordierite + garnet + sillimanite ± andalusite + hypersthene a) Semi pelitic paragneiss to schist and interlayered impure quartzite b) Impure quartzite to quartzite c) Augen gneiss d) Biotite-feldspar gneiss with granodiorite *lits*	**SEQUENCE I** Seal River Volcanic Rocks 9a Conglomerate volcanic derived 9b Conglomerate and greywacke 9c Metasiltstone (+ uvarovite) 8 Amphibolite 7a Andesite and minor basalt 7b Interlayered tuff and pillowed andesite 7c Intermediate tuff lapilli tuff and interlayered siliceous metasedimentary rocks local rhyodacite and andesite flows 7d Rhyolite ro rhyodacite
ARCHEAN		5 Foliated quartz monzonite 4 Foliated alaskite 3 Metadiorite to amphibolite and magnetite biotite hornblende schist 2a Hypersthene-quartz diorite 2b Hypersthene trondhjemite 2c Hypersthene-quartz monzonite (monzocharnockite) 1 Hypersthene gneisses	
ARCHEAN? PROTEROZOIC?		Unit A Grey tonalitic to granodioritic gneisses Unit B Foliated to lineated biotite granodiorite to tonalite Unit C Granodioritic diatexite to biotite metatexite + garnet Unit D Amphibolite	

GENERAL GEOLOGY

INTRODUCTION

Bedrock exposures are in general sparse (1 - 2%) throughout the whole region. Areas centered on Stony and Belsham Lakes (Maps GR80-9-2, 7) and immediately to the west and north of Caribou Lake (Map GR80-9-6), have higher than normal outcrop density ranging up to 5 per cent. A third area, which includes almost all of the southern quarter of the project area east from the course of the Cochrane River in the Whiskey Jack Lake map area exhibits lower than normal outcrop density. On North Knife Lake the exposure is confined to the lake shore. The average bedrock exposure in this zone is less than 1 per cent and in many instances reworking of Pleistocene deposits and the thick cover of fluvial and lacustrine clay deposits have made even boulder examination a fruitless exercise.

The rocks in the project area range in age from Precambrian to Paleozoic (Table 1). This report deals only with mapping of the Precambrian rocks. The Ordovician and Silurian rocks which outcrop as part of the Hudson Bay Lowlands, in the extreme southeast edge of the project area, have been mapped in detail as part of Operation Winisk (Sanford et al., 1967), and by later studies on Ordovician strata of the Hudson Bay Lowlands (Cumming, 1971) and on the Silurian Stratigraphy of Northern Manitoba (Norford, 1971).

The Precambrian rocks are part of the Churchill structural province of the Canadian Shield. These rocks can be divided into four major categories

i) Archean and Probable Archean rocks;
ii) Metasedimentary and localized metavolcanic rocks; (Sequence I) of uncertain age or mixed age;
iii) Metasedimentary rocks (Sequence II) of Aphebian age;
iv) Hudsonian palingenetic rocks and igneous rocks.

i) The Archean rocks comprise mainly foliated granite and granitoid rocks ranging in composition from monzocharnockite to enderbite with isolated lenses of basic granulite.

ii) The identification of a viable stratigraphic succession for the large region encompassed by this project is complicated not only by the complexity of the structure but also by the high degree of metamorphic recrystallization manifest in most of the region. Present regional radiometric age data are consistent with the concept that the Cochrane River-Seal River project encompasses the southern margin of an Archean Crustal block which has been variably affected by a depositional-orogenic cycle (Aphebian-Hudsonian). The problem of distinction of pre-Aphebian gneisses and those formed during the Hudsonian orogeny has been discussed by Eade, (1971 and 1973), Wanless and Eade (1975), Weber et al. (1975a and 1975b) and Schledewitz (1978) and as yet remains unresolved. These difficulties are further compounded by the presence of large areas of intrusive rocks and, possibly the most detrimental factor, a paucity of bedrock exposure. Consequently, in order to avoid the use of a stratigraphically biased terminology and the attendant inferences of correlation, a broad subdivision of the metamorphosed cover rocks into two major regionally predominant groups - Sequence I and Sequence II - has been employed. Sequence I denotes a varied suite of rocks which at any given locality have the possibility of containing pre-Aphebian supracrustal rocks. Sequence II is a varied suite of rocks considered to be no older than Aphebian. Sequence I comprises sedimentary-derived paragneisses and migmatites in the Wollaston River, Seal River and Nejanilini domains and metavolcanic rocks in the Great Island domain (Maps GR80-9-3, 4, 5 and 6). The metavolcanic rocks have been tentatively placed within the lower part of the Sequence I rocks.

iii) Sequence II rocks are metasedimentary rocks which outcrop at Tadoule Lake, Great Island, east of Great Island along Seal River, along North Knife River and in the area of the town of Churchill.

iv) The Hudsonian igneous and metamorphic derived anatexites occur at all scales from 1 cm *lits* to large stocks and larger bodies covering up to 2000 km^2. These bodies are massive to weakly foliated.

The part of the Churchill Province covered by this project comprises five lithotectonic domains. The concept of domains is used as an informal attempt to identify zones, on a regional scale, that possess some unifying characteristics, such as metamorphic grade, structure, lithology or a combination of all three. However, the position of the boundaries between domains is often arbitrary since, in many cases, the criteria chosen to characterize a domain are regional but generally well defined in only one area. The boundaries of the domains for the most part are complex zones that could be treated separately on a smaller scale of mapping. The five lithotectonic domains are (Fig. 3):

i) the Seal River domain;
ii) the Wollaston domain;
iii) the Great Island domain;
iv) the Nejanilini domain
v) the Chipewyan domain.

The Seal River domain comprises a basement of granitoid rocks overlain by the metamorphosed cover rocks of Sequence I. The structural trend of the Seal River domain is dominated by east to southeast-trending folds. These structures are locally overprinted by the younger northeast structural trends and are in part synchronous with younger northwest- and east-trending faults. In general, the younger northeast-trending deformation produced open to tight minor folds and only locally formed narrow zones of intense penetrative deformation and shearing, such as the Fergus River shear zone (Fig. 3).

The Wollaston domain merges with the westward extension of the Seal River domain and contains similar lithologies and similar grades of metamorphism. However, the rocks of the Wollaston domain have followed a different path of deformation and have been subjected to an intense penetrative northeast-trending deformation which has obscured the earlier deformational history. The characteristics of the Wollaston domain are outlined in the report on the Kasmere Project (Weber et al., 1975a).

The Great Island domain lies at the east end of the Seal River domain. Within this domain Sequence I metasedimentary and metavolcanic rocks and Sequence II metasedimentary rocks are underlain by granitic rocks ranging in composition from porphyritic quartz diorite to granite. The metavolcanic and metasedimentary rocks of Sequence I are intruded by a porphyritic quartz diorite and a younger quartz monzonite. The basal metasedimentary rocks of Sequence II are intruded by younger granites. The "Churchill quartzite," which locally contains pebbles of granite and feldspar phenocrysts, may represent the youngest Sequence II rocks in the domain. The rocks of the Great Island domain are deformed about an east-trending fold axis and along east to southeast zones of shearing and cataclasis. North- to northwest-trending cross-folding and faulting postdate this phase of the deformation. The regional grade of metamorphism in the Great Island domain is lower than in the Seal River domain to the west and north. Contact metamorphism is clearly demonstrated within the southern half of the Great Island domain.

The Nejanilini domain is dominated by granitoid basement rocks overlain by narrow discontinuous remnants of migmatized cover rocks. The basement rocks are in part foliated grey tonalite, and tonalitic to granodioritic gneisses with minor hypersthene-bearing tonalites or enderbites. The eastern half of the Nejanilini domain is the Nejanilini Massif which comprises hypersthene-bearing intermediate to basic gneisses and foliated hypersthene monzocharnockites to enderbites displaying varying degrees of hematization and potassium metasomatism. The structural trends

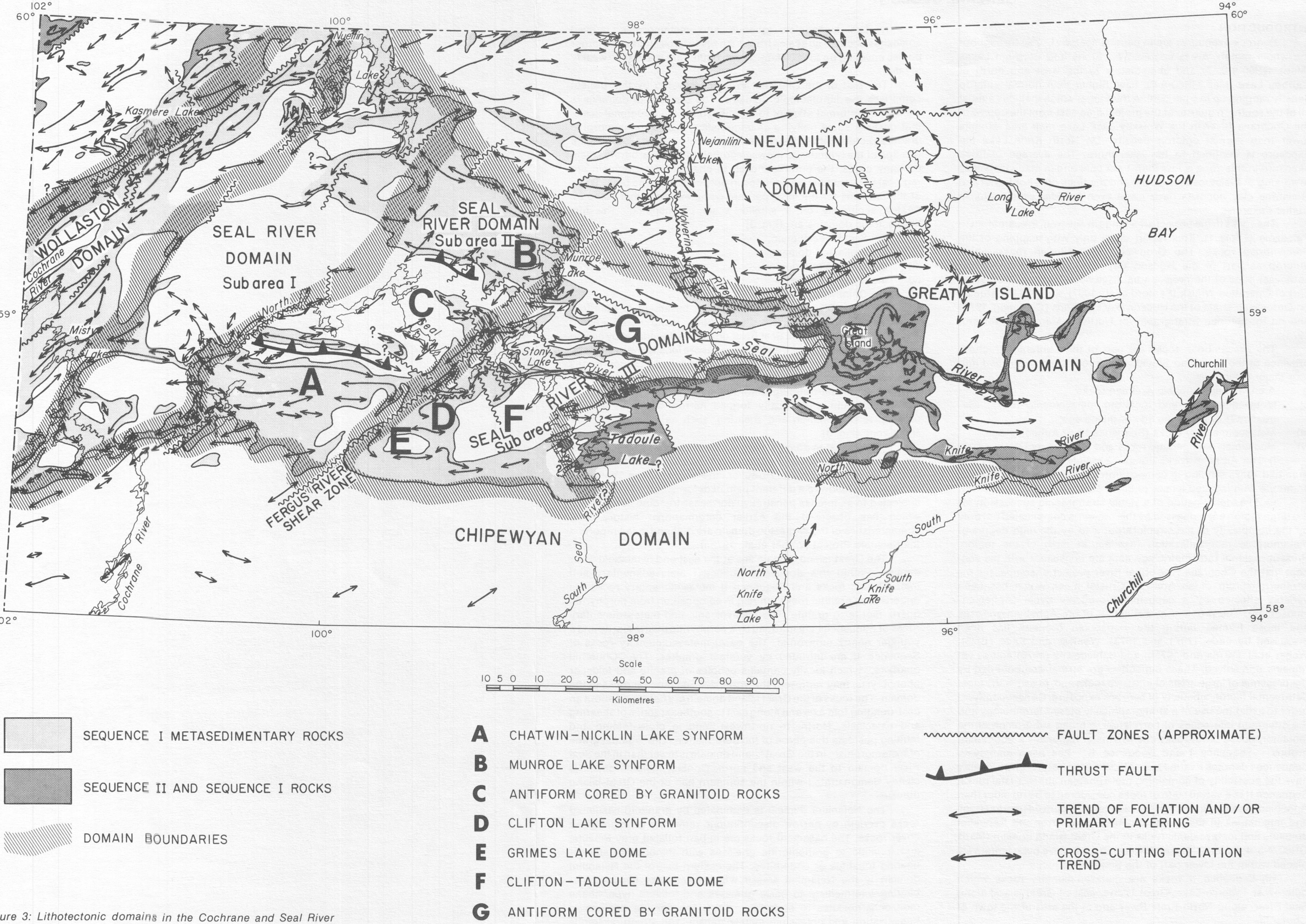


Figure 3: Lithotectonic domains in the Cochrane and Seal River area.

are north of west to westerly and are intersected by numerous narrow northeast- to north-trending shear zones and faults.

The Chipewyan domain is an east-trending batholithic complex. This region is poorly exposed and in compiling the geological map great reliance has been placed on widely spaced outcrop data, boulder examination and regional aeromagnetic data.

ROCKS OF UNCERTAIN AFFINITY

Grey tonalitic to granodioritic gneiss (Unit A)

This gneiss forms a broad zone which makes up 50 per cent of the Nejanilini domain. It is the principal rock type in the northern half of the Munroe Lake map area (Map GR80-9-7). It also occurs in the area of Caribou Lake on the south flank of the Nejanilini Massif and forms larger irregular-shaped bodies in the Caribou River map area (Map GR80-9-5).

These rocks form clusters of low flat outcrops which are characteristically light grey to buff on the weathered surface and greyish white to greyish pink on the fresh surface. The pink colour is due to abnormally high potassium content either as porphyroblasts or as thin granitic *lits*.

Generally the gneisses (Unit A) are medium grained and foliated. The foliation is defined by the orientation of biotite and ellipsoidal quartz and feldspar grains. A weak compositional layering is also present and is defined by the alternation of buff plagioclase-rich layers and pale pink potassium feldspar-rich layers. The biotite (3-8%) is generally disseminated but can also form discontinuous laminae. The grey gneiss is gradational into zones that are much higher in potassium and the rocks have a distinct red coloration due to hematization. One of these zones of potassium and hematitic alteration occurs east and southeast of Blevins Lake in the north half of the Munroe Lake map area. The layered character is poorly defined but the foliation still persists. The rock in places takes on the appearance of a reddish-pink hybrid granite gneiss. A characteristic of the tonalitic gneiss is its uniform low radioactivity (Appendix). This is well displayed on the airborne radiometric maps of the Federal-Provincial airborne radiometric survey (URP Survey 1976, 1977; see Table 8). This low radioactivity was confirmed by on-ground scintillometer readings. However, within the hematized and granitized areas the radiometric response is much greater (Map GR80-9-11).

The age of the grey gneiss is uncertain. Cross-cutting relationships indicate the gneiss (Unit A) is older than the Hudsonian granites (31 and 32). Field relationships also suggest that the gneiss (Unit A), is overlain by the pelitic gneiss (6).

Lithologically similar rocks occur in the Kasmere Project area. These rocks have been mapped as quartz dioritic to granodioritic gneisses (unit 5, Kasmere Project) and have yielded a Rb/Sr age of 1900 ± 25 Ma (Weber et al., 1975b). This has been interpreted as a primitive age based on the low initial ratio of $^{87}Sr/^{86}Sr$, 0.7038 + 0.003. However, it is acknowledged by Weber et al. (1975a) that the region designated as unit 5 (Kasmere Project) is inhomogeneous and contains areas of possibly older rocks and younger Hudsonian intrusions.

The areal extent of the early to middle Aphebian grey quartz dioritic gneiss (unit 5, Kasmere Project) is unknown and it may form part of the grey gneisses (Unit A) in the Nejanilini domain. Due to the inhomogeneity of the rock type and the broad range in possible age, the grey tonalitic gneiss (Unit A) has been classified as a rock of uncertain affinity. For the purpose of regional correlation (Map GR80-9-9, Scale 1:500 000), unit 5 of the Kasmere Project has been grouped as part of Unit A.

Foliated to lineated granodiorite to tonalite (Unit B)

This rock type outcrops in the area between Munroe Lake south to Copeland Lake. It also outcrops further to the northeast along the southwest side of Nejanilini Lake and in the area north of Caribou Lake. A lineated variety of this rock type outcrops south of Shethanei Lake and smaller bodies occur immediately to the west in the Tadoule Lake to Albert Lake region.

The foliated tonalite to granodiorite comprises biotite (5-10%), plagioclase (40-60%), microcline (5-20%) and quartz (10-20%). Magnetite (0-1%) is an accessory mineral and is conspicuous by its occurrence as zoned porphyroblasts. The magnetite occurs as the core in lenticular porphyroblasts with quartzofeldspathic coronas.

The variety in the Shethanei and Tadoule Lake areas is similar in composition but has a lineated character. Biotite, instead of defining discrete foliae, contributes to linear structures defined by quartz rods and linear biotite trains.

It is uncertain whether these widely separated occurrences define a single intrusive event and it is equally uncertain whether this rock type (Unit B) has affinities with the grey tonalite (Unit A) or the porphyritic quartz diorite (10) or the Archean hypersthene diorite to trondhjemite (2a and 2b).

Field relationships indicate the tonalite (Unit B) was intruded by the Hudsonian quartz monzonite (Unit 31) thereby establishing a minimum relative age.

Granodiorite diatexite to biotite metatexite ± garnet (Unit C)

This migmatite forms narrow zones mainly in the Caribou Lake map area and to the south in the Churchill map area.

According to Mehnert's (1968) guidelines a metatexite consists of macroscopically distinguishable mobilizate (granitic portion) and a less altered country rock (restite). In a diatexite the two portions cannot be separated because of more complete melting and mixing.

The biotite metatexite ± garnet is exposed in only a few small localities in the northwest corner of the Caribou River map area (GR80-9-5). The occurrences are of an isolated nature and as such have no diagnostic field relationships. The rock comprises layers of biotite (25-30%), plagioclase (25%), microcline (30%) and quartz interlayered with white plagioclase An_{28}-quartz *lits*. Bright red, fine- to medium-grained garnet occurs as a variable accessory in both the restite and mobilizate. The diatexite is of broader occurrence and forms a large body 18 by 27 km. It also forms a zone immediately north of North Knife River with another occurrence directly east at Nowell Lake. The diatexite is grey-buff and well foliated, with foliation being defined by closely spaced abundant schlieren. Rafts of metatexite are also sporadically present within the diatexite.

The age and derivation of these migmatites are uncertain and it is conceivable that the process of migmatization has affected more than one rock type which could be of similar or quite different ages.

Amphibolite (Unit D)

The amphibolite (Unit D) occurs mainly in isolated outcrops within areas of granitic and granitoid rocks. It outcrops at the south end of Maria Lake in the Whiskey Jack Lake map area (Map GR80-9-1), within an area of hybrid gneisses(31d). It also outcrops within an area of hybrid gneisses (31d) along the shorelines of Greening, Copeland and Seddon Lakes in the southwest corner of Munroe Lake map area. Other amphibolites lie at the southeast end of Nejanilini Lake within areas comprising hypersthene-quartz monzonite (2c) and hybrid quartz monzonite (31a). Other amphibolites of a similar type outcrop in the Churchill map area (Map GR80-9-4) immediately north of North Knife Lake in an area o diatexite (Unit C). A layered magnetiferous amphibolite outcrops : km south of Caribou Lake on the south flank of foliated tonalite tc granodiorite.

In general the amphibolite is medium- to coarse-graine granoblastic with 20 to 30 per cent plagioclase An_{32-36} whereas olive brown biotite varies from 3 to 8 per cent. Accessory magnetite an pyrite range from 0 to 2 per cent. The layered magnetiferou amphibolite (Unit D) south of Caribou Lake is an exception since carries disseminated magnetite (1-3%) and more massive magneti interlayered with non-magnetiferous amphibolite layers. Th disseminated magnetite occurs in the core of complex lenticul porphyroblasts with plagioclase and minor quartz coronas. An occurrence of interlayered quartz and massive magnetite layers was reported by prospecting crews carrying out ground follow-up work for Marlin Oil on the now expired Permit 25, Table 9 (Map GR80-9-10). The magnetite-quartz iron formation was apparently sampled from large angular frost-heaved blocks considered to be outcrop in the immediate area of the layered magnetiferous amphibolite. Accordingly, the layered magnetiferous amphibolite may be part of a layered iron formation. However, the other occurrences of amphibolite are more indicative of metamorphosed dykes, sills or layered volcanic flows.

ARCHEAN AND PROBABLE ARCHEAN ROCKS

Hypersthene gneisses (1)

Hypersthene-bearing gneisses of probable Archean age occur in the Nejanilini Lake map area (Map GR80-9-6) in the northeast corner of the project area. They outcrop within the "Nejanilini Massif" of the Nejanilini domain. This suite of rocks also outcrops in the Whiskey Jack Lake map area with associated hypersthene-bearing Archean granitic rocks (Kasmere Project, Weber et al., 1975a).

The hypersthene gneisses (1) of the "Nejanilini Massif" are intermediate to basic in composition. The layering is defined by alternating buff plagioclase-rich, and dark green to black ferromagnesian-rich layers. Within the intermediate layers the plagioclase ranges in composition from An_{37-61}. Hypersthene and biotite are characteristic constituents whereas the amounts of hornblende and magnetite are variable. Magnetite is conspicuous because of the associated 2 to 4 mm coronas of quartz and feldspar which form a pronounced bird's eye structure.

The garnet-biotite variety is dark grey to buff, and medium grained with a moderate to strong schistosity defined by biotite. The hypersthene varies from medium grained xenoblasts to bronze-coloured euhedral poikiloblasts (0.5 - 1 cm). Buff-coloured garnet-bearing granitic layers (2 - 5 cm thick) comprise 10 - 25 per cent of the rock.

The amphibolitic layers, 2 cm to several metres thick, are interlayered with the previously described hypersthene gneisses. The amphibolitic layers may comprise 95 per cent of the gneisses. The amphibolitic layers are medium grained granoblastic, with moderate to strong schistosity defined by the preferred orientation of biotite, hornblende and pyroxene. The hornblende varies from euhedral poikiloblasts (0.5 - 1.5 mm) to fine- to medium-grained xenoblasts. Sporadic hypersthene forms bronze-coloured, tabular poikiloblasts. An impersistent gneissosity is defined by thin alternating quartzofeldspathic lenses and amphibole-plagioclase lenses. The quartzofeldspathic layers have a hypidiomorphic granular texture and contain hornblende (3%).

A granulite of ultrabasic to basic composition outcrops at a single locality 24 km west-southwest of Caribou Lake (Map GR80-9-5). The rock type outcrops in the contact zone between the foliated grey tonalite and the monzocharnockite rocks of the Nejanilini Massif. The basic granulite has a layered appearance with thick interlayers of coarse grained diopside-hypersthene and layers of diopside-amphibolite. Magnetite-garnet-hypersthene-plagioclase (An_{48}) layers are sporadic and irregular in shape.

Hypersthene-quartz diorite (2a)

A stock of hypersthene-bearing quartz diorite (5 by 12 km) outcrops to the west of Lac Brochet south of Esaruk Lake (Map GR80-9-1). The stock is elongated northeast and coincides with a magnetic high (2800 to 3800 gammas) on Federal Aeromagnetic Map 1072G. Age relationships of the stock with foliated quartz monzonite (5) to the east and southeast, and with hypersthene trondhjemite (2b) to the north, are unknown due to lack of outcrop. The quartz diorite (2a) is flanked on the south by meta-arkose (20) and to the northwest by the calc-silicate rock (17) and semi-pelitic gneiss (6a), respectively, but contacts are not exposed.

The core of the quartz diorite stock forms blocky, joint-controlled outcrops with high relief, whereas the margin is characterized by ridges (1 - 1.5 km long) that are controlled by the intersection of joints and a northeast-striking foliation. The quartz diorite weathers white to buff, but the fresh surface is dark grey. The altered margins of the intrusion are characterized by grey to pinkish-grey, weak to moderately foliated rocks. The thickness of the alteration zone varies from 1 km on the northwest to 2 km on the southeast side of the stock.

The principal minerals (Appendix) in the least altered quartz diorite are plagioclase (An_{34-36}; 53-75%), hornblende (15%), hypersthene (2-5%), diopside (3-8%), quartz (7-10%) and magnetite (1-2%).

Hypersthene trondhjemite (2b)

Hypersthene trondhjemite (2b) forms an elongate, lens-shaped body (4 x 20 km) extending from the south shore of Misty Lake into the Lac Brochet map area. It also forms discontinuous bodies within the rocks of the Nejanilini domain, predominantly within the Nejanilini Massif. The trondhjemite in the Misty Lake area is inhomogeneous and contains phases of leucogranodiorite and minor hypersthene granodiorite. The areas of intrusion coincide with magnetic intensity ranging from 2600 to 3300 gammas. Contacts with the surrounding rocks are not exposed.

Hypersthene trondhjemite weathers white and is a translucent olive-green to olive-brown on the fresh surface. The rock has a weak schistosity defined by the preferred orientation of biotite and small flattened clots of mafic minerals; a sporadic gneissosity is defined by thin layers (2 - 5 mm) of biotite. In places, a weak lineation is defined by the elongation of mafic minerals and quartz aggregates, and by microcrenulation on foliation planes. The trondhjemite has a high plagioclase An_{29-33} (70-75%) and quartz (20-25%) content. Other minerals present are potassium feldspar (0-10%), biotite, idioblastic hypersthene (0-2%) and hornblende (0-2%); magnetite and rare garnet are accessories. The texture is medium grained granoblastic.

Hypersthene granodiorite occurs sporadically within and at the margins of the occurrences of the hypersthene trondhjemite. This phase weathers grey to dark grey, is olive-brown on the fresh surface, and has a weak schistosity with a sporadic incipient augen structure.

Hypersthene-quartz monzonite (monzocharnockite) (2c)

Hypersthene-quartz monzonite forms irregular-shaped bodies within the Nejanilini Massif. The hypersthene-bearing rock comprises 35% of the Nejanilini Massif, the remainder being hybrid quartz monzonite (31a). These two rock types have indistinct and gradational boundaries and interfinger on outcrop scale as well as regional scale. The outcrop commonly shows a colour variation from brown to pinkish brown and/or pink on the fresh surface. The hypersthene-quartz monzonite also forms an almost circular body approximately 30 km in diameter north of Lezun and Chatwin Lakes (Kasmere Project; Weber et al., 1975a), the south half of which is exposed in the Whiskey Jack Lake map area (Map GR80-9-1). Other smaller bodies occur within an area of foliated quartz monzonite (5) between Lezun Lake and Lac Brochet in the north central part of the Whiskey Jack Lake map area.

The fresh surface of the hypersthene-quartz monzonite is characteristically brown. The foliation varies from a weak to moderate schistosity imparted by oriented biotite and smeared-out mafic clots of hornblende and hypersthene to a cataclastic foliation with porphyroblastic feldspar. The texture is medium- to coarse-grained and ranges from hypidiomorphic inequigranular to xenoblastic. The hypidiomorphic type is brown on the fresh surface and the xenoblastic type is pinkish brown. The principal minerals of the hypidiomorphic type are perthitic orthoclase, mesoperthite, and

TABLE 2: CHEMICAL ANALYSES OF HYPERSTHENE TRONDHJEMITE (2b) AND HYPERSTHENE QUARTZ MONZONITE (2c)

	(1)	(2)	(3)	(4)	(5)	(6)*
SiO_2	69.15	72.15	71.45	71.80	71.30	72.10
Al_2O_3	16.2	12.55	12.5	13.25	12.95	13.20
Fe_2O_3	1.44	1.16	1.23	1.42	1.55	1.43
FeO	1.40	2.61	2.69	2.12	2.56	2.12
CaO	4.17	2.23	1.93	1.90	2.20	1.49
MgO	0.87	0.57	0.52	0.45	0.49	0.30
Na_2O	4.13	2.92	2.84	3.09	3.09	2.83
K_2O	1.30	4.36	4.72	4.77	4.42	5.75
TiO_2	0.35	0.56	0.60	0.48	0.63	0.54
P_2O_5	0.10	0.14	0.14	0.10	0.18	0.05
MnO	0.06	0.06	0.06	0.05	0.06	0.07
H_2O	0.61	0.40	0.54	0.41	0.37	0.40
CO_2	0.46	0.26	0.70	0.10	0.10	0.15
TOTAL	99.46	99.95	99.9	99.94	99.90	100.43

Sample Locations
(1) McCann Lake area, 35 km north of Great Island, hypersthene tonalite (2b); UTM 636850 mE, 6566000 mN
(2) McCann Lake, 30 km north of Great Island, hypersthene quartz monzonite (2c); UTM 635900 mE, 6562500 mN
(3) McCann Lake area, 40 km north of Great Island, unit 2C; UTM 631700 mE, 6570000 mN
(4) McCann Lake area, 40 km north of Great Island, unit 2C; UTM 633000 mE, 6569950 mN
(5) McCann Lake area, 40 km north of Great Island, unit 2C; UTM 632500 mE, 6569000 mN
(6)* Kasmere Lake Report (Weber et al, 1975a), unit 2c; UTM 395000 mE, 6540550 mN

variably antiperthitic plagioclase An_{21-30}, quartz and biotite, some hornblende and hypersthene. The hypersthene occurs as fine- to medium-sized grains variably altered to bastite. Chemical analyses are listed in Table 2.

The xenoblastic zones on the other hand contain flaser and augen of potassium feldspar (microcline) which is associated with minor perthitic orthoclase and mesoperthite. The porphyroclasts commonly have a rim of fine grained plagioclase, some microcline and myrmekite; hypersthene is almost completely altered to red-brown bastite, whereas hornblende is well preserved. A younger variety of hornblende is also present at the margins of some plagioclase grains. The xenoblastic texture is attributed to a phase of deformation and recrystallization which has affected the hypersthene-quartz monzonite (2c).

Metadiorite to amphibolite and magnetite-biotite-hornblende schist (3)

These basic rock types are exposed in the south half of the Whiskey Jack Lake map area and in the Shethanei Lake map area south of South Knife Lake. This rock type (3) occurs within a quartz monzonite complex and forms discontinuous zones ranging in size from several km square to bodies 5 km wide and 15 km in length. The areas of magnetite-bearing biotite-hornblende-plagioclase-quartz granoblastites, gneisses and schists coincides with magnetic highs of 2900 to 4500 gammas. Clinopyroxene-bearing less altered metadiorite occurs as zones within the larger areas of metamorphosed basic rocks. These basic rocks are best exposed along the southern shoreline of Whiskey Jack Lake, 12 km south of Whiskey Jack Lake and along the southern extent of the Cochrane River.

The medium- to coarse-grained metadiorite comprises biotite (3%), augite (5-8%), diopside (5%), hornblende (30%), plagioclase An_{28-32} (50%), epidote (3%), sericite and chlorite (2%). The amphibolite is medium- to coarse-grained and comprises hornblende (60-65%), plagioclase (35%) and magnetite (1-2%).

The degree of alteration in the basic rocks is related directly to the intensity of intrusion by aplite and quartz monzonite (31) dykes. The formation of a magnetite + chlorite + hornblende + epidote + plagioclase + microcline schist defines the most intensely altered areas of the basic rocks. Fractures coated by epidote and a bright salmon-orange microcline are common in both the schist and the younger quartz monzonite (31) in the zone of contact metamorphism,

The complex of metamorphosed basic rocks and younger granitic rocks exposed in the south half of the Whiskey Jack Lake area appears to be an extension of the Peter Lake complex mapped to the west in Saskatchewan by Ray (1979; Fig. 4). The basic rocks of the Peter Lake complex in Saskatchewan yield a 2538 ± 38 Ma U/Pb zircon date (Ray and Wanless, 1980) indicating an Archean age. By inference the metabasic rocks in the Whiskey Jack Lake area can tentatively be considered to be Archean. The inference of an Archean age for the metabasic rocks(3) of the Whiskey Jack Lake area is not intended for the metabasic rocks of the South Knife Lake region despite the apparent similarity of these rocks. The age of the metabasic rocks of the South Knife Lake region are to be considered as Aphebian or Archean.

Foliated alaskite ± fayalite (4)

The foliated alaskite occurs as an elliptical stock (4 x 14 km) north of Rutledge Lake and Lezun Lake (Map GR80-9-1). It also forms an inhomogeneous body of alaskite (4) and aplite (31b) which underlies the pelitic gneiss in an apparent fault-bounded contact. This body lies between Minuhik Lake and the Nicklin and Egenolf Lakes regions. Alaskite (4) is in gradational contact with an area of hybrid quartz monzonite (31a). The rocks in this linear belt vary in

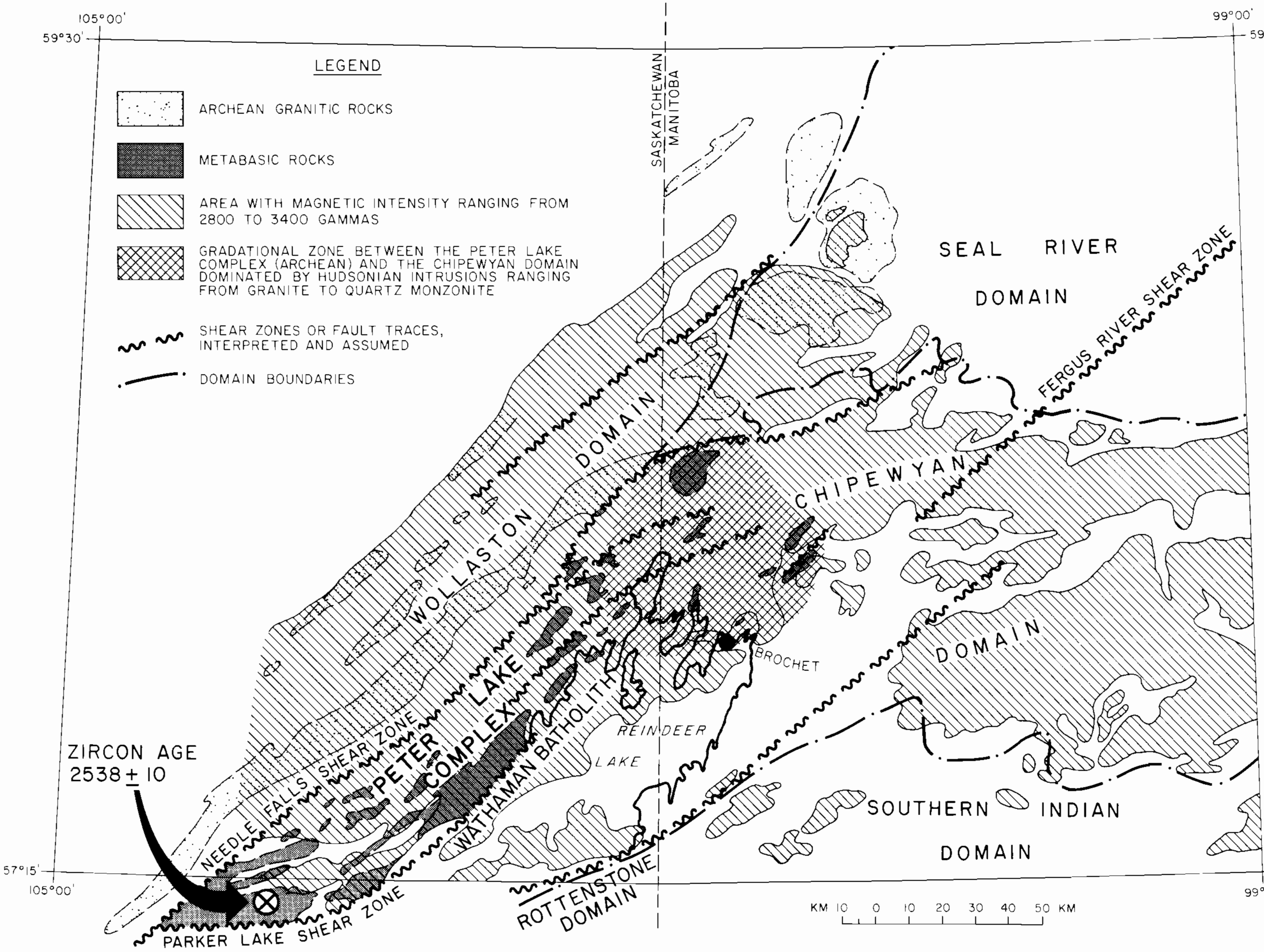


Figure 4: Location of the Peter Lake Complex and extension into Manitoba.

colour from pink to brownish grey to olive-brown. The alaskite gives rise to a ridge topography owing to a closely-spaced sub-horizontal joint set. The rock has a weak to moderate foliation which in part comprises a schistosity defined by sheared-out mafic and oxide minerals within distinct cataclastic foliation planes. This gives rise to a brick and mortar fabric. In addition, a weak gneissosity, parallel to schistosity, is imparted by porphyroblasts of quartz and feldspar drawn out into augen and flasers. The alaskite contains irregular pegmatite bodies, and aplite as irregular thin layers with gradational contacts and dykes with sharp contacts.

The alaskite comprises microperthite or mesoperthite and quartz, minor oligoclase and biotite, and lesser amounts of hornblende, serpentine(?), magnetite and hematite. The quartz has a dark appearance due to the oxide coating on mineral grains. Accessories include zircon, fluorite, monazite and aplite (Appendix). The sporadic occurrence of fayalite was observed in thin section and the observation was confirmed by A. Littlejohn of the Geological Survey of Canada (pers. comm.). Xenomorphic mesoperthite or microperthite is characteristic. In the more strongly foliated pink alaskite the perthite is marginally recrystallized to microcline. Albite, produced by exsolution during recrystallization, appears as rims around oligoclase. Biotite forms planar aggregates which were recrystallized from sheared-out mafic clots. The microscopic texture of the alaskite (4) is xenoblastic inequigranular and represents a cataclastic foliation overprinted by a recrystallization. The primary texture was hypidiomorphic granular and porphyritic. The alaskite plots as a potassium-rich quartz granite (Fig. 5). It is suggested by Weber et al. (1975a) that the alaskite (4) was a hypersolvus granite indicating high temperature crystallization in a dry environment (Tuttle and Bowen, 1958). A close genetic relationship is suggested between alaskite (4) and monzocharnockite (2c) as indicated by the gradational contacts and by petrographic similarities.

Foliated quartz monzonite (5)

This rock type forms a large irregular batholith extending east from Cochrane River for more than 40 km, and about 30 km in a north-south direction between Rutledge Lake and Chipewyan Falls, in the Whiskey Jack Lake map area (Map GR80-9-1). The remaining occurrences are of uncertain areal extent due to poor exposure and to gradational contacts with a rock type of similar composition (unit 31). It appears to form part of the zones of mobilized granitic rocks along the contact of the Chipewyan batholith.

The foliated quartz monzonite is pink on fresh surface and weathers pale pink to white. The principal minerals are microcline (30-35%), plagioclase An_{17-23} (25-55%), quartz (20-40%) and biotite (Appendix). Modes for the three components - plagioclase, potassium feldspar and quartz - are plotted in Figure 6. The rock possesses a cataclastic foliation, which varies from a porphyroclastic structure with relict phenocrysts to a strongly cataclastic foliation containing conspicuous quartz and feldspar augen. In some cases the augen may have been flattened into discontinuous lenses

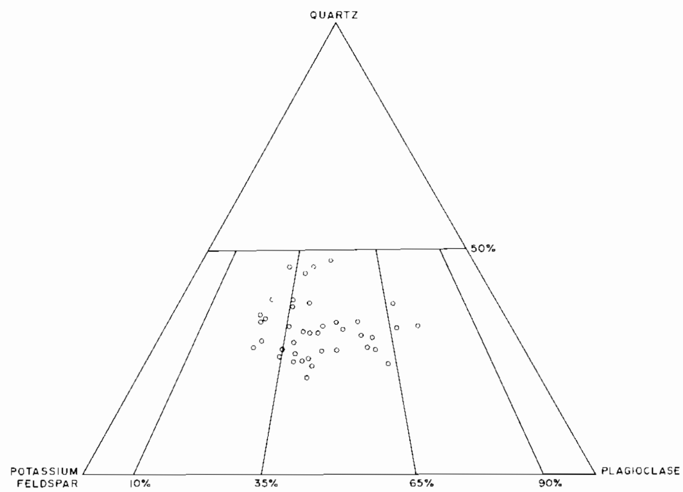


Figure 6: Triangular plot of foliated quartz monzonite (5).

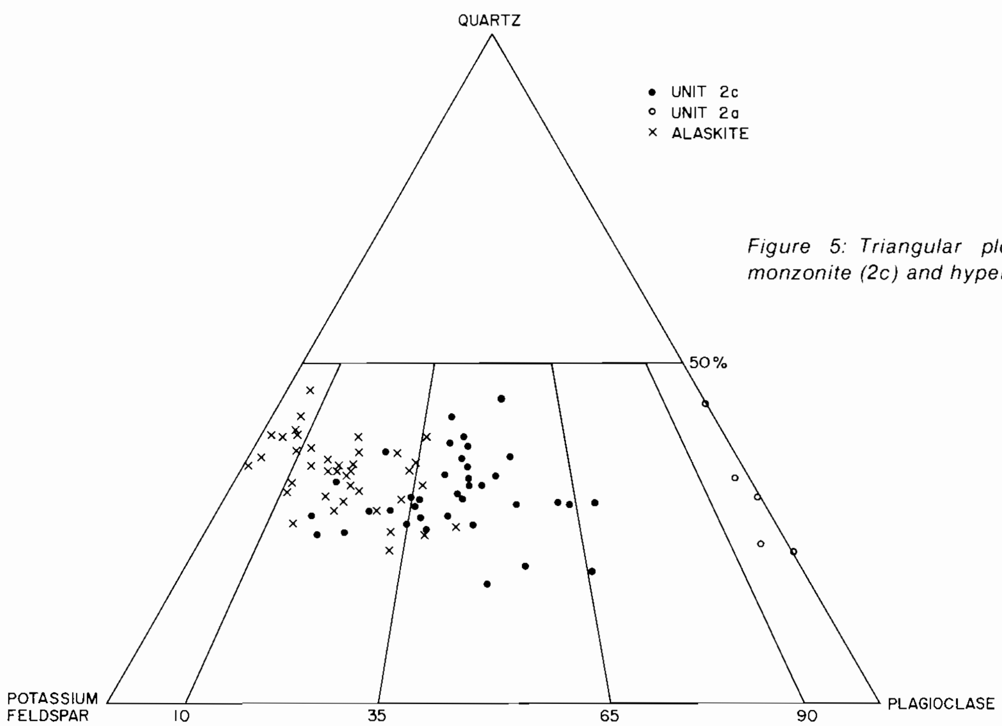


Figure 5: Triangular plot of alaskite (4), hypersthene-quartz monzonite (2c) and hypersthene quartz diorite (2a).

of quartz and feldspar-quartz. Layering is defined by pegmatitic granitic *lits* emplaced into the foliated quartz monzonite. The feldspar porphyroclasts, either microcline or plagioclase (1 - 3 cm long) are aligned in a medium grained groundmass of plagioclase An_{18-20}, microcline, myrmekite and quartz. Microcline and plagioclase porphyroclasts may be rimmed by fine grained plagioclase (An_{18}) and myrmekite but plagioclase porphyroclasts are more commonly rimmed by albite (An_{6-7}) or show a chessboard pattern. Microcline porphyroclasts are perthitic (fine string perthites). Fabric and mineralogy indicate that the foliated quartz monzonite (5), like the alaskite (4), was affected by:

i) a deformational event which led to cataclasis; and
ii) a coeval or younger metamorphic event which caused a recrystallization or partial annealing of the rock.

The foliated quartz monzonite (5) has been dated by a Rb-Sr whole rock isochron which gave an age of 2580 ± 163 Ma (Weber, et al., 1975b). Its age, relative to the surrounding rocks, is difficult to establish since contacts are poorly exposed. Inclusions within the foliated quartz monzonite provide conflicting evidence regarding the radiometric age of the foliated quartz monzonite, relative to the country rocks. Four types of inclusions were observed:

i) layered biotite gneiss + cordierite + garnet;
ii) poorly layered cordierite-quartz-biotite gneiss;
iii) poorly layered hypersthene-cordierite gneiss + sillimanite;
iv) foliated monzocharnockite (unit 2c). Inclusions of the fourth type (unit 2c) were found 16 km south, and 12 - 17 km southwest of Rutledge Lake.

The similarity of the first three types of inclusions to the pelitic gneiss (unit 6) suggests the quartz monzonite may have intruded the pelitic to semi-pelitic gneiss. This interpretation is contradicted, however, by the Hudsonian metamorphic age of the pelitic gneiss as interpreted from a Rb-Sr whole rock isochron age of 1762 ± 60 Ma (Weber et al., 1975b). The apparent contradiction can be resolved by considering the quartz monzonite (5) to be the core of a mantled gneiss dome formed during the Hudsonian orogeny or, alternatively, the pelitic gneiss remnants are inclusions of a metamorphosed Archean sedimentary cover.

SEQUENCE I (Units 6-20)

Sequence I rocks occur as narrow discontinuous belts in the Wollaston, Seal River, Nejanilini and Great Island domains (Fig. 7). The rocks of Sequence I are interpreted to be metasedimentary-derived paragneisses and metatexites. The metavolcanic rocks of the Great Island domain are an exception. Rock types of Sequence I have been mapped in the Kasmere Project area (Weber et al., 1975a). The north half of the Whiskey Jack Lake area from latitudes 58° 30' to 59°, formed the southern extent of the Kasmere Project. The map of Whiskey Jack Lake (Map GR80-9-1) from latitudes 58° to 59° has been published incorporating data from the Kasmere Project and information gathered as part of the present project. The map units are consistent with the legend adopted for the present Cochrane and Seal River Project area.

Semi-pelitic paragneiss to metatexite (6)

Semi-pelitic biotite gneiss occurs as a basal unit of the Sequence I rocks within the Wollaston domain (Fig. 7) extending from Whiskey Jack Lake to Nueltin Lake. It extends from Nueltin Lake eastwards into the Nejanilini domain. This rock type (6) is present in the western part of the Seal River domain and extends from Chatwin Lake to Stony Lake. However, it becomes more quartzofeldspathic and is interlayered with semi-pelitic paragneiss to schist and interlayered impure quartzite (6a) in the east half of the Seal River domain. Areas underlain by these rocks coincide with areas of low magnetic intensity (2000 - 2200 gammas). For the most part the gneiss shows a well developed metamorphic layering due to alternating grey to dark grey biotite-rich layers (1 - 50 cm thick) and white to cream coloured, medium- to coarse-grained granitic *lits* 1 - 10 cm thick. Layers of pale green calc-silicate rock (1 - 5 cm thick) and pale, grey, impure quartzite, 1 mm to several metres thick, are of sporadic occurrence. Granitic material comprises between 30 - 60 per cent of the rocks. The granitic *lits* and the pegmatitic sills and veins were most likely derived from the semi-pelitic gneiss by partial anatexis.

The principal minerals of the biotite-rich layers are quartz, plagioclase (An_{25-28}), biotite and potassium feldspar (microcline). Both cordierite and garnet are common whereas sillimanite is a minor component occurring typically as fibrolite inclusions in cordierite, and also as flaser-like matted and fibrous aggregates. The texture of the biotite-rich layers in general is an augen to incipient augen texture. The augen comprise biotite and plagioclase aggregates and lenticular cordierite and garnet. Poikiloblastic microcline has a silvery or brilliant white lustre and may be ovoid to subangular in shape. The subangular-shaped porphyroblasts lie athwart the foliation indicating that potassium feldspar blastesis was late-kinematic to post-kinematic.

A hypersthene- cordierite-bearing variety of the semi-pelitic gneiss occurs in the Nejanilini domain in a zone extending from the northeast end of Nejanilini Lake eastward to Commonwealth Lake. The texture of this rock type is medium grained xenoblastic with augen to incipient augen texture. The schistosity is defined by the parallel alignment of biotite and augen of feldspar. The feldspar augen (mesoperthite) have rims of very fine- to fine-grained plagioclase, quartz and biotite. Myrmekite intergrowths of quartz, plagioclase and biotite occur commonly along the contact between hypersthene and the feldspar augen. This indicates a phase of recrystallization postdating the cataclastic foliation. Hypersthene, although rare, forms medium sized grains and is commonly intergrown with cordierite.

The principal minerals in the white granitic *lits* in the pegmatitic sills and veins are quartz and feldspar, the latter comprising highly variable proportions of plagioclase and potassium feldspar. The plagioclase is oligoclase An_{24-28} and the potassium feldspar is microperthitic microcline. The texture is hypidiomorphic granular. Variable amounts of biotite, cordierite, garnet and black tourmaline (dravite) are present. Hypersthene is a rare constituent and occurs in the Nejanilini domain in the area of Commonwealth Lake, east of Nejanilini Lake. A series of occurrences also lies within the semi-pelitic paragneiss to metatexite (6) within the northwest corner of the Whiskey Jack Lake map area (Map GR80-9-1). These are described in the Kasmere report (Weber et al., 1975a). Hypersthene is idioblastic and is commonly intergrown with biotite and cordierite. Both the Nejanilini Lake and Whiskey Jack Lake occurrences are underlain by hypersthene-bearing granitic rocks or Archean granitic rocks.

Garnet

Garnets are deep red and occur in both the biotite-rich layers and mobilizate fractions of the gneiss. Some garnets contain inclusions of cordierite, quartz and fibrolite. The inclusions in general are elongated parallel to the long axis of the garnet indicating para-crystalline deformation of the garnet during the development of the foliation. Garnet also occurs as late-kinematic idioblastic grains. It also forms large aggregates of garnet and quartz 2 to 5 cm in diameter with a sieve structure.

Cordierite

The principal types are bluish-grey, lenticular porphyroblasts or dark blue to pale milky olive-green idioblastic grains. The bluish-grey variety occurs within the biotite-rich layers and contains sillimanite fibres which are strung out parallel to the elongation direction of the cordierite augen. These porphyroclasts are bordered by fine grained plagioclase and quartz. The second variety of cordierite occurred within the mobilizate or within small quartzo-feldspathic segregations within the biotite-rich layers. The milky

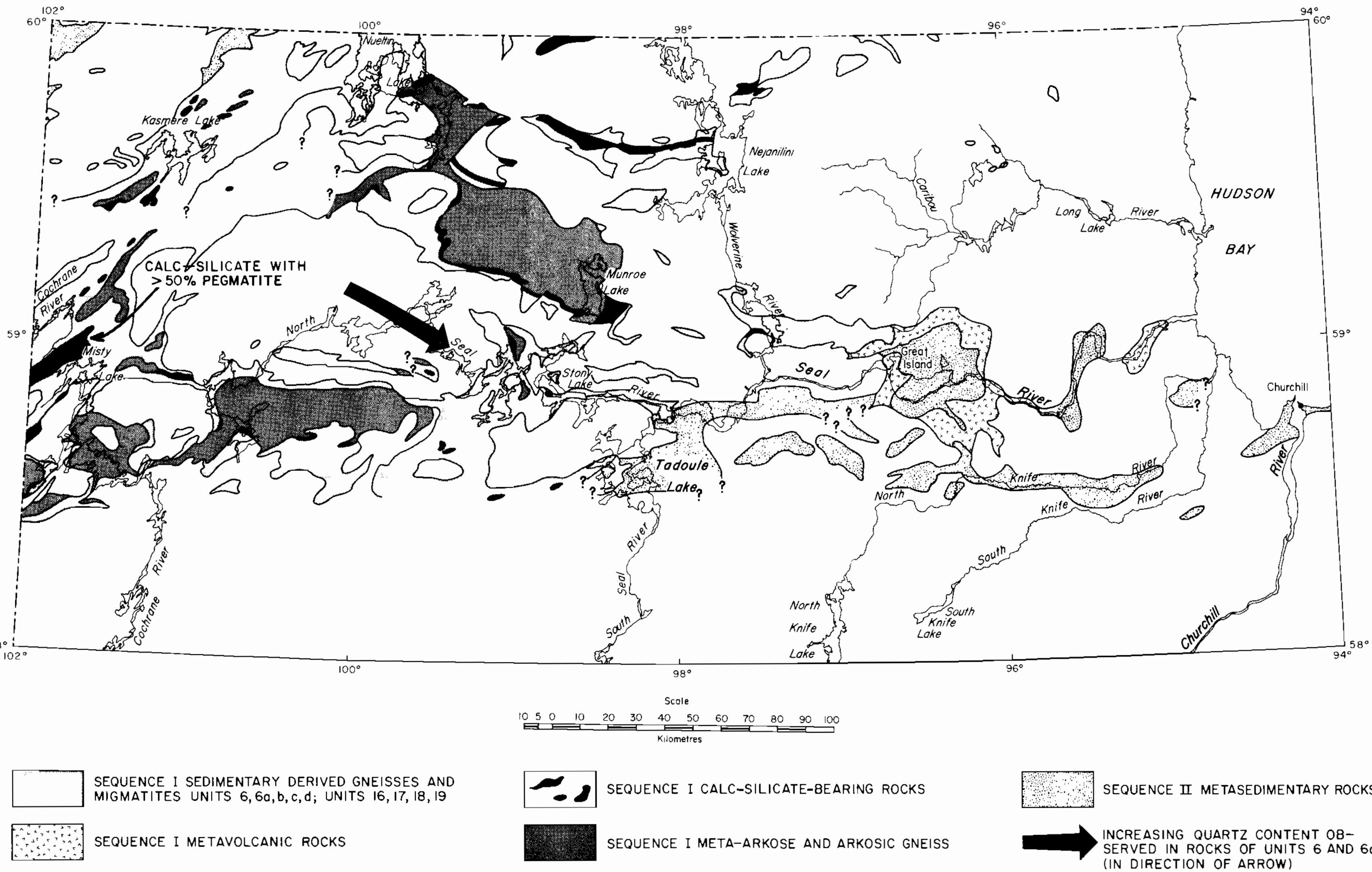


Figure 7: Distribution of Sequence I and Sequence II lithologies.

olive-green coloration is due to late stage pinitization. The grain size varies from medium- to coarse-grained. It also occurs as web or sieve-like intergrowths with quartz and microcline. These intergrowths range in size from 2 to 6 cm and are irregular in shape. They represent a late kinematic recrystallization.

Sillimanite

The sillimanite forms lenses of densely matted optically parallel needles intergrown with quartz. These lenses are contained within the biotite-rich layers. However, they can also occur in the quartzofeldspathic layers as smeared-out sheets with a silky lustre. The sillimanite sheets in the quartzofeldspathic setting may represent metamorphosed shear zones. These shear zones in many cases are parallel to the youngest axial planar foliation.

The sillimanite also forms loose aggregates of very fine fibrolite, with some large needles which occur mainly within cordierite and quartz or within quartz. The fibrolite inclusions within cordierite are oriented parallel to the external foliation or oblique to it. In crenulated layers fibrolite is often axial planar, suggesting recrystallization during the latest observed period of folding.

Andalusite

Andalusite was observed in two widely separated localities. One set of occurrences is in the northeast corner of the Whiskey Jack Lake map area (Map GR80-9-1), and the other northwest of Great Island in the area of Cavaghan Lake (Map GR80-9-6).

Andalusite occurs as fine- to medium-grained idioblastic crystals in the cores of biotite aggregates and with anhedral biotite.

In the first occurrence, andalusite displays coronas of acicular sillimanite. In places contacts between the two minerals are myrmekitic. However, andalusite in the rocks of the northwest occurrence near Great Island displays slightly different relationships. Andalusite still occurs as idioblastic grains in biotite. The biotite displays a change to pale green from fox-red, but the change is gradational and variable. Sillimanite in the Great Island occurrence forms needles and fibrolite in cordierite and very rarely co-exists with andalusite. Rarely, the sillimanite needles project across biotite-cordierite grain boundaries and are in contact with andalusite. Andalusite only rarely contacts cordierite and never forms inclusions in cordierite.

Semi-pelitic paragneiss to schist and interlayered impure quartzite (6a)

This rock type occurs in the south half of the project area and is most prominently developed east of Fergus River extending to Shethanei Lake. It is considered to be a lateral facies equivalent to the basal unit of the pelitic to semi-pelitic gneiss (6). A lithologic change is defined by the greater quartz content in the semi-pelitic gneiss to the east and also in the volume of interlayered quartzite (6b).

The rock has a distinct layered appearance on the weathered surface with the biotite-rich layers weathering deeply. The rock comprises biotite-rich quartzofeldspathic laminations and interlayered medium grained buff to grey biotite-quartzite to biotite-feldspathic quartzite. Buff to pink quartzofeldspathic *lits* are also very common.

The relative amount of each of the components varies but the quartzofeldspathic layers are from 2 cm to 1 m thick. The pelitic laminations contain lenticular porphyroblasts of grey-blue cordierite that contain fibrolite and lenticular aggregates of sillimanite and quartz + cordierite + muscovite. Garnet is a rare constituent. The quartzite to quartzitic to quartzofeldspathic layers have a more variable character and can comprise dense biotite-quartzite to more inequigranular buff biotite + cordierite-feldspar-quartz layers. The feldspar comprises perthitic microcline + plagioclase An_{20-24} constituting from 10 - 20 per cent of the layer. Biotite is fine- to medium-grained and aligned parallel and/or oblique to the compositional layering. Sieve-like quartzofeldspathic aggregations containing translucent honey-coloured to blue cordierite are present in the quartzofeldspathic layers. These segregations have a corona and a framework of feldspar (microcline) and quartz.

The quartzofeldspathic buff to pink granitic *lits* are similar in appearance to the granite that occurs in the previously mentioned quartzo-feldspathic segregations. The *lits* are buff to pink, massive, and medium grained to pegmatitic. Accessory minerals are cordierite, minor tourmaline and rare garnet.

Impure quartzite to quartzite (6b)

A wide range of quartzites and impure quartzites have been grouped into unit 6b in order to simplify mapping. These lithologies are locally impersistent and have a broad regional extent and varied position in the basal section of Sequence I rocks. Unit 6b occurs in three principal areas:

i) the northwest corner of the Whiskey Jack Lake map area (Map GR80-9-1);
ii) the west halves of the Munroe Lake and Tadoule Lake map areas (Maps GR80-9-7 and GR80-9-2);
iii) the northeast corner of the Munroe Lake and the northwest corner of the Nejanilini Lake map area (Maps GR80-9-7 and GR80-9-6), respectively.

In the Whiskey Jack Lake map area the quartzite is a 'glassy' quartzite outcropping south of Paulson Lake. The quartzite (6b) was originally Map Unit 7 of the Kasmere Project. This rock type weathers white and is frosted to vitreous on the fresh surface. The rock has a cataclastic texture, defined by a fractured mosaic of subrounded to subangular quartz clasts ranging from coarse to pebble size (0.5 - 3 cm). Quartz makes up 95 - 99 per cent of the rock and hematite is an accessory. The quartzite overlies a complex of quartz monzonite (5) of Archean age and a quartz monzonite (31) of Hudsonian age. Contacts with these rocks were not observed.

In the west halves of the Munroe and Tadoule Lake map area, the quartzite forms thick, massive beds of medium grained grey biotite-bearing quartzite. It comprises quartz grains with sutured boundaries of interstitial plagioclase (10%), and olive-green biotite (5%). Magnetite is a variable accessory. In the Nueltin Lake region of the Munroe Lake map area (Map GR80-9-7) the quartzite is interlayered with pelitic gneiss (6). In the Tadoule Lake map area at the west end of Wilkie Lake the quartzite is interlayered with semi-pelitic paragneiss to schist (6a).

The third zone containing quartzite (6b) is in the northeast quarter of the Munroe Lake area and the northwest corner of the Nejanilini Lake area. The occurrences are at Askey Lake, Nejanilini Lake and an area 49 km east of Nejanilini Lake. The quartzite at Askey Lake and Nejanilini Lake is a white weathering sillimanite-bearing quartzite. It is massive and thickly bedded. The rock has a fracture cleavage and a sporadic foliation. Sillimanite is concentrated along these foliation planes. At these localities the quartzite is interlayered with the semi-pelitic gneiss (6a). It occurs, apparently, at the base of the semi-pelitic gneiss overlying granitic rocks and as layers within the pelitic gneiss. It is uncertain whether these relationships reflect a primary stratigraphic succession or whether faulting has produced the succession observed. A gradational contact between the quartzite and the base of the overlying calc-silicate at the west end of Askey Lake indicates the quartzite (6b) at this locality was deposited at the top of the pelitic gneiss. However, the nature of the contact relationships elsewhere between the pelitic gneiss (6) and quartzite (6b) are unknown.

The most easterly occurrence of the quartzite, 49 km east of Nejanilini Lake, contains accessory cordierite and sillimanite, biotite (3 - 5%) and quartz. The rock is a honey brown on both the weathered and fresh surface due to the pinitization of cordierite. The biotite is disseminated or occurs as widely spaced thin (0.5 mm) biotite laminations. This quartzite overlies Archean granitoid rocks.

Augen gneiss (6c)

The principal occurrence of augen gneiss (6c) is near Misty Lake in the Whiskey Jack Lake map area (Map GR80-9-1). It was previously named Map Unit 7b of the Kasmere Project. Mapping to the east, in the Tadoule Lake map area, has identified several more outcroppings of augen gneiss (6c); however, occurrences are too small to be depicted at the present scale of mapping. The rock outcrops in a zone between Clifton Lake and Belsham Lake and along North Seal River between Stony Lake and Shethanei Lake. The augen gneiss north of Clifton Lake contains small remnants of segmented layers of impure quartzite (Fig. 8).

The outcrops have a spotted appearance with buff to silvery white feldspar augen. The augen are flattened in the plane of schistosity. The principal minerals are microcline (45 - 50%), quartz (25 - 30%), biotite (20 - 25%), cordierite (0 - 5%), plagioclase (0 - 5%), and muscovite (0 - 5%). The rock possesses a cataclastic fabric in which the biotite laminae are wrapped around the poikiloblastic augen rimmed by quartz, feldspar and muscovite. Muscovite also occurs as ragged sheaves in shears that cut across microcline porphyroblasts. Near Misty Lake large rare composite feldspar-cordierite crystals contain a plagioclase core (An_{57}), rimmed by microcline, mesoperthite, perthite, orthoclase, and plagioclase.

Biotite-feldspar gneiss with granodiorite *lits* (6d)

This rock type occurs at the northwest end of Great Island along the Big Spruce River and at Spruce Lake. It occurs as inclusions within the pink quartz monzonite (31) and the quartz porphyry (14). It also interfingers with the metavolcanic rocks (7a and 7b) to the east and metasedimentary derived paragneisses and metatexite rocks to the west (6 and 6b).

The biotite gneiss (6d) contains biotite (15%), microcline, plagioclase and quartz. Trains of biotite give the rock a linear fabric rather than a planar foliation.

Buff, fine- to medium-grained monzonite to tonalite *lits* are common. At some outcrops the *lits* are attenuated, boudinaged and rolled, giving the rock the appearance of a conglomerate. The granitic *lits* which intrude Unit 6d at Spruce Lake also intrude metavolcanic rocks (7b) further to the east in the area north of Meades Lake.

VOLCANIC ROCKS, INTERLAYERED METASEDIMENTARY AND EPICLASTIC ROCKS, AND RELATED INTRUSIVE ROCKS (Units 7 to 14).

Rocks of the volcanic suite outcrop in the Great Island domain at Great Island as a belt (30 by 10 km) and on the Lower Seal River 66 km downstream.

The Lower Seal River rocks comprise in part pillowed andesitic flows (7a). A grey rhyodacite (7d) lens occurs in the south-central part of the belt. The southern and western outer zone (3 to 5 km wide) comprise an interlayered sequence of massive andesite and intermediate andesite and intermediate to basic tuffaceous rocks consisting of pale buff to green plagioclase-rich layers and black amphibole-rich layers (1 - 20 mm thick). A magnetic high on the Federal-Provincial aeromagnetic maps (Maps 7144 and 7148G) suggests the presence of a gabbro stock in the central region of the Seal River volcanic belt. These rocks have been intruded by a granodiorite and porphyritic quartz diorite (10).

The Great Island volcanic suite underlies the Sequence II Great Island Group at Great Island. The volcanic rocks form the lower part of a structural basin which is 30 km wide, from west to east, and 50 km long from north to south. The Great Island volcanic suite comprises:

i) andesite, partly pillowed (7a) or massive;
ii) interlayered tuffaceous rocks and andesite (7b);
iii) interlayered tuffaceous rocks, lapilli tuff and siliceous metasedimentary rocks (7c);
iv) rhyolite to rhyodacite (7d);
v) conglomerates (9a and 9b);

These rocks have been intruded by stocks of quartz-feldspar porphyry (13) and gabbro (11).

Andesite to basalt (7a)

The medium- to fine-grained andesite flows occur mainly at the east and southeast edge of the basin at Great Island. The fresh dark olive-green andesite weathers dark green and can be massive to pillowed and vesicular. The grain size is coarser and the definition of plagioclase and amphibole becomes marked or well defined in the contact zones between the andesite and both the younger quartz

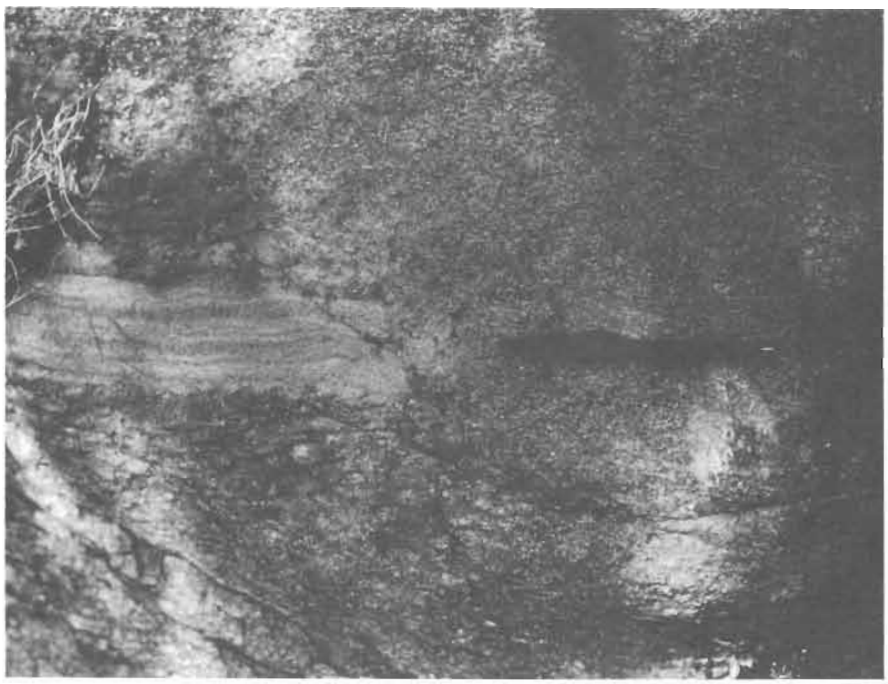


Figure 8: Augen gneiss (6c) with relict layering.

monzonite (31) north of Great Island and the porphyritic quartz diorite (10) in the occurrence 66 km east of Great Island.

The andesite comprises a felted mass of actinolite, chlorite (70 - 74%) and cryptocrystalline to very fine grained laths of plagioclase An_{24-31} (10 - 25%). Secondary epidote and calcite form irregular zones within plagioclase and also occur as fillings in thin veinlets. Pyrite is a minor accessory in the area of the carbonate veins and trace malachite was also noted.

The pillows have a selvage of fine- to medium-grained biotite and microlites(?). The pillows are zoned with an outer and dense fine grained margin containing small disseminated vesicles. Within the dense zone or layer tubular structures are connected to vesicles. Some of the "tubes" extend to the selvage boundary. The minerals in the vesicles and tubular structures are mainly cryptocrystalline plagioclase, quartz, very fine grained calcite, biotite, and minor epidote. Superimposed on this pillow structure is a secondary tectonic fabric defined by the weak alignment of biotite and feldspar laths.

The massive andesite is locally interlayered with pillowed andesite. The thickest zone of massive andesite outcrops 15 km east of Great Island along Seal River. The flow is highly brecciated in places.

The rock is dark green and has a dense felty texture with 10 - 15 per cent infilled vesicles and (10 - 15%) fine grained plagioclase laths. The vesicles contain epidote, clinozoisite, biotite, actinolite and quartz. Coronas of a mineraloid are common in the infilled vesicles. This mineraloid also forms discontinuous anastomosing trains in the matrix.

The plagioclase laths range in size from 0.01 by 0.15 mm to 0.5 by 0.75 mm. The plagioclase laths contain quartz segregations and actinolite(?) needles. The matrix is a felty mass of plagioclase and uralite. Where the felty mass is more coarsely recrystallized actinolite, olive-brown biotite and plagioclase are identifiable. Chlorite and the brown mineraloid are also disseminated in the groundmass. Carbonate forms veins and small laths in the immediate area of the veins. Randomly collected samples (listed in Table 3), range from andesite, with higher than normal Al, Ca and Na to locally more basic flow material of basalt (tholeiitic) to high Al basalt composition. However, the high calcium values and the high ferrous to ferric iron ratio indicate the rocks have been altered.

Interlayered tuff and pillowed andesite (7b)

This rock type occurs around the north edge of the Great Island basin and along the western edge of the Seal River volcanic belt 45 km east of Great Island.

The andesite is as described for Unit 7a. The tuffaceous interlayers comprise alternating dark green layers and pale green layers. The dark green layers comprise actinolite and stubby fine grained hornblende grains. Very fine grained plagioclase and quartz are interstitial. The dark green layers comprise very fine- to fine-grained altered plagioclase, chlorite and disseminated actinolite and epidote. Where the tuffaceous rocks are intruded by the porphyritic quartz diorite (10) contact metamorphism has altered the rock to medium grained amphibolite and interlayered medium grained pale green diopside-epidote-plagioclase layers.

An alteration zone with a unique mineral assemblage lies in a contact zone between the tuffaceous material of Unit 7b and underlying lens of rhyolite to rhyodacite. The lens of rhyolite is only poorly exposed at the base of a steep cliff. This occurrence lies 7 km northeast of Wolochatiuk Lake (Location S-25, Map GR-80-9-13). The alteration zone material is a dark grey rock cut by numerous quartz and carbonate veins that sporadically contain black

TABLE 3: CHEMICAL ANALYSES OF ANDESITE AND BASALT (7a) AND GABBRO (11)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	A	B	C	D
SiO_2	61.15	61.05	55.75	60.75	51.65	49.45	50.1	54.85	51.10	58.65	60.0	53.8	49.15
Al_2O_3	15.00	15.25	18.15	14.30	14.55	12.65	15.7	14.5	16.65	17.43	16.0	13.9	17.73
Fe_2O_3	1.03	1.83	1.01	0.75	1.30	3.69	0.93	1.20	2.00	3.21	1.89	2.6	2.76
FeO	4.45	4.04	5.14	5.20	8.53	12.01	7.57	8.06	6.29	3.48	6.20	9.3	7.20
CaO	6.30	5.73	6.21	8.10	13.30	8.55	12.12	7.20	8.58	6.26	5.87	7.90	9.91
MgO	4.94	4.79	4.02	4.35	6.94	4.28	9.35	6.40	7.05	3.28	3.90	4.10	6.91
Na_2O	5.04	3.20	5.53	4.55	1.23	2.41	1.38	2.20	3.32	3.82	3.85	3.0	2.88
K_2O	0.18	1.98	1.05	0.15	0.21	0.95	0.14	1.99	1.70	1.99	0.87	1.5	0.72
TiO_2	0.61	0.64	1.34	0.60	0.65	3.27	0.36	1.02	0.95	0.79	1.04	2.0	1.52
P_2O_5	0.20	0.16	0.12	0.06	0.29	0.47	0.02	0.24	0.25	0.18	0.23	0.4	0.26
MnO	0.11	0.10	0.17	0.13	0.24	0.23	0.16	0.14	0.19	0.10	0.16	0.2	0.14
H_2O	0.80	1.15	1.42	0.75	1.22	1.52	1.99	1.63	1.41				
CO_2	0.20	0.02	0.19	0.12	0.51	0.08	0.07	0.15	0.16				
TOTAL	100.01	99.95	100.10	99.81	100.62	99.55	99.9	99.6	99.65				

Sample Locations

(1) North of Great Island, andesite (7a); UTM 649500 mE, 6553150 mN
(2) North of Great Island, andesite (7a); UTM 655000 mE, 6554375 mN
(3) 58 km east of Great Island, andesite (7a); UTM 376990 mE, 6541850 mN
(4) 58 km east of Great Island, andesite (7a); UTM 374750, 6543370 mN
(5) 58 km east of Great Island, basalt (7a); UTM 378260 mE, 6543370 mN
(6) Nichol Lake, 25 km south of Great Island, gabbro (11); UTM 660125 mE, 6505175 mN
(7) North of Great Island, gabbro (11); UTM 665200 mE, 6546475 mN
(8) 15 km east of Great Island, basalt (7a); UTM 666775 mE, 6529475 mN
(9) North of Great Island, basalt (7a); UTM 657700 mE, 6558200 mN

Comparative Analyses after Irvine and Baragar (1971)

Calc-Alkali Series:

A - High-alumina andesite
B - Andesite
C - Tholeiite
D - High-alumina Basalt

tourmaline. The rock contains sericite to fine grained muscovite, fine grained plagioclase, quartz and biotite. The sericite occurs in discontinuous ragged lenticular layers whereas the muscovite is disseminated in the groundmass of plagioclase and quartz. The biotite occurs as disseminated very fine grained elliptical aggregates and is concentrated in a fracture pattern. Tourmaline also occurs in the fracture pattern. The biotite is fox-red but is altered to an olive-green in the area of the quartz veins.

