

GEOLOGICAL SURVEY OF CANADA

OPEN FILE REPORT 1243



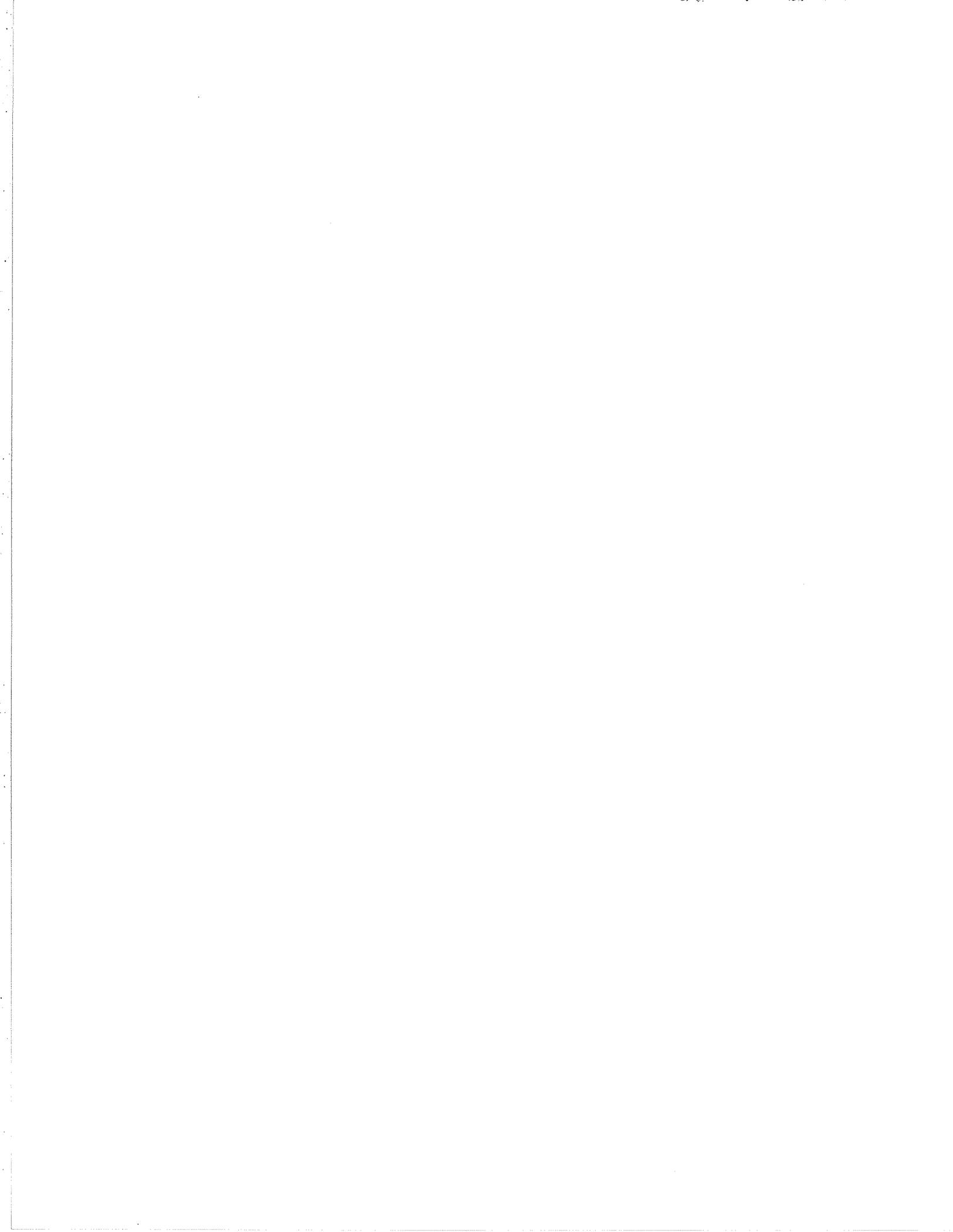
PRECAMBRIAN GEOLOGY OF THE INDIN LAKE MAP AREA

NTS 86B, DISTRICT OF MACKENZIE

This document was produced
by scanning the original publication.

Ce document a été produit par
numérisation de la publication originale.

R.A. FRITH



Photographs*

- i Typical landscape above and below the tree-line.
- 1 Basement tonalite gneiss from the Cotterill lake area.
- 2 Basement tonalite gneiss, cut by gabbro (now amphibolite) dykes and subsequently deformed.
- 3 Relatively undeformed pillows from near Indin Lake.
- 4 Highly deformed pillows from the Grenville Lake area.
- 5 Volcanic flow breccia from south of Spider Lake.
- 6 Volcanic conglomerate from the west arm of Indin Lake.
- 7 Sub-biotite grade greywacke-mudstones turbidites from the Damoti Lake area.
- 8 Migmatitic paragneiss, west end of Indin Lake, derived from metasedimentary rocks.
- 9/10 Schlieren migmatite from the Snare Lake migmatite complex.
- 11 Banded migmatite south of Drumlin Lake.
- 12 Breccia migmatite south of Drumlin Lake.
- 13 Folded Snare Group greywackes, Brownwater Lake area.
- 14/15 Snare Group conglomerate beds, Clearwater Lake area.
- 16 Margin of the Rodrigues Lake granite, showing intrusive relationship.
- 17 Margin of the Rodrigues Lake granite showing a common late-garnet growth in both host paragneiss and the pluton.
- 18 Second fold in Yellowknife Supergroup metagreywackes, north arm of Indin Lake.
- 19 Third phase cleavage (S3) in argillaceous greywackes, north arm of Indin Lake.
- 20 Third phase folds in coarsly bedded sedimentary rocks of the Yellowknife Supergroup.
- 21 Porphyroblasts of andalusite growing parallel to S2 in metasediments, north arm of Indin Lake.
- 22a Boudinaged quartz veins and tension gashes in rocks equivalent to the Yellowknife Supergroup, found west of the Bear Slave Boundary, Mattberry Lake area.
- 22b S1 foliation cutting across remnant bedding in Snare Group sub-greywackes, Brownwater Lake area.
- 23 Andalusite porphyroblasts in argillaceous greywacke near the cold side of the cordierite-staurolite isograd, north arm of Indin Lake.
- 24 Retrograded cordierite porphyroblasts in Yellowknife Supergroup metagreywackes from the Grenville Lake area.
- 25 Porphyroblasts of cordierite and staurolite near the more argillaceous top of a graded bed, west arm of Indin Lake.
- 26 Retrograded cordierite porphyroblasts showing selective growth in the more argillaceous beds.

* Photographs are not included in this Open File report

TABLES

- 1 Table of Formations.
- 2 Chemical analyses of basement rocks.
- 3 Whole rock analyses of Yellowknife Supergroup metasedimentary rocks.
- 4 Whole rock analyses of the Origin Lake plutonic complex and the Sphynx Lake pluton.
- 5 Modal analyses of diabase dykes from the Indin structural basin.
- 6 Metamorphic minerals in the Yellowknife Supergroup metasedimentary rocks.
- 7 Assay results from Lex Lake, 1984-1985.
- 8 Correlation of supracrustal deposition, plutonism, structure and metamorphism from the Slave part of the map area.
- 9 Time-stratigraphic relationship of events in the Wopmay Orogen compared with events in the Indin structural basin.

FIGURES

- 1 Geologic sketch-map of the map area and environs.
- 2 Geologic sketch-map showing the distribution of granitoid rocks in the map area.
- 3 Mesonormal plot of basement gneiss from the Grenville Lake and Cotterill Lake area.
- 4 Trace element distribution in the basement rocks.
- 5 Distribution of volcanic and sedimentary rocks in the map area.
- 6 Graphic comparison of metasedimentary whole rock compositions from the map area and the northeast and south Slave Province.
- 7 Trace element content of metasedimentary rocks from the north arm of Indin Lake.
- 8 Meyer migmatite sample location map.
- 9 Density contour map of the Origin plutonic complex.
- 10 Mesonormal plot of whole rock analyses from the Sphynx Lake pluton and the Origin plutonic complex.
- 11 Trace element contents of rocks from the Origin plutonic complex.
- 12 Schematic map of the Basler intrusive complex showing the distribution of igneous textures.
- 13 Sample location map for the Basler plutonic complex.
- 14 Streckeisen diagram for rocks of the Basler plutonic complex.
- 15 Diabase dykes in the Indin Lake area.
- 16 Geologic map of the Spider Lake area showing the east-northeast trend of S0-S1 in the volcanic rocks and the north-northeast trend of S2 in the metasedimentary rocks.
- 17 Sketch-map of the gneiss domes in the Emile River area.
- 18 Isograds in the Brownwater Lake area.
- 19 Gold showings in the Steeves Lake area showing the location of the Colomac Adit into the auriferous quartz albite sill.
- 20 Cause and effect of regional stress - Indin structural basin.

CONTENTS

V-1	Abstract
1-1	Introduction
	General character of the area
1-2	Acknowledgements
1-3	General geology – Slave Province
	Archean
	Basement complex
1-5	Yellowknife Supergroup metavolcanic rocks
1-10	Yellowknife Supergroup metasedimentary rocks
1-12	Hybrid Granitoids
1-15	Plutonic rocks
1-16	Archean plutons associated with the "Kenoran" Orogeny
1-21	Pegmatites
2-1	Proterozoic
2-1	Diabase dykes
2-2	General Geology - Wopmay Orogen
2-3	Archean basement rocks
2-6	Proterozoic Rocks
	Coronation Supergroup
	Snare Group
2-9	Gabbro dykes & sills
	Hepburn Intrusive Suite
2-10	Pegmatite
	Structural geology
	Slave Province
	Pre-Yellowknife Supergroup events
2-11	Kenoran deformation
2-13	Proterozoic deformation
2-14	Tectonic Interpretation of the Indian Structural Basin
2-15	Slave Structural Province Boundary
2-17	Wopmay Orogen
2-17	Archean deformation
2-18	Proterozoic Deformation
2-20	Metamorphism
2-20	Slave Province
2-20	Pre-Kenoran metamorphism of the basement
2-20	Metamorphism of the Yellowknife Supergroup metasediments
2-22	Contact metamorphism
2-23	Wopmay Orogen
	Archean metamorphism
2-24	Proterozoic metamorphism
2-24	Calderian metamorphism
2-26	Economic Geology
2-26	History of Exploration
2-28	Mineral Deposits
2-29	Hints to gold prospectors
3-1	Tectonic synthesis
3-6	Plate Tectonics
	References
	Figure captions
	Tables



Abstract

The Indin Lake map area straddles the boundary between the Slave Structural Province and the south central zones of the Wopmay Orogen. Within the Slave, supracrustal rocks occur in irregular, generally north-south trending belts made up of basaltic volcanic rocks and turbiditic greywackes and mudstones of 2.67 Ga age. Intervening areas are made up of hybrid rocks derived from both basement granitoid (Ca. 2.99 Ga) and supracrustal rocks as well as plutonic rocks generally of granodiorite or granite composition. An orogeny, analogous to the Kenoran, (ca. 2.6 Ga.) modified existing structures, metamorphosed rocks to the upper amphibolite facies and re-equilibrated some isotopic systems.

The boundary between the Slave and the Wopmay Orogen in the map area is a normal fault over most of its length. Proterozoic, penetrative deformation due to the Calderian Orogeny is most evident in the supracrustal rocks of the Coronation Geosyncline, but also as minor penetrative and brittle deformation as much as 40 km into the Slave craton. The west margin of the Slave Province has been thickened by westward subduction of the Slave plate, causing regional uplifts of areas underlain by buoyant granitoid rock and downwarps of areas underlain by more-dense rock.

Within the Wopmay Orogen, Archean craton rocks are unconformably overlain by Proterozoic Coronation Supergroup, which is deformed into tight upright to eastward verging folds adjacent to the Slave Province. The style and complexity of deformation and regional metamorphism increase westward, changing from a single set of folding and one recognized phase of greenschist metamorphism to three sets of deformation and regional metamorphism up to the granulite facies. Plutons of megacrystic, rapakivi-textured granite, correlated with the Hepburn Intrusive Suite, intrude metamorphosed and deformed rocks of the Coronation Supergroup. Older rocks of the Wopmay Orogen show isotopic re-equilibration at 2.3 Ga and again with Proterozoic rocks at about 1.9 Ga.

INTRODUCTION

The Indin Lake map-area was mapped during the summer of 1972, 1973 and half of the summer of 1974 as part of a program to update geologically and economically important areas of the Northwest Territories. The work was partly a compilation of former one mile to the inch maps that cover about 25 percent of the area. Important localities were revisited and most granitoid areas were remapped. The interpretation of the geology of the area benefited from Rb-sr whole rock, U-Pb zircon and K-Ar geochronological studies, geochemical whole rock analyses and detailed structural studies.

Geological work within the map area began in 1938, when gold was discovered near Indin Lake. Reconnaissance 4 mile to the inch mapping began in 1939 by C.S. Lord and J. Tuzo Wilson, who mapped the west half of the Indin Lake map area as the east half of the Ingray Lake map area (Lord, 1942). The east half of the present map area was mapped by Fortier in 1948 (Fortier, 1949). More detailed maps were made of potential gold producing areas within the volcanic and sedimentary rocks in the Chalco Lake (Stanton et al. 1948) Ranji Lake (Tremblay et al. 1947) and Ghost Lake areas (Wright, 1954). Other one mile to the inch studies of the Bear-Slave Structural Province boundary were carried out in the east half of the Arseno Lake map area (McGlynn and Ross, 1966), the west half of the Mesa Lake area (Ross, 1966), the east part of the Mattberry Lake map area (Smith, 1966) and the Basler Lake area, along the south margin of the Mattberry Lake area (McGlynn and Ross, 1965). Some unpublished detailed mapping around mineral prospects, available from the Resident Geologist's Office in Yellowknife, were used in the compilation.

General character of the area

The map area lies along the tree-line, which extends roughly, from due north of Mesa Lake, through Origin Lake, to Truce Lake and to the southeast corner of the map area. The area north of the line contains patches of stunted, black spruce, arctic willow and other low ground cover. Within forested areas, white and black spruce and white birch are abundant, with local abundance of poplar, jack-pine and tamarack. White spruce may be as much as 60 cm at the base, but most commonly diameters are 15 cm or less.

Wildlife was abundant during the mapping of the area. In 1972, several thousand caribou were seen migrating southward in early August near the east end of Mesa Lake. Moose are found in the timbered areas and along the tree-line. Black bears were all too numerous, but grizzly bears were sited infrequently near Mesa and Grenville lakes. Small game included Arctic hare, spruce grouse, ptarmigan, and many species of water-fowl. Many sittings of bald eagle were made in the Brownwater Lake area and both common and arctic loons were observed. Lake trout, pike, and greyling are common. Lord (1942) reported northern sucker, yellow pickerel and ling.

The Snare Mountains are found in the western part of the area, where north-south trending topography provide the necessary protection from northwesterly prevailing winds that give rise to forested west-facing slopes. Local relief of 60 m occurs west of Rodingues Lake, with some vertical fault-bounded cliff facies. A fault scarp separates the Snare Mountains from the plateau area to the west. Grenville Lake is located at the height of land

between arctic drainage through the Coppermine River system and southward drainage through the Emile River system into Great Slave Lake. The rivers in the map area are fast, rocky and mostly unnavigable.

The terrain around Indin Lake is moderately rugged and forested, with local relief up to 60 m. North of Spider Lake and around the Snare Lakes topography is relatively flat, with local relief generally less than 30 m.

Settlements: No permanent settlements occur in the area. However, a village on Snare Lake was inhabited during the trapping seasons of 1972-1975 by people from Rae, Great Slave Lake. The village consisted of about 10 log cabins and a regional game management station.

Climate and frost action: Break-up of Indin Lake took place during early June in 1973-1974 and large lakes near the northern margin of the area a few weeks later. During the peak of summer, temperatures rarely exceed 30 degrees and winters have been reported as low as -40 (Yardley, 1951). The 5 degree, mean annual isotherm passes 160 km to the south of the area, as does the southern boundary of continuous permafrost (Jenness, 1949).

Frost action has produced polygonal ground beneath shallow lakes and under swampy ground. Frost thrust blocks are common and blocks weighing many tons have moved up and locally out of the surrounding bed-rock. Frost thrusting is most common in flat swampy ground and in rocks that have a well developed fissility. The largest blocks are from granitic rocks and the smallest from cross-fractured slates. Thrusting takes place by expansion during warming phases (Yardley, 1950). Trapped water is super-cooled to as low as -22 C degrees (Bridgman, 1915) and then expands with the increase of temperature.

Pleistocene geology: Glacial deposits consist of kames, deltas and sand plains, most of which have been modified by subsequent water action. Felsenmir is common in flatter terrain, underlain by granitoid rocks. The west slopes of hills are generally covered with bouldery till and lowlands are immature, swampy and generally devoid of outcrop.

Flat granitoid terrain is covered with a glacial fluvial blanket of variable thickness. In the east half of the area and north of Truce Lake, the blanket is relatively thick and rock crops out only where resistant rocks like dykes and volcanic rocks stand out in relief.

Ice moved west, modified locally by north-south trending topography. Directions of ice advance are shown by boulder trains, eastern drumlin stoss slopes and eastern roches moutonees. Some ice fanning may have taken place, as indicated by deviations in local glacial striae. Most glacial deposits are of local derivation, with individual deposits showing westerly transportation and a strong correlation to local bedrock (Sklash, 1973).

Acknowledgements:

The writer was capably assisted by Rosaline Goodz, Hewart Helmstaedt, Michael Sklash, Renald Tremblay and William Hamilton in 1972 and by John Hill, Robert Leatherbarrow, Ian Bell, Randolphe Rice and Nathan Rey in 1973. The

Brownwater Lake area was mapped at a scale of 1:50 000 during a 6 week period during 1974 by R. Leatherbarrow and the author. In 1972, Liftair Helicopters' pilot George Causey and engineer Edward Godleski provided excellent service, as did engineer-pilot Gerry Dykers in 1973. Logistics were carried out through the Resident Geologist, Robert Hornal, who provided advice and friendship.

GENERAL GEOLOGY - SLAVE STRUCTURAL PROVINCE

The map area straddles the Slave Structural Province boundary, as defined by Stockwell (1964). East of the boundary, bedrock is mostly Archean (Fig. 1), but Proterozoic intrusive stocks, dykes and pegmatites are also present, making up about 2% of the area.

Archean

Archean rocks include; granitoid basement complex rocks, plutonic rocks, and supracrustal rocks of the Yellowknife Supergroup. Proterozoic rocks include; small stocks of granodiorite and hypabyssal pegmatite and diabase. The map units and their stratigraphy are outlined in the Table of Formations (Table 1).

Basement complex

The basement rocks in the Indin Lake map area were recognized initially in the Grenville Lake area by their stratigraphic position beneath the volcanic rocks in the Grenville lake area and by the relatively low grade of regional metamorphism (Frith et al. 1974). The basement tonalite resembles tonalite gneiss found elsewhere in the Canadian Shield (Baragar and McGlynn, 1976). Follow-up dating (Frith et al. 1973; Frith et al. 1986) showed the rocks to be older than the supracrustal rocks of the region and further regional mapping, outlined other basement areas within the map area (Fig. 2).

Grenville Lake area

The Grenville Lake area rocks are heterogenous and characterized by the presence of grey to light buff coloured outcrops of granitoid gneiss, cut by gabbro or amphibolite dykes that trend in an east-northeast direction. Patchy areas of undeformed muscovite-bearing pegmatite occur within the complex. The granitoid gneiss is cut by pink aplitic veins and minor irregular bounded, uniform, medium even grained granite. The granite contains minor biotite and, in places, muscovite bearing pegmatitic dykes, veins and irregular segregations. All together the secondary granitoid rocks make up about 25 percent of the complex area. The rocks are almost ubiquitously metasomatized or migmatized by the addition of potassium, alternating the rocks from a tonalitic to a granodiorite or granite in over all composition. In locally restricted areas the rock is grey, medium grained and of tonalitic or trondhjemitic composition, which was likely the composition of the rock before introduction of potassium. Areas of least metasomatized gneiss are accentuated in Fig. 2.

The complex is bounded to the west by basalts, that face away from the complex. The contact between the granitoid complex and the volcanic rocks is mostly a zone of displacement, with the lighter complex rocks moving up relative to the volcanics. This deformation diminished away from volcanic rocks, but was

observed as much as a kilometer from the contact. Only scattered outcrops of paragneiss migmatite are present to the north and east, so that the nature of the contacts with these rocks is largely unknown.

Meta-gabbro dykes, possible feeders to the adjacent volcanic rocks, intrude the basement gneiss in a east-northeast direction. They are amphibolitic at the margins and have a foliation that is common to the east-west regional direction. The dykes on the major promontory of Grenville Lake have all been retrograded but ophitic textures are preserved near their centres.

Cotterill Lake basement complex:

The Cotterill Lake basement complex is more migmatitic than at Grenville Lake and the few amphibolite dykes present are more deformed and granitized. Some are veined by potassic aplites, others contain porphyroblasts of potassium feldspar. Deformation has produced a vertical to steeply inclined foliation that is oriented parallel to the volcanic-granitoid contact. In the Cotterill Lake peninsular region and in nearby islands, a fine- to medium-grained, biotite-hornblende paragneiss is in contact with the basement gneiss. These rocks are similar to mafic paragneiss in the Chartrand Lake area and were likely derived from a mafic volcanic source (McGlynn and Ross, 1963) and have been mapped as part of the Yellowknife Supergroup metasediments. The complex is intruded by megacrystic granodiorite that also intrudes the east adjacent Snare Lakes migmatite complex, both of which are discussed further on (units AM and AP).