Quartz occurs as:

i) ellipsoidal to sygmoidal fine- to medium-sized grains with coronas of biotite; and

ii) as discontinuous layers or tectonized quartz veins.

Within the quartz-rich layers the quartz forms laths and irregular angular fragments which give the appearance of a microbreccia. The interstitial material is mainly sericite. Tourmaline is also present in these quartz layers.

The alteration zone outcrops in a zone over which an isolated airborne electromagnetic anomaly was detected. The survey was conducted by Jellicoe Mines Ltd. in 1957. This alteration zone also lies on the eastern flank of a geochemical arsenic anomaly outlined by a lake bottom (centre) sediment survey (Map GR80-9-13).

Intermediate tuff, lapilli tuff and interlayered siliceous metasedimentary rocks (7c)

These rocks outcrop at the west end of Great Island, in a narrow zone along Seal River east of Great Island and in a large area south of Great Island.

The lapilli tuff is most abundant at the west end of Great Island and in the narrow zone along Seal River. In this area the lapilli tuff makes up 90 per cent of Unit 7c. The intermediate tuff and interlayered siliceous metasedimentary rocks are most abundant south of Great Island from the southwest end of Great Island to the Dechanhooledezay River.

The lapilli tuffs are grey to dark grey with a fine grained dense matrix containing clasts of intermediate to acid composition. The clasts or lapilli range from 2 - 5 cm in length, 5 mm to 1 cm in width and 2 to 5 mm in thickness. The clasts comprise disseminated brown biotite (3%), fine grained to locally medium grained aggregates of quartz (20 - 35%), and fine grained microcline and plagioclase (65 - 75%). Clasts of more intermediate composition are present but not as common as the more acid buff coloured variety. The more mafic clasts weather deeply and comprise very fine- to fine-grained olive-green biotite, and very fine grained microcline (60 - 70%). Accessory minerals are magnetite (1 - 3%) and zircon (0.5%). The clasts or lapilli make up from 5 - 12 per cent of the rock. The matrix is very fine grained and comprises disseminated biotite (3 - 10%), fine grained actinolite (5 - 7%), quartz (15 - 25%) and plagioclase (60 - 75%).

The rock is well foliated and the disseminated biotite and actinolite are aligned. Sporadically, the biotite forms discrete laminae in zones of incipient cataclasis. The degree of layer thinning and deformation in the Great Island region is well displayed in the narrow belt of Unit 7c along Seal River east of Great Island. Here granite pegmatite sills or veins have been boudinaged and then subsequently rolled indicating a complex deformational history for the rocks in the Great Island basin.

The cryptocrystalline to very fine grained dense tuffaceous rocks and interlayered metasedimentary rocks of Unit 7c predominate in the area south of Great Island. On rare lichen-free weathered surfaces fragmented tectonized layers are visible due to differential weathering and resultant colour banding. On the fresh surface the rock appears to be a dense grey rock of almost uniform composition. Thin beds of light to dark grey meta-argillite and biotite-quartz metasiltstone are interlayered with the tuffaceous rocks. The proportion of metasediment to tuff cannot always be determined from the lichen-covered outcrops. Deformation and accompanying recrystallization have produced a complex system of S-surfaces identified in thin section examination. As many as four surfaces can often be identified from the crystallization and recrystallization of minerals such as biotite and actinolite either along discrete planes or as realigned disseminated grains. Primary layering in general is highly disrupted either by conjugate joint and shear sets, zones of cataclasis, mylonitization and silicification. Isoclinal folding has resulted in over-tightened minor folds with detached fold noses.

The dense thin to thick bedded tuffaceous rocks comprise cryptocrystalline to very fine grained plagioclase and microcline (60%), with a layering defined by variations in concentration of olive-green biotite. Actinolite (0 - 8%) is generally disseminated and very commonly formed in the latter stages of recrystallization as crystals aligned parallel to the youngest S-surface or with an apparent random growth pattern. Accessory minerals are chlorite (ripidolite), muscovite and apatite.

The thickest zone of the volcanic-derived metasedimentary rocks outcrop along the south shore of Omand Lake 7.5 km south of Great Island. The zone appears to have a minimum thickness of 100 metres. The meta-argillite comprises biotite (25 - 30%) and very fine grained feldspar and quartz. Garnet and stubby acicular actinolite are sporadic in occurrence. The metasiltstone, with 5 - 10 per cent biotite and minor muscovite disseminated in a groundmass of quartz, forms beds 5 mm to 2 cm thick.

Rhyolite to rhyodacite (7d)

These more acid volcanic rocks outcrop southeast and east of Great Island and also in the south-central zone of the belt of volcanic rocks along Seal River 66 km east of Great Island.

To the southeast of Great Island the rocks best fit rhyolite to rhyodacite in chemical composition (Table 4). Along the east side of Great Island the rocks are high in potassium, sodium and silica. In the lens-shaped zone along Seal River, 66 km east of Great Island, analysis best fits a rhyodacite.

The rhyolitic to rhyodacitic rocks are buff to cream on the weathered surface and grey-green to pinkish grey on a fresh surface. Quartz phenocrysts are common in the rhyolite whereas feldspar phenocrysts are rare. In the rocks of rhyodacitic composition, feldspar phenocrysts are common with sporadic occurrences of tiny clots or lenticular aggregates of very fine grained biotite and minor actinolite.

The more alkaline siliceous extrusive rocks that occur along the eastern margin of Great Island north of Seal River are dense, siliceous and pale green in colour. South of Seal River these dense rocks are interlayered with thinly layered crystal tuffs. The crystal tuff has the composition of a high sodium comendite glass. The rocks have a well developed cleavage and layering is crenulated about these cleavage planes. Sulphides occur as trace accessory minerals. Arsenopyrite was observed at one locality 4 km north of the Seal River (S-16, GR80-9-13). The mineralogy comprises very fine grained quartz (35%), sericitized microcline (50 - 55%), biotite and chlorite intergrowths (3%), and plagioclase (1 - 5%). Accessory minerals are muscovite and actinolite.

Amphibolite (8)

The amphibolite (8) outcrops at the northwest end of Great Island along Big Spruce River and also along the northwest edge of the metavolcanic rocks north of Spruce Lake. The occurrences along the Spruce River are the product of regional metamorphism where the quartz monzonite (31) intrudes the metavolcanic rocks.

The amphibolite is layered to massive and weathers reddish-brown to black. The rock comprises hornblende (50 - 55%), biotite (8 - 10%), diopside (2 - 10%), and plagioclase An_{27-32} (30%). The diopside occurs as wispy lenses or thin pale olive-green layers with plagioclase.

The occurrences along and west of the Big Spruce River indicate an increase in the degree of deformation and metamorphism from east to west. The amphibolite is interlayered with pelitic

TABLE 4: CHEMICAL ANALYSES OF INTERMEDIATE TUFFS (7b, 7c) RHYODACITE (7d)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	A	B
SiO_2	71.85	73.40	71.80	73.75	65.45	67.45	76.05	76.75	69.68	73.23
Al_2O_3	14.35	12.75	15.30	11.95	17.85	15.24	12.15	12.05	15.21	14.03
Fe_2O_3	0.52	0.84	0.97	1.09	1.19	0.94	1.5	1.08	1.08	0.60
FeO	1.84	3.25	0.99	3.15	1.59	1.94	0.92	0.62	1.90	1.70
CaO	4.01	0.27	1.08	1.31	2.04	2.10	0.41	0.62	2.70	1.32
MgO	0.66	0.37	0.59	0.40	1.34	0.67	0.13	0.10	0.91	0.35
Na_2O	0.58	3.43	3.82	3.01	5.35	0.54	3.73	3.68	4.47	3.94
K_2O	4.84	4.02	3.77	2.94	2.56	9.10	4.38	4.52	3.01	4.08
TiO_2	0.19	0.34	0.22	0.39	0.41	0.35	0.17	0.13	0.36	0.24
P_2O_5	0.07	0.06	0.08	0.09	0.22	0.09	0.01	0.00	0.10	0.05
MnO	0.04	0.05	0.03	0.08	0.09	0.07	0.03	0.02	0.04	0.02
H_2O	0.61	0.72	0.80	0.91	1.04	0.85	0.43	0.38	—	—
CO_2	0.75	0.10	0.24	0.54	0.46	0.78	0.17	0.19	—	—
TOTAL	100.31	99.60	99.69	99.61	99.59	100.12	100.15	100.15	—	—

Sample Locations
(1) North of Great Island, rhyodacite (7d); UTM 654900 mE, 6552650 mN
(2) Great Island, intermediate tuff (7c); UTM 635350 mE, 6537950 mN
(3) North of Great Island, intermediate tuff (7b); UTM 654850 mE, 6553700 mN
(4) Southeast of Great Island, intermediate tuff (7b); UTM 666250 mE, 6519000 mN
(5) Southeast of Great Island, rhyodacite (7d); UTM 661750 mE, 6515600 mN
(6) 58 km east of Great Island, rhyodacite (7d); UTM 374450 mE, 6535650 mN
(7) Omand Lake, south of Great Island, feldspar porphyry (13); UTM 646150 mE, 6517650 mN
(8) Omand Lake, feldspar porphyry (13); UTM 646150 mE, 6517100 mN

Comparative Analyses after Irvine and Baragar (1971)

A - Dacite
B - Rhyolite

schist (6), impure quartzite (6b), and biotite gneiss (6d) near the base of Sequence I. East of Big Spruce River, the amphibolite exhibits relict pillow structures whereas further to the west primary structures are lost in the more highly deformed and foliated amphibolite. The amphibolite also weathers to a bright orange soil in this area due to rapid oxidation of an extensively sheared zone in which pyrite and pyrrhotite are more abundant.

Conglomerate (volcanic derived) (9a)

This conglomerate lies north of Wolochatiuk Lake on the north-central edge of the Great Island volcanic belt. The rock is well exposed on the lake shore but inland exposures are heavily overgrown by lichen which almost totally obscures the nature of the rock. A clean weathered surface reveals clasts which range in size from pebbles to cobbles; however, on a fresh surface the clasts are difficult to define.

The rock is well foliated and the clasts are flattened and lineated in the plane of foliation. The length: width: thickness ratio is 8:4:1. The percentage of clasts estimated from the weathered surface is 40 - 50 per cent. Clasts of intermediate to more andesitic composition make up 15 - 20 per cent and felsic clasts 75 - 80 per cent.

Some of the clasts are zoned and have an outer ring of biotite or a more complex outer rim of quartz and biotite with a thin inner layer of biotite. The core of these clasts is dense and quartzofeldspathic.

The matrix comprises very fine- to fine-grained bright green amphibole (10%), olive-brown biotite (8-10%) and carbonate (1%), cryptocrystalline plagioclase (40%), microcline (10%), and quartz (30-35%). This estimate was based on cut surfaces etched with hydrofluoric acid and stained with sodium cobaltinitrate.

Conglomerate and greywacke (9b)

This rock type outcrops south of Great Island in the southern belt of the Great Island metavolcanic rocks. It occurs at two localities, one immediately east of Omand Lake and the other 6 km south of Omand Lake at the south end of Zadworny Lake.

The exposure at Zadworny Lake provides the best information about the nature of the conglomerate. The exposures are at least 50 per cent free of lichen. On the clean surface it can be seen that the conglomerate occurs as lenses within the metagreywacke. The lenses have a minimum thickness of 5 m. The clasts comprise feldspar porphyry, layered metasiltstone, and meta-argillite, non-layered metasiltstone (15 - 20%), and very fine- to fine-grained meta-arkose (2 - 5%). Minor amounts of crystal tuff, quartz, quartzite or possibly recrystallized chert.

The matrix has a greywacke composition and is fine- to coarse-grained. The matrix comprises plagioclase (40%), quartz (36%) and an intergrowth of chlorite and biotite (10 - 15%). The matrix also contains a distinct milky blue quartz as pebble-size clasts readily visible in hand sample.

The fabric of the matrix varies from massive to weakly foliated to well foliated with an alignment of the disseminated micaceous minerals and the elongation of the clasts in the same orientation. A second fabric is also present and defined by very fine grained biotite. The second fabric is oriented at 50° to the main penetrative fabric.

Tuffaceous metasiltstone (9c)

This rock type was observed by Bostock (1969) at the southwest corner of the metavolcanics of the Lower Seal River. The following account is a summary of his description. The metasiltstone consists of varied laminations:

i) foliated dark green hornblende, biotite, epidote and quartz; calcic oligoclase, opaque minerals and sphene;

ii) clinozoisite-diopside-tremolite laminae;

iii) grey, fine grained metasiltstone: quartz, diopside, tremolite, and clinozoisite, bright green uvarovite (CaO 14%, Fe total 10%, Cr_2O_3 10%, MnO 6% by semi-quantitative spectrographic analysis) and/or hyalophane (barium-potassium feldspar 8-9% BaO by electron probe analysis).

"Scattered chromite grains are associated with laminae containing uvarovite. The combination of elements appears to be geochemically unusual, and it is likely that they have been brought together coincidentally; chromium by detrital accumulation of chromite and leaching of chromium, barium either by detrital accumulation or by direct precipitation. In either case the present mineral assemblage is largely due to superimposed almandine-amphibolite facies metamorphism." (Bostock, 1969).

A possible source for the chromium may have been the serpentinized ultramafic (Unit 12) which lies to the northwest; however, a more plausible explanation is the reworking of a volcanogenic exhalative sediment with a high barium and chromium content.

Granodiorite to porphyritic quartz diorite (10)

This rock unit forms the underlying rock type for a belt extending from the eastern edge of the Great Island basin to the Hudson Bay shoreline. The belt is approximately 60 km wide and is centered on the Seal River. The rock is moderately to strongly foliated.

The composition varies from a granodiorite to quartz diorite. The quartz diorite comprises matrix plagioclase An_{24-26} (40 - 45%), plagioclase phenocrysts An_{26-32} (up to 10%), medium- to coarse-grained hornblende (5 - 20%) and biotite (5 - 10%). The plagioclase in general is saussuritized. Quartz and buff-coloured microcline appear to be highly variable ranging from 10 - 20 per cent and 10 - 15 per cent, respectively. This variation is not to be confused with an alteration due to granitization near contact areas of the rocks of Unit 10 and the younger quartz monzonite (31). In these areas the rocks of Unit 10 display potassium feldspar-blastesis and pink quartz monzonite lits. Epidote, allanite, sericite clasts, and sphene formed from the alteration of plagioclase and biotite occur as accessory minerals. Inclusions of the granodiorite to quartz diorite occur within the quartz monzonite near the contact. These inclusions grade from rocks typical of Unit 10, overprinted by potassium feldspar blastesis, into zones of biotite granite gneiss.

Metagabbro (11)

Stocks of gabbro are common in the Great Island metavolcanic rocks. A gabbro stock is inferred in the north central part of the Seal River volcanic belt based on a small circular high magnetic anomaly occurring on the Federal-Provincial aeromagnetic maps 637 and 1691 at a scale of 1 inch to 1 mile. An isolated satellite pluton outcrops 10 km southeast of Caribou Lake. This body is recrystallized to a massive amphibolite and lies within a zone of granite gneiss (31c).

The outcrop surface of the gabbro weathers reddish brown and the rock is black on the fresh surface. A greenish colour is imparted to the rock where the plagioclase grains are heavily saussuritized. Within the gabbro (11) there are mafic pods of hornblende up to 1000 m^2. Pyrrhotite and chalcopyrite are local minor accessories in these zones.

The rock is massive, medium- to coarse-grained and comprises plagioclase An_{27-40} (25 - 30%) which often contains green microlites of amphibole(?). The mafic minerals are augite to augite-diopside (45 - 50%), hornblende (15 - 20%) and biotite (5 - 8%). Magnetite (1%) is an accessory. Chemical analyses are listed in Table 3.

The gabbro displays three types of alteration. The main broad or regional alteration is indicated by the ubiquitous alteration of clinopyroxene and plagioclase to hornblende, actinolite, biotite and carbonate. Plagioclase has a dusty appearance and contains epidote, sericite, and carbonate alteration products. A second type of alteration occurs in discrete narrow zones only a few millimetres to a few centimetres wide. These zones contain a felty mass of chlorite, actinolite or cummingtonite, carbonate and trace pyrite. The third alteration is contact metamorphism related to intrusion of either the quartz monzonite (31) or the fluorite-bearing quartz monzonite (32b). The contact zone may display a metamorphic layering defined by alternating layers of epidote, black actinolite, hornblende-rich zones and orange-red siliceous feldspathic layers. It can also be a massive zone of amphibolite heavily veined by epidote-quartz veinlets. The mineralogy is totally altered to actinolite, cummingtonite, epidote with accessory magnetite, and pyrite. Plagioclase is altered to chlorite (pinite, epidote, sericite plus carbonate).

Serpentinite and ultramafic rock (12)

A serpentinized ultramafic body occurs as an arcuate-shaped dyke north of Eppler Lake. No surface exposures of the dyke were observed, but a distinct linear zone was mapped consisting of frost-shattered serpentine fragments in areas of dark orange-brown sand. This zone of fragments coincides with a magnetic high which has been drilled at several localities (Table 11 and Map GR80-9-12, Locations D-17, 39, 40 and 41), revealing ultramafic bedrock. The contacts as indicated on the maps are based on the surface distribution of the fragments together with the continuity indicated by the magnetic anomaly. The northeast end of the anomaly is truncated sharply. Drill core from this region indicates the serpentinite has been altered to a garnetiferous amphibolite-bearing rock type with accessory magnetite. At the southwest end of the body almost all surface trace is lost in a very swampy terrain. The linear magnetic anomaly spreads out into an irregular-shaped zone extending to the south and either dies out beneath the eastern edge of the Great Island basin or continues under the Great Island basin but is masked by the overlying rocks of the Great Island Group.

Pink to grey quartz-feldspar porphyry (13)

The feldspar porphyry outcrops as a small stock along the south shore of Omand Lake, south of Great Island. In this area it intrudes the interlayered tuffaceous and metasedimentary rocks (7c). The porphyry also occurs as small dykes, which outcrop along and south of the Seal River east of Great Island.

The quartz-feldspar porphyry weathers to a smooth dense light grey to buff surface. Phenocrysts make up 8% of the rock and comprise quartz (5 - 8%), microcline (10 - 15%), and plagioclase (80%). The core of the plagioclase phenocrysts comprises sericite, epidote and clay minerals. The matrix is cryptocrystalline to very fine grained and comprises microcline (40 - 45%), plagioclase (20 - 25%), quartz (20 - 25%), olive green biotite (3 - 5%) and variable amounts of acicular hornblende (3 - 10%). The hornblende commonly exhibits alteration to actinolite, epidote and chlorite. Magnetite with coronas of epidote, zircon and a green mineraloid is a common accessory (1 - 2%). The rock is cut by hair-like veins of plagioclase and quartz. These veinlets are zoned with plagioclase in the centre and quartz on the margins.

The porphyry is weakly to moderately foliated. The weak schistosity is defined by an alignment of biotite and actinolite or trains of these two minerals. In addition to the foliation, a faint flow layering is defined by thin hair-like layers rich in dusty oxide minerals alternating with 1 - 3 mm thick quartz-feldspar layers.

A complex zone of multiple intrusion and deformation outcrops along the Seal River 12.5 km downstream from the point of intersection of the 96° longitude with Seal River. A pink feldspar porphyry has intruded grey actinolite-bearing volcanic rocks of rhyodacite composition which contain folded dykes of a basic intrusive. The pink feldspar porphyry gives the appearance of having been intruded explosively since the older rocks occur as large disoriented blocks in the pink porphyry (Figs. 10a and b). These rocks were later intruded by granite pegmatite and affected by intense deformation along narrow discrete shear zones.

Quartz porphyry (14)

The quartz porphyry is cut by Big Spruce River and lies immediately west of Spruce Lake. It outcrops in a zone of complex interfingering of the basal Sequence I rocks (Unit 6, 6b and 6d) and metavolcanic rocks (Units 7b and 8). Contacts are not exposed but age relationships can be inferred from the inclusions of the biotite gneiss (6d) and blocks of a layered amphibolite (8) within the quartz porphyry. These indicate that the quartz porphyry (14) is younger and intrusive into rocks of Sequence I and the metavolcanic rocks.

The rock is dense to fine grained and weathers buff to pink. Lenticular quartz eyes 2 - 5 mm long weather prominently and give the rock a distinctive appearance on the outcrop surface.

The rock comprises fine grained microcline (30%), plagioclase (20%), quartz (20 - 25%) and biotite (5%). Aggregates of very fine grained interlocking, microcline grains form relict phenocrysts and make up to 5 - 8 per cent of the rock.

Metagabbro and ultramafic rock and amphibolite (15)

These mafic rocks form small occurrences around the south and east shoreline of Nueltin Lake and at the southeast corner of Corbett Lake in the Munroe Lake area. An altered pyroxenite outcrops at Tadoule Lake and east of Tadoule Lake on the west shore of Albert Lake. The same rock type outcrops in a similar geological setting 16 km southeast of Albert Lake. A sill and dyke complex of layered amphibolite to hornblendite occurs in the Nejanilini Lake area along the western and northern shoreline.

The rocks in the Nueltin Lake and Corbett Lake areas are mainly metagabbro with minor occurrences of ultramafic rocks. The metagabbro comprises plagioclase An_{36-48} (25%), pyroxene (augite-diopside) (10 - 15%), hornblende (55 - 60%), biotite (3%), and magnetite (2%). Hypersthene is a variable accessory and ranges from 0 - 8 per cent.

These rocks form elongate sill-like occurrences. However, contact relationships with the surrounding rock types are uncertain. Magnetic intensities of 2900 to 4900 gammas, with steep gradients, coincide with areas mapped as Unit 15 in the Nueltin Lake and Corbett Lake areas. Zones of similar magnetic intensity may indicate other basic sills trending westward into the Kasmere Lake project area.

The occurrences in the Tadoule Lake and Albert Lake areas are diopside-rich pyroxenites cut by pegmatites of calcium-rich plagioclase An_{36-40}. They do not have a distinct magnetic response. These rocks intrude the lineated biotite granodiorite Unit B. However, the contact with the Sequence II metasedimentary relationships can only be inferred due to poor exposure.

An amphibolite and hornblendite forms a series of outcrops which outcrop within the grey basement tonalite gneisses (A) and the rocks of Sequence I along the west side of Nejanilini Lake. The trend of the amphibolite is parallel to the foliation in the basement rocks and to the easterly-trending layering and foliation in the paragneisses and migmatites of Sequence I rocks. The amphibolite displays a marked change in orientation at the north end of Nejanilini Lake where it strikes to the north. The trend is parallel to a marked structural discontinuity which is expressed as a series of north-trending *en echelon* faults and shear zones. The amphibolite again undergoes a marked change in direction and is observed in outcrop immediately to the east where it again displays the attitude of a sill which has intruded the rocks of Sequence I.

The amphibolite appears to be layered with a leucocratic metagabbro phase and a more basic hornblendite phase. The metagabbro phase is grey medium grained and granoblastic, comprising hornblende and plagioclase. The rock has a clotted appearance due to the presence of coarse aggregates of fine- to medium-grained hornblende. The hornblendite contains hornblende (90%), biotite (3%), and plagioclase (6 - 7%) with trace to 1 per cent pyrite and/or pyrrhotite.

Biotite psammite gneiss; minor calc-silicate rock (16)

This rock type occurs in persistent association with either the calc-silicate rocks (17) or the marble (17b). Major outcrop belts lie south of Nueltin Lake (Map GR80-9-7) and between Belsham Lake and Stony Lakes (Maps GR80-9-2 and 7). Another minor occurrence outcrops in the Duffin Lakes area (Map GR80-9-6). The areas underlain by Unit 16 have a magnetic intensity ranging from 2200 to 2500 gammas (GR80-9-10). However, the areas outlined by mapping as psammitic gneiss (16) display narrow zones of higher magnetic intensity in the area south of Nueltin Lake. These narrow linear anomalies extend west into the Kasmere Lake Project area and range up to 3300 gammas and exhibit steep magnetic gradients. Bedrock data in this zone at present are insufficient to interpret this magnetic anomaly.

The gneiss (16) ranges from psammite to semi-pelite with variation in the biotite content. The foliation is a schistosity defined by oriented biotite, which forms 1 mm thick laminae, interlayered with 2 - 5 cm thick dense biotite psammite layers. The texture of the gneiss (16) is medium grained granoblastic. Granitic *lits* vary in abundance and the rock ranges from a migmatitic biotite psammitic gneiss to paragneiss in the region south of Nueltin Lake.

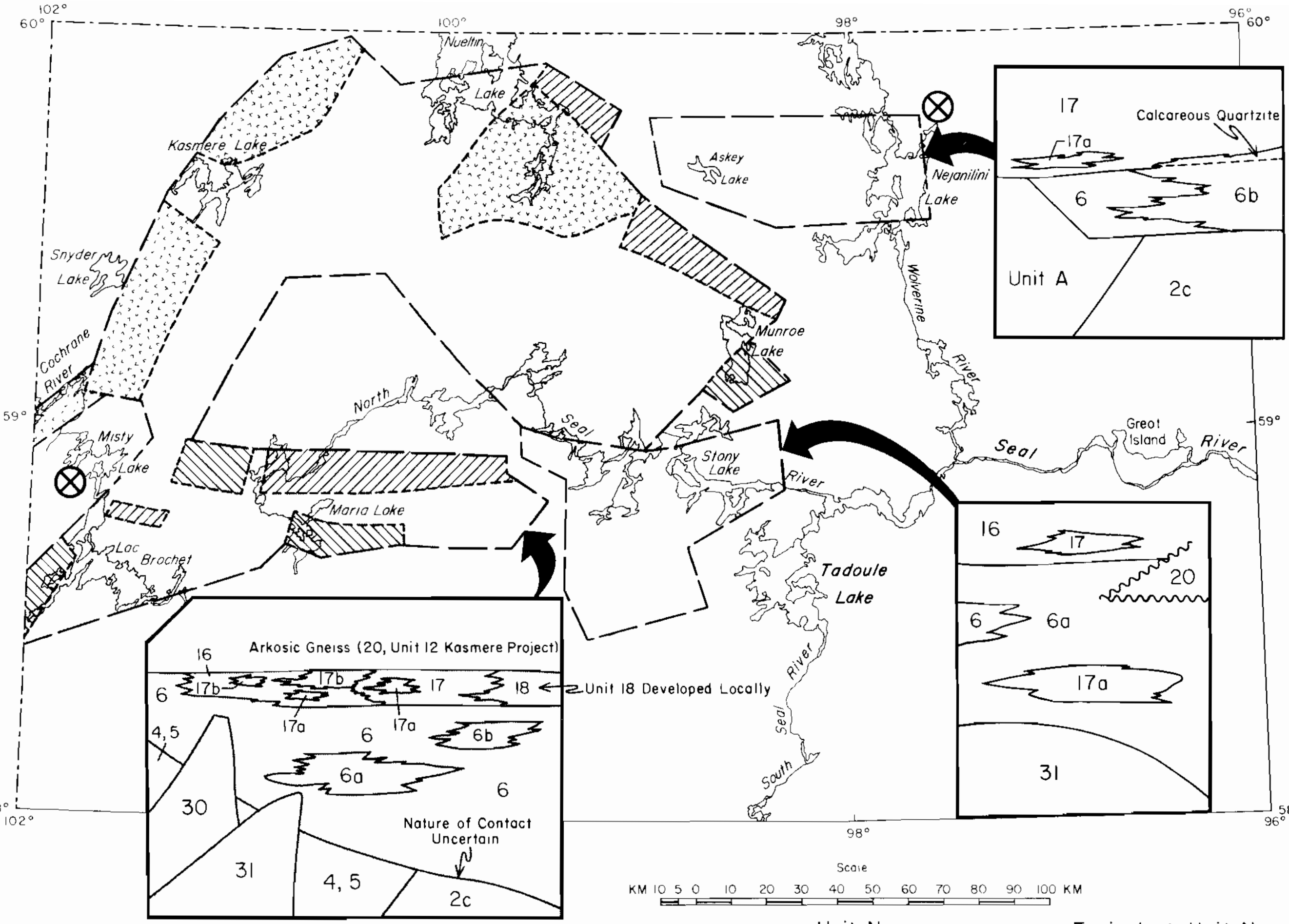
Calc-silicate layers of variable appearance and thickness are locally interlayered with the psammitic gneiss (16). They occur as pale grey-green diopside layers (2 - 10 cm thick) or as buff, dense medium grained layers (2 - 8 cm thick) comprising plagioclase, diopside and biotite.

The principal minerals of the psammitic gneiss are microcline, plagioclase, quartz and biotite. Variable chloritization of biotite and sericitization of plagioclase indicate retrogressive metamorphism. Magnetite is an accessory mineral (1 - 2%) and forms medium to coarse grains in the granitic *lits*. It also forms a bird's-eye structure comprising magnetite surrounded by a corona of quartz and feldspar. This is particularly characteristic of the Nueltin Lake occurrences.

A second accessory mineral of sporadic occurrence is black tourmaline (dravite) which is developed spectacularly in the Belsham to Stony Lake zone. Here the semi-pelitic gneiss (6a) and biotite psammite gneiss (16) are in gradational contact. The granitic *lits* in this zone contain large tourmaline crystals up to 12 cm in length. Cordierite can also be present in the granitic *lits*. However, where the biotite psammite gneiss (16) is interlayered with calc-silicate rock (17) tourmaline is absent in the granitic *lits*.

Calc-silicate rock (17)

The calc-silicate rock occurs in the Wollaston, Seal River and Nejanilini domains as bodies of variable size and varied lithologic relationship. The Kasmere Project (Weber et al., 1975a) inferred a time stratigraphic connotation for the calc-silicate rock in the Wollaston and Seal River domains. This was based on stratigraphy which indicates a calc-silicate-bearing zone consistently lies between the pelitic metatexite (6) and a younger suite of quartzofeldspathic rocks (20), (Fig. 9). The calc-silicate rock in this stratigraphic setting is apparently part of a suite of rocks that vary locally from calc-silicate rock (17) with biotite psammite (16), and/or marble (17a) and/or calcareous quartzite to conglomerate (18) (Fig. 9). An Aphebian age has been assigned to the calc-silicate rock based on a Rb/Sr whole rock age of 1762 ± 60 Ma (Weber et al., 1975b) for the underlying pelitic metatexite and a sedimentary history and tectonic setting has been based on this stratigraphic framework. The more widespread mapping of the Cochrane-Seal River project indicates a similar stratigraphic succession appears in the Munroe Lake synform and also in the area of Nueltin Lake (Fig. 9). However, the additional mapping also indicates similar calc-silicate rocks in lithologic settings that differ from this stratigraphic



LEGEND

- REGIONS IN WHICH SILICEOUS CALC–SILICATE, CALCAREOUS QUARTZITE AND LOCALLY CONGLOMERATE ARE PRESENT
- REGIONS WITH INTENSE PLANAR DEFORMATION, STRATIGRAPHY DISRUPTED, CALC–SILICATE GENERALLY ABSENT
- REGION WITH MAXIMUM AREAL EXTENT OF PSAMMITIC GNEISS (16) AND ALBITE PYROXENE ROCK (17b)
- ⊗ SCAPOLITE IN CALC–SILICATE ROCKS

Unit Nos. COCHRANE–SEAL R. PROJECT	Equivalent Unit Nos. KASMERE PROJECT
31	19
30	17
20 meta–arkose	12
18	11
17	8a
17a marble	8b
17b	9
16	10
5	4
4	3
2c	2c
Unit A	5

Figure 9: Distribution and variation of calc-silicate rock stratigraphy, (16 to 18).

framework (Fig. 9). Therefore, a regional time stratigraphic connotation is not implied by grouping the calc-silicate rocks as a single lithologic unit in this report. An extensive occurrence of the calc-silicate rocks lies in the area from Askey Lake to Nejanilini Lake (Fig. 9). The calc-silicate rock in that area overlies or is interlayered with the semi-pelitic metatexite (6) and/or impure quartzite (6b). It also overlies granitoid rocks (Unit A) of probable Archean age. The age of the calc-silicate rocks there is uncertain.

The calc-silicate rock in general consists of the following layers in varied proportions:

i) pink to green layers of amphibole-plagioclase-quartz containing widely spaced discontinuous, olive-green diopside seams;

ii) grey biotite + amphibole plagioclase layers

iii) rare buff carbonate layers with discontinuous olive-green diopside laminae;

iv) dense buff, boudinaged and resistant to weathering, boudinaged *lits* of biotite (5%) quartz-plagioclase + pyrrhotite + pyrite plagioclase *lits*;

v) mottled pink and green medium grained to pegmatitic scapolite-clinopyroxene-feldspar layers and veins.

The scapolite-bearing layers and veins were observed only to the east of Nejanilini Lake and in the northwest corner of the Whiskey Jack Lake map area, specifically in the area of Misty Lake (Fig. 9). Both these areas are underlain by hypersthene-bearing Archean granitic rocks.

Figure 10a: Intrusion breccia, (13).

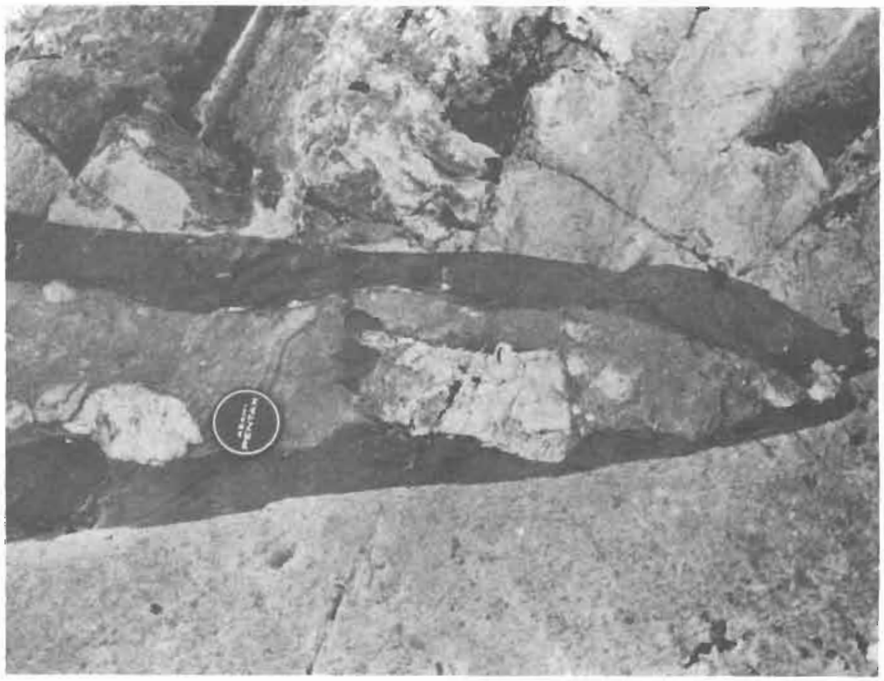


Figure 10b: Inclusion in feldspar porphyry (13).

Marble (17a)

The marble forms thin discontinuous layers within the calc-silicate rock exposed in the Nueltin Lake area, on the flanks of the Munroe Lake synform and at Askey Lake. An additional isolated occurrence outcrops along Wolverine River in the southwest corner of the Nejanilini Lake map area (Map GR80-9-6).

The marble forms layers several metres to 100 m thick with widely spaced laminae of more resistant-weathering grey-green calc-silicate. Sulphide and graphite mineralization is sporadically associated with the calc-silicate laminae. Pyrite and minor pyrrhotite shows have been examined by Ducanex Syndicate (Tables 9 and 11) along the north side of Askey Lake. Similar sulphide showings form a series of occurrences on the south flank of the Munroe Lake synform. These have been examined by surface prospecting, ground geophysics and in certain instances drilling (Table 9). Outcrops of the transition facies rocks (17, 17a, 18) are sparse and frost-shattered along the south flank of the Munroe Lake synform.

The thickest layer of marble occurs in the south half of the Tadoule Lake map area, at Wilkie Lake and Ryan Lake. In this zone, the marble outcrops within an area of interlayered semi-pelitic gneiss to schist and impure quartzite (6a). These rocks (6a) appear to represent a period of cyclic sedimentation. The marble appears to occur within the basal unit (6a) and does not mark a transition zone of a different lithology as in the other occurrences in the Whiskey

Jack Lake map area, and the Munroe Lake map area. In those areas a distinct lithologic sequence is preserved from a basal pelitic to semi-pelitic gneiss (6) overlain by a transition facies (6b, 16, 17, 17a) and an overlying meta-arkose to arkosic gneiss (20) (Fig. 9).

The marble weathers buff and white to brilliant white. It is medium- to coarse-grained granoblastic and massive. A sporadic layering is defined by calc-silicate layers containing mainly diopside. Calcite forms 80-90 per cent of the rock. At the Wilkie Lake and Ryan Lake occurrence tremolite forms large white crystals 3 mm to 1 cm in length whereas diopside forms fine disseminated grains.

In the Whiskey Jack Lake map area the marble contains diopside (15%) as colourless prismatic grains. Spinel was found locally as small, disseminated, euhedral, colourless to green grains. Unaltered olivine (forsterite) is rare with yellow serpentinite pseudomorphing olivine being more common. Other accessory minerals are pargasite, scapolite, apatite, phlogopite, idocrase, microcline and sphene.

Albite-pyroxene rock (17b)

The albite-pyroxene rock was observed only at the west end and along the north flank of the Munroe Lake synform.

It forms small outcrops and the rock unit can rarely be traced for more than a few kilometres along strike. These outcrops seem to be the eastern extent of the albite-pyroxene rock which also outcrops to the west in the Kasmere Project area.

The albite-pyroxene rock (17b) weathers pale pink to white and shows an anastomosing pattern of discontinuous, green to dark grey, crudely aligned layers which define a gneissosity. The principal minerals are albite (An_{5-7}) and augite to aegerine-augite. Minor minerals are quartz, ilmenite and/or sphene. Disseminated pyrite occurs in the outcroppings at the west end of the Munroe Lake synform.

This rock type may have crystallized as an evaporite in lagoonal deposits, as suggested for scapolite-bearing rocks and associated albite-quartzites of the Belt series (Hietanen, 1967). Chandler (1978) has not ruled out the possibility of a primary sedimentary origin for similar albite-pyroxene rocks in the Wollaston domain in Saskatchewan. Alternatively, the high sodium content may have resulted from secondary sodium and chlorite metasomatism of carbonate-free shales as proposed by Edwards and Baker (1953) for the formation of albite-rich rocks in Queensland, Australia.

Quartzite to conglomerate (18)

This rock type has a variable mineralogy and texture. The occurrences do have a common relationship in that they are high in quartz with accessory calc-silicate minerals.

In the Munroe Lake map area, at the southeast end of Munroe Lake, the rock is a glassy quartzite with discontinuous and boudinaged layers of dark green diopside, epidote and pale pink wispy layers of epidote-microcline and quartz. Epidote forms disseminated grains and irregular veins within the quartzite. This rock type underlies the large elongate ridges which stand over 100 m above the surrounding topography.

This same rock type also outcrops, in an area widely separated from the Munroe Lake occurrence, in the region immediately north of Whiskey Jack Lake (Map GR80-9-1). This rock type with higher feldspar content again forms ridges that stand more than 100 m above the surrounding countryside.

Other occurrences of this rock type are at Rutledge Lake and Maria Lake in the northeast quarter of the Whiskey Jack Lake map area (GR80-9-1). These occurrences vary from calcareous quartzite to conglomerate. The matrix makes up 10 to 70 per cent of the conglomerate and varies from a glassy quartzite to semi-pelite. The clasts are mainly dark green calc-silicate rock with lesser amounts of grey to cream coloured impure quartzite and brownish meta-arkose. The clasts are variable in size, roundness and abundance. The shape varies from ellipsoidal to disk-shaped indicating differing degrees of tectonic flattening.

The lithology is considered to be part of a transition facies deposited as a calcareous sandstone with limy-mud interlayers during a static period in shallow water. Localized uplift and erosion followed the depositional cycle resulting in the formation of the conglomerate phases of unit 18.

Feldspathic quartzite (19)

Feldspathic quartzite occurs in the south half of the Tadoule Lake map area, and between the Fergus River and Tadoule Lake with a minor occurrence at the west end of Shethanei Lake. At Clifton Lake, immediately east of Fergus River, unit 19 occurs in the core of a refolded synform.

At the south and north end of Tadoule Lake it appears to underlie the quartzite and interlayered biotite schist (22) of Sequence II rocks. A paucity of exposures obscured the relationship of these rocks with the interlayered semi-pelitic gneiss and impure quartzite (6a).

The rock is grey to buff on the weathered and fresh surface. It is medium grained granoblastic. In general, it is well foliated with a pronounced schistosity defined by aligned medium-grained biotite disseminated throughout the rock. The biotite may also occur in discontinuous laminae. The schistosity is enhanced by aligned ellipsoidal porphyroclasts or *faserkiesel* comprising muscovite ± sillimanite and quartz. These porphyroclasts are 1 - 2 mm thick, 5 - 10 mm wide and 1 - 3 cm long. They make up 3 to 8 per cent of the rock.

Meta-arkose to arkosic gneiss (20)

The major exposures of the meta-arkose lie in two large synformal structures:

i) the Chatwin-Nicklin Lake synform, and
ii) the Munroe Lake synform.

The Nicklin Lake portion of the synform is the eastern extension of the east-trending synform which extends west of Chatwin Lake in the Kasmere Lake project area. Two small occurrences of the meta-arkose outcrop immediately west of Stony Lake. These exposures are faulted remnants of the Chatwin-Nicklin Lakes synform. In one occurrence which lies to the south of Seal River the stratigraphic relationships are reversed and the meta-arkose occurs in the core of a small domal structure less than 2 km in diameter.

The Munroe Lake synform trends southeasterly and is 30 km wide and 60 km long. The meta-arkose is well exposed on the margin of the structure but is poorly exposed in the central zone of the synform. The synform is truncated by a fault at its southeast end and at Munroe Lake. Its continuity has also been affected by a complex system of faults at its northwest end where it bifurcates into two separate-trending belts. In the area of Corbett Lake the broad Munroe Lake synform is represented by a narrow zone 5 km wide. This narrow zone trends to the west into the Kasmere Lake project area. The meta-arkose also trends to the north to Nueltin Lake where it occurs in a series of small shoreline exposures. Unit 20 is migmatitic in the zone lying between Nueltin Lake and Corbett Lake. It comprises a metatexite with granite mobilizates as *lits* and irregular patches, and minor amounts of black hornblende. The restite is a medium grained greyish-pink hornblende-biotite-feldspar-quartz granoblastite. The hornblende is dark green and poikiloblastic.

The meta-arkose, where it is less recrystallized, displays two types of layering:

i) discontinuous alternating pink and grey, fine- to medium-grained layers or lenses (2 - 6 cm thick); pink layers may be spotted due to coarse grains of poikiloblastic green amphibole and clinopyroxene;
ii) pink and white granitic interlayers or lenses (1 cm - 1 m thick) make up as much as 40 per cent of some outcrops.

The principal minerals in the pink and grey layers (1) are feldspar, quartz, biotite, hornblende and diopside, with minor actinolite, magnetite and hematite. The feldspar of the grey and pink layers is mainly plagioclase with lesser amounts of microcline. The pink coloration is due mainly to red hematite coating quartz and feldspar grains. The texture is medium grained granoblastic to heteroblastic. The variable grain size is partly the result of recrystallization but may also reflect a primary grain size variation. Superimposed on the granoblastic texture are ellipsoidal poikiloblasts of pale green hornblende and diopside with minor actinolite, and aggregates of fine- to medium-grained, intergrown actinolite and hornblende, or hornblende and diopside. Dense green interlayers of calc-silicate minerals occur sporadically.

The granitic layers are interpreted as products of recrystallization and partial anatexis of the meta-arkose. The principal minerals in the granitic layers are microcline (20-30%), plagioclase An_{12} (20-60%), quartz (20-55%), hornblende and actinolite (0-2%), magnetite (0-2%) and hematite (0-1%). The texture is hypidiomorphic granular.

SEQUENCE II — COVER ROCKS (Units 21-29)

Sequence II cover rocks occur as erosional remnants in the southeast quarter of the project area from Hudson Bay to Tadoule Lake (Fig. 7). This region constitutes the Great Island domain. The thickness and number of units varies from one erosional block to another. A metamorphic overprint which varies in its intensity further complicates correlation on the basis of lithologies.

The thickest stratigraphic column with the greatest number of units occurs at Great Island and Meades Lake in a complexly deformed basin structure. This is the type locality for the Great Island Group. Other erosional remnants occur:

i) along the Seal River 44 km east of Great Island
ii) along the North Knife River;
iii) 11 km north of Nowell Lake and immediately east of the North Knife River;
iv) in the area of the town of Churchill extending southwest to Lofthouse Lake.

A broad triangle-shaped area, bounded on the north by Seal River and having Wither Lake, Nichol Lake and Tadoule Lake at its apices, contains several erosional remnants of Sequence II rocks. The mineral assemblages within the pelitic component of the erosional remnants indicate the metamorphic gradient increases to the west. There is also evidence for a contact metamorphism which overprints the regional metamorphism. The contact metamorphism increases to the south and is well developed south of Nichol Lake.

In general, the basal units of the Sequence II rocks are:

i) oligomictic or polymictic conglomerate (21a and 21b);
ii) protoquartzite (+ andalusite) and interlayered phyllite to biotite schist (22);
iii) grey-green phyllite to biotite schist + garnet + biotite porphyroblasts + andalusite (22a).

Oligomictic conglomerate (21a)

This rock type forms high blocky ridges and weathers to white or reddish orange. It outcrops south of Great Island between Seal River and Omand Lake and also east of Omand Lake. It forms a northwest-oriented lens-shaped outcrop zone with a north-trending fault intersecting the outcrop zone.

The rock comprises a quartz matrix with matrix-supported quartzite and vein quartz clasts. The pebbles range in size from 2 to 6 cm in length and are ellipsoidal in shape.

Sericite forms 10 per cent of the matrix and is also concentrated at the margins of the clasts and in discrete shear zones. Limonite can make up to 2 per cent of the rock and may represent alteration after pyrite.

This conglomerate overlies gabbro (11) and metavolcanic and epiclastic rocks (7a to 7d).

Polymictic conglomerate (21b)

This conglomerate (21b) occurs at the northeast end of Coll Lake (Map GR80-9-3) and 4 km northwest of Omand Lake immediately south of Great Island. At both localities it forms thin lenses ranging from 3 to 6 km in length.

The conglomerate (21b) forms elongate blocky ridges of moderate to high relief. The outcrops are dark grey and grey to light grey on the fresh surfaces. The clasts range in size from 5 mm to 3 cm and comprise quartzite, quartz sericite schist, impure biotite metasiltstone and rare quartz-tourmaline pebbles. The matrix varies from quartzite to quartz sericite schist and contains magnetite (1 - 3%) and pyrite (0 - 3%).

At Coll Lake the conglomerate (21b) underlies the protoquartzite (22) and overlies a quartz monzonite (31) and aplite (31b) complex. Northwest of Omand Lake the conglomerate overlies metavolcanic and epiclastic rocks (7b and 7c).

Variation and relationship of protoquartzite (unit 22) and phyllite (unit 22a)

The major basal unit of the Sequence II rocks comprises:

i) grey protoquartzite to quartzite and zones, making up 10 - 15 per cent of the unit, of thinly bedded grey-green phyllite to biotite schist (22);
ii) grey-green phyllite to grey or silvery grey muscovite-biotite schist (22a).

These units are the most laterally persistent and widespread of the Sequence II rocks. However, the exact nature of the basal unit of Sequence II rocks and the relationship with the underlying rocks can only be inferred since the contact is not exposed.

In summary, on a regional basis the basal unit of the Sequence II rocks is a unit with a minimum thickness of 1200 m. The major component is a quartzite to quartz metasiltstone (22) containing laterally and vertically impersistent aluminous phyllite (22a) and a graphite and pyrite-bearing meta-argillite (22b). Subsurface data indicate a greater lateral persistence for the graphitic pyritic beds (22b) than that inferred from surface exposures. Based on surface exposures, the base of the Sequence II rocks is marked by localized variations, such as the presence of discontinuous lenses of conglomerates (21a and 21b), and an increase in aluminum, potassium and iron towards the base.

Anomalous occurrences observed in drill core and surface exposures are:

i) the presence of a galena (trace)-pyrite-bearing quartzite in surface exposures south of Seal River 44 km east of the Great Island basin.
ii) interlayered metasiltstone and carbonate sequence in drill core from a hole collared on the east edge of the Great Island basin.

The drill hole bottomed out in the metasiltstone-carbonate zone and it is uncertain what lies beneath this carbonate-rich rock.

Protoquartzite (22)

At the type locality of the Great Island Group at Great Island the basal unit comprises an interlayered sequence of grey quartzite, protoquartzite and thinly bedded grey-green to grey phyllite and metasiltstone (22). The phyllite and metasiltstone form widely spaced zones of discontinuous layers that make up 10 - 15 per cent of the basal unit (22). North of Meades Lake the basal unit is 1200 m thick. Current crossbedding and wave ripple marks, though recorded, are too rare for reliable top and current direction inferences. The primary clastic texture of the protoquartzite (22) is preserved as rounded coarse- to medium-grained quartz crystals with secondary silica overgrowths and a silica cement. Sericite, chlorite, biotite and hematite are present as accessory minerals. In areas of tight folding subsequent recrystallization has resulted in a massive or foliated quartzite.

Localized vertical variations were observed near the base of the Sequence II protoquartzite at Great Island. One variety lies 10 km south of Meades Lake. The rocks form a series of low well exposed outcrops near the base of a high north-trending esker. The rocks of the most southerly outcrop are a thick bedded sequence of grey protoquartzite and metasiltstone containing 15 to 20 per cent fine grained biotite, chlorite and sericite. To the north the laminae become progressively thinner across strike ultimately comprising an interlayered sequence of protoquartzite (1 - 2 cm) and biotite-chlorite-sericite-rich metasiltstone (1 - 2 cm).

Andalusite was also observed near the base of the Great Island Group northwest of Meades Lake. At this locality the rock is a protoquartzite with 15 per cent very fine grained biotite and sericite. Outlines of ghost-like pebbles and cobbles are defined by an increase in the percentage of biotite (25%). Andalusite occurs as irregular knot-like composite intergrowths of several highly poikiloblastic andalusite grains. These knots are up to I.5 cm across. Chemical analyses of this rock type are listed in Table 5.

In summary the main variations observed in surface outcrops towards the base of the Sequence II protoquartzite (22) at Great Island are:

a) the suggested increase in the content of aluminum indicated by the presence of andalusite and sericite;
b) the increase in the potassium content indicated by the presence of sericite and biotite; and
c) an increase of the ferromagnesian content indicated by the presence of biotite and chlorite in the laminated rocks.

The variability of the basal unit at Great Island is also indicated in a number of diamond drill holes and geophysical surveys. Airborne geophysical surveys, (Reference Nos. 3a, 3b, 8 & 11, Table 9, Map GR80-9-10) indicate elongate discontinuous conductors close to the inferred position of the base of the Great Island Group along the south and east edges of the basin structure at Great Island. Similar types of conductors outline the edge of Sequence II rocks in the north-trending outlier 44 km east of Great Island. The nature of the conductors on the south flank of Great Island remains uncertain. However, diamond drilling has been carried out along the east side of Great Island and along the length of the north-trending outlier of Sequence II rocks 44 km east of Great Island.

Immediately east of Great Island two diamond-drill holes were completed by Keevil Mining Group and one hole was drilled by Manitoba Mineral Resources Limited in 1975 (Table 11, Locations D-19, 20, 35; GR80-9-12) along Seal River. In addition three holes were drilled in an area 7 km north of Seal River (Table 11, Locations D-36, 37, 38; GR80-9-12). The diamond-drill holes along the Seal River 1(D-19, 20) encountered a zone of black to dark grey graphitic and pyritic argillites (22b) and one hole intersected a zone of sulphide and magnetite iron formation (25). These rock types make up the upper section of the drill holes whereas the lower intersections are interlayered metasiltstone and phyllite. The most southerly diamond-drill hole (Location D-20, Map GR80-9-12), collared on an island in the Seal River, encountered a thin upper zone of argillite, and a thick middle zone of grey protoquartzite to meta-arkose with pyritic phyllite laminations (22). The lower section comprises interlayered buff metasiltstone and carbonate. The hole bottomed in this material. Of the three diamond-drill holes (D-36, 37, 38) 7 km to the north of the Seal River, two (D-37, 38) encountered upper sections of graphitic, pyritic argillite (22b) underlain by thin bedded metasiltstone and phyllite (22). One of these diamond-drill holes bottomed in metadiorite (10) (D-37). The third hole (D-36) intersected siliceous and sulphide-bearing metavolcanic rocks overlying meta-andesite (7a).

TABLE 5: CHEMICAL ANALYSES OF QUARTZITE AND INTERLAYERED PHYLLITE (22) AND PHYLLITE (22a)

	(1)	(2)	(3)	(4)	A	B	C	D	E
SiO_2	65.30	60.65	54.30	74.05	74.43	53.26	57.80	66.24	65.2
Al_2O_3	17.60	20.31	21.28	13.79	11.32	20.64	18.37	15.28	16.6
Fe_2O_3	1.15	1.25	2.93	0.89	0.81	1.26	1.67	0.70	0.80
FeO	4.76	4.40	5.62	2.81	3.88	7.13	6.21	4.53	4.0
CaO	0.27	0.07	1.26	0.00	1.17	1.24	1.89	1.70	2.2
MgO	1.35	1.49	3.55	1.92	1.30	4.71	3.93	2.74	2.3
Na_2O	1.04	0.28	1.13	0.07	1.63	2.20	2.19	3.12	3.5
K_2O	4.19	5.81	2.65	3.45	1.74	3.53	3.26	1.91	2.5
TiO_2	0.67	0.80	0.54	0.00	0.83	0.93	0.70	0.64	0.5
P_2O_5	0.10	0.05	0.89	0.03	0.18	0.16	0.19	0.12	0.12
MnO	0.12	0.04	0.33	0.01	0.04	0.09	0.09	0.06	0.07
H_2O	2.37	3.59	5.10	2.02	2.15	4.73	3.11	2.57	1.75
CO_2	0.51	0.05	0.12	0.39	0.48	0.10	0.17	0.38	0.03
TOTAL	99.43	99.39	99.70	99.43	99.96	99.98	99.58	99.99	99.57

Sample Locations

(1) Great Island, Unit 22a; UTM 634850 mE, 6539775 mN

(2) Great Island, unit 22a; UTM 651220 mE, 6529950 mN

(3) North Knife River; Unit 22a; UTM 666350 mE, 6496650 mN

(4) Northeast of Great Island, Unit 22, UTM 656450 mE, 6546675 mN

Comparative Analyses

A Subgreywacke from Tyler slate (Precambrian); Hurley, Wisconsin (Pettijohn, 1957).

B Average of 3 Burwash Formation mudstones; N.W.T. (Henderson, 1972).

C Average of 20 Archean slates; N.W.T. (Henderson, 1972).

D Average of 3 Burwash Formation greywacke; N.W.T., (Henderson, 1972).

E Average Archean greywacke, (Goodwin, 1971).

Quartzite and interlayered quartzite, protoquartzite and grey-green phyllite also occur:

i) along the North Knife river
ii) 12 km north of Nowell Lake;
iii) at Nichol Lake;
iv) along Seal River 44 km east of Great Island; and
v) in a triangular-shaped area between Wither Lake and Tadoule Lake.

These rocks have been tentatively correlated with the basal zone of interlayered quartzite, protoquartzite and grey-green phyllite (22) at Great Island.

Along the North Knife River this rock type is very similar to its counterpart at Great Island and may represent a lateral facies equivalent to the southwest. At a point 3.5 km downstream from Teepee Falls along the North Knife River the protoquartzite (22) is folded into a series of Z-folds with steep dipping easterly-trending axial planes and shallow plunge. The folds are of moderate closure with north-facing limbs dipping 60 to 70 degrees and south-facing limbs 20 - 30 degrees. The shallow plunges of the folds reverse their orientation from west to east every 30 m. Bostock (1969) referred to these folds as "whaleback folds." Right-way-up current crossbedding is preserved in the protoquartzite beds half a kilometre from the "whaleback folds." The current directions, indicated by the current bedding, reverse rapidly over a short vertical stratigraphic interval. In this same area 12 km west of Teepee Falls the protoquartzite is medium- to coarse-grained with the outline of the clastic quartz grains preserved. A faint layering is present and is defined by variations in the concentrations of sericite (5 - 15%), chlorite and hematite. Quartz pebbles and quartz cobbles are present. These cobbles are widely spaced in a grey hematite-bearing quartzite.

The protoquartzite (22) occurs in a basin-like structure 6 km southwest of the confluence of North Knife and South Knife Rivers 12 km north of Nowell Lake. At this locality the volume of phyllite and metasiltstone in the protoquartzite is 30 - 40 per cent. The protoquartzite to quartzite beds range from 1 m to 100 m thick. At the east end of the basin structure current crossbedding is common and concentrations of red hematite defines the bedding planes.

An outlier of andalusite-sericite-bearing massive to thick bedded quartzite outcrops at Nichol Lake 25 km south of Great Island. This rock type has been equated with the basal section of the protoquartzite (22) because of the aluminous character of the quartzite. The quartzite is more highly recrystallized and possesses a localized foliation defined by the alignment of sericite. The chemical analyses are listed in Table 6.

Drilling was carried out by Manitoba Mineral Resources Ltd. in 1975 (Table 11, Location D-22 to 34, 42; GR80-9-12) to test E.M. anomalies in the north-trending outliers of Sequence II rocks along Seal River 44 km east of Great Island. The drilling intersected graphite and/or pyrite-bearing argillaceous metasediments (22b). The graphite and pyrite is concentrated along bedding planes and has also been remobilized into the zones of fracture cleavage. These graphite-pyrite-bearing metasediments appear to overlie a zone of thinly bedded metasiltstone ($\pm$ pyrite) of variable thickness.

Drill hole records (Table 11) indicate a variation in the depth of overburden from the west to the east side of Seal River. The thickness of overburden on the east side of the river in general is 6 m greater than on the west side. However, some drill holes indicate the overburden to be up to 30 m thicker on the east side of the river. Since the drill holes were collared at similar elevations this thickness variation is due to irregularities in the Precambrian subcrop possibly related to a fault scarp trending along the northerly-trending Seal River.

Bedrock exposure in this outlier is broken by extensive areas of drift cover. However, frost-shattered material indicates this outlier of Sequence II metasediments is 24 km long and 2 to 6 km wide. At the north end of the outlier a frost-shattered outcrop of grey- to red-weathering phyllite occurs on the west side of Seal River. Diamond drill holes collared in this zone encountered pyritic argillites in the upper part of the holes. The holes bottomed out in white pegmatite or biotite gneiss. On the east side of Seal River outcrops of interlayered protoquartzite and phyllite (22) define open to tight folds with steep dipping easterly axial planes and shallow easterly plunges. An anomalous variety of quartzite was observed at the south end of the outlier, at a point 8 km southeast of Seal River. The frost-shattered outcrop comprises a white quartzite with well defined medium- to coarse-grained disseminated pyrite, trace galena and disseminated very fine grained brilliant green muscovite. This quartzite makes up 40 per cent of the frost-shattered material. The remainder is the more typical interlayered protoquartzite, metasiltstone and phyllite (22).

The Sequence II rocks that lie within the triangular-shaped area between Tadoule, Wither and Nichol Lakes, have been interpreted as variably metamorphosed equivalents of the basal unit (22) of the Great Island Group. The rock is an interlayered sequence of muscovite + chloritoid + biotite-quartz laminations and + chlorite + muscovite + biotite-bearing quartzite (22). Andalusite and garnet are common accessory minerals in the aluminous layers. The grain size of the micaceous minerals increases to the east and to the south. The Sequence II rocks are preserved in a patchwork pattern overlying granitic rocks. This pattern appears to result from the intersection of north- to northeast-trending faults with older east-trending folds (F_1). The most continuous zone of Sequence II rocks lies along Seal River between Tadoule Lake and Wither Lake. Folded Sequence II rocks in this area are intersected by a series of north to west of north faults with apparent left lateral offset. The east end of a synformal fold near Wither Lake plunges to the west at 10 to 20 degrees.

Grey-green phyllite to muscovite-biotite schist (22a)

This rock type outcrops:

i) along Seal River on the south side of Great Island;
ii) along North Knife River;
iii) along Seal River at the northwest end of Great Island; and
iv) at Tadoule Lake.

At the type locality for the Great Island Group (Great Island), the unit (22a) is silvery green to darker grey-green. The silvery green colour occurs in areas where the rock has been altered to a phyllite. The argillite to phyllite sporadically contains accessory garnet and/or biotite porphyroblasts. This rock type in general comprises 2 - 5 mm laminations of very fine grained to felty chlorite, biotite, sericite and alternating layers of buff metasiltstone. The chemical analyses are listed in Table 5. The euhedral biotite porphyroblasts are 1 mm in diameter and 2 to 5 mm in length. Dark red pinhead garnets occur as disseminated grains within certain layers or as concentrations along layer boundaries. The habit of garnet formation reflects a primary composition control. Medium- to coarse-grained garnet occurs in areas of localized tight folding with well developed axial surfaces, transposition of layering, related shearing and attendant quartz veins. The garnets, 2 to 4 mm in diameter, are concentrated at the boundaries of quartz veins indicating migration of elements during the mobilization of quartz in these zones of intense deformation.

Outcrops of phyllite (22a) are exposed along the floor of the North Knife River channel. Contacts with the protoquartzites are not exposed. All layering measurements are made on fine secondary laminae and reflect deformation of the layering. Minor folds are complex structures with two distinguishable ages of fracture cleavage. One set of fracture cleavages trends easterly and dips to the north or south. They are intersected by a later fracture cleavage which trends north to northeast. Grey-green phyllite, exposed along North Knife River, has been equated with the phyllite (22a) at Great Island based on its lithologic similarities. However, along North Knife River pyrite porphyroblasts are more common in this phyllite than biotite porphyroblasts or garnet. The phyllite (22a) of North Knife River is folded into a series of very tight folds with steep-dipping axial planes overturned to the north. The axial planes trend easterly and the plunges of the folds show sharp reversals in orientation from east to west. The river runs parallel or subparallel to the easterly structural trend and as a consequence little diagnostic stratigraphic information is available. The result of the tight folding is the development of a pervasive axial planar schistosity and hence the development of silvery green phyllite. Primary layering is still visible as a colour banding but planar surfaces represent an axial planar schistosity. Chemical analyses of the phyllite are listed in Table 5.

At the northwest corner of Great Island and at Tadoule Lake, rocks equated with the phyllite (22a) at the type locality, exhibit a greater degree of recrystallization. At the northwest end of Great Island, along Seal River, the rock is an andalusite-garnet-biotite-sericite + chlorite-quartz schist (22a) with red pinhead garnets displaying a primary interlayering of micaceous and quartzite laminae intersected by a prominent fracture cleavage and schistosity. Moderate to pronounced transposition of primary layering is detectable. The alignment of the sericite defines a schistosity that gives the rock the structure of a phyllite to a very fine grained schist. The underlying volcanic rocks (7b) are highly foliated, and in places garnetiferous. Younger graphitic and pyritic slickensided shear zones are also present along the contact indicating repeated episodes of faulting and recrystallization. The relatively high metamorphic grade of the garnet-andalusite-biotite-sericite + chlorite-quartz schist may indicate that it is part of a zone of deformation at the base of the Great Island Group. The chemical analyses are listed in Table 5.

This rock type (22a) outcrops on a series of islands on the west side of Tadoule Lake where it is a medium grained cordierite-sillimanite-muscovite-biotite-quartz schist. Primary layering although present is detectable only under the closest scrutiny. The planar fabric of the rock is a schistosity which cuts the faint or "ghost-like" primary layering. This relict primary layering is a colour variation of alternating thick (3 cm to 3 m) silvery buff layers and thin (3 mm to 1 cm) dark green to black bands. The darker bands contain more quartz-rich buff layers. These micaceous minerals are aligned at an angle to the primary layering within even the thinnest beds. These planes of penetrative schistosity have a silvery appearance due to the fine grained and disseminated habit of the biotite and muscovite. Cordierite is present as an accessory mineral and forms rectangular-shaped inclusion-filled porphyroblasts 1 to 2 cm long. This habit of cordierite is unique to this rock type. Elsewhere in the project area cordierite is deformed into lenticular augen in paragneiss and migmatites or forms large pegmatitic clots within anatectic pegmatites.

Metaconglomerate and impure metasiltstone (23)

This rock type outcrops as a zone of discontinuous exposures trending east across the central part of Tadoule Lake. The conglomerate is concentrated in exposures along the shore of Tadoule Lake whereas the siltstone, with pebble layers, occurs inland immediately east of the lake. The conglomerate forms small knobby weathering outcrops of low relief. The matrix-supported cobbles of feldspathic quartzite stand in relief relative to the more easily weathered fine grained biotite-feldspar-quartz matrix. The feldspar grains have diffused boundaries within the siliceous matrix of the cobbles. The matrix of the conglomerate comprises very fine- to medium-grained disseminated biotite within feldspar (20 - 40%) and quartz. The matrix has a moderate to good foliation. However, the cobbles appear to be relatively undeformed.

The metasiltstone is grey on the weathered and fresh surfaces. The primary layering is defined by planar concentrations of biotite and muscovite alternating with beds of massive metasiltstone with a sucrosic texture. The micaceous layers are silvery green in colour. The pebbles either form thin layers or occur as isolated clasts. The size of the pebbles range from 3 mm to 2 cm. The composition of the pebbles comprises vein quartz, quartzite, white trondhjemite, and gneissic pebbles and cobbles. The white trondhjemite pebbles are very similar to the palingenetic derived trondhjemite (30) whereas the gneissic pebbles are very similar to the lineated granodiorite (B) immediately to the east of Tadoule Lake. If indeed these pebbles are derived from the Hudsonian igneous rocks (30) and the older granodioritic terrane (B) it implies a period of uplift and erosion of the metamorphic terrane synchronous with the deposition of the conglomerate and metasiltstone (23). The uplift may represent only a localized fault complex based on the restricted nature of the occurrence of the metaconglomerate and siltstone (23). The conglomerate and metasiltstone (23) are folded into open folds which plunge to the west at approximately 40 degrees. Quartz is mobilized into the axial planar fracture cleavage. The degree of metamorphism and style of deformation is similar to that exhibited by rocks of the Great Island Group at Great Island.

Dolomitic marble (24)

This rock type outcrops at Great Island. Several occurrences lie on the north side of Great Island with a small frost-heaved occurrence at the east end of Great Island where the north and south channels of the Seal River merge. Another occurrence, not observed at the surface, was noted in a drill hole collared along the south bank of Seal River 10 km east of Great Island (Location D-20, Map GR80-9-12).

The metadolomite (24) weathers pink to red due to iron staining. Abundant lath- to rod-shaped greenish-white clinochlore porphyroblasts are present. Quartz occurs as discontinuous anastomosing quartz veins, lenses and disseminated grains indicating contemporaneous deposition of silica sand and carbonate minerals and subsequent partial mobilization of the quartz. The occurrence of the Mg-Al chlorite, clinochlore, in the presence of excess quartz indicates medium to low temperature of metamorphism.

Black meta-argillite, with quartz pebbles (diamictite) (25)

This unique rock type has only one occurrence which is along North Knife River. However, its unusual character merits giving the rock type a unit designation.

The matrix of this rock type with highly contrasting grain size is a grey to black argillaceous material which contains rounded quartz clasts. The clasts range in size from 5 mm to 1 cm and make up 25 per cent of the rock. The clasts are distributed throughout the argillaceous material and are matrix-supported.

Garnet-amphibole schist (iron formation) and pyritic meta-argillite (26 and 26a)

The argillite is made up of:

i) layered garnet-magnetite-amphibole layers, magnetite-amphibole layers and massive magnetite layers (26).
ii) garnet-amphibole meta-argillite and slate with discontinuous layers of massive pyrite and pyrrhotite-bearing argillite (26a).

The iron formation (26) underlies the south half of the Meades Lake basin and is exposed along Seal River on the north side of Great Island. The aeromagnetic maps at a scale of 1 inch to 1 mile indicate an arcuate shape for the trend of this body which dies out to the north. Other occurrences are along the south side of Great Island in the Seal River channel and a single exposure east of Great Island and inland 1 km north of the river.

A brilliant red weathering layered magnetite-amphibole iron formation occurs along Seal River on the north side of Great Island. The outcrop comprises a red shale with acicular grains of amphibole locally altered to a brilliant white. A green shaly zone, possibly derived from a pyrite member of the iron formation, occurs structurally below the red weathering zone. The fresh magnetite-amphibole iron formation was observed only in drill core. The diamond drilling was carried out in the early 1950's by the Great Island Prospecting and Development Syndicate (Location D-8-10, 12-14, Map GR80-9-12, Table 11). Other drill locations were along Seal River at the eastern limits of the Great Island Group east of

Great Island. Some of the drill core is stored at a drill site along Seal River east of Great Island. The iron formation in the drill core comprises layers 2 cm to 2 m thick of disseminated magnetite (10 to 15%) within acicular olive-green amphibole crystals oriented in a random and radiating pattern, alternating with layers of massive magnetite and minor olive-green amphibole. The magnetite layers are 2 mm to 1 cm thick.

The garnet-amphibole meta-argillite and slate (26a) occurs interlayered with the grey-green phyllite along Seal River, on the south side of Great Island. The rock weathers grey and/or brown with a smooth dense surface and pronounced layering. The layering is defined by garnet-amphibole layers interlayered with dense hard argillite which sporadically contains pyrite and pyrrhotite. The garnets are deep red, small and pinhead-sized whereas the amphibole is black and acicular. A second occurrence of the garnet amphibole and pyrite- pyrrhotite-bearing iron formation outcrops east of Great Island 1 km north of the Seal River.

Metagreywacke (27)

The metagreywacke forms a series of high blocky ridges that define the Meades Lake basin north of Great Island. It overlies either a silicate iron formation (26) at the south end of the basin structure or an interlayered quartzite-phyllite sequence (22) in the northern two-thirds of the basin. The nature of the contact underlying the subgreywacke is uncertain. The overlap of the metagreywacke on the two underlying lithologies (22 and 26) indicates either a regressive cycle of sedimentation or a fault contact. The metagreywacke (27) displays graded bedding where it outcrops in large cliffs at the south end of the basin. The graded bedding information indicates that the metagreywacke is steeply dipping and overturned to the north. Therefore, the possibility of a fault contact between the metagreywacke and iron formation exists in this zone of deformation. Elsewhere around the basin the metagreywacke conformably overlies the interlayered quartzite and phyllite (22) and the beds dip towards the centre of the north-trending oval-shaped basin.

The metagreywacke is light grey on the weathered surface with prominent milky white to bluish-white quartz clasts. The rock is dark grey on the fresh surface, medium- to coarse-grained, and massive to weakly foliated. The foliation is a fracture cleavage. The mineralogy of the metagreywacke comprises plagioclase (35%), microcline (20%), quartz (35 - 40%), and lithic fragments (5%). The lithic fragments comprise plagioclase plus quartz. The clasts are angular to subrounded. The matrix occurs as interclast void fillings and is fine grained feldspar, quartz and sericite. The rock has a weakly metamorphosed appearance.

The marked contrast between the grain size, angularity and composition of the clasts of the metagreywacke compared to the underlying quartzite and interlayered phyllite indicates a dramatic change in the pattern of sedimentation. This apparent sharp change to a more immature type of sediment suggests a period of rapid uplift in a distant source area accompanied by rapid erosion and the resultant influx of new detritus. The 700 m to 1 km thickness of the metagreywacke indicates subsidence of the basin was also taking place.

Red to green metagreywacke and interlayered green phyllite (27a)

This rock type was observed only along North Knife River. It forms low flat step-like outcrops which display differential weathering. The metagreywacke varies from red to grey-green depending on the hematite and chlorite content. Quartz grains (40%) are generally clear to grey or white but at one locality the quartz grains are a distinctive milky blue-white. This type of quartz is a characteristic feature of the red granite (32c) which outcrops north and south of North Knife River. The microcline which occurs in metagreywacke with these quartz grains is a deep orange-red which is also characteristic of the microcline feldspar in the red granite (32c). At one locality inverted bedding is indicated by well preserved rip-up structures at the contact of an arkose and meta-argillite.