The Cotterill Lake basement complex is highly deformed (Photo. 1), but in tonalite gneiss areas (Fig. 2) rocks are more massive and are less contaminated by externally derived granitoid pegmatite and aplite. The largest area of basement gneiss occurs in an oval-shaped area, also denoted by an anomalously high aeromagnetic pattern.

The contact between the Cotterill Lake basement complex and the metavolcanic rocks of the Indin Lake area is relatively sharp. Rocks on both sides being highly foliated and sheared. Hornblende gneiss within the basement complex is stretched and folded and porphyroblasts of potash-feldspar are locally deformed into augen structures. The hornblende gneiss is locally interlayered with biotite granite gneiss and across strike the rocks are heterogenous and locally mylonitized. The metamorphic grade of the adjacent Yellowknife metasediments near the outlet to the Snare Lakes, suggest that part of the basement gneiss is below the regional cordierite-staurolite isograd (Fig. 2).

Other basement occurrences

Possible basement rocks occur within the Origin plutonic complex southwest of Mesa Lake and near Origin Lake. Basement may have been uplifted with the complex during Proterozoic isostatic adjustment.

The marginal rocks of the Origin Lake intrusive complex in the Origin Lake area are made up dioritic, tonalitic and granodioritic gneiss that are fractured and intruded by secondary, lesser deformed, medium equigranular granite dykes. The secondary rocks show intrusive relationships with the volcanic rocks but the tonalitic gneiss does not and its relationship with the volcanic rocks is uncertain. Chemical analyses of the more gneissic tonalitic rocks indicate they are similar to those of the Grenville and Cotterill Lake area (compare Table 2 with Table 4).

A smaller isolated area of basement tonalite gneiss occurs northeast of the Basler plutonic and metamorphic complex. Smith (1966) thought the rocks were the oldest in the Mattberry Lake map-area. The area is made up of hybrid rocks consisting mostly of tonalite and quartz diorite, with secondary, more alkalic, deformed rock. Discontinuous banding at the margins grades to a more massive texture toward the centre of the tonalite.

An irregular area of basement gneiss occurs along the eastern part of the Snare Lakes Complex. The gneiss is heterogenous, but like the Cotterill Lake rocks, it is characterized by a high aeromagnetic anomaly which may reflect the greater abundance of opaque minerals in these rocks. Amphibolite made up of coarse grained hornblende with 10 to 20 percent plagioclase occurs in an outcrop poor area southeast of the basement gneiss. The extent of the amphibolite is not well defined, but it may be derived from metagabbro dykes similar to those in the Grenville Lake area.

Age of the basement granitoid gneiss

The basement complex is a region of hybrid rocks, formed in part by metasomatism and/or migmatization of older granitoid gneiss. Initial Rb-Sr whole rock isochrons of remnant gneiss indicated an age of 2939 +/- 51 Ma (Frith et al. 1973). However, this value dates the time of regional metasomatism, as deduced from field relationships. Further U-Pb geochronological studies of zircons has shown that the intrusive age is slightly older at 2989 +/- 5 Ma (Frith et al. 1986).

Geochemistry of the basement gneiss and related rocks

Whole rock analyses of the various rocks from the basement complexes at Grenville Lake and Cotterill Lake are listed in Table 2. The analyses are highly variable in K_2O content ranging from 0.69-4.34%. This contrasts with the Na_2O and Al_2O_3 range, which remains within one percentile. The reason for this may be observed in the field. Pink patches occur within grey gneissic terrane, where K-feldspar has replaced plagioclase. The analyses have been converted to give Barth mesonorms (Barth, 1962) and the appropriate mineral proportions have been plotted on a Strekeisen diagram (Fig. 3).

Trace element analyses of basement whole rocks support observations in the field that indicate K-metasomatism. There is a marked decrease in the K/Rb in the more leucocratic rocks of the study sample (eg. No. 2 and 4, Table 2). This is possibly due to the production of K and Rb by partial melting of the lower crust, where biotite (allow K/Rb mineral) is preferentially melted. The fluids accumulate at higher levels as leucosome, enriches the bulk composition of the permeated rocks in potassium and rubidium with low K/Rb.

Yellowknife Supergroup metavolcanic rocks

Most of the volcanic belts of the area have been mapped previously at 1:63,360 scale, resulting in a good understanding of lithological relationships and petrography. The age of the Yellowknife Supergroup has been determined elsewhere at 2669 +/- 15 Ma (Frith and Loveridge, 1982). The age is based on U-Pb zircon determinations from a variety of locations within the Slave Province, from volcanic and detrital sources as well as syn-volcanic plutons.

The following accounts are partly digested from earlier reports by Tremblay (1948), Stanton (1947), Wright (1950), Yardley (1951), Fortier (1949), McGlynn and Ross (1963) and Ross (1966). The Grenville Lake belt is less well known and is described for the first time.

Indin volcanic belt:

The Indin belt is irregular and for descriptive purposes is divided into three segments. The northern segment extends from Hewitt Lake toward Spider Lake where it curves toward Chalco Lake in an Archean structure called the Spider Lake synclinorium. The second segment lies east of Chalco Lake and thins toward the north and east, becoming interstratified and folded with metasedimentary rocks toward Pate Lake, a second segment extends from south of Chalco Lake to Ranji Lake, where it is disjointed by a series of left-lateral faults. The third segment, northwest of Damoti Lake, parallels the west bank of the lower Snare River.

There are three principal groups of volcanic rocks: 1) basic volcanic rocks, consisting mostly of pillow basalt with minor andesite; 2) felsic volcanic rocks consisting of dacitic flows and pyroclastic rocks; and 3) porphyritic or sill rocks of mafic and felsic composition.

1) The pillowed basalts, which make up the bulk of the mafic volcanic rocks, are mostly altered by the effects of greenschist to upper amphibolite facies regional metamorphism. The rocks are further affected by two or more penetrative phases of deformation. Where pillows are not overly deformed the dimensions are about 1:2:3 and similar to those illustrated in Photo 3. The mafic volcanic rocks are commonly interbedded with minor felsic tuffs and breccias and the proportion of these rocks is generally greater toward the tops of these successions. Although the minor rocks are not mappable at the scale of this study, a small area from the Spider Lake area was mapped in detail that showed the presence of basaltic and andesitic breccias, interlayered with pillowed flows to outline a coarse bedding which shows east-west trending deposition.

The west limb of the Indin belt is mostly comprised of recrystallized gneissose or schistose hornblende bearing rocks that are dark green to grey-green or buff in colour. Commonly the rocks are banded, alternating greenish-brown with buff colours. Fresh surfaces are shades of green and black similar to rocks found northwest of Grenville Lake (Photo 4). Some flows are amygdaloidal, with calcite infillings. Narrow intercalations of tuff, flow breccia and dacite are common.

Where basic volcanic rocks are in contact with the Sphynx Lake pluton, the contact is sharp and well defined with a few xenoliths present in the intrusion. The flows have been recrystallized to a granular, gneissic rock made up of black hornblende and waxy green plagioclase. Basic sills are present within the basic flows, but due to their similarity in colour and texture, an accurate estimate of their volume is not reliable, but is probably less than 5%.

2) Felsic volcanic rocks include; tuff, lapillae tuff, breccia, and minor porphyry. These are interbedded with the more mafic rocks. They are most common near the base of the Yellowknife Supergroup metasedimentary rocks. Large areas of these rocks are found along the margin between Spanner and Indin Lakes. Between Cranston and Schwerdt Lake, the rocks cover the full width of the belt. The rocks mostly weather grey-green to rusty white. Shear zones and fractures are commonly filled with buff-brown carbonate. In thin-section the rocks

are recrystallized to a mass of fine quartz, plagioclase and mica with minor sericite, hornblende, carbonate and various fine opaque minerals.

The tuffaceous rocks are fine-grained, light coloured and banded in shades of buff, grey and green. The tuffs are probably the most voluminous of the felsic rocks and are similar to the felsic interlayers found within the basic volcanic rocks. The tuffs generally have a dacitic composition but are locally as mafic as andesite. However, the original composition is contaminated by carbonate introduced along fractures which may accentuate or cause the fine banding noted locally.

Felsic flows of dacitic composition locally contain quartz phenocrysts or more rarely, feldspar phenocrysts. These rocks are massive and flinty in outcrop and fractured in places. Several ovoid masses are present that may open to sub-surface domes.

Volcanic breccia is locally interbedded with other volcanic rocks and commonly occurs as lens-like bodies which grade laterally and vertically into tuffs and lapillae tuffs. Like other felsic volcanics in the map area, they occur in the uppermost part of the pile. They contain angular to sub-rounded fragments and are normally contained in a tuffaceous matrix of the same composition. The proportion of fragments larger than lapillae size varies and may constitute as much as 50 percent of the rock. The fragments are more resistant to weathering and commonly stand out from the matrix, as lighter coloured rock. On fresh surfaces, the matrix is greenish and reveals a schistose texture that appears devoid of fragments. Carbonatization associated with shearing, has obliterated many primary depositional features.

Flow-breccia was observed in a few localities in the Spider Lake area (Photo 5). These rocks contrast with pyroclastic breccias by the presence of a meta-igneous matrix and a flow-like orientation of clasts. The fragments are lens-shaped and commonly tapered. Conglomerates may be present along the interface between volcanic and sedimentary deposition. A spectacular example of this type of deposition is found along the east margin of a volcanic finger, extending from islands near the centre of Indin Lake (Photo 6). The conglomerates are close packed and made up entirely of felsic volcanic rocks that are flattened along the principle foliation direction.

3) Porphyritic sill rocks of both basic and felsic composition are present in the rocks of the Indin Lake belt. The dioritic or gabbroic bodies west of Baton Lake are massive, containing hornblende and plagioclase and locally small blue quartz phenocrysts. The finer grained phases resemble fine grained andesite flows. Large gabbroic plugs are present in the Ranji Lake area which may be feeders to mafic flows at higher stratigraphic levels. Minor porphyry rocks are present as dykes and sills, which were possibly feeders to felsic volcanic eruptions, as they are within and near the felsic flows and pyroclastics found along the northwest margin of the Damoti Lake segment.

The albitic sill intruded into and near the flank of mafic sills in the Baton Lake area (Fig. 19) is a medium grained, grey-white to pink weathering rock composed of albite, quartz and minor chlorite, biotite, hornblende and pyrrhotite. Small blue quartz phenocrysts are found in places. The dykes are highly fractured and as described in the section on economic geology, are locally auriferous. The fractures containing gold are related to late, Archean, regional deformation and low grade metamorphism.

Between Henderson and Damoti Lakes, the belt is comprised of two north-south trending limbs that form the sides of a synclinal structure. The intervening area contains isoclinally folded, younger metasedimentary turbiditic greywackes and mudstones. The western limb, from Chalco to Strachan Lake, contains felsic volcanic rock along its west margin which thins eastward, like the more northerly part of the belt. The easternmost volcanic rocks are in upright, vertical, deformed contact with similarly deformed rocks of the Cotterill basement complex. The volcanics have been altered to a hornblende gneiss, but vestiges of extremely attenuated pillows are locally evident. The main Ranji Lake segment is banded from stretching of pillow structures and recrystallization. The rocks contain some secondary biotite. The south end of the Chalco-Ranji segment is faulted against hybrid granitoid rocks.

The more felsic rocks are less deformed and fragmentary textures are mostly preserved. The felsic rocks are comprised of tuffs, lapillae tuffs and breccias. Small felsic plugs intrude both felsic volcanic rocks and the overlying metasedimentary greywackes. If these are feeders for younger felsic volcanic rocks, then sedimentation was locally contemporaneous.

The volcanic segment east of the Snare River is metamorphosed beyond the cordierite-andalusite isograd, altering the rocks to chlorite, epidote and hornblende bearing gneiss. Along the western margin of the segment, the basic volcanic rocks have been completely recrystallized to hornblende-plagioclase gneiss. The metasediments between the western margin of the segment and the Basler Lake plutonic complex have been tightly folded and progressively metamorphosed toward the west where they become migmatitic.

Chartrand Lake Volcanic Belt:

The volcanic rocks that extend from north of Chartrand Lake to the northern boundary of the map-area, form a dipper-shaped belt that faces westward, bounded to the west over much of its length by the Slave Province boundary fault. This part of the belt thins toward the north and becomes interlayered with metasedimentary rocks of the Yellowknife Supergroup. Elsewhere, stratigraphic relationships suggest the Archean volcanic and metasedimentary rock are unconformably overlain by Proterozoic metasediments of the Snare Group (Mattberry Lake area). The bedding in the volcanic rocks along the wider parts of the belt has been thinned by east-west compression. However, in the Mesa Lake area, the metasedimentary rocks and the inter-layered volcanic rocks were folded together in two stages of Archean deformation. During the Proterozoic, these rocks were folded and metamorphosed again, along with the unconformably overlying Snare Group.

The southern Chartrand belt is more than 6 km wide and top determinations across it suggest a homoclinal succession with the base against the Origin Lake plutonic complex and the top in conformable contact with paraconglomerate and hornblende gneiss, which are in turn overlain by Yellowknife Supergroup metasedimentary rocks. The widest, southeast part of the volcanic belt has been modified by three buoyant, granitoid bodies; the Origin plutonic complex to the northeast, the Sphynx Lake pluton in the southeast and the Meyer migmatite complex to the southwest. These bodies have forced a three tongued saucer shape to the southeastern part of the belt, but has left the stacked, inclined, domino-like stratigraphy more or less intact. The southeast part of the belt is highly deformed at the margins, but toward the centre, the basalts are little deformed and primary textures, such as pillow structures and amygdules are well preserved.

McGlynn and Ross (1963) describe the Chartrand Lake volcanic rocks as mostly dark green, fine-grained and foliated with blue-green hornblende, local actinolite and plagioclase, with or without small amounts of quartz, sphene, sulphide minerals, epidote, chlorite or biotite. Like other volcanic rocks of the map-area, the amphibole minerals are secondary and platy minerals are oriented parallel to the regional foliation. The foliation has been modified by Proterozoic uplift of the Origin Lake Granitoid Complex. Plagioclase is commonly crushed and elongated and pillows are stretched along steep to vertical lines, parallel to the foliation.

Within the volcanic succession are minor tuffaceous bands, small dykes and irregular masses of felsic porphyry and synvolcanic diorite and gabbro. Banded amphibolites are present, along parts of the east margin of the belt. The westernmost lavas have been sheared into a zone of chlorite-carbonate schist which is up to 150 m wide. Paraconglomerates that overly the lavas are highly deformed and the volcanic and granitoid cobbles have been flattened into elongated discs.

The Chartrand Lake belt in the Mesa Lake area has been described petrographically by Ross (1966) as banded hornblendic rock with lenses of vestigial pillow lava, similar to that shown in Photo 4. They are mostly dark black to dark green, fine-even-grained, massive to foliated rocks. The banded rocks alternate from hornblende-rich bands to quartzofeldspathic-rich bands, that like the more southern banded gneiss, were likely derived from stretched out pillow structures. Persistent strike of some leucocratic bands, suggest that the original rocks may have been more felsic and tuffaceous in this part of the belt.

Grenville Lake volcanic belt:

Volcanic rocks of the Grenville Lake belt are, for the most part, similar to those of the Chartrand Lake belt. They are comprised almost entirely of pillowed basalt and andesite. Felsic rocks are less abundant. West and south of Grenville Lake, they overlie the basement granitoid gneiss and are in turn overlain conformably by metasediments of the Yellowknife Supergroup.

Regional metamorphism of the volcanic rocks along the south shore of Grenville Lake is of greenschist grade, but the basement and the volcanic rocks are highly deformed at the interface. This has the effect of destroying any primary structures and relationships between the two rock types. However, the centre of the belt preserves pillow-like structures that suggest the belt faces away from the older basement rocks. The least deformed volcanic rocks are commonly fractured and impregnated with carbonate and quartz veins that further mask or destroy primary depositional structures.

Gneissose meta-gabbro dykes intrude the Grenville basement complex in the Grenville Lake area and trend in an east-northeast direction. These rocks have been mapped as part of the basement gneiss, but they are probably feeders to the overlying basic volcanic rocks, as compared to the origin proposed for dykes in the Point Lake area (Stockwell, 1933).

Yellowknife Supergroup Metasedimentary Rocks

The extent of the Yellowknife metasedimentary rocks and rocks derived from them is outlined in Fig. 5. They are best preserved in areas where regional metamorphism is lowest, as on the low temperature side of the cordierite-staurolite isograd (eg. Damoti Lake, Indin Lake structural basin, Photo 7).

They are relatively uniform in composition, consisting of greywackes and mudstones that have a bulk composition near that of granodiorite. The rocks are highly susceptible to thermal metamorphism and deformation. Deformation is poly-phase and regional metamorphism results in the formation of schist, gneiss, porphyroblastic schist, porphyroblastic gneiss and migmatite (Photo 8).

Where the rocks become migmatitic, the leucosome may vary from a few percent, to as much as 95 percent of the rock. Primary sedimentary features are commonly discernable, even though highly metamorphosed. Where the leucosome exceeds 50% the rocks have been mapped as migmatites. For convenience, the metasedimentary rocks are divided in two mappable units based on the presence or absence of porphyroblasts, denoted by the cordierite-staurolite isograd.

Greywackes and mudstones

Little metamorphosed meta-greywacke and meta-mudstones are referred to in this report as greywackes. They commonly occur in 20-30 cm graded beds with sandy tops and more argillaceous and darker bottoms (Photo 7). They are invariably well bedded and were likely deposited as turbidites, as they have most of the features common to the Bouma cycle (Henderson, 1970).

The coarser greywackes are sandy textured, grey to greenish-grey and are composed of quartz, plagioclase and lithic fragments in a finer grained matrix comprised of chlorite, sericite and biotite, all of which are secondary. Lithic fragments are difficult to pick out in thin section, but where identified, invariably turn out to be of volcanic origin. Southwest of Origin Lake, paraconglomerates occur near the base of the overlying sedimentary successions. They contain plutonic granitoid clasts as well as felsic and basic volcanics indicating granitoid as well as volcanic provenance.

The finer more argillaceous rocks tend to be slate-like, even in areas of low grade metamorphism. In hand-specimen, chlorite, sericite and other phylitic minerals impart a sheen and a marked fissility. In thin-section, the minute grain size of the mineral and lithic constituents makes identification difficult. From secondary minerals, it is concluded that the matrix minerals are in approximately the same proportion as the framework minerals. Near volcanic contacts, the greywackes are commonly finer grained and locally contain carbonaceous mudstones.

Primary depositional features are most noticeable in low grade areas. Graded bedding is the most striking feature (Photo. 7) but less commonly; cross-bedding, ripple marks, de-watering structures and other primary depositional features are present.

Contacts between metasedimentary rocks and the basement complex were found southeast of Damoti Lake. Metasedimentary rocks lie adjacent to the basement complex, of migmatitic tonalite and tonalite gneiss. The rocks on both sides of the contact are sheared over a width of 100 m parallel to the contact, but due to the lack of kinematic indicators, the nature of the shear zone is unknown.

Contacts with volcanic rocks are conformable wherever observed. The volcanic rocks are more commonly more felsic than basic. The contacts also reflect changing depositional conditions, as noted by the occurrence of close-packed conglomerates (beach or river?) and carbonaceous mudstones (slow rates of deposition associated with anerobic bacteria in tranquil depositional basins).

Contacts with plutonic rocks are intrusive, but contact effects, such as chilled and baked margins were not observed, except in rare cases where plutonic rocks have intruded sub-amphibolite facies metasedimentary rocks. This is similar to other parts of the Slave Province, where contact aureole porphyroblasts only occur in rocks of greenschist facies. The aureoles predate regional metamorphism and are commonly deformed by the latter stages of regional Archean deformation (Hill and Frith, 1982). The general lack of similar marginal effects in the Indin Lake area reflects the higher grades of regional metamorphism of host metasediments after intrusion.

Paraconglomerates and conglomerates

Paraconglomerates have been described by McGlynn and Ross (1963). The clasts consist mostly of angular to rounded metavolcanic rocks, but locally granitoid clasts of granodioritic, quartz diorite composition are evident. Other clasts are made up of quartz and fragments of greywacke. The clasts range in size from 2-30 cm in diameter and are imbedded like drop-stones in a matrix of hornblende, quartz and plagioclase, presumably of volcanoclastic origin, with hornblende making up as much as 50 percent of the volume. Other minerals include chlorite, biotite, epidote and minor sulphides. The pebbles are usually stretched and flattened along the principle northwest striking lineation and foliation directions.

Conglomerates made up entirely of volcanic detritus occur between basalts and metasediments in the western part of Indin Lake (Photo 6). These close-packed cobbles have been stretched about 2:1. Cobble size and texture suggest shallow water deposition. Other less voluminous conglomerates occur along the Indin River inlet to Indin Lake. The pebbles are made up of felsic and mafic volcanic rocks which make up about 15 percent of the rock.