The presence of this coarse, more immature clastic metasediment may correspond to the deposition of the metagreywacke (27) in the Meades Lake basin north of Great Island.

Metasiltstone and meta-argillite (28)

This rock type occurs within the core of the Meades Lake basin immediately north of Great Island. It apparently represents the youngest unit of the Great Island Group and overlies a coarsely clastic metagreywacke to subgreywacke (27). This lithologic unit (28) is a sequence of interlayered thin beds of buff metasiltstone and thick layers of grey meta-argillite. The micaceous minerals (Appendix I) are aligned parallel to the bedding, the exception being in fold hinges where incipient to well defined axial planar cleavage, to phyllite schistosity is present in minor folds. Very fine grained garnets and quartz mobilization occur sporadically in these zones of deformation.

"Churchill quartzite" (29)

The type locality for the "Churchill quartzite" is in the area of the town of Churchill. The quartzite outcrops in a series of ridges west and east of the mouth of Churchill River. Rock types on these ridges comprise an interlayered series of orthoquartzite, proto-quartzite and minor conglomerate. The clastic material is dominantly fine- to medium-grained rounded quartz grains and, where lithic components are present (0 - 3%), clasts of quartzite. The only other prominent components are authigenic sericite (3 - 25%), minor very fine grained chlorite (0 - 3%), and hematite (1 - 5%). Chemical analyses of the Churchill quartzite are listed in Table 6. Sericite and chlorite are considered to be derived from void-filling clay minerals because of their disseminated distribution in the rock. Hematite occurs on bedding planes and as disseminated very fine grains, indicating an oxidizing environment of deposition. The Churchill quartzite is interpreted as a series of interlayered protoquartzites and orthoquartzites (Fig. 11) using Bokman's (1955) sandstone classification scheme.

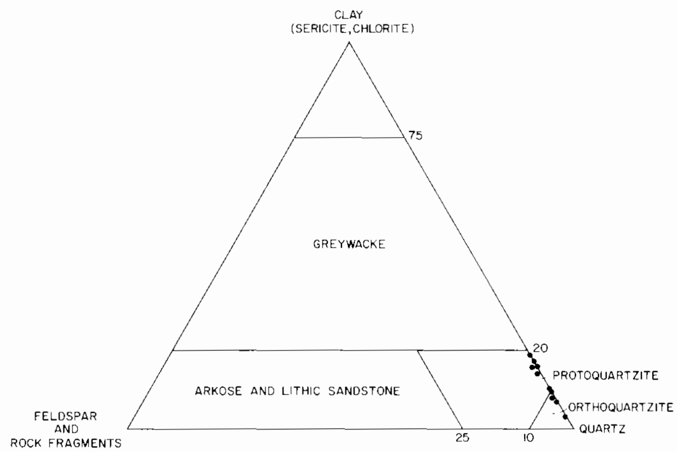


Figure 11: Sandstone classification applied to the Churchill quartzite, (29), Churchill, Manitoba (classification after Bokman, 1955).

An appraisal of the lithofacies distribution is based on the occurrence of conglomerate lenses, primary structures and trends in mineralogy. Conglomerate lenses are abundant in ridges east of Churchill River especially in the area east of 94 degrees. An isolated occurrence lies 55 km southwest of Churchill at Lofthouse Lake. At these localities the conglomerate makes up 15 - 20 per cent of the

TABLE 6: CHEMICAL ANALYSES OF QUARTZITES FROM NICHOL LAKE (22) AND FROM CHURCHILL QUARTZITE (29)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SiO_2	90.40	97.00	97.65	97.20	90.90	87.95	87.25	88.70	87.05	87.55	75.70
Al_2O_3	7.64	1.62	0.98	1.27	4.66	6.20	6.35	6.02	6.51	6.36	12.87
Fe_2O_3	0.06	0.31	0.60	0.68	1.88	2.44	2.96	1.35	0.74	2.21	3.82
FeO	0.1	0.12	0.12	0.12	0.16	0.16	0.16	0.16	0.99	0.16	0.28
CaO	0.05	0.07	0.00	0.01	0.03	0.01	0.01	0.01	0.25	0.04	0.01
MgO	0.03	0.05	0.02	0.02	0.21	0.11	0.11	0.30	0.58	0.17	0.89
Na_2O	0.13	0.02	0.02	0.04	0.05	0.03	0.04	0.03	0.06	0.04	0.07
K_2O	0.23	0.49	0.21	0.28	1.45	1.69	1.86	2.03	2.72	1.89	3.82
TiO_2	0.08	0.04	0.04	0.05	0.12	0.19	0.25	0.14	0.20	0.20	0.43
P_2O_5	0.00	0.02	0.04	0.03	0.02	0.03	0.02	0.01	0.03	0.04	0.04
MnO	TRACE	TRACE	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.05
H_2O	1.00	0.42	0.28	0.46	0.81	0.38	0.76	0.95	1.03	1.12	1.88
CO_2	0.23	0.15	0.12	0.14	0.15	0.27	0.08	0.15	0.18	0.15	0.15
TOTAL	99.95	100.33	100.09	100.30	100.45	99.95	99.85	99.84	100.35	99.94	99.81

Sample Locations
(1) Nichol Lake, Unit 22, 122 km west of Churchill; UTM 660490 mE, 6504900 mN
(2) Bird Bay, Unit 29, 17 km east of Churchill; UTM 451000 mE, 6507970 mN
(3) West of Churchill and Churchill River, Unit 29; UTM 425550 mE, 6507970 mN
(4) West of Churchill and Churchill River, Unit 29; UTM 425550 mE, 6507970 mN
(5) West of Churchill and Churchill River, Unit 29; UTM 425700 mE, 6510750 mN
(6) West of Churchill and Churchill River, Unit 29; UTM 430100 mE, 6518775 mN
(7) Mosquito Point west of Churchill River, Unit 29; UTM 430350 mE, 6505650 mN
(8) Northeast of Airport, Unit 29; UTM 441350 mE, 6513170 mN
(9) West of Airport, Unit 29; UTM 437500 mE, 6513170 mN
(10) West of Churchill, Unit 29; UTM 426625 mE, 6513400 mN
(11) North of Airport, Unit 29; UTM 439200 mE, 6513925 mN

outcrop. The conglomerate lenses are generally 10 cm to 1 m thick and have a concave-up lens-shape when viewed in cross-section. They occur within areas of trough crossbedding and at the base of scour channels. Clasts range from 1 to 10 cm in diameter and are rounded to well rounded. The clasts comprise vein quartz, quartzite, dark grey impure metasiltstone and very rare, medium buff granodiorite. At Lofthouse Lake the conglomerate contains an abundance of subrounded medium grained granite pebbles and subrounded to subangular pegmatitic microcline pebbles in addition to the clast types observed at Churchill. The matrix of the conglomerate is sericite, chlorite and quartz. North of the Churchill airport, the conglomerate makes up less than 5 per cent of the outcrop and isolated cobbles in the protoquartzite are common. Further west, in the area of Fort Prince of Wales, on the west bank of Churchill River, the conglomerate lenses are rare, and the clasts occur as isolated pebbles and cobbles.

A concentric colour zonation is a common feature exhibited by pebbles in the Churchill quartzite. The concentric zones range from 2 mm to 1 cm in thickness (Fig. 12). The zoned weathering of the pebbles is compatible with alteration in an oxidizing and subaerial environment of deposition such as has been suggested for the Churchill quartzite. The random occurrence of zoned pebbles within the conglomerate lenses suggests that the pebbles were weathered prior to the reworking and subsequent deposition in scour channels.

Current crossbedding of the trough (festoon) type and asymmetric crossbedding are common primary structures on the east side of Churchill River. This type of crossbedded protoquartzite is interlayered with tabular bedded protoquartzite with asymmetric crossbedding. On the west side of Churchill River the trough crossbedding is still common, but becomes less abundant in the rocks 4 km southwest of Fort Prince of Wales. Beyond this point tabular bedding with minor asymmetric crossbedding is more common. It is in these zones of tabular bedding that the most distinct interlayered sequences of protoquartzite and orthoquartzite beds are observed. The layers of orthoquartzite are from one-half to 2 m thick, interlayered with quartzite layers 2 to 4 m thick. Isolated cobbles up to 3 cm in diameter occur sporadically. In general, the primary layering in the most southwest ridges on the west side of the river is more or less obscured by the schistosity. The protoquartzite beds consistently contain 20 per cent sericite whereas this mineral is less abundant in the orthoquartzite.

In summary the coarse clastics and trough crossbedding, both indicators of high velocity currents, decrease from east to west in the area of Churchill. Tabular bedding is more common in the southwest-trending ridges, west of Churchill River. An increase in the sericite content of the protoquartzite is coincident with the increase in tabular bedding.

However, this apparent lithofacies pattern does not imply that the current direction was from east to west. Based on limited current bedding direction measurements the main current direction was to the north and northeast (Fig. 13). The conglomerate at Lofthouse Lake is located 55 km southwest of Churchill but it is uncertain whether it can be used to indicate a southwesterly trend for the conglomerate phase of the Churchill quartzite.

The high maturity of the quartzite, the polymodal festoon trough crossbedding, sporadic ripple marks, graded bedding and conglomerates indicate the Churchill quartzite was probably deposited in a shallow water, current dominated sand flat dissected by tidal and fluviatile channels.

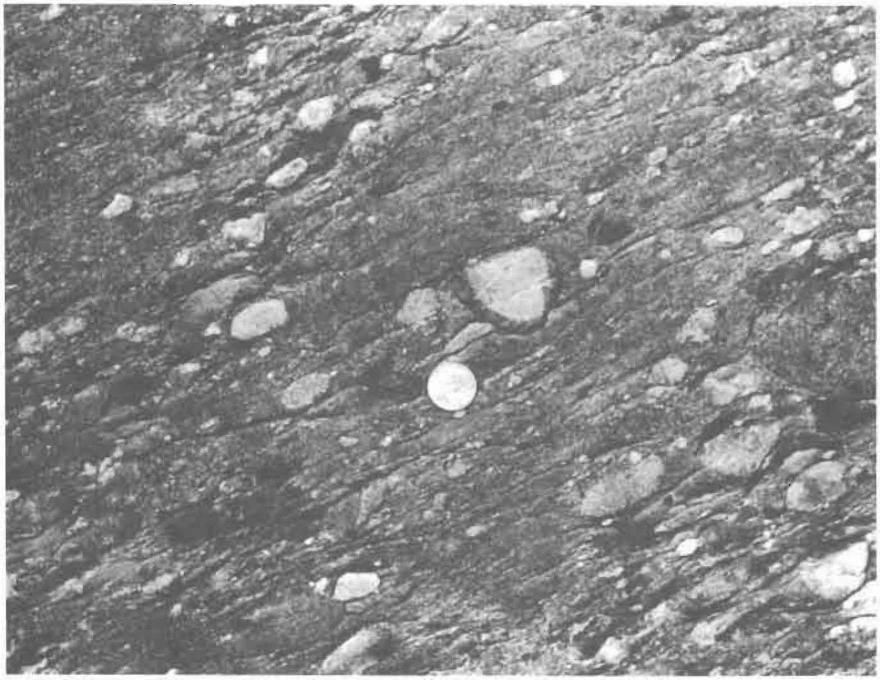
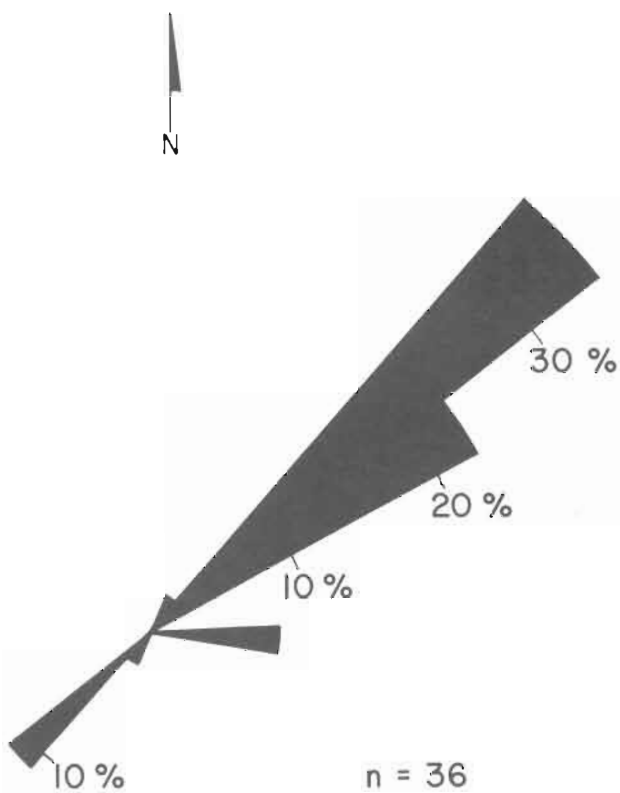


Figure 12: Zoned pebbles in Churchill quartzite, (29).

Figure 13: Plot of restored trough crossbedding, Churchill quartzite.



The rocks of the Churchill region have been metamorphosed and deformed. The protoquartzite is well foliated to weakly foliated and varies from a fracture cleavage to a schistosity. The foliation is generally at a very high oblique angle to the bedding on the east side of Churchill River but is parallel or slightly oblique to the bedding in the rocks of the southwest ridges on the west side of Churchill River. The schistosity is defined by the alignment of sericite and locally by elongation of quartz clasts (Fig. 14). In the conglomerate the clasts are often aligned parallel to the foliation. The re-alignment is most evident in impure metasiltstone clasts. The schistosity is very intense in narrow northeast- and north-trending shear zones. These zones are up to 10 m wide, and comprise alternating weakly foliated buff planar layers containing abundant sericite. In the area of 94 degrees longitude some shear zones contain pyrite and weather to a rusty surface. The less sheared protoquartzite in these areas may locally exhibit a pale green colour possibly due to secondary sericite.

Mobilized quartz occurs as veins and as tensional fracture fillings. In many instances these quartz-filled tension gashes have been deformed into a sigmoidal shape. More than one age of quartz veining is indicated by the presence of folded quartz veins cut by later non-folded veins. Veins range in size from 1 mm to 2 m and commonly contain coarse grained specular hematite. Pegmatitic lazulite and chlorite are rare accessories in the quartz veins. The lazulite is blue, massive and forms irregular-shaped bodies up to 4 cm across. The most abundant occurrences of lazulite are in the area of Cape Merry on the east bank of Churchill River.

The Churchill quartzite (27) in the area of Churchill has been of interest for uranium exploration for some time. Bostock (1969) indicated several important differences between this rock and the uranium-bearing conglomeratic Matinenda Formation of the Elliot Lake-Blind River area, Ontario. The nature of the source area was different as indicated by the quartz and plutonic pebbles in the Matinenda Formation as opposed to the mainly quartz and quartzite to protoquartzite pebbles in the Churchill quartzite. Feldspar is common in the Matinenda whereas it is virtually absent in the Churchill quartzite. Perhaps one of the most significant contrasts is the presence of abundant coarse grained pyrite associated with the radioactive minerals in the Matinenda Formation, as opposed to the presence of specular hematite along the bedding planes and as disseminated grains in the Churchill quartzite. The potential for deposition of uranium in the oxidizing depositional environment of the Churchill quartzite would be low, making this rock more unfavourable for significant primary accumulation of uranium. Airborne radiometric surveys and follow-up ground examination by Imperial Oil of Canada in 1977 (Reference Nos. 21a, 21b, Table 9) is the most recent examination of the uranium potential. The ground survey indicated small and localized minor concentrations of uranium in what appears to be bedding plane concentrations of heavy minerals.

HUDSONIAN IGNEOUS AND ANATECTIC ROCKS

The Hudsonian igneous and anatectic rocks comprise:

i) synkinematic granitic stocks and sills formed through partial anatexis (units 30 and 31), of pre-existing semi-pelitic and quartzofeldspathic rocks;

ii) late orogenic, post-kinematic high level plutons and a batholith (32).

The late orogenic nature of the latter is self-evident from their discordant relationship to the Hudsonian structures.

White granite to quartz monzonite and trondhjemite (30)

This rock type forms stocks, sills and *lits* within the semi-pelitic gneiss, psammitic gneiss and calc-silicate layered rocks. The occurrences of granitic rocks of this type are coincident with areas within which the metasediments display the highest grade of metamorphism. They range from large stocks to intimately interlayered and discontinuous *lits* and irregular anastomosing networks on outcrop scale. The Munroe Lake and the west half of the Tadoule Lake, the Nejanilini Lake and the Caribou River map areas contain many examples of this rock type. The largest bodies occur in the Nueltin Lake area in the northwest corner of the Munroe Lake map area. These granitic rocks (30) are considered to represent products of partial anatexis of the enclosing metasedimentary gneisses.

Weathered and fresh surfaces are characteristically white. The rocks (30) are coarse grained to pegmatitic, with local fine grained phases; accessory garnet is characteristic. The presence of

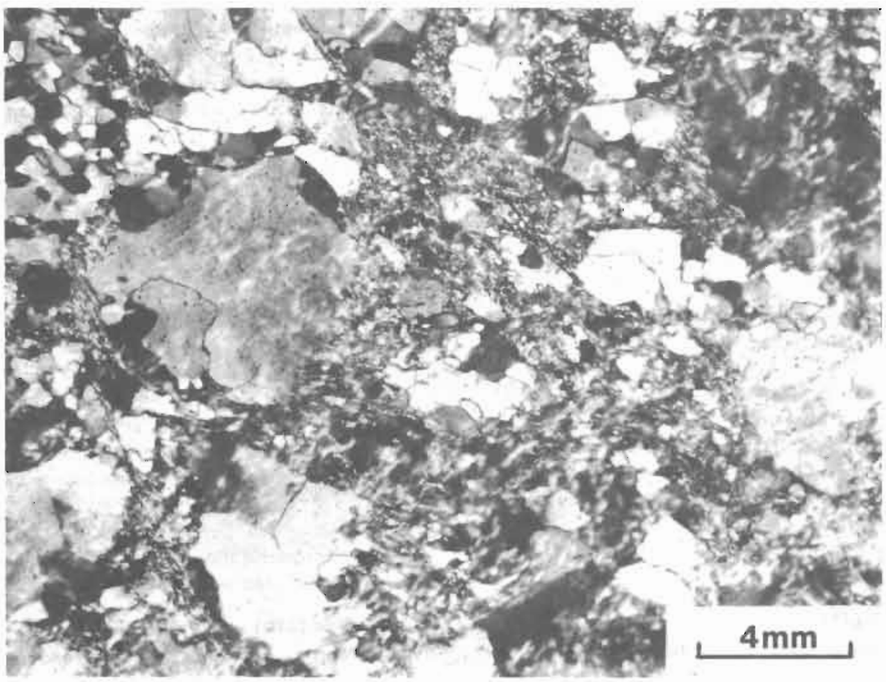


Figure 14: Churchill quartzite schistosity (photomicrograph, crossed nicols).

accessory cordierite, black tourmaline and rare hornblende is apparently controlled by the nature of the host rock. Cordierite or cordierite-garnet are present as accessory minerals in the white granitic rocks within areas of the semi-pelitic and aluminous quartzite rocks. Cordierite-tourmaline or tourmaline are common within interlayered semi-pelitic (6a) biotite psammite (16) and calc-silicate (17) sequences. This is especially true in the region along North Seal River between Bain Lake and Stony Lake (Tadoule Lake map area). Hornblende as an accessory mineral is rare and appears to be confined to occurrences of the anatectic granite within areas of layered calc-silicate and biotite psammite rocks. This variety of the anatectic granite (30) is undersaturated in quartz (5 - 10%) and the feldspar is a bone white to cream colour.

The unit ranges in composition from a granite to quartz monzonite with some overlap into the undersaturated granodiorite field (Fig. 15). The texture is generally massive, but a cataclastic

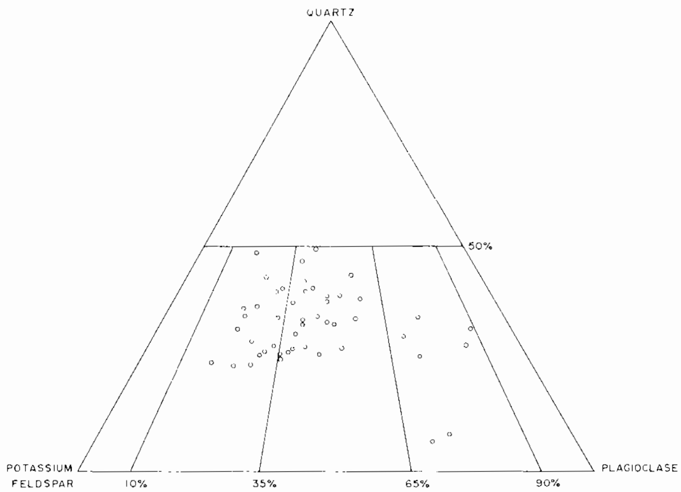


Figure 15: Triangular plot of anatectic quartz monzonite (30).

foliation may be superimposed, in zones of later shearing. Quartz, potassium feldspar, plagioclase and biotite form a hypidiomorphic-granular texture. The mafic minerals show a weak preferred orientation and are either disseminated, or aggregated into clots. Quartz can be aligned into a platy fabric parallel to the axial planes of the younger phases of folding or shearing. However, within the anatectic granite, symplectic intergrowths of quartz and garnet, cordierite-garnet-quartz or cordierite-quartz up to 12.5 cm in diameter, appear to postdate the youngest phase of folding.

Porphyritic white granodiorite (30a)

The granodiorite outcrops 15 km south of Nicklin Lake where it forms a circular stock at the west end of a body of white trondhjemite (30).

The rock weathers white and is grey on the fresh surface. The granodiorite is porphyritic with coarse- to medium-grained matrix and is massive to weakly foliated. The plagioclase phenocrysts An_{28-32} are 1 to 2 cm in a matrix of plagioclase An_{26-34}. Perthitic microcline constitutes 15 per cent of the phenocrysts and the matrix.

The rock type has been recognized only in this area. Field relationships clearly indicate the granodiorite has intruded the meta-arkose (20).

Granite to quartz monzonite (31)

The rock type is the main map unit in the south half of the Whiskey Jack Lake area (Map GR80-9-1). It also forms part of the granitic rocks that make up the Chipewyan Batholith which covers the southern quarter of the project area. Other occurrences have indistinct gradational boundaries with aplitic rocks (31b) and hybrid rocks (31a). These occurrences can be linear in shape, such as the zone immediately north of Seal River between Stony Lake and Shethanei Lake whereas other occurrences in the Nejanilini Lake domain contain irregular-shaped plutons. Contacts with rocks of the granitoid basement are in general gradational. Modal analyses are indicated in Figure 16 and chemical analyses in Table 7.

Characteristic features of the aplites (31) are their pink colour, both on fresh and weathered surfaces and their hypidiomorphic, granular and massive texture. The grain size generally is medium to coarse but locally pegmatitic. A sporadic yet prominent gneissosity is developed as a result of incipient cataclastic deformation. This is defined by the ovoid nature of the feldspar and the lenticular aggregation of quartz. The quartz aggregations may also contain biotite.

Deformation and recrystallization of the Hudsonian granite to quartz monzonite (31) produces a rock similar in character to the older foliated quartz monzonite (5). Consequently, because of their similar composition and comparable textures, these two rock types cannot readily be separated in the absence of clear contact relationships. Hence, the increase in the volume of younger quartz monzonite to the east of the Whiskey Jack Lake map area (Map GR80-9-1) may only be an apparent increase and may incorporate areas of the older foliated quartz monzonite (5).

A possible criteria for the distinction of Hudsonian rocks is their generally higher uranium background values and localized areas of uranium enrichment. This can be demonstrated in areas where field relationships indicate the presence of Hudsonian intrusive rocks. However, this criterion is not absolute. Areas previously mapped as the older foliated quartz monzonite (unit 5, this report, 4 in Kasmere Project), in the Colbeck Lake area of the Kasmere Project (Weber et al., 1975a) display similar background values which may be due to the presence of younger Hudsonian granites (31 and 32) undetected during earlier mapping. Alternatively, there could be an overlap in the background values of uranium for these two similar rock types.

Hybrid quartz monzonite (31a)

Zones of hybrid quartz monzonite have been mapped in the Nejanilini domain, specifically within the Nejanilini Massif east of Nejanilini Lake and extending to the region north of Caribou Lake. The "hybrid" also outcrops in a narrow northeasterly trending zone that extends from Burnie Lake through Egenolf Lake to the Blackfish Lake area. The occurrences of hybrid quartz monzonite comprise areas of megacrystic medium- to coarse-grained quartz monzonite, foliated biotite-quartz monzonite and irregular-shaped areas of metasomatized and altered hypersthene-bearing monzocharnockite (2c). These rock types have gradational boundaries.

The potassium feldspar within all the rock types of this hybrid zone has a distinct brown and pink varigated coloration. Within the areas of foliated quartz monzonite (31) the pink coloration prevails and brown is subordinate. Within and marginal to areas of monzocharnockite the microcline is dominantly brown with anastomosing zones of pink being subordinate. Irregular-shaped areas of the massive to weakly foliated pink megacrystic quartz monzonite may represent zones of younger metamorphic rocks derived by partial melting of basement rocks. This is suggested by the faint mottling of the microcline in the megacrystic quartz monzonite zones. The megacrystic quartz monzonite phase is very evident in areas peripheral to the quartz monzonite (31) and porphyritic quartz monzonite (32) which occur within the Nejanilini Massif in the area of Round Sand Lake.

Pink aplite (31b)

The pink aplite (31b) appears to have broad tectonic controls as indicated by its field occurrences. It outcrops in areas peripheral to the basement rocks and cover rocks of Sequence I as part of a tectonized, altered and recrystallized contact zone.

This rock type outcrops within a zone of reactivated basement rocks between Lac Brochet and Chatwin Lake (Whiskey Jack Lake map area GR80-9-1). It also occurs within a roughly triangular-shaped zone which has Burnie Lake, Booth Lake and the west end of Great Island as the apices of the triangle (GR80-9-9). The aplite forms linear zones to domal structures generally having gradational contacts with the Hudsonian igneous rocks and with the basement rocks. It displays igneous relationships with the paragneisses and migmatites of Sequence I rocks.

The largest zone of the aplite is a zone extending from Stony and Munroe Lakes southeast to the west end of Great Island. The aplite in this zone is ultimately associated with inclusions of biotite and hornblende hybrid gneisses (31d) of arkosic appearance. The aplite itself displays large areas where cataclastic and annealed cataclastic foliation are common.

The rock has a distinct translucent pink colour. This colour may locally be masked by an orange-brown stain due to surface weathering of the oxides and biotite. The quartz content is generally uniform; however, localized extreme variations do occur in syenitic zones and extremely quartz-rich zones. These variations can be related to contact zones around inclusion blocks. The low quartz content of the included material, such as the inclusion of quartz-poor hornblende gneisses (31d), gives rise to undersaturated contact phases and also the presence of accessory amphibole. The quartz-rich phases can be related to areas of quartzite-rich inclusions or annealed silicified cataclastic zones.

The pink coloration of the aplite is due in part to hematite which is a common accessory. The plagioclase is well twinned, visible even on the fine grains. In general the plagioclase displays a platy or a rodded structure imparting a foliation and/or lineation to the rock.

Biotite ± hornblende granite gneiss (31c)

This rock type occurs principally in the south half of the Caribou map area (Map GR80-9-5). It forms a narrow zone which lies within an area of Hudsonian quartz monzonite (31) and porphyritic quartz monzonite (32).

The rock is pink and displays a discontinuous layering defined by concentrations of biotite and/or hornblende. This layering is also defined by thin indistinct inclusions of a granodioritic gneiss. Pink quartz monzonite similar to the Hudsonian quartz monzonite (31) constitutes up to 30 per cent of the rock type and forms *lits* and veins.

The granite gneiss (31c) forms an enclave within an area of intrusive rocks considered to be of Hudsonian age. The gneiss forms an east-trending zone apparently wedged between a large body of quartz monzonite (31) on its south and two large stocks of porphyritic quartz monzonite (32) on its north side. The gneiss (31c) with its attendant large volume of quartz monzonite sills, *lits*, and veins is a migmatite derived by intrusion and granitization of a country rock. The country rock is considered to have been a complex of the foliated porphyritic quartz diorite to granodiorite (Unit B), grey foliated tonalite to granodiorite gneiss (Unit A), and hypersthene-quartz monzonite (2c).

Hybrid gneiss (31d)

The hybrid gneiss occurs in the southeast corner of the Munroe Lake map area and in the northeast corner of the Tadoule Lake map area. These zones are narrow, irregular in shape and highly discontinuous. In the Tadoule Lake map area they form a zone of narrow faulted occurrences from Stony Lake to Overby Lake and eastward toward Shethanei Lake. The hybrid gneisses form only minor occurrences along Wolverine and Seal Rivers, east of Shethanei Lake, whereas in the Stony Lake to Seal River area hybrid gneisses (31d) form a complex zone, gradationally interlayered with aplite (31b). In the eastern occurrence along Seal and Wolverine Rivers it forms widely spaced small areas within the aplite (31b). Field relationships also indicate a progressive granitization of the hybrid gneiss to the east. The inclusion boundaries of the hybrid gneiss with the aplite are indistinct and the layering within the gneiss is poorly defined and is a relict layering. The potassium feldspar content and the microcline grain size increases. The hornblende poikiloblasts are well defined reaching 1 cm in length. They are very similar to those found within the less granitized hybrid gneiss (31d) the only difference being the larger size in the more highly granitized gneiss (31d). The large poikiloblasts of hornblende also display well

Figure 16: Modal plot of quartz monzonite (31).

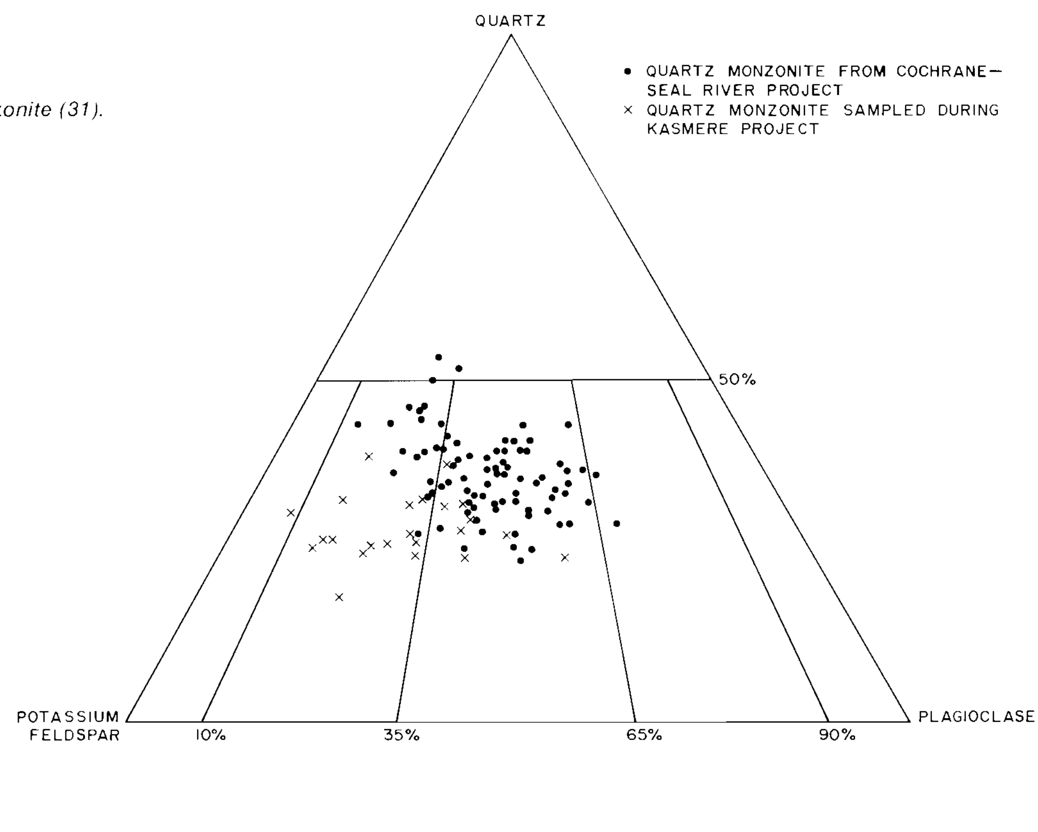


TABLE 7: CHEMICAL ANALYSES OF QUARTZ MONZONITE (31)

	(1)	(2)	(3)	(4)	(5)
SiO_2	72.45	73.35	72.0	70.45	76.4
Al_2O_3	13.00	12.65	13.0	13.3	11.65
Fe_2O_3	0.43	1.01	1.51	1.41	0.76
FeO	3.10	1.87	2.27	2.73	1.46
CaO	2.01	1.65	1.90	2.65	1.12
MgO	0.49	0.40	0.48	0.61	0.12
Na_2O	3.05	2.92	3.02	3.11	2.79
K_2O	4.51	4.86	4.49	4.12	4.51
TiO_2	0.52	0.38	0.49	0.61	0.24
P_2O_5	0.16	0.09	0.10	0.17	0.03
MnO	0.05	0.04	0.06	0.06	0.04
H_2O	0.32	0.62	0.67	0.57	0.52
CO_2	0.07	0.49	0.53	0.19	0.29
TOTAL	100.16	100.35	100.5	100.00	99.95

Sample Locations
(1) 28 km northwest of Great Island, UTM 625050 mE, 6555600 mN
(2) Darcis Lake area, 35 km north of Great Island; UTM 646250 mE, 6570125 mN
(3) Darcis Lake, 25 km north of Great Island; UTM 642250 mE, 6561675 mN
(4) Tourand Lake area, 25 km north of Great Island; UTM 653200 mE, 6561475 mN
(5) Darcis Lake, 25 km north of Great Island; UTM 642100 mE, 6560000 mN

defined coronas of fine- to medium-grained myrmekitic biotite and plagioclase which also appear to be forming at the expense of hornblende.

The hybrid gneiss also outcrops in the Greening, Copeland and Seddon Lakes areas at the southeast end of the Munroe Lake synform. The hybrid gneiss is also exposed along the north and south flanks of the Munroe Lake synform. On the northern flank it intimately interfingers with the grey foliated tonalite to granodiorite gneiss (Unit A) and on the south flank it forms a complex with the foliated tonalite (Unit B) and the quartz monzonite (31). Towards the northwest it forms smaller almost indistinct remnants within areas of the quartz monzonite.

The hybrid gneiss (31d) is medium grained and has a distinct layered appearance. In thin section it has a polygonized texture. It comprises grey-buff to honey-brown plagioclase An_{26-28} and pale pink microcline (60% combined) with disseminated biotite (3 - 8%) and lenticular to irregular-shaped elongate quartz grains (20 - 25%). Hornblende and a brown mineraloid, as aggregations, are sporadic accessories (0 - 3%). Magnetite is only of sporadic and minor occurrence. This compositional rock type is interlayered with pale pink granitic *lits* to aplitic *lits*.

A third, but less common, type of compositional layering is dense, mafic and sporadically interlayered with the previously described layers. These zones are in general discontinuous with an extent of up to 100 m along strike and a thickness of between 1 and 5 m. The rock is medium grained and comprises hornblende (5 - 8%) and biotite (3 - 5%). The hornblende is highly poikiloblastic and the margins are often intergrown with myrmekitic biotite and plagioclase. The plagioclase An_{28-36} (50 - 60%) and microcline (15%) form irregular-shaped but elongate grains. The quartz (15%) forms lenticular grains. Hypersthene and diopside are sporadic and minor in their occurrence. The diopside has incomplete or irregular coronas of hornblende. Hypersthene is fractured and altered to a red-brown mineraloid along the fractures. The hypersthene can also display a weak overgrowth of fine grained myrmekitic biotite and plagioclase. Magnetite (0 - 1%) is an accessory and displays coronas of fine grained biotite.

Porphyritic quartz monzonite (32)

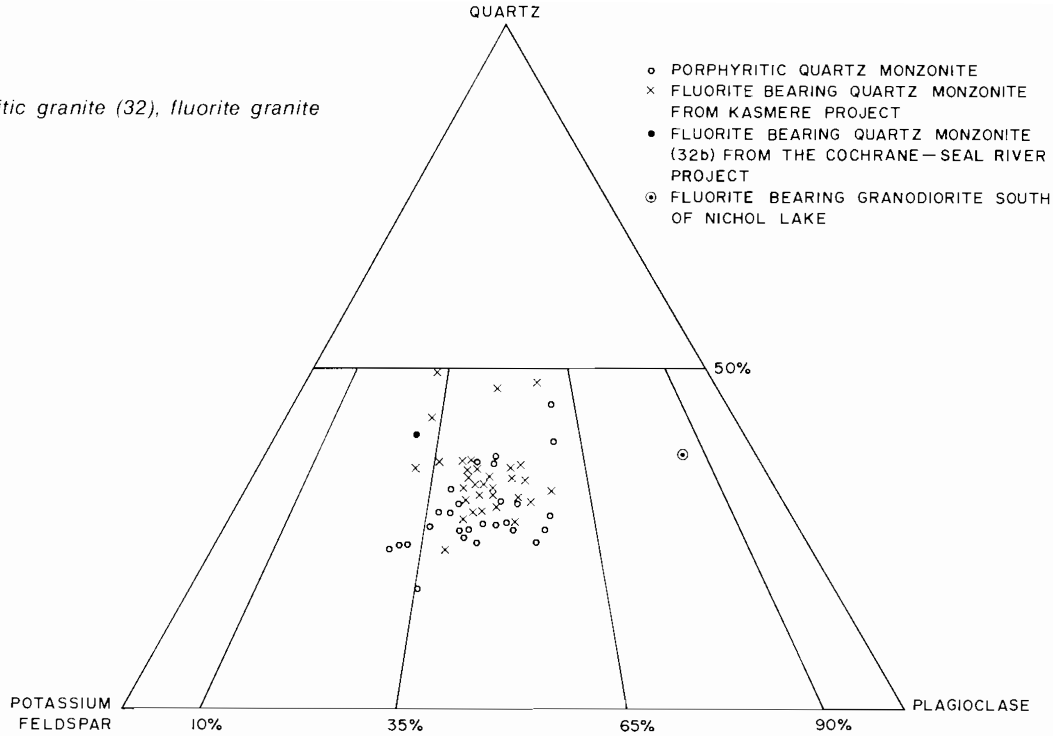
The porphyritic quartz monzonite (32) forms a batholith, the Topp Lake Pluton, which outcrops in the west half of the Munroe Lake map area (Map GR80-9-7). This body represents the eastern projection of a larger body three-quarters of which outcrops in the Kasmere Lake project area (Weber et al., 1975a) which lies to the west of the Munroe Lake map area. Rocks of the Topp Lake Pluton have yielded a Rb-Sr whole rock isochron age of 1815±62 Ma (I.R. 0.7113) (Weber et al., 1975b).

Three other occurrences outcrop within the Caribou Lake map area (Map GR80-9-5). One well defined stock lies immediately east of Caribou Lake. The areal extent of the two other occurrences are more poorly defined due to a paucity of outcrop in an area of reworked drift that falls within the zone of the retreating Hudson Bay shoreline. Samples from these plutons yielded a Rb-Sr isotopic age of 1795±60 (I.R. 0.7057) (Clark, 1981).

The porphyritic quartz monzonite is extremely homogeneous in composition (Fig. 17) and fabric over the entire outcrop area. This rock weathers pale pink on the weathered surface and is pink on the fresh surface. The rock is generally massive and has a typical hypidiomorphic granular texture. The characteristic phenocrysts (3 - 5 cm) are potassium feldspar, commonly showing Carlsbad twinning. The phenocrysts are randomly oriented. The potassium feldspar is partly microperthitic (fine string perthite) and locally forms myrmekitic intergrowths with plagioclase. Quartz is characteristically dark grey to black and shows signs of slight cataclasis. Biotite is the only mafic mineral and commonly is partially altered to chlorite.

The porphyritic quartz monzonite consistently displays the highest background for uranium and contains local occurrences of

Figure 17: Modal plot of porphyritic granite (32), fluorite granite (32b).



uranium mineralization and uranium enrichment. Results from lake centre sediment geochemical sampling during the Uranium Program Survey (URP) in 1976 and 1977 (Table 8) indicates a coincidence of molybdenum anomalies and the occurrence of the porphyritic quartz monzonite (unit 32 and 32b).

Pegmatite (32a)

Pegmatite, as mappable bodies, occurs in the Stony Lake, Tadoule Lake, Shethanei Lake and Munroe Lake areas. The pegmatites in these areas occur along the margins of the bodies of the Hudsonian quartz monzonite (31) and as dykes along faults and fractures. The pegmatites also occur as sills within the paragneiss to metasedimentary interlayered sequence of semi-pelite and quartzite in and south of the Tadoule Lake area. The sills are 10 - 50 m thick and are spaced 100 to 200 m apart. This gives rise to a small-scale ridge and valley terrain with the pegmatites forming the core of the ridges. The metasedimentary rocks are preserved at the base of the ridges or as a veneer on the dip slope of the ridges.

The pegmatite occurrences that appear to be emplaced along fracture systems display uranium enrichment in the Munroe Lake area and along a zone centered on the north shore of Shethanei Lake. Pegmatite dykes along Shethanei Lake have yielded a radiometric age of 1790 Ma from analysis of muscovite using the K-Ar radiometric dating method (Douglas, 1970).

Pegmatites are also abundant in the area of North Knife River south of Nichol Lake (Shethanei Lake map area). These pegmatites do not form mappable bodies but occur as dyke swarms along a north-trending fracture system. The dykes are several metres thick.

The feldspar is a perthitic microcline and the quartz is grey occurring commonly in graphic intergrowths. Biotite constitutes 2 - 15 per cent and frequently forms books up to 4 cm in size. Muscovite occurs sporadically and varies from 0 to 3 per cent.

Fluorite-bearing porphyritic quartz monzonite (32b)

This rock type occurs in the northwestern part of the project area in the Munroe Lake map area (Map GR80-9-7) immediately east of Nueltin Lake. It also outcrops in the southeast of the project area east of Nichol Lake and immediately east of Duddles Lake in the Churchill map area (GR80-9-4).

The quartz monzonite is white to pink on both fresh and weathered surfaces. It is composed of quartz, microcline, plagioclase and biotite (Appendix, Fig. 17) with a predominantly hypidiomorphic granular to porphyritic texture. Fluorite is the characteristic accessory mineral (average 1%) occurring in about 90 per cent of the analyzed sections.

In general the fluorite bodies of the project area are similar to the fluorite-bearing quartz monzonite of the Kasmere Lake Project. A potassium-argon age of 1735 Ma was determined from biotites of the Chekask Lake pluton (Lowden et al., 1963) in the Kasmere Project area. This date is in agreement with Rb-Sr whole rock isochron ages obtained from similar fluorite-bearing quartz monzonites around Nueltin Lake (1775 ± 59 [.7060 I.R.]; Wanless and Loveridge, 1972 and 1760 ± 16 [.7050 I.R.]; Wanless and Eade, 1975) in the Northwest Territories.

Fluorite-bearing white granodiorite (32c)

The fluorite-bearing granodiorite outcrops south of Nichol Lake and extends south of North Knife River. The southern extent is unknown due to extensive glacial and fluvial lacustrine clay deposits.

The rock forms large high ridges and has brilliant white to grey outcrop surfaces. The fluorite-bearing intrusions (32b) of the project area are relatively free of inclusions. This rock (32c) contains inclusions ranging in size from highly recrystallized muscovite-biotite-garnet-quartz aggregations several centimetres in length to bodies of more coarsely recrystallized interlayered semi-pelitic schists and quartzite several metres in length and thickness. The white fluorite-bearing granodiorite has accessory mineral assemblages unique to these areas of inclusions. Large muscovite and/or biotite books up to 25 cms in length can occur within pegmatite of the granodiorite (32c) in the areas rich in inclusions. Garnet and green tourmaline (rare) are also present. The content of biotite (5 - 10%) is higher than that found in the fluorite-bearing pink quartz monzonite (32b). Biotite concentrations are commonly aligned and give the appearance of a ghost layering.

In thin section the granodiorite is medium grained to pegmatitic and has a hypidiomorphic granular texture.

Red granite (32d)

This granite is of limited occurrence outcropping sparsely in a belt of poor exposure east of Nichol Lake extending to the North Knife River (Churchill map area GR80-9-4). Surface weathering of rocks in this area is non-diagnostic due to the intense bleaching of humic acid generated in this treeless peat-covered terrain. The rocks in this area weather white.

The granite on the fresh surface is a deep orange-red and the quartz grains are a distinctive milky blue. Trace pyrite and fluorite are commonly observed accessory minerals. This fluorite-bearing granite is more potassic, higher in quartz, and the anorthite content of the plagioclase An_{12-17} is lower than that observed in the other fluorite-bearing bodies (32b), and may represent a late differentiate.

POST-HUDSONIAN INTRUSIVE ROCKS

Diabase (33)

Outcrops of diabase were observed only at Great Island along the north and south side of Seal River in the river channel (Shethanei map area GR80-9-3). Several diabase dykes have been inferred on the basis of aeromagnetic anomaly patterns (Fahrig et al., 1965). Bostock (1969) noted:

"these dykes trend northwestwards and are therefore parallel to the Mackenzie swarm about 1200 Ma with which they have been correlated."

The dyke on the north side of Great Island trends in a northwesterly direction and is intermittently exposed over a strike length of 1 km along the river channel. The second exposure on the south channel around Great Island trends more northerly but its strike length is only 300 m with the exposure being three isolated outcrops trending across the river channel.

The rock weathers reddish brown. The plagioclase on the weathering surface is yellowish green. The rock has a medium- to coarse-grained ophitic texture grading to a trachytic texture at the finer grained margins of the dyke. In thin section the plagioclase displays zoning from An_{28} at the rim to An_{65} at the core. The plagioclase is moderately to heavily saussuritized. Clinopyroxene (30 - 35%) is augite or augite-diopside whereas olive-brown hornblende (8%) is a minor constituent. Magnetite and very minor pyrrhotite are present as accessory minerals.

TABLE 8: LIST OF FEDERAL GOVERNMENT PUBLICATIONS

YEAR	TYPE OF WORK	AREA, REPORT OR MAP	AUTHOR
1958	Regional Mapping, Scale 1:250 000	NTS 64I, Shethanei Lake; Paper 58-7	F.C. Taylor
1960	Regional Mapping; Scale 1:250 000	NTS 64K, Whiskey Jack Lake; Map 52-1960	K.L. Currie
1962	Regional Mapping; Scale 1:250 000	NTS 64N, Kasmere Lake; Map 31-1962	J.A. Fraser
1962	Regional Mapping; Scale 1:250 000	NTS 64J, Tadoule Lake; Map 30-1962	W.L. Davison
1963	Regional Mapping, Scale 1:250 000	NTS 64-O, Munroe Lake; Map 35-1963	W.L. Davison
1966	Regional Mapping, Scale 1:250 000	NTS 54M, Caribou River; Paper 65-25	W.L. Davison
1968	Regional Mapping, Scale 1:250 000	NTS 64P, Nejanilini Lake; Map 14-1967	W.L. Davison
1968	Regional Mapping, Map Scale 1:1 000 000 with detailed locations	Hudson Bay Lowlands (Operation Winisk); Paper 67-60	A.W. Norris, B.V. Sanford and R.J. Bell
1969	Regional Mapping, Map Scale 1:250 000	NTS 54E, F, K, L, Deer River; Paper 69-24	H.H. Bostock
1976	Uranium Reconnaissance Program (URP) Map Scale 1:250 000, Airborne Regional Radiometric Survey — 5 km line spacing and lake sediment geochemical sampling	NTS 64J, Lake Sediment Geochemistry; Open File Report 320	
		NTS 64J, Airborne Gamma-Ray Spectrometry; Open File Report 316	
		NTS 64K, Airborne Gamma-Ray Spectrometry; Open File Report 317	
		NTS 64N, Airborne Gamma-Ray Spectrometry; Open File Report 319	
		NTS 64-O, Lake Sediment Geochemistry; Open File Report 323	
		NTS 64-O, Airborne Gamma-Ray Spectrometry; Open File Report 319	
1976	Geochemical Follow-up Studies of Uranium Reconnaissance Program	Northwestern Manitoba; Report of Activities, Part C, Paper 76-1C, 1976	W.B. Coker
1976	Uranium Reconnaissance Program Scale 1:250 000	NTS 64P and 54M (W½); Lake Sediment Geochemistry; Open File Report 407	
		NTS 64P and 54M (W½); Airborne Gamma-Ray Spectrometry; Open File Reports 35764G and 35964, respectively	
		NTS 64I and 54L (W½); Lake Sediment Geochemistry; Open File Report 408	
		NTS 64I and 54L (W½); Airborne Gamma-ray Spectrometry; Open File Reports 36254G and 36354G, respectively	
1977	Uranium Reconnaissance Program Airborne follow-up, line spacing 1 km; scale 1:50 000	NTS 64N/6 and 64N/11, Airborne Gamma-Ray Spectrometry; Open File Report 430	

STRUCTURAL GEOLOGY

INTRODUCTION AND REGIONAL SETTING

The section of the Churchill Province in Manitoba lying north of latitude 58 degrees is a composite of:

i) an Archean granitoid terrane constituting a basement complex;
ii) a sequence of variably metamorphosed Aphebian cover rocks; and
iii) Hudsonian migmatites and intrusive rocks.

The interpretation of the deformation history is based on the identification of large-scale structures and the interference relationships of minor structures. Large-scale structures are delineated by lithostratigraphic units of Sequence I and/or Sequence II. The geometry of the large-scale structures has been reconstructed from primary layering trends in rocks of Sequence II whereas the geometry of the major folds in units of Sequence I has been deduced from changes in the trend of metamorphic layering and/or foliation. Subsequent deformational events are interpreted from the presence of younger metamorphic layering and/or foliations.

The concept of domains is used to identify zones, on a regional scale, that possess some unifying characteristic such as metamorphic grade, structure, lithology or a combination of all three. However, the boundaries between domains are often arbitrary limits since in many cases the criteria chosen to characterize a domain are regional but are simply better defined in only one area. The domain boundaries for the most part are complex zones that could be treated separately on a smaller scale of mapping (Figure 3).

1) *The Nejanilini domain* is dominated by the presence of Archean basement (Units 1, 2a, 2b, 2c), and probable Archean basement (Unit A).

2) *The Wollaston domain* is dominated by evidence of a pervasive northeast-trending deformation which has deformed Archean granitoid basement and the overlying supracrustal rocks of Sequence I.

3) *The Seal River domain* is dominated by east-trending more openly folded Sequence I supracrustal rocks which overlie reworked Archean basement. The Seal River has been subdivided into three subdomains based on structural style of deformation.

4) *The Great Island domain* is dominated by Sequence II supracrustal rocks which locally unconformably overlie Sequence I metavolcanic rocks and/or quartz diorite to granodiorite intrusive rocks. Quartz monzonite to granites intrude all of these rocks.

5) *The Chipewyan domain* is dominated by Hudsonian quartz monzonite to granite intrusions.

NEJANILINI DOMAIN

Foliated granitic and granitoid rocks dominate the Nejanilini domain. The foliation is steep in general; however, at Askey Lake an apparently monoclinal sequence of calc-silicate, marble and biotite psammite gneiss with minor quartzite (6b) and very minor pelitic gneiss (6) dips at moderate angles to the north. The contact of this sequence with the surrounding grey gneiss is poorly exposed. Grey to white trondhjemite commonly occurs in the contact zone with the surrounding tonalitic to granodioritic gneiss (unit A). Calc-silicate layering is also terminated along strike in areas of the grey trondhjemite. the field relationships indicate intrusion of a white trondhjemite in areas of large-scale boudinage of the calc-silicate layering. The layered sequence is offset by numerous north-trending faults as a sequence is traced towards Nejanilini Lake.

The Nejanilini Massif lies to the east of the Wolverine River fault (Fig. 3). This north-trending fault has an apparent left lateral displacement of 20 km, the Massif to the east having moved up relative to the block on the west side of the fault. This interpretation is based on the presence of rocks of a higher metamorphic grade within the Nejanilini Massif. Within the massif, as in Subarea III of the Seal River domain, enclaves or keels of sedimentary-derived paragneiss and migmatites occur within a granitic terrane. The granitic terrane contains large areas of well defined hypersthene-bearing quartz monzonite, retrograded equivalents and younger Hudsonian intrusive rocks. Stratigraphic relationships within the sedimentary-derived metamorphic suites are indistinct. The foliation for the most part is upright. However, low angle recumbent folds with amplitudes of several metres (Fig. 18 a,b) are defined by a metamorphic layering. These low angle structures postdate the S_1 metamorphic layering and indicate either thrust faulting or vertical flattening related to local diapirism of granulite basement.

The Nejanilini Massif is cut by numerous north-trending fractures which can be identified from Landsat imagery. Ground truthing of these lineaments indicates narrow discontinuous northerly zones of fracture cleavage on the flanks of well defined scarps. However, the amount and sense of movement is indeterminate.

The eastern boundary of the Nejanilini Massif appears to be defined by a zone of faulting and intrusion. Further east very limited exposure indicates a region of tonalite gneiss, tontalitic migmatites and broad areas of megacrystic biotite-quartz monzonite.

WOLLASTON DOMAIN

Definition and regional setting

The region encompassing the Wollaston domain lies in the northwest corner of Manitoba (Fig. 19). It is proposed that the Wollaston domain in Manitoba be restricted to the zone of prominent northeast-trending major and minor structures that extend from the north shore of Whiskey Jack Lake (Map GR80-9-1), northeast to an area along the southwest shore of Nueltin Lake in the Northwest Territories. The northwest boundary lies along strike of the northeast-trending Mudjatik-Wollaston domain boundary as delineated in Saskatchewan. It is defined in part by a lithologic change, and along its full extent by a marked northeast-trending narrow, steep magnetic gradient. The linearity of this gradient is even more prominent on residual aeromagnetic maps (Fig. 19). The southeast boundary marks the transition to the Seal River domain. It is irregular and step-like (Figs. 19 and 3) as indicated by geological structures and aeromagnetic trends. The lithologic sequence and range of ages are similar for the Wollaston and Seal River domains but the orientation and style of major and minor structures differ markedly.

The region to the northwest of the Wollaston domain lies on the extension of the Mudjatik domain of Saskatchewan (Fig. 20). In Manitoba this zone exhibits the geological characteristics of the Mudjatik domain but also possesses features that are compatible with the southwest end of the Archean terrane as defined by the workers in the Northwest Territories. It is suggested that the Manitoba segment marks a change from the Mudjatik domain, an extensively reworked Archean terrane, to a segment of Archean crust to the northeast that is less reworked Archean basement (Fig. 20). This less reworked basement is characterized by the presence of numerous discrete bodies of uraniferous Hudsonian granite ($\pm$ fluorite) and Hurwitz Group metasedimentary cover rocks. The underlying granitoid rocks comprise grey foliated tonalites (1900 $\pm$ 25 Ma; Weber, et al., 1975a) (Unit B?), migmatites (Unit C) and grey tonalite (Unit A) (Map GR80-9-8). Rocks similar to the grey tonalite gneiss (Unit A), sampled at a site 6 km north of the Manitoba border (60° latitude) in the Northwest Territories, yield a tentative age of 3335 Ma (zircon, concordia, K.A. Eade, pers. comm.). A pronounced discontinuity on the Bouguer gravity anomaly map of Canada coincides with this suggested transition zone between the style of

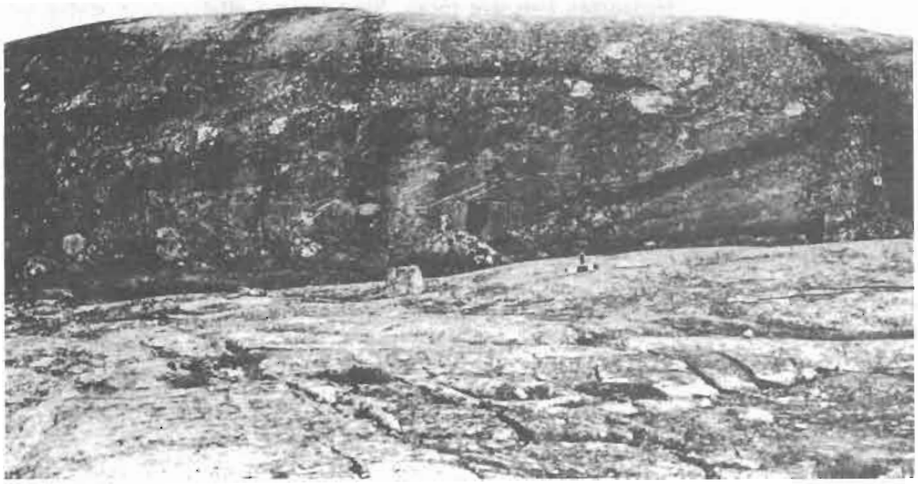
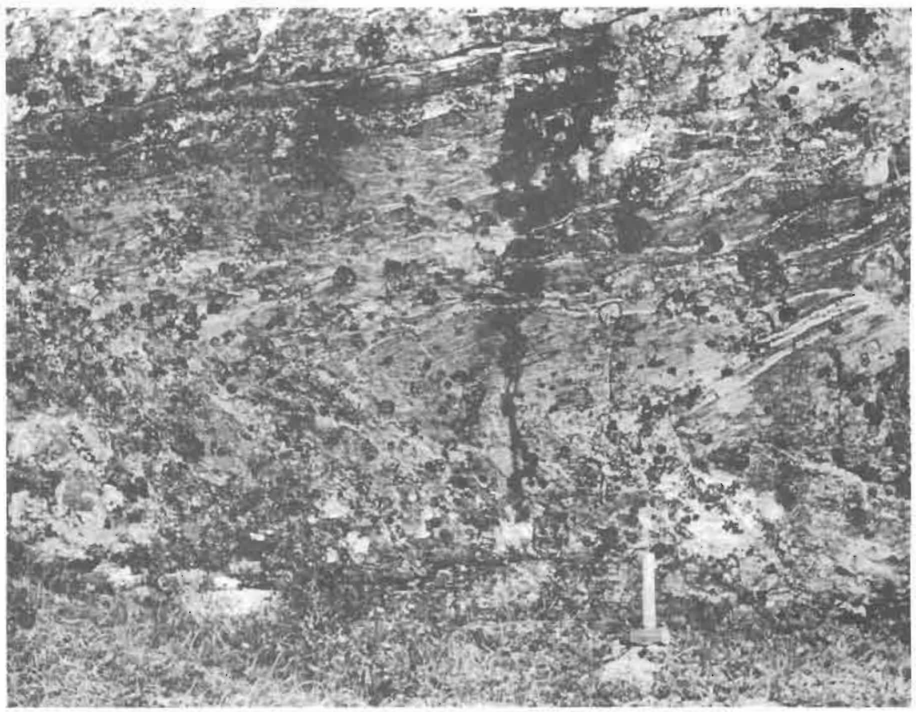


Figure 18a: Recumbent fold in semi-pelitic metatexite (6) within the Nejanilini massif.

Figure 18b: Detailed view of fold closure near centre of Figure 18a.



reworked Archean crust of the Mudjatik domain and the style of reworked Archean crust immediately to the northeast in the Northwest Territories (Fig. 20).

Structure of the Wollaston domain

The style of deformation is characterized by tightly spaced antiforms and synforms. The antiforms have cores of pelitic gneiss (6), semi-pelitic gneiss (6a) and, in the southwest, hypersthene-bearing enderbites to monzocharnockites (2a, 2b and 2c) of inferred Archean age. The synforms have cores of meta-arkose (20) and calc-silicate (17). These major folds are in general tight or isoclinal with axial surfaces dipping steeply to the northwest.

Minor folds are tight or isoclinal and show a weak to strong axial planar schistosity. In the southwestern part of the Wollaston domain elongate aggregates of feldspar and cordierite and porphyroblasts of cordierite with quartz-feldspar coronas are flattened in the axial planes of these folds. The lineations defined by the axis of minor folds and mineral aggregates, plunge southwest and northeast (Weber et al., 1975a). Assuming polyphase deformation, the orientation of these linear structures could

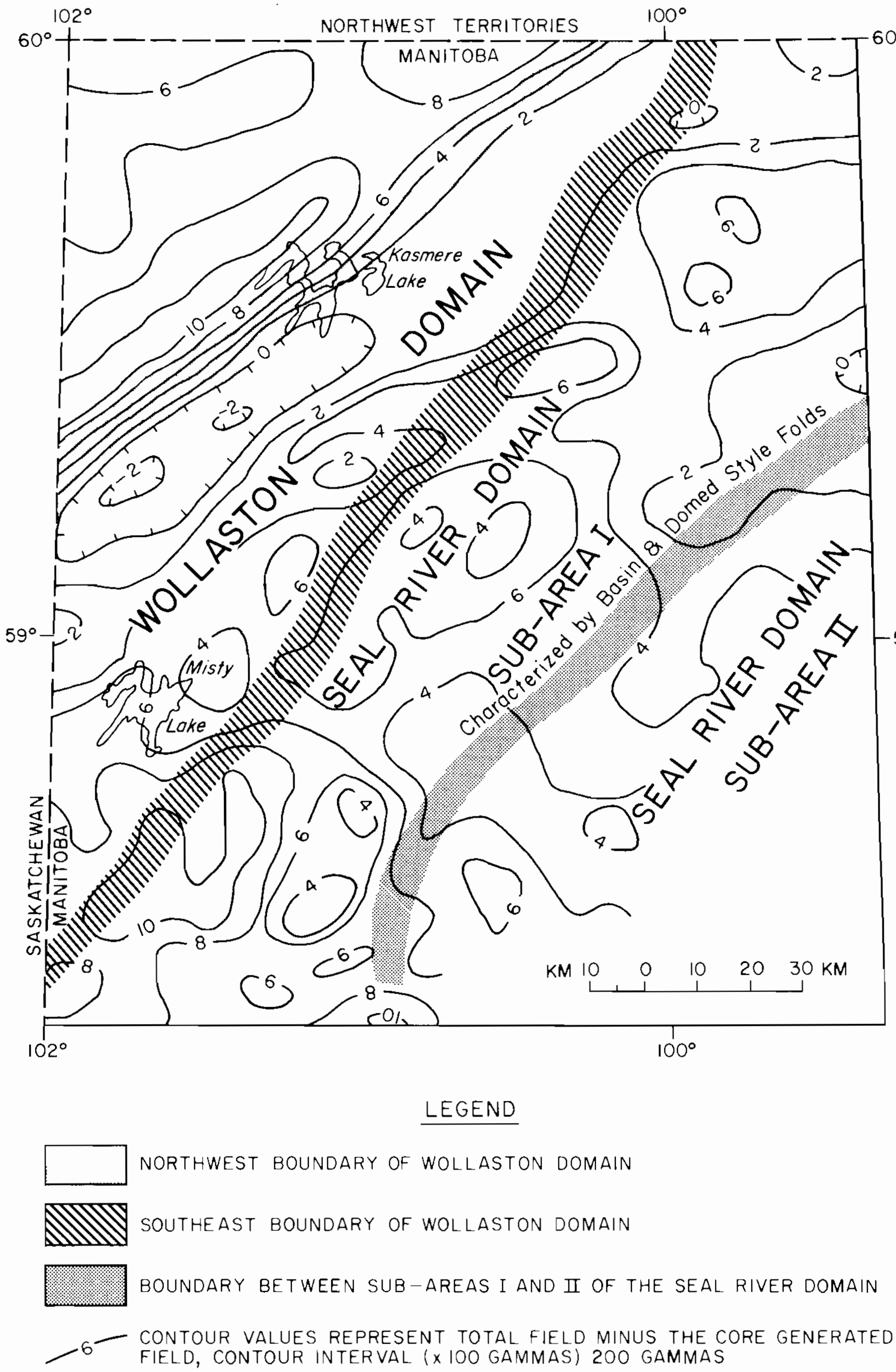


Figure 19: Delineation of the Wollaston domain.

represent co-planar folding about northeast-trending F_2 axial planes or interference of F_2 northeast-trending axial planes with limbs of older F_1 folds.

Moderately tight asymmetric minor folds and related shears locally intersect the northeast-trending axial planar fabric in the Wollaston domain in the Whiskey Jack Lake map area (Map GR80-9-1). This young axial planar fabric is a gneissosity defined by pale pink or cream, medium- to coarse-grained granite lenses. Shears are defined by a foliation containing smeared-out sheets of sillimanite or by narrow discrete zones of cataclasis. The strike of these narrow (2-5 mm), and discontinuous (1 m to 10 m), steeply dipping young axial planes and related shears ranges from 75 to 110 degrees.

Structural trends and lithologic contacts are highly segmented by deformation about northwest- and northerly-trending

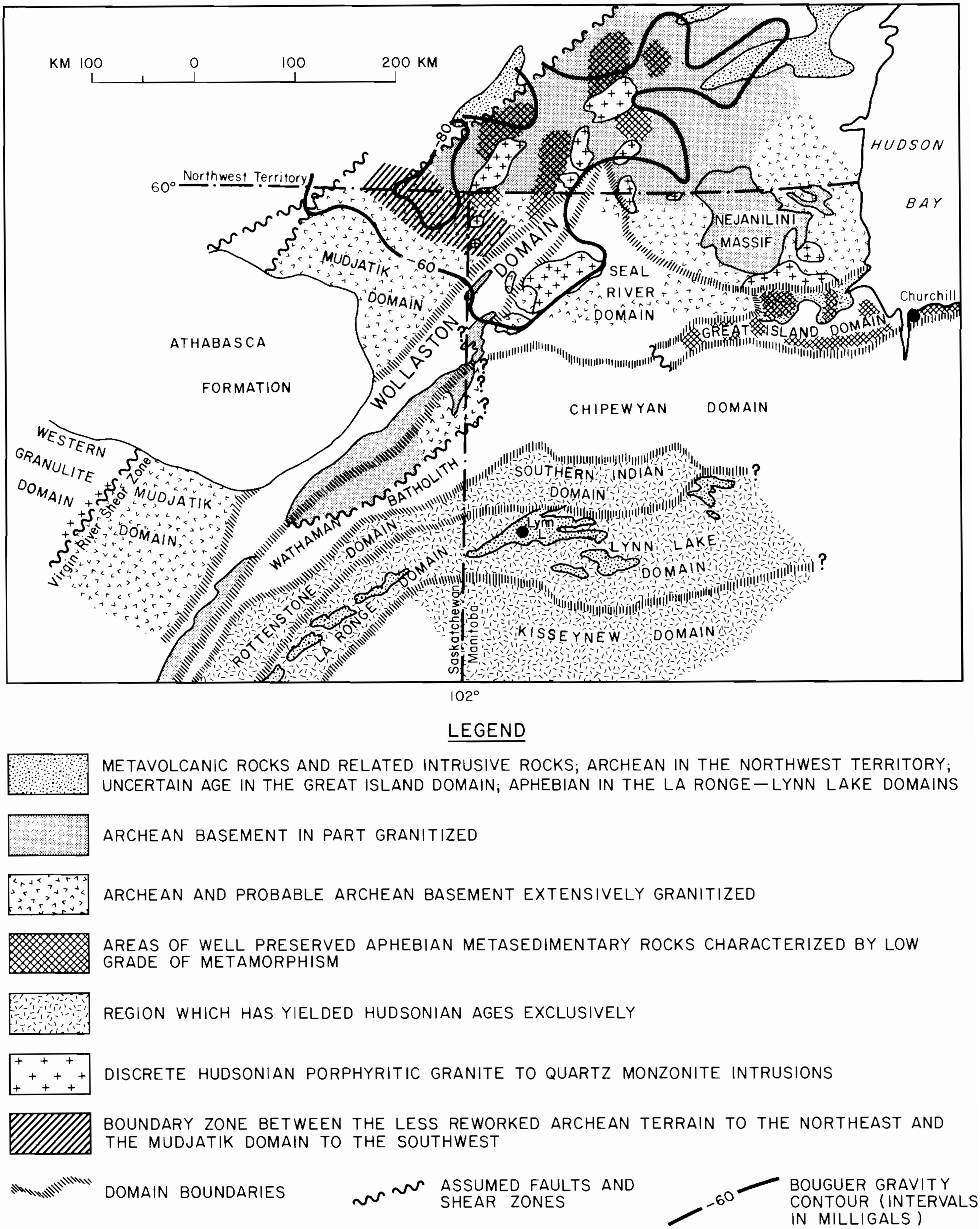


Figure 20: Regional setting of the domain boundaries.

faults and shear zones in the northeast half of the Wollaston domain from Snyder Lake to Putahow Lake. Minor folds have a style which is similar to the F_2 minor folds in the southern half of the Wollaston domain. Therefore, these minor structures have been tentatively labelled as F_2 structures and the subsequent deformation of these structures is D_3. However, evidence of a pre-existing F_1 fold phase has not been observed.

SEAL RIVER DOMAIN

The structure of the Seal River domain has been subdivided into three subareas (Fig. 3).

Subarea I

This subarea is characterized by basin and dome polyphase deformation. Major structures are outlined by large-scale layering of Sequence I lithologies. Domes are elongate and cored by Archean, Aphebian and/or Hudsonian granitic rocks. The basins are cored by arkosic gneiss (20) or calc-silicate rocks (17). Synforms in general are highly tightened and the trends of axial traces are highly variable.

The characteristics of minor folds are described in the "Kasmere Report" (Weber et al., 1975a) for this subarea. In general, minor folds observed in Subarea I are defined by deformed metamorphic layering S_1. The axial planar fabric is a subvertical schistosity or gneissosity S_2. The associated minor folds are thus defined as F_2. Porphyroblasts of cordierite, cordierite-feldspar, feldspar and garnet are aligned in the axial plane and the longest axis of minerals or mineral aggregates plunges parallel to the axes of local minor folds. Away from hinge regions, porphyroblasts are flattened parallel to limbs, with the longest axis parallel to the axes of local minor folds.

Subarea II

Subarea II contains well defined major folds which trend east to southeast. The Chatwin-Nicklin Lake synform and the Munroe Lake synform are broad, upright folds cored by meta-arkosic rocks (A & B respectively, Fig. 3) and are considered to be F_1 folds. The corresponding antiforms are cored by granitic rocks of Archean to Hudsonian age (C, Fig. 3). North-dipping thrust zones of uncertain age are defined by low angle annealed cataclastic zones in granitic rocks lying on the north flank of the Chatwin Lake synform. A similar thrust zone lies on the south flank of the Munroe Lake synform (Fig. 3). Northeast-trending zones of deformation are marked by cross-cutting foliation or well defined shear belts with accompanying minor folds which plunge northeast and east. The minor folds outlined by S_1 metamorphic layering exhibit an axial planar fabric and foliation which is steep-dipping. Away from zones of well defined deformation, the cross-cutting fabric is indicated by a realignment of biotite oblique to S_1 metamorphic layering.

Subarea III

The western margin of this subarea is marked by the Fergus River shear zone and the subarea extends east to the western edge of the Great Island domain. Deformation in this subarea has resulted in polyphase folding in the southwest half of the subarea whereas, in the northeast, major cataclastic zones flank discontinuous slivers of Sequence I rocks, remobilized basement rocks, and younger intrusive rocks (Fig. 3).

In the southwest half of the subarea an earlier F_1 synform, the Clifton Lake synform (D, Fig. 3), is refolded to form a basin structure steeply overturned to the south. The Clifton Lake synform is cored by a more competent quartzofeldspathic *faserkiesel* gneiss (Unit 19). The underlying quartz metasiltstones and pelitic schist (6a), recrystallized at upper amphibolite facies of metamorphism, display extensive passive slip deformation which has obliterated the primary layering (Fig. 21). The configuration of the deformed Clifton Lake synform belt fits a complex basin faulted on its western margin by the Fergus River shear zone. Domal structures lie south and east of Clifton Lake. The Grimes Lake dome and the Clifton-Tadoule Lake dome (E and F respectively, Fig. 3) are cored by Aphebian(?) tonalite to granodiorite and/or Hudsonian quartz monzonite. Metasedimentary-derived schists and a quartzite sequence (6a) on the southwest flank of the Clifton-Tadoule Lake dome does not have the strong S_2 cross-fabric nor the intense zones of D_2 shearing displayed in other parts of the subarea. *Lit-par-lit* gneiss and migmatites are less common and the white trondhjemite to quartz monzonite occurs as thick sills intruded along bedding planes. The sills, from 1 to 5 m thick, are intruded at the boundary of the schistose pelitic layers and quartzite.