Hornblende gneiss

Hornblende gneiss of uncertain origin is present above paraconglomerates, interstratified with porphyroblastic metasedimentary rocks in the area northwest and southeast of Chartrand Lake. These rocks are folded along with the metasedimentary rocks. The hornblende gneiss is compositionally similar to metamorphosed basic volcanics. However, even though similar (both are made up of hornblende and plagioclase), the rock is persistently banded into dark and lighter coloured mineral constituents, like the hornblende paragneiss in the Chartrand Lake area which preserve sedimentary textures (McGlynn and Ross, 1963) suggesting the rock may have been a volcanogenic sediment.

Hornblende-biotite rocks of even more enigmatic origin occur in the Cotterill Lake region (Fig. 5), where they form a poorly defined area between basement rocks and a plutonic megacrystic granodiorite. The rocks are compositionally similar to those in the Chartrand Lake region, but the rocks are mostly gneiss or schist comprised of hornblende, biotite, plagioclase and quartz, with biotite making up to 30 percent of the rock. Pink alaskite and aplite form variably sized veins

that locally transform the rock into a banded or schlieren migmatite. Toward the west margin the gneiss is fine grained and equigranular and of quartz dioritic composition. Some outcrops are rusty coloured. The foliation is steep to vertical, but is irregular and locally contorted by right-lateral displacements. The rock is only in contact with migmatite.

Chemistry

The chemistry of the Yellowknife Supergroup metasediments is complicated by heterogeneity due to graded bedding. Whole rock chemistry has been carried out on the Burwash Formation from the Yellowknife area (Jenner et al., 1981) and from the Beechey Lake Group, from the northeastern Slave Province (Frith, 1985). These were compared with geochemical analyses from a single outcrop from an island in the north arm of Indin Lake (Table 3). All three areas were channel-sampled to obtain average compositions. The results are plotted and fitted with error envelopes to show a single standard deviation (Fig. 6). The Indin Lake data are intermediate between those of the Beechey Lake and Yellowknife areas, suggesting a comparable but slightly more felsic source for the Beechey Lake rocks and a slightly more mafic source for the Yellowknife area rocks. Trace element analyses from the Indin Lake samples are bar-graphed in Fig. 7 to show the variation among Ba, Sr, Rb, Zr, Zn, and Ni.

Porphyroblastic gneiss and schist

Porphyroblastic gneiss and schist are found on the high temperature side of the cordierite-staurolite isograd shown in Fig. 5. The rocks of the unit are discussed in more detail in the section on structure and metamorphism, where the significance of the mineral assemblages, the reactions involved and the tectonic conditions of regional metamorphism are outlined.

Hybrid granitoids

The rocks of this unit include migmatites derived from Yellowknife Supergroup, granodioritic gneiss of uncertain origin, minor pegmatite and anatectic granite and granodiorite. Hybrid granitoid rocks have been divided into three areas which include the Meyer lake migmatite complex, the Snare River migmatite complex, and the Truce Lake and Dune Lake granitoid complexes (Fig. 2).

Migmatites* are typically of granodioritic bulk composition, although some areas are distinctly more granitic or dioritic. Several varieties of migmatite were recognized including; schlieren types (Photo 9 and 10), banded types (Photo 11), and breccia or agmatitic types (Photo 12). Schlieren migmatite may grade into Yellowknife Supergroup paragneiss and is likely derived from it, whereas the banded and agmatitic types have been found to be most closely associated with paleosome derived from metavolcanic rocks. Migmatites of the area commonly occur as prograde metamorphic products, on the higher temperature side of migmatitic paragneiss (Photo. 8) which are in turn beyond porphyroblastic gneiss and schist. The boundary between migmatitic rocks and true migmatites is mostly an arbitrary line except where cut by intrusive rocks such as those of the Basler plutonic complex.

* Migmatites Definition: Migmatites are defined, for the purposes of this report, as heterogeneous hybrid granitoid rocks in which the leucosome portion exceeds 50%. Areas mapped as migmatite may contain rocks with less leucosome but, due to the scale of this study are not always delineated.

(1) Meyer migmatite complex

The rocks of this unit are characterized by an overall heterogeneity on the outcrop scale, which usually extends to hand-specimen scale. The major rocks include; migmatite derived from sedimentary paragneiss, biotite gneiss, pegmatite and plutonic rocks of variable composition. They cover an extensive area to the east of the Indin Basin between the Basler plutonic complex to the south and Chartrand Lake to the north. The complex is separated from the Sphynx Lake pluton by a septum of gneiss and nodular schist. The complex to the west is in fault contact with rocks of the Wopmay Orogen.

The best studied areas include the the southern part of the Meyer Lake migmatite complex referred to as the Eau Claire pluton by Smith (1966). Work was carried out on other parts of the complex by Stanton (1951), Yardley (1951), Frith et al. (1977).

Smith (1966) recognized two types of migmatite in the southern part of the Meyer migmatite complex. The most widespread is characterized by pegmatite and aplite veins in a fine to medium grained intermix of granite, gneiss or schist. A second younger migmatite similar to the above contains abundant coarse grained granite, which cuts across the finer grained type. Typically the migmatites are layered and/or foliated and commonly folded on both outcrop and hand-specimen scale.

Megacrysts of unoriented K-feldspar may be present locally. The migmatites and gneiss usually contain sodic plagioclase, biotite and quartz, but muscovite is rare. Potash-feldspar and tourmaline are uncommon and only occur in pegmatites associated with the leucosome phase of migmatites. Contacts with metasedimentary rocks, are mostly gradational and they parallel the host foliation.

Northwest of Hewitt Lake the Meyer migmatite complex is surrounded by nodular schists that contain numerous pegmatites, most commonly oriented parallel to the foliation. The contact between these rocks and the complex is gradational and the location of the mapped contact is ambiguous. The biotite in the nodular schist becomes coarser grained toward the contact with the complex and porphyroblasts become retrograded and less evident. The transition to migmatite terrane is characterized by the presence of muscovite in coarser leucosome. The migmatite is deformed and the paleosome has a 'digested' appearance. Garnet is present locally. Coarse, homogenous, pegmatitic granite occurs in places, which may contain books of muscovite up to a few cm thick. The rocks weathers to pinkish white or white. The granitoid rocks are more distinctly granitic near the contact with the metasediments, which contrasts with the more granodioritic border phase gneiss in the southern part of the complex (Fig. 8).

Several small areas of massive, coarser-grained granite are found within the complex. There are several localities of coarse muscovite-bearing granite in the area northwest of Hewitt Lake. The largest mass occurs around 'Fetus' Lake (Fig. 8).

Pegmatite dykes commonly make up 10% or more of the complex and are made up of coarse microcline, oligoclase and quartz with large muscovite books, and in places biotite. Black tourmaline commonly occurs as fine needles and aggregates.

Smith (1966) carried out a systematic sampling of the whole of the southern part of the complex including a detailed 24 sample grid over a 120 square metre area to determine the variability over such an area. The location of the grids and a

Streckeisen diagram of the modal analyses are shown in Fig. 8. The data indicate a range in composition from tonalite, through granodioritic to granite, with the bulk of the rocks being granodioritic. Some tonalitic compositions occur similar to the composition of the basement granitoid rocks, suggested that they may make up part of the Meyer migmatite complex. Gneissic rocks occur north and east of the Basler Plutonic Complex, which have been mapped as pre-Yellowknife basement.

Studies elsewhere in the Slave Structural Province, show the metasediments of the Yellowknife Supergroup are granodioritic, to tonalitic, within a narrow range of compositional variation (Fig. 6). Rocks melted from such a protolith should be of similar composition. However, this is not always the case. The granitic rocks are too potassic to be batch melted from Yellowknife metasediments. Modal analyses from the margin of the complex are less granitic than some of the more central muscovite-bearing parts of the complex (Fig. 8) suggesting that large cation additions from an extraneous source were mixed to batch melts of paragneiss. One possible source is from the mantle during anatexis (Collerson and Fryer, 1978). Recent studies discount partial melting as a viable magma forming process (Wyllie, 1984).

Age of the Meyer migmatite complex:

The coarse anatectic granite at 'Fetus' Lake and near the eastern part of the complex were dated by Rb-Sr whole rock isochron at 2473 +/- 101 Ma (Frith, et al. 1977). The isochron had an initial Sr^{87}/Sr^{86} value of 0.711 +/- 0.002, which along with the gradational contact, is in keeping with an anatectic origin for the more coarse-grained, massive parts of the complex. The age is younger than the more accurately dated 2596 +/- 3 Ma age obtained for syn-orogenic monazite from the Grenville Lake area basement gneiss, which dates the thermal peak in the region.

(2) Snare Lakes migmatite terrain:

The terrane is characterized by over all heterogeneity, with schlieren migmatites and wispy rust stained gneiss and schist of granodiorite and granite composition predominating (Photos 9-10). Pink, fine- to medium-grained granite with only a few percent mafic minerals is common in layers or zones. The composition is largely controlled by the proportion of biotite which is in turn controlled by the mix of leucosome to paleosome. The gneiss may have skeletal remnants referred to as 'ghost' gneiss, derived from almost complete digestion or granitization of paraschist. Rocks may contain garnet, particularly where the proportion of biotite is greatest, near migmatitic paragneiss contacts.

Contacts with the Yellowknife Supergroup metasedimentary rocks are gradational and similar to those of the Meyer migmatite complex. In the area east of Strachan Lake and south to the Snare River, the paragneiss is migmatitic, but remnant bedding is locally preserved. The actual contact is arbitrary. The rocks of this terrain are mostly devoid of porphyroblasts. However, sillimanite and more rarely retrograded cordierite, is locally evident within the paleosome. The leucosome commonly cuts across the foliation or layering (Photo 9) and may be folded.

(3) Truce Lake - Drumlin Lake migmatite terrain:

The complex is bounded to the west by rocks of the Yellowknife Supergroup, both metasedimentary and metavolcanic, and is of unknown extent to the northeast. The complex is intruded by numerous plutons in the Truce Lake area and the intervening migmatites and biotite gneiss is likely related genetically to metasedimentary paragneiss. Rocks south of Drumlin Lake and the area to the north and west of it, are overlain by heterogeneous gneiss, commonly highly contorted, that contain amphibolitic paleosome that is more likely derived from volcanic rocks (Photos 11 and 12). The complex grades to the west from Drumlin Lake into the Grenville Lake basement complex. This area is of dioritic to granodioritic composition and contrasts in overall colour index with migmatites found elsewhere. The close association of the migmatite with basement gneiss and the presence of fine grained amphibolite suggests that volcanic rocks form keel-like remnants within basement areas that are stretched and thinned in vertical orientations. The north boundary region of the map unit is underlain by migmatitic rocks derived from rocks similar to the Yellowknife metasedimentary rocks.

The gneiss and migmatite southwest of Whitewolf Lake, locally contains porphyroblasts of K-feldspar. The oval body southwest of Whitewolf Lake is more massive than the surrounding migmatites and contains abundant K-feldspar porphyroblasts or megacrysts. The contact between this body and the surrounding rocks was not evident, but from the varying content of K-feldspar porphyroblasts in the surrounding migmatite, it is probably gradational. This pluton has been grouped with the megacrystic granodiorite plutons common to the Cotterill lake area.

Volcanic selvages within the unit consist of hornblende gneiss which show rare relict pillow structures. The selvages are widespread within the terrane but only the larger ones are shown on the map as easterly to northeasterly trending doubly terminated bands. They are particularly evident along the north margin of the Whitewolf area and in the region between Drumlin Lake and the Indin River. The rocks are similar to the thinner parts of the Grenville volcanic belt and are undoubtedly of similar origin.

Fortier (1949) noted that fine grained dioritic rocks within the migmatites south of Drumlin Lake (which he thought were derived from basic volcanic rocks) were more heterogeneous than paleosome derived from paragneiss of metasedimentary origin.

Volcanic paleosome is more refractory. Leucosome on the other hand, is coarse grained, white to grey, rather than buff to pink and is comprised of quartz and feldspar that is most likely not derived in situ, but from an outside leucocratic rich source. The origin of this source is highly speculative, but its trondhjemitic to granitic composition and its association with nearby basement granitoid basement complex rocks, suggests it was melted from basement tonalites or derived from mantle out-fluxing of lithophile cations. The leucosome veins were intruded during or slightly after regional deformation, as many are deformed.

Plutonic rocks

Plutonic rocks of the area are characterized by granitic or granodioritic composition, modal biotite, few inclusions and generally well defined contact relationships. The Origin intrusive complex and the Basler Lake pluton were studied in more detail than other intrusives in the area, particularly those in the east half of the map area which were only mapped at reconnaissance scale.

Archean plutons associated with the "Kenoran" Orogeny

Generally speaking plutons post-date the peak of "Kenoran" deformation, but most have an internal intrusive fabric formed during emplacement that parallels the country rock contact. Some plutons have little or no fabric, are commonly coarse grained and may have megacrysts of K-feldspar and gradational boundaries with migmatites. Other plutons are poly-phased and have both gneissic borders and massive internal parts. There are plutons likely intruded prior to the peak of the "Kenoran" Orogeny, as they are retrograded and deformed. Some are possibly syn-volcanic.

Origin plutonic complex

The Origin plutonic complex is polyphased, as shown in Fig. 1. The west margin is a gneissic tonalite or mafic granodiorite which is older and extends along the east margin of the Chartrand Lake volcanic belt. These rocks grade eastward into massive granite near the centre. The marginal phase is similar to the marginal phase of the Sphynx Lake pluton.

The northern lobe of the complex is bounded to the west, northwest and southwest by an outward facing homoclinal volcanic belt, by a narrow belt of metasedimentary rock to the east and by the southern lobe of the complex, referred to separately, as the Sphynx Lake pluton. The northern part of the complex has many of the properties of an asymmetrical gneiss dome. The rocks are more than 7% denser along the west margin than at the core (Fig. 9). The central phase is oval and likely represents the lowest structural level. The marginal rocks are commonly sheared and the core rock, mineral lineations steepen to the east from 25 degrees to 45 degrees. Upward movement likely took place during the Proterozoic, at the same time as the downwarping of the Indin Lake structural basin. This aspect is discussed more fully in the section on structural geology.

The rocks that make up the marginal phase in the west and southwest corner of the northern lobe of the complex include; granodiorite, tonalite and quartz diorite cut by alaskitic and aplitic veins of at least 3 generations. Salmon pink microcline and pistachio green epidote are common late forming minerals. The composition of the host granitoid rock changes from quartz diorite, through granodiorite to granite near the centre of the complex. The southern margin is in fault contact with the Sphynx Lake pluton, possibly due to uplift of the more buoyant Origin lake complex.

The north margin is structurally and lithologically complex, containing areas of migmatite derived from metasedimentary rocks and possibly from basement gneiss. Much of the complex southwest of Mesa Lake has been intruded by diabase dykes oriented in a north-northwest direction. The complex is in fault contact with the migmatites south of Mesa Lake, and there are numerous north-northeast trending quartz-feldspar-muscovite-tourmaline pegmatites. The host rocks are comprised of both massive and heterogenous rocks, including migmatitic gneiss and schlieren migmatite, derived from paragneiss. Some pink and grey migmatites occur just east of a fault zone that separates the volcanic rocks from the complex. They are similar in appearance to the tonalite basement gneiss found in the Grenville Lake area, suggesting that the marginal parts of the complex may have dragged basement gneiss from deeper levels.

The east margin of the northern lobe of the complex is almost devoid of ferromagnesian minerals and is made up, for the most part of pink to white granite or quartz-monzonite. The complex is intruded by numerous aplite and alaskite veins that locally make up to 25 percent of outcrop areas. Like other parts of the complex, epidote is common.

The central part of the northern lobe is similar to the east margin, but is less deformed and less retrograded. Many outcrops are devoid of mafic minerals, except for a few volume percent epidote.

Sphynx Lake pluton

This pluton (Fig. 2) is an irregular-shaped body, rounded to the southwest and west where it is in contact with metamorphosed volcanic rocks and greywackes. Along the south and east margin, it is in contact with similar rocks but they have been faulted by a series of left lateral oblique-slip off-sets, giving the east margin an irregular outline.

The pluton is comprised dominantly of quartz monzonite and silica-poor granite with lesser amounts of granodiorite, quartz monzodiorite and quartz diorite. The more plagioclase-rich rocks are found mostly near the margins of the body.

The contact relationships with the volcanic and sedimentary rocks of the Yellowknife Supergroup is intrusive. Contact metamorphism is not obvious. The contact is sharp and characterized by a general lack of inclusions. According to Yardley (1951) the pluton margins are pink or red, generally massive, medium to coarse grained and contain up to 30% mafic minerals. The weathered surface is commonly grey to light tan in colour with a chalky pink cast. Marginal rocks are mostly quartz diorite in composition and have a gneissosity that parallels the contacts.

Mafic minerals typically make up 12 percent of the rock with retrograde chlorite and biotite, making up about half of this. In thin-section, epidote, sericite zoisite, and leucoxene replace plagioclase. Epidote is abundant, occurring as scattered grains and veinlets that comprise as much as 12 percent of the rock. A Berlin-blue peristerite variety of chlorite was observed replacing hornblende. Olive-green to uneven brown coloured biotite with ragged outlines was observed in some thin-sections.

Potash-feldspar is fresh and unaltered, suggesting that alteration predated the growth of the K-feldspar. Yardley (1951) proposed that potassic metasomatism replaced plagioclase by microcline, releasing CaO to form secondary zoisite and epidote.

At the margins of the Sphynx Lake pluton, cataclastic movement produced broken grains, bent feldspar twins, veinlets and small fractures, all of which are aligned parallel to the margin. Deformation occurred either during late magmatic emplacement or, as suggested above, during the Proterozoic, when vertical movements were triggered by events taking place in the Wopmay Orogen. The northwest sinistral strike-slip or oblique-slip faulting of the east margin of the pluton took place during the Calderian Orogeny, as discussed further on.

Age of the Origin plutonic complex:

The Origin plutonic complex were dated by Rb-Sr whole rock techniques which yielded an isochron age of 2506 +/- 186 Ma and an initial ratio of 0.701 (Frith et al., 1977). Although the age was interpreted as an age of magmatism, more recent dating of rocks in the area (Frith et al. 1986) suggests that this value may be low.

Chemistry and petrogenesis of the Origin Lake plutonic complex:

Eleven whole rock analyses were carried out on samples from the Origin plutonic complex and from the Sphynx Lake pluton. The results are listed in Table 4 and the major rock forming minerals calculated from Barth (1962) mesonorms have been plotted together in Fig. 10 and their trace elements in Fig. 11.

The bulk of the Sphynx Lake pluton is more mafic than the bulk of the Origin Lake plutonic complex. Samples representative of the various phases of the body vary from quartz diorite, through quartz -monzonite to granite. The Origin Lake intrusive complex, on the other hand, contains marginally more quartz and is compositionally a granodiorite and tonalite.

Basler plutonic complex

The Basler pluton is an orogenic pluton that intrudes Yellowknife metasedimentary rocks in the southwest part of the Map area. The pluton is bounded on the south and east by migmatite and paragneiss that becomes progressively less metamorphosed toward the east (up to greenschist facies, near the axis of the Indin structural basin). The pluton is bounded to the west by porphyroblastic paragneiss and both the pluton and the host paragneiss are unconformably overlain by basal rocks of the Proterozoic Snare Group (Lord, 1942). To the north, the pluton grades into migmatite and granitoid gneiss of the Meyer Lake granitoid complex. The pluton has a penetrative deformation formed during emplacement, as foliated inclusions are oriented in the same plane as the host metasedimentary rocks. The two are likely contemporaneous.

The following account is digested from Smith (1966) and from subsequent geochronological studies, and re-mapping of part of the east margins of the Basler Pluton.

The Basler pluton is a poly-phased intrusion made up of varying lithologies and textures as shown diagrammatically in Fig. 12. Most rocks exhibit preferred orientation of platy minerals in a east-northeast direction. The pluton has been faulted and uplifted during the Proterozoic, a feature common to the less dense granitoid rocks along the west margin of the Slave Province boundary. The pluton is intruded by diabase dykes, most likely related in age to the Indin Diabase swarm. At the margins, coarse pegmatite is locally present. The same type of pegmatite is also present within the host metasedimentary rocks and migmatites and is presumed to be derived from an extraneous, possibly anatectic source.

The rocks are mostly biotite granites (with or without muscovite) and biotite granodiorites. The rocks in the eastern part of the pluton are comparatively fine-grained, potassium poor granodiorite and granite that locally inter-calate with the adjacent migmatite-paragneiss. In outcrop, the rocks are medium- to coarse-grained and mostly grey, but with some red and pink colouration.

Some contacts are faults. Contacts on the west margin were not observed, but textural contrast between the pluton and host rock suggest they are sharp. Toward the centre of the pluton the textures are more massive and individual intrusive phases are more bulbous than sheet-like in form. Some cross-cutting relationships are present and the younger ones are commonly more massive, suggesting local resurgence. For example, the round biotite granodiorite present near the centre of the intrusion, cuts across other more foliated intrusive phases.

The degree of foliation is generally related to the proximity of marginal host rocks and to the relative age of plutonic phases. Contact aureoles were not observed, except along the margin of the Mattberry granite, the round northeast lobe of the intrusion.

Textures vary systematically within individual intrusive phases and throughout the pluton as a whole. Foliation is best developed in the more basic phases and the grain size is generally coarser near the margins than the centre. The eastern margin of the intrusion is medium to coarsed grained and contains xenoliths of metasediment oriented in the same direction as the regional fabric. Xenoliths are rare on the west margin and the host rocks are more massive, coarser grained and have less compositional variation.