An extensively sheared antiform, cored by remobilized Archean basement and Hudsonian intrusions, lies northeast of the Clifton-Tadoule Lake dome (G, Fig. 3). The western termination of this antiform in the Belsham and Bain Lakes areas (Fig. 3) is marked by a complex of small domal structures within a zone of sheared semi-pelitic gneiss (6a) and biotite psammite (16). The domes are cored by either aplite (31b) or meta-arkose (20). Domal structures cored by meta-arkose (20) are interpreted as refolded recumbent F_1 folds.

Along and north of Stony Lake and Seal River, belts of metasedimentary rocks are narrow and discontinuous. The metamorphic layering on a large and small scale is boudinaged and sheared along strike. Stratigraphic relationships and earlier folding and intrusive episodes are indeterminate in most of these discontinuous belts or slivers. Areas of granitic rocks display faint relict layering and sporadic detached fold closures. A zone of aplite with an annealed cataclastic foliation extends from the northeast end of Stony Lake to the west side of Great Island. The aplite contains remnants of a tonalitic gneiss and its metasomatized counterparts. The aplite also contains sporadic trains of amphibole and magnetite which define a weak compositional layering. This layering may be relict after tonalite gneiss or hypersthene-bearing granitic rocks (Unit 2c). The hypersthene-bearing granitic rocks form small isolated remnants in the area of the Stony Lake-North Seal River channel.

The D_2 deformation of the earlier F_1 folds resulted in the development of northeast-trending, steep-dipping shear belts, and the coeval development of steep-dipping east-trending shear belts. Northwest-trending minor folds and shear zones which cross S_2 fabrics are considered to be related to a younger phase of deformation D_3. D_2 minor folds and fabrics deform the earlier S_1 foliation or metamorphic layering. Metamorphic minerals such as cordierite, garnet, sillimanite and biotite have been deformed during this phase of deformation without having suffered any major retrogressive metamorphism. In this respect, the D_2 phase of deformation in Subarea III of the Seal River domain is comparable to the major D_2 northeast-trending deformation within the Wollaston fold belt and second phase deformation within the remainder of the Seal River domain.

The Fergus River shear zone is a well developed narrow zone of D_2 shearing postdating F_1 folding. The Fergus River shear zone is 2 km wide and can be traced from the North Seal River channel, at the north end of Bain Lake, southwest for 110 km into the Chipewyan domain. Examination of the shear zone at its southern extent is hampered by a lack of bedrock exposure. The Fergus River shear zone proper appears to have a northern termination in the Bain Lake/North Seal River channel area.

GREAT ISLAND DOMAIN

Tadoule-Wither Lake folds

Discontinuous belts of Sequence II quartzite and interlayered schist to phyllite define folds that trend east to north-of-east from Tadoule Lake east to Wither Lake (Fig. 3). The folds have upright axial planes and tight to moderate closure. They plunge to the west at

Figure 21a: Minor fold in biotite-hornblende-psammite (16) with axial planar metamorphic layering.

Figure 21b: Minor folds in semi-pelitic paragneiss (6a) with axial planar schistosity and alignment of feldspar and quartz porphyroclasts which disrupts and locally obliterates the older gneissic layering.

23 degrees; however, steeper plunges are recorded in areas where the folds are intersected by faults that trend north to west-of-north. Minor folds with azimuths at high angles to the major fold axes (average trend of 345°), occur along Seal River and the south shore of Shethanei Lake (Fig. 22a). Primary compositional layering that defines these main folds is highly attenuated and boudinaged, locally forming pseudo-conglomerate (Fig. 22b). Folding recorded in the central islands and north shore of Shethanei Lake is disharmonic within areas of intense pegmatite intrusion. Pegmatite is prevalent from Tadoule Lake to the east end of Shethanei Lake. Locally the pegmatites are uraniferous. Extensive pegmatite intrusion appears to have occurred in this region after the major period of D_1 folding. Subsequent to pegmatite intrusion deformation occurred along northwest, and north of east, to easterly planes of deformation (D_2 and/or D_3).

The north flank of an F_1 synform that extends from Tadoule Lake to Wither Lake is truncated along a zone of cataclastic aplite and remobilized basement rocks. This zone of cataclasis extends along Seal River to the west side of Great Island. It delineates a sharp boundary between the metamorphically high grade Seal River domain (Subarea III) and lower grade Great Island domain to the south. The same F_1 east-trending synform terminates at Wither Lake and is separated from the Great Island basin by an arch of quartz monzonite and a northwest-trending shear zone

Great Island Basin Structure

The Great Island basin is interpreted as a complex system of basins and domes resulting from deformation superimposed on earlier F_1 folds (Fig. 23). Stratigraphy, primary layering and minor structures within the sedimentary cover rocks provide information that has been used to interpret the sequence for post-Great Island Group deformation. The stratigraphic units outline a system of synforms, basins, antiforms and domes lying within the shear-bounded Great Island basin structure (Fig. 23). The synforms and basins are open folds whereas antiforms are tightly folded and often obscured by faulting parallel to axial traces. The domal structures are smaller than the basins. Primary layering within domal structures is obscured by deformation and accompanying recrystallization. Basin and dome structures typify the east half of the Great Island basin whereas the western half is characterized by open F_1 synforms which are locally intersected by narrow zones of penetrative deformation and broad areas of weak S_2 schistosity. Antiforms are obscured by faulting along an axial planar strike trend which has resulted in an apparent juxtaposition of synformal structures. This late D_2 deformation has resulted in co-planar folding about earlier east-trending F_1 axial surfaces accompanied by localized minor cross-folds and faults along northeast and northwest trends.

Major fold axes along the east side of the Great Island basin, from the southeast corner of Great Island to north of Meades Lake, define a basin and dome pattern resulting from the interference of two mutually perpendicular fold axes. Minor parasitic folds in phyllites (22a), along the Seal River in the southeast corner of Great Island, indicate an early F_1 set of minor folds refolded openly about upright (80 - 85°) axial surfaces ranging in strike from 205° to 015°. Primary layering defines the early set of S-shaped parasitic folds (Fig. 24). The axial planar fabric of F_1 folds is a weak fracture

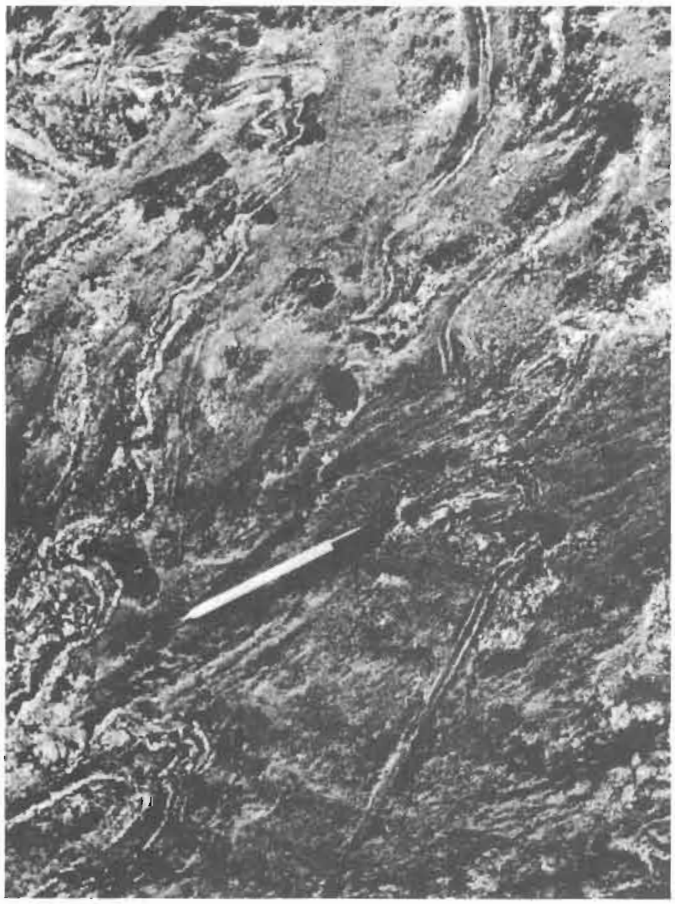


Figure 22a: Disharmonic folding of interlayered quartzite and quartz-muscovite schist with granitic lits, (22).

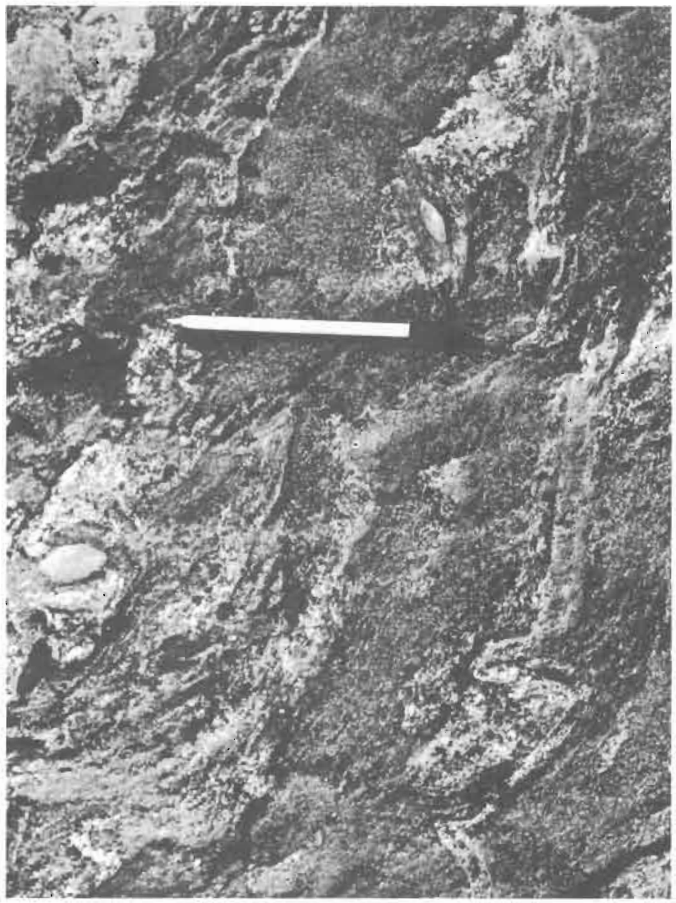


Figure 22b: Pseudo-conglomerate: lenticular remnants of dense light grey layers due to extreme boudinage of an interlayered quartzite and quartz-muscovite schist (22).

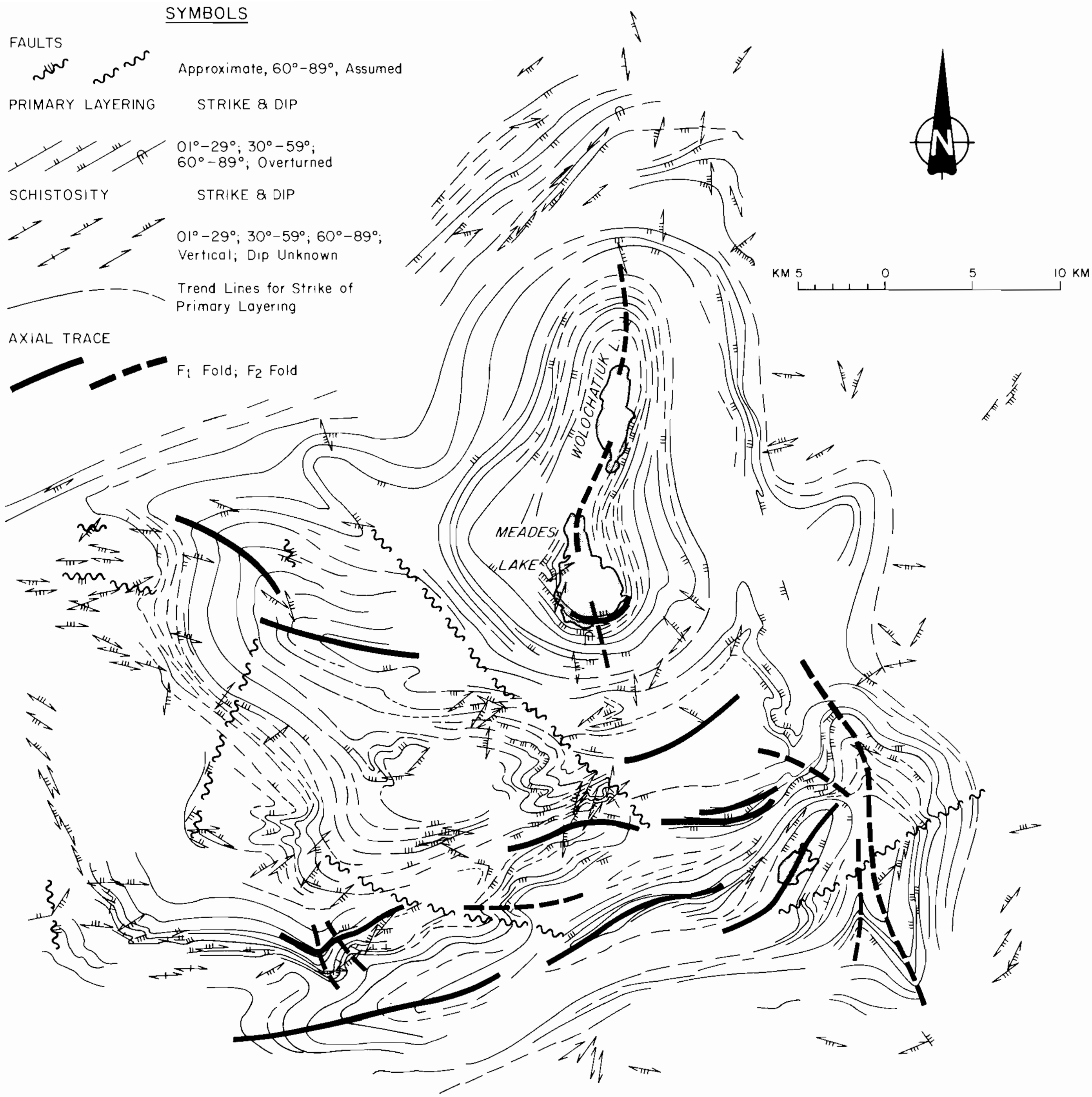


Figure 23: Structural trend lines with interpreted fold axis depicting the cross-folded nature of the Great Island Group (Sequence II) cover rocks related to faulting in the underlying Sequence I metavolcanic rocks (the topographic trace of the Seal River has been deleted for simplification).

cleavage to a weak schistosity.

Thin section examination of grey-green phyllite (22a), from the southeast corner of Great Island, indicates the peak of metamorphism was reached after F_1 folding. Overgrowths of large poikiloblastic biotite postdate the development of the S_1 fracture cleavage to weak schistosity (Figs. 25a & b). A period of deformation postdating the poikiloblastic biotite growth resulted in an S_2 fabric which can be parallel or at a high oblique angle to the primary layering. The S_2 fabric is locally well developed and may obliterate early F_1 folds (Fig. 26). The S_2 fabric is refracted between the more competent quartz siltstone beds and less competent micaceous layers resulting in a curviplanar S_2 foliation with changes in strike of up to 116 degrees. The intense penetrative S_2 fabric is associated with fold hinges of tight minor F_2 parasitic folds. Biotite suffered retrogression and is partly altered to chlorite in the matrix whereas the biotite poikiloblasts are only moderately or very weakly altered.

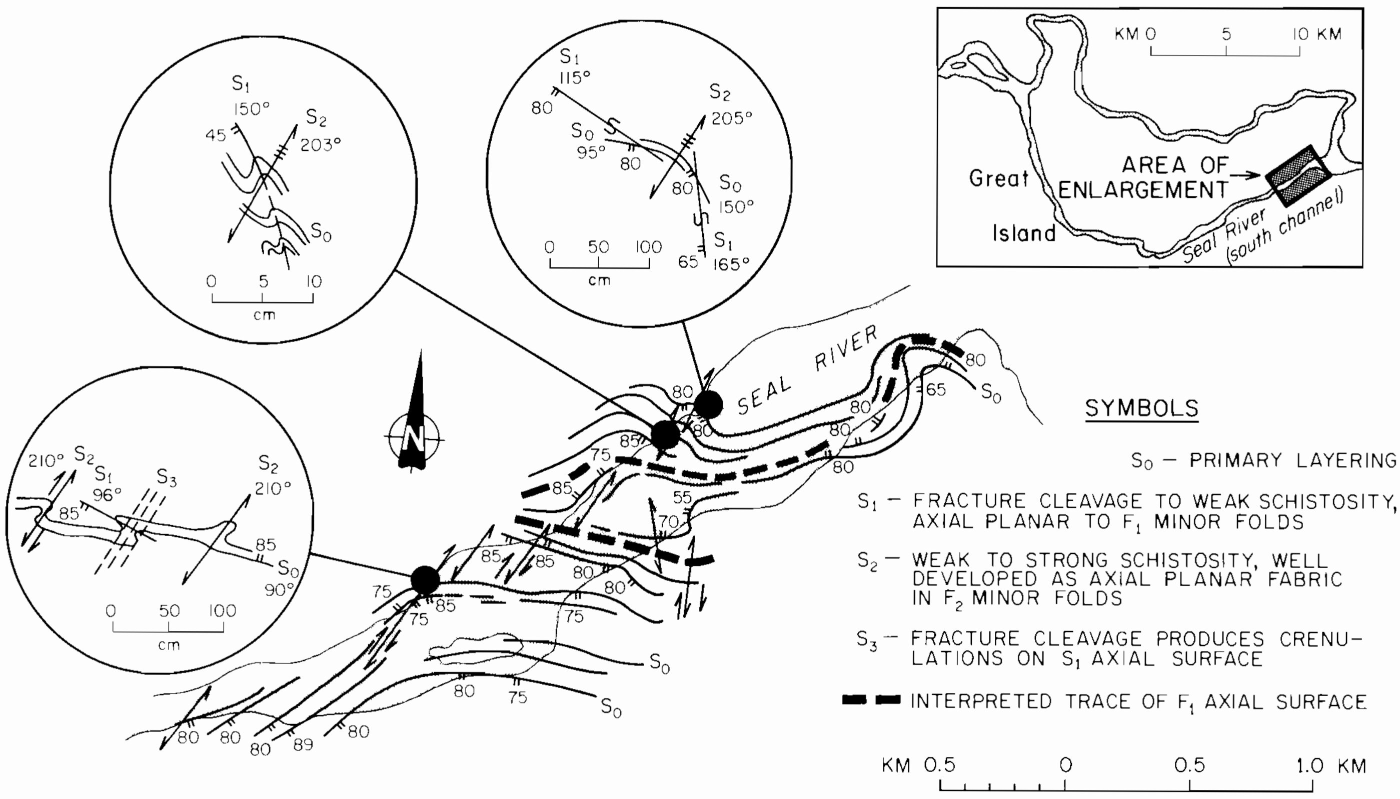


Figure 24: Minor folds along Seal River channel, south side of Great Island.

The underlying metavolcanic rocks and granitic rocks on the margins and near the edge of the Great Island basin contain zones of intense foliation possibly related to shear belts. The configuration and distribution of the rocks on the west side of the basin appears to be controlled by a system of D_2 northwest shears and east-trending faults (Fig. 28), whereas the strain pattern on the eastern margin of the basin can be related to a system of D_2 northwest-trending faults. The style of deformation within the northwest-trending shear zone is similar on both the west and east side of the Great Island basin. Both shear zones occur within fine grained biotite-plagioclase-quartz rocks with accessory amphibole needles. This fine grained rock contains highly flattened lenses of more biotite-rich material. These rocks have been interpreted as deformed lapilli tuffs (7c). Rolled and milled segments of granite dykes are present in this rock type in the shear zones along Seal River southeast of Great Island (Fig. 27). The interference folds and fault patterns in the overlying Sequence II metasedimentary rocks is considered to be the response of a cover sequence of sedimentary rocks to shearing and brittle failure of the underlying rocks. The orientation of the D_2 structures in the underlying Sequence I metavolcanic rocks may reflect the influence of a pre-Great Island Group fracture system. This is suggested by the linear alignment of pre-Great Island Group gabbro stocks and the occurrence of a large ultramafic dyke oriented approximately 45° to the linear zone of gabbro intrusions (Fig. 28). The occurrence of an intrusion breccia, with fragments of the Sequence I metavolcanic rocks and migmatites of uncertain age (Unit C), within a feldspar porphyry cut by dykes of similar feldspar porphyry, also indicates possible fracture-controlled explosive intrusive activity (Fig. 28).

Fold Structures South and East of the Great Island Basin

South and east of the Great Island basin (including the "Churchill quartzite" at Churchill), the Great Island domain comprises isolated remnants of Sequence I metavolcanic and/or Sequence II metasedimentary rocks. The Sequence I and/or Sequence II rocks overlie quartz diorite to granodiorite, tonalitic gneisses and/or Hudsonian quartz monzonites. Bedrock exposures are less than one-half of one per cent and, consequently, the analysis of folds and structures is speculative. Deformation has resulted in a dominant east-trending regional F_1 fold set subsequently intruded by quartz monzonite (31) and deformed by a younger phase of shearing and faulting with resultant minor F_2 folds. The post-intrusion phase of deformation is equated with the D_2 event outlined in the Wollaston and Seal River domains.

Remnant east-trending folds (F_1) are well defined southwest of Great Island, and along North Knife River. Large-scale east-trending antiforms and synforms are outlined by bedding defined by interlayered quartzite (22) and thin laminations of phyllite to biotite schist (22a) (Fig. 28). Rocks of Sequence II (mainly units 22a - 26) are exposed in the deeply incised narrow east-trending channel of North Knife River. These rocks have been tightly folded about steep-dipping axial planes. Bedding on the south limbs of the synclinal folds has been overturned to the north. The axial planar fabric is a well defined phyllitic foliation (S_1). North Knife River swings to the north at Teepee Falls and cuts across F_1 structures. In this area the river has exposed a series of asymmetric folds with steep-dipping short limbs and shallow-dipping long limbs. These folds are defined by more competent beds (22) with micaceous laminations. The axial planar fabric is an east-striking fracture cleavage and the fold axes have an undulatory east to west shallow plunge. These structures are the whaleback folds described by Bostock (1969). The folds which lie along the North Knife River appear to be parasitic S-folds on the south flank of a large-scale antiform. The antiform axis may lie within the east-trending tonalite gneiss, amphibolite, and Hudsonian quartz monzonite complex that lies immediately to the north (Fig. 28). A second set of minor Z-folds (F_2 are defined by the folded S_1

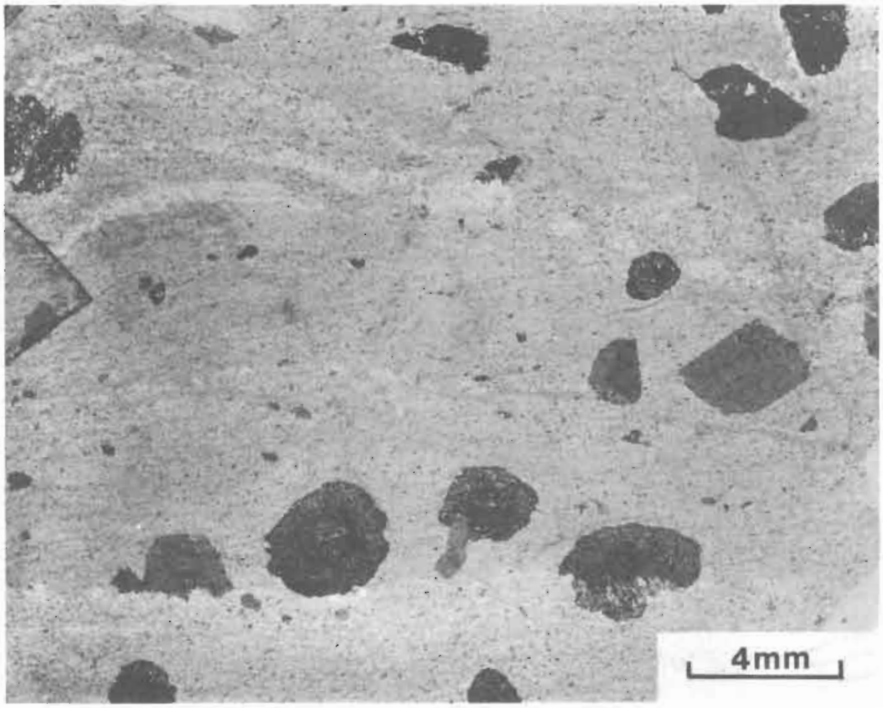


Figure 25a: Biotite porphyroblasts overgrowing S_1 fabric in phyllite (22a) (photomicrograph, plain light).

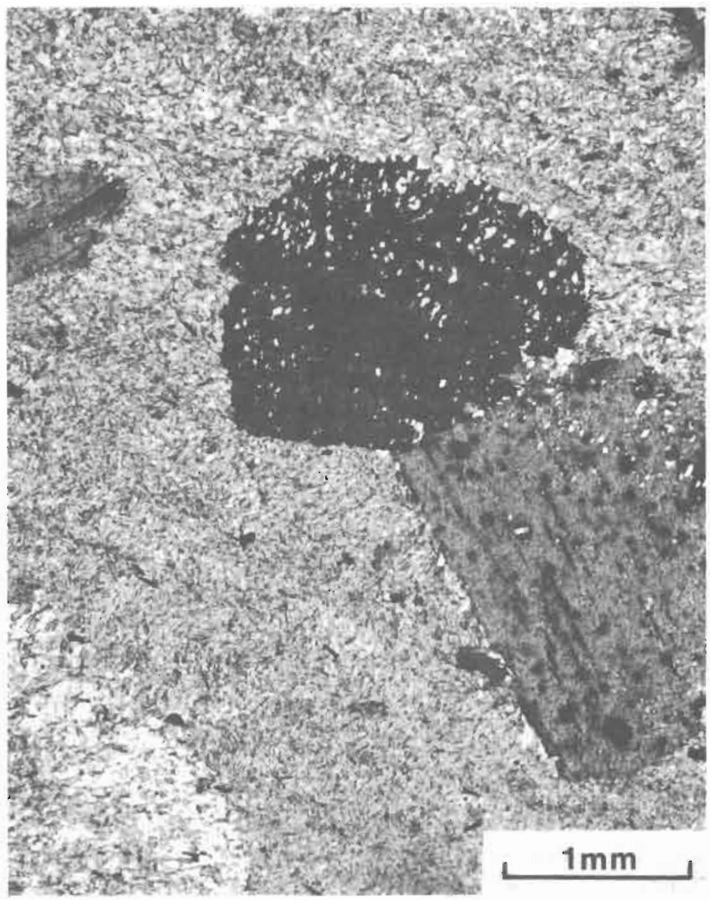


Figure 25b: Biotite porphyroblasts overgrowing S_1 fabric (22a) (photomicrograph, plain light).

Figure 26: S_2 fabric, parallel to long axis of pencil, overprinting F_1 folds in phyllite (22a) along the south channel of the Seal River at Great Island.

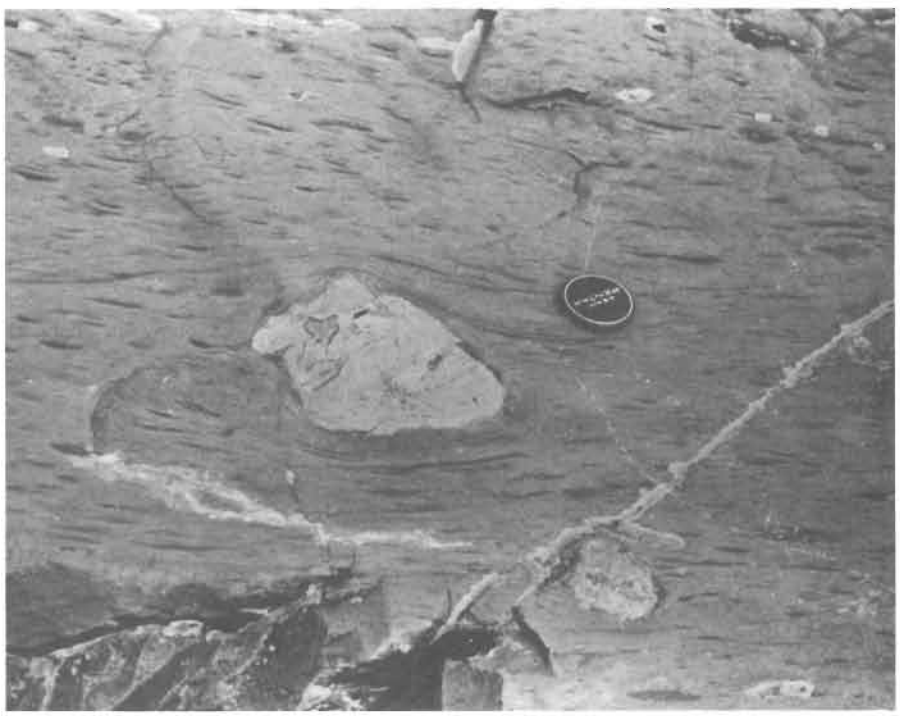


Figure 27: Segmented granite dyke rolled and milled in a cataclastically deformed lapilli tuff (7c).

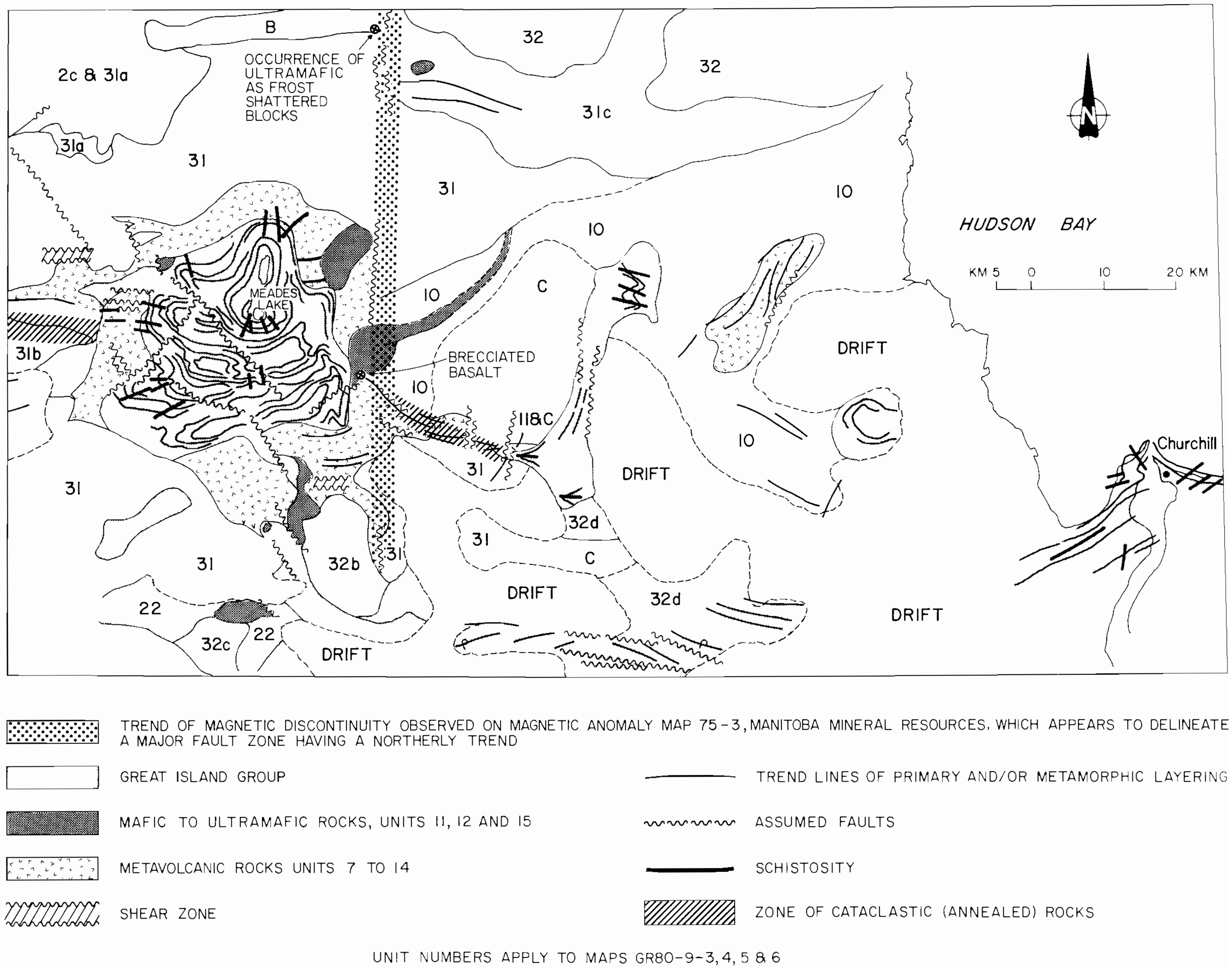


Figure 28: Great Island to Churchill structural trend lines and basic to ultramafic rock occurrences.

foliation and primary layering. The axial planes of these minor folds strike northeast (035° to 065°) and have vertical to steep dips to the southeast. The axial planar fabric is a fracture cleavage or phyllitic foliation with minor narrow zones of intense foliation.

The other outliers of Sequence II rocks lie east of Great Island: i) along Seal River; ii) 45 km east of Great Island north of Nowell Lake; and iii) at the townsite of Churchill. A single outlier of Sequence I metavolcanic rocks also outcrops near the lower part of Seal River near Hudson Bay.

The bedrock exposures of Great Island Group rocks along Seal River, 45 km east of Great Island, outcrop at the north and south ends of the 30 km long north-trending section of the river (Fig. 28). In the northern occurrence the primary layering defines a sequence of folds of moderate closure, folded about upright east-striking axial surfaces and axes which plunge moderately to the east. The primary layering is readily identifiable on large and small scale. The foliation is a fracture cleavage which displays a fanning relationship to the folded primary layering (Fig. 29). In the southern belt of exposure primary layering defines minor folds of tight closure with well defined axial surfaces (Fig. 30). The axial planar fabric is a phyllitic foliation which trends east, and south of east, with a steep dip to the south and/or northeast. The axial planar fabric has been locally folded into small-scale D_2 kink folds with axial planes at 055°. The most southeasterly exposures are highly cleaved frost-heaved outcrops with a well developed axial planar foliation. Although the outcrops are highly frost shattered the small variation of strike readings (085° to 100°) on the near vertical to steep dipping axial planar fabric indicates little disturbance by the Pleistocene

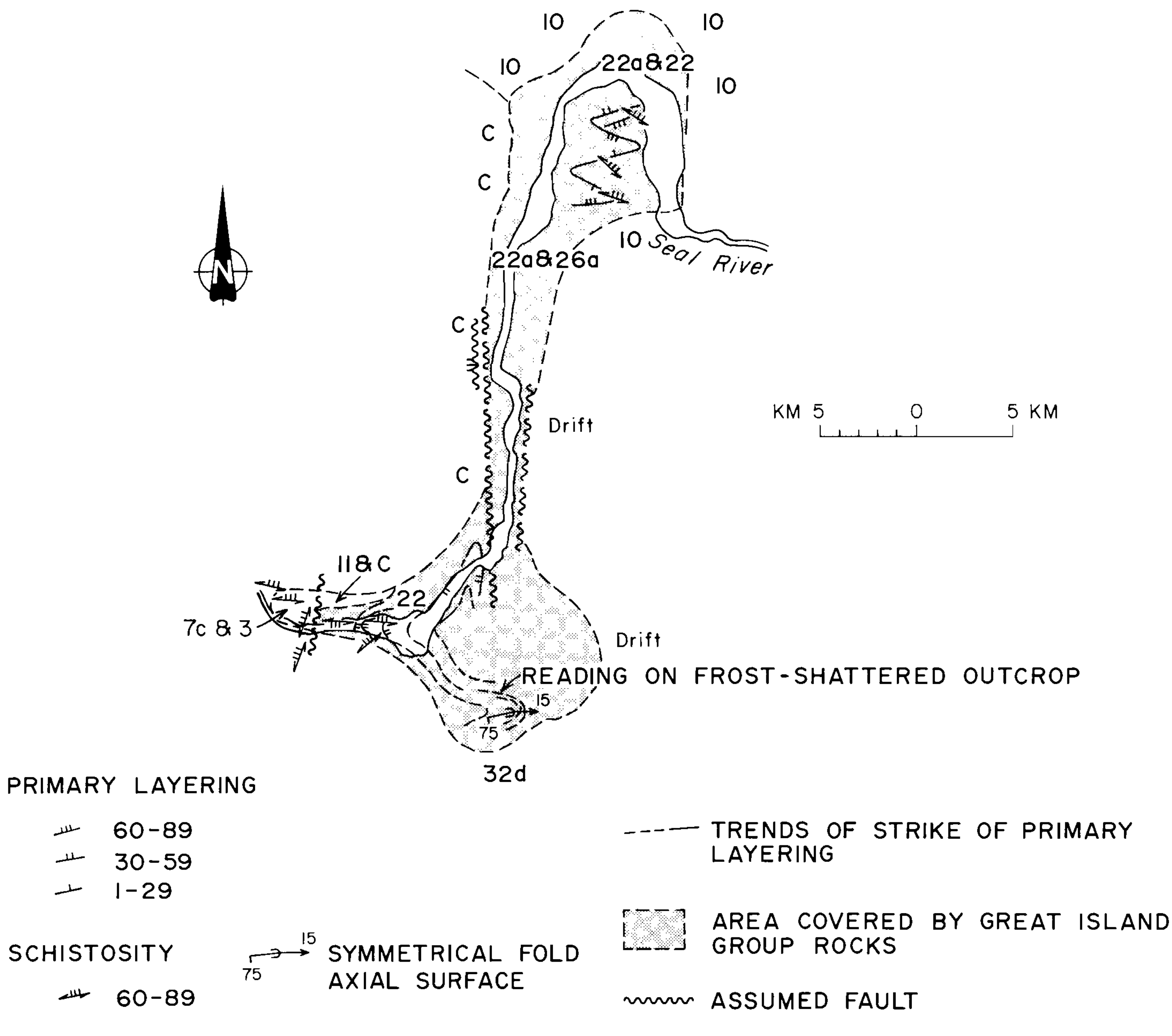


Figure 29: Interpretative diagram of fault and fold structures 42 km east of Great Island.

Figure 30: Minor folds outlined by primary interlayers of psammitic silty layers and micaceous layers (S_0) tightly folded with pronounced axial planar foliation defined by lenticular aggregates of quartz and thin laminations of micaceous minerals (S_1) interlayered quartzite and phyllite (22).

glaciation. The plunge of minor folds is shallow to the east. The intervening area between the north and south clusters is almost devoid of outcrop. Bostock (1969) indicates two structural readings along the water's edge near the south end of the 30 km channel These are indicated as primary layering which defines a synform with the axial trace trending 020°. Further north on the upper parts of the river bank frost-shattered phyllite was observed in areas of bright red to orange soil. The only exposure occurs halfway along the channel on the west bank 200 m west of the river. The rock here is a foliated tonalite with cream granite *lits*. The rock displays a strong north-trending cataclastic foliation. Geophysical information from Federal-Provincial airborne magnetic maps, airborne electromagnetic surveys (Economic geology, this report) indicate a narrow magnetic trend, and a set of electromagnetic conductors oriented 020°. Diamond drill logs (D25-34, 42, Map GR80-9-12, Table 11) indicate the presence of graphitic-micaceous metasedimentary rocks and interlayered quartz metasiltstone to quartzite. The drill logs also indicate the overburden is 20 to 30 m thicker on the east side of the river as compared to the west bank. This difference in overburden depth may indicate the presence of a buried fault scarp along the channel of the river. Metasedimentary rocks appear to be confined to a narrow strip along the course of the river since bedrock exposures immediately to the west are of migmatitic tonalite and outcrops and frost-heaved blocks east of the river are foliated quartz diorites. Based on the available information the structure appears to be a dumbbell-shaped refolded and faulted F_1 fold (Fig. 29).

At Nowell Lake bedrock exposure is limited to Sequence II interlayered thick beds of massive + cross-bedded quartzites and thin beds of grey-green phyllite which outline an asymmetric basin structure (Figs. 28 & 31). The configuration of the basin can be resolved simply as the interference of mutually perpendicular axial surfaces one oriented to the east and another oriented to the north.

At Churchill a southeast-plunging synform is outlined by measurements of primary layering in thickly bedded Churchill quartzite (Figs. 28 & 31). The layering describes a synclinal structure that becomes more open to the southeast. The fold has a tight closure in the area of Eskimo Island but appears to open into a broad curvature further southeast. The presence of possible overturned layering on the west side of Churchill River has been used to propose a synclinal structure (Bostock, 1969). However, on re-examination the facing criteria appear inconclusive. The secondary planar fabric is a weak schistosity to fracture cleavage and is subparallel to layering in the southwest-trending limb, whereas on the east-trending limb it is at a high oblique angle. Within the fold nose the fracture cleavage appears to radiate or fan from the centre of curvature. This style of folding and secondary structures can be related to differential movement about a southeast-trending axial surface. This being the case, a slip surface or detachment must lie between the tightly folded nose and the broad curvature. The sense of movement on this surface would be right lateral.

The preservation of primary layering, low grade of metamorphism, and flexural slip style of deformation characteristic of cover rocks at high structural levels are typical in these three outliers. The folds along the Seal River and the basin structure north of Nowell Lake indicate deformation of east-trending early open F_1 folds.

Sequence I metavolcanic rocks which outcrop along the lower Seal River near Hudson Bay display a large-scale primary zonation, a penetrative foliation, and metamorphic layering, all trending to the northeast (Fig. 28). Zones of contact metamorphism have been produced by intrusion of quartz diorite into the metavolcanic rocks. The angle of dip for the large-scale primary zonation is uncertain; however, the metamorphic layering and penetrative foliation dip steeply to the southeast or northwest. The airborne magnetic map (Federal-Provincial) indicates a northeast-trending magnetic belt with minor flexures about sporadic easterly trends (D_3?).

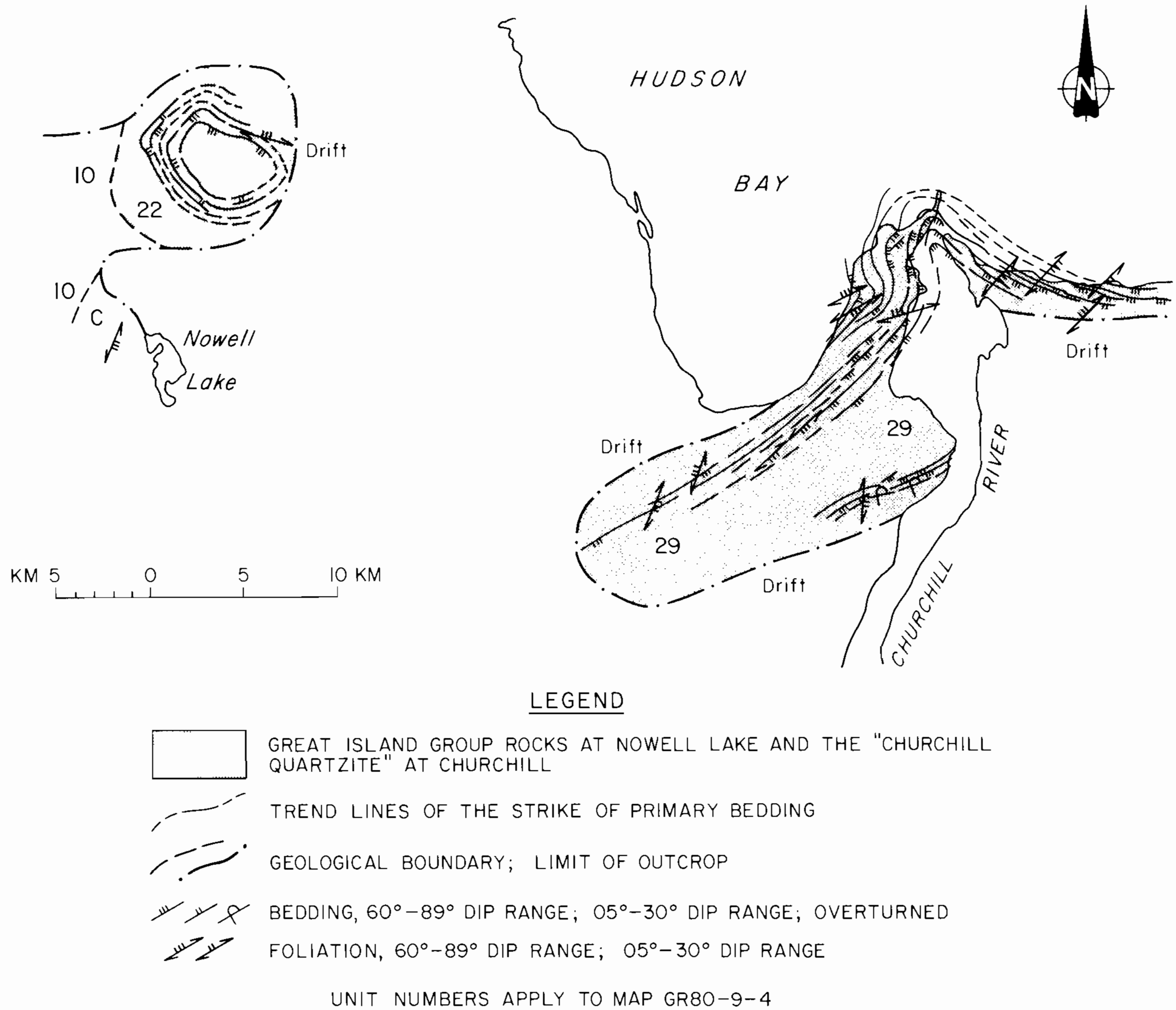


Figure 31: Structural trend lines of Nowell Lake and Churchill structures.

CHIPEWYAN DOMAIN

Geological stations are distributed across most of the Chipewyan domain and although widely spaced the data indicate a domain predominantly underlain by granitic and granitoid rocks. Mapping within the Chipewyan domain in Manitoba (Schledewitz, 1975, 1976, 1977 and 1978a) and in the contiguous Wathaman Batholith in Saskatchewan (Ray, 1975, 1977, 1978 and 1979) indicates an extensive igneous complex of varied composition. However, the compositional range and distribution of the various rock types are only partially understood due to the widely spaced nature of the data.

The trends of the boundaries of the batholithic complex, as established by lithology, are concordant, but only locally coincident, with a prominent magnetic trend (2500 to 2900 gammas) outlined on a regional magnetic anomaly map at a scale of 1:1 000 000 (Fig. 32). The broad magnetic trend that mirrors the Chipewyan domain in Manitoba parallels the northern boundary of the Chipewyan domain and the trend of the major F_1 fold axis of the Seal River and the Great Island domains. Pronounced magnetic discontinuities cross this broad regional magnetic trend that mirrors the position of the Chipewyan domain. Cataclastic zones coincide with these linear magnetic discontinuities at the west end of the Chipewyan domain in the Whiskey Jack Lake map area. The cataclastic zones occur within grey to pink quartz monzonite (unit 31). The cataclastic zones are 1 cm to 3 m wide and contain numerous closely spaced microlayers of dense hornfelsic material and grey ribbon quartz. Networks of epidote-filled fractures are also present. This suggests that the magnetic discontinuities are in part related to zones of faulting and cataclasis.

The trends of the magnetic discontinuities describe a regional variation which is similar to the regional variation for the trends of the post F_1 structures, outlined by geological data, in the Wollaston, Seal River and Great Island domains (Fig. 33). This consistent similarity of the post-F_1 structural trends and the trend of the magnetic discontinuities suggests application of the aeromagnetic data is valid in a regional structural analysis for the Chipewyan domain

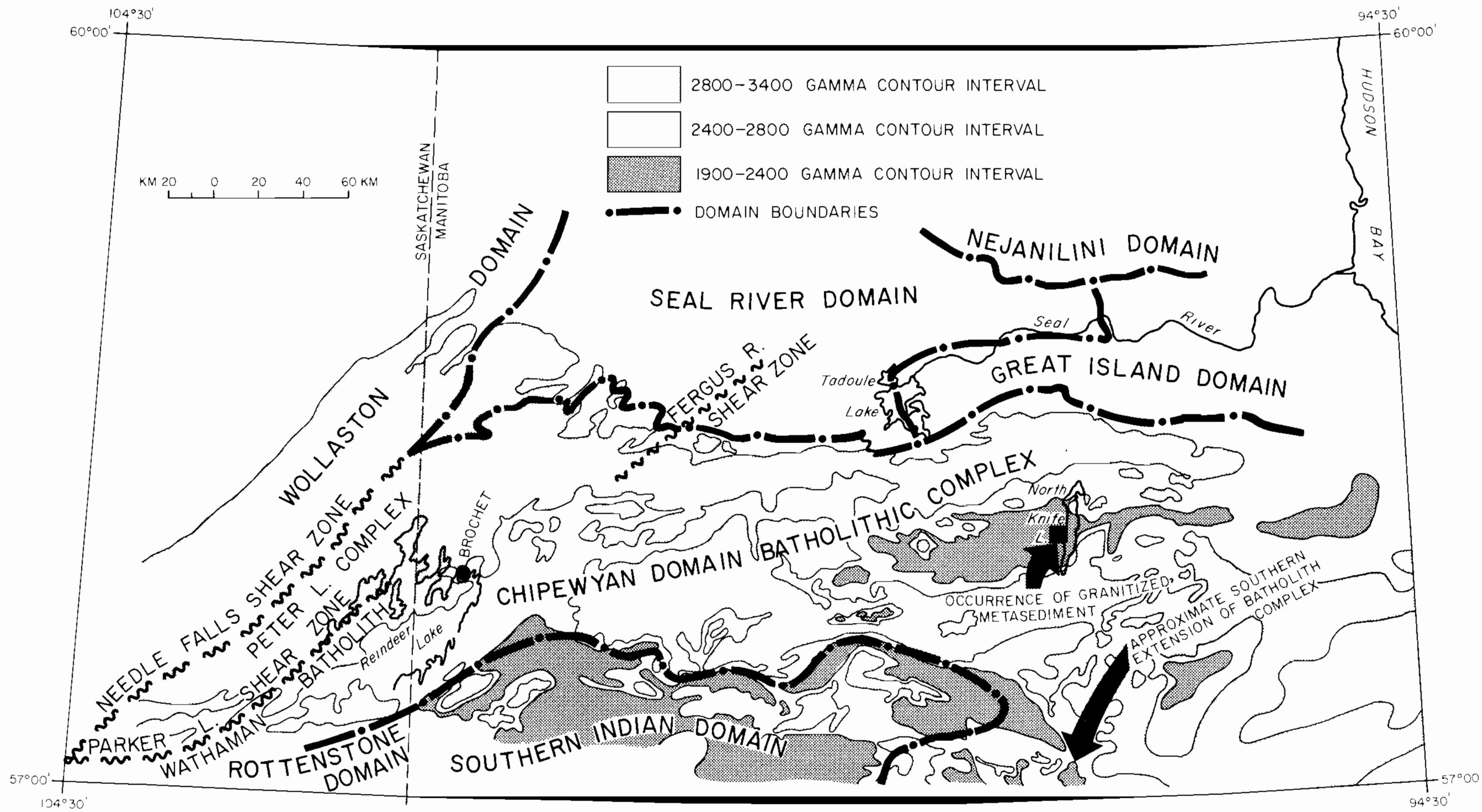


Figure 32: Boundaries of the batholithic complex and superimposed regional magnetics.

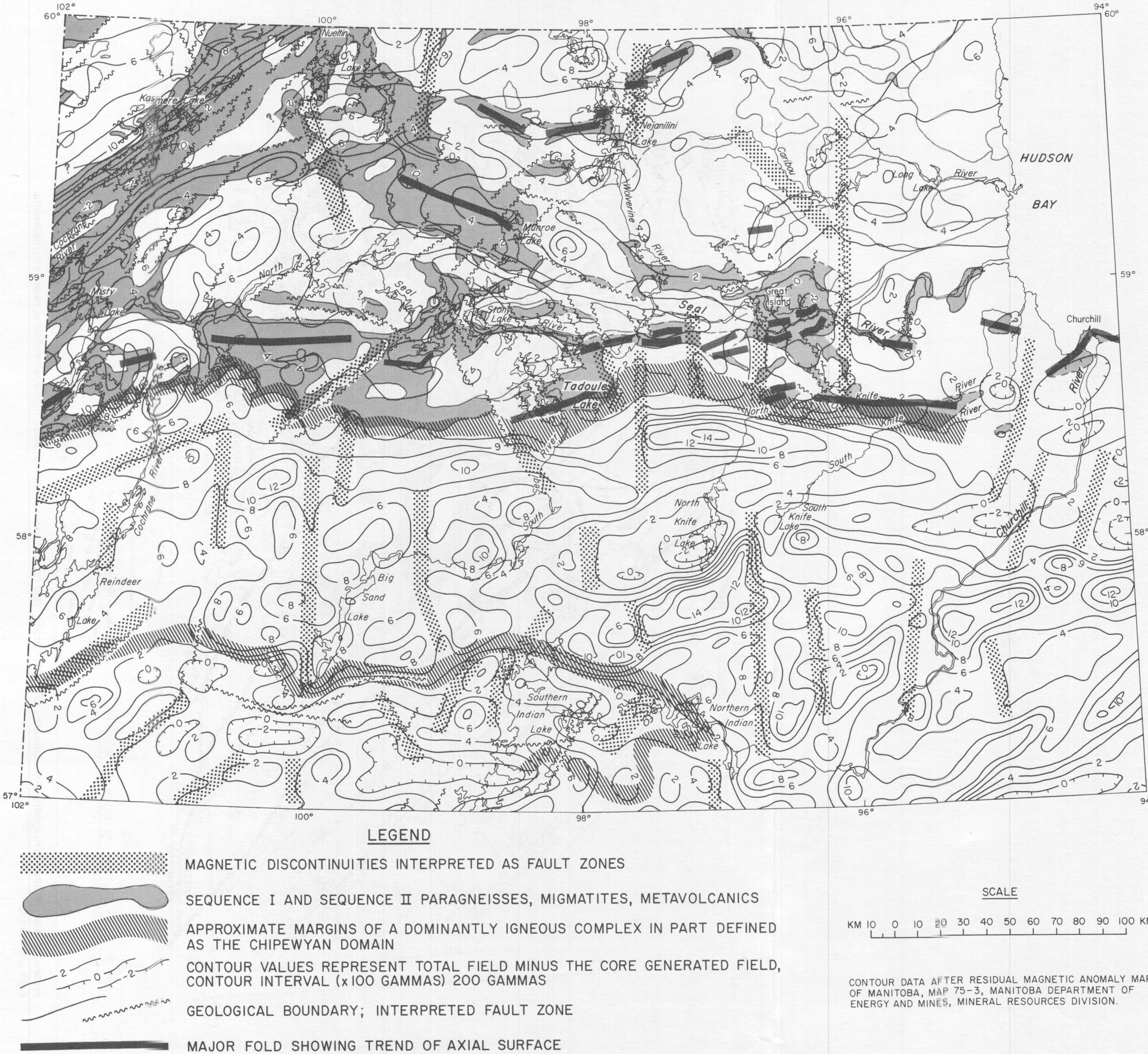


Figure 33: Magnetic trends with magnetic discontinuities and geologically determined post-F_1 structures.

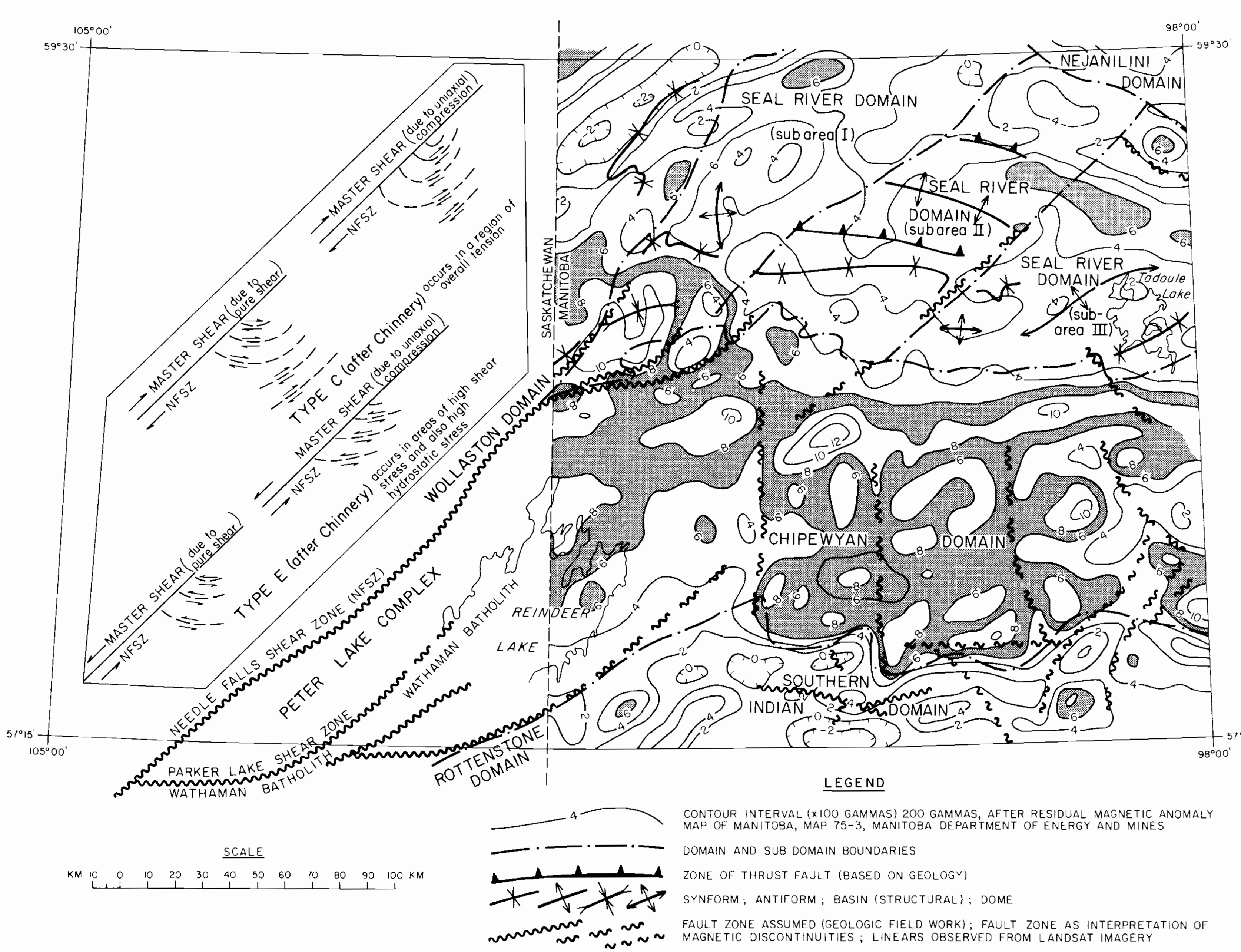


Figure 34: Interpretation of magnetic discontinuities in the Wollaston, Seal River (subareas I and II) and Chipewyan domains, relative to the Needle Falls shear zone.

despite the present sparse geological data base.

The dominant northeast-trending post-D_1 structures of the Wollaston domain and Subareas I and II of the Seal River domain are apparent in the pattern of the magnetic discontinuities at the west end of the Chipewyan domain. In the Whiskey Jack Lake map area (GR80-9-1) a number of northeast-trending structures are coincident with magnetic discontinuities in the Chipewyan domain. These northeast-trending structures can be extrapolated, using the aeromagnetic maps, suggesting that they merge in an imbricate pattern with larger northeast-trending structures such as the Needle Falls shear zone (Fig. 34). This pattern of imbrication is similar to the "type C" or "type E" secondary fault systems at the termination of a transcurrent master shear (Chinnery, 1966).

The limit of well defined northeast-trending discontinuities coincides with the Fergus River shear zone at the east edge of Subarea II of the Seal River domain (Fig. 33). The geologically defined Fergus River shear zone coincides with a zone of northeast-trending magnetic discontinuities which extend southwest into the Chipewyan domain suggesting a southwest extrapolation of the Fergus River shear zone.

East of the Fergus River the fanning pattern of the geologically determined post-F_1 faults of Subarea III of the Seal River domain and the Great Island domain is also apparent in the fanning pattern of the magnetic discontinuities in the east half of the Chipewyan domain (Fig. 33).

METAMORPHISM

INTRODUCTION

The metamorphic mineral assemblages of the Sequence I and Sequence II pelitic to semi-pelitic derived schists and gneisses and the pelitic laminations within quartzites are the most sensitive indicators of the metamorphic grades for the region. A plot of the metamorphic mineral assemblages (Fig. 35) indicates that:

i) the Great Island domain is characterized by a regional upper greenschist to middle amphibolite facies of metamorphism;

ii) the Seal River and Wollaston domains are characterized by the upper amphibolite facies of metamorphism with localized occurrences of granulite facies of metamorphism in the south half of the Wollaston domain;

iii) the Nejanilini domain is characterized by upper amphibolite facies mineral assemblages with upper amphibolite to granulite facies of metamorphism in the Nejanilini Massif.

The uncertainty of the age relationships for Sequence I rocks over the project area remains implicit in the presentation of the mineral assemblages. Therefore, time equivalence is not inferred in the description of similar mineral assemblages from different parts of the project area.

MINERAL ASSEMBLAGES AND TEXTURES OF THE LOW GRADE METAMORPHIC ZONE

The region of low grade metamorphism is confined to the Great Island domain (Fig. 35). The nature of the metamorphism is defined by the mineralogy of the interlayered phyllite and quartz metasiltstones of Sequence II rocks. Mineral assemblages within the metavolcanic rocks of Sequence I appear to be consistent with mineral assemblages in the overlying Sequence II rocks. However, Sequence I metavolcanic rocks along Seal River 66 km east of Great Island provide evidence of contact metamorphism prior to deposition of the Sequence II rocks. The mineral- assemblages of chlorite + epidote + blue green amphibole + chloritoid was observed within the metavolcanic rocks broadly indicating conditions of greenschist to locally lower amphibolite facies of regional metamorphism. The assemblages:

i) diopside-tremolite-epidote (calc-silicate layer);

ii) oligoclase + blue-green hornblende + epidote (metasiltstone);

within the tuffaceous metasiltstone (Unit 9c) which outcrops as part of the lower Seal River metavolcanic rocks, indicate lower almandine-amphibolite metamorphic facies (Bostock, 1969). Well layered amphibolite is formed within the volcanic rocks near contacts with a porphyritic quartz diorite to granodiorite (unit 10) indicating a contact metamorphism related to the intrusion of the quartz diorite. The metasedimentary rocks of the Great Island Group (Sequence II) overlie the igneous rocks of unit 10 and to date no contact metamorphism or any other evidence of intrusion has been observed in the Sequence II rocks relative to the porphyritic quartz diorite (10). Present evidence suggests an unconformable relationship.

The following mineral assemblages were observed in the Sequence II metasedimentary rocks:

i) muscovite-chlorite + biotite + quartz + feldspar;

ii) andalusite + garnet + muscovite + chlorite + feldspar + quartz;

iii) andalusite + muscovite + chloritoid + chlorite + quartz + feldspar;

iv) garnet +acicular amphibole + magnetite, clinochlore + quartz + carbonate;

v) muscovite + cordierite + sillimanite + biotite.

Muscovite-chlorite + biotite + quartz + feldspar

This mineral assemblage occurs in metasedimentary rocks east of Great Island and at the town of Churchill. This assemblage in general indicates greenschist facies metamorphism.

Andalusite + garnet + muscovite + biotite + quartz + feldspar + chlorite

This assemblage occurs within the area of Great Island. The biotite occurs as groundmass medium-sized grains intergrown with chlorite and/or as euhedral inclusion-filled porphyroblasts. Garnet occurs only sporadically and most commonly as red pinhead garnets in zones that are highly deformed and injected with quartz viens. Andalusite is rare and occurs in the basal section of the interlayered quartzite and phyllite (unit 22) as globular aggregates or as discrete inclusion-filled porphyroblasts in the matrix of medium grained muscovite + biotite + feldspar + quartz schist. The andalusite-bearing assemblage indicates conditions of lower to middle amphibolite facies of metamorphism. Compositional layering is preserved except in the cores of tight minor folds. Primary sedimentary layering is the main type of preserved layering. Locally at the northwest tip of Great Island (Location A, Fig. 35), the layering is a recrystallized pre-metamorphic cataclastic zone that has also deformed the underlying Sequence I intermediate metavolcanic rocks.

Andalusite + muscovite + chloritoid + chlorite + quartz + feldspar

This assemblage occurs sporadically in the region southwest of Great Island (Location B, Fig. 35) within an area of interlayered quartz metasiltstone and phyllite to schist exhibiting the muscovite-biotite + feldspar + chlorite assemblage. The andalusite forms euhedral poikiloblasts in a matrix of muscovite, chloritoid, quartz and feldspar. The andalusite blasts are zoned with an outer rim of pinnite chlorite and an inner zone of muscovite lying between the pinnite rim and the andalusite. A pronounced layering in part defined by quartz grains is present within the poikiloblasts but this layering is not identifiable outside the poikiloblasts. The layering in the poikiloblasts is oblique to the external schistosity of the rock. However, the realignment of the long axis of quartz grains within the poikiloblasts is subparallel to the external schistosity.

Garnet + acicular amphibole + magnetite and clinochlore + quartz-bearing assemblage

Iron formation containing garnet and acicular amphibole and an underlying siliceous metadolomite containing clinochlore and quartz form discontinuous layers which overlie the interlayered phyllite, quartz metasiltstone and quartzite of the lower part of the Great Island Group. These assemblages are representative of lower amphibolite facies metamorphism.

Muscovite + cordierite + sillimanite + biotite

This assemblage occurs at Tadoule Lake within a well-layered phyllite with thin interlayers of quartz metasiltstone (Location C, Fig. 35). Cordierite forms inclusion-filled porphyroblasts 1 to 2 cm long. According to Winkler (1974) this assemblage can form only in rocks with a high Mg-Fe ratio (greater than .25) and a lower Mn content. The presence of fine grained groundmass muscovite distinguishes this assemblage as medium grade rather than high grade. The mineral assemblages in Sequence II rocks indicate a general increase in the grade of metamorphism to the middle amphibolite facies of low pressure and high temperature from the west side of Great Island to Tadoule Lake.

CONTACT METAMORPHISM

In addition to the increase in metamorphic grade from Churchill west to Tadoule Lake there appears to be a change in the style of metamorphism to the south of Great Island. The assemblage: andalusite + biotite + muscovite + garnet occurs in fine grained schist approximately 30 km south of Great Island. Within this area the

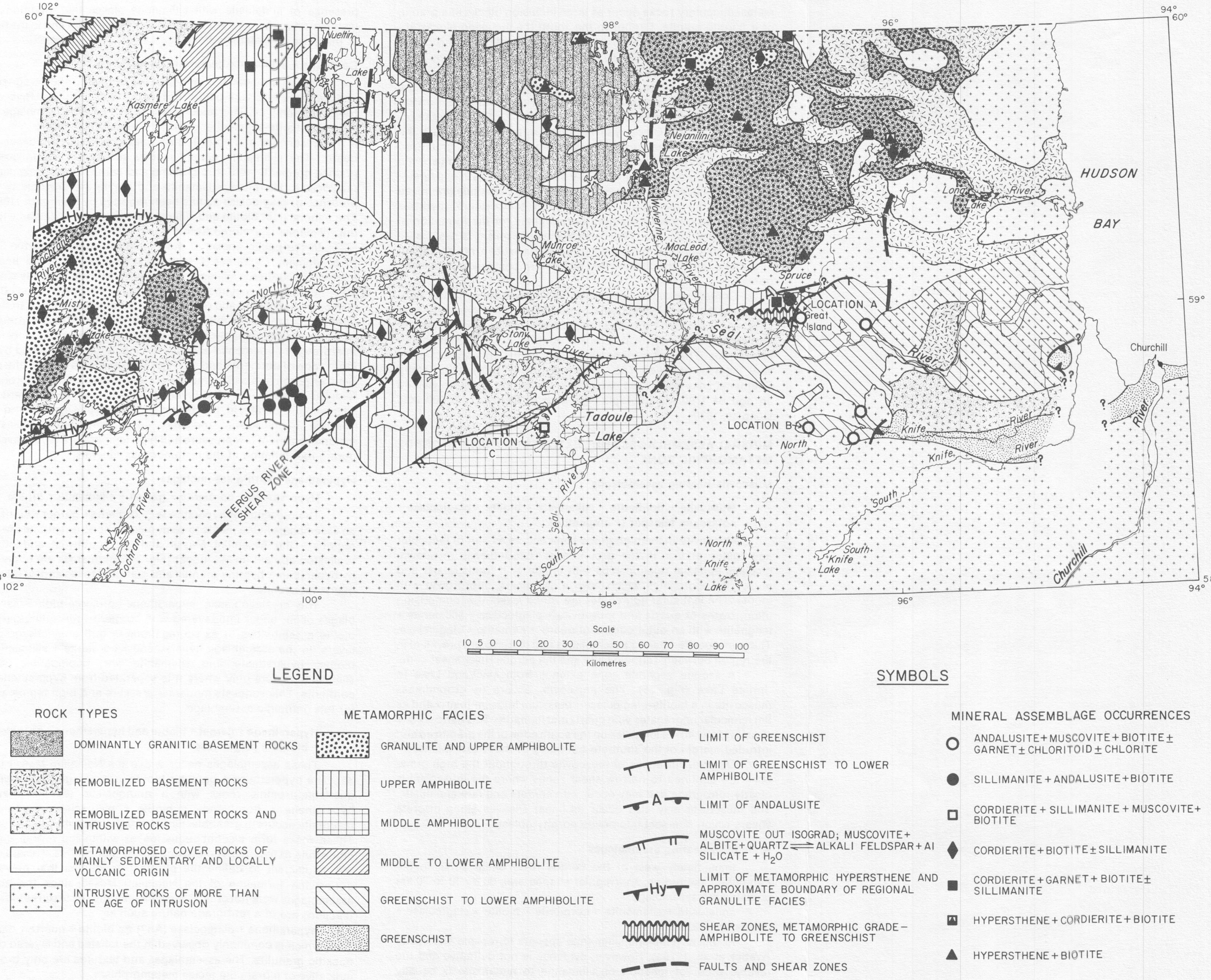


Figure 35: Metamorphic mineral assemblages and simplified zonations.

metasedimentary rocks occur as large inclusion blocks in a granite or a fluorite granite. Further to the south the inclusion blocks are smaller and the grain size within the metasedimentary rocks is coarse grained to very coarse grained. The andalusite forms large porphyroblasts which have been folded about the hinge line of younger folds. A high percentage of paragonite molecules in the muscovite, which occurs as inclusions in the andalusite poikiloblasts, indicates temperature of at least 500°C during metamorphism. Within the Chipewyan batholith further to the south the inclusions of metasedimentary rocks are present only as granitized relict layers defined by concentrations of coarse grained muscovite and/or biotite interlayered with very siliceous feldspathic layers.

The coarseness of the grain size and the ultimately granitized nature of the inclusions indicate high temperature, hydrous conditions of contact metamorphism suitable for the formation of coarse grained schists. The contact metamorphism is associated with late granites and fluorite granites that have been intruded along and marginal to the Chipewyan batholithic complex (Chipewyan domain).

Contact metamorphism is also in evidence along the northern margin of the Great Island domain along the south shore of Tadoule Lake and between Tadoule and Shetanei Lakes. Pegmatites are particularly abundant in this region (Map GR80-9-9), some being uraniferous. The metasedimentary rocks in this area are coarse to very coarse grained. The muscovite from pegmatites along Shethanei Lake have been dated by K-Ar method and have yielded an age of 1790 Ma (Isotopic Age Map of Canada, 1:5 000 000, Douglas, 1970).