Age of the Basler pluton:

A Rb-Sr whole rock isochron age of 2517 +/- 106 Ma was obtained for a suite of 5 rocks from the Basler pluton, the Meyer Lake migmatite complex and the Mattberry Lake granodiorite (McGlynn, 1972). The data are derived from three different intrusive phases, possibly of differing ages. The co-linearity suggests a metamorphic re-equilibration that approximates the age of intrusion of the rocks. The age is some what less than more recent age determinations determining the peak of thermal metamorphism in the region (Frith et al., 1986).

Composition of the Basler pluton:

Modal analyses carried out on sample grids from the pluton as a whole and from detailed grids are shown in Fig. 13 and 14. The modal analyses illustrate the range of composition of the suite. Average compositions were determined from the data that show the bulk of the samples analysed are of granite or granodiorite composition.

Other plutonic rocks

Other more massive and homogenous plutons are found northeast and south of Truce Lake. These intrusions are like the bulk of the terrain, composed mostly of granodiorite and granite with biotite, and chlorite being the predominant mafic minerals. The rocks are plutonic, judged from their more homogenous composition and texture. They have few inclusions. The Truce Lake pluton, on the north shore of the lake with that name, consists of fresh looking medium- to fine-grained and usually equigranular rock. The Truce Lake pluton cuts across the regional trend of foliation. The large massive pluton in 86B/10 is similar to the Truce Lake pluton but contains some tonalitic gneissic rock toward the northeast margin. The contact relationships between these plutons and the migmatitic and gneissic granitoid that surround them is unknown, but from the lack of compositional contrast with the host rocks it is presumed the change is gradational.

Megacrystic plutons

K-feldspar, megacrystic granodiorite and granite form irregular and oval shaped plutons in the Cotterill-Snare Lakes area, a 10 km wide oval pluton in the Whitewolf area and a small stock, the Mattberry Lake granodiorite, near the north end of Mattberry Lake.

(1) Cotterill Lake-Snare Lakes area

The rocks are coarse grained, granoblastic granodiorites or granites with 2-4 cm long K-feldspar megacrysts which make up between 5 and 40 percent of the rock. The rocks are pink to light buff coloured on the fresh surface. The groundmass is coarse grained and equigranular and uniform in mineral proportions. Biotite is the most abundant mafic mineral making up 5 to 10 percent of the rock where it occurs mostly as randomly oriented grains, but locally oriented parallel to the regional gneissosity and not necessarily to the margins of the host rocks.

Although the groundmass is granoblastic, the megacrysts are commonly zoned and twinned on the Carlsbad law. This implies a late magmatic paragenesis as noted elsewhere in the Slave Province (Hill and Frith, 1982). The megacrysts are locally augened, suggesting the pluton intruded during or slightly after major regional deformation (see the following sections on structure and metamorphism).

The unit intrudes the Cotterill basement complex of tonalite gneiss and migmatites. Contacts were not observed, but within the complex small areas of metasedimentary rock are present that contain in situ K-feldspar porphyroblasts likely formed at the same time as the leucosome in the migmatite.

Age of the Cotterill Lake megacrystic granites:

Textural and stratigraphic relationships suggest that magmatism and regional metamorphism were contemporaneous. The age of the Cotterill Lakes megacrystic granites was determined at 2532 +/- 126 Ma by Rb-Sr whole rock techniques (Frith, 1980). This age is younger than the culmination of regional metamorphism, dated at 2596 +/- 5 Ma from monazite from the Grenville Lake basement gneiss (3.0 Ga.) and 2580 +/- 50 Ma dated from Pb-Pb whole rock isochron techniques from the nearby Ghost Lake area granitoid gneiss (Robertson and Folinsbee, 1974).

(2) Mattberry Lake Granodiorite:

The Mattberry Lake granodiorite is considered to be part of the Basler Lake pluton. However, it closely resembles other megacrystic granodiorites and granites found elsewhere in the area. It is a medium- to coarse-grained roughly circular stock made up of biotite, plagioclase, quartz and megacrysts of microcline which makes up to 25% of the rock. The microcline megacrysts commonly contain inclusions and is reminiscent of Rapakivi textures (Smith, 1966). The stock is texturally homogenous, equigranular and has sharp cross-cutting relationship to the surrounding host rocks, but does not contain marginal xenoliths. The contacts are locally hornfelsed.

The Mattberry Lake granodiorite is similar to the Basler Lake plutonic rocks as a whole and is likely of comparable Archean age. The granodiorite was used to construct one point on the Rb-Sr age of the Basler Lake pluton (McGlynn, 1972) but

the point by itself is ambiguous. However, similar rock types occur to the west of the Bear-Slave Province boundary and these rocks have Rb-Sr whole rock isochron ages of approximately 2.2 Ga, the same age as the K-Ar age for the Mattberry Lake granodiorite.

Biotite Granodiorite

In the Strachan Lake to Daran Lake area, granodiorite stocks which range in size from 300 m to 15 km long, intrude the basement and the supracrustal rocks of the Yellowknife Supergroup (Fig. 15). The stocks are riddled with foliated xenoliths of biotite schist or hornblende gneiss derived from the Yellowknife supracrustal host rocks. The rocks are mostly medium-grained, light to dark grey and contain 20 to 50 percent mafic minerals. Their composition is highly variable and the mafic mineral content increases with the proportion of xenoliths present. The margins of the stocks are gneissic and the foliation is steep and oriented parallel to the margins. Where the unit outcrops at the south end of the northeast arm of Indin Lake, the rocks are fractured in a 010 degree azimuth direction.

The more homogenous, xenolith-free rocks are medium grained, equigranular and made up of biotite, hornblende, stubby plagioclase and K-feldspar and quartz. Deuteric alteration of plagioclase and mafic minerals to saussurite and chlorite is common.

Age of the Strachan Lake stock:

The Strachan Lake stock were imprecisely dated at 1887 +/- 179 Ma by Rb-Sr whole rock isochron techniques (Frith et al., 1977) and at 1925 Ma by K-Ar biotite techniques, but K-Ar age determination of hornblende from one of the inclusions in the stock is 25 Ma (Frith, 1978) suggesting that the pluton may even be late Archean in age.

The rocks contain igneous textures that suggest the pluton was epizonal and anorogenic. The Strachan Lake stock and the elongate granodiorite near the south-centre of the map area are intruded by diabase dykes with no aeromagnetic expression and they are presumed to be part of the northeast set of Indin Lake dykes estimated to be 1.9 Ga (see below). The intrusion also pre-dates D3, as the northwest oriented upright cleavage, noted mostly in the Yellowknife metasediments, is locally present near the margins of the Strachan pluton.

Pegmatites

Simple pegmatites of granite composition commonly occur along the contact between granitoid areas and the Yellowknife Supergroup. They occur in the Grenville Lake basement complex, along the east margin of the sedimentary rocks east of the Origin Lake intrusive complex, Daran Lake, in the contact zone between the Basler Lake pluton and the Meyer Lake complex, along margin between the Truce Lake complex and the metasedimentary rock to the west. The pegmatites are generally undeformed and either oriented parallel to the regional gneissosity or they have a bulbous shape that cuts across regional structures.

The pegmatites commonly contain quartz, plagioclase, perthitic microcline and muscovite with minor amounts of biotite, epidote and black tourmaline. Grain size is highly variable. The Grenville Lake occurrence contains books of muscovite several cm thick and microcline measuring up to 15 cm in length. The pegmatites south of Mesa Lake contain tourmaline crystals measuring 2 by 10 cm.

Simple pegmatite are also abundant in migmatite terrains. They consist mostly of feldspar and quartz. The pegmatites are unzoned and of granite or granodiorite composition. This type is usually concordant with the foliation of the country rock and are most likely genetically associated with the development of regional migmatites with which they were mapped.

Crudely zoned, beryl-bearing pegmatites have been reported from the Ranji Lake area and east of Indin Lake. Fortier (1949) remarked that the latter closely resembled those of the Yellowknife-Beaulieu River area, subsequently described by Hutchinson (1955).

Age of the pegmatites:

Rb-Sr whole rock dating of muscovite from the Grenville Lake area have given preliminary results that indicate an age of 2573 +/- 39 (Van Breeman, personal communication, 1985). These pegmatites cut the basement gneiss and the Grenville Lake volcanic rocks of the region. Similar pegmatites are found in regional migmatites and within the metasedimentary Yellowknife Supergroup and are likely associated with the close of the Kenoran Orogeny.

Proterozoic

Diabase Dykes

The distribution and strike of diabase dyke swarms in the Slave Structural Province have been reviewed by McGlynn and Henderson (1972) and their paleomagnetism by McGlynn and Irving (1975). The intrusions consist mostly of diabase with lesser volumes of gabbro as sills and stocks. Dykes of the Indin and Mackenzie swarms trend in the same direction, but since there are few prominent geomagnetic anomalies, a feature commonly associated with the Mackenzie suite, there are probably few dykes of this age, compared with the Indin Diabase. Some dykes matching those described as Mackenzie dykes or their equivalents found elsewhere in the Slave Province (Leech, 1966) are present in the Indin Lake area (Table 5, Eade, 1948), but they have not been distinguished on the map. Some older dykes are found within the basement gneiss complexes have been tentatively linked to Yellowknife volcanism. These are described with the basement complex rocks.

Indin Diabase

The dykes that form the Indin Diabase form a swarm that is most dense between Spider Lake, in the north, to Ghost Lake in the south of the map area (Figure 15). The dykes range in size from 100 m in the Ranji Lake area to minute dykelets a few centimetres wide. There are two principle compositions – one with olivine, which weathers down and a second with no olivine which resists erosion and is topographically embossed. The following descriptions are from the Indin structural basin and are based on the descriptions and modal analyses (Table 5) of Eade (1948).

(a) The northwest trending diabase dykes constitute about 90 percent of the dykes in the area (Figure 15). The dykes are most commonly 30 to 40 m wide, as long as 20 km and are tapered near the ends. Apophyses occur, but are of limited extent. Chilled margins of 15 cm wide are common. The dykes weather to a brown or rusty colour, but fresh surfaces are dark green to grey with white feldspar. Microscopically, plagioclase is present as ophitic equidimensional or elongated grains 1 to 2.5 mm long and contain 50 to 60 percent anorthite. The plagioclase is variably altered with sericite, zoisite and epidote present. Augite is the only pyroxene present and occurs as colourless to light brown intragranular grains 1-2 cm across. The augite may be ringed by secondary actinolite, which occurs as discrete, irregular shaped olive green to blue grains that are further altered to chlorite at the margins. Minor minerals include; euhedral magnetite, pyrite and minute biotite, locally altered to chlorite.

Olivine in the more basic dykes, occurs as 1 mm wide grains that may be overgrown by pyroxene. Round pseudomorphs after olivine comprised of matted serpentine are present, commonly with exolved magnetite. Plagioclase in the olivine bearing dykes is more anorthite rich and opaques are more abundant.