MINERAL ASSEMBLAGES AND TEXTURES OF THE HIGH GRADE METAMORPHIC ZONE

Muscovite-bearing assemblages

Muscovite + cordierite + sillimanite + biotite + plagioclase + potassium feldspar (+ magnetite)

Muscovite in the high grade zone occurs as part of lenticular aggregates and/or in the groundmass. Groundmass muscovite displays epitaxial relationships with biotite or it forms quartz and muscovite aggregates which have a symplectic intergrowth with biotite. The lenticular aggregates are zoned *faserkiesel* comprising intergrowths of quartz and muscovite + plagioclase + sillimanite + magnetite with an outer corona of quartz + hematite + plagioclase. These muscovite-bearing assemblages and textures are prevalent in the region between Tadoule Lake and the Fergus River shear zone.

A second separate zone extends from MacLeod Lake to Spruce Lake (Fig. 35). The muscovite occurs as groundmass muscovite in a biotite-plagioclase-potassium feldspar matrix and as flat lenticular aggregates with quartz and hematite. This narrow zone (5 km wide by 40 km long) lies on the south edge of the granitized and intruded margin of the southern boundary of the Nejanilini Massif.

Other occurrences of muscovite throughout the high grade zone are confined to narrow shear zones where the muscovite is clearly retrograde and may occur with epidote and rare andalusite. The muscovite may also occur as linear sheaves along discrete shears which intersect microcline porphyroblasts.

Andalusite-bearing assemblages

Immediately west of the Fergus River shear zone, in the Pangman Lake region, an irregular-shaped area 60 by 10 to 20 km contains the assemblage:

andalusite + sillimanite + cordierite + biotite + plagioclase + potassium feldspar.

In this assemblage sillimanite appears to replace andalusite (Weber et al., 1975a). However, evidence is not definitive and the reverse order of reaction of sillimanite to andalusite is equally possible. The absence of muscovite in the assemblage and the presence of andalusite with sillimanite places the conditions of metamorphism below the aluminosilicate triple point and to the right of the muscovite stability field.

Cordierite + sillimanite-bearing assemblages

This mineral pair is common in the migmatite and paragneiss-derived pelitic and semi-pelitic rocks in the Wollaston, Seal River and Nejanilini domains. This mineral pair is part of the assemblage:

cordierite-sillimanite + garnet + biotite + magnetite

in the presence of granoblastic plagioclase + potassium feldspar and quartz. The sillimanite occurs mainly as needles within coarse grained cordierite and/or microcline and garnet in the presence of plagioclase. Therefore, sillimanite and biotite are unstable in the presence of plagioclase as has been reported by Reinhardt (1968). The mineral pair, biotite and sillimanite, have been observed where the sillimanite is armored from contact with plagioclase.

In the pelitic gneiss of the Wollaston domain and the Seal River domain (Subareas I and II), cordierite-sillimanite and/or microcline-cordierite sillimanite porphyroblasts are normally elongated, parallel to a metamorphic layering. The porphyroblasts have also been re-oriented and recrystallized into the axial planar trend of tightly folded metamorphic layering. The re-oriented porphyroblasts of cordierite are variably zoned. Some have a core of symplectic intergrowths of hercynite-sillimanite + magnetite surrounded by an inner zone of cordierite and an outer corona of quartz and feldspar. Simpler porphyroblasts comprise cordierite with an outer corona of feldspar and quartz. The mineral assemblage of cordierite + sillimanite + biotite in the pelitic to semi-pelitic gneiss and the absence of muscovite indicates upper amphibolite facies of metamorphism of low pressure and high temperature type prevailed during reorientation of the metamorphic minerals.

Hypersthene-bearing assemblages

Hypersthene + cordierite + garnet + sillimanite + biotite

The presence of hypersthene + cordierite + garnet + biotite as an assemblage in the pelitic to semi-pelitic gneiss is restricted to two regions - the Nejanilini Massif and the southwest end of the Wollaston domain (in Manitoba) (Fig. 35). Both areas are underlain by hypersthene-bearing granitic and granitoid rocks and/or foliated quartz monzonite.

The crystalloblastic hypersthene-cordierite-biotite assemblages occur either interlayered with cordierite-sillimanite-garnet-biotite assemblages or as segregations in buff anatectic granitic layers. In the assemblage hypersthene + cordierite + sillimanite + biotite, hypersthene and sillimanite are incompatible since sillimanite occurs only where it is separated from hypersthene by cordierite. This suggests moderate pressure and high temperature for this granulitic assemblage.

Hypersthene + garnet + biotite and hypersthene + hornblende + biotite + plagioclase

These assemblages occur within the Nejanilini Massif (Fig. 35). The hypersthene + garnet + biotite assemblage occurs within quartzofeldspathic rocks with a granoblastic texture whereas hypersthene + hornblende + biotite + plagioclase + garnet + magnetite occurs in granoblastic amphibolites and metabasic rocks. These rocks form discontinuous lenses within the overall quartz monzonite to hypersthene-bearing quartz monzonites. Present data are insufficient to define the physical conditions that prevailed during the formation of the Nejanilini Massif since the above assemblages were not critical assemblages and the textures indicate reactions are of a retrograde nature such as:

hypersthene + plagioclase (An?) $\leftrightarrows$ biotite + quartz + plagioclase which is commonly observed in the foliated and layered charnockitic granulite. The assemblages and textures are only broadly indicative of a granulite facies metamorphism.

Thin section examination of the hypersthene-bearing quartz monzonite to tonalites remote from linear belts and younger granitic intrusions indicates only sporadic retrograde metamorphism. Hypersthene may be partially altered to a red-brown serpentine. In hand specimen fresh samples are a translucent green to honey brown. However, within fault zones, shear zones and/or areas of granitic intrusions, these hypersthene-bearing intrusive rocks are intensely altered to pink biotite and/or hornblende-bearing quartz monzonite. The feldspar in these altered rocks is generally variegated pink and brown. Layered hypersthene-bearing amphibolites and metabasic rocks are almost entirely altered to biotite + hornblende gneisses and amphibolites. Portions of these altered basic rocks have relict textures of the hypersthene-bearing assemblages but no longer contain hypersthene.

ECONOMIC GEOLOGY

INTRODUCTION

Early recorded mineral exploration in the interval between 1953 and 1957 centered around the area of Great Island and downstream along Seal River. Exploration was facilitated by the proximity of Churchill (128 km by aircraft) and also the region's accessibility by water from Hudson Bay up the turbulent Seal River. Geological investigations by Johnston (1935) and Russell (1953) were confined to the navigable waterways. Federal/Provincial aeromagnetic maps (initiated in 1956) and a localized one mile to the inch geological map of Great Island (Milligan, 1955) focussed interest in the region around Great Island. Regional mapping and a report on the Shethanei Lake area (Taylor, 1958), revived exploration interest in the earlier prospected regions. Later geological studies by the Geological Survey of Canada (1961-1969) stimulated intermittent new exploration on a regional basis (Table 8). However, the most dramatic increase in widespread regional exploration activity was generated by the release of Federal/Provincial Uranium Reconnaissance Program (URP) open file reports and maps in 1976 and 1977 (Table 8). It would appear from the foregoing investigations that uranium and base metals are the main types of mineralization encountered in the area.

Summary of Activities:

The sources of information used in this review are:

i) assessment work (Open File) submitted to the Mineral Resources Division by exploration companies;

ii) observations and assays during the course of field mapping for the Cochrane River-Seal River Project;

iii) geochemical exploration data of the Manitoba Exploration Operations Branch 1976-78 (unpublished map);

iv) Federal/Provincial Uranium Reconnaissance Program open file reports and maps;

v) geochemical profile of till from Long Lac, Ontario, to Somerset Island, Northwest Territories (Shilts, 1980);

vi) Federal/Provincial aeromagnetic maps;

vii) Summary of Field Activities and geological maps, Manitoba Mineral Resources Division; Geology of Mineral Resources of Manitoba (Davies et al., 1962); and reports of the Geological Survey of Canada.

The assessment work has been divided into:

1. Airborne geophysics, ground geophysics, prospecting and trenching (Table 9 and Map GR80-9-10).
2. Diamond drill core descriptions (Table 11) with general locations (GR80-9-12).

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
1	91623	Airborne Permit #18	Jellicoe 1957	Airborne electromagnetic and magnetometer survey	Many strong conductors of considerable length are outlined These conductors fall into the following types 1 Stratabound conductors within the metasediments of the Great Island Group 2. Fault zones oblique to layering 3 A pronounced zone of conductors at the eastern edge of the Great Island Group of metasedimentary rocks at Great Island 4 Short well-defined conductors within the metavolcanic and metavolcanic-derived sedimentary rocks at Great Island Some of these conductors correspond to zones of felsic volcanic rocks. 5 Short conductors occurring in areas of high magnetic intensity that coincide with occurrences of metagabbro and hornblendites.
2a & 2b	91672	Airborne Permit #77	Canico 1969	Airborne electromagnetic survey carried out in the Churchill reconnaissance areas, using International Nickel Airborne EM instrument mounted in a Mark V Anson aircraft — mean terrain clearance 150 m	2a Several easterly-trending conductive zones were outlined which contain a large number of conductors The number of intense conductors with favourable profiles or shapes is small The enveloping lines that define the trends of the anomalies strike easterly. The undulatory outline suggests a phase of deformation about north-trending axial planes 2b No anomalous zones.
3a & 3b	91680	Airborne Permit #87	Keevil Mining Group 1970	DIGHEM Survey of 3069 line km was flown during August. The survey was flown in a line spacing of 200 m using a FH-1100 helicopter Anomalies are presented on 5 sheets compiled from an uncontrolled photo mosaic.	Anomalies occur on only three of the five sheets A number of isolated discrete satellite conductors were outlined and also a large number of long linear conductors Claim blocks 3738, 3739 **(Locations L-1, L-2** respectively, Ref No 3b) and claim blocks 3744 and 3745 **(Locations L-3, L-4,** Ref No 3a) were staked over a number of the discrete anomalies. Ground geophysics was carried out in these claim blocks
			1971	Ground Geophysical Survey, V E M. using a modified Sharpe S.E 200 unit, using a fixed transmitter method at a transmitter-receiving interval of 120 m. Magnetometer survey was carried out using a Sharpe fluxgate Model M.F. 1 magnetometer.	Four conductors were outlined and recommended to be tested by diamond drilling (see Table 11, **Locations D-17 to 19, Map GR80-9-12).**
4	91760	Exploration Res. #72 (Part of Exploration Reservation holdings #68-72)	Dynamic Petroleum Products Limited 1969	Radiometric, electromagnetic and magnetic coverage was undertaken over all of the reservations using equipment installed in a helicopter. The survey involved flying 6929 line km Radiometric Survey - ABEM, crystal EM survey - Rio Mullard system measures in-phase and out-phase components of the secondary field at a frequency of 320 Hz	Twenty radiometric anomalies were outlined within Exploration Reservations #68-72. Three of these anomalies lie within Reservation #72 (Map Reference 4, map GR80-4-10) These were described as weak anomalies and no follow-up was carried out The EM survey indicated three anomalous zones trending easterly It is felt by the author of this report that these trends reflect regional structural trends of metamorphic layering, fold axis and major shear zones

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
				Magnetic survey - Barringer Model Am-101A Magnetometer.	Anomaly 19 lines 1-9 **(Location L-5, Map GR80-9-10).** Mainly swamp covered. Some mineralization, principally graphite, some pyrite and pyrrhotite. Chip samples assayed Cu - 0.01, Ni - trace; Zn - 0.02%.
4	91760	Exploration Res #72 (Part of Exploration Reservation holdings #68-72)	Dynamic Petroleum Products Limited 1970	1970 Ground follow-up was carried out to investigate some of the airborne EM anomalies in the area of Nicklin Lake The instruments used were a V H E M. unit made by McPhar and a M F 2 Fluxgate magnetometer.	
4	91760	Exploration Res #72 (Part of Exploration Reservation holdings #68-72)	Dynamic Petroleum Products Limited 1970	Blazed compass lines were set up for the ground survey grids	Anomaly 19 lines 10-23 **(Locations L-6, Map GR80-9-10).** Conductor strong, 4-5 km in length Area of investigation at depth mainly swamp covered: frost-heaved outcrop and float show up to 20% graphite with some pyrite in float. A weathered boulder of schist was sampled and assayed Cu - 0 04%, Ni - trace, Zn - 0.05%. Anomaly 22 **(Location L-7, Map GR80-9-10).** Deep sand-covered conductor is only moderately strong The main mineralization observed was in a rounded boulder which contained 5% graphite.
5	92030	Exploration Res. #17	Noranda Exploration Company 1973	Airborne Questor MK VI Input Survey of 1221 line miles at ¼ mile spacing were flown using a Skyvan (CF-QSL) during March 9, 16 and 17. Mean terrain clearance was 135 m with the EM bird 50 m above ground.	A number of conductors were indicated as a result of the survey and 29 were considered to be of interest These were numbered and discussed in the company evaluation of the survey. The following anomalies 5-73, 9-73 and 21, 22 and 23-73 were recommended for further work in the form of a ground reconnaissance EM and magnetometer survey
	92030	Exploration Res #17	1974	During March and April grids were cut on anomalies 5, 9, 21, 22 and 23. The EM survey was carried out using the Crone EM unit (C E M.) manufactured by Crone Geophysics Ltd. The two-man crew used the "horizontal shootback" method of survey. The magnetic survey was conducted at the same time as the EM survey using a Scintrex F-2 Fluxgate magnetometer	Anomaly 5-73 **(Location L-8, Map GR80-9-10).** A Turon survey was recommended to locate the anomalous trned and then a follow-up drill program. Anomaly 9-73 **(Location L-9, Map GR80-9-10).** A further two miles of EM 17 surveying will be required to pinpoint both conductive trends. Anomaly 21 and 22 **(Location L-10, Map GR80-9-10).** A program of trenching is recommended since the response indicates a near-surface conductor A drilling program would then be based on these results Anomaly 23-73 **(Location L-11, Map 80-9-10).** This conductive trend should be tested at line 20N, 9400° E. The anomaly is vertical to steeply dipping to the west and is overlain by approximately 8 m of overburden.
6	92036	Exploration Res #137	Ducanex Resources and Manitoba Minerals 1974	An area of 256 km^2 which included Exploration Res #137 was flown along north-south lines at 8 km spacing to outline areas of outcrop and gossan	Ground follow-up Prospecting is seriously hampered by a lack of outcrop in this region Most exposure is along and north of Seal River.
7 North and 7 South	92015		Ducanex Syndicate (Rayrock Mines Ltd. - Ducanex Resources Ltd) 1974	A program of reconnaissance geological mapping at a scale of ½ mile to the inch and prospecting was carried out in two areas, one centered on Askey Lake, Ref. No. 7 North, Map GR80-9-10, and a second in an area from Munroe Lake to Booth Lake. Ref No. 7 South, Map GR80-9-10. Detailed prospecting was carried out within Reservations #139-144 (Ref No. 7a to 7f, Map GR80-9-10) and Claim Blocks 6641, 6643 (Ref. No. 7h) all of which lie within 7 South. Detailed prospecting was also carried out within 7 North within calc-silicate rocks in the area of Askey Lake Follow-up work consisted of detailed: i) gamma-ray spectrometer surveys; ii) rock trenching and chip sampling. An Exploranium portable gamma-ray spectrometer Model DISA-300 was used for detailed grids.	Twelve locations of interest were outlined Seven were base metal prospects, six of which are associated with calc-silicate rocks and one with quartzitic rocks. Five areas of uranium mineralization were outlined. The uranium mineralization falls into three types. 1. Pink pegmatite with associated magnetite, 2 White pegmatite and mignatite; 3 Narrow weak zones of radioactivity in sheared calc-silicate rock **Detail Work - Base Metals** **Location L-12** (Map GR80-9-10) Southwest corner Ref. No. 7c. Mineralized calc-silicate-amphibolite in contact with pelitic gneiss. A grab sample from a zone 120 m wide made up of mineralized bedrock exposure and boulders assayed 0.70% Cu. A trench across a 13 5 m width of outcrop was mineralized over its full length and contained up to 1-3% chalcopyrite, bornite and pyrrhotite, chip samples across 10 m assayed 0.198% Cu **Location L-13 and L-14 (Map GR80-9-10)**, Ref. No. 7b. Boulder fields of hornblende gneiss and calc-silicate rocks. L-13 grab sample - 0.57% Cu L-14 grab sample - 0.11% Cu **Location L-15 (Map GR80-9-10)**, Ref. No 7a Boulder fields of calc-silicate rocks. one oxidized boulder - 25% disseminated pyrrhotite and chalcopyrite assayed 0.79% Cu. **Location L-16 (Map GR80-9-10)** South central portion of Ref. No. 7a
7a		Exploration Res. #139			
7b		Exploration Res. #140			
7c		Exploration Res #141			
7d		Exploration Res #142			
7e		Exploration Res #143			
7f		Exploration Res #144			
7h		Claim Block 6651, 6643			

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
					Stringers of chalcopyrite and minor pyrrhotite were located in calc-silicate rocks along the shore A trench was blasted across the outcrop for a length of 7 m Chip samples from the centre of the trench (3 m) returned an assay of 0 28% Cu A grab sample assayed 0 75% Cu **Location L-17 (Map GR80-9-10)** 4 km east of the north end of Booth Lake, 7 South A 3 m trench was blasted in an outcrop of calc-silicate and marble The sulphide mineralization, pyrrhotite, assayed trace Ni **Location L-18 (Map GR80-9-10)** Southwest corner of 7 South Numerous boulders of quartzite contain 5% pyrrhotite and chalcopyrite.
				Five locations were examined with detailed ground geophysics Grids were cut and stations established at 30 m intervals to conduct 1 A magnetometer survey, carried out using a Barringer GM-122 Proton Magnetometer 2. An EM survey, carried out using a Geonics EM 17 horizontal loop with a 120 m coil spacing	**Location L-12** A long conductor (2 km) was located under the lake Previous prospecting at location L-12 located bedrock mineralization along the south shore of the lake. The conductors were drilled, the results are listed in Table 11, Ref No D-43, Map GR80-9-12 The continuous conductor with widths from 16 or 35 m (50 m on line 64E) dips to the north The conductor does not have coincidence with a magnetic anomaly **Location L-14** No conductors indicated. Negative values were noted on either side of a magnetic low **Location L-15** No conductors were located by the EM survey The magnetometer survey indicated considerable change in magnetic relief **Location L-16** Negative out-of-phase values under the lake, probably conductive lake bottom No other conductors **Location L-18** No conductors are indicated by the EM survey.
7f		Exploration Res. #144		**Location L-19** (Ref. No 7f southwest corner of Munroe Lake, Map GR80-9-10) Grid lines 340 m spaced 33 m apart with east-west lines at 30 m intervals for detailed geologic mapping and spectrometer survey	**Detail Work - Radiometric Anomalies** **Location L-19** Lenticular pink pegmatite dykes strike north-south within quartzites and are locally radioactive, especially when associated with blebs of magnetite and yellow uranium bloom. Grab samples assayed 0 11% U_3O_8
7h		Claim Blocks 6641 and 6643 (36 claims)		**Location L-20 (Map GR80-9-10)** A picketed base line over a strike length of 1.3 km with cross lines at 30 m intervals over a length of 300 m was located for the purpose of detailed geologic mapping and spectrometer survey	**Location L-20** Radioactive pegmatite sills strike 060° and dip 70° to the northwest A series of radioactive zones in the pegmatite are exposed over a strike length of 100 m and a width of 16 m A trench was cut across the strongest anomaly A sample from a strong yellow uranium stain and hematite alteration in the trench over 3 m assayed 0 075% U_3O_8, the average assay over 9 m is 0 037% U_3O_8.
7f		Exploration Res #144			**Location L-21** (Southeast corner of Ref. No. 7f) A moss sample from the area of radioactive spring assayed 780 ppm U_3O_8
7d		Exploration Res. #142			**Location L-22** (Southeast edge of Ref No 7d) The grid covered a large area of weakly radioactive white pegmatite within migmatites The pegmatites strike to the east. The spectrometer survey indicated an area of 300 m by 1650 m of uniformly low radioactivity that would probably range in the order of 50 - 125 ppm U_3O_8.
7 North				Prospecting, shallow trenching. On ground scintillometer survey, using a BGS-1 Scintillometer.	**Location L-23** (7 North - Askey and Bangle Lakes). Mineralization of base metal sulphide and radioactive anomalies lie along the north side of Askey Lake A sequence of calc-silicate, marble and biotite psammite outcrop in a zone 4-5 km wide and 22 km long centered on Askey Lake. Occurrences of pyrite were obtained within the calcareous zones of the sequence. Narrow zones 10 to 15 cm wide occur in approximately 10 locations. A narrow zone of radioactivity containing weak red hematization is fairly continuous along strike with total count reading 100-400 cps.
8	92021	Airborne Permit #113	Manitoba Mineral Resources Ltd. 1973	Airborne Electromagnetic Survey using the Questor Mark VI Input Airborne EM systems and Barringer AM-104 or AM-101A Proton Precession Magnetometers. The survey totalled 1770 line miles. The survey aircraft was a Shorts Skyvan CF-QSL.	Formational conductors dominate the survey areas However, 12 targets were outlined for further follow-up work Exploration permits were taken out in the areas of interest Exploration Reservations No. 125, 126 were taken over a narrow belt of volcanic rocks which contain nine anomalies. Exploration Reservations Nos 129-132 were taken over a narrow belt of metasedimentary rocks only partially exposed. Abundant stratiform conductors of graphite and pyrite outline a complex synformal structure. However, three distinct anomalies were outlined on the western edge of the structure

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
					Exploration Reservation No 134 was taken out over the eastern edge of the Great Island metasedimentary cored structure where abundant formation conductors are present Exploration Reservation Nos. 133, 135 were taken out over a northeast-trending group of weak conductors This northeast trend coincides with the magnetic high associated with a serpentinized ultramafic previously tested by Keevil Mining Co., Accession No 91680, Ref. No 3a, Map GR80-9-10
9	91395	Exploration Res. #125, 126	Manitoba Mineral Resources Ltd 1974	Horizontal loop EM-17, instrument was a Geonics EM-17 unit utilizing a frequency of 1600 cps with a 100 m cable and an ABEM-EM gun utilizing a frequency of 880 cps and a 100 m cable	In 1974, nine grids were outlined based on the airborne survey. A total of 215 line km were completed The stronger anomalies on Grids S-1, 2, 3, 4, 5 and 8 **(Locations L-24, 25, 26, 27, 28 and L-31, Map GR80-9-10)** were recommended for drilling and 79 drill holes would be required **(Table 11, Location D-21, Map GR80-9-12)**. Grid S-7 **(Location L-30, Map GR80-9-10)** was only partially tested and Grid S-9 **(Location L-32, Map GR80-9-10)** was not completed
			1975	Selected portions of Grids S-4 and S-8 **(Locations L-27 and L-31, respectively)** were established and a number of one line EM-17 surveys undertaken Grid S-9 **(Location 32)** was established and surveyed by EM-17 This amounted to 19 line km. The technique was identical to that used for the 1974 survey	No new conductors of economic significance were outlined by this work. The input conductor outlined by the airborne survey on Grid S-9 **(Location L-32)** is now known to have resulted from causes other than significant bedrock responses
10	92097	Exploration Res #129, 130	Manitoba Mineral Resources Ltd. 1975	Ground survey with horizontal loop - Geonics EM-17 frequency 1600 Hz and a coil separation of 90 m. 1. Two on Reservations #129 and #130. 2. Three on Reservation #130 and in total 107 km of section lines were investigated by geophysical survey	Moderate to strong conductors were established on all five grids Grids B-6, 7, 8, 9, 10 **(Locations L-33-37, Map GR80-9-10).** As a result eight diamond drill holes were spotted and completed to test these anomalies. Core intersections of all holes showed abundant graphite, minor barren sulphides in meta-sedimentary rocks **Table 11, Locations D-28-34 and 42, Map GR80-9-12.**
	92098	Exploration Res #131, 132	1975	Ground survey with horizontal loop - Geonics EM-17 frequency 1600 Hz and a coil separation of 90 m. Cutline grids were established, two on Reservation #132 and three on Reservation #131; 18 km of section lines were investigated by geophysical surveys.	Moderate to strong conductors were established for two grids B-2 and B-3, Permit #132 and two grids B-4 and B-5, Permit #131 **(Locations L-39, 40, 41, 42, respectively, Map GR80-9-10).** These conductors were tested by 6 ddh's. The holes indicate the conductors are associated with graphite schists bearing minor pyrite and pyrrhotite (Table 11, **Locations D-22-27, Map GR80-9-12**).
11a, 11b, 11c	92099	Exploration Res. #133, 134 and 135	Manitoba Mineral Resources Ltd. 1975	Geophysical program as on Exploration Reservation #129-132.	Moderate to strong conductors were outlined on Grid B-11 **(Location L-43)**, Permit #135 (Map Ref. 11C, Map GR80-9-10). Grids B-14 and B-15 **(Locations L-46, 47)**, Permit #134 (Map Ref 11b, Map GR80-9-10) and poor conductors on Grids B-12, 13 and 20 **(Locations L-44, 45 and 48)**, Permit #133 (Map Ref 11a, Map GR80-9-10). Subsequently drilling was carried out in these areas in 1975 (Table 11, **Location D-35-41, Map GR80-9-12**).
12	92117	Exploration Res. #125 and #126 active in early 1976 but reduced after March, 1976 to 41 claim blocks Claim Blocks 6882 to 6892, 6896-6922, 6944-6946.	Manitoba Mineral Resources Ltd. 1976	Horizontal loop EM survey using a Geonics EM-17 with a 90 m cable was conducted over 119 km Grid S-4 was extended to provide grid coverage of that area bounded by previously established grids S-3 (Grids S-4, S-5, and S-6 [1974] **Locations L-26-29, respectively**). Also included are one line surveys as Grids S-1, S-2 and S-3 **(Locations L-24, L-25, L26)** to confirm conductor axis and to finalize drill collar locations	The extension of Grids S-4 **(Location L-27)** indicated six moderate to strong conductors within or close to the margin of a zone of felsic volcanic rocks. 24 ddh. were drilled on Grid S-2 and Grid S-3 **(Locations L-25, L26)** based on this survey and previous survey (1974) (Table 11, **Location D-21**, Map GR80-9-12).
	92114	Claim Block 6882	March, 1976 to May, 1977	105 km of EM survey were conducted with a Geonics EM-17. The grid in part was designed to extend Grid S-4 **(Location L-27)** to the north	It was recommended that 29 holes be drilled to test the six to seven anomalies around a felsic volcanic core Trenching was carried out at two sites: Claim Block 6888 - **Location L-23A** } Map GR80-9-10 Claim Block 6915 - **Location L-28A** } **Location L-23A** - sulphides in dacite pyrite, pyrrhotite, trace chalcopyrite; zone 600 ft by 10 ft. Assay: .03% Ni, 07% Cu, trace Zn, trace Au. **Location L-28A** - rusted zone 2000 ft long, sulphides - pyrite, pyrrhotite Assay: 0.20% Cu, 0.27% Zn.
13	92043	Permit #4	Silver Standard holder of Permit - others participating: - Province of Manitoba Colt Resources Yukon Gold Placers Messrs. Blusson, Mackey & Petancic March, 1976	1. Airborne Radiometric Survey. The survey was conducted by Questor Survey using a Exploration Geometrics Spectrometer Model DGRS-3001 system and a crystal detector assembly consisting of two Model GAX-100 packages for a total crystal volume of approximately 32,300 cubic cm. Four channel spectrometer representing total count potassium, uranium and thorium were collected. Flight lines were oriented north-south, spaced at 220 m and flown at mean terrain clearance of 83 m (radar altimeter elevation) and at a	Three areas were selected for ground follow-up zones A, B and C, (Map GR80-9-10) Zone A - Airborne anomaly was a broad anomaly of relatively low amplitude but a favourable uranium to thorium ratio anomalous areas were determined to be those locations exhibiting a count rate of: $U - 0.6\ Th \geqslant 20$ Thirty-eight anomalous zones were outlined. Zone B - 25 anomalous zones Zone C - 44 anomalous zones The glacial deposits are sufficiently thick to preclude any

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
				speed of 180 km/hr. Plotted results reflect corrections made for terrain clearance variation and Compton effects 2. Based on the result of the Airborne survey three zones designated A, B and C (Map GR80-9-10) were selected as targets for ground follow-up Ground measurements were made utilizing a McPhar Model Spectra 44 gamma-ray spectrometer and 76 mm x 76 mm crystal detector. Radiometric readings were taken at 30 m intervals along flagged grid lines.	bedrock source of radiation from penetrating to the surface It is believed that the radiometric and geochemical anomalies (Geological Survey of Canada Open File 323) in the project area reflect U in the overburden which is finely dispersed in rocks or perhaps small rock fragments. Ground prospecting in and adjacent to the grid areas indicate the large boulders do not host anomalous concentrations of U Further exploration should use methods of subsurface sampling such as Alpha-ray survey
14	92043	Permit #5	Urangeseli-schaft Canada Ltd. 1976	Geological mapping, geochemistry for U in rock chips, lake sediment, stream sediment, water samples. Scintillometer and spectrometer BGS-1SL were used as part of the mapping program. Exploranium DISA 400A spectrometer was used to measure U and Th ratios UG airborne radiometric survey flown line at ¼ mile spacing and at ⅛ mile spacing and approximate altitude of 200 ft.	No bedrock samples contain high U values, also U values in float are not of economic interest No primary radiometric anomalies were found in the Putahow area Geological Survey of Canada lake sediment anomalies in this area are attributed to leaching of uranium from none to subeconomic granitic rocks. "Since anomalous U values are not associated with anomalous Cu, Ni, Pb or Zn values and since the U anomalies are associated only with granitoid rocks from the point of view of geochemistry the Putahow River area is downgraded."
15	92453	Permit #7	Urangesell-schaft	UG airborne survey flown at ¼ mile spacing and approximate altitude of 200 ft Ground follow-up consisted of conventional mapping, uranium ground geophysical prospecting and rock geochemical sampling techniques were used to examine the above areas.	Examination of four zones with anomalous radioactivity were found to be caused by concentrations of mineralized migmatitic quartz-monzonite boulders. However, one in situ mineral occurrence was discovered outside the zones targeted by the airborne survey This was named the "Donini Lake North" showing.
16	92442	Claim Blocks 1820 and 1819	Urangesell-schaft Canada Ltd. 1978	Grids were cut over the claim group, VLF-EM and Proton precession magnetometer surveys were conducted over the grid. Max - Min II-HEM survey were conducted over parts of the grid. Alpha-nuclear radar surveys were conducted over parts of the grid.	A radiometric anomaly 600 m x 400 m was located near Lake Donini, **Location L-49, Map GR80-9-10,** within calc-silicate rocks 1. Radioactive boulders of a pegmatitic diopside potassium-feldspar gneiss returned assays up to 8% U_3O_8 2. Radioactivity in outcrop associated with north-trending shear zones occurring in a diopside graphite marble; best assays from surface showings were 3 lbs U_3O_8/ton over 1 m 3. Soil and rock geochemical and alpha nuclear radon surveys in overburden covered area adjacent to the showing outlined significant U and Radon anomalies VLF and Max-Min II horizontal loop EM surveys established strong conductors (attributed to graphite) oriented parallel to the northeast regional strike of the calc-silicate succession The graphite conductor is offset by north-south faults, one of which is on strike with the surface showing
17	99639	Permits #13, 14, 15, 16, 17, 18, 21	Siscoe Metals of Ontario Ltd. 1976	Geological mapping, rock geochemical survey, geochemical soil and lake sediment, ground magnetic survey, ground VLF-EM survey.	Permits have been cancelled and holdings have been consolidated to several groups of claim blocks, diamond drilling has been carried out but results remain confidential.
18	92136	Claim Block 7384	Province of Manitoba, Mineral Resources and Environmental Management, Exploration and Operations Branch, 1976.	An area of 360 km² was flown by a tree top helicopter Airborne Scintillometer survey at 250 m line spacing accompanied by lake sediment and Radon surveys. The survey isolated an anomaly which was staked (Claim Block 7384). Ground surveys on Claim Block 7384 were as follows: 1. Scintillometer survey. 2. In situ gamma ray spectrometer survey. 3. Portable drill samples. 4. Radon Emanometer. 5. VLF-EM survey. 6. Proton-Precession magnetometer.	The showing consisted of a boulder field of white granite containing up to 597 ppm eU (gamma-ray spectrometer) with an average of 180 ppm (0.36 lb/ton). Neutron activation analysis of "GSC Drill" samples is 0 61 lb/ton.
19	92142	Claim Block 7540	Province of Manitoba, Mineral Resources and Environmental Management, Exploration and Operations Branch, 1976, 1977	Airborne helicopter scintillometer survey (40 m altitude and 250 m spacing). U lake sediment geochemistry and Radon at a density of one sample/km. The survey resulted in an anomaly that was staked, Claim Block 7540. Detailed work carried out on the claim block was: 1. Scintillometer survey 2. Radon Emanometer 3. In situ gamma-ray spectrometer assay for K, U and Th. 4. "GSC Drill" samples of boulders and neutron activation assay of these samples. 5. VLF-EM survey. 6. Geological mapping (boulder trains).	1. Radioactive leucogranite boulders with U content in the 0.2 to 3.5 lb./ton range have been located over an area of 1500 by 400 m. 2. 1558 m of diamond drilling has demonstrated that mineralization in bedrock is similar to that found in the boulders at surface. **Location D-70** (21 drill holes), Map GR80-9-12. 3. Mineralization is continuous for at least 400 m along strike at 0.2 lb./ton. Higher concentrations occur but they are erratic 4. Uraninite is the prominant uranium mineral.

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
				7. IP/Resistivity 8. Diamond drilling and gamma-logging **(Location D-70, Map GR80-9-12).**	
20	92212	Permit #12	McIntyre Mines Ltd 1976, 1977	Low level helicopter survey using the STRAT SPP2NF instrument in the nose of the helicopter, flight altitude was 23 m. Lake water and sediment sample was carried out and samples were analyzed for U, Mo **Detailed Local Surveys:** Reconnaissance traverses with the STRAT scintillometer and the McPhar TVS differential spectrometer and Aspectra 44 (McPhar) GP-70 Magnetometer; Spectra 44/scintillometer and Radon Surveys, Model RD200, EDA electronic. Diamond drilling was carried out on eight targets, mainly defined by Radon and geochemical results, **(Locations D-62-69, Map GR80-9-12)**. A minor program of outcrop blasting, mapping, rock sampling and geophysical surveying was completed	Prospecting with the STRAT instrument led to the discovery of a small radioactive fracture system striking N30° E/80. A zone of 1.2 m was sampled and yielded results of .065% U_3O_8 **(Location L-50, Map GR80-9-10)**. The fracture is filled with smoky quartz and coarse biotite up to a width of 5 cm in a coarse grained white quartz
21a and 21b	91483	NTS-54L-9, 16, 54K-12, 13 in the area of Churchill, Manitoba on the east and west side of the Churchill River	Imperial Oil Ltd Manitoba Mineral Resources Ltd Eldorado Nuclear Ltd Warren Exploration Ltd., Imperial Oil Ltd. - Operator 1976	Airborne radiometric survey. The survey was conducted using a Bell 206B equipped with an INAX Model 1287 Spectrometer coupled to an Exploranium Mar 56 Chart Recorder, 54 lines were flown 21a (East of the Churchill River) contained 24 east-west lines, a total of 355 line km. 21b (West of the Churchill River) contained 30 lines of 516 line km. The helicopter maintained an altitude of 50 m AGL during the survey. Ground follow-up work consisted of geological traverses over anomalies carrying a SPRAT SPPZ or a Scintrex BSL-ISL scintillometer. In area 21a three anomalies were checked. In area 21b, 27 anomalies were checked Geological and radiometric mapping was carried out over the complete areas of outcrop, a BGS-ISL broad band, gamma-ray scintillometer was used. North trending lines were run at intervals of 30 m except in areas of known showings where lines were at 65 m. Traverses were by pace and compass and radiometric readings were taken every 35 m. At **Location L-51, Map GR80-9-10**, the airborne spectrometer anomaly coincides with prospectors radiometric showings.	Fifty-six anomalies were found during the survey. Six anomalies were in 21a, 50 anomalies were in 21b Spectrometer readings were very low in this survey. Background values were as follows **21a** / **21b** K: 100-150 counts/2.5 secs / 100-150 counts/2.5 secs U: 15-25 counts/2.5 secs / 20-30 counts/2.5 secs Th: 40-60 counts/2.5 secs / 35-50 counts/2.5 secs Integral: 800-2500 counts/2.5 secs / 1000-2100 counts/2.5 secs Ground checks in Area 21a indicated two types of radioactive occurrences 1. Heavy mineral concentrations and secondary quartz veins in the quartz **(Location L-51, Map GR80-9-10)** 2. High background due to surficial deposits of metasediment and granite gneiss boulders, **(Locations L-52 and L-53, Map GR80-9-10)**. Ground follow-up in area 21b. Quartzite contains small localized patches of weak radioactivity **Conclusions:** Airborne results show mostly weak, thorium-rich anomalies. Ground checking indicates where radioactivity in excess of background does occur, it is very localized. The few granite gneiss boulders found hold no interest at present One anomaly, No. 3-4-07 **(Location L-51)** in the extreme east of Area A is of passing interest. The radioactivity is found in heavy mineral concentrations along cross-bedding planes and/or concentrations of radioactive minerals in quartz filled fractures
22	92059	Permit #23	Manitoba Mineral Resources Ltd., Eldorado Nuclear Ltd., Placer Development Ltd 1977	Radiometric survey. Airborne survey carried out using a Mount Sorpis Model SC-160 scintillometer connected to a Hewlett Packard Model 680 strip chart recorder Lines were flown at ⅛ mile spacing at a height of approximately 30 m above ground level using a Bell 206-B helicopter, 830 line miles were flown. Radiometric Ground Survey was carried out using a Scintrex BGS-ISL scintillometer. A soil geochemical survey was conducted to test for uranium. The permit was flown and examined on the ground in an attempt to find outcrop. A northerly-trending contact between metasediments and granitic rocks is suggested by geophysical surveys. No outcrop was found to substantiate this	A regional high forms an asymmetrical dome-shaped pattern with steep northern and western slopes and gentle southern and eastern slopes. The centre of the zone coincides with the radiometric anomaly shown in the Federal/Provincial Surveys. Eighty-four weak anomalies were defined with values 1.1 to 1.5 times local background level A weak correlation is suggested by rock chip samples from boulders in comparison to soil anomalies For anomalous soil values, there is a corresponding enrichment in U in the rock analysis. However, the results in general are inconclusive. Examination of geochemical soil samples indicate that there is a corresponding increase in Cu and Ni with the U No significant Uranium occurrences were observed.
23	92132	Permit #3	Shell Canada March, 1977	Ground geophysics (Geonics EM-16 and Magnetometer) followed by establishing grids based on results of EM-16 and magnetometer survey. A Geonics EM-17 (1600 Hz and 91 m separation and a Scintrex MF-2 fluxgate	Eight anomalies were located and grids set up. Bedrock conductors were indicated on five grids, **(Locations L-54-58, Map GR80-9-10)**. Six diamond drill holes were drilled to test these anomalies, **(Locations D-56-61, Map GR80-9-12)**

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
				magnetometer were used to take readings at each station (25 m spacing).	
23	92133	Permit #3	Shell Canada August, 1977	Geological mapping and accompanying geophysical investigation using Scintrex BGS-IS and BGS-ISL scintillometer. Lake sediment geochemical survey, at a sample density of approximately 1 sq km. using a torpedo sampler Samples were analyzed for U and loss on ignition.	The highest readings occur around 101° 49'30" and 59° 58'20" **(Location L-59, Map GR80-9-10)** This duplicates the results of the G S.C lake sediment survey The underlying rocks are believed to be Hurwitz Group dolomite The cause of the anomaly is unknown Yukon Antimony Anomaly Zone 'C' lies within Permit #3 **(Location L-60, Map GR80-9-10)**. However, it was not part of the Shell Ltd. option, but rather was being investigated by Mid-North Uranium Ltd. Anomaly zone 'C' was examined originally in 1967, 1970 Detailed description of the work is available in the Kasmere Project (Weber et al , 1975)
24	92135	Claim Block 8023	Province of Manitoba Mineral Resources and Environmental Management, Exploration and Operations Branch, 1977	Helicopter-borne scintillometer survey (¼ km line spacing), ground follow up spectrometer survey and lake sediment survey.	Anomaly in porphyritic quartz monzonite Anomaly due to large surface exposure of uranium enriched quartz monzonite (35 ppm).
25	92137	Claim Block 8024	Province of Manitoba Mineral Resources and Environmental Management, Exploration and Operations Branch, 1977	Helicopter-borne scintillometer survey (¼ km line spacing), follow-up ground spectrometer survey, sampling with portable diamond drill at 29 sites	White medium to coarse grained quartz monzonite Three of the 10 assays greater than 100 ppm eU with a high of 849 5 ppm eU.
26	92257	Permit #10	Union Oil 1977	Reconnaissance prospecting programs, detailed VLF-EM Reconnaissance and detailed Radon Survey (EDA Instruments, Model RDU-200 Alpha counter) Airborne radiometric and magnetic survey (Kenting Earth Sciences), flight line spacing, 205 m. Rock and soil geochemistry Soils - Standard Fluormetric method for U, Cu, Pb, Zn, Ni and Co, Standard Atomic Absorption.	**Location L-61, Map GR80-9-10** Reconnaissance prospecting isolated two areas of interest - Sites A and B. Site A is in felsenmeer Trace pyrite and Mo were found in radioactive granite pegmatite Site B - outcrop radioactivity measured 7000 cps max (BGS-ISL), associated with biotite-quartz segregations in a zone 1 to 2 m by 20 cm within coarse grained granite Minor disseminated Mo were observed. Radon - Water and Soil (Reconnaissance) indicated a zone in the north-central part of the Permit to be of interest However, no corresponding bedrock or boulder uranium mineralization was observed. Soils - Uranium in soils coincides with Radon in water. U_3O_8 and Mo show a trend, however, the majority of U_3O_8 and Mo values were present in muskeg samples (A zone) U and Mo anomalies in this region relate to high background levels in a late stage Hudsonian granitic intrusion. High Radon levels in springs and seeps remain unexplained and may relate to a more active leaching process mobilizing U from granitic rocks
27	92281	Permit #20	E and B Exploration	Reconnaissance prospecting with scintillometer, Geochemistry (lake sediment), Radon survey soil and lake water. Limited VLF-EM and magnetometer surveys.	29 sites were outlined based on geochemical results and prospecting Of these 29 sites, five were subsequently staked and Permit #20 lapsed **Locations:** **L-62** - Claim Blocks 9118-9120 **L-63** - Claim Blocks 9105-9113 **L-64** - Claim Blocks 9121, 9125 **L-65** - Claim Blocks 9114-9117 **Map GR80-9-10.**
27	92280	Claim Block 9118, 9119, 9120 **Location L-62**	E and B Exploration Ltd , 1978	1. Geochemical, rock samples. 2 Emanometer 3. Magnetometer 4. VLF-EM surveys	Scattered trains of hot boulders trending north-northwest across the property Chip samples gave a high of 384 ppm U The boulders are well rounded and are believed to be from a source area north-northeast of the claim block group
		Claim Block 9105-9113, **Location L-63**		1. Geochemical, rock samples 2. Emanometer 3. Magnetometer 4. VLF-EM surveys	Radioactive boulders are sparsely distributed. The best values obtained from chip samples are 88 and 66 ppm U. The boulders are well rounded and do not appear to be frost heaved
		Claim Blocks 9121, 9125, **Location L-64**	E and B Exploration Ltd 1978 on behalf of Can-Lake Explorations	1. Geochemical, rock samples lake sediment 2 Emanometer 3. Magnetometer 4. Detailed spectrometer readings along compass traverse line.	Highest U_3O_8 lake sediment value of 94 ppm in this area. However, spectrometer readings were low Note the high lake sediment reading was within the Camflo-United Scisco Permit. The anomalous zone was near the contact of an albite-pyroxene rock and a metagreywacke.
28	92359	Claim Blocks 7210-7214 and 7217. Staked 1976, work undertaken in 1977.		1. Reconnaissance and detailed prospecting using a Scintrex BGS-IL scintillometer. 2. Line cutting and scintillometer survey. 3. VLF-EM and magnetic survey.	The best soil geochemical values (both A and B horizons) for uranium and molybdenum exhibit fair to good correlation with the radon soil gas and scintillometer survey results, particularly along the west side of Leathwood Lake. High background radio-

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
				4. Radon gas-soil determinations 5. Detailed lake bottom sediment sampling program. 6. Limited geochemical soil sampling and radon in water determinations were also completed	activity levels and anomalous lake water and lake sediment uranium values can be largely attributed to the high background in the granite to quartz monzonite (Units 30 and 32e) intrusive rocks. Also the pegmatitic leucosomes associated with sediment-derived migmatites are enriched in uranium to the level of 100 ppm U and greater.
29	92454	Permit #25	Marlin Oil Ltd., 1977	Taiga Consultants Ltd. at the request of Marlin Oil undertook a high density lake sediment geochemistry program and a detailed ground prospecting evaluation Ground scintillometer traversing and boulder prospecting at a minimum of 450 m spacing were achieved over 90% of the property outcrop areas and boulder fields and anomalous areas (geochemical) were traversed at 220 m Instrumentation - SRAT SPPZ and Scintrex BGS-1S1 total count scintillometers, and a McPhar TV-1A differentiated gamma-ray spectrometer. Lake sediment Geochemistry Helicopter support - 528 lakes and open muskeg areas - sample density 1.6 samples per km². Sample tool - 1976 model "Hornbrook" torpedo-type sampler. Analysis for U was by fluorometric technique and standard atomic absorption for remaining elements.	Taiga 1977 survey yielded similar results to the 1976 GSC-URP Survey (Open File 407, 408). The high density 1977 survey primarily better delineated and reduced the areal extent to the anomalies. Six anomalies were delineated and evaluated. Two **Locations L-67, 68** (Map GR80-9-10) were considered of interest and subsequently a group of 31 claim blocks were staked to cover these anomalies and Permit #25 lapsed The two areas **(Locations L-67, 68)** both lie within granitic terrains. This granitic terrain exhibits radioactivity levels that are 3 to 4 times the surrounding derived gneisses and migmatite. However, it is apparent that both these rock types constitute readily leachable (U, Mo) host rocks under the prevailing geochemical cycle The anomalies **Location L-67, 68** overlie granite exhibiting minor pegmatite component transected by several lineaments. Four other anomalies **Locations L-69, 70, 71 and 72,** (Map GR80-9-10) can be summarized: **Location 69** - Uranium - 60 to 177 ppm, 31 samples - Strongly coincidental Mo response: scattered weakly anomalous Co, scattered weakly correlatable Cu, Zn underlain by porphyritic granite. **Location 70** - Uranium 42 to 78 ppm weak coincidental Mo, slight concentration of Zn, Ni, Co and Cu. - Rock type dark pink, finer to medium-grained granite **Location 71** - Uranium 54 to 78 ppm. Fair Mo, Co, Ni, and Cu responses. Rock type dark pink, fine to medium-grained granite. **Location 72** - Uranium 89 ppm, single sample site. Coincidental fair Zn, Cu, Mo, Co and Ni lie immediately south of gneisses (sedimentary origin?) No further work was recommended for **Location L-69, 70, 71 and 72.**
29a		Claim Blocks 9133 to 9163 (inclusive)		No further work recorded, claims were staked on the basis of observations at **Locations L-67 and L-68.**	
30	92231	Claim Blocks 7510-7524	Rock Ore Exploration and Development Ltd., 1978	Helicopter-borne radiometric survey, altitude 65 m, spacing 95 m. Instrument-Scintrex GAM-1 Differential Spectrometer coupled with Scintrex GSA-61 sensor and an Esterline Angus Miniservo Recorder. Airborne anomalies were investigated on the ground by two parties using scintillometers and a radon gas detector.	Airborne highs are caused by boulder fields; the boulders are mainly rounded granitic material. These boulders have a gamma response moderately above the local background count.
31	92353	Claim Blocks 9501-9529	Manitoba Mineral Resources Ltd., June-November, 1979	Line cutting, ground geophysical survey: EM-Horizontal loop.	The EM survey established a number of conductors. Twelve diamond drill holes tested these conductors. **Locations D-44-45,** Map GR80-9-12
32	92452	Claim Blocks 8762 1979 NTS 64N/10, 64N/11	United Siscoe Mines Ltd. - Camflo Mines Ltd. - Getty Minerals Co. Ltd.	Ground survey, using a McPhar TC-33A scintillometer, to examine an area of good uranium-thorium ratios.	The heart of the radiometrics is on high ground covered with small boulder fields. The radiometrics can be explained by topographic and mass effects of the pink granites.
32a	92452	Claim Block 8853 1978		Ground survey, using a McPhar TC-33A scintillometer, to examine an area of moderate uranium highs, (eU - 4 ppm) but good uranium-thorium ratios (1.5). United Siscoe Mines Ltd., radiometric survey, 1977.	The radiometrics are due to high background U content in pegmatite.
32b	92452	Claim Blocks 7442, 7434 NTS 64N/5		Ground survey, using a McPhar TC-33A scintillometer, to examine two gradient magnetic anomalies lying up-ice from a radiometric high.	The area is underlain by pelitic gneiss and white pegmatite-bearing very minor uranium mineralization. Magnetic anomalies are probably caused by minor concentrations of pyrrhotite.
32c	92452	Claim Blocks 8738, 8739 NTS 64N/5 1979		Ground survey, using a McPhar TC-33A scintillometer, to examine an area with a 4 ppm eU anomaly and a uranium to thorium ratio of .5 to 1.0.	Results inconclusive; scattered pyrite with trace chalcopyrite observed in extreme northeast corner of Claim Block 8738. No further work recommended.
32d	92452	Claim Blocks 8763, 8764 NTS 64N/5		Ground survey, using McPhar TC-33A to examine a large 4 ppm eU anomaly with good U/Th ratio.	Magnetic expression of this area can be attributed to diopside + magnetite-bearing pelitic gneiss with a unit width of at least 400 ft. Three radioactive boulders of calc-silicate were found; 3000 cps

TABLE 9: GEOPHYSICAL SURVEYS, PROSPECTING, TRENCHES (OPEN ASSESSMENT FILES) (Cont'd)

Ref. No.	Accession No.	Permit or Reservation	Co. and Year of Work	Type of Work	Summary
		1979			were recorded No conclusive evidence could be found to delineate a source for the uraniferous calc-silicate Recommendation - establish a 6000 foot base line and westerly grid lines and carry out magnetometer and EM-16 readings, also mapping and detailed prospecting
32e	92452	Claim Blocks 8766, 8767 and 8730 NTS 64N/5 1979		Ground survey, using a McPhar TC-33A scintillometer, to examine a uranium anomaly with accompanying magnetic anomaly An airborne electromagnetic input survey indicated two weak (two channel) conductors, (Denison Mines Ltd., 1968)	Airborne radiometrics can be attributed to the mass effect of the exposed radioactive white pegmatites The EM conductors are directly associated with the ridge area of graphitic quartzofeldspathic gneiss.
33	92335	Claim Blocks 6961, 6962, 6966, 6967 64N/15NW Claim Blocks 6969-6972, 7328-7331 64N/5 1976, 1977, 1978	Denison Mines Ltd., 1977 and Mitsui	Geological field work is indicated for both claim blocks However, only work on the Claim Blocks 6961, 6962, 6966 and 6967 has been recorded (Putahow Lake property) In 1978, Denison Mines Ltd. conducted a ground radiometric and geologic survey A total of 10 km of scintillometer traversing was completed using a Scintrex BGS-1SL scintillometer Readings were taken every 50 m with a line spacing of 61 m	The survey defined a train of radioactive boulders Background readings are approximately 140 counts per second The rock type is mainly white pegmatitic granite, which range up to 2200 counts per second Two metasedimentary boulders on Claim Blocks 6962 registered radioactivity of 1200 to 8500 total counts per second
34	92334	Claim Blocks 6961, 6962, 6966, 6967 August-September, 1979	Denison Mines Ltd and Mitsui Mining and Smelting Company	Detailed geophysical and geochemical surveys Line cutting - 32.5 km Geophysics 1 Ground radiometric survey with Scintrex BGS-1SL. 2. VLF survey 3 Magnetometer survey Geometric G816 Proton Magnetometer. 4. Geochemistry gases - soil and water samples analyzed with EDA RD-200. Rock samples Four boulders were sampled.	Ground radiometric as in 1978 VLF Several weak east-west conductors near area of anomalous radioactivity. Magnetometer Magnetic anomaly coincidental with the anomalous radioactivity in Claim Block 6962 Geochemistry - gases, soil gas anomaly at Claim Block boundary between Claim Block 6962 and 6967 - rock samples assay range from 0 005 - 0 061% U_3O_8 0 01 - 0 02% ThO_2 Rock type white pegmatitic granite with highest U_3O_8 and ThO_2 readings in biotite gneiss

URANIUM

Uranium Reconnaissance Program (URP)

The URP survey was a nation-wide program with Manitoba participating in 1975 and 1976 (Table 8). The survey was flown on a line-spacing of 5 km using a high sensitivity gamma-ray spectrometer (50 litre) thallium-activated sodium iodide gamma detector. The average speed of the survey aircraft was 190 km/hr, with a mean terrain clearance of 120 m. Lake-centre sediment sampling, with an approximate density of one sample per 13 km^2, was carried out as part of a concurrent geochemical survey. Samples were analyzed for U, Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, Mo, As, Hg and loss on ignition. Lake waters were analyzed only for uranium.

The program was intended to define broad regions containing higher than average uranium and was based on the assumption that a significant probability exists of discovering economic uranium mineralization within or peripheral to such areas. Broad zones of uranium enrichment were delineated in the western third of the URP survey area mainly within the Kasmere Project area (Weber et al., 1975a) and in the northeast quarter of the URP survey area (Fig. 36) in the Cochrane River-Seal River area.

The southern quarter of the URP survey area, excluding the region west of the Cochrane River, displays a very low radiometric and geochemical response due to extensive glacial lacustrine deposits. Later lacustrine and fluvial reworking of the glacial deposits has formed a veneer over the bedrock effectively masking it from the surficial probing of the URP survey (Fig. 36).

The capabilities of the URP survey as a rapid prospecting tool are best illustrated by the definition of the zone of uranium enrichment within the Kasmere Lake map area NTS 64-I (Map GR80-9-11) (Darnley et al., 1975). The potential for uranium deposits in this area was originally indicated from limited prospecting and more extensive coverage by Denison Mines and Dynamic Petroleum, and Yukon Antimony Corp. Ltd., Anomaly "C" (Weber et al., 1975a). However, the extent of the uranium zone was not realized until the URP survey was conducted. The survey revealed a chain of lake sediment uranium anomalies, trains of radiometric anomalies and relatively higher ratios of uranium to thorium (.55 eU/eTh) (Map GR80-9-11) between Snyder Lake and Kasmere Lake.

Uranium Occurrences and Distribution

Subsequent to the release of the URP survey, extensive ground follow-up was carried out by mining companies (Table 9, Map GR80-9-10), the Manitoba Mineral Resources Division and the Geological Survey of Canada.

The Geological Survey of Canada follow-up program comprised an airborne scintillometer survey with a 1 km line spacing in the Kasmere Lake region (Geological Survey of Canada Open File Report 430) and detailed lake sediment, lake water and whole rock geochemistry within areas determined to be anomalous (Coker, 1977). Detailed geochemical studies were carried out in the Kasmere Lake map area (NTS 64-J), McGill Lake (Whiskey Jack Lake map area, NTS 64-K and Map GR80-9-11).

The Manitoba Mineral Resources Division conducted a multi-stage follow-up of several URP anomalies starting with a helicopter-borne scintillometer survey (1.8 litre thallium activated sodium iodide sensor) to accurately delineate the radioactive zones (Soonawala, 1980). The survey was flown at a line spacing of 250 m and an altitude of 40 m. Lake sediment sampling was also conducted at this stage. Second stage ground investigations using a scintillometer and a digital ground spectrometer and a 50 m line spacing were used as a guide to selected sampling using a portable drill. Diamond drilling of resultant targets was carried out in the Widlake Lake area (Table 11, Map GR80-9-12).

Uranium mineralization or on-rock radiometric anomalies were observed in the following rock types:

1. Uraninite in calc-silicate (unit 17) + marble (Unit 17a) and albite-pyroxene rock (unit 17b).
2. Uraninite in white coarse grained to pegmatitic quartz monzonite to trondhjemite (unit 30).
3. Porphyritic and fluorite-bearing quartz monzonites (units 32, 32b and 32c).

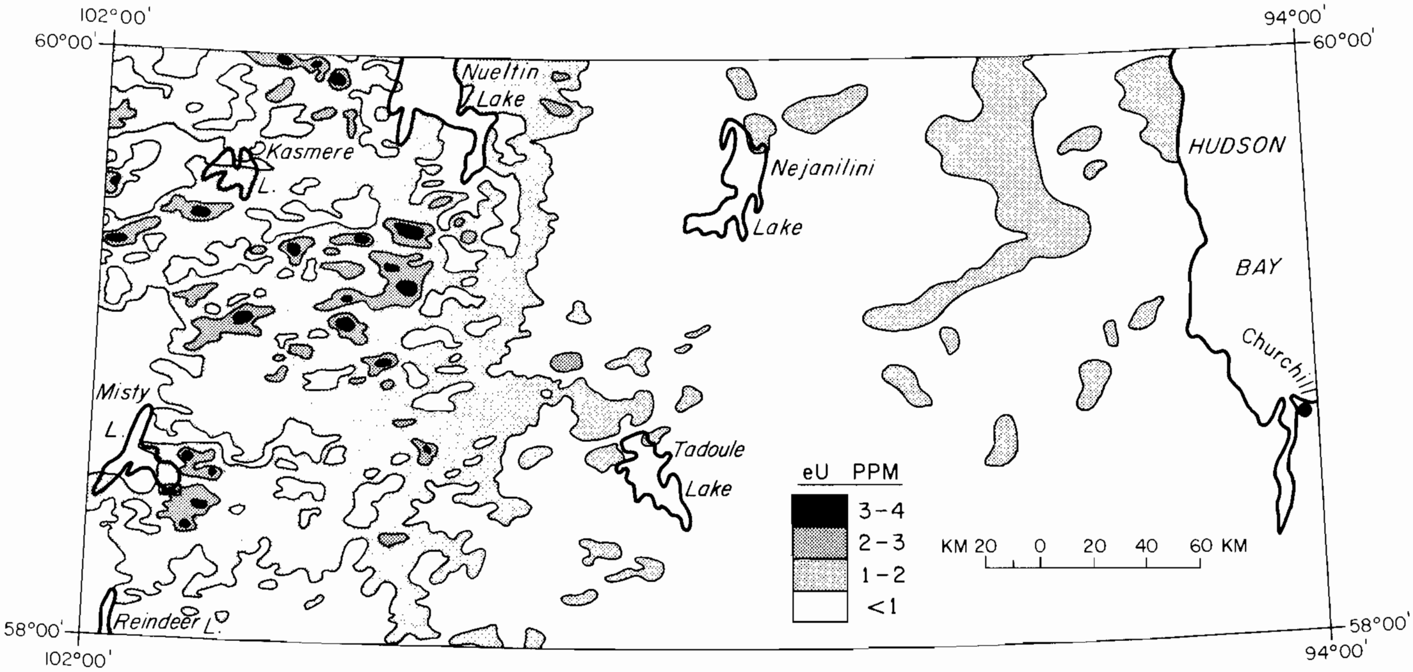


Figure 36a: Contour map of equivalent uranium (eU) of northern Manitoba compiled from airborne gamma-ray spectrometric surveys with 5 km line spacing.

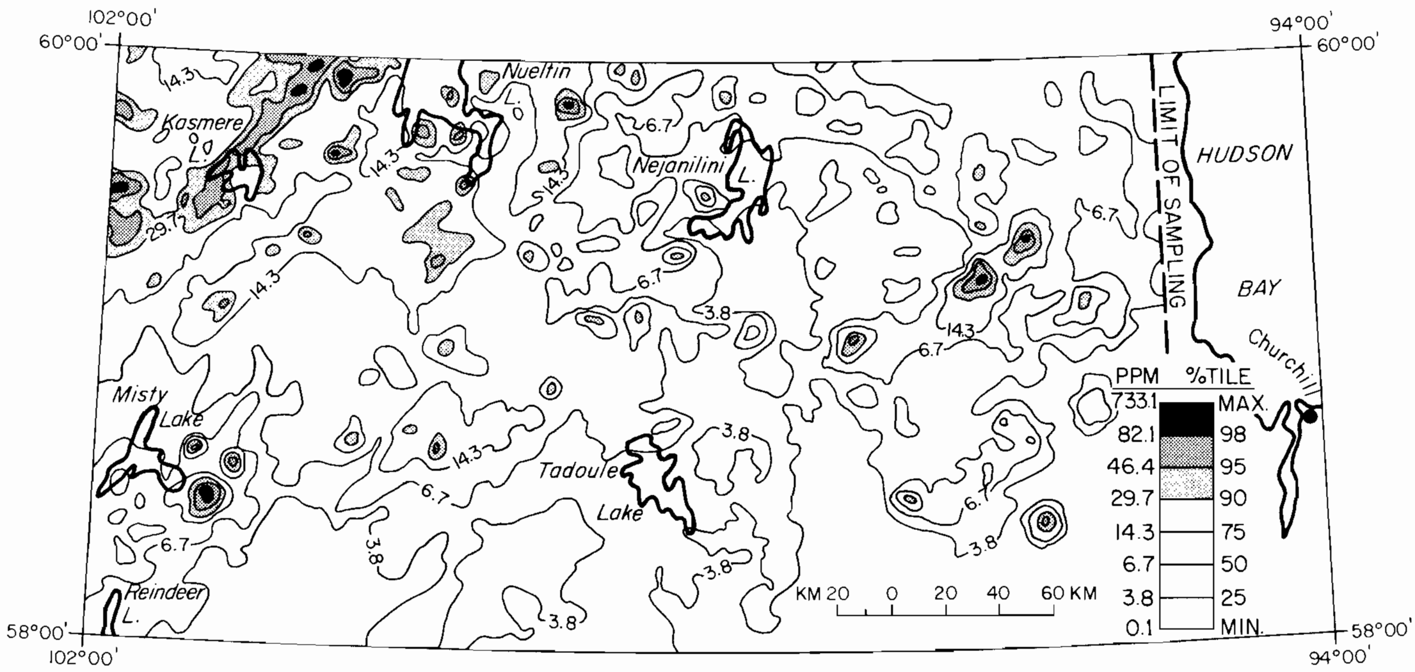


Figure 36b: Uranium in lake sediment (after National Geochemical Reconnaissance, Open File 742, Geological Survey of Canada).

4. Granite pegmatite (unit 32a).
5. Alaskite with accessory fayalite.
6. Churchill quartzite.

The characteristics of these occurrences are summarized in Table 12 with locations on Map GR80-9-11 and exploration histories in Table 9.

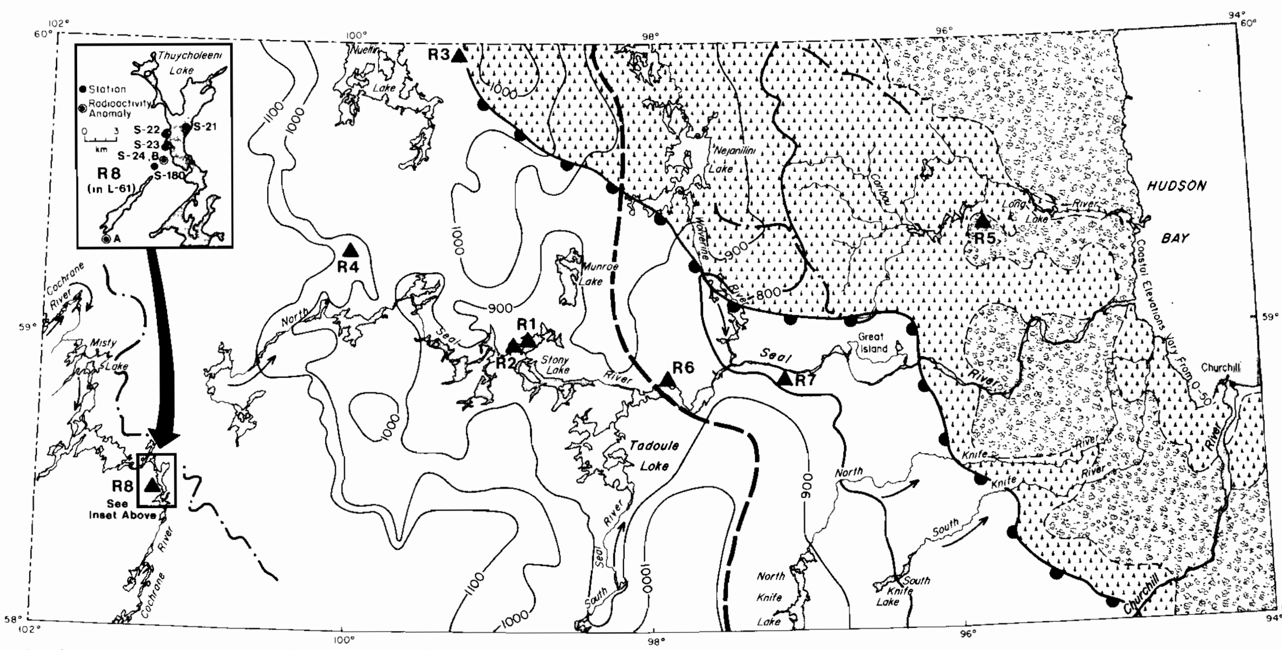
1. Uranium mineralization, uraninite and pitchblende (Stewart, 1977) occurs within calc-silicate rocks (Sequence I) in the region between Snyder Lake and Kasmere Lake. Exploration by Denison Mines Ltd. and others, indicated the presence of a fracture-controlled fine steel grey mineral "thought to be uraninite," Weber et al. (1975a). The calc-silicate rock appears to be part of a suite of rocks that comprise:

i) biotite psammite gneiss (unit 16)
ii) calc-silicate rocks (unit 17)
iii) impure marble (unit 17a)

TABLE 10: ON-ROCK SCINTILLOMETER READINGS

Locations are shown on diagram below.

Ref. No.	Scintillometer Readings T_1 - total count T_2 - U and Th Band	Minerals	Rock Type	Location
R-1	500 to 700 CPM (T_2)	Unidentified associated with biotite	Pale pink to white pegmatite, biotite (8%)	Copeland Lake
R-2	500 CPM (T_2)	Unidentified	White quartz monzonite and white feldspar-quartz pegmatite	Stony Lake, North Seal River
R-3	650 CPM (T_2)	Unidentified	Fluorite-bearing quartz monzonite (32b)	25 km east of Nueltin Lake
R-4	350 CPM (T_2)	Unidentified	Porphyritic quartz monzonite (32)	25 km north of Egenolf Lake
R-5	50 000 - 90 000 T_1 2900 - (T_2)	Unidentified	Porphyritic granite to quartz monzonite	East of Caribou Lake
R-6	55 000 - 60 000 (T_1) 850 - 1500 (T_2) U/Th = 2.5	Uranium within biotite along cleavage, secondary mobilization	Pegmatite (highly oxidized) sill intruded into quartzite, quartz metasiltstone and muscovite-biotite schist	North shore of Shethanei Lake
R-7	40 000 (T_1) 700 (T_2)	Unidentified	Pegmatite contains gneissic inclusions in an area of aplite	South of Seal River and east of Shethanei Lake
R-8	8000 CPM (T_1)	Unidentified	Porphyritic quartz monzonite (32)	Thuycholeeni Lake on Cochrane River (Whiskey Jack Lake map area)
	40 000 CPM (T_1)	Uraninite, accessory allanite and magnetite	Grey-green plagioclase plus quartz veins	



Location of Reference Numbers R1 to R8 (Base map from Fig. 2)

Scale 10 5 0 10 20 30 40 50 60 70 80 90 100 Kilometres

iv) albite-pyroxene rock (unit 17b)

A comparison of uranium anomalies (Map GR80-9-11) and base metal anomalies (Map GR80-9-13) indicates a complex U-Ni-Co lake sediment geochemical anomaly (URP Survey) which is restricted to the region of Snyder Lake to Fort Hall and Thanout Lakes. The anomalies can be related to the calc-silicate suite of rocks which contain a greater than average component of amphibolite and uniquely contain cobalt and nickel-bearing minerals and trace amounts of gold.

Within the Cochrane River-Seal River Project area prospecting by Ducanex Ltd. recorded radiometric readings of 100 - 400 cps in the calc-silicate and biotite psammite suite along the north shore of Askey Lake (Table 9, Map GR80-9-11) in the Munroe Lake area (GR80-9-7). Background radiometric readings for the calc-silicate rocks elsewhere are 80 to 100 cps. Uranium mineralization was not recognized in samples from this suite of rocks. The URP survey registered only a weak radiometric response and lake sediment sampling recorded only a single 200 ppm uranium lake sediment anomaly.

2. Uraninite associated with biotite occurs within a white leucocratic monzogranite to trondhjemite (Soonawala, 1977, 1980; Garber and Soonawala, 1977; Soonawala et al., 1979), as typified in a zone extending from Snyder Lake to Nueltin Lake (zone A of Soonawala, 1980). Gummite occurs as a prominent waxy yellow fracture coating in the Yukon Antimony Anomaly "C" Veal Lake occurrence (Weber et al., 1975a), northwest of Kasmere Lake (Table 9, Location L-60, Map GR80-9-10). Uraninite in association with biotite was also confirmed in this pegmatitic to coarse grained occurrence of the white quartz monzonite to granite (unit 30). The consistent association of the white quartz monzonite with the pelitic to semi-pelitic gneisses and migmatites and the mineralogy of the white quartz monzonite suggest it is an anatectic derivative of the semi-pelitic to pelitic gneisses of Sequence I (Weber et al., 1975a) rocks. The uranium present as uraninite in biotite in this anatectic granitic rock is therefore considered to be derived from a sedimentary precursor.

Within the Cochrane River-Seal River project area white, coarse grained to pegmatite quartz monzonite to trondhjemite displays the highest readings in the area of Copeland Lake and where North Seal River enters Stony Lake (Locations R-1 and R-2, Table 10; Map GR80-9-11). The spectrometer readings ranged from 250 to 700 cpm (T_2, Ur & Th spectral band), in the intrusion which forms large sills and small stocks within pelitic to semi-pelitic gneiss. A weak radiometric anomaly occurs over this area (Map GR80-9-11). Uranium mineralization was not identified in thin section; however, maximum scintillometer readings were recorded in the biotite-rich zone.

Ducanex Syndicate carried out a prospecting program in the area of Poulsen Lake (Table 9, Map GR80-9-10, location L-22), and Manitoba Mineral Resources Division also carried out a follow-up airborne and ground examination near Poulsen Lake (Whitworth et al., 1977; Soonawala, 1980; Table 9, Map GR80-9-10, Reference No. 25). Both programs examined the white trondhjemite to quartz monzonite (30) in the contact zone of migmatized semi-pelitic gneiss with an underlying heterogeneous granitic terrain comprising tectonically reworked Archean granitic rocks and deformed Hudsonian intrusive rocks. Ducanex indicated low mineralization of 50 to 125 ppm U_3O_8 at location L-22.

Follow-up ground survey by the Manitoba Mineral Resources Division in the Poulsen Lake area, (Reference No. 25, Table 9, Map GR80-9-10), indicated anomalous radioactivity associated with a garnet-bearing, white, medium- to coarse-grained granite which occurred as boulders and outcrops. "Five of the rock samples assayed in excess of 200 ppm uranium and 10 of 30 samples had uranium in excess of 100 ppm" (Soonawala, 1980).

3. The Hudsonian granitic rocks (units 32, 32a and 32b) occur as large outcrops with relatively high relief and/or as felsenmeer of large angular boulders. A ground spectrometer survey carried out by the Mineral Resources Division, at the west end of the Topp Lake pluton in the Kasmere Lake map area (GR80-9-8, Reference No. 24, Table 9 and Map GR80-9-10) yielded the following results for uranium: mean 30.9 ppm, range 7.7 to 66.3 ppm, and standard deviation 15.5 ppm. Airborne scintillometer anomalies are quite possible "even with uranium concentrations below the 30 ppm level if the outcrops (or boulder fields) are large, i.e., of dimensions of the order of several kilometres" (Soonawala et al., 1979).