The quartz bearing diabase dykes that make up part of the northwest trending swarm are more sodic and contain euhedral pyroxenes that are always altered partly to actinolite and chlorite. Biotite is present in small quantities.

(b) The north-northeast trending dykes commonly cut the northwest dykes. They are 20 to 30 m wide and in the northeast arm of Indin Lake they occur as chain-like islands. The dykes are brown on the weathered surface and in places plagioclase phenocrysts emboss the surface. Some of the north-northeast dykes are olivine

bearing, but most are black to dark grey on broken surfaces and have glassy clean plagioclase and some pyroxene. Olivine and pyroxene alter to serpentine and actinolite.

Age of the Indin Diabase

McGlynn and Irving (1975) determined from paleomagnetic studies that the northwest and north-northeast trending dyke sets were conjugate. However, the paleomagnetic properties of the dykes (Fahrig and Buchan, personal communication, 1985) suggest that the rocks have been metamorphosed and that more than one swarm of dykes may be present in the area. Early K-Ar age determinations of whole rocks in the Indin Lake map area range between 1155 and 1965 Ma (Wanless, 1970). Leech considered these dates too young and assigned a "preferred age" of 2000 Ma. Rb-Sr whole rock and mineral age determinations using an assumed initial ratios yielded dates of 2023 and 2049 Ma (Gates and Hurley, 1973). If the Indin Diabase correlate with gabbro sills in the Wopmay Orogen, they are between 1.89 and 1.88 Ma (Hoffman and Bowering, 1984). Because of the magnitude of the northwest swarm, it is likely that the dykes are deeper equivalents to the gabbro sills that intrude the Epworth in the Arseno Lake and Lac Castor regions of the map area.

Mackenzie Diabase

The scale of mapping did not allow individual mapping of these dykes, however, some of the northwest trending dykes cut earlier northwest and north-northeast dykes. These are more sporadic in distribution and are rarely more than 10 m wide. The dykes weather brown with waxy white plagioclase phenocrysts up to 1 cm in diameter. In thin-section, the plagioclase is saussuritized and zoisite, epidote and sericite are present (see modal analysis 6, Table 5).

GENERAL GEOLOGY - WOPMAY OROGEN

The Wopmay Orogen, which lies to the west of the Slave Structural Province, has been divided into 5 north-south trending tectonic zones that extend westward from Takijuq Lake at the west margin of the Slave Province, 100 km north of this map area, to the unconformity with the Paleozoic near Great Bear Lake (Hoffman, 1984). The central zones, 2 and 3 (Asiak fold-thrust belt and Hepburn metamorphic-plutonic belt) extend from the type area at the latitude of Hepburn Lake, into this area. The supracrustal rocks of these two zones form a continental sedimentary prism (Coronation Supergroup) that has been thrust to the east by westward subduction of the Slave plate (Hoffman, 1984). The prism has been shortened, thickened and transported to the east along a sole fault during the Calderian Orogeny (St-Onge et al.; Tirrul, 1983). The sedimentary prism was intruded by the peraluminous Hepburn Intrusive Suite (1.89 Ga) before the close of the orogeny (Hoffman, 1983) and much of the suite is allochthonous (Lalonde, 1984). Gabbroic sills intruded the Coronation Supergroup in the Arseno Lake and Lac Castor regions prior to the folding of these rocks.

The Coronation Supergroup in the map area is made up entirely by the Snare Group, which as described below, is probably equivalent to the Akaitcho Group and/or possibly the Epworth Group described to the north of the map area (Hoffman, 1984).

Archean rocks within the Wopmay Orogen of the map area are similar in type to those of the Slave Province, but deformed by the Calderian Orogeny. The rocks include granite and granodiorite gneiss, amphibolite rocks derived from basaltic

pillow lavas and migmatitic and gneissic rocks derived from rocks equivalent to turbidite greywacke-mudstones of the Yellowknife Supergroup. In the southern part of the map area, the basement rocks occur along the core of an anticlinorium. Contacts between the basement and the overlying Snare Group rocks are steep and the supracrustal rocks are present as narrow, but extensive on strike infolds that suggest the basement was folded with the overlying Proterozoic rocks. Near the Slave Province boundary the cover rocks are more tightly folded and locally thrust to the southeast. Further north, basement rocks in the cores of gneiss domes are little deformed, despite high grade regional metamorphism of the basement. Relationships suggest that east-west compression was taken up mostly in the overlying supracrustal rocks but both are likely allochthonous.

Archean basement granitoid rocks

(1) Granitoid rocks in the cores of the Emile River gneiss domes:

The granitoid rocks are similar to the those of the Slave Structural Province. The gneiss domes are mantled by para-migmatite or paragneiss of Archean and/or Proterozoic age. The granitoid and mantle rocks have been metamorphosed up to the granulite facies.

The Brownwater Lake dome (Figure 17) is cored with medium equigranular pink to grey granodiorite or granite with 5-15% biotite, which defines a planar fabric best developed near the contacts with its mantle gneiss. Near the centre of the dome the rocks are surprisingly massive and cut by pods of coarse grained alaskite and dykes of metagabbro or meta-diabase. The gneiss is cut by a 50 m wide northwest trending amphibolite dyke, likely derived from Archean diabase or gabbro.

The Baldeagle gneiss dome is structurally and lithologically heterogenous. The rock is a buff coloured, equigranular granodiorite, containing hornblende and biotite and is cut by leucocratic pegmatite and veins of aplite and alaskite. The gneissosity and the leucosome veins are contorted. Locally, the rocks are banded and these too are folded in contorted patterns. Near the margins, the gneissosity parallels the contacts. Along the west margin, mullion structures dip 70 degrees to the west. The east margin is sheared and deformation has obliterated any unconformable relationship that may have been present. Some thin sections of the core gneiss show the presence of retrograded orthopyroxene.

The Inbetween gneiss dome is oval in outline and has a well developed concentric foliation. The west margin is sheared and the east margin and the adjacent mantle gneiss is migmatized by coarse grained, white quartz feldspar leucosome. Quartz pebble conglomerate is present along part of the north margin of the structure. The core gneiss is a medium grained, equigranular granodiorite comprised of biotite, quartz and feldspar that is cut by 2-10% pegmatite and vein aplite that is locally folded. Lineations near the north, west and east margins show consistent west to north plunges between 30 and 40 degrees. The east margin is bordered by mixed gneiss and migmatite. The south margin host rocks are locally calc-silicate bearing and purple quartzite was noted in one locality.

The Emile River gneiss dome is similar to the Inbetween dome in its lithology and contact relationships, but its different shape suggests that the dome may have formed by compressive, as well as by gravitational deformation. This is discussed further on.

Two small outliers of basement granitoid gneiss are present south of a right lateral fault between the Rodrigues Granodiorite and the south end of the Emile River gneiss dome. They are irregular in shape and bordered locally by dolomite

and/or calc-silicate rocks. The rocks are gneissic and this foliation is irregular but strikes in a generally northerly direction. The rocks are similar to the Baldeagle gneiss dome, but no orthopyroxene was noted.

(2) Migmatite and gneiss – Mattberry Anticlinorium

Gneiss and migmatite that make up the core of the Mattberry anticlinorium (Fig. __) consist partly of paragneiss derived from rocks similar to those of the Yellowknife Supergroup¹. More homogenous granitoid gneiss, augen granite gneiss and migmatite are also present, derived from Archean granitoid rocks that have been significantly changed by Proterozoic metamorphism and deformation.

(a) Hornblende Gneiss

Hornblende gneiss occurs in long northerly trending windows in anticlinorial structures in the area between Castor and Norris Lake. The rocks are mostly sheared and the origin of the rocks is not apparent from outcrop or hand specimen. However, the rocks are found below unconformities, overlain by quartz-pebble conglomerates which in the Mattberry Lake area overlie rocks equivalent to the Yellowknife Supergroup metasediments. The amphibolites are considered to be equivalent to Yellowknife Supergroup volcanics.

The contacts between the hornblende gneiss and calc-silicate bearing dolomite of Proterozoic age is locally sheared and its nature is unknown. West of Mirror lake, hornblende gneiss is in contact with megacrystic, commonly augened granite gneiss. Frith and others (1972) considered the augen gneiss west of Mattberry Lake to be deformed Archean granitoid rock, as they unconformably underlay Snare Group conglomerates. Furthermore, the massive megacrystic rocks west of Mirror Lake preserve Rb-Sr isotopic values that suggested an age in excess of 2.2 Ga. The deformed and migmatized equivalents of the Yellowknife Supergroup metasediments in the same region gave a Rb-Sr whole rock isochron age of 2210+/- 245 Ma (Frith et al., 1977) older than the basal units of the Coronation Supergroup.

The hornblende gneiss that forms part of an anticlinorial structure, is cored by gneiss and migmatite of suspected Archean age. The hornblende gneiss is usually banded to massive, fine- to medium-grained and has a well developed sub-vertical foliation that strikes northerly. The hornblende gneiss may be interlayered with biotite schist and coarse grained, white, feldspar pegmatite. The biotite schist may be a reactant between the hornblende gneiss and the pegmatite. Anthophyllite was recognized in some hand-specimens, but generally the rocks are made up entirely of hornblende and plagioclase. The grain size may be reduced by shearing and some rocks are distinctly mylonitic.

(b) 'Yellowknife Supergroup' metasedimentary rocks.

The inter-domal paragneiss that makes up the bulk of the rocks in and around the Emile River gneiss domes are possibly of Archean age. The location and extent of these rocks are shown as locality 8 on Fig. 5. They are similar in over all appearance to the metamorphosed Snare Group arkoses with which they may be confused and for similar reasons, their distribution and contact relationships are not well defined. The rocks commonly attain granulite facies metamorphic grade.

¹ Henderson (1970) in his definition, restricted the distribution of the Yellowknife Supergroup to the Slave Structural Province. In this study equivalent rocks within the Wopmay Orogen are similarly termed but are expressed in single quotation marks.

They are spatially associated with Archean granitoid rocks (Frith et al., 1977) that have been metamorphosed to the same grade of regional metamorphism. Throughout the gneiss dome area, Proterozoic conglomerates and minor calcisilicate rocks have been folded along with the paragneiss. 'Yellowknife Supergroup' rocks also occur west of Mattberry Lake where they have been deformed and migmatized during the Proterozoic (Frith, 1978). The rocks preserve sedimentary textures such as turbiditic graded bedding, despite isoclinal folding and high grade thermal metamorphism. The rocks locally make up mega-boudinage blocks within aplitic leucosome areas.

Rb-Sr whole rock studies indicate they are at least 2.2 Ga (Frith et al., 1977). The rocks unconformably underlie Snare Group conglomerates on islands of north Mattberry Lake.

(c) Granitoid augen gneiss, biotite gneiss and migmatite:

The most abundant rocks in the Mattberry Lake anticlinorium are granitoid augen gneiss, biotite gneiss