Monazite, proto-uraninite and gummite were observed within biotite-bearing smoky quartz veins within a Hudsonian fluorite-bearing white quartz monzonite to granodiorite (unit 32c). The uranium mineralization is sparse within the host rock but is concentrated within the biotite pegmatite segregations. This mineralization lies within the area of McIntyre Mines Ltd. expired Permit 12 (Accession No. 92212, Tables 9, 11, Map GR80-9-10, Location L-50 and DDH locations D62 to 69, Map GR80-9-12) in the Putahow River region of the Kasmere map area GR80-9-8.

Within the Cochrane River-Seal River project area porphyritic quartz monzonite (unit 32) and fluorite-bearing quartz monzonite (32b) display sporadic scintillometer readings of 350 to 650 cpm (U and Th spectral band) which are three to four times background (125 to 150 ppm U and Th spectral band). Field examination failed to reveal any diagnostic features to account for these radiometric anomalies. At one locality, the eastern margin of the Topp Lake pluton (Location R-4, Table 10; Map GR80-9-11), accessory pyrite and minor garnet were observed in an area of the elevated spectrometer readings.

Two types of uranium mineralization were observed within the porphyritic quartz monzonite. Both are within or marginal to airborne anomalies with corresponding lake sediment uranium anomalies (Table 10, Map GR80-9-11).

One occurrence comprising uraninite and allanite lies immediately to the west of Thuycholeeni Lake (Cochrane River) in the Whiskey Jack Lake area (Location R-8, Table 10; Map GR80-9-11). The second comprises a vitreous pitch-like substance within the porphyritic quartz monzonite east of Caribou Lake (Location R-5, Table 10; Map GR80-9-11).

West of Thuycholeeni Lake the URP survey outlined a cluster of well defined radiometric uranium anomalies. The enveloping zone of 2 ppm uranium equivalents contains five anomalous areas which display greater than 3.0 ppm uranium equivalents. Anomalies A and B (Table 10) are the most prominent. Anomaly A lies in an area of poor exposure and a distinct radioactivity peak was not defined upon field examination. Ground follow-up registered scintillometer readings ranging from 10 000 to 17 000 cpm (total count) at anomaly A. Uranium mineralization was observed within the area of anomaly B. The rock type is a pink to greyish-pink biotite-quartz monzonite grading into porphyritic to coarsely porphyritic zones of quartz monzonite. On-rock scintillometer readings were taken starting within the background region to the northeast of the anomaly. Readings at these stations ranged from 8000 to 10 000 cpm (total count) (Station 21 and 22) (Map GR80-9-11; Location R-8, Table 10). At stations 23 and 24 readings ranged from 13 000 to 15 000 cpm (total count). The highest on-rock readings were recorded within the peak zone of the anomaly and the corresponding lake sediment anomaly. Readings of 40 000 ppm (Station 180, Location R-8) were recorded on pale grey to cream plagioclase and quartz veins. The veins, up to 1 cm thick, are of variable strike length, the longest being 3 m. The host rock, grey to pink, medium grained foliated quartz monzonite to granite, registered background readings of 6000 to 8000 cpm (total count). X-ray analysis confirms the presence of uranium and thin section examination indicates the mineral assemblage uraninite-allanite-magnetite. A brown radiometric mineraloid also occurs as inclusions within plagioclase. The uranium minerals are not confined to the veinlets but also occur marginal to the veinlets within the quartz monzonite up to 1 cm from

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-1	90180	1	15/6/53	Great Island Prospecting Syndicate (G.I.P.S.)	Churchill #1 P. 26190	65°S 30′	Weathered phyllite and red clay, no core recovery.
D-2	90180	2	22/7/53	G.I.P.S.	Rusty #1 P. 26187	45°W 175′	Phyllite, quartzite, (conglomerate?)
D-2	90180	3	20/7/53	G.I.P.S.	Rusty #1	80°W 252′	Phyllite, quartzite, (conglomerate?)
D-2	90180	4	30/7/53	G.I.P.S.	Rusty #1	80°NW 252′	Weathered phyllite — 0-50 ft., phyllite — 50-200 ft., interlayered quartzite and phyllite — 200-252 ft.
D-3	90180	5	15/9/53	G.I.P.S.	Redstone #3 P. 26209	80°NW 150′	Slate and pyrite.
D-3	90181	7	5/4/54	Great Island Syndicate (G.I.S.)	Redstone #3 P. 26209	65°NW	Pyritic slate — 10-55 ft., sulphide (pyrrhotite, arsenopyrite?) bearing dark rock + hornblende.
D-4	90180	6	26/9/53	G.I.P.S.	Vein #2 P. 26205	65°W 242′	Interlayered phyllite and quartzite.
D-4	90180	9	25/7/54	G.I.S.	Vein #2 P. 26205	85°NW 175′	Pyritic slate — 0-60 ft., interlayered quartzite and phyllite — 60-80 ft., pyritic slate — 80-175 ft.
D-5	90181	8	10/7/54	G.I.S.	Lead #2 P. 30222	80′NW 240′	Pyritic slate — 0-85 ft., pyrrhotite- and arsenopyrite-bearing dark rock + hornblende
D-6	90181	14	29/4/54	G.I.S.	Vein #1 P. 26204	60°NE 175′	Pyritic slate — 0-60 ft., quartzite (+ hornblende?) — 60-120 ft., quartzite ± sulphides + hornblende? — 120-175 ft.
D-6	90181	15	22/6/54	G.I.S.	Vein #1	80°NE	Pyritic slate — 0-60 ft., quartzite + hornblende? — 60-120 ft., quartzite ± sulphides + hornblende? — 120-240 ft.
D-7	90185	1	23/5/53	Great Seal Prospecting & Development Syndicate (G.S.P.D.S.)	P.A. #2 P. 22674	45°S 106′	Weathered rusty phyllite, interlayered amphibolite and possibly quartzite.
D-7	90185	4	20/6/53	G.S.P.D.S.	P.A. #2 P. 22674	45°S 85′	As in hole #1, D-7
D-8	90185	2	13/6/53	G.S.P.D.S.	P.A. #1 P. 22673	45°N 172′	As in hole #1, D-7
D-8	90185	6	10/10/53	G.S.P.D.S.	P.A. #1 P. 22673	55° 297′	118-182 — weathered interlayered phyllite and amphibole schist. 182-270 — no core. 270-297 — olive-green amphibole schist
D-9	90185	3	18/6/53	G.S.P.D.S.	P.A. #4 P. 22676	45°S 111′	As in hole #1, D-7
D-9	90185	5	2/7/53	G.S.P.D.S.	P.A. #4 P. 22676	45°N 161′	As in hole #1, D-7
D-10	90186	7	15/6/55	G.S.P.D.S.	Peter #7 #24100	Vertical 105′	Red mud.
D-11	90210	1	26/7/57	E. Kronlund	Red #1 58715	70° 50′	No core.
D-11	90210	2	6/8/57	E. Kronlund	Red #1 58715	75° 220′	Amphibolite — 0-200 ft., accessory calcite, schist and quartzite — 200-220.
D-11	90210	3	29/8/57	E. Kronlund	Red #1 58715	65°S 235′	Amphibolite — 0-135 ft., quartzite and schist — 135-200 ft., amphibolite — 200-235 ft., accessory calcite.
D-11	90210	4	9/9/57	K. Kronlund	Red #1 58715	80° 185′	Amphibolite — 0-100 ft., amphibolite, accessory magnetite and calcite — 100-185 ft.
D-11	90210	5	27-9-57	E. Kronlund	Red #1 58715	65°S 210′	Amphibolite — 0-90 ft., amphibolite with accessory carbonate and magnetite — 90-210 ft.
D-12	90182	1	30/7/53	A.A. Anderson	AA #1 P. 24002	85°SE	Interlayered phyllite and actinolite ± magnetite schist — 0-10 ft., interlayers of quartz, siltstone and actinolite ± garnet schist.
D-12	90182	2	7/8/53	A.A. Anderson	AA #1 P. 24002	85°SE	Interlayered phyllite and actinolite ± magnetite schist — 0-10 ft., interlayered quartz, siltstone and actinolite ± garnet schist.

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-13	90183	101	11/11/53	Wood & Gunnarson	Bill #7 P. 27111	45°N 182′	Magnetite common along length of holes either disseminated or massive in thin layers 1 to 5 mm thick, hematite forms thin layers.
D-14	90183	102	15/11/53	Wood & Gunnarson	Bill #6 P. 27110	45°N 79′	As in hole #101.
D-14	90183	103	21/11/53	Wood & Gunnarson	Bill #6 P. 27110	45°N 170′	Olive-green amphibolite ± magnetite. The amphibole occurs as fine grained acicular bundles; however, it can be coarse grained in the area of quartz veining. Indurated quartz siltstone forms layers 1 mm to 1 cm thick.
D-14	90183	104	27/11/53	Wood & Gunnarson	Bill #6 P. 27110	45°SW 69′	As in hole #103
D-14	90183	105	1/8/55	Wood Diamond Drilling & Mining Co. Ltd.	Bill #6 P. 27110	55°SW 185′	As in hole #103
D-14	90183	106	14/8/55	Wood Diamond Drilling & Mining Co. Ltd.	Bill #6 P. 27110	50°SW 167′	As in hole #103
D-14	90183	107			NO CORE		
D-14	90183	108	29/10/55	Wood Diamond Drilling & Mining Co. Ltd.	Bill #6 P. 27110	55°SW 195′	As in hole #103
D-15	90184	1	23/5/54	Bock, Kronland and Stewart	Nickel #1 P. 30052	65°E	Quartzite — 5-50 ft., pyritic black slate with layers of biotite porphyroblasts, zones of dense acicular amphibole, sulphides, disseminated pyrrhotite,arseno-pyrite (?) in the black slate.
D-16	90184	6	7/10/57	E. Kronlund	Claim #2 58719	85°N 120′	No core — 0-40 ft., hematite iron formation — 40-60 ft., interlayered quartzite, amphibolite and granitic veining — 65-120 ft.
D-16	90184	7	18/10/57	E. Kronlund	Claim #2 58719	Vertical 100′	No core — 0-50 ft., hematite iron formation — 50-65 ft., and interlayered quartzite and granitic veining.
D-17	91680	S71-1	20/7/71	Keevil Mining Group	CB. 3744	N15°W 447′	Highly serpentinized ultramafic (peridotite?), abundant calcite and brucite veining, accessory magnetite.
D-17	91680	S71-2	23/7/71	Keevil Mining Group	CB. 3744	S16°W 227′	Highly serpentinized ultramafic, abundant calcite and brucite veins, accessory magnetite.
D-18	91680	S71-3	1/8/71	Keevil Mining Group	CB. 3738	N20°E 487′	Minor occurrence of chalcopyrite and pyrrhotite throughout the drill core — rock type metamorphosed, intermediate volcanic rock, minor altered gabbro, quartz chlorite alteration zones. Zone of sulphide mineralization — 134-198.5 — barren pyrite and pyrrhotite Assay (#6406) — 189-198 — trace silver
D-19	91680	S71-4	5/8/71	Keevil Mining Group	CB. 3745	N25°E	Black slate to phyllite, accessory pyrite and marcasite, magnetite-rich zones indicating iron formation similar to the type that outcrops 1 km to the west of this claim block.
—	91680	S71-5		Abandoned after 80 ft. due to incorrect location.			
D-20	91680	S71-6	14/8/71	Keevil Mining Group	Drilled SE of claim block 3745 on island in Seal River	N40°E 447′	0-75′ — light grey to greenish-grey phyllite with marcasite nodules. 70-180′ — fine grained grey meta-arkose to subgrey-wacke and interlayered grey phyllite with small biotite porphyroblasts, schistosity parallel to long axis of the core, grey to black pyrite (massive 1 mm to 2 mm thick). Pyrite also mobilized into schistosity planes. Bedding planes range from 30° to 45° angles of intersection with the drill core. 180-390′ — missing core. 390-410′ — black phyllite and pyrite. 410-447′ — interlayered carbonate and quartz siltstone.

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21	92117	133-1	Apr. 28/76	M.M.R. Ltd.	6888	45°E 187′	11 - 121 — greyish-green, fine grained, well layered, very siliceous minor chloritic alteration (felsic intermediate tuffs and flows?).
						121 - 141	Rhyolite — grey.
						141.2 - 187	Intermediate — Mafic volcanic tuffs and flows — greyish green.
D-21		133-2	Apr. 25/76	M.M.R. Ltd.	6888	45° N60°E 207′	
						44 - 168	Felsic to intermediate volcanic — greyish green, fine grained, very siliceous. 44 - 60 minor to moderate chlorite, 60 - 154 decrease in chlorite, 153 - 169 — well defined tuffaceous fragments, 162 - 168 — moderate to strong chlorite — sericite alteration.
						168 - 187	Chlorite schist, light green, fine grained, massive chlorite to intensely altered andesite.
						187 - 197	Andesite, less altered.
						197 - 207	Intermediate flows, greyish green.
D-21		133-3	Apr. 30/76	M.M.R. Ltd.	6888	45°E 157′	
						14 - 50	Felsic volcanic flow — dark grey, abundant, fine grained biotite.
						50 - 71	Felsic to intermediate volcanic flow, light grey, well layered, increasing chlorite, decreases in biotite.
						71 - 150	Intermediate to mafic volcanic greyish green, fine grained with banded, very siliceous, abundant quartz feldspar to rhyolitic and intermediate layers.
D-21		133-4	May 7/76	M.M.R. Ltd.	6885	45°W 150′	
						28 - 84	Felsic volcanic flow — grey. Rhyolite to dacite, minor fine to tuffaceous sections.
						84 - 150	Intermediate volcanic flow — greyish green, fine grained, massive to weakly banded dacite flow.
D-21		133-5	May 10/76	M.M.R. Ltd.	6885	45°W 248′	
						16 - 97	Intermediate volcanic tuff, greenish grey, fine grained, well layered, numerous tuffaceous fragments. 36 - 48 weak to moderately altered, chlorite-rich.
						97 - 144	Dacite, light green.
						144 - 153	Quartz vein.
						153 - 166	Rhyolite flows — light grey.
						166 - 187	Intermediate volcanic tuff.
D-21		133-6	May 9/76	M.M.R. Ltd.	6888	45°E 177′	
						36 - 106.5	Dacite — dark green, massive.
						106.5 - 132	Felsic to intermediate volcanic flow, greyish green, fine grained.
						132 - 177	Dacite — dark greyish green, abundant rhyolite interflows.
D-21		133-7	May 3/76	M.M.R. Ltd.	6887	45°W 149′	
						35 - 149	Intermediate to mafic volcanic, greyish green, fine grained, abundant biotite and chlorite schist bands. 46.8 - 53 — coarse grained, irregular layering, garnetiferous quartz-rich zone.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
42 - 42.3 — 90% coarse pyrite in massive band. Trace - 15% pyrite, trace chalcopyrite, 15-20% pyrrhotite. 86 - 86.2 — 80-90% pyrite in coarse vuggy crystalline band 121 - 141 — 15-20% pyrrhotite, trace - 5% pyrite, trace chalcopyrite. 126.8 - 127.7 — 80% pyrite. 176 - 183 — 10-15% pyrrhotite, scintillation counts 15-17 cps (background)	126.7 - 130			0.05		0.03
52 - 147 — 5-20% pyrite, 92-97: bands, 70-80%.						
13 - 142 — 10-15% pyrrhotite	139 - 142	Tr.				0.02
Scintillation counts 15 - 17 cps.						
57 - 65.8 — Trace - 8% pyrite.						
149.4 - 149.6 — Trace — 8% mud seam, scintillation counts 15 - 17 cps.						
28 - 79 — Trace — 2% pyrite. 79 - 84 — 40-50% pyrrhotite, 10-15% pyrite. Trace chalcopyrite. Scintillation counts 15 - 17 cps	79 - 84		0.05	0.08	0.03	
145.2 - 145.4 — 30% pyrrhotite 149.7 - 153.3 — 5-90% pyrrhotite. Trace chalcopyrite. 151 - 5% chalcopyrite.	149 - 152	Tr.		.022	Tr.	0.03
189 - 192 — 20-30% pyrite, 5% pyrrhotite, Trace chalcopyrite. 199.6 — 20% pyrite band. 238.2 — 5% pyrrhotite, 3% chalcopyrite. Scintillation count 15 - 17 cps.	189 - 192			Tr.	0.05	0.03
107 - 117 — 5-15% pyrrhotite, 2-5% pyrite, Trace chalcopyrite. Scintillation count 15 - 17 cps.						
48-8 - 55.5 — 2-8% magnetite, Trace — 5% pyrrhotite.						
104.1 - 104.7 — 45% pyrrhotite, 2-3% pyrite. Scintillation count 15 - 19 cps.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21		133-8	July 9/76	M.M.R. Ltd.	6885	45°E 318′	
						56 - 106	Dacite — greyish green.
						106 - 129	Rhyolite, greyish blue, very siliceous, numerous felsic fragments of brecciated material in the mineralized zone.
						129 - 178	Dacite — decrease in rhyolite interflows — appearance of gabbroic section.
						178 - 198	Gabbro — speckled, greyish green, narrow sections of of dacite.
						198 - 241	Dacite, dark green, fine- to coarse-grained, well layered, numerous sections of gabbroic material, abundant chlorite.
						241 - 318	Gabbro — dark green, abundant chlorite, scattered narrow sections of dacite.
D-21		133-9	June 28/76	M.M.R. Ltd.	6885	45°W 157′	
						40 - 157	Intermediate to mafic volcanic, greyish green to dark green, interlayered sections of dacite.
D-21		133-10	July 3/76	M.M.R. Ltd.	6885	45°E 157′	
						32 - 84.5	Dacitic tuff, greyish green, interlayered bands of fine felsic fragments, moderate chlorite.
						84.5 - 94	Rhyolite — dark grey.
						94 - 134.5	Felsic intermediate volcanic, light to dark grey, fine grained, very siliceous, intensely folded scattered felsic fragments.
						134.5 - 151	Rhyolite.
						151 - 157	Dacite tuff — greyish black, fine grained, abundant biotite.
D-21	92117	133-11A	July 2/76	M.M.R. Ltd.	6885	45°W 199′	
						8 - 133	Dacite — greenish grey, fine grained, well layered, siliceous, minor tuff section.
						133 - 199	Rhyolite. 133 - 180 — greyish black, abundant fine- to medium-grained biotite.
D-21		133-12	July 8/76	M.M.R. Ltd.	GRID S-1	45°W 218′	
						23 - 60	Dacite tuff — greyish green, narrow bands of flow material.
						60 - 74.7	Rhyolite — light gray, very siliceous.
						74.7 - 93.5	Dacite
						93.5 - 108	Gabbro — speckled, greyish green, medium- to coarse-grained.
						108 - 218	Dacite as above, also scattered section 5 ft. of massive rhyolite flow material.
D-21		133-13	May 2/76	M.M.R. Ltd.	6892	45° 190′	
						37 - 105	Metasediment — well layered, section of coarse grained granitic material and intermediate layered biotite schist.
						105 - 137	Granitic material, light-dark grey, fine- to medium-grained quartz-feldspar-biotite material.
						137 - 153	Metasediments — dark grey, fine grained with medium grained biotite, minor tuffaceous fragments.
						153 - 190	Granite — light grey, massive, fine- to medium-grained, minor fracturing.
D-21		133-14	Apr. 30/76	M.M.R. Ltd.	6892	45°W 187′	
						47 - 96	Diorite with sections of quartz-feldspar pegmatite, minor diorite gneiss.
						96 - 142	Felsic volcanic flows — massive to well banded siliceous material, scattered sections of fine- to medium-grained granitic gneisses or diorites.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
108 - 116 — 2-5% pyrrhotite, Trace — 3% pyrite. 116 - 125 — 20-50% pyrrhotite, 2-5% pyrite. 125.2 - 127.4 — 4-5% pyrrhotite, 3% pyrite.	122.5 - 125.3			0.07	0.09	0.06
190 - 190.2 — 20% pyrite.						
Scintillation counts 15 - 17 cps.						
115 - 116 — 0-12% pyrrhotite, 5-8% pyrite. 116 - 118 — 2-5% pyrrhotite, 2-3% pyrite. 144.8 - 144.9 — 60% pyrrhotite, 5% pyrite.	115 - 118			0.02	0.04	0.06
98 - 117 — 5-30% pyrrhotite, 2% pyrite.	111 - 116			0.03	0.02	0.02
Scintillation count 15 - 17 cps.						
80.4 - 81.4 — 20% pyrrhotite, 2% chalcopyrite.	80.4 - 81.4			0.01		0.07
134 - 180 — 4-5% pyrrhotite, Trace - 3% pyrite. 150 - 153 — 40-50% pyrrhotite, 15% pyrite, Trace chalcopyrite, Trace chalcopyrite, Trace sphalerite. Scintillation counts 15 - 17 cps.	150.1 - 153.7			0.03	0.03	0.08
70 - 73.4 — 3-4% pyrrhotite, 2-3% pyrite. 73.4 - 74 — 70% pyrrhotite, 8% pyrite.	73.4 - 74			0.18	Tr.	0.11
169 - 173 Trace — 8% pyrrhotite. 188 - 188.4 — 8% pyrrhotite, 2% pyrite 202.3 - 202.4 — 60% pyrrhotite, 4% pyrite. Scintillation counts 15 - 17 cps.						
125 - 129 — 70-80% pyrrhotite, 5-20% pyrite. 129 - 133 — 2-5% pyrrhotite, 2-3% pyrite.	125 - 130			0.14	Tr.	0.08
132 - 133 — 20% pyrite.	130 - 133			0.02	Tr.	Tr.
153 - 190 — 2-3% pyrrhotite, 2-3% pyrite. Scintillation counts 15 - 17 cps.						
111.8 - 141.2 — scattered bands 40-50% pyrrhotite, Trace 1% pyrite.	137 - 141					0.03

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						142 - 187	Metasediments, greyish black, fine- to medium-grained, section chlorite-biotite schist section gneissic.
D-21		133-15	Apr. 28/76	M.M.R. Ltd.	6892	45° N65°E 317′	
						47 - 82	Dark greyish green, coarse mafic crystals in a silicate fused matrix.
						82 - 120	Light to dark grey, siliceous rhyolite flow material with sections of medium grained quartz-feldspar granular material with minor garnets.
						120 - 165	Dark grey, fine grained, very siliceous, abundant dark chloritic diorite with scattered quartz-feldspar, granular sections.
						165 - 187	Light-dark grey, more massive, siliceous rhyolite to dacite flow.
						187 - 252	Dark grey, very siliceous, fine grained, irregular banded, locally folded, fine- to medium-grained material, abundant chlorite and biotite, abundant quartz veins.
						252 - 276	Intermediate volcanic tuff and flows, siliceous, abundant biotite.
						276 - 317	Intermediate to mafic volcanic tuff and flows, greyish green, well banded, abundant chlorite with section moderately altered to near chlorite schist, minor to moderate felsic interlayers.
D-21		133-16	May 7/76	M.M.R. Ltd.	6896	45°E 327′	
						56 - 110	Intermediate volcanic tuff, moderate chlorite alteration.
						110 - 282	Felsic to intermediate volcanic, dark grey, fine grained, minor chlorite alteration, rhyolite and dacite flow bands, minor tuffaceous section.
						282 - 297	Intermediate — mafic volcanic tuff, dark greenish grey, abundant chlorite alteration increases down section.
						297 - 310	Felsic volcanic tuff — massive, well fragmented, strong chlorite alteration down section.
						310 - 327	Intermediate to mafic volcanic tuff, strong chlorite alteration down section.
D-21		133-17A	Apr. 24/76	M.M.R. Ltd.	6896	45°E 107′	
						42 - 107	Intermediate volcanic tuff — massive, fine grained, siliceous, weak to moderate sericite and chlorite.
D-21	92117	133-18	Apr. 12/76	M.M.R. Ltd.	6905	45° E20°N 289′	
						23 - 186	Andesite tuff, grey to green, fine grained, chloritic.
						186 - 213	Dacite tuff.
						214 - 264	Metasediment — light green to dark grey, fine grained.
						264 - 289	Andesite tuff — chloritic with feldspar altered to kaolin.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
173.4 - 173.7 — 40% pyrrhotite. Scintillation counts 15 - 17 cps.						
114 - 116 — 15% pyrrhotite, 10% pyrite.						
197 - 249 — 10-15% pyrrhotite, 2-3% pyrite, Trace chalcopyrite.	227 - 232			0.03		0.02
56 - 81.4 — 2-5% pyrite.						
81.9 - 100.2 — 10-40%	81.3 - 84.9			0.07	Tr.	0.06
pyrite, Trace chalcopyrite.	94.8 - 101			0.13	Tr.	0.06
118 - 125 — 30-70% pyrrhotite, 1% chalcopyrite, scattered	118 - 123			0.05	Tr.	0.03
massive bands and disseminated.	123 - 125			0.06	Tr.	0.07
125 - 208 — 10% pyrrhotite, 5% pyrite.	232 - 237			0.04	0.20	0.04
200 - 249 — 5-30% pyrrhotite, 2-10% graphite, 5% pyrite, 10% magnetite.						
249 - 276 — 10% pyrrhotite, Trace pyrite.						
43.8 - 43.9; 44.7 - 44.8 — 70-80% pyrrhotite, 5-10% pyrite, Trace chalcopyrite.						
72.7 - 75.7 — 60-70% pyrrhotite, 5-10% pyrite, Trace chalcopyrite, solid sulphides with various sized quartz inclusions.						
75.7 - 77.2 — 5-10% pyrrhotite, 1-3% pyrite, Trace chalcopyrite.						
77.2 - 80.6 — 50-60% pyrrhotite, 5-15% pyrite, Trace chalcopyrite.	72.7 - 75.7			0.11		0.03
80.6 - 83.5 — 8% pyrrhotite, 1% pyrite, Trace chalcopyrite in narrow sulphide stringers.	80.6 - 85				0.03	
167 - 183 numerous quartz veins — pyrrhotite 2-3%, Trace chalcopyrite.	167 - 169			0.09		
199 - 205 — highly chloritic, 2-3% pyrrhotite.						
206 - 213 — chloritic schist, 3-4% pyrrhotite, 1-2% pyrite.						
213 - 234 chloritic, 10%	215 - 220			0.03		0.04
2% pyrite, 2% graphite, Trace chalcopyrite, numerous narrow siliceous bands.	233 - 238			0.03		0.10
238 - 250 near massive bands, pyrrhotite, 2-3% pyrite, Trace chalcopyrite.	254 - 259			0.04		0.03
250 - 264 — massive bands of pyrite with specks of magnetite, Trace chalcopyrite, resembles iron formation.						
213 - 264 conductor. Pyrrhotite mineralization in banded metasediments, sulphides in massive bands and stringers. Scintillation counts 15 - 17 cps.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21		133-19A	Apr. 5/76	M.M.R. Ltd.	Res. 125	45° E10°N 167′	
						56 - 107.8	Dacite tuff, light to dark grey, fine grained, tuff fragments, chloritic along cleavage planes.
						107.8 - 167.8	Andesite tuff, green, chloritic, numerous calcite stringers.
D-21		133-20	Apr. 6/76	M.M.R. Ltd.	6905	186′	
						17 - 131	Dacite tuff, light grey, numerous, fine grained, siliceous tuff fragments, chlorite.
						131 - 136	Quartz vein and massive pyrrhotite, trace chalcopyrite.
						136 - 165	Dacite tuff, grey to light green, some section andesitic in composition.
						164 - 186	Gabbro — dark grey to green, medium to coarse grained, pyroxene, mostly altered to chlorite. 10% olive, barren to trace pyrite.
D-21		133-21	Apr. 16/76	M.M.R. Ltd.	6905	45°E 232′	
						30 - 181	Andesite tuff, fine grained, grey to green, chloritic, numerous stringers of calcareous material. 101 - 127 — mafic material calcareous cement, possible metasediment. Odd speck of pyrite.
						181 - 194	Dacite tuff, light grey to green, fine grained, minor chlorite to sericite alteration.
						194 - 232	Andesite tuff, fine grained, light green to grey, numerous irregular calc-stringers, chloritic.
D-21		133-22	Apr. 27/76	M.M.R. Ltd.	6700	45°E 187′	
						40 - 187	Generally dark green, fine grained, chloritic, some small garnets in chloritic material. Conductors: 60 - 88 trace to well mineralized pyrrhotite. 145 - 155 — 5-10% pyrrhotite.
D-21		133-23	Apr. 22/76	M.M.R. Ltd.	6405	45°E 565°W	
						40 - 197	Intermediate to volcanic tuff, light grey to green; generally fine grained, massive weakly banded in places, chloritic with fine grained, siliceous material. 87 - 91 fractured and broken 5%, core recovery (mud seam?). 116 - 157 — sections resemble andesitic tuff, banded metasediments. 157 - 197 — siliceous decrease in green, fine grained, mafic bands.
D-21		133-24	Apr. 17/76	M.M.R. Ltd.	6405	45°E 247′	
						20 - 82	Andesite tuff, fine grained, bedded, siliceous material along cleavage planes, calcareous stringers. 42 - 65 chloritic schist.
						82 - 247	Dacite tuff, fine grained, generally grey, some sections andesitic in composition.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
56 - 78 — 1-3% pyrite. 94 - 99 — 3-4% pyrite, pyrrhotite traces, sericite alteration, Trace chalcopyrite. 113 - 114 — 20-25% pyrite, 1-2% pyrrhotite. Conductors: 99 - 101 — 20-25% pyrrhotite, 1-2% pyrite. 113 - 114 — 20-25% pyrite, 1-2% pyrrhotite. Scintillation counts 15 - 17 cps.	94 - 99			0.03		0.07
	99 - 101			0.06		0.09
80.6 - 87.8 — 2-10% pyrrhotite. 87 - 113 — sulphide with fine grained, green chloritic material. 113 - 131 — 1-2% disseminated pyrrhotite. pyrite. 136 - 136.4 — narrow quartz stringers, 20% pyrite, 2-3% pyrite 136.4 - 139.6 — 2-3% pyrite Conductor: 133.3 - 136 near massive pyrrhotite, Trace chalcopyrite.	132 - 136			0.15		0.06
	136 - 140			0.05		Tr
125 - 190 — 5-10% pyrrhotite, 190 - 193 — 10-15% pyrrhotite. numerous quartz, feldspar fragments.	180 - 190			0.03		0.03
	190 - 193			0.04		0.04
47.2 - 60.1 — 4-5% pyrrhotite in narrow stringers and blebs of Trace chalcopyrite. 60.1 - 88 Trace to well mineralized in pyrrhotite, narrow bands. 88 - 102 — 5-10% pyrrhotite. 162 - 187 — Alteration chlorite — siliceous bands.						
57 - 63 — 2-3% pyrite, 1-2% pyrrhotite. 127 - 130 — 3-4% pyrrhotite 130 - 139 — 10-15% pyrrhotite, Trace graphite. 134.5 - 157 — 2-5% pyrrhotite, 1-2% pyrite. Scintillation count 15 - 17 cps.	127 - 130					0.03
	130 - 135.5					0.04
	135.5 - 139.2			0.04		0.04
	146.6 - 151	0.05		0.08		0.05
87 - 97 — 2-5% pyrrhotite. 97 - 141 Trace to near massive pyrrhotite. 141 - 143 — massive coarse grained, pyrrhotite, Trace chalcopyrite. 143 - 148 — Trace to massive pyrrhotite. 148 - 158 — massive to coarse grained pyrrhotite, Trace chalcopyrite. 158 - 204 — 10-80% pyrrhotite.	82 - 85					0.02
	103 - 108	0.01		0.02		0.03
	127 - 132			0.05		0.04
	137 - 141	0.12		0.02		0.02
	141 - 143	Tr.		0.06		0.12
	143 - 148	0.11		0.03		0.03
	148 - 153	0.08		0.06	0.03	0.28
	153 - 158			0.09	0.13	0.08
	176.5 - 181.5			0.02		0.03
	199 - 204			0.04		0.04

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21	91395	133-25	May 6/75	M.M.R. Ltd.	Ex. Permit 125 and 126	50° 237′	
						13 - 170	Andesite, green, quartz veining.
						170 - 183	Hornblende, biotite, quartz, schist. (Altered andesite.)
						183 - 237	Andesite, green, massive.
D-21		133-26	May 7/75	M.M.R. Ltd.	Ex. Permit 125 and 126	50° 217′	
						34 - 153	Porphyritic dacite, grey to light green.
						153 - 180	Rhyodacite — grey to greyish green.
						180 - 217	Andesite, fine grained, green, thin layers of dacite.
D-21		133-27	May	M.M.R Ltd.	Ex. Permit 125 and 126	45° 181	
						12 - 22	Andesitic dark green.
						22 - 80	Dacite, thin rhyolite and andesite layers.
						80 - 86	Andesite, dark green.
						86 - 128	Rhyolite, light grey.
						128 - 135.7	Rhyolite, light grey.
						139.5 - 181	Andesite.
D-21		133-28	May 21/75	M.M.R. Ltd.	Ex. Permit 125 and 126	50° 167′	
						50 - 167	Andesite.
D-21		133-29	May 19/75	M.M.R. Ltd.	Ex. Permit 125 and 126	45° 157′	
						35 - 102	Rhyodacite
						102 - 110	Rhyolite agglomerate.
						110 - 133	Rhyolite, light grey.
						133 - 157	Andesite, green.
D-21		133-30	May 18/75	M.M.R. Ltd.	Ex. Permit 125 and 126	50° 200′	
						26 - 88	Andesite, green.
						88 - 93	Rhyolite (tuff?), finely layered.
						93 - 105	Andesite.
						105 - 132	Rhyolite (tuff)
						132 - 154	Andesite, green
						154 - 167	Rhyolite (tuff?)
						167 - 176	Andesite
						176 - 194	Porphyritic dacite
						194 - 206	Andesite
D-21		133-31	Apr. 3/75	M.M.R. Ltd.	Ex. Permit 125 and 126	50° 209′	
						8 - 54.6	Metasediment, dark grey-green.
						54.6 - 67	Graphitic chlorite schist, dark grey-black.
						67 - 121.3	Andesite — 94 - 104 numerous small grey amygdales.
						121.3 - 180.3	Rhyolite, grey.
						180.3 - 209	Rhyodacite
D-21		133-32	Apr. 7/75	M.M.R. Ltd.	Ex. Permit 125 and 126	50° 230′	
						12 - 27	Andesite.
						27 - 47	Rhyolite, light grey.
						47 - 85	Andesite.
						85 - 100	Rhyolite
						100 - 109	Andesite, green
						109 - 117	Volcanic, agglomerate, large subrounded rhyolitic fragments, 10% pyrite as blebs.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
29 - 29.5 — Minor disseminated pyrrhotite; chalcopyrite 1%						
39.7 - 40.7 — 10% pyrrhotite, 2% chalcopyrite.	39.7 - 40.7	Tr		0.05		
74 - 78 — 5% finely disseminated pyrrhotite.	157	Tr.				
157 - 158.3 — 15% pyrrhotite, 1 - 3" band pyrrhotite.						
150 - 153 — Massive sulphides, 40% pyrrhotite.	150 - 153	Tr.				
10% pyrite. Rhyolite fragments throughout.	154 - 167			0.03		
	170 - 176.6			0.09		
128 - 130 — Massive sulphide. 40% pyrrhotite, 30% pyrite.	128 - 130			0.11		
135.7 - 139.5 — Massive pyrrhotite 90%, Trace calcopyrite.	135.7 - 139.5	Tr.		0.13	0.06	0.02
87 - 91 — 20% pyrrhotite, Trace chalcopyrite.	87 - 91	Tr.		0.39	0.02	Tr.
112 - 114 — 20% pyrrhotite, 3% pyrite.	112 - 114				0.17	
123 - 124 — 15% pyrrhotite.						
102 - 110 - 10% pyrite, 5% pyrrhotite, speckled	102 - 107			0.07		
chalcopyrite.	107 - 110	Tr.		0.05	Tr.	0.02
110 - 121 — 3% disseminated pyrite, 1% pyrrhotite.						
139 — stringer of pyrite, pyrrhotite and chalcopyrite.						
123 - 128.7 — 7% pyrrhotite.						
128 - 132 — 3% pyrite.						
154 - 160 — 5% pyrrhotite.						
160 - 161 — 7% pyrrhotite.						
161 - 167 — 4% pyrrhotite.						
54.6 - 67 — 2-3% disseminated pyrrhotite, 2% graphite, Trace chalcopyrite.						
77 - 78.8 — 5% pyrrhotite.						
78 - 79.8 — 30% pyrrhotite.	78			0.08		0.07
116 - 121.3 — 4-5% pyrrhotite.						
130 - 134 — 4-8% pyrrhotite.						
138 - 138.5 — 10% pyrrhotite.						
143.6 - 146.8 — 25-30% pyrrhotite.						
180 - 194 — 2-3% pyrrhotite, 1-2% magnetite.	143.3 - 146.6			0.09		0.08
2-5% pyrrhotite disseminated.	44.9 - 45.3			0.36		
	109 - 113			0.03		
	113 - 117			0.02		
	117 - 124			0.02		

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						123 - 125.5	Volcanic agglomerate.
						125 - 126	Volcanic tuff, dark green, finely bedded.
D-21		133-35	May 15/78	M.M.R. Ltd.	Ex. Res. 125 and 126	45° 367'	
						35 - 67	Chlorite — biotite schist (altered andesite?).
						67 - 80	Andesite, green, specks of chalcopyrite at 82 ft.
						80 - 186.5	Rhyolite grey.
						188.5 - 199	Rhyolite, tuff, well defined rhyolite fragments, subrounded.
						200.5 - 205	Rhyolite tuff
						211 - 234	Rhyolite tuff
						239 - 258	Graphite schist
						262 - 269	Graphite schist
						271 - 273	Graphite schist
						325 - 367	Rhyolite, light grey.
D-21		133-36	May 3/78	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 257'	
						19 - 187	Andesite, green.
						187 - 201	Rhyolite, light grey.
						208 - 209	Rhyolite, light grey.
						218 - 257	Rhyolite, light grey breccia and tuffaceous zones.
D-21		133-37	May 17/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 461'	
						123 - 140	Chlorite schist (altered andesite), saturated with water, conductive, poor core recovery.
						140 - 145	Lost core.
						145 - 220	Chlorite schist (altered andesite or andesite tuff).
						220 - 416	Rhyolitic tuff, grey, finely bedded, contains weakly conductive chlorite and biotite, water-rich zone.
D-21		133-38	Apr. 23/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 187'	
						50 - 99	Metasediment — light greyish green, siliceous, weakly layered.
						99 - 122	Gabbro medium- to coarse-grained.
						122 - 141	Metagabbro — greyish green, porphyritic, weak to moderate layering.
						141 - 159	Metasediments — dark grey, very silicic with coarse grained mica schist layers.
						159 - 187	Metagabbro.
D-21		133-39	Apr. 17/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 167'	
						4 - 58.2	Gabbro, greyish green.
						58.2 - 167	Metasediment, dark greyish green, siliceous layers of chlorite schist.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
117 - 124, massive sulphide, 30% pyrite, 10% pyrrhotite.						
186.5 - 188.5 — Massive sulphide, 60% pyrite, 10%	184 - 186	0.01		0.03		
pyrrhotite.	186 - 188.5	Tr.		0.03		
188.5 - 190 — 3% pyrrhotite, 2% pyrite.						
195 - 199 — 5% pyrite, 2% pyrrhotite, 10% graphite.	190 - 195	Tr.		0.02		
199 - 205 — Massive sulphide, 70% pyrrhotite, 15% pyrite.	205 - 211	Tr.		0.04	0.22	0.08
Pyrite appears to have replaced large rock fragments						
whereas pyrrhotite replaced matrix.						
10% graphite.						
205 - 211 — Massive sulphide, 50% pyrrhotite, 10% pyrite.						
211 - 219 — 2% pyrite.						
219 - 239 — 15% pyrrhotite,	219 - 224	Tr.		0.04		
5% pyrite, Trace graphite.	224 - 229			0.02		
	229 - 234	Tr.		0.03		
239 - 258 — 50% graphite.	234 - 239	Tr.		0.06		
258.5 - 262 — Massive sulphide.	258 - 262	0.01		0.03	0.05	0.04
30% pyrite, 30% phyrrhotite.	262 - 269	Tr.		0.03		
269 - 271 — Massive sulphide, 5% pyrrhotite, 5% pyrite.	269 - 271	Tr.		0.06	0.05	0.07
	295 - 301	Tr.		0.02	Tr.	0.02
295.6 - 325 — Massive sulphide, 85% pyrite, 10%	301 - 306	Tr.		0.02	Tr.	0.03
pyrrhotite.	306 - 311	Tr.		0.02	Tr.	0.02
	311 - 316	Tr.		0.02	0.02	0.02
	316 - 321	Tr.		0.03	Tr.	0.02
182 - 184 — 3% pyrrhotite, 1% pyrite.	184 - 187			0.03		
184 - 187 — 8% pyrrhotite, 2% pyrite.						
187 - 189 — 5% pyrrhotite.						
189 - 201 — 15% pyrite.	189 - 196			0.02		
201 - 208 — Massive sulphide, 35% pyrrhotite,	196 - 201				0.02	
15% pyrite.	201 - 208	Tr.		0.02	Tr.	0.03
208 - 209 — 5% pyrite, 2% pyrrhotite.	208 - 209				Tr.	
209 - 218 — Massive sulphide.	209 - 214	Tr.		Tr.	Tr.	0.02
80% pyrite, 5% pyrrhotite.	214 - 218	Tr.		Tr.	Tr.	0.02
The following zones are weakly conductive.						
278-291) } 15% graphite,						
309-318) } 1% pyrite						
340-342) }						
342 - 414 — 5-10% graphite, 1-3% pyrite.						
	141 - 146			0.08		0.14
	146 - 151			0.10		0.13
141 - 149 — 8-12% pyrrhotite, 1-3% pyrite, Trace to	151 - 146			0.05		0.12
½% chalcopyrite	156 - 159			0.05		0.13
72.0 — more chalcopyrite and pyrite in siliceous vein	134.8 - 135.2			0.07		0.22
material.						
131.2 - 146 — 3-4% pyrrhotite, 1-2% pyrite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21		133-40	Apr. 15/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 237'	Metasediments, grey-green, siliceous chlorite-biotite schist zones.
						130 - 159	Gabbro, dark green.
						159 - 202	Light green to grey-black siliceous.
						202 - 237	Gabbro, sporadic biotite schist zones.
D-21		133-41	Apr. 13/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 217'	
						32 - 217	Metasediments, light to green, siliceous cherty layers, chloritic fractures.
D-21		133-42	Apr. 11/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 202'	
						47 - 99	Gabbro, chloritic fracture zone.
						99 - 110	Andesite.
						110 - 132	Rhyolite
						132 - 202	Andesite
D-21	91395	133-43	Apr. 25/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 141'	
						20 - 41.5	Biotite-quartz-feldspar gneiss, greyish black, fine grained.
						41.5 - 141	Metasediment, greyish black.
D-21		133-44	May 3/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 277'	
						23- 137	Andesite
						137 - 220	Rhyolite, fine grained.
						220 - 227	Quartz vein
						227 - 231	Rhyolite, fine grained, light grey.
						233 - 277	Rhyolite, fine grained, light grey.
D-21		133-45	May 2/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 267'	
						21 - 23	Granite
						23 - 56	Actinolite schist — altered andesite.
						56 - 62	Pink pegmatite. Last 3 feet mixed with diorite.
						62 - 70	Diorite mixed granodiorite.
						70 - 72	Pegmatite, pink.
						72 - 77	Altered andesite, fine grained.
						77 - 83	Pegmatite
						83 - 110	Altered andesite.
						110 - 114	Diorite
						114 - 136	Pegmatite, pink.
						136 - 138	Altered andesite.
						138 - 154.5	Granite, pink, medium grained.
						154.5 - 160	Diorite, medium grained.
						160 - 165	Altered diorite.
						169 - 181	Altered diorite.
						181 - 185	Granite
						185 - 209	Altered diorite, well foliated gneissic.
						209 - 236	Metasediment, dark grey, siliceous, garnet accessory.
						236 - 238	Diorite, medium grained.
						238 - 243	Metasediment, dark grey, siliceous, pinhead garnet.
						243 - 251	Diorite, medium grained.
						251 - 267	Metasediments, dark grey, siliceous, pinhead garnet accessories.
D-21		133-46	May 5/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 207'	
						19 - 56	Metasediments, dark grey, siliceous disseminated garnet.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
134 - 145.7 — 40-60% pyrrhotite, 1% pyrite and ½% chalcopyrite.	145.4 - 145.9			0.21		0.13
104 - 115 — 6% pyrrhotite.						
63.0 - 77 — 8% pyrrhotite. Trace pyrite.						
137 - 142 — 4-10% pyrrhotite, 2-3% pyrite.						
148.2 - 148.5 — 80% pyrrhotite, 2% pyrite.	148 - 153			0.03		0.10
197 - 202 — 4-5% pyrite.						
81.9 - 82.1 — 10% chalcopyrite, 4% pyrite.	81.8 - 82.1			3.56		0.03
110 - 132 — 5-8% pyrrhotite.						
4-5% pyrite.						
41.0 - 41.3 — 2% pyrrhotite, 2% chalcopyrite	40.8 - 41.4			0.45		0.02
	82 - 84			0.05		0.03
45 - 56 — 5% chalcopyrite. Trace chalcopyrite	87 - 90			0.05		0.03
	90 - 91.3			0.33		0.05
82 - 93 — 15-20% pyrrhotite, Trace 2% chalcopyrite.	91.3 - 94			0.07		0.02
71.5 - 81.5 — 3% pyrite						
98 - 101 — 2% disseminated pyrrhotite.						
101 - 103 — 5% pyrrhotite, 2% pyrite.	101 - 103	Tr.		0.05		
220 - 227 — Quartz vein, 5% pyrrhotite, 5% pyrite. Trace chalcopyrite.	207 - 208			0.10		
231 - 233 quartz vein, 15% vuggy pyrite.						
165 - 169.1 — Massive sulphide, 25% pyrrhotite, 1-5% chalcopyrite.	165 - 169			0.12		

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						56 - 61	Pegmatite, coarse grained.
						61 - 62	Metasediment
						62 - 64	Diorite
						64 - 177	Metasediments, dark grey, siliceous, tiny garnets.
						177 - 207	Andesite, medium grained and interlayered biotite-rich tuffaceous sections.
D-21		133-47	Apr. 29/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 167′	
						47 - 167	Metasediments, greyish black, very siliceous.
D-21	91395	133-48	Apr. 28/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 187′	
						14 - 35.2	Quartz-feldspar-biotite gneiss.
						35.2 - 52.6	Diorite
						52.6 - 83.2	Quartz-feldspar-biotite gneiss.
						83.2 - 99	Feldspar-biotite-chlorite gneiss, greenish grey.
						99 - 174.5	Metasediments, greyish black, well layered.
						174.5 - 187	Diorite — grey-black.
D-21		133-49	Apr. 27/75	M.M.R. Ltd.	Ex. Res. 125 and 126	50°W 247′	
						32 - 38	Diorite gneiss — greyish black, trace pyrrhotite and trace pyrite.
						38 - 54.2	Pegmatite, grey, trace pyrite.
						54.2 - 230.4	Quartz-feldspar-biotite gneiss, grey to black.
						230 - 247	Gneissic gabbro — greyish green, well layered with massive siliceous sections, minor garnet.
D-21	92119	133-50	May 4/78	M.M.R. Ltd.	C.B. 6906	45°W 177′	
						49 - 177	Graphitic chlorite schist, light to dark grey, fine- to medium-grained, foliated, disseminated pyrite and pyrrhotite throughout.
D-21		133-51	May 6/78	M.M.R. Ltd.	C.B. 6919	45°W 167′	
						7 - 167	Biotite-chlorite schist, grey-green, fine grained, well banded, foliated, garnetiferous.
D-21		133-52	May 5/78	M.M.R. Ltd.	C.B. 6919	45°W 177′	
						63 - 103.2	Graphite-chlorite schist, grey-green, fine grained, well layered, well foliated, mineralized throughout with graphite and pyrite.
D-21		133-53	May 3/78	M.M.R. Ltd.	C.B. 6916	45°W 217′	
						53 - 103	Dacite, light to dark green, massive 76.4-79.6 quartzite? 81.3-82.7 quartzite? disseminated pyrrhotite and pyrite throughout.
D-21		133-54	May 7/78	M.M.R. Ltd.	C.B. 6912	45°W 207′	
						30 - 107	Dacite, light to dark grey-green, fine grained, massive, chloritic, banded sections, numerous narrow quartz stringers.
						107 - 207	Andesite, light to dark green, fine grained, massive sections, chloritic, minor disseminated pyrite.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
102 - 106.7 — 5% pyrite, 1% pyrrhotite. 106.7 - 110 — 20-30% pyrrhotite, 2-5% pyrite, Trace chalcopyrite.	106 - 110			0.05		0.03
82.2 - 99 — 6% pyrrhotite, 4% pyrite. 99 - 123 — 6% pyrrhotite, 1% pyrite. 123 - 125 — 70-80% pyrrhotite, Trace pyrite, Trace chalcopyrite. 125 - 174 — 2% pyrrhotite, 1% pyrite. 179 - 185 — Pegmatite with minor sulphide.	123 - 125			0.20		0.11
84.9 - 87 — 80-90% pyrrhotite. 119 - 123 — Quartz vein with minor sulphide. 164 - 206 — 1-3% pyrrhotite, 1% pyrite. 206 - 230 — 4-10% pyrite, 1% pyrrhotite. 230 - 237 — 4% pyrite.						
95 - 113 — 0-20% pyrrhotite, 0-10% pyrite, Trace graphite. 113 - 116 — 25-50% pyrrotite, 5-10% pyrite and graphite, Trace chalcopyrite. 116 - 124 — 10-25% pyrrhotite, 5-10% pyrite and graphite. 124 - 125.5 — 20-50% pyrrhotite, 5-10% graphite, Trace chalcopyrite. 161.8 - 162.5 — Solid pyrrhotite.	113.6 - 116.4 161 - 162	Tr. Tr.		0.15		
85.6 - 87.7 — 10-25% pyrrhotite, 0-10% pyrite. 87.7 - 97.6 — solid sulphide, pyrrhotite, 0.10% pyrite, Trace graphite, Trace chalcopyrite. 97.6 - 107.6 — 10-25% pyrrhotite, 0-10% pyrite.	87.6 - 92.6 92.6 - 97 97. - 102	Tr. Tr.		0.07 0.07 0.06		
99.8 - 103.3 — 10-25% pyrite 10-25% graphite 103.3 - 127.9 — 10-15% pyrrhotite and pyrite. 127.9 - 129.5 — Solid pyrrhotite, 10-15% pyrite 130.5 - 139.4 — Chlorote-biotite schist, 0-15% disseminated pyrite.						
105 - 111 — Near solid sulphide, pyrrhotite, 0-10% pyrite, chalcopyrite 111 - 113 — 50-75% pyrrhotite, 0-10% pyrite, Trace chalcopyrite. 113 - 126 — 10-25% pyrrhotite, 0-10% pyrite. 126 - 128 — Solid sulphide, pyrrhotite, 0-10% pyrite.	105 - 111 110 - 111 111 - 113 126 - 128	Tr. Tr.		0.10 0.12 0.11 0.05		
94.5 - 102.8 — 10-25% pyrrhotite.	94 - 97	Tr.				

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21		133-55	May 6/78	M.M.R. Ltd.	C.B. 6907	45°W 181′	
						10 - 80.9	Diorite, grey-green, medium grained.
						80.9 - 107.6	Dacite, light to dark grey, fine grained, disseminated pyrrhotite and pyrite throughout.
						107.6 - 126.9	Rhyolite, light grey. Disseminated pyrite and pyrrhotite throughout.
						126.9 - 181	Andesite, light to dark green, fine grained, generally massive. Disseminated pyrite and pyrrhotite throughout.
D-21	92119	133-56	Apr. 30/78	M.M.R. Ltd.	C.B. 6906	45°W 675′	
						75 - 242	Quartz-biotite-chlorite schist, light to dark grey, fine to medium grained. Mineralization throughout with pyrrhotite and pyrite.
						242 - 297	Dacite tuff, light grey-green, fine grained, foliated, abundant chlorite and sericite alteration. More massive near bottom of section. Disseminated pyrrhotite and pyrite.
						297 - 420	Graphitic chloritized, light to dark grey. Well foliated quartzite laminations. Pyrrhotite, pyrite.
						420 - 467	Dacite tuff — light grey, fine grained, thinly layered fragmental.
D-21		133-57	Apr. 29/78	M.M.R. Ltd.	C.B. 6906	45°W 364′	
						75 - 87	Sericite schist, vuggy chloritic, well mineralized.
						87 - 156	Chlorite schist — light to dark grey-green in colour, fine grained, well banded, sections contorted, vuggy. Well mineralized throughout with a pyrite and graphite as massive lenses, disseminations and vuggy fillings.
						155.7 - 320.6	Chlorite schist (altered andesite), light to dark green.
						320 - 364	Rhyolite, light grey in colour, fine to medium grained.
D-21		133-58	Mar. 25/78	M.M.R. Ltd.	C.B. 6907	45°W 177′	
						37 - 108	Andesite — fine grained, massive, green hornblende.
						108 - 115	Rhyolite — light grey, 3% pyrrhotite, 1% pyrite, 1% arsenopyrite, ½% chalcopyrite.
						115 - 118	Quartz vein — 5% pyrite, trace pyrrhotite.
						119 - 121	Rhyolite — light grey, 2% pyrrhotite, 1% pyrite, 1% arsenopyrite, Trace chalcopyrite.
						124 - 129	Rhyolite — light grey, fine grained, 2% pyrrhotite, 1% pyrite, 1% arsenopyrite, ½% chalcopyrite.
						129 - 134	Andesite — green, fine grained.
						134 - 136	Massive sulphide, 40% pyrrhotite, 10% pyrite, Trace arsenopyrite.
						136 - 177	Andesite, fine grained, weakly foliated to massive.
D-21		133-59	Apr. 26/78	M.M.R. Ltd.	C.B. 6906	45°W 229′	
						55 - 128	Andesite, light to dark green, fine grained, chloritic, minor disseminated pyrrhotite and pyrite.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
16.7 - 20 8 — 10-25% pyrrhotite, 10-25% graphite, Trace chalcopyrite	111 - 113	Tr				
111 - 113 — Solid sulphide, pyrrhotite, pyrite, Trace chalcopyrite, Trace pyrite						
113 - 124 — 5-10% pyrrhotite, pyrite, graphite.						
124 - 125 — 10-25% pyrrhotite, pyrite, Trace chalcopyrite, Trace sphalerite.						
125 - 127 — 50-75% pyrrhotite, pyrite, Trace chalcopyrite and sphalrite, Trace graphite.						
158 - 196 — 20-25% pyrrhotite, 10-25% pyrite.						
223 - 242 — 10-25% pyrrhotite and pyrite, 10-25% graphite.						
297 - 307 — 10-25% pyrrhotite, 10-20% pyrite.						
307 - 310 — 50-75% pyrite, 10-25% pyrrhotite.						
316 - 318 — Solid sulphide-pyrite and pyrrhotite 25%						
343 - 346 — 50-75% pyrrhotite, 10-25% pyrite, 10-25% pyrite.						
346 - 348 — Solid sulphide, pyrrhotite and pyrite						
348 - 353 — 10-25% pyrrhotite, pyrite and graphite						
353 - 361 — Solid to near solid sulphide, pyrite and pyrrhotite.						
361 - 393 — 50-75% graphite and pyrrhotite, 0-1% pyrite						
393 - 404 — Solid sulphide-pyrite.						
404 - 420 — 50-75% graphite-pyrrhotite and pyrite.						
420 - 424 — 50-75% pyrrhotite.						
75 - 87.4 — 50-75% pyrite						
87 - 98 — 25-50% pyrite, 25-50% graphite.						
99 - 105 — Solid pyrite						
105 - 116 — 10-25% pyrrhotite, 10-25% graphite.						
116 - 123 — Solid pyrite.						
123 - 131 — 10-25% pyrite, 10-15% graphite.						
131 - 132 — Solid pyrite.						
132 - 155 — 10-25% pyrite, 10-25% graphite.						
185 - 206 — 20-30% pyrite.						
206 - 217 — 5-10% pyrite						
217 - 220 — 10-15% pyrite, 25% graphite.						
220 - 225 — Solid to near solid sulphide pyrite, 10-25% graphite.						
225 -228 — 25-50% pyrite, 0-10% graphite.						
231 - 232 — 50-75% pyrite.						
232 - 245 — 10-25% pyrite, 0-10% graphite.						
306 - 317 — 50-75% graphite, 10-25% pyrite						
342.4 - 343.5 — 10-25% graphite.						
118 - 119 — Massive sulphide 60% pyrrhotite, 1% pyrite, 1% chalcopyrite, 5% graphite.						
121 - 124 — Massive sulphide, 50% pyrrhotite, 10% graphite, 1% pyrite, [illegible]% chalcopyrite, [illegible]% sphalerite						
148 - 152 — 5-10% pyrrhotite, 0-5% pyrite, 10-15% graphite, Trace chalcopyrite.						
167 - 170 — 10-15% pyrrhotite, 0-5% pyrite, 10-15% graphite, Trace chalcopyrite.						
172 - 177 — 10-15% pyrrhotite, 1-5% pyrite, 10-15% graphite, Trace chalcopyrite.						
183 - 186 — 10-15% pyrrhotite, 10-25% graphite, Trace chalcopyrite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-21		133-60	Apr. 23/78	M.M.R. Ltd.	C.B. 6902	45°W	
						167′	
						36 - 167	Andesite — fine grained, light greenish grey, chloritic, minor tuffaceous sections.
						112 - 114	Siliceous, massive, possibly rhyolite layer.
D-21		133-61	Apr. 24/78	M.M.R. Ltd.	C.B. 6902	45°W	
						177′	
						50 - 112	Andesite — light greenish grey, chloritic
						112 - 120	Rhyolite — light green, some andesite sections, trace pyrite.
						142 - 149	Quartz veins — 1% chalcopyrite, 1% pyrite and pyrrhotite.
						150 - 177	Andesite — fine grained, light green-grey, chloritic to pyrite and pyrrhotite.
D-21		133-62	Apr. 21/78	M.M.R. Ltd.	C.B. 6902	45°W	
						157′	
						28 - 62	Andesite — fine grained, light green to grey, generally massive, chloritic. Trace pyrite and pyrrhotite.
						62 - 72	Solid pyrrhotite.
						72 - 157	Andesite — fine grained, massive chlorite.
D-21		133-63	Apr. 20/78	M.M.R. Ltd.	C.B. 6902	45°W	
						157′	
						27 - 157	Andesite — fine grained, chloritic, tuffaceous, bedded in sections.
						117 - 124	Bedded andesite tuff.
D-21	92119	133-64	Apr. 18/78	M.M.R. Ltd.	C.B. 6902	45°W	
						167′	
						55 - 72	Rhyolite — fine grained, highly siliceous, 50% quartz veins, weak disseminated chlorite-sericite alteration. Trace pyrite and pyrrhotite.
D-21		133-65	May 2/78	M.M.R. Ltd.	C.B. 6903	45°W	
						206′	
						5 - 130	Andesite — light to dark green, fine grained, chloritic, minor pyrite and pyrrhotite.
						130 - 172.6	Dacite — light grey-green, fine grained, massive, chloritic. Disseminated pyrite and pyrrhotite throughout.
						172.6 - 206	Dacite tuff — light grey-green, fine grained, well layered sections, fragmental, highly chloritic becoming more mafic at the bottom of the section.
D-21		133-66	May 3/78	M.M.R. Ltd.	C.B. 6903	45°W	
						167′	
						40 - 83	Dacite — light to dark grey-green, fine grained, massive, rhyolitic section, chloritic.
						83 - 90	Biotite-chlorite, schist, light to dark grey-green, medium grained, banded, foliated, minor disseminated pyrite.
						98 - 167	Andesite tuff — light to dark green, fine grained, becoming more felsic at bottom of section, minor disseminated pyrite and pyrrhotite.
D-21		133-67	May 1/78	M.M.R. Ltd.	C.B. 6903	45°W	
						285′	
						32 - 51	Rhyolite — light grey, medium grained, well layered to fragmental, minor chlorite-sericite alteration, disseminated pyrite and pyrrhotite throughout.
						51 - 67	Biotite-chlorite schist — light to dark green, fine grained, banded, foliated, gradational with above section.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
91 - 94 — 5-10% pyrrhotite, 1-2% pyrite, Trace chalcopyrite. 94 - 117 — 1-2% pyrrhotite, 1-2% pyrite, chlorite-sericite alteration. 142 - 144 — 10-15% pyrrhotite, 1-2% pyrite. 144 - 167 — 1-2% pyrrhotite and pyrite.						
50 - 78.5 — Trace to 10% pyrite, Trace pyrrhotite. 78.5 - 108 — Trace to 8% pyrite. 106 - 109 — Solid pyrite, some siliceous fragments. 109 - 112 — Trace pyrite.						
62 - 72 — Solid pyrrhotite — 5-10% pyrite, 20% mafic blebs and siliceous fragments. 72 - 92 — 1-2% pyrrhotite. Trace chalcopyrite, 1-2% pyrite. 115 - 123 — 2-3% pyrite, pyrrhotite in narrow stringers. 125 - 130 — Fine grained, siliceous, possible rhyolite. 130 - 147 — 2-3% pyrite, Trace pyrrhotite.						
27 - 110 — Trace to 5% pyrite, pyrrhotite. 110 - 113 — Solid pyrite to pyrrhotite. 114 - 117 — 15-20% pyrite, Trace pyrrhotite. 117 - 124 — 20% pyrite, 2-5% pyrite in massive bands. 127 - 137 — Several solid narrow bands of pyrite and pyrrhotite.						
72 - 76 Solid graphite, Trace pyrite, pyrrhotite. 78 - 91.4 graphite, 10% pyrrhotite, 2% pyrite. 102 - 104 — Solid pyrite, Trace arsenopyrite?						
132 - 134 — 10-25% pyrrhotite, 0-10% pyrite, Trace chalcopyrite. 134 - 142 — 0-10% pyrrhotite and pyrite. 142 - 158 — 50-75% pyrrhotite, 10-25% pyrite, Trace chalcopyrite.						
73 - 81 — 10-25% pyrite, 0-5% pyrrhotite. 81 - 83 — 50-75% pyrrhotite and pyrite.						
40 - 50 — 25-50% pyrrhotite, 0-25% pyrite, Trace chalcopyrite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						68 - 115	Dacite — light to dark grey, fine grained, massive, sections fragmental. Rhyolite sections.
						115 - 153	Dacite tuff — light to dark grey, fine grained, well layered, fragmental, sections rhyolitic.
						153 - 245	Rhyolite tuff — light grey, well layered, fragmental.
						245 - 285	Andesite — light to dark green, fine grained, massive.
D-21		133-68	Apr. 27/78	M.M.R. Ltd.	C.B. 6903	45° W 167′	
						42 - 66	Andesite — generally massive, layered chloritic sections, some hematite stain, minor pyrite throughout.
						66 - 153	Felsic to intermediate volcanic, well layered to fragmental, chlorite and sericite alteration. Bottom of section garnetiferous.
						163 - 167	Andesite — light to dark green, fine grained, fragmental, chloritic, minor pyrite throughout.
D-21		133-69	Mar. 30/78	M.M.R. Ltd.	C.B. 6902	45° W 252′	
						59 - 67	Andesite — green, fine grained, massive, tiny granitic veins.
						67 - 208	Altered diorite — light grey, calcareous.
						208 - 252	Graphite-chlorite schist, black, fine grained. 5-20% graphite, 5% pyrite, 2% pyrrhotite.
D-21		133-70	Apr. 17/78	M.M.R. Ltd.	C.B. 6902	45° W 165′	
						42 - 63	Andesite — chloritic.
						63 - 73	Chloritic graphite schist — dark green to black, well mineralized graphite. 5-10% pyrrhotite, 5% pyrite.
						73 - 165	Andesite tuff — light grey to green, trace pyrite and pyrrhotite. 159 - 165 — Siliceous, possibly quartzite.
D-21		133-71	Apr. 14/78	M.M.R. Ltd.	C.B. 6896	45° W 127′	
						65 - 83	Intermediate tuff, chloritic schist.
						83 - 92	Felsic tuff — light grey, bedded, some sections of intermediate composition.
						117 - 127	Intermediate tuff, chloritic schist, 10% pyrite.
D-21		133-72	Apr. 14/78	M.M.R. Ltd.	C.B. 6897	45° W 387′	
						33 - 52	Andesite — fine grained, dark to greenish grey, chloritic.
						57 - 98	Rhyolite — fine grained, grey, fragmental in sections, weak disseminated chlorite-sericite alteration.
						140 - 156	Rhyolite tuff — fine grained, light to dark grey, numerous layers of mafic material — 10-20% pyrrhotite, 5-10% pyrite.
						212 - 265	Quartz veins, numerous sections of layered mafic material.
						265 - 340	Dacite tuff — greenish, chloritic, becomes andesitic in places, 10-15% pyrrhotite, 5% pyrite.
						357 - 369	Rhyolite tuff — fine grained, light grey, 50% interbedded fine grained mafic material.
						369 - 387	Andesite tuff — fine grained, chloritic, dark greenish black.
D-21		133-75	Apr. 24/78	M.M.R. Ltd.	C.B. 6897	45° W 197′	
						34 - 40	Granite — boulder?
						40 - 94	Andesite — fine grained, light green, chloritic, soft, muddy in sections with trace graphite.
						94 - 108	Graphitic chlorite schist — 10% pyrrhotite. Trace pyrite, mineralized graphite in sections.
						108 - 130	Andesite tuff — fine grained, light green, altered. Highly chloritic, slightly sericitic.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
222 - 238 — 10-75% pyrite, 10-25% pyrrhotite. 238 - 245 — Solid sulphide.						
77 - 117 — 10-30% pyrite, 0-5% pyrrhotite. 117 - 126 — 10-15% pyrite, 10-25% graphite.						
141 - 2.5 cm stringers of 75% pyrrhotite. 133 - 154 — 50-75% pyrrhotite, 0-10% pyrite.						
117 - 208 — Occasional 2-6 conductive mud seams, some reddish brown hematitic stain.						
53 - 57 — Trace pyrrhotite and pyrite. 99 - 102 — Weakly graphitic. 121 - 127 — chloritic graphite schist. 10% pyrite. 127 - 159 — Trace graphite, 2-5% pyrite and pyrrhotite.						
78 - 82 — 10-20% pyrite. 91 - 95 — Solid pyrite, 20-30% banded mafic material. 95 - 102 — Solid pyrite, mafic and siliceous fragments. 108 - 117 — Solid pyrite, mafic bands and fragments.						
55 - 62 — 20% pyrrhotite, 10% pyrite. 98 - 116 — Solid pyrite, 20% pyrrhotite, 10% banded mafic material. 121 - 136 — Solid fine grained whitish pyrite, mafic bands at end of section. 136 - 140 — Solid pyrite, pyrrhotite, 10-15% pyrite. 156 - 161 — Solid pyrite, 10-20% pyrite. 161 - 206 — Solid pyrite, white, fine grained. 206 - 212 — Solid pyrite, 10-20% pyrrhotite, numerous mafic layers, some siliceous fragments. 300 - 305 — Solid pyrrhotite, Trace pyrite, mafic and siliceous fragments. 340 - 347 — Solid pyrite, 20-30% pyrrhotite, siliceous fragments. 347 - 352 — Solid pyrite, pyrrhotite, 20% mafic band with trace graphite. 351 - 357 — 5-10% pyrite and pyrrhotite, 10-15% graphite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						130 - 153	Graphitic chlorite schist, highly mineralized with graphite, trace pyrite, pyrrhotite, sections barren andesite tuff.
						153 - 197	Andesite tuff — fine grained, light green to grey, altered. Highly chloritic, slightly sericitic, generally barren. Trace graphite, pyrite, pyrrhotite.
D-21		133-76	Apr. 21/76	M.M.R. Ltd.	C.B. 6897	45° W 204′	
						37 - 105	Andesite — fine grained, light green to grey. 37 - 59 — weathered, dark green to black, chloritic, 10-15% biotite, 2-3% pyrrhotite. 59 - 105 — massive chlorite-sericite alteration.
						105 - 164	Andesite tuff — altered, chloritic and weakly sericitic section mineralized with 5-8% pyrrhotite, 1-2% pyrite in narrow stringers.
						164 - 204	Dacite tuff — fine grained, light green to grey, chlorite-sericite alteration, 1-2% pyrrhotite, pyrite, trace chalcopyrite.
D-21		133-77	May 27/78	M.M.R. Ltd.	C.B. 6898	45° W 114′	
						100 - 114	Andesite — fine grained, light green to grey, generally massive, slightly banded, chloritic with minor biotite along cleavage.
		133-77A	Mar. 31/78	M.M.R. Ltd.	C.B. 6898	45° W 287′	
						50 - 138	Andesite tuff — fine grained, light to dark green, highly chloritic. Some andesite sections. Sections of chlorite alterations almost schistose.
						138 - 191	Chlorite-graphite schist. 138 - 152 — highly chloritic, minor graphite, muddy section. 152 - 171 — chloritic 2-5% pyrite and pyrrhotite in narrow stringers, minor graphite, conductive. 171 - 191 — highly chloritic, weakly graphitic, trace pyrite, pyrrhotite.
						191 - 287	Andesite tuff — fine grained, light to dark green, chloritic. Trace pyrite and pyrrhotite.
D-21		133-78	Mar. 29/78	M.M.R. Ltd.	C.B. 6898	45° 165′	
						24 - 45	Andesite — fine grained, light green to grey chlorite with numerous sections high in biotite, massive. Some irregular stringers and narrow bands of calcareous material.
						45 - 125	Quartzite — fine grained, light grey, layered. Highly micaceous in sections. Trace pyrite and pyrrhotite.
						125 - 165	Andesite — fine grained, light green to grey, massive, chloritic, barren.
D-22	92098	126-1	July 12/75	M.M.R. Ltd.	Res. 132	45°E 173′	
						80 - 180	Graphitic slate, weakly mineralized with disseminated and banded pyrite.
						180 - 240	Metasediment — grey-green, well banded to massive, very siliceous.
						240 - 314	Graphitic slate.
						314 - 358	Metasediment, grey-black to greenish black — interlayered. Chert at depth — minor magnetite present. Granite, whitish grey, coarse grained, massive.
D-23		126-2	July 7/75	M.M.R. Ltd.	Res. 132	45° S50°E 310′	
						79 - 310	Graphitic slate 184 - 192 — Well folded and brecciated graphite zone with felsic folding. 197 - 199 — Chlorite, altered intermediate volcanic material.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
117 - 123 — Trace chalcopyrite. 141 - 144 — Trace chalcopyrite. 159 - 164 — Trace chalcopyrite						
226 - 245 — pyrite, 5% pyrrhotite in narrow solid stringers. 245 - 250 — 10-15% pyrite, 2-5% pyrrhotite in narrow solid stringers. 250 - 258 — Several narrow solid stringers pyrite and pyrrhotite.						
54 - 58 — Solid pyrite, siliceous, fine grained quartzose fragments. 115 - 120 — 10-15% pyrite, 15% pyrrhotite. Highly siliceous quartzose material, mineralization, coarse grained. 120 - 125 — Solid pyrite and pyrrhotite. Some chloritic material.						
80 - 180 — 30-40% graphite, 5-8% pyrite. 240 - 314 — 30-40% graphite, 10-12% pyrite.						
79 - 310 — 20-40% graphite, 10% pyrite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-24		126-3	July 4/75	M.M.R. Ltd.	Res. 132	50°E 503′	
						80 - 211	Grey, fine grained with abundant medium grained biotite flakes, massive with minor banding. Minor sulphides in felsic fractures, following intense sericite and chlorite.
						211 - 241	Speckled grey-blue, fine granular appearance, siliceous fused matrix, weakly layered.
						241 - 294	Light greenish grey, fine grained, intense chlorite alteration to soft massive material, zones of disseminated and thin layered pyrite.
						294 - 503	Graphitic slate, dark grey-black, abundant dark chlorite, varying concentrations of graphite, weak to moderate pyrite mineralization, pyrrhotite replacing pyrite at depth.
D-25		126-4	July 15/75	M.M.R. Ltd.	Res. 131	50°W 263′	
						64 - 219	Graphitic slate, well layered, numerous felsic stringers, scattered concentrations of graphite and minor bands of coarse pyrite.
						219 - 263	Metasediments — dark grey, very fine grained, weakly layered to massive material.
D-26		126-5	July 18/75	M.M.R. Ltd.	Res. 131	50°W 285′	
						51 - 98	Metasediment as previous chlorite alteration.
						98 - 244	Graphitic slate as previous
						244 - 271	Metasediments — grey to greenish black, fine grained, well layered. Soft chlorite altered material.
						271 - 285	Granite — massive, whitish black, coarse grained.
D-27	92098	126-6	July 20/75	M.M.R. Ltd.	Res. 131	50° S50°W 337′	
						38 - 290	Slate, dark greyish black, fine grained. 150 - 290 — decrease in graphite and pyrite in core; more siliceous, grey and black interbanded.
						290 - 318	Metasediments, dark grey to greenish black, siliceous material, soft chlorite, altered sections.
						318 - 337	Quartz-feldspar-biotite gneiss, whitish black, medium grained, irregular layering.
D-28	92097	126-7	July 23/75	M.M.R. Ltd.	Res. 130	50°W 250′	
						0 - 62	Casing: sand, boulders.
						62 - 194 (62 - 127 poor core recovery)	Graphitic slate, dark greyish black, fine grained, weakly banded, scattered concentrations of graphite and numerous pyrite layers.
						194 - 233	Metasediments: dark grey to greenish black, well banded, fine grained, minor sections.
						233 - 250	Quartz-feldspar-biotite gneiss: whitish black, medium grained, scattered interbanded sediments, poor core angle throughout.
D-29		126-8A	July 28/75	M.M.R. Ltd.	Res. 130	50°E 462′	
						0 - 128	Casing: sand boulders.
						128 - 462	Graphitic slate — dark grey-black, scattered concentrations of graphite and moderate disseminated and banded pyrite.
D-30		126-9	Aug. 1/75	M.M.R. Ltd.	Res. 130	50° S65°E 391′	
						0 - 131	Casing:
						131 - 337	Graphitic slate — dark grey to black, fine grained, graphite 10-40% along bedding planes, many sheared and contorted, minor quartz stringers.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
100 - 103 — Poorly consolidated chlorite material. 294 - 434 — 30-40% graphite, 8% pyrite. 434 - 503 — 30-40% graphite, 8% pyrite, 3% pyrrhotite.						
64 - 219 — 20-40% graphite, 3-5% pyrite.						
98 - 244 — 30-40% graphite, 10-15% pyrite.						
38 - 150 — 30-40% graphite, irregular bands of pyrite up to 3 inches wide, 12-15%. 150-290 — 10-15% graphite, 5-8% pyrite.						
62 - 194 — 20-30% graphite, 8-10% pyrite.	143 - 146.5	NIL				
128 - 462 — 30-40% graphite, 5-8% pyrite.						
175 - 256 — 2-8% pyrite. 259 - 337 — 2-8% pyrite.	260 - 265 374 - 380	Tr. Tr.				

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-31		126-10	Aug. 5/75	M.M.R. Ltd.	Res. 130	50° W	
						347'	
						0 - 70	Casing: Graphitic slate — dark grey to black. 20-80% graphite along bedding planes.
						314 - 347	Metasediments — fine grained, interlayered, light and dark grey, often siliceous. Interlayered phyllite and quartz, siltstone, traces of graphite and pyrite
D-32		126-11	Aug. 9/75	M.M.R. Ltd.	Res. 129	50° W	
						373'	
						0 - 33	Casing
						33 - 110	Metasediment — grey to dark grey, fine grained, massive. Trace graphite throughout.
						110 - 351	Graphitic slate — dark grey to black, bedding planes with 20-60% graphite.
						351 - 373	Metasediment — dark grey to grey. Fine grained, weakly foliated, a few specks of pyrite.
D-33		126-12	Aug. 13/75	M.M.R. Ltd.	Res. 129	50° E	
						560'	
						0 - 41	Casing
						41 - 57	Metasediment.
						57 - 535	Graphitic shale, bedding, well defined with 20-60% graphite.
						535 - 560	Metasediment — grey to dark grey, fine grained, well foliated, siliceous.
D-34	92097	126-13	Aug. 20/75	M.M.R. Ltd.	Res. 129	50° W	
						463'	
						0 - 32	Metasediments — grey, fine grained, siliceous.
D-35	92099	126-15	Sept. 8/75	M.M.R. Ltd.	Res. 134	50° E	
						347'	
						90 - 211	Graphitic slate, dark grey to black, fine grained, bedding planes poorly defined, contain 10-15% graphite.
						211 - 241	Metasediments, dark grey to black, well foliated. Occasional specks of pyrite.
						241 - 280	Graphitic slate, dark grey to black. Bedding poorly defined, 10-30% graphite on bedding planes, Trace pyrite.
						280 - 347	Metasediments — dark grey to black, fine grained, well foliated.
D-36		126-17	Sept. 2/75	M.M.R. Ltd.	Res. 134	45° E	
						203'	
						20 - 75	Diorite — grey, medium grained, massive. Predominantly plagioclase minor biotote.
						75 - 97	Quartz diorite as above with minor quartz.
						97 - 104.5	Breccia, pyrite and pyrrhotite. Mineralization as matrix between fine grained, light coloured, angular fragments up to 2" in diameter.
						104.5 - 144	Massive sulphides, some distinguishable siliceous and other types of angular fragments.
						144 - 151	Dacite — grey, fine grained, generally massive, 6% pyrrhotite, 2% pyrite.
						151 - 165	Massive sulphide — 20% pyrrhotite, 20% pyrite, 20% graphite.
						165 - 203	Andesite — green, fine grained, massive, 10% irregular quartz stringers.
D-37		126-18	Aug. 31/75	M.M.R. Ltd.	Res. 134	45° E	
						337'	
						50 - 127	Metasediments, grey, fine grained, weakly foliated, siliceous.
						127 - 265	Graphitic phyllite, dark grey to black, fine grained. Trace pyrite and pyrrhotite. 207 - 215 — fault zone? Only 2 feet of quartz and soft talc-like material recovered.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
110 - 130 — 2-5% pyrite.						
133 - 361 — 2-7% pyrite.						
176 - 178 — Quartz vein with specks of pyrite and chalcopyrite.						
100 - 535 — 2-6% pyrite.						
535 - 560 — 1-3% pyrite.						
32 - 256 — 1-4% pyrite and pyrrhotite.	354 - 365	Tr.				
256 - 256.4 — 3% arsenopyrite	412 - 417	Tr.				
256.5 - 462 — 5% pyrite and pyrrhotite.	437 - 442	Tr.				
97 - 100 — 3% pyrrhotite, 2% pyrite.	97 - 101	Tr.				
100 - 101.5 — 40% pyrite, 30% pyrrhotite,	104 - 110			Tr.		0.02
101.5 - 104.5 — 2% pyrrhotite, 2% pyrite.	110 - 115			Tr.		Tr.
	115 - 120			Tr.		0.02
	120 - 126			Tr.		0.02
104.5 - 144 — 75% pyrite, 5% pyrrhotite, 5% graphite.	126 - 131			Tr.		0.02
119 - 126 — 10% pyrite, 10% pyrrhotite, 15% graphite.	131 - 136			Tr.		0.02
126 - 136 — 50% pyrite, 10% pyrrhotite, 5% graphite.	136 - 144			Tr.		0.02
136 - 144 — 15% pyrite, 10% pyrrhotite, 15% graphite.	144 - 151	Tr.				
	151 - 156	Tr.				
127 - 207 — 10-15% graphite						
215 - 265 — 5-10% graphite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						285 - 337	Diorite — medium grained, chiefly plagioclase with minor biotite. A few metasedimentary inclusions. Weakly foliated.
D-38		126-19	Sept. 4/75	M.M.R. Ltd.	Res. 134	40° E 226'	
						60 - 226	Graphitic slate — dark grey to black, bedding well defined with 20-60% graphite. Trace pyrite.
						226 - 266	Metasediments, fine grained, siliceous alternating light and dark grey layers.
D-39		126-20	Aug. 27/75	M.M.R. Ltd.	Res. 133	45° N 345'	
						33 - 79	Altered ultrabasic, serpentine, locally talc dominating with minor chlorite; talc can have red-brown stain.
						79 - 345	Serpentinite — green waxy lustre, trace of talc and chlorite throughout.
D-40		126-21	Aug. 22/75	M.M.R. Ltd.	Res. 135	50° E 184'	
						23 - 184	Serpentine — green, locally chloritic traces of talc. 141 - 142 — trace graphite.
D-41		126-22	Aug. 22/75	M.M.R. Ltd.	Res. 135	50° E 232'	
						42 - 142	Serpentine — green, gradational to peridotite below.
						142 - 155	Peridotite — dark green, medium grained, massive. Rich in olivine with olivine content decreasing with depth. Gradational to gabbro below. 150 - 155 — yellowish-green epidote stringers along irregular fractures.
						155 - 232	Gabbro — medium green, initially mafic with plagioclase content increasing with depth.
D-42		126-23	Aug. 17/75	M.M.R. Ltd.	Res. 130	50° W 254'	
						57 - 223	Graphitic slate as previous. Metasediment as previous.
D-43	92015	M76-1	Apr. 22/76	Ducanex Syndicate	Expl. Res. 141	60° 286'	
						42 - 66	Biotite-garnet gneiss, pelitic gneiss, 1/4 layers. Biotite and garnet 20%.
						66 - 70	Granite — pink and white, minor 1 inch to 2 inch zones of amphibole.
						70 - 76	Biotite-garnet gneiss, upper 2 feet amphibolitic with gradation to calc-silicate, local epidote alteration.
						76 - 87	Granite — pink and white.
						87 - 109	Granitized quartzite, light pink and grey colour. 108 — Local calc-silicate zones.
						109 - 174	Siliceous garnetiferous greywacke.
							Conductor:
						174 - 175.5	Graphite — massive, blocky, very conductive.
						175.5 - 178.5	Granite — medium grained, mottled, leucocratic.
						178 - 239	Quartzite
						239 - 322	Siliceous metagreywacke as in footage 109 to 234, layered with frequent granitic stringers.
						322 - 327	Granite.
						327 - 364	Granite, pink, fine grained, massive.
						364 - 386	Granite gneiss, fine grained, well foliated, 10-15% biotite, very siliceous, less than 10% feldspar.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
79 - 295 — 1-10% magnetite disseminated, massive stringers and long hair-like dendritic fractures (relict spinifex structures?).						
116 - 120 — 3% magnetite in hair-like stringers along dendritic fractures, spinifex structure (?).						
100 - 142 — 5% magnetite.						
78 - 223 — 1-5% pyrite.						
Manganese in zones up to 0.06 feet. Trace pyrite.						
127 - 129 — Pyrite 3-5%.						
134 - 139 — Disseminated pyrite, pyrrhotite 1-3%.						
140 - 3% sulphide in chloritized slip surfaces.						
146 — Graphitic slip ¼" wide.						
145 - 150.5 — Very disseminated pyrite in chlorite-biotite slips, 1-3% sulphide.	145 - 151	NIL		0.01	Tr.	
153 - 157 — Calc-silicate member 1 foot thick.	153 - 157	Tr.		0.01	0.01	
167.5 — 2 inch wide disseminated pyrite, slightly conductive.						
170 - 173 — Disseminated pyrite 1-3%, locally 10 inches in layers.						
215 - 1 foot zone of calc-silicate with 5% pyrite.						
217 - 1 foot zone of 2% pyrite in silicate.						
235.5 - 5-8% disseminated pyrite, trace chalcopyrite.						
230 — Minor pyrite.						
256 — Garnetiferous with 10 pyrite veinlets ⅛" wide.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-43		M76-2	Apr. 28/78	Ducanex Syndicate	Expl. Res. 141	60° 357′	
						38 - 105	Metagreywacke — fine-to medium-grained, mottled garnet with 10% biotite, garnetiferous. 78 - 82 — Trace pyrite.
						105 - 111	Calc-silicate, quartzite, fine- to medium-grained.
						111 - 123	Metagreywacke, as 38 - 105, with finer garnets.
						123 - 151	Quartz-feldspar gneiss, fine- to medium-grained, pink and grey with sporadic pegmatite veinlets.
						151 - 156	Metagreywacke — fine grained, 3-5% graphite in narrow slips.
						156 - 162	Conductor: very sheared and blocky graphite with occasional quartz veinlets.
						162 - 163	Meta-argillite, fine grained with frequent graphite slips, medium to dark grey.
						163 - 174	Meta-arkose — (granitized quartzite?) — fine-to medium-grained, light pink, massive.
						174 - 191	Metagreywacke, as in footage 38 - 105. Frequent pegmatite veinlets closer to lower contact.
						191 - 199	Quartz-biotite gneiss, fine-to medium-grained, forms layers in fine grained siliceous rock. Less than 10% visible feldspar in siliceous rock.
						199 - 205	Metagreywacke as in 38 - 104.5 feet.
						205 - 211	Granitized quartzite (meta-arkose).
						211 - 233	Amphibolite, fine-to medium-grained, massive, dark green. Less than 8% leucocratic minerals.
						233 - 284	Metagreywacke — very siliceous and fine grained, grading to biotite quartz gneiss.
						284 - 288	Pegmatite — white and pink mottled, less than 10% mafics, 25% feldspar.
						288 - 306	Quartz-biotite gneiss, as in 191 - 199. Sporadic pegmatite zones.
						306 - 308	Amphibolite — coarse grained, fresh, very dark grey with euhedral ¾" hornblende laths.
						308 - 321	Quartz-biotite gneiss, as in 191 - 199.
						321 - 357	Leucogranite — coarse grained to medium grained with 5-8% mafics, siliceous.
D-44	92353	177-1	Sept. 6/79	M.M.R. Ltd.	3519	45°W 266′	
						0 - 22	Casing
						22 - 57.5	Fragmental; greenish grey with feldspar and quartz fragments. Some tuffaceous andesitic sections. Narrow diorite sections.
						57.5 - 108.4	Diorite, fine-to medium-grained, somewhat gneissic in sections. 5-10% quartz, some fragmental sections.
						108.4 - 165.5	Andesite, fine grained, massive, dark greenish grey, slight lineation near bottom of section.
						165.5 - 220	Fragmental; numerous quartz and feldspar fragments; disseminated chlorite-sericite alteration in sections.
						220 - 255	Andesitic to basaltic, chloritic, numerous intruded bands of felsic material.
						255 - 266	Andesite, massive, fine grained, dark greenish grey.
D-45		177-2	Sept. 8/79	M.M.R. Ltd.	9516	45°E 500′	
						0 - 20	Casing.
						20 - 165	Andesite, tuff; greenish grey, generally fine grained with fragmental sections. Chloritic with fragments mostly of mafic material.
						165 - 478.3	Fragmental; rock composed of fine grained angular fragments of various composition. Composition varies from felsic to mafic. Some tuffaceous sections.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
111 - 123 — Disseminated to trace pyrite and pyrrhotite.						
151 - 156 — Trace pyrite.						
156 - 162 — Minor disseminated pyrite. Slight trace chalcopyrite. Sulphides 3-5%. over 2 ft.						
211 - 233 — Disseminated pyrite, pyrrhotite, Trace chalcopyrite. Total sulphides — 1-3%.	211 - 216	Tr.		0.21	0.06	
165.5 - 176 — Trace pyrite, pyrrhotite.						
176 - 188 — 20% pyrrhotite, 2-3% pyrite in solid stringers and blebs.						
188 - 209.9 — Pyrite, pyrrhotite.	183 - 188	Tr.	Tr.	0.05	0.07	NIL
208.9 - 209.3 — Pyrrhotite, 5% pyrite.						
74.4 - 130.2 — 10% pyrrhotite, 2% pyrite in solid narrow bands and stringers, some felsic fragments.						
175.6 - 177.9 — Near solid pyrrhotite, 5-10% pyrite.	175.6 - 177.9	Tr.	Tr.	0.02	0.15	NIL
177.9 - 195.4 — 15% pyrrhotite; 2% pyrite.	177.9 - 195.4	BARREN	BARREN	NIL	NIL	NIL
195.4 - 200.4 — 20-25% pyrrhotite; 5% pyrite.	195.4 - 200.4	Tr.	Tr.	0.03	0.04	NIL
206.1 - 211.1 — pyrrhotite, 10% pyrite.	206.1 - 211.1	Tr.	Tr.	0.02	0.08	NIL
211.1 - 212.7 — 5% pyrrhotite; pyrite.	211.1 - 212.7			BARREN		
212.7 - 217.7 — Near solid pyrrhotite; 10% pyrite.	212.7 - 217.7	Tr.	Tr.	0.02	0.05	NIL
217.7 - 237.2 — 10% pyrrhotite; 2-3% pyrite.	217.7 - 237.2			BARREN		
237.2 - 243.3 — Near solid pyrrhotite; 10% pyrite.	237.2 - 243.3	Tr.	Tr.	0.03	0.04	NIL

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
						478.3 - 500	Diorite, fine grained, gneissic.
D-46		177-3	Sept. 17/79	M.M.R. Ltd.	9512	45° E 93' 0 - 93	 Casing broke off at shaft. Went ahead with core barrel to 93 feet. Still in overburden.
D-47		177-4	Sept. 2/79	M.M.R. Ltd.	9512	45° W 200'	
						0 - 72	Casing
						72 - 112.2	Andesite tuff; greenish grey, fragmental in sections with mafic and feldspar fragments.
						112.2 - 137.1	Andesite tuff; greenish grey, fragmental in sections, chloritic.
						150.6 - 157.8	Andesite tuff; greenish grey, fragmental, chloritic.
						165.7 - 169.2	Andesite tuff; greenish grey, chloritic, some fragmental sections with mafic and feldspar fragments.
						182 - 200	Andesite tuff; greenish grey, fragmental in sections, chloritic, generally barren, trace pyrite, pyrrhotite.
D-48	92353	177-5	Aug. 28/79	M.M.R. Ltd.	9502	45° E 248'	
						0 - 22	Casing
						22 - 248	Andesite tuff; greenish grey, fine grained, fragmental in sections, chloritic with traces of pyrite, pyrrhotite along bedding. Mineralization generally increases in concentration down section.
D-49		177-5A	Sept. 12/79	M.M.R. Ltd.	9502	45° W 159'	
						0 - 20	Casing
						20 - 159	Altered greywacke, fine grained, some short sections at top almost a chlorite schist. Intensely folded.
D-50		177-6	Aug. 29/79	M.M.R. Ltd.	9503	45° N 168'	
						0 - 63	Casing
						63 - 124.5	Andesite tuff; light grey to greenish grey, fragmental in sections. Chloritic towards bottom of section.
						124.5 - 168	Diorite gneiss, massive, fine grained grading to medium grained down section. Traces pyrite and pyrrhotite.
D-51		177-7	Aug. 31/79	M.M.R. Ltd.	9510	45° N 164'	
						0 - 31	Casing
						31 - 42.5	Quartz-biotite gneiss, fine grained, quartz, plagioclase, biotite, 5% muscovite and a few scattered small garnets, 1% pyrite.
						42.5 - 56.3	Massive, coarse grained porphyry approaching granodiorite.
						57.9 - 164	Rhyolite porphyry, massive with visible quartz, potassium feldspar and plagioclase phenocrysts.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
243.3 - 288.5 — 23% pyrite; 5% pyrrhotite.	243.3 - 275.5			BARREN		
	275.5 - 280.8	Tr.	NIL	0.02	0.01	NIL
288.5 - 314.6 — 10% pyrrhotite; 5% pyrite.	280.8 - 314.6			BARREN		
314.6 - 317.8 — Solid pyrrhotite; speck chalcopyrite.	314.6 - 317.8	NIL	Tr.	0.05	0.01	NIL
317.8 - 336.5 — 2-5% pyrite pyrrhotite.	317.8 - 386.4			BARREN		
336.5 - 356.2 — 2-3% pyrite-pyrrhotite.						
356.2 - 380.4 — Traces of pyrite and pyrrhotite in fine grained, weakly bedded, light green, metasediment (?).						
380.4 - 478.3 — Banded mafic and feldspar fragments — pyrite 5%, pyrrhotite.	386.4 - 390.3	NIL	Tr.	0.03	0.01	NIL
386 - 390 — 20-25% pyrite, 5% pyrrhotite; 440 - 465 — very soft chlorite zone.						

105 - 112.2 — 5% pyrite, 5% pyrrhotite.	112.2 - 114	Tr.	Tr.	0.04	0.02	
112.2 - 122.6 — Solid to near solid pyrrhotite, 5% pyrite,	114 - 116	NIL	Tr.	0.04	0.04	
Trace chalcopyrite; abundant quartz-feldspar fragments.	116 - 119.5	0.01	Tr.	0.06	0.03	
122.6 - 137.1 — 2-5% pyrite, pyrrhotite.	119.5 - 122.6	0.03	Tr.	0.10	0.04	
137.1 - 150.6 — Solid — near solid pyrrhotite, 5% pyrite,	137 - 140	0.01	Tr.	0.05	0.03	
Trace chalcopyrite; abundant fine grained quartz-	140 - 145	0.02	Tr.	0.06	0.03	
feldspar fragments.	145 - 151	0.02	Tr.	0.05	0.03	
150.6 - 157.8 — 5% pyrrhotite; 2% pyrite.	151 - 157.8			BARREN		
157.8 - 165.7 — Solid to near solid pyrrhotite, 5% pyrite,	157.8 - 162.8	0.02	Tr.	0.09	0.02	
Trace chalcopyrite, abundant quartz-feldspar fragments.	162.8 - 165.7	NIL	Tr.	0.03	0.04	
165.7 - 169.2 — 2-5% pyrite, pyrrhotite.	165.7 - 169.2			BARREN		
169.2 - 182.0 — Solid to near solid pyrrhotite; 5% pyrite,	169.2 - 174.2	Tr.	Tr.	0.09	0.03	
Trace chalcopyrite, abundant quartz-feldspar fragments.	174.2 - 177	NIL	Tr.	0.07	0.02	
	177 - 182	0.01	Tr.	0.09	0.01	
				BARREN		

63 - 88 — Trace pyrrhotite, pyrite.						
88 - 92.6 — 10% pyrrhotite, 2-3% pyrite, speck chalcopyrite.	88 - 92.6	Tr.	NIL	0.04	0.04	
92.6 - 120.6 — Trace pyrite — pyrrhotite.						
120.6 - 159 — Trace pyrite, pyrrhotite.						

100 - 102 — 5-10% pyrrhotite, stringers.	100.3 - 101.9	Tr.	Tr.	0.04	Tr.	
108 - 112.9 — 10% pyrrhotite, 2% pyrite in solid to near solid sections.	108 - 112.9	Tr.	Tr.	0.06	Tr.	
112.9 - 117.2 — 2-5% pyrite-pyrrhotite in narrow stringers.						

42.5 - 56.3 — 1-2% disseminated pyrite and pyrrhotite.
56.3 - 57.9 — 10-15% pyrite in blebs.
57.9 - 95.6 — Trace disseminated pyrite and pyrrhotite.

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-52	92353	177-8	Aug. 25/79	M.M.R. Ltd.	9526	45° E 151′	
						0 - 8	Casing
						8 - 119.3	Quartz diorite, massive medium-coarse grained, 20-30% quartz.
						119.3 - 151	Dacite; greenish grey, fine grained, massive, a few small blue quartz-eyes.
D-53		177-9	Sept. 21/79	M.M.R. Ltd.	9526	45° E 435′	
						0 - 80	Casing
						81 - 185	Quartz gabbro; medium- to coarse-grained, massive to weakly foliated. 10% quartz, some potassium feldspar.
						185 - 187.5	Dacite
						199.3 - 206	Dacite; light grey, generally massive, porphyritic in sections, traces of pyrite and pyrrhotite.
						209 - 435	Dacite, light grey, generally massive, slightly foliated in sections, becomes porphyritic, coarse grained in places. Traces pyrite, pyrrhotite, chalcopyrite throughout (disseminated).
D-54		177-15	Sept. 10/79	M.M.R. Ltd.	9515	45° N 183′	
						0 - 44	Casing
						44 - 183	Rhyolite, generally massive, fine grained, light grey to light greenish grey.
						44 - 68.1	Slightly porphyritic, somewhat weathered near top of section.
						137 - 140	Foliated in sections with slight chlorite-sericite alteration.
						155 - 162.6	Fragmental in sections, foliated in places, slightly folded at top of section grading to massive rhyolite, barren.

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
95.6 - 99.8 — Pyrite 5-10%, 5% pyrrhotite.	95.6 - 99.8	0.01	Tr.	0.02	0.02	
99.8 - 109 — Pyrite 5%, pyrrhotite 5-10%.	99.8 - 109			BARREN		
109 - 117.9 — 20-25% pyrrhotite, 5% pyrite.	109 - 114	0.02	0.10	0.02	0.01	
117.9 - 120.3 — Solid-near solid pyrrhotite, Trace	114 - 117.9	Tr.	Tr.	0.02	0.02	
chalcopyrite.	117.9 - 120.3	Tr.	Tr.	0.04	0.02	
120.3 - 133.7 — 5% pyrrhotite, 2% pyrite.	120.3 - 133.7			BARREN		
133.7 - 135.3 — Solid pyrrhotite, 10% pyrite.						
135.3 - 164 — Massive rhyolite, 1-2% disseminated						
pyrite, pyrrhotite, sporadic garnet.						
8 - 119.3 — 1-3% pyrite, pyrrhotite and magnetite,	8 - 68.6			BARREN		
disseminated.	68.6 - 73.6	—	—	0.34	—	0.05
46.5 - 68.6 — 5% magnetite, 1-2% pyrite, pyrrhotite in	73.6 - 78.6	—	—	0.24	—	0.05
blebs and disseminated.	78.6 - 83.6	—	—	0.22	—	0.04
68.6 - 119.3 — 5% magnetite, 5-10% pyrite, pyrrhotite,	83.6 - 88.6	—	—	0.20	—	0.04
1-2% chalcopyrite, mineralization mostly in solid blebs.	88.6 - 93.6	—	—	0.29	—	0.05
113.9 - 151 — 1-2% pyrite, pyrrhotite, disseminated.	93.6 - 98.6	—	—	0.17	—	0.04
	98.6 - 103.6	—	—	0.13	—	0.03
	103.6 - 108.6	—	—	0.23	—	0.06
	108.6 - 113.6	—	—	0.33	—	0.09
	113.6 - 119.3	—	—	0.26	—	0.09
	119.3 - 151			BARREN		
81 - 185 — 1-2% disseminated sulphides (pyrite, pyrrhotite, chalcopyrite) increasing towards end of section.						
5% magnetite disseminated and in blebs.						
81 - 99.2 — highly weathered, muddy.						
185 - 187.5 — highly chloritic, 15-20% pyrite, 2-5% pyrrhotite. Trace chalcopyrite.						
187.5 - 192.4 — 15% pyrite, 5% pyrrhotite. Trace chalcopyrite.						
192.4 - 195.5 — Near solid pyrrhotite; 5% pyrite, 6% chalcopyrite.						
195.5 - 199.3 — 10% pyrrhotite, 5% pyrite, Trace chalcopyrite.						
206 - 209 — Solid near-solid pyrite, pyrrhotite, 70%	175 - 180	—	—	0.03	—	Tr.
pyrite, 30% pyrrhotite. Trace chalcopyrite.	180 - 185	—	—	0.07	—	0.03
	185 - 187.5	0.01	Tr.	0.09	—	0.04
	187.5 - 192.4	0.01	Tr.	0.12	—	0.07
	192.4 - 195.5	Tr.	Tr.	0.50	—	0.18
	195.5 - 199.3	—	—	0.18	—	0.07
213 - 241 — 5% pyrrhotite, 5% pyrite, 2-3% chalcopyrite,	206 - 209	Tr.	Tr.	0.15	—	0.11
disseminated along narrow fractures and in blebs.	213.8 - 217.2	—	—	0.18	—	0.05
241 - 242 — 5% pyrite, 5% pyrrhotite, 10-15% chalcopyrite,	217.2 - 220.9	—	—	0.06	—	0.03
highly chloritic schist.	220.9 - 223.8	—	—	0.12	—	0.02
317.4 - 318.4 — 10% pyrite, 2% pyrrhotite, 8%	223.8 - 226	—	—	0.11	—	0.02
chalcopyrite.	226 - 229.7	—	—	0.12	—	0.02
375 - 435 — Fragmental, some narrow chloritic bands	229.7 - 232	—	—	1.60	—	0.04
mineralized with pyrite. Becomes massive, barren	232 - 237	—	—	0.35	—	0.01
near end of section.	237 - 241.4	—	—	0.09	—	0.02
	241.4 - 242.5	—	—	1.50	—	0.06
	242.5 - 245	—	—	0.27	—	0.03
	299.4 - 301.5	—	—	0.25	—	Tr.
	317.4 - 318.4	0.04	0.80	2.50	—	0.03
44 - 68.1 — 2-5% pyrite as replacement blebs.						
68.1 - 115.5 — 2-3% pyrite, pyrrhotite, as fracture fillings.						
115.5 - 117.9 — Near solid pyrrhotite, 5% pyrite.	115.5 - 117.9	NIL	NIL	0.02	Tr.	—
	152 - 155	Tr.	NIL	0.03	Tr.	—
117.9 - 127.1 — 2-3% pyrite - pyrrhotite.						
127.1 - 140 — 10% pyrrhotite, 2-3% pyrite.						
140 - 152 — 3-4% pyrite, pyrrhotite.						

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
D-55		177-17	Sept. 18/79	M.M.R. Ltd.	9526	45° W 256'	
						0 - 10	Casing
						10 - 35.9	Andesite; generally massive, fine grained, dark green, minor quartz.
						35.9 - 54.5	Dacite; massive, greenish grey, generally fine grained, porphyritic in sections.
						54.5 - 64.2	Andesite, fine grained, dark green, chloritic with slight foliation.
						64.2 - 75.3	Rhyolite; massive, light grey, porphyritic
						75.3 - 85.7	Andesite, massive, fine grained, dark green, slight foliation in sections.
						85.7 - 95.1	Quartz gabbro; fine- to medium-grained, 10% quartz.
						95.1 - 127.5	Andesite; generally massive, slightly foliated in sections. Dark green, fine grained. 110 - 114.3 dacite, porphyritic.
						127.5 - 132.8	Dacite, porphyritic with numerous large granitic inclusions.
						132.8 - 160.3	Andesite; green, foliated with numerous sections of chlorite schist. 10% blue quartz-eyes.
						160.3 - 256	Quartz gabbro, medium- to coarse-grained, 10% quartz.
						160.3 - 177.5	Well foliated chloritic.
						177.5 - 181.9	Rhyolite, light grey, massive, slightly porphyritic, barren.
						181.9 - 191.4	Slightly foliated, quartz gabbro.
						191.4 - 199	Fine grained, massive, andesite.
						199 - 256	Quartz gabbro.
D-56-61	92132	7701-77 (1 to 6)	Mar. 16 to Mar. 31, 1977	Shell Canada Ltd.	Permit #3		A total of 497 m was drilled March 16 - 31, 1977. Drilling indicated the argillite and associated siltstones and quartzites contain barren pyrrhotite and pyrite and carbonate in stringers and fracture fillings which cause EM and magnetic anomalies (Location D-56, 57, 58 and 60). Two D.D.H.'s (Locations D-56, 59) were drilled in granite, pegmatite and biotite-feldspar-quartz gneiss ± hornblende ± actinolite. One conductor in the quartz-feldspar-biotite gneiss is apparently related to sulphide stringers (Location D-56). A few specks of chalcopyrite were noted.
D-56	92132	7701-77-1				-50° 129°	Biotite-feldspar-quartz-sulphide zone.
						75.3 m	Biotite-quartz-feldspar-sulphide gneiss.
							Biotite-quartz-feldspar gneiss.
D-58	92132	7701-77-3				-50° 157° 90.5 m	Quartz, carbonate and black chlorite(?) in numerous tiny fractures; occasional specks of pyrite becoming dark grey downwards, numerous irregular fractures with sulphides. Quartzite as in interval 20.1 - 21.3 m, intensity of fracturing is variable; quartz-carbonate veinlets or sulphides, sulphides give local good conductivity; some interbedded argillites.
D-62-69	92212	D.D.H. 1-8	Feb. 26 to Mar. 26, 1977	McIntyre Mines Ltd.	Permit #12		A total of 2,905 feet (901 m) was drilled. Uranium mineralization is very sparsely disseminated in the host rocks, but becomes concentrated in biotite pegmatite segregations which in all cases where recognized are small (up to 20 cm) and erratically distributed. These

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %
152 - 155 — 35% pyrite, pyrrhotite.						
155 - 162 — 5-10% pyrrhotite, 2-3% pyrite.						
54.5 - 64.2 — Traces disseminated pyrite.						
64.2 - 75.3 — Trace pyrite and pyrrhotite along fractures.						
75.3 - 85.7 — Trace pyrite and pyrrhotite along fractures.						
86.8 - 91.0 — 20-25% pyrrhotite, 10% pyrite, 5% magnetite, 4-5% chalcopyrite.	86.8 - 91	NIL	Tr.	0.29	—	0.18
	91 - 95	—	—	0.14	—	0.04
91 - 95.1 — 4-5% magnetite. Trace pyrrhotite, chalcopyrite.	110.8 - 114.3	—	—	0.10	—	0.02
95.1 - 127.5 — Trace pyrite pyrrhotite, magnetite.						
110 - 114.3 — Trace pyrrhotite, magnetite, chalcopyrite.						
127.5 - 132.8 — Traces pyrite and pyrrhotite.						
137.9 - 140.5 — 5-10% pyrrhotite, 2% pyrite, 5% chalcopyrite.	137.9 - 140.5	—	—	0.08	—	0.04
	142.2 - 143.2	0.01	Tr.	0.17	—	0.22
142.2 - 143.2 — Near solid pyrite, pyrrhotite, .3% chalcopyrite.	144.6 - 146.6	—	—	0.19	—	0.13
	146.6 - 148.4	—	—	0.20	—	0.08
144.6 - 146.6 — 20% pyrrhotite, 10% pyrite, 2% chalcopyrite.	148.4 - 151.6	—	—	0.14	—	0.04
	151.6 - 156.6	—	—	0.16	—	0.07
146.6 - 156.6 — 5-10% pyrrhotite, 2-3% pyrite, .5% chalcopyrite.	160.3 - 163.4	—	—	0.18	—	0.03
	163 - 168.4	—	—	0.27	—	0.04
	168.4 - 172.5	—	—	0.28	—	0.08
160.3 - 177.5 — 5-10 pyrrhotite, 2-3% pyrite, 1% chalcopyrite, 5% magnetite.	172.5 - 177.5	—	—	0.14	—	0.04
181.9 - 191.4 — 5% pyrrhotite, 2-3% pyrite, 5% magnetite, .5% chalcopyrite (near top of section).	181.9 - 185.4	—	—	0.07	—	0.03
	201.6 - 206.6	—	—	0.04	—	Tr.
199 - 256 — 3-4% pyrrhotite, 1-2% pyrite, 2-5% magnetite, Trace chalcopyrite.	221.2 - 226.2	—	—	0.10	—	0.01
	228 - 233	—	—	0.04	—	0.01
10% sulphides, 5-6% pyrite, 2-3% pyrrhotite, 1% chalcopyrite	16.4 - 16.7 m	0.001	0.04	0.05	0.01	0.01
10-15% sulphide, stringers and conformable bands of pyrrhotite, minor pyrite.	49.3 - 49.7 m	0.001	0.04	0.01	0.01	0.01
5-10% pyrrhotite disseminated and locally as stringers, also pyrite smeared on fracture planes.	50 - 50.9 m	0.001	0.03	0.01	0.01	—
5% pyrrhotite, 1% pyrite, Trace chalcopyrite.	20.1 - 21.3 m	0.001	0.02	0.01	0.01	—
5% pyrrhotite, 4% pyrite, Trace chalcopyrite.	66.5 - 67.5 m	0.001	0.03	0.01	0.01	—

Diamond-drill hole results are outlined on Map GR80-9-12

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
							radioactive minerals were recognized: 1) monazite, 2) gummite, 3) proto-uraninite (soft, shiny black sub-vitreous). Diamond-drill hole results are detailed on Map GR80-9-12.
D-70	92142	1976- 1, 2, 3	1976, 1977	Province of Manitoba Mineral Resources Exploration and Operations Branch	Claim		A total of 1558 m was drilled in 20 D.D.H.'s. Three holes were drilled in 1976 and 17 in 1977. The diamond drilling demonstrated that mineralization in bedrock is similar to that found in the boulders in the areas of the radioactive anomaly or C.B. 7540 as two principal rock types were encountered in drilling, a pelitic biotite gneiss and leucogranite, and the mineralization was confined to the leucogranite. Uraninite is the prominent uranium mineral.
		1976-1	76/08/16		7540	-50° 305° 201 ft.	Predominantly white granite; pegmatite Predominantly white granite Predominantly white granite Predominantly white granite Predominantly white granite Predominantly white granite
		1976-2	76/08/29		7540	-50° 322° 236 ft.	White granite and pelitic biotite gneiss
		1976-3	76/09		7540	-47° 80° 110 ft.	White granite White granite
		1977-1	77/06/06		7540	-48° 105° 250 ft.	Pelitic biotite gneiss, talc-silicate, white granite
		1977-2	77/06/13		7540	-50° 105° 250 ft.	White granite
		1977-3	77/06/16		7540	-50° 305° 250 ft.	White granite White granite White granite White granite White granite White granite White granite
		1977-4	77/06/18		7540	-45° 305° 250 ft.	White granite White granite White granite White granite White granite White granite Predominantly white granite Predominantly white granite
		1977-5	77/06/20		7540	-50° 305° 251 ft.	White granite White granite White granite White granite
		1977-6	77/06/22		7540	-45° 305° 501 ft.	White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite
		1977-7	77/06/24		7540	-46° 305° 250 ft.	White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite
		1977-8	77/06/25		7540	-45° 305° 80 ft.	White granite White granite

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %	U (lbs/ton)
	85 - 90						0.20
	95 - 100						0.31
	105 - 110						0.38
	140 - 143.3						2.01
	136 - 161						0.51
	170 - 175						0.32
							All Assays < 0.20
	53.5 - 63.5						0.23
	78.5 - 93.5						0.75
							All Assays < 0.20
	112 - 116						0.28
	27 - 32						0.28
	67 - 71						0.31
	76 - 81						0.38
	119 - 124						0.68
	95 - 144						0.27
	159 - 164						0.21
	231 - 236						0.33
	26 - 42						0.27
	52 - 62						0.25
	71 - 76						0.25
	101 - 125						0.26
	134 - 138						0.22
	147 - 172						0.29
	212 - 217						0.22
	236 - 241						0.23
	73 - 88						0.27
	131 - 140						0.45
	193 - 198						0.23
	218 - 223						0.25
	149 - 156						0.36
	186 - 191						0.21
	266 - 271						0.68
	266 - 281						0.47
	315 - 320						0.40
	324 - 329						0.27
	333 - 339						0.35
	368 - 373						0.35
	455 - 460						0.27
	463 - 468						0.21
	488 - 493						0.29
	496 - 501						0.47
	23 - 28						0.27
	43 - 63						0.31
	116 - 120						0.29
	183 - 188						0.25
	204 - 205						0.25
	31 - 41						0.35
	47 - 57						0.28

TABLE 11. DIAMOND-DRILL HOLE CORE DESCRIPTIONS AND ASSAYS (Cont'd)

Ref. No.	Accession No.	Hole No.	Date Completed	Company	Claim No.	Angle Azimuth Footage	Rock Type
		1977-8A	77/06/28		7540	-65° 305° 251 ft.	White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite
		1977-9	77/06/30		7540	-47° 305° 251 ft.	Predominantly white granite with pelitic gneiss.
		1977-10	77/07/03		7540	-45° 305° 250 ft.	White granite and pelitic biotite gneiss.
		1977-11	77/07/04		7540	-50° 305° 250 ft.	White granite with layers of pelitic gneiss ± calc-silicate.
		1977-12	77/07/06		7540	-48° 305° 250 ft.	White granite, pegmatite
		1977-13	77/07/09		7540	-50° 305° 288 ft.	White granite, pegmatite White granite, pegmatite
		1977-14	77/07/11		7540	-50° 305° 251 ft.	White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite
		1977-15	77/07/13		7540	-45° 305° 252 ft.	White granite, pegmatite White granite, pegmatite White granite, pegmatite White granite, pegmatite
D-7D	92142	1977-16	77/07/14		7540	-50° 305° 168 ft.	White granite, pegmatite
		1977-17	77/07/18		7540	-48° 305° 248 ft.	White granite, pelitic gneiss

the veinlets. Biotite grains within the veinlets are almost opaque due to metamictization indicating inclusions of uranium-bearing minerals present in the biotite. Within the veins the plagioclase is heavily altered to epidote, calcite and sericite. Chloritization of biotite and the formation of epidote and sericite in microcline and plagioclase are common in the host quartz monzonite adjacent to the plagioclase veins. Epidote and fluorite also occur as lenses within altered biotite grains. This occurrence lies within the limits of the expired permit #10 (Reference No. 26, Location L-61, Map GR80-9-10, Table 9). The conclusions by Union Oil suggest a uranium-molybdenum association.

The uranium mineral occurrence east of Caribou Lake (Location R-5, Table 10; Map GR80-9-11) is within coarse grained to megacrystic biotite quartz monzonite to granite. The uranium mineral or mineraloid is a black vitreous, pitch-like substance which is amorphous and exhibits no X-ray pattern. Anomalous radioactivity occurs in two steeply dipping fracture sets trending 023° and 192° The fractures are spaced 3 to 4 m apart and are 3 to 4 m in length. The pitch-like substance occurs as large clots or small grains in these fractures or sporadically in the areas between the fractures. In one instance it occurs within the core of a potassium feldspar phenocryst which displays a radial fracture pattern centered on the vitreous material and associated cloudy quartz. The background radioactivity for the porphyritic quartz monzonite at this locality ranges from 9000 to 11 000 cpm (total count), whereas the radioactivity in the area of the fracture zone is 50 000 to 75 000 cpm (total count). The radial fracture pattern centered on an inclusion within a feldspar phenocryst indicates the formation of a primary magmatic uranium mineral which was subsequently replaced by a secondary process. Extensive metamictization of the radioactive mineral and the radiogenic-related radial fracture pattern contributed to the dispersion of the radioactive elements by a low temperature leaching process. Low temperatures are suggested by the absence of major alteration along the radioactive fractures.

4. Monazite and a mineraloid complex of niobium, cerium and uranium have been identified as uranium minerals in alaskite (unit 4) that occurs in the McGill Lake region in the centre of the north quarter of the Whiskey Jack Lake map area (Map GR80-9-1). Prominent airborne uranium, thorium and potassium anomalies coincide with the alaskite occurrence (Map GR80-9-11). The alaskite was originally defined as an elliptical body (6 x 16 km) in the Kasmere project report (Weber et al., 1975a). The airborne spectrometer anomaly over the west half of the alaskite was chosen as one of the areas to be examined as part of follow-up geochemical study by the Geological Survey of Canada (Coker, 1977; Coker and DiLabio, 1979; Dredge, 1981). The map limits of the bedrock, centre-lake

Mineralization	Sample Footage	Au (oz./ton)	Ag (oz./ton)	Cu %	Zn %	Ni %	U (lbs/ton)
	20 - 25						0.26
	29 - 34						0.36
	54 - 58						0.20
	68 - 89						0.23
	94 - 109						0.38
	124 - 144						0.33
	192 - 136						0.43
	215 - 220						0.22
	240 - 251						0.28
						All Assays	< 0.20
						All Assays	< 0.20
							0.25
	66 - 77						0.35
	57 - 62						0.23
	222 - 242						0.33
	121 - 130						0.24
	140 - 145						0.22
	158 - 163						0.40
	181 - 193						0.43
	203 - 208						0.32
	232 - 237						0.32
	242 - 248						0.55
	61 - 66						0.25
	84 - 94						0.27
	197 - 202						0.21
	230 - 236						0.52
	23 - 28						0.32
						All Assays	< 0.2

sediment and lake water sampling program are outlined on Map GR80-9-11. Preliminary results of the follow-up geochemical survey of bedrock samples (Coker, pers. comm.) indicate uranium enrichment in the rocks west of McGill Lake compared to the rocks east of the lake (Map GR80-9-13). Lake sediment samples also reflect this uranium distribution; lake water sampling indicates a coincidence of uranium and fluorine and sporadic copper to the west of McGill Lake. Comparison of whole-rock chemical analyses indicates a relatively uniform composition for the major elements west of McGill Lake whereas east of the lake calcium, aluminum, silica and titanium display much wider variations. Trace element variations are unsystematic with the exception of barium which has consistently higher values in the rocks east of McGill Lake. A mineraloid complex of niobium, cerium and uranium, has also been observed but identification is hampered by a metamict habit. Thin section examination was conducted by A. Littlejohn of the Geological Survey of Canada (pers. comm.).

The geological setting of the alaskite (+ fayalite) in the McGill Lake region appears to be that of a circular stock on the south margin of a domal area of variably altered hypersthene + hornblende-biotite-quartz monzonite (with trace fluorite) (Unit 2c). Aplite (Unit 31b) occurs intimately associated with both the alaskite and hypersthene-quartz monzonite. The hypersthene-quartz monzonite is considered to be Archean and the alaskite of probable Archean age.

5. Granite pegmatites are most abundant in a triangular-shaped area between Munroe, Tadoule, and Shethanei Lakes. The pegmatites postdate the major tectonism but have been affected by the late-kinematic faults. Granite pegmatites with uranium mineralization were observed at the southeast corner of Munroe Lake (Munroe Lake area, NTS 64-O), and along the length of Shethanei Lake (Shethanei Lake area, NTS 64-I).

Pink pegmatites near Munroe Lake were examined by Ducanex Syndicate (Map GR80-9-10, Locations L-9 and 20). A yellow uranium bloom was reported by the company at both locations within pegmatites. At location L-19 north-trending pegmatites intrude meta-arkose (20) and quartzite (18). Grab samples of a magnetite-bearing pegmatite assayed 0.11 per cent U_3O_8. In the northern site (Location L-20), a radiometric pegmatite strikes 045° to 060° along a fault system. The rock intrudes foliated tonalite (Unit B) and biotite-plagioclase-quartz gneiss (Unit C). A sample from a trench blasted across the strongest part of the radiometric zone exhibited a yellow uranium stain with hematite alteration. The sample assayed 0.075 per cent U_3O_8 whereas a 9 m sample length gave an average assay value of 0.037 per cent U_3O_8. The secondary yellow uranium bloom on fracture surfaces was the only uranium-bearing mineralization defined. However, this

TABLE 12. TYPES OF URANIUM MINERALIZATION

Rock Type	Field Relationships	Type of Mineralization	Uranium Minerals or Geochemical Anomalies	Location	Possible Origin
White coarse grained to pegmatitic trondhjemite to quartz monzonite + cordierite + garnet + tourmaline (unit 30)	Lits, irregular bodies concordant and discordant within semi-pelitic and pelitic gneiss. Rarely forms broad areas, e.g. region north of Topp Lake Pluton, Kasmere map area (GR80-9-8) containing rafts of derived pelitic and semi-pelitic gneiss	Uraninite (disseminated) Gummite (fracture coatings) Uraninite most often associated with biotite	Mo, Cu	Widely dispersed occurrences in the Kasmere Lake map area, Munroe Lake map area and north half of Tadoule Lake map area	Metamorphic-anatectic derivative of the pelitic to semi-pelitic suite. The uranium formation relates to original concentrations within the sediment
Calc-silicate (unit 17) + marble (unit 17a) + albite Pyroxene rock (unit 17b)	Zone of high grade metamorphic rocks deformed by major shears and faults. Magnetic and gravity readings suggest a thick section of semi-pelitic and pelitic gneiss. This thickness may relate to a deep sedimentary basin, a tectonically thickened zone or a combination of both	Uraninite, Pitchblende	Ni, Co, Cu, Mo Pyrite and trace chalcopyrite	Snyder Lake to Sucker Lake Kasmere Lake map area GR80-9-8	Post-metamorphic, epigenitic source of uranium-anatectic derivative (unit 17) late-Hudsonian plutons Unit 32, 32a and c or pegmatite 32b
Calc-silicate interlayered with biotite psammite + marble as discontinuous lenses	Overlies thin remnants of garnet-biotite-plagioclase-quartz gneiss (unit 6) and quartzite + sillimanite (unit 6b). Grey Archean gneiss (unit A) forms a basement to these rocks	Uranium mineralization-detected as widely scattered but numerous areas of weak radio-activity — unidentified	Zones of trace Cu, Zn-bearing marble	Askey Lake area north of Munroe Lake, Munroe Lake map area GR80-9-7	Sedimentary-mobilized during upper amphibolite facies of metamorphism
Churchill "Quartzite"	Inlier of Precambrian within Paleozoic limestone	Detrital heavy minerals on bedding planes. Quartz veins and fractures present in fracture zones. Quartzite has green coloration, normally it is grey in color	Hematite along bedding planes and disseminated pyrite in fracture zones	Churchill Townsite and east of Churchill	Sedimentary with localized fractures. Localized reducing environments indicated by pyrite formation, quartz veins in fractures contain radioactive mineral
Alaskite ± fayalite (unit 4)	Core of domal structure overlain by semi-pelitic gneiss (6b)	Monazite and complex of Niobium and Cerium	Copper (lake sediment)	McGill Lake, north-central part of Whiskey Jack Lake map area GR80-9-1	Igneous. Reactivated Archean basement partially mobilized in core of gneiss dome. Primary uranium mineralization would be of Archean (Kenoran Age)
Pink porphyritic quartz monzonite (unit 32)	Stocks, sills, rarely large plutons, e.g. Topp Lake Pluton, Kasmere and Munroe Lake map areas. Occur within all rock types except Sequence II rocks. Deformed by cataclasis	Uraninite, allanite, magnetite, secondary minerals in fractures (not identified)	Mo lake sediment rarely as grains in quartz-rich veins	Whiskey Jack Lake map area, south of Lac Brochet and along Cochrane River, Kasmere map area, Munroe, Nejanilini and Caribou Lakes map areas	Igneous. Secondary mobilization of uranium from primary minerals along fractures
Pink porphyritic quartz monzonite + fluorite (Unit 32a)	Stocks. Post-Hurwitz Group. Occur in area of broad negative gravity feature	Unidentified, occurs within biotite grains	Mo ± Cu Fluorite disseminated	Kasmere Lake and Munroe Lake map areas	Igneous, late-kinematic
White quartz monzonite to granite	Stocks. Post-Hurwitz Group	Monazite Gummite Proto-uraninite	Mo in pegmatitic phase Mo + pyrite	Kasmere Lake map area. Putahow Lake and River region	Igneous, late kinematic and vein-type, locally mobilized in quartz-filled fractures and pegmatitic segregations
Pink to cream granite to pegmatite	Sills, dykes, in part along fault zones	Uranophane Kasolite	Magnetite	Triangular-shaped zone bounded by Munroe Lake-Tadoule Lake-Shethanei Lake	Igneous and vein-type
Pink to cream pegmatite	Sills along contact zone of quartz monzonite and sedimentary rock	Monazite Secondary minerals unidentified	Pyrite	As above, along the north shore of Seal River	Igneous to Metamorphic
Pink pegmatite to aplite	Intrude granite gneiss	Not identified, very localized at centres of radioactivity		Between Shethanei Lake and Great Island	Metamorphic related to remobilization of Archean basement

TABLE 13. ASSAYS OF SULPHIDE OCCURRENCES

Ref. No.	Sample No.	Mineralization	Rock Type, Geological Setting	Cu	Zn	Pb	Mo	Ni
S-1	24-5-769	Pyrrhotite, chalcopyrite	Andesite to dacite, Lower Seal River metavolcanic suite	0.02%	0.11%			
S-2	24-5-773	Pyrrhotite, chalcopyrite	Andesite, Lower Seal River metavolcanic suite	0.04%	Tr			
S-3	24-5-854-5	Pyrrhotite, chalcopyrite	Rusty zone in pillowed andesite	0.02%	Tr			
S-4	24-5-414	Pyrite	Dacite with quartz veins, metavolcanics north of Great Island	NIL	Tr	Tr		
S-5	24-5-416	Pyrite	Volcanic-derived conglomerate, disseminated pyrite, metavolcanic suite north of Great Island	Tr	NIL			
S-6	24-5-419-2	Pyrite	Dacite, metavolcanic suite north of Great Island	0.02%	Tr		Tr	
S-7	24-5-421-2	Pyrite	Quartz-feldspar porphyry	Tr			Tr	
S-8	24-4-197		Dacite, interlayered tuff and andesite	NIL				Tr
S-9	24-4-213-3		Dacite and interlayered pillowed andesite	Tr	Tr	Tr		
S-10	24-5-802-2		Near tourmaline, carbonate alteration zone	Tr	Tr			

TABLE 13. ASSAYS OF SULPHIDE OCCURRENCES (Cont'd)

Ref. No.	Sample No.	Mineralization	Rock Type, Geological Setting	Cu	Zn	Pb	Mo	Ni
S-11	24-5-459-3	Pyrite	Chlorite, garnet, schist in shear zone on margin of quartz-feldspar porphyry, and tuff zone	Tr	Tr		NIL	
S-12	24-5-460-1, 2, 3	Pyrite	AS ABOVE.	Tr	Tr		NIL	
S-13	24-5-655-3	Pyrrhotite, chalcopyrite	Andesite, metavolcanic suite, north of Great Island	0.10%	Tr			Tr
S-14	24-5-660	Pyrrhotite, chalcopyrite	Massive basalt — south of Great Island, contact zone between Great Island, metavolcanic rocks; quartz monzonites	0.03%	Tr			Tr
S-15	24-4-2111		Basalt breccia, from very east margin of Great Island metavolcanic rocks	0.03%	Tr			
S-16	24-5-812	Pyrite, arsenopyrite	Chloritized and sheared rhyolite, massive quartz, stock works, small deeply leached lenses, east flank of Great Island metavolcanic rocks	0.02%				
S-17	24-4-185-2	Pyrite	Layered felsic volcanic rocks (crystal tuff), pale green	NIL	NIL			
S-18	24-4-214	Pyrrhotite, chalcopyrite	Northerly gabbro, intrudes metavolcanic rocks, north margin of Great Island metavolcanics	0.06%				
S-19	24-5-652	Pyrrhotite, chalcopyrite	Gabbro, intrudes metavolcanic rocks north of south margin of Great Island metavolcanic rocks	0.04%	Tr			Tr
S-20	24-4-103a	Pyrrhotite	Alteration zone in contact zone between gabbro and younger quartz monzonite	Tr	Tr			0.09%
S-21	24-4-89	Pyrite	Rusty argillite lenses within feldspar porphyry	Tr	0.02%			NIL
S-22	24-4-179	Pyrite	Conglomerate; greywacke matrix, feldspar porphyry clasts and metasedimentary clasts	Tr				Tr
S-23	24-4-256	Pyrite, pyrrhotite	Amphibolite	Tr	Tr			
S-24	24-4-259	Pyrite, pyrrhotite	Amphibolite, highly rusted	0.04%				Tr
S-25	24-4-215		Tourmaline, carbonate alteration zone on margin of large arsenic anomaly					
S-26	Milligan, 1950	Iron formation	Ferruginous red, green-blue sphalerite and garnet-magnetite-actinolite?-amphibole. Blue clay — derived by weathering of iron formation?		4-11%			
S-27	24-4-2116	Iron formation 19.7% soluble iron	Friable red phyllite					
S-28	24-4-127	Pyrite, pyrrhotite	Black meta-argillite to meta-ironstone ± pyrite along bedding planes	0.02%				0.04%
S-28	24-4-128	Pyrite, pyrrhotite	Black meta-argillite and meta-ironstone ± garnet ± acicular amphibole	Tr	0.02%	Tr		
S-29	24-4-135A	Pyrrhotite, pyrite	Black meta-ironstone ± garnet ± amphibole	0.01%	0.01%	0.04%		0.01%
	24-4-135B	Pyrrhotite, pyrite	Black meta-argillite	Tr	0.02%	Tr		
S-30	Drill Site Shilts, 1979 89-2-3 (K.P. 246802)		Deformed interlayered phyllite-quartz (suite?) and black meta-argillite to ironstone	219-290 ppm	134-217 ppm	198-510 ppm		
S-31	24-4-2283	Pyrite	Pyrite, phyllite ± garnet	Tr	Tr	Tr		Tr
S-32	24-4-2266	Pyrite	Phyllite ± garnet	Tr	Tr			
S-33	24-5-657	Pyrite, trace galena	Quartzite thick bedded and interlayered, more thickly bedded phyllite, quartzite	Tr	Tr	0.03%		
S-34	24-6-528	Pyrite	Calc-silicate and marble, rusty zone	75 ppm	115 ppm	6 ppm	4 ppm	
S-35	24-6-730	Pyrite	Quartzite, feldspathic with calc-silicate lenses	64 ppm	13 ppm	Tr	Tr	
S-36	24-6-728-1	Pyrite	Well layered calc-silicate, high percentage of andradite garnet — possible skarn	281 ppm	10 ppm	1 ppm	4 ppm	
S-37	24-6-398	Pyrite	Semi-pelitic gneiss, on the flank of a pelitic granite dome	Tr	79 ppm			
S-38	24-6-697-3	Pyrrhotite	Gabbro, large sill or dyke, schistose, cut by quartz veins	237 ppm				66 ppm
S-39	24-6-700-2	Pyrrhotite	Gabbro, small sill 10 feet thick in foliated quartz monzonitic gneiss	237 ppm				45 ppm

observation may only reflect the limitations imposed by the small number of samples examined.

Similar magnetiferous pegmatites were examined by Manitoba Mineral Resources Division at the southeast corner of Munroe Lake. The pegmatites occur as discrete bodies localized along probable fault zones within quartzite (18) and meta-arkose (20). Uranophane was found to be the predominant uranium mineral with minor kasolite (X-ray diffraction analysis) (Soonawala et al., 1979). The location of this sampling coincides with Location L-19 on Map GR80-9-10.

Pale pink to cream pegmatites occur along the length of Shethanei Lake. These pegmatites form the main and commonly the only rock type on islands in the central part of the lake. The pegmatites in this region have been the target of early exploration for uranium as evidenced by the number of abandoned drill holes observed on islands in the east and central part of the lake. However, no records are available to indicate the results of this work. Occurrences of radioactive granitic gneiss were reported by Taylor (Shethanei Lake, 1958) on the north-central shoreline of Shethanei Lake. The URP radiometric survey indicates a favourable uranium/thorium ratio but a low level of uranium (Map GR80-9-11) for this locality. These locations were re-examined during this project (Location R-5, Table 10, Map GR80-9-11). Mapping indicated a pink to cream pegmatite lying along the contact zone of muscovite-biotite-quartz schist + garnet (6a), and porphyritic quartz monzonite. The pegmatite contains schlieren of quartz and coarse grained biotite as remnants of muscovite-biotite-quartz schist. A zone of radioactive pegmatite extends over a length of 300 m and a width of 200 m. This zone is quite visible from the air because of a pronounced orange limonitic stain. The pegmatite registered a total count of 55 000 to 60 000 cpm with 1 500 cpm on the uranium-thorium channel. The uranium to thorium ratio is 2:5. Corroded and highly fractured monazite grains occur as inclusions in biotite. The biotite commonly displays a metamict aureole around the monazite grains. Mobilization of uranium from its primary minerals is indicated by radiogenic damage along fractures in biotite. Biotite and muscovite are a disequilibrium assemblage:

$$\text{biotite} \rightleftharpoons \text{sericite} + \text{muscovite} + \text{chlorite}$$

This alteration and the mobilization of uranium appear to be coincident. Limonitic alteration is pervasive but the mineral phase replaced by limonite is uncertain. Trace pyrite was observed as inclusions in plagioclase.

Isolated occurrences of radioactive pegmatites occur outside this triangular zone. Twenty-five kilometres east of Shethanei Lake (Location R-7, Table 10; Map GR80-9-11) pink granite pegmatites, which intrude aplite (31b) and biotite granite gneiss (31d), registered a total count of 40 000 cpm and uranium-thorium channel readings of 700 cpm (Table 10). The nature of the uranium mineralization was not defined.

6. Prospecting for uranium in the Churchill quartzite in the area of Churchill was carried out on a minor scale by local prospectors for many years. In 1976 Imperial Oil conducted a co-ordinated airborne scintillometer and ground follow-up survey of the outcrop belt around the town of Churchill. Uranium values proved to be low over the whole belt (Reference No. 21a and 21b, Table 9, Map GR80-9-10). Background and anomalous values for uranium were established resulting in the definition of 56 anomalies. Thirty of the better sites were examined during ground follow-up studies. These ground checks indicated:

1. high background value due to surficial deposits and granite gneiss boulders;
2. heavy mineral concentrations in the quartzite to protoquartzite;
3. radioactive quartz veins.

At locality 3-4-07 (Map GR-9-10, Location L-51) the radioactivity is found in heavy mineral concentrations 0.5 to 3 mm thick along crossbedding planes. Such deposits appear to indicate detrital uranium-bearing minerals. Near this locality radioactive purplish quartz veinlets (up to 3 mm thick) register radioactivity at 6 to 7 times background. This type of mineralization indicates local mobilization of uranium from its primary minerals in the quartzite and its concentration in quartz veins.

Radioactive fractures were investigated by the Geological Survey of Canada (Ruzicka, 1978) in an area approximately 13 km east of the town of Churchill. "The fracture zones rarely exceed one metre in width and discontinuous radioactivity is traceable for a distance of up to 100 m. The in situ TV-1A reading in the most radioactive area was T_1 = 3200 cpm, T_2 = 1400 cpm, T_3 = 700 cpm.

The Churchill quartzite has been loosely compared to the uranium-bearing conglomeratic Matinenda Formation of the Elliot Lake-Blind River area, Ontario (Table 14); however, a close comparison indicates:

1. different types of source areas or hinterlands for the two sediments;
2. the greater maturity and considerable reworking of the Churchill quartzite;
3. the contrasting oxidation states in the area of deposition, with the much lower potential for fixing uranium in the highly oxidizing environment associated with the deposition of the Churchill quartzite.

TABLE 14: COMPARISON OF THE CHURCHILL QUARTZITE AND THE MATINENDA FORMATION

CHURCHILL QUARTZITE	MATINENDA FORMATION
Dominantly oligomictic	Polymictic
Vein quartz and quartzitic pebbles	Quartz, granite and jasper pebbles
Feldspar almost totally absent	Feldspar common
Specular hematite along bedding planes and as dissemination	Coarse grained pyrite
Scour and fill conglomerate beds	

The Churchill quartzite more closely resembles the mature hematitic quartzite of the Lorrain Formation (Cobalt Group) which overlies the uraniferous Matinenda Formation in the Elliot Lake - Blind River area, Ontario. The Matinenda lies at the base of the older Elliott Lake Group which directly overlies Archean rocks (Robertson, 1969).

Summary

The observed occurrences of uranium can be interpreted to relate to four phases of uranium concentration:

1. in Archean alkaline intrusions (unit 4);
2. in the sedimentary precursors of the Sequence I pelitic gneiss (unit 6) and the suite of calc-silicate rocks (units 16, 17, 17a and 17b); in the Sequence II Churchill quartzite as heavy minerals;
3. in the anatectic quartz monzonite to trondhjemite (unit 30) during high grade metamorphism of Sequence I rocks; in quartz veins during deformation and low grade metamorphism of the Churchill quartzite;
4. in late Hudsonian igneous quartz monzonites to granite (+ fluorite) units 32, 32b, 32c and granite pegmatites (unit 32a).

BASE AND PRECIOUS METALS

Mineralization, or host rocks with a potential for base and precious metal mineralization, have been observed:

i) in the metavolcanic and metabasic rocks along the lower Seal River and in the area of Great Island;
ii) in the metasedimentary rocks of Sequence II at Great Island, 42 km east of Great Island along Seal River and also on North Knife River;
iii) in the metabasic intrusive rocks (Unit 15) within Sequence I rocks
iv) in the paragneisses and migmatites of Sequence I, primarily in the Munroe Lake map area (NTS 64-0).

Mineralization in this context includes either observation of minerals such as chalcopyrite, sphalerite or massive magnetite in hand specimen or diamond-drill core; detection of base and/or precious metals from assays. Environments for potential mineralization are based on observed barren sulphides and/or geochemical and geophysical studies.

LOWER SEAL RIVER AND GREAT ISLAND METAVOLCANIC ROCKS

Lower Seal River

The metavolcanic belt lies 64 km northwest of the town of Churchill on the lower stretches of Seal River 12 km west of Seal River delta on Hudson Bay. The belt comprises a suite of metavolcanic rocks and interlayered volcanic-derived metasedimentary rocks (Units 7a, 7b and 7d). These rocks have been intruded by porphyritic quartz diorite to granodiorite (10), gabbro (11), and feldspar porphyry (13). The volcanic sections are approximately 5 km thick and appear to be vertical to steeply dipping and strike to the northeast. The extent of thickening due to folding and/or faulting is uncertain. The areal extent of the metavolcanic rocks is 100 km^2 (5 x 20 km). Exposure is 1 to 2 per cent and the quality of the exposed bedrock surfaces is poor due to lichen cover. During the course of mapping, sulphides were detected at three sites (Table 13, Map GR80-9-13, Locations S-1, 2, 3). Samples from these sites upon assay indicated minor values of copper and zinc (Table 13). The samples are from within interlayered intermediate to andesitic tuffs and andesitic flows. Alteration zones related to the sulphide mineralization were not detected. One site (S-3) near the southwest end of the belt occurs in a zone of pronounced rusting as part of amphibolitic interpillow material within a sequence of pillowed andesites.

The belt has been the focus of a 6-year exploration program by Manitoba Mineral Resources Ltd., initiated in 1972-73. The investigation included airborne EM surveys and follow-up mapping, ground EM and diamond drilling (Tables 9 and 11). Mapping resulted in the discovery of two sulphide showings which were then examined by trenching (Table 9, Map GR80-9-10, Map Reference No. 12, Locations L-23A, L-28A). Trenching in the andesite, L-28A, was done along a northerly strike length of 630 m. Assays yielded 0.27 per cent and 0.20 per cent Cu over parts of the southern portion of the trench. In the second trench in the northwest part of the belt, L-23A, a sulphide zone that has a strike length of 200 m with a maximum width of 3 m was outlined in dacite. The sulphides are pyrite, pyrrhotite and trace chalcopyrite. Assays yielded values of 0.70 per cent Cu, 0.03 per cent Ni and trace zinc and gold, based on diamond-drill core records by Manitoba Mineral Resources Ltd. (Table 11, Reference No. D-21, Map GR80-9-12). The drilling tested conductors outlined by the airborne EM survey and targets subsequently defined by ground EM surveys (Map GR80-9-12). Drill logs recorded felsic volcanic rocks, rhyolite to rhyodacite (7d) interlayered with tuffs and andesite flows (Unit 7b) along the west side of the river. This relationship is not readily apparent from surface exposures of Unit 7b. Drill records also indicate EM conductors coincident with sulphides + graphite. The main sulphide is pyrite with a lesser amount of pyrrhotite. Sporadic occurrences of chalcopyrite and minor occurrences of sphalerite were also observed. The sulphide-bearing zones were assayed for gold, silver, copper, zinc and nickel (Table 11, Reference No. D-21). Copper and zinc are widespread in trace values of 0.06 per cent and less commonly up to 0.1 per cent, or greater. The assay indicates two diamond-drill holes with anomalous copper values, DDH 132-42 and 133-47 (Table 11, Map GR-9-12, Reference No. D-21). A gabbro sill intersected by DDH 133-42 registered 3.65 per cent Cu and 0.1 per cent Ni. The gabbro occurs near the top of the drill hole and overlies andesite with a minor rhyolite flow section (6.7 m thick). DDH 133-48 lies at the southern extremity of the belt and appears to have intersected a contact zone of the metavolcanic suite with the quartz diorite. Mineralization grading 0.20 per cent copper and 0.11 per cent nickel was intersected in grey-black, well layered sediment(?). Immediately to the north of this, DDH 133-47 penetrated very siliceous greyish black metasediments. The drill hole intersected a sulphide-rich zone 8 feet (2.4 m) thick with pyrite, pyrrhotite and chalcopyrite. A maximum value of 6.05 per cent Cu was registered over a small sample interval of 35 m. This particular zone appears to be a section of Unit 7c, an interlayered siliceous metasedimentary and lapilli tuff sequence which is not exposed at the surface in this belt but which is exposed in the Great Island volcanic suite to the west.

Gold values are sporadic with only three DDH's intersecting measurable gold values, 133-12, 133-24 and 133-58 (Reference Nos. D-21, Table 11, Map GR80-9-12). These drill holes occur along a zone that lies at right angles to the apparent strike of the large-scale layering. These drill hole data, combined with data from DDH 133-57 and 133-59, indicate a large-scale layering of a tuffaceous sequence and a flow sequence. The contact between the predominantly tuffaceous section to the west and the dominantly flow rock section to the east is a broad shear zone (DDH 133-57). The tuffaceous section, intermediate and andesitic tuffs, is interlayered with minor rhyodacite to dacite flows and felsic tuffs. The best gold values occur in the tuffaceous zone in a dacitic tuff. The shear zone contains extensive essentially barren sulphides in sericitic and chloritic schist. The sequence of flow rocks (DDH 133-58), comprises mainly andesite flows with minor rhyolite flows. Gold values occur within the felsic flow material and in the andesite immediately to the west. Lack of way-up criteria leaves top directions indeterminate.

GREAT ISLAND METAVOLCANIC ROCKS

The areal extent of the Great Island metavolcanic rocks is approximately nine times as large as the lower Seal River metavolcanic belt. The metavolcanic and volcaniclastic rocks (7a to 7d) occur at the base of a layered sequence that defines a structural basin centered on Great Island. The central part of the basin is occupied by overlying metasedimentary rocks of the Great Island Group which cover approximately the central half of the Great Island metavolcanic belt (Map GR80-9-3,6).

The Great Island metavolcanic belt comprises interlayered intermediate and basic tuffs and andesite-dacite flows, in part pillowed (Unit 7b). This suite of rocks dominates the north flank of the belt. The central part of the belt is occupied by siliceous volcanogenic metasediments and lapilli tuffs (7c). A system of interlayered massive to pillowed andesitic flows with sporadic breccia zones and broad zones of rhyolite to rhyodacite flows forms a crescent-shaped area along the southern and eastern margins of the belt. Polymictic conglomerates form small lenses in the northern and southern segment of the belt. The northern conglomerate lenses indicate a volcanic source area (Unit 9a) whereas the southern conglomerate contains metasedimentary and feldspar porphyry clasts and has a greywacke matrix (Unit 9b).

Metagabbro intrusions (Unit 11) are concentrated along a northerly trend which appears to coincide with a fault-bounded eastern margin of the belt (Map GR80-9-9 and Figure 28). A pronounced magnetic high coincides with an area of gabbro bodies and a northeast-trending serpentinized ultramafic dyke (Unit 12). Stocks of feldspar porphyry appear to be the youngest subvolcanic intrusion (Unit 13). All units are described elsewhere in the report.

The Great Island metavolcanic belt has seen modest exploration in the past. Jellicoe Mines Ltd. conducted a limited airborne EM survey (Table 9, Reference No. 1 Map GR80-9-10). The company also carried out a limited diamond-drill program on a very high magnetic anomaly of 12 300 gammas (Federal/Provincial Map 550G). Limited results of the drill program are documented only in Davies et al., (1962):

"a drill hole encountered iron formation from 319 to 514 feet. The 195 foot section of core was reported to average 18.5 per cent soluble iron. The hole stopped in iron formation. Zinc and silver values were reported from other holes drilled in this general locality."

The relative position of this iron formation within the stratigraphic column remains uncertain. Metagabbro (11) and metavolcanic rocks (Unit 7a) outcrop at surface suggesting the iron formation may occur as part of the metavolcanic suite of rocks. However, the only iron formation observed in outcrop lies in the overlying Great Island Group metasedimentary rocks. The thrusting of the metavolcanic rocks over a segment of the Great Island Group is a remote but possible interpretation.

The Keevil Mining Group conducted airborne and ground EM surveys (Table 9, Reference Nos. 3a and 3b, Map GR80-9-10) and a diamond drill program (Table 11, Map GR80-9-12) during the period 1970 and 1971. The program concentrated on the east and southeast boundary of the metavolcanic belt and the northeast-trending ultramafic (Unit 12).

Magnetite was the only accessory mineral of note in drill core of the serpentinized ultramafic rocks. Barren sulphides and trace silver were reported in drill hole S71-3 (Location D-18, Map GR80-9-12) in the southeast corner of the belt. The rocks at surface are pillowed to massive andesite (Unit 7a). Description of the drill core indicates metagabbro in dominantly andesitic to dacitic volcanic rocks with minor traces of chalcopyrite and pyrrhotite. Quartz-chlorite alteration zones are common. A drill core intersection of 31 m contained sulphide mineralization. Assays indicated trace silver in otherwise barren sulphides.

Noranda Exploration Ltd. conducted an airborne EM survey in 1975 in the southern part of the belt, followed by geological mapping, prospecting, ground geophysics and a drilling program. Due to the proprietary nature of the information only a partial record of the work is available in open file reports (Table 9, Map GR80-9-10). Noranda Exploration Ltd. and Manitoba Minerals Resources Ltd. have conducted exploration programs in the southern and eastern zones of the metavolcanic belt (Table 9, Reference No. 5, Map GR80-9-10)

Manitoba Mineral Resources Ltd. (1974 to 1978) concentrated activity on the northeastern boundary of the metavolcanic belt east of Great Island and also in the northeast-trending serpentinized ultramafic east of Great Island. An airborne EM Survey was conducted and this was followed up by ground EM and a drilling program (Tables 9 and 11, respectively). Drilling along the northeast segment of the volcanic belt (Reference Nos. D35 and 38, Map GR80-9-12), intersected metasediments, possibly of the Great Island Group, whereas D-36 intersected quartz diorite (10) and metavolcanic rocks and D-37 encountered faulted siliceous metasediments overlying quartz diorite. In addition D-36 encountered an altered breccia(?) zone with siliceous fragments and abundant matrix sulphides and graphite over a drill core interval of 16 m. The sulphides were pyrite and pyrrhotite and assays indicated 0.02 per cent nickel, trace copper, and sporadic trace gold. Dacite, massive sulphide (barren pyrite and pyrrhotite 45 m thick) and andesite lie beneath the breccia. The layer of massive sulphide lies between the dacite and underlying andesite. The EM conductor tested by D-37 related to a graphitic dark grey to black phyllite (+ pyrite) 45 m thick. A zone of poor core recovery comprising talc-like material has been interpreted as a fault zone within the phyllite. The phyllite occurs within a siliceous metasediment which overlies a diorite containing inclusions of metasediment.

The diamond-drill core (D-39, 40 and 41, Map GR80-9-12) of the northeast-trending serpentinized dyke indicates a layering of ultramafic to gabbro and anorthosite. Magnetite (5-10%) is the only accessory mineral of note. However, the samples were not tested for chrome. Lake centre sediment geochemical nickel anomalies, ranging from 80 to 500 ppm (Map GR80-9-13), detected by the Geological Survey of Canada (URP Survey), coincide with a segment of the serpentinized dyke (Map GR80-9-9). These anomalies occur in the area of an esker which comprises a red-brown sand containing a large volume of serpentinite fragments. The overall trend of the esker is to the south. A localized southwest trend occurs where the esker overlies the serpentinite but the main southerly trend of the esker can be traced to a point at least 15 km south of the Seal River. The geochemical pattern for the nickel anomalies suggests a mechanical concentration of nickel-bearing minerals (sulphide or silicate?), within an esker system followed by leaching of the mechanically derived material releasing nickel into the hydrological system. Diamond-drill core indicates only very low concentrations of nickel-bearing minerals. However, the geochemical anomaly is approximately 12 km long and the underlying serpentinite has been tested at only two widely separated drill sites (D-17 and 39, Map GR80-9-12), leaving a broad zone unexamined. Although of a highly speculative nature, consideration should be given to the possibility of sulphide mobilization in the area of the intersection of the older serpentinized dykes and a broad Mackenzie dyke, within the area of the geochemical nickel anomaly. The existence of the Mackenzie dyke is based on the interpretation of aeromagnetic maps.

Twelve diamond-drill holes (D-44 to 55, Table 11, Map GR80-9-12) were drilled in the metavolcanic rocks south of Great Island. Barren to near barren sulphides were encountered in most of the drill holes. Copper, nickel and very minor gold values were encountered in two drill holes D-53, 55. Drill hole D-53 intersected mineralized dacite whereas D-55 encountered a mineralized andesite, quartz gabbro sequence. Copper-nickel values were encountered in drill hole D-52 which intersected mineralized quartz diorite.

During the course of the present mapping, sulphide occurrences within the Great Island metavolcanic belt were sampled and assayed for copper, zinc, nickel and molybdenum (Table 13, Map GR80-9-13):

1. Nine sites (S-4-12) were sampled in the interlayered tuffs and andesite-dacite flows (Unit 7b) north of Great Island.
2. Three sites (S-13-15) were sampled from the mainly massive to locally pillowed and locally brecciated more basic segment of Unit 7a (Map GR80-9-13) south and east of Great Island.
3. Two sites (S-16, 17) were sampled in the rhyolite and rhyodacite (Unit 7d), east of Great Island.
4. Three sites (S-18-20) were sampled from the metagabbro (Unit 11) (Map GR80-9-13).

5. One sample site (S-21) was sampled from the siliceous volcanogenic metasediments (7c) and interlayered felsic lenses at Omand Lake south of Great Island.
6. One site S-22 was sampled in the conglomerate (9b) east of Omand Lake.
7. Two sites S-23, 24 were sampled from amphibolite (Unit 8) at the northwest corner of Great Island (Map GR80-9-13).

In summary, the assay samples from Unit 7b indicated barren sulphides, a minor exception being the occurrence of 0.02 per cent Cu (S-6) on the east side of Great Island. This sample was taken from a rust-stained sulphide-bearing layer of latite with high potassium and magnesium contents and low sodium.

The sulphides from the basic component of Unit 7a display consistent Cu mineralization (0.03 - 0.10 per cent). The higher value of 0.1 per cent Cu occurs in a zone heavily intruded by quartz monzonite dykes.

One sample of rhyolite-rhyodacite S-16, GR80-9-13, registered 0.02 per cent copper and trace gold. The sample was taken from a zone of altered rhyolite. The rhyolite is chloritized, silicified and sheared. Trace arsenopyrite was tentatively identified in fractures in addition to heavily leached pyrite.

The metagabbro registered 0.03 to 0.06 per cent Cu. Two samples (S-19 and S-18) came from within metamorphosed ultrabasic zones comprising hornblende. A third sample, S-20, from a zone of contact metamorphosed and tectonized gabbro exposed on an island on Nichol Lake, analyzed 0.09 per cent nickel.

The sample sites on the south shore of Omand Lake (S-21), occur within a zone of siliceous metasedimentary rocks and lenses of grey-green rhyodacite. These rocks have been intruded by the feldspar porphyry (unit 13). Values of 0.02 per cent Zn were obtained from rusty lenses of rhyodacite(?).

The samples from the amphibolites northwest of Great Island along Big Spruce River indicate trace Ni and Cu (S-23) and 0.04 per cent Cu (S-24, GR80-9-13). These amphibolites are tentatively considered to be metamorphosed equivalents of the andesite-basalt metavolcanics of Unit 7a. These amphibolites are 30 to 60 m thick and have a pronounced orange-red weathering and an orange-brown sandy soil flanking the outcrops. Pyrite and pyrrhotite occur as disseminated grains and massive clots. The plagioclase in the mineralized amphibolite is pale green.

A lake bottom (centre) sediment geochemical URP survey indicated a pronounced arsenic anomaly within the western half of the interlayered tuff and andesite to dacite flows north of Great Island (Map GR80-9-13). The lithologies of unit 7b are felsic and intermediate flows and tuffaceous volcaniclastic sediments, favourable environments for massive sulphide deposits. The coincidence of an arsenic anomaly in this lithologic environment suggests the massive sulphides have potential for mineralization. A zone of microbrecciation and a carbonate quartz-tourmaline assemblage in an alteration zone on the eastern flank of the arsenic anomaly S-25, Map GR80-9-13, adds additional interest to this zone in terms of mineral potential. A short conductive zone, outlined by an airborne EM survey carried out by Jellicoe Mines Ltd., has been defined in an area peripheral to this alteration and the arsenic anomaly (Table 9).

Summary of volcanic-related mineral occurrences

The extensive exploration within the lower Seal River metavolcanic rocks, 12 kilometres west of the Seal River delta at Hudson Bay, indicates the presence of copper and zinc and gold mineralization within a sequence of andesitic and dacitic rocks. These rocks were intruded by high level feldspar porphyry and gabbro intrusions. The rocks of the Great Island volcanics to the west are very similar to the lower Seal River volcanic suite. Therefore, similar types of mineralization should also be present.

Exploration to date has been concentrated within a small segment of the southeast corner and along the northeast margin of the Great Island volcanic belt. The areal extent of the Great Island volcanic belt is approximately nine times greater than that of the lower Seal River volcanics. It is comparable in areal extent to the volcanic belt that hosts the Ruttan Lake orebody and is almost as large as the Lynn Lake greenstone belt.

Younger Great Island Group metasedimentary rocks unconformably overlie the central half of the Great Island metavolcanic rocks. This cover blocks geochemical testing and many of the geophysical techniques for exploring the underlying volcanic rocks. However, a positive aspect of the younger cover rocks is that they may have acted as a cap rock during a period of faulting that postdated deposition of Sequence II rocks. A comparable model would be the rocks of the Athabasca Formation which acted as a geochemical barrier and cap rock to fault-controlled fluid movement and mobilization of minerals that resulted in economic concentrations of minerals in rocks underlying the unconformity at the base of the Athabasca Formation.

Therefore, considering the areal extent of the Great Island volcanic rocks, the wide distribution of sulphide occurrences, geochemical and geophysical anomalies, it appears that the mineral potential remains to be fully explored.

METASEDIMENTARY ROCKS OF SEQUENCE II

The Sequence II metasedimentary rocks outcrop at Great Island, 42 km east of Great Island on Seal River and on North Knife River.

Past exploration activity has concentrated on the metasedimentary rocks at Great Island. Early exploration has centered on the iron formation (26), and has attempted to evaluate its potential as iron ore. Prospecting and diamond drilling were carried out in friable weathering products of the iron formation. Drill core descriptions are listed in Table 11 and drill hole locations (D1 to 16) are shown on Map GR80-9-12. Samples from trenches in the weathered iron formation S-26 (Map GR80-9-13) indicate trace gold (Milligan, 1955). A trench 6 m deep was dug at this locality in a zone of iron formation cut by a quartz stockwork. Coarse grained acicular amphiboles occur in clusters and/or radial growths. The rock is highly rusted. Samples from the area of S-26 also analyzed 35 to 59 per cent soluble iron. Approximately 35 m south from the trench Milligan (1955) sampled a blue-black clay at the base of the riverbank exposure of green-black to green-grey friable shale. The sample of the blue clay analyzed 4 to 11 per cent zinc; however, the nature of the zinc mineralization was unknown. Water levels during the mapping seasons of 1974 and 1975 were well above normal seasonal levels and the blue clay was not encountered. At location S-27 (Map GR80-9-13, Table 13), a red ferruginous friable shale grades southward into a green-black shale. Samples of red shale yielded 20 per cent soluble iron, 0.03 per cent phosphorus, and 0.02 per cent to 0.1 per cent titanium.

During the course of mapping metasedimentary rocks of Sequence II, sulphides were observed in a black meta-argillite (26a) (Locations S-31, 32) and an amphibole-garnet-bearing dense black meta-ironstone (26) along the south channel of the Seal River (Locations S-28, 29). These sulphides were analyzed for copper, zinc, nickel and lead (Table 13). Assays of S-31, 32 indicated trace amounts of these elements whereas samples S-28, 29 indicated trace Cu, Ni and Zn to 0.02 per cent Zn, 0.02 Cu, 0.04 per cent Ni and 0.04 Pb. A possible extension of this lithology is suggested in the analysis of borehole samples collected during the course of the Polar Gas pipeline study. W. Shilts (1980) reported an analysis of a borehole located immediately east of Great Island along the south bank of the Seal River, S-30 (Map GR80-9-13, Table 13). The borehole penetrated:

"6 m of till overlying weathered but not gossaneous phyllite sandstone and phyllite pebble conglomerate."
The overlying till was unmineralized but samples selected from 4 m of bedrock core registered copper (190 to 217 ppm), lead (19 - 510 ppm), zinc (134 - 217 ppm) and uranium (9.9 - 16.0 ppm). The borehole site was along strike from a rusty-weathering cliff exposure of black and light grey interlayered meta-argillite (22b) and lenses of amphibole- garnet- bearing black meta-ironstone (26). These rocks are intruded by quartz veins and a quartz stockwork. A phyllitic foliation or cleavage superimposed on the primary layering in some cases obliterates it and segments the quartz veins. It is conceivable that the borehole at S-30 encountered a deformed zone of units (22b and 26) immediately below overburden.

A sedimentary iron oxide-iron sulphide facies model should be considered in the interpretation of the rocks of unit 26 and 26a. The possibility of copper and zinc mineralization in the meta-argillites (of unit 26 and 26a) on the north and south channels of the Seal River should be further investigated.

Jellicoe Mines Ltd. conducted an airborne survey over the Great Island metasedimentary rocks (Table 9, Reference No. 1), but no follow-up work is recorded. The conductors in part define fault structures whereas others appear to be stratabound (Map GR80-9-12). Keevil Mining also conducted airborne EM surveys covering the eastern edge of the Great Island metasedimentary rocks (Table 9, Reference Nos. 3a and 3b).

The Keevil and Jellicoe surveys independently define a narrow pronounced system of linear conductors. The Keevil survey was followed up by ground EM surveys and a drill program (Tables 9 and 11, Map GR80-9-10 and 12). Two diamond drill holes D-19 and D-20 intersected the Great Island metasediments. D-19 intersected black meta-argillite with accessory pyrite and minor magnetite-rich zones similar to unit 26. D-20 encountered pyrite, marcasite-bearing phyllite and massive pyrite (Table 11) within a sequence of clastic rocks.

Additional airborne EM surveys were conducted by Noranda Exploration Ltd. The results are listed in Table 9 and on Map GR80-9-10. The Noranda survey indicates a broad synformal fold on the southern boundary of the metasediments. A survey by Manitoba Minerals Resources Ltd. covers the eastern margin of the Great Island metasediments and the north-trending segment of Seal River 42 km east of Great Island (Reference Nos. 8 and 10, Map GR80-9-10). The airborne survey which confirmed the presence of extensive linear conductors on the eastern margin of the metasediments at Great Island, was followed up by ground EM surveys and diamond drilling (Tables 9 and 11). The survey 42 km east of Great Island defined a narrow system of conductors which was interpreted to outline a synform. Diamond drilling (D-22 to 34, 42, Table 11, Map GR80-9-12) indicated the conductors correspond to pyritic and graphitic grey to black meta-argillite and phyllite with some zones containing up to 60 per cent graphite (Table 11). Mapping for the Cochrane River-Seal River project along the southern margin of this conductive zone encountered a unique occurrence of white to light grey pyritic-quartzite + trace galena (Location S-33). The quartzite is interlayered with light to dark grey-green meta-argillite displaying an axial planar phyllitic foliation. Pyrite is interstitial and the galena forms small grains within the pyrite disseminations. This pyritic quartzite is unique to the quartzites of the Great Island Group, being the only area indicative of a porous sandstone subjected to a syn- or post-depositional reducing environment prior to lithification.

Sulphide deposition related to a porous sandstone trap should be considered of interest based on the occurrence of the lead-zinc (silver) deposits in Scandinavia (Laisvall, Sweden; Rickard et al., 1979) and in the Trias of Germany, France and Morocco. The genesis proposed for these deposits ranges from syn-depositional, syn-diagenetic to hydrothermal. The common denominator in most of these deposits is the control by sandstone porosity and permeability.

METABASIC INTRUSIVE ROCKS WITHIN SEQUENCE I ROCKS

These rocks outcrop south and southeast of Nueltin Lake where they occur as small segmented lenses that probably represent tectonized dykes or sills of metamorphosed gabbro. These occurrences appear to correlate with areas of high magnetic intensity. The basic rocks are variably altered to biotite-amphibole schist injected by quartz veins. Sulphide minerals are pyrite and pyrrhotite with chalcopyrite. The sulphide zones were sampled and analysed (Locations S-38, 39; Table 13; Map GR80-9-13) yielding copper (237 ppm) and nickel (45 - 66 ppm). It is possible that linear magnetic highs observed to the west in the Kasmere Lake project also correspond to these mineralized metagabbros.

PARAGNEISS AND MIGMATITES, SEQUENCE I

Exploration activity, although sparse, has centered on the Munroe Lake map area (Map GR80-9-7) and the area along its southern boundary. Dynamic Petroleum examined an area north of Nicklin Lake by airborne EM survey and ground follow-up (Table 9, Reference No. 4, Map GR80-9-10). The survey indicated three east-trending anomalies (Locations L-5, 6, 7). The ground site is described as mainly swamp but minor EM follow-up was carried out and some sulphides were observed. However, the geological settings of the samples are not defined. Assays of chip samples ranged from 0.01 per cent to 0.04 per cent Cu, trace to 0.02 per cent Zn (Table 9).

Ducanex Syndicate conducted a prospecting and geological mapping program in the Munroe Lake map area. The program concentrated on the margins of the Munroe Lake synform cored by meta-arkose to arkosic gneiss (Unit 20) (Table 9, Reference No. 7, Map GR80-9-10). Eight sites of sulphide mineralization were observed and these were confined to occurrences in the rocks of the calc-silicate suite (Units 17 and 18). The samples were assayed for copper, zinc, and nickel (see Table 9, Reference No. 7). The sulphides in the trench at location L-12 contain 1 to 3 per cent chalcopyrite and bornite. Chip samples across 10 m assayed 0.2 per cent Cu. Location L-12 was also examined by ground geophysics and diamond drilling. The results of the diamond drilling are listed in Table 11. At location L-16 stringers of chalcopyrite and minor pyrrhotite were located in the calc-silicate rocks. Chip samples from the centre of the trench (3 m) returned an assay of 0.2 per cent Cu with a grab sample registering 0.75 per cent Cu.

During the course of mapping, several occurrences of sulphides were observed within the calc-silicate suite in the Munroe Lake area, S-34 to 36, Table 13, and a single occurrence within the semi-pelitic gneiss (6) in the Tadoule Lake map area northeast of Bain Lake (Location S-37). The rusted and leached pyrite + pyrrhotite-bearing zones were sampled and analyzed for copper, zinc, lead and molybdenum. The results are listed in Table 13. The two sample sites in the calc-silicate rocks have different host rock associations. At Askey Lake (Location S-34, Map GR80-9-13, Table 13), the zinc mineralization occurs in a sulphide zone along a marble layer within the calc-silicate, biotite psammite sequence. This site coincides with the sampling conducted by Ducanex Syndicate (Location L-22, Map GR80-9-10). The second calc-silicate occurrence (S-36, Map GR80-9-13), registered anomalous copper values of 291 ppm. The type of copper mineralization was not determined; however, the rust-stained zones lie within what appears to be a skarn-like sequence of rocks. The sequence comprises a dense biotite-quartzofeldspathic rock interlayered with a broad zone of apparently massive, dark brown andradite garnet with seams of bright dark green fibrous epidote. Thin section examination revealed 70 per cent andradite blasts which impinge on each other giving the appearance of a single mass of andradite in hand specimen.

These results and the work conducted by Ducanex Syndicate indicate a preferred stratigraphic control for the copper-zinc

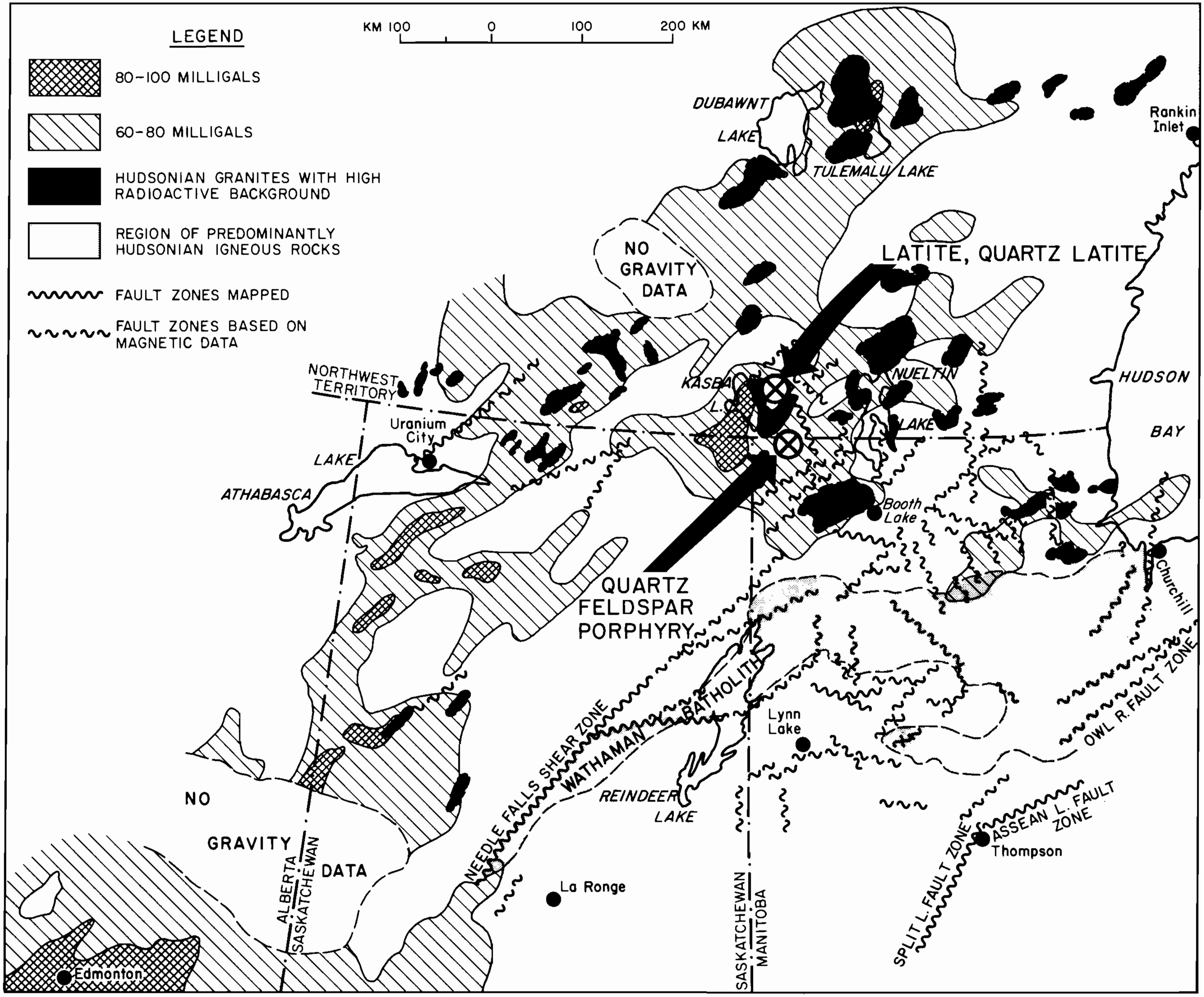


Figure 37: Regional distribution of late Hudsonian high uranium background granites and gravity trends.

mineralization in the calc-silicate zone lying between the underlying semi-pelitic gneiss (Unit 6a) and the overlying meta-arkose (Unit 20). A sedimentary genesis has been proposed by Weber et al. (1975a) for a mineralized calc-silicate suite within a closely comparable stratigraphy in the Kasmere Lake Project area. The presence of a regionally metamorphosed skarn deposit at location S-36 in the Munroe Lake map area, indicates the possibility of a second type of mineralization related to contact metamorphic mineral deposits within the calc-silicates.

Zinc mineralization (79-111 ppm) in the semi-pelitic gneiss was restricted to a zone of contact metamorphism (S-37, Map GR80-9-13). The contact zone occurs 3 km northeast of Bain Lake on the south flank of a dome or stock of aplite. The aplite contains pinpoint disseminations of bright green chlorite and hematite; assay results for copper were zero. The semi-pelitic gneiss in the contact zone is graphitic and pyritic.

Lake sediment geochemical anomalies, URP survey and geochemical sampling by the Manitoba Mines Branch (Exploration Branch, unpublished data), appear to coincide with:

i) contact zones between the intrusive quartz monzonite and semi-pelitic gneiss and/or calc-silicate rocks;
ii) calc-silicate occurrences of Sequence I rocks.

The geochemical anomalies, primarily Zn and Cu, are prevalent in the Tadoule Lake map area and to a lesser extent in the Whiskey Jack Lake map area (Map GR80-9-13). This zone marks the northern flank of the Chipewyan Batholith. Numerous contact zones correspond to inclusion blocks within the Hudsonian intrusions. Geochemical anomalies corresponding to the calc-silicate suite of rocks are primarily arsenic, copper and zinc (Map GR80-9-13). This system of anomalies occurs in a zone from Askey Lake west to Nueltin Lake and south to Booth Lake.

The area from Nueltin Lake to Booth Lake, which remains largely unexplored for minerals due to a paucity of outcrop and its inaccessibility, appears to be a favourable region for economic concentrations of Cu-Zn-U minerals. This prediction is based on the combined occurrence of the following geologic elements:

i) the coincidence of lower and middle Sequence I rocks (Units 6, 17, 17a and 17b) and their anatectic derivatives within zones of aeromagnetic lows;
ii) late Hudsonian, high uranium background plutons;
iii) Mo-U-Zn anomalies which are presently unexplained;
iv) abundant faults and a major fracture system.

The influence of uraniferous plutons in relation to radiogenic heat and hydrothermal convection in fracture and faulted terrains has been examined by Fehn et al. (1978). The high uranium background granites can act as long-lasting heat sources and, therefore, as a driving mechanism that can cause intense hydrothermal convection. The studies indicated that a critical element is permeability. Depth of intrusion is a second order factor as a consideration in its effect on permeability. The degree of tectonic preparation of the country rock, and the degree of fracturing of the uraniferous plutons, relate to the regional tectonic setting.

The regional tectonic setting of the Nueltin Lake to Booth Lake fault zone relates to a much larger crustal feature, the Edmonton-Kasba Lake gravity low (Burwash and Culbert, 1976), (Fig. 37). Darnley (1982) pointed out the coincidence of uranium highs along the Edmonton-Kasba Lake gravity low. He also points out the common observation (Walcott, 1968; Gibb and Halliday, 1974; Moreau, 1976; Brown et al., 1979), that uraniferous granites are spatially associated with negative gravity anomalies. Darnley postulates that the gravity low relates in part to the presence of uraniferous granites along the Edmonton-Kasba Lake gravity low and, "that the intrusion of uraniferous granitoids are in some way related to crustal extension either as a cause or an effect."

The fault zone that extends from Nueltin Lake to Booth Lake lies along the eastern boundary zone of a region to the west which exhibits a negative Bouguer gravity response and is characterized by the presence of late Hudsonian uraniferous granites. This fault zone coincides with the lithotectonic boundary between the Seal River domain and the Nejanilini domain. The intensity of faulting along a major crustal boundary between the Nejanilini domain and the Seal River domain may have served to prepare this zone for greater fluid movement by increasing permeability. The presence of uraniferous plutons such as units 30 and 32 along this zone of deformation adds to its potential.

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APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
33	Diabase	No reading	Forms outcrops in the lower parts of the river valleys. Weathers reddish brown. Plagioclase grains have a yellowish-green colour.	Dark grey to black	Medium-to coarse-grained, ophitic	Minor, as part of micrographic intergrowths	45-50% plagioclase, An_{36-40} average; zoned plagioclase from An_{25} at rim to An_{65} in cores. Micrographic potassium feldspar 1-3%.	Hornblende 8% Biotite 5% Augite 30-35%	Trachytic near the finer grained margins of the dyke. Random elsewhere as in central part of the dykes.	Magnetite Pyrrhotite	This rock type outcrops only rarely; however, the rock consistently outcrops in zones corresponding to linear magnetic highs outlined by the Airborne Magnetic Survey (Fed./Prov. Series). Many more dykes can be inferred on this basis.
32	Pink porphyritic quartz monzonite	150-200 cps, high 450 6 000-15 000 cpm	Forms massive ridge-like outcrops of moderate to high relief. Pinkish grey to pink.	Pink	Porphyritic, phenocrysts (1-5 cm long) matrix coarse grained hypidiomorphic granular. Phenocrysts locally aligned (primary igneous).	20-25% grey, irregular shaped coarse grains	35-40% idiomorphic partly microperthitic microcline; 25-30% plagioclase An_{25-30}; commonly saussuritized rims.	Biotite 5-8%, partially altered to chlorite	Small aggregates, no orientation	Myrmekite 2-3%	The main occurrence of the quartz monzonite is in the Munroe Lake area (Map GR80-9-7) where it forms the nose of a large body extending west into the Kasmere area (1975 Weber et al.). This rock type also forms small stocks, some greater than 10 km in diameter which have intruded an Archean granitoid terrain. One such body is in the northeast of the Munroe Lake area while other stocks occur within the Nejanilini-Caribou Lakes area (Map GR80-9-6) and on the south and southeast flank of the massif.
32a	Pink and/white granitic pegmatite	100-120 cps; 4500 with highs of 60 000 cpm.	Prominent knolls and ridges, weathers pink.	Pink	Pegmatitic with feldspar crystals up to 10 cm.	Grey, irregular in shape, and in graphic intergrowths.	Perthitic microcline	Biotite 2-8%; books up to 4 cm and as coarse grains.	Random	±Tourmaline 1% ±Magnetite 2% Muscovite 5-10% Garnet - rare.	The pegmatites as mappable bodies are concentrated at the contacts of the quartz monzonite (31) and the country rocks in the Tadoule, Stony and Shethanei Lakes region (Maps GR80-9-2, 3). Other occurrences are as sills, dykes and irregular-shaped bodies too small to show on the present scale of mapping. The most prominent area of pegmatite dykes is along the North Knife River south of Nichol Lake (Map GR80-9-3). The pegmatite may represent more than one age of intrusion.
32b	Pink fluorite-bearing porphyritic quartz monzonite	125-150 cps. High 600.	Forms massive outcrops of high relief. White to pink.	Pink	Coarse grained hypidiomorphic granular, commonly porphyritic with irregular grains of coarse interstitial quartz.	24-40%	Microcline in part perthitic, phenocrysts	Biotite 5%	Irregular-shaped aggregate	Fluorite (purple) .5-1%	This rock type occurs in the northwest part of the project area in the Munroe Lake area (Map GR80-9-7) immediately east of Nueltin Lake. It also outcrops in the southeast of the project area in the Nichol Lake area (Map GR80-9-3) immediately east of Nichol Lake.
32c	Fluorite-bearing white granodiorite	No readings	Forms large high flat top ridges. Weathers white.	White	Medium-to coarse-grained hypidiomorphic granular, locally pegmatitic	25-35%	Microcline in part perthitic 35-40%. Microcline is more abundant in the pegmatitic phases. 25-35% plagioclase An_{22-25}	Biotite 5-10%, forms books 15 cm thick and 25 cm in length in the pegmatitic phase.	Random to aligned, outline a "ghost layering"	Muscovite 5%, forms books 15 cm in length in the pegmatite phase. Garnet, euhedral crystals, 0-2%. Tourmaline 1% (green). Fluorite 1%.	Occurs southwest of Nichol Lake near North Knife River in the Nichol Lake area.
32d	Red granite	No readings	Forms low flat outcrops that rise 2 to 3 metres above the surrounding peat bog; white to pink.	Deep orange-red	Coarse grained to porphyritic	35-40% Milky blue in colour	Microcline 50%. 10-15% myrmekitic plagioclase and plagioclase An_{12-17}	Biotite 2%	Random	Pyrite, trace. Fluorite 1%	Occurs east of Nichol Lake in a zone between the North Knife and Seal Rivers.
32e	Quartz-feldspar porphyry		Reddish grey	Reddish grey	Porphyritic with very fine grained cataclastic matrix, massive.	Blue quartz phenocrysts, quartz in matrix is granulated.	10% microcline phenocrysts	Magnetite 10% Epidote 5%	Evenly distributed and in discontinuous streaks.	Hematite	Late stage hematization; this rock type occurs in the Kasmere Lake project area.

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
31	Quartz monzonite	125-180 cps. 4 000-9 000 cpm.	Elongate ridges, moderate to high relief, weathers pinkish grey.	Pale pink to grey	Medium-to coarse-grained, partly porphyritic. Foliation varies from well defined to weak.	23-35% grey to translucent	25-35% microcline in part micro-perthitic. 21-25% plagioclase An_{17-21}	Biotite 5% Chlorite 1% Hornblende 0-3%	Generally dissemi-nated, aligned less commonly as trains of mafic clots.	Magnetite Apatite Zircon	This rock type forms the main map unit in the south quarter of the project area. It appears to be the northern edge of a massive batholith complex which extends west from Hudson Bay to the Saskatchewan border and south for approximately 100 km. It also forms a series of easterly-trending bodies in the central part of the project area immediately north of Seal River. Other occurrences are as stocks within the areas of Archean granitoid rocks in the northern quarter of the project area.
31a	Hybrid quartz monzonite	4 000-9 000 cpm	Forms high blocky ridges, weather white to rusty brown.	Pink to a pink and brown vari-gated pattern.	Medium-to coarse-grained spo-radically porphy-ritic weakly foliated to massive.	25-35% Grey to dark brown due to limonite stain.	25-35% microcline in part perthitic with traces of anti-perthite 15-20% plagioclase An_{22-27}	Biotite 5-8% Hornblende 0-2% Chlorite 1%	Generally dissemi-nated, aligned less commonly as trains of mafic clots.	Magnetite	This rock type occurs randomly within areas of brown hypersthene quartz monzonite (2c), and grey gneisses (Unit A). The hybrid quartz monzonite contains from 5-35% brown hyper-sthene-bearing quartz monzonite as inclusions. It occurs within the Nejanilini massif east of Nejanilini Lake and north of Caribou Lake, and in the Egenolf Lake area.
31b	Pink aplite ± hornblende	2 500-3 500 cpm	Large	Translucent pink.	Very fine-to locally medium-grained, massive to exhibi-ting a weak com-positional layering deformed by spo-radic planar con-centrations of oxides and biotite. Also sporadically displays a colour variation buff and pink related to in-cipient cataclasis.	15-20% often displays a platey or elongated fabric spo-radically rodded.	45% microcline in part perthitic. 30% plagioclase	Biotite 3% Hornblende 2%	Concentrated in discrete planes.	Magnetite 1% Hematite 1-2% Pyrite	Forms two small bodies; one a stock 4 km in diameter, 10 km northwest of Bain Lake (Tadoule Lake area, Map GR80-9-2), and another body apparently deformed in areas to the southeast of Bain Lake. The main occurrence is a zone trending from east of Munroe Lake to the west side of Great Island.
31c	Well foliated biotite-hornblende-granite gneiss	3 500-8 500 cpm	Low elongated ridges to flat equant outcrops. Pinkish-white with a vague colour layering.	Pink and grey.	Medium to coarse, pronounced to weak composi-tional layering de-fined by variation in mafic mineral distribution and *lits* of pink quartz monzonite.	15-30%	30-40% microcline - pink to pearly grey. 20-25% plagioclase An_{15-31}	Biotite 3-10% Hornblende 0-3%	Concentrated in discontinuous laminae or with quartzofeldspathic layers where they are disseminated.	Magnetite 1-2% Hematite 1%	Occurs mainly east of Caribou Lake where it lies between areas of quartz monzonite (31 and 32) and the area of porphyritic diorite (10) and grano-diorite of the Seal River.
31d	Hybrid gneiss	80-100 cps	Moderate relief, large flat surfaces pale pink, faint layering visible on weathered surface.	Pink	Fine grained polygonized to cataclastic texture	20-35% elongate lenticular grains.	60% combined microcline and honey brown plagioclase An_{26-28}	Hornblende 3% Biotite 3%	Disseminated hornblende medium grained to coarse grained poikiloblastic.	Magnetite very fine grains hematite.	
30	White quartz monzonite to trondhjemite	100-180 cps 4 000 cpm	Where it forms the dominant rock type it occurs as high rounded ridges. Weathers bone white to light grey.	Light grey to brilliant white	Massive medium grained to porphy-ritic and also pegmatitic. This grain size varia-tion is random and is gradational. The pegmatite portion in general is 5-10% but pegmatite may constitute 90-100%.	25-40%	30% microcline (perthitic) 35% plagioclase An_{26-34}	Biotite 3-8%	Disseminated and random	Cordierite Garnet Sillimanite Magnetite Tourmaline (black)	Occurs commonly associated with the semipelitic schist to gneiss (6). It is always associated with the semipelitic metatexite. It forms *lits* and stocks within these rock types.

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
30a	White porphyritic granodiorite	No reading	Light grey	Grey	Porphyritic with coarse-to medium-grained matrix.	15%	Plagioclase pheno-crysts 1-2 cm An_{28-32} in a matrix of plagioclase An_{27-30}	Biotite 8% Hornblende 2%	Interstitial weakly aligned biotite.	Apatite Magnetite Sphene Zircon	The type locality for this rock is 15 km south of Nicklin Lake (Tadoule Map area GR80-9-2). There a stock 5 km in diameter clearly intrudes the meta-arkose (20).
29	"Churchill quartzite"		High elongate ridges that appear to be controlled by the orientation of the primary layering. Weathers light to dark grey. Some zones are reddish grey due to hematite stain.	Light grey. Bedding planes often delineated by dark grey hematite concen-tration.	Fine-to medium-grained. Primary bedding planes, with sub-parallel to high oblique foliation, the latter being a fracture cleavage to a schistosity defined by align-ment of sericite. Some pebbly beds display an align-ment and deforma-tion of clasts, specifically the more argillaceous clasts.	80-96%	1-3% microcline and albite	Chlorite 0-3%		Specular hematite. Grey granular.	This rock type outcrops in the immediate area of the town of Churchill and on the west bank of Churchill River at its mouth. A similar rock type occurs to the west of Churchill (54 km) along Herriot Creek. Other occurrences of a similar pebble-bearing quartzite are along the south bank of North Knife River 80 km southwest of Churchill.
28	Metasiltstone to meta-argillite		Intermittent ridges of moderate relief trending along strike of layering. Smooth surface grey to dark grey.	Dark grey	Very fine grained.	Metasiltstone: quartz 50-60%. Meta-argillite?	Metasiltstone: plagioclase untwinned and microcline 30%	Felty biotite and chlorite	Aligned parallel to bedding, the exceptions being in fold hinges where incipient axial planar to well deformed axial planar schistosity is present.	Garnet very fine grained, sporadic.	This rock type occurs around Meades Lake immediately north of Great Island.
27	Meta-greywacke		High blocky ridges, form the backbone of the north-trending oval structure centered on Meades Lake, north of Great Island. Light grey with milky white to bluish-white quartz clasts.	Dark grey	Medium-to coarse-grained, massive to bedded to graded bedding.	35-40% Grey to bluish-white	20-25% microcline; 30-35% plagioclase.		Foliation is a fracture cleavage.		The rock contains lithic fragments (comprising plagioclase and quartz) — 5%. These fragments are angular to subrounded. The matrix of the greywacke is fine grained feldspar, quartz and sericite.
27a	Interlayered red and/or green meta-greywacke		Low flat outcrop buff and differentially weathered.	Variegated red and green.	Medium-to coarse-grained, clastic, layers of fine grained phyllite.	40% Grey to white with sporadic milky blue grains.	Microcline buff to deep orange-red.	Chlorite aligned parallel to bedding.		Sericite	Sedimentary bedding and textures are preserved and inverted bedding is indicated by well preserved "rip up" structures at the contact of the meta-greywacke and phyllite.
26	Garnet amphi-bole schist - (Iron Formation)		Low linear out-crops with some resistant beds. Weathers red. Acicular grains of an unidentified white mineral pseudomorph in the amphiboles.	Olive-green with black interlayers. Fresh mag-netite amphibole iron forma-tion was observed only in drill core.	Very fine-to fine-grained magnetite layers are massive.			Amphibole 80-90% Magnetite 10-20%	Disseminated magnetite occurs within acicular olive-green amphibole which displays a radial but random pattern. These layer 2 cm to 2 mm thick alternate with layers of massive magnetite.		Iron formation of this silicate type occurs only on the north side of Great Island.

APPENDIX:

SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
26a	Black pyrite meta-argillite ± black acicular amphibole ± garnet.		This resistant unit layer forms prominent linear ridges of moderate to low relief. Weathers brown to reddish-brown.	Black	Very fine grained to amorphous.			Black acicular very fine grained random orientation.		Pyrite 5-8% is disseminated and also occurs along bedding planes and fracture cleavage. Pyrrhotite 0-2%; Garnet 0-2%; very fine grained but euhedral, deep red.	This rock type occurs along Seal River on the south side and also east of Great Island. It forms a thin layer up to 100 m thick. Layering is defined by garnet-amphibole layers interlayered with dense meta-argillite which sporadically contains pyrite and pyrrhotite.
25	Black meta-argillite with quartz pebbles.				Very fine grained to amorphous matrix supports quartz clasts (rounded).						Only one occurrence of this unique rock type which is along the North Knife River.
24	Dolomitic marble		Low narrow linear outcrops.	Buff	Medium grained	5-8% as disseminated fine grains 10% as discontinuous lenses and veins.				Lath to bladed clinochlore porphyroblasts	This rock type occurs as discontinuous ridges along and north of the Seal River on the north side of Great Island. A single occurrence lies at the junction of the north and south channels at the east side of Great Island. A more isolated occurrence of a carbonate unit occurs in the lowest section of drill core from a diamond drill hole collared along the south bank of Seal River 15 km east of Great Island.
23	Meta-conglomerate and inter-layered grey metasiltstone with pebble beds.	90-125 cps	Low flat outcrops. Grey with rough outcrop surface due to differentiated weathering of matrix, and more resistant clasts.	Buff to grey	Matrix very fine- to fine-grained, equigranular, schistose clasts appear to be undeformed.	30-60%	Undifferentiated feldspar 20-40%	Biotite 15%	Concentrated in layers preferred orientation.	Muscovite 10% Tourmaline 3%	Restricted in occurrences to Tadoule Lake. Cobbles and pebbles within the grey meta-siltstone matrix are widely spaced out but do show concentrations along bedding planes in general. The compositions of the clasts are white quartz monzonite, quartzite, vein quartz and gneissic cobbles and pebbles.
22	Quartzite and inter-layered pale green phyllite ± garnet		Large rounded elongate ridges. The more siliceous units weather light grey to greenish grey whereas the more micaceous units weather pale greyish green. The variation from proto-quartzite and/or meta-siltstone defines the primary layering as does the presence of the phyllite layers.	Grey and olive-green to dark grey.	Quartzitic component medium grained sporadic ghost-like pebbles.	Quartzite: 90% rounded grains with silica overgrowths.	Feldspar 5-8%	Quartzite: chlorite biotite.	The quartzite in general forms massive beds while the more micaceous units have a foliation defined by the alignment of the platy minerals. This foliation is parallel to the major unit contacts, exceptions being in the noses of folds where an axial planar schistosity is developed.	Quartzite Sericite Hematite	This basal unit of the Great Island Group comprises an interlayered sequence of grey quartzite, proto-quartzite, metasiltstone and 10-15% widely spaced discontinuous layers of grey-green to grey phyllite. North of Meades Lake, this basal unit is 1 200 m thick. Current crossbedding and wave-ripple marks, though recorded, are too rare for reliable top and current direction inferences.

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
22a	Grey green phyllite ± garnet ± biotite porphyroblasts		Low flat outcrops occurring along the course of Seal River or North Knife River. Grey to dark grey and greenish grey.	Dark grey to light olive-green	Rock comprises 2-5 mm laminations of very fine to felty chlorite, biotite and sericite alternating with layers of buff quartzose metasiltstone.	Micaceous layers 20% Metasiltstone 90%	Feldspar 45% Feldspar ?	Biotite 20% Chlorite 5% Metasiltstone	Aligned parallel to compositional layering, exception being in fold hinges.	Sericite 5% Garnet 10%	The main occurrence is along the Seal River on the south side of Great Island, with smaller occurrences at the northwest tip of Great Island where it is andalusite-bearing. Other occurrences are along the course of North Knife River.
21a	Conglomerate (oligomictic)		Blocky ridges high to moderate relief. White with rusty orange zones.	White	Rock comprises quartz matrix with supported quartzite and quartz clasts. Pebble-size clasts are elliptical in shape.					Sericite 10% Pyrite: ? Limonite 2%, after pyrite? Disseminated to concentrated in shear planes.	Occurs south of Great Island between Seal River and Omand Lake and also 10 km east of Omand Lake.
21b	Conglomerate (polymictic)		Small low outcrops dark grey	Light grey	Rock comprises quartz, biotite, hematite matrix with clasts of quartz-tourmaline pebbles, micaceous pebbles, highly elliptical quartzite and bull quartz pebbles.						
20	Meta-arkose, arkosic gneiss and metatexite	50-90 cps	Low smooth outcrops also high massive bluffs where abundant sills and stocks of quartz monzonite (31) intrude meta-arkose. The meta-arkose has a layered appearance which is grey and white or pale pink and grey. Pale green to dark green discontinuous layers of calc-silicate minerals may also be present.	Pale pink with white or pink granitic *lits*. Red hematite is readily visible in the pink layers.	Fine-to medium-grained granoblastic	25-40%	20-40% microcline 20-40% plagioclase	Hornblende Actinolite Diopside Biotite	As aggregations forming disseminated lenses, also as discrete layers.	Hematite 3% Magnetite 1% Calcite Sphene Apatite Epidote	Various degrees of alteration from meta-sediment to para-gneiss to migmatite (metatexite with arkosic restite) are present. The Nueltin Lake area in the northwest of the Munroe Lake map area GR80-9-7 contains the most highly migmatized zones. The least altered regions in the arkosic belt extends west-northwest from Munroe Lake. The belt of arkose in the Nicklin Lake area of the Tadoule Lake map area GR80-9-2 is the most intensely intruded by sills and small stocks of quartz monzonite (31). Other occurrences are along the north shore of Whiskey Jack Lake in the extreme southwest of the project area.
19	Feldspathic quartzite	110-145 cps	Low elongate ridges. Grey with widely spaced dark grey laminae.	Grey to buff	Medium grained granoblastic moderately to well foliated. Sporadic porphyroblasts of lenticular microcline-muscovite-sillimanite-quartz intergrowths.	50-70%	10-20% microcline; 8-10% plagioclase	Biotite 5-8%	Biotite is disseminated and also forms planar concentrations or biotite laminae. Biotite is aligned parallel and/or oblique to layering.	Hematite Magnetite Sillimanite Muscovite	This rock type can be gradational into a massive, thickly bedded quartzite. It outcrops at the north end of Tadoule Lake area (Map GR80-9-2).

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
18	Quartzite ± andradite ± diopside ± epidote	65-105 cps	Moderate relief, blocky outcrops to long rounded ridges. Some have high relief, examples being the quartzite at southeast end of Munroe Lake in the Munroe Lake area (Map GR80-9-7). Grey to whitish pink.	Colourless to grey pinkish-grey, minor pale green	Fine-to medium-grained massive. The colourless quartzite has an aphanitic appearance.	65-95%	0-5% microcline in the quartzite, 20-25% in the thin pale pink layers.	Biotite 5% Actinolite 2% Diopside 10%	Biotite aligned parallel and/ or oblique to the compositional layering.	Epidote 2-8% Andradite 0-1%	This rock type occurs in the southeast corner of the Munroe Lake area within the Munroe Lake map area. It also outcrops in the extreme southwest of the project at the north end of Whiskey Jack Lake within the Whiskey Jack Lake area (Map GR80-9-1).
17	Calc-silicate rock	60-100 cps silicate layers	Prominent elongated ridges. Prominently layered. Dark grey biotite-rich beds and pale green to pinkish green calc-silicate-rich beds. Marble beds when present weather deeply, enhancing the layered appearance.	Interlayers red-grey biotite plagioclase layers and dense green calc-silicate layers.	Medium grained granoblastic in the biotite-plagioclase layers. The calc-silicate layers are medium-to coarse-grained granoblastic layers.	0-15% with most of the quartz in the biotite-plagioclase layers.	20% microcline 35-40% plagioclase An_{24-28}	Biotite 15% Hornblende-actinolite Diopside	Biotite is aligned parallel and/or oblique to the compositional layering.		The calc-silicate although a thin unit 800 to 1000 m thick is persistent in its occurrence within the rocks of sedimentary-derived gneisses. It outcrops at the base of the meta-arkose in the Munroe Lake area (Map GR80-9-7), and also outcrops north of the arkosic belt at Askey Lake. From Askey Lake it extends eastward to Nejanilini Lake. Its occurrences in the Tadoule Lake map area to the south are less extensive and more discontinuous. The marble unit (17a) in many places is in close association with the calc-silicate rock or interlayered with it.
17a	Marble		Low ridges with a distinct differential weathering. White to buff to brown.	Buff	Medium-to coarse-grained granoblastic massive. A sporadic layering is defined by calc-silicate layers and/ or biotite-plagioclase layers. These are as described for unit 17.	0-5%			Phlogopite	Phlogopite 0-3% Diopside 3-5%	The most distinct occurrences are in the south central part of the project in the Tadoule Lake area (Map GR80-9-2) at Wilkie and also at Ryan Lake. A small isolated occurrence of the marble outcrops near Wolverine River in the southwest corner of the Nejanilini Lake area (Map GR80-9-6). Elsewhere the marble is interlayered with the calc-silicate rock.
17b	Albite-pyroxene rock	Nil	Low to moderate relief, small outcrops. White to pink with discontinuous dark green to dark grey layers.	Light grey to pale pink	Fine-to medium-grained granoblastic weakly to moderately foliated.	0-10%	70-90% albite An_{5-10}	Augite 8%	Random to C-axis parallel orientation	Sphene 0-3% Pyrite 1%	Observed at only two locations in the project area, both in the northwest part of the Munroe Lake map area. Both occurrences are at the base of the meta-arkose (20) which extends west from Munroe Lake.
16	Biotite psammite gneiss ± calc-silicate lenses.	50-80 cps	Interlayered dark grey, light grey and grey and pale green discontinuous layers.	Grey and buff layers	Medium grained granoblastic foliated.	20%	20-25% microcline; 30-35% plagioclase An_{21-24}	Biotite 10% Hornblende 3% Actinolite 3% Chlorite 1%	Disseminated and preferentially oriented.	Sphene Tourmaline Magnetite	This rock type generally contains thin and discontinuous pale green layers of calc-silicate rock. The psammatic biotite gneiss may also occur intimately interlayered with the semi-pelitic gneiss (6a). Where the psammitic biotite gneiss is intruded by or contains white pegmatite, the pegmatite often contains black tourmaline.
15	Meta-gabbro to (norite) metabasic rock	35-50 cps	Small isolated outcrops, dark grey to olive-grey.	Black	Medium-to coarse-grained hypidiomorphic, weakly foliated.	0-5%	Plagioclase	Hypersthene 5% Diopside 8% Augite 5% Hornblende 15-10% Biotite 5-8% Chlorite 1% Actinolite 5%	Random orientation	Calcite Epidote Magnetite Pyrite	This rock type was observed as isolated occurrences in the Munroe Lake, Tadoule Lake and Nejanilini Lake areas (Maps GR80-9-7, 2 and 6).

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
14	Meta-quartz porphyry		Flat tabular hills to elongate high relief ridges. Weathers buff to grey.	Pink	Fine-to medium-grained with quartz phenocrysts 2-5 mm long. These phenocrysts are lenticular and aligned thus enhancing the biotite schistosity.	30-35%. 5% being in the quartz phenocrysts.	40-45% potassium feldspar, microcline? 15-20% plagioclase	Biotite 3%	Disseminated and aligned.	Muscovite 2%	This rock type occurs near Spruce Lake 18 km northwest of Great Island. The contact of this rock type with the volcanic rocks (unit 8 to 7d) is not exposed.
13	Pink to grey, very fine grained feldspar porphyry		Blocky, flat topped outcrops of moderate relief. Weathers with a smooth grey surface.	Pink to grey	Very fine-to-fine-grained with up to 8% phenocrysts	25-30% minor amount as phenocrysts (1%)	45% microcline phenocrysts (.3 - 1 cm). 20% plagioclase as matrix. Plagioclase phenocrysts An_{30-31}: 3%.	Actinolite (acicular) Biotite (olive-green)	Disseminated random.	Epidote Chlorite	This rock type forms stocks and dykes within the volcanic rocks south of Great Island and east of Great Island.
12	Ultramafic (serpentinite)		No surface exposures observed, but a distinct in situ linear weathering identifies the subsurface location. Weathering produces a deep orange-brown sand comprising limonitic alteration products and coarse fragments of serpentine. Elsewhere such as at Caribou Lake only angular boulders with a brown weathering were observed.	Green-black variegated.						Magnetite 5%	The serpentinized ultramafic occurs as an arcuate-shaped dyke north of Eppler Lake in the northeast part of the project area, Caribou Lake area (Map GR80-9-5). A distinct linear zone of weathered red-brown sand material was mapped and this zone corresponds closely with a linear magnetic high on the Federal/Provincial airborne magnetic maps 7145G and 7148G. The second occurrence is at Caribou Lake where a boulder field of ultramafic rocks was observed.
11	Gabbro to metagabbro		Low to moderate relief blocky outcrops. Dark grey to brownish grey.	Black	Coarse grained, massive to locally weakly foliated.	0-5%	30% plagioclase An_{27-40}	Hornblende Diopside: Augite 5% Altered zones: Chlorite Actinolite	In random orientation	Magnetite Pyrrhotite Trace Chalcopyrite Carbonate	Stocks of gabbro are common in the Seal River volcanic rocks which outcrop north and south of Great Island, and east of Great Island. A stock of metagabbro outcrops within a granitic terrain 8 km southeast of Caribou Lake (Map GR80-9-5).
10	Granodiorite to porphyritic quartz diorite		Low flat outcrops. Weathers grey.	Dark grey	Medium-to coarse-grained, locally porphyritic	5-10%	5-10% microcline; 40-45% plagioclase An_{24-26} Phenocrysts can make up to 10% of the plagioclase content.	Hornblende 5-20% Biotite 5-10%	Disseminated and aligned.	Epidote Pyrite	This rock type forms the major lithologic unit along the lower reaches of the Seal River to its mouth on Hudson Bay. The Seal River volcanic rocks form enclaves within this unit.
9a	Volcanic derived conglomerate		Low flat outcrops. Weathers grey-green to grey with a pitted surface.	Variably coloured due to variety of clasts. Matrix is grey-green.	Matrix is medium-to coarse-grained. Clasts range from pebble to large cobbles	Matrix: 30-35%	Matrix: 10% microcline: 40% plagioclase	Matrix: Biotite 8% Chlorite 1% Actinolite 10%	Disseminated aligned.		This conglomerate occurs north of Meades Lake in the south quarter of the Nejanlini Lake map area. The clasts comprise meta-andesite, feldspar porphyry and rhyodacite with minor amounts of quartztofeldspathic cobbles. The framework is clast supported.

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
9b	Greywacke meta-conglomerate		Forms tabular steep-sided outcrops 1 to 2 metres high.	Dark grey and light grey.	The rock type is an interlayered sequence of metagreywacke, meta-argillite and impure quartz metasiltstone, with lenses of conglomerate with greywacke matrix.						This conglomerate outcrops 1 km east of Omand Lake and 6 km southeast of Omand Lake. This area lies south of Great Island in the Nichol Lake area. The clast-supported conglomerate contains clasts of feldspar porphyry and tuffaceous layered meta-argillite which occur in a greywacke matrix.
8	Amphibolite		Reddish-brown to black. Small high outcrops.	Black to greenish black to layered black and green layers.	Medium grained granoblastic. Weak schistosity to massive.	5%	Trace microcline; 30% plagioclase An_{27-32}	Hornblende 50-55% Biotite 8% Diopside	Hornblende occurs as equant grains. Biotite is disseminated and aligned.	Pyrrhotite 0-2% Epidote	This amphibolite occurs northwest of Great Island along and east of Big Spruce River, in the extreme southwest corner of the Nejanilini Lake area (Map GR80-9-6).
7a	Andesite to basalt		Low flat outcrops, dark green to pale green.	Dark olive or greyish green.	Very fine grained matrix with fine- to medium-grained laths of plagioclase.	10-15%	40-50% microcline; 10-25% plagioclase laths. An_{24-30}	Actinolite Chlorite	Felted mass weakly to well foliated.	Graphite 1% Calcite as veins and void fillings. Magnetite trace. Pyrite trace. Chalcopyrite rare.	Pillowed to massive.
7b	Interlayered tuff and pillowed andesite		Low flat narrow outcrops.	Interlayered pale grey-green layers.	Fine grained	10-15%	50-60% combined microcline and plagioclase.	Actinolite and equant grains of chlorite; pale green layers contain actinolite and chlorite.	Foliation parallel to layering.	Epidote Trace Pyrite	Pillow structures were identified, are flattened in the plane of layering defined by the tuffaceous layers.
7c	Intermediate tuff, lapilli tuff and inter-layered siliceous meta-sedimentary (epiclastic) rocks.		Outcrops of moderate relief; weathers light grey-green; clastic fragments can be seen on well weathered surfaces. Dark grey lapilli are also visible on clean weathered surfaces.	Grey-green to dark grey.	Cryptocrystalline with fine grained amphibolite. The amphibole lies athwart the layering.	15-30%	40-60% combined plagioclase and microcline.	Actinolite 10% Biotite	Massive with discrete zones of aligned biotite.	Sericite Magnetite Zircon	Lapilli make up 5 - 12% of rock.
7d	Rhyolite to rhyodacite		Low relief, fragmented outcrops, light grey to cream.	Pale grey to light grey-green to pinkish-grey.	Cryptocrystalline with phenocrysts of quartz and/ or feldspar.	30%	60% microcline and plagioclase	Biotite 5-8% Minor actinolite	Lenticular aggregates	Hematite Minor arseno-pyrite Sericite	
6	Semi-pelitic paragneiss to mextatexite	100-160 cps	Rounded outcrops of low relief; (1) grey layered sequence	Grey	Medium grained. granoblastic, cordierite ± garnet, ± microcline, foliated.	15-25% locally up to 35%	0-50% microcline partly poikiloblastic; 0-50% plagioclase An_{23-26}	Biotite 15-30% fox-red in thin section; in areas of magnetite can be olive-green.	Girdle fabric or concentrated in layers and parallel oriented.	Cordierite ± Sillimanite, fibrolite, garnet, sillimanite needles and mats, andalusite, graphite, hercynite, tourmaline (dravite), zircon, apatite, pinite, pyrite, rare hypersthene.	

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
			(2) white, massive granitic *lits*, partially boudinaged.	White	Medium-to-coarse-grained, hypidio-morphic granular, massive.	20-30%	30-70% microcline, rarely orthoclase; 10-30% plagioclase An_{26-32}	Biotite 2-5%	Disseminated fine to medium grains with random orientation.	Cordierite, garnet, graphite, rare hypersthene in the Nejanilini Lake and Caribou Lake areas.	White granitic *lits* vary in amount from 15 - 80%, gradational into meta-texite (with mobilizate 30%).
6a	Semi-pelitic to paragneiss to schist and interlayered impure quartzite	100-150 cps	Moderate to prominent ridges.								
			i) grey discon-tinuous layers 2 mm to several metres thick.	Grey to grey-green	Medium grained granoblastic with ± porphyroblastic cordierite ± microcline, ± magnetite, foliated.	30-35%	40-45% microcline partly poikilo-blastic; 0-10% plagioclase	Biotite 10-20%	Parallel and/or oblique to com-positional layering	Cordierite Graphite Sillimanite Andalusite Garnet Magnetite Apatite	This rock type is gradational with the pelitic gneiss and contains pelitic interlayers and vice versa. The volume of impure quartzite is variable. The quartzite layers are from 2 mm to several metres thick and make up from 10 to 40% of the outcrop.
			ii) buff impure quartzite to arkose layers 2 mm to several metres thick.	Buff	Medium grained granoblastic, weakly foliated.	50-60%	10-20% microcline	Biotite 8%	Disseminated and aligned with sporadic cross fabric.	Zircon	The volume of buff granitic *lits* decreases to the east, as does the degree of metamorphism displayed by the semi-pelitic schist.
			iii) white to buff granitic *lits*	White to buff	Medium-to coarse-grained hypidio-morphic granular, massive.	35-40%	35-40% microcline; 10-15% plagioclase	Biotite 5%	Disseminated random	Graphite Cordierite Magnetite	
6b	Impure quartzite to quartzite		Elongate high ridges; weathers white to grey.	White to grey	Glassy in appearance to fine grained.	65-95%	10-20% microcline	Biotite 5-8%	Biotite is disseminated and aligned.	Cordierite 0-5% Muscovite 0-5% Sillimanite 0-2% Andalusite 0-2%	This rock type occurs either interlayered within the semi-pelitic gneiss becoming more persistent in its appearance towards the top of the sequence of semi-pelitic gneiss, or it forms a distinct zone of thickly bedded aluminous quartzites at the top of the pelitic gneiss. This rock type outcrops in the Munroe Lake, Nejanilini and Nichol Lake areas.
6c	Augen gneiss		Smooth, dark grey surtace	Dark grey, white augen	Fine grained quartz-biotite matrix with poi-kiloblastic microcline augen.	30-35%	35-45% microcline poikiloblastic augen; 0-5% albite inclusions in microcline.	Biotite 15-20%	Girdle fabric	Cordierite-quartz (as irregular clots).	Occurring in the Misty Lake and Clifton Lake areas.
6d	Biotite feldspar gneiss with buff grano-dioritic *lits*		Low flat outcrops. Dark grey with a rough surface; where abundant, the *lits* give the outcrop a ribbed appearance. At a few localities the *lits* during deformation were detached or boudinaged and rolled, giving the rock the appear-ance of a con-glomerate.	Dark grey	Medium grained well foliated to lineated.	20-25%	25-30% microcline; 30% plagioclase An_{19-25}	Biotite 15%	Linear trains of biotite give the rock a lineated appearance.	Magnetite 0-1% Zircon	This rock type occurs northwest of Great Island east and west of the Big Spruce Lake. It interfingers with the metavolcanic rocks and with the metamorphic sedimentary-derived rocks to the west.

APPENDIX:
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Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
5	Foliated quartz Monzonite		Pink with localized white patches; form large elongate ridges parallel to joints or foliation.	Pink	Fine-to medium-grained, cataclastic matrix with porphyroclasts of feldspar (up to 3 cm long) mortar texture.	25-40%	30-55% microcline string perthite largely as porphyroclasts; 25-30% ± plagioclase An_{8-20} rims of myrmekite and/or of chessboard albite.	Biotite 5% Hornblende 0-2%	Clots or patches of fine-to medium-grained parallel oriented biotite ± hornblende	Magnetite Apatite Zircon	Occurs in the north half of the Whiskey Jack Lake area (Map GR80-9-1) in the extreme southwest of the project area.
4	Foliated alaskite		Grey-brown or pink, partly rusty streaky surface; step-like outcrops of high relief.	Brown-grey, olive-brown or pink.	Fine-to coarse-grained xenoblastic; or heteroblastic to porphyroblastic; recrystallized mortar texture and cataclastic foliation.	25-45%	40-70% microcline. Xenomorphic to microperthitic recrystallized porphyroclasts, microcline rims in pink alaskite. 5-30% plagioclase An_{11-16} Albite in pink alaskite.	Biotite 3-5% Hornblende 0-3% Hypersthene 0-1% Largely altered.	Aggregated in parallel patches, slight to pronounced preferred orientation.	Magnetite Hematite Epidote Fluorite Zircon Apatite Monazite particularly in the pegmatitic phases.	Transitional to foliated quartz-monzonite; contains local pegmatite phases aplitic rocks.
3	Metadiorite to amphibolite	50-60	Moderate to high relief; dark grey.	Black to grey-buff.	Medium-to coarse-grained.	5-10%	50% plagioclase An_{28-32}	Chlorite Hornblende 10-65% Augite 5-8% Biotite 3-60%	Massive to weakly foliated biotite coarse grained highly aligned in a rock where it dominates over hornblende.	Epidote. Magnetite 1-2%. Red-orange Microcline 5-8% porphyroblasts.	Locally highly schistose forming a magnetite-microcline-hornblende-biotite-schist ± epidote.
2a	Hypersthene quartz diorite		White to buff or pink to pinkish-grey; forms very high ridges or steep blocky outcrops.	Dark grey	Medium to coarse hypidiomorphic granular, massive (core) to foliated (margin of 2a).	7-10%	0-5% microcline up to 25% in the altered margin of unit 2a. 50-70% plagioclase An_{34-36}	Hypersthene 2-5% Diopside 3-8% Hornblende 10-15% Biotite 5-8% (Chlorite and actinolite in the margin zone).	Biotite oriented.	Magnetite	Quartz diorite has a massive core with a foliated and altered margin. This rock is on the extreme southwest of the project area in the north half of the Whiskey Jack Lake map area.
2b	Hypersthene trondhjemite		Massive rounded outcrops with ribbed or steplike surface. White to buff, locally pale pink.	Brown to olive-green	Medium grained hypidiomorphic granular; locally cataclastic foliation with incipient augen structure.	20-25%	0-5% microcline; 45% string perthitic microcline. 35-60% plagioclase An_{21-28} Variably antiperthitic.	Biotite 5-17% Hornblende 0-2% Diopside 0-2% Hypersthene 0-2%	Biotite preferentially oriented, hornblende, diopside, hypersthene aggregated in parallel lenses.	Magnetite Garnet	Occurs in prominently foliated zones; composition ranges from quartz-rich diorite to quartz monzonite. This rock type occurs in the extreme southwest of the project area in the north half of the Whiskey Jack Lake area (Map GR80-9-1).
2c	Hypersthene -quartz monzonite	45-65 cps 1500-3000 cpm	Outcrops of moderate relief, blocky appearance, deeply weathered.	Deep olive-brown to translucent green.	Medium-to coarse-grained locally pegmatitic, hypidiomorphic granular weak schistosity to locally well foliated.	20%	35% microcline; 25-30% plagioclase An_{22-30} Myremkite 5%.	Biotite 3-5% Hornblende 0-3% Hypersthene 1-5%	Disseminated as lenticular aggregates of hypersthene, hornblende	Magnetite Apatite Zircon Trace fluorite	The main occurrence of this rock type is within the Nejanilini Massif which occupies the north half of the Nejanilini Lake area (Map GR80-9-6). The hypersthene-quartz monzonite makes up to 20% of the rock types in the massif. The remainder being dominated by the grey gneiss (unit A) and hybrid brown quartz monzonite (31a).
1	Hypersthene gneisses										
	(1) garnet-bearing		Grey to white; smooth outcrops with low relief.	Alternating dark grey and buff layers.	Medium-to coarse-grained, granoblastic foliated.	25-30%	40-45% plagioclase An_{45-50}	Hypersthene 2-3% Biotite 20%	Hypersthene as medium grained xenoblasts or poikilolitic porphyroblasts; biotite shows preferred orientation.	Garnet 3% Graphite 1%	

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
1	(2) clino-pyroxene-garnet-bearing amphibolitic		Dark grey to dark green; low outcrops with ribbed surface.	Grey-green	Coarse-to fine-grained, granoblastic; foliated.	40-50%	20-30% plagioclase commonly zoned (rim An_{35}, core An_{75})		Augite and aegerine-augite 8-10% Biotite 8-10% partially altered to chlorite and calcite as alteration product of hypersthene and clinopyroxene.	Garnet 1-5% Graphite 1%	Clinopyroxene, hypersthene and biotite bleached and reduced to opaque minerals. Occurs only at Misty Lake.
	(3) hornblende-bearing to amphibolitic		Buff to grey layers alternating with dark grey layers.	Grey-brown layers alternating with black layers.	Medium grained granoblastic foliated.	10-20%	30-70% plagioclase An_{28-40}	Biotite 10-20% Hypersthene 5-8% Hornblende 3-50%	Biotite aligned. Hornblende euhedral poikilitic porphyroblasts to fine-to medium-grained xenoblasts. Hypersthene bronze coloured tabular poikilitic porphyroblasts	Trace pyrite Hematite Magnetite with coronas of plagioclase.	Minor occurrence in the Misty Lake area with the major occurrences in the Nejanilini Massif (Nejanilini Lake map area).
	(4) metabasic		Forms a dark orange-brown coarse grained sand. Outcrop surface weathers brownish black.	Black to greenish black.	Coarse grained to medium grained, massive to granoblastic foliated.	5-10%	0-30% plagioclase An_{48}	Diopside 10-20% Hypersthene 20% Hornblende 30-50%	Diopside forms equant medium grains. Hornblende medium to coarse grains.	Magnetite 1-10% Garnet	Layering is irregular and discontinuous.
	(5) cordierite ± sillimanite ± corundum bearing		Grey	Buff	Coarse grained.	25-30%	20-30% perthitic orthoclase, microcline. 5-10% plagioclase	Hypersthene 8-10% Biotite 15-20%	Biotite shows preferred orientation.	Cordierite 10-20% Sillimanite 2% Hercynite 1% Corundum 0-1%	Occurs as a large inclusion in foliated quartz monzonite; biotite is green in colour where it contacts with hypersthene.
A	Grey gneiss	50-100 cps High 150 Low 30	Outcrops of moderate to high relief, generally as clusters of outcrops. Grey buff to brown, pale reddish pink deep weathering.	Grey, reddish pink	Medium grained granoblastic well to weakly foliated.	25-35% often in lenticular aggregates.	Microcline 40-45% Plagioclase 15-20%	Biotite 3-8% Hornblende 0-3%	Disseminated and aligned or in wispy lenticular aggregates.	Magnetite 0-1%	This gneiss comprises a group of granitoid rocks which are intimately related on an outcrop scale. These rocks vary from a fine grained grey foliated quartz monzonite to monzonite gneisses. A second rock type present is a reddish brown foliated quartz monzonite to granodioritic gneiss. Pink quartz monzonite *lits* are common in all these rock types. The grey gneiss is the major rock type in the north half of the Munroe Lake and Nejanilini Lake area (Map GR80-9-6). Within the Nejanilini Massif (Nejanilini Lake map area) the grey gneiss contains lenses (1000 cm^2 to 1000 m^2) of hypersthene quartz monzonite (unit 2c).
B	Biotite-granoblastic to tonalite	60-80 cps	Moderate relief, weathers grey; lineated variety has a pitted surface.	Buff-grey	Medium grained hypidiomorphic granular.	10-20%	5-20% microcline. 40-60% plagioclase An_{24-29}	Biotite 5-10%	Disseminated. aligned; in lineated variety forms rodded aggregates.	Magnetite 0-1%	Lineated variety occurs south of Shethanei Lake and at Tadoule Lake.

APPENDIX:
SUMMARY OF ROCK DESCRIPTIONS, COCHRANE RIVER — SEAL RIVER PROJECT (Cont'd)

Map Unit	Rock Type	Radiometric Intensity	Weathering Characteristics	Colour of Fresh Surfaces	Grain Size and Fabric	Quartz	Feldspar	Mafic Minerals	Fabric of Mafic Minerals	Accessory Minerals	Comments
C	Granodioritic diatexite to biotite metatexite	60-80 cps	Moderate relief.	Buff-grey	Medium grained.	20%	30% microcline. 25% plagioclase An_{28}	Biotite 25-30%	Well aligned.	Garnet	
D	Amphibolite	40-50 cps	Moderate to high relief, dark grey.	Black to grey-buff	Medium-to coarse-grained.	5-10%	50% plagioclase An_{28-32}	Biotite 3-8%; olive-green hornblende.	Hornblende forms equant grains; rock has layering but poor foliation	Magnetite 1-3%	Iron formation is associated with amphibolite immediately south of Caribou Lake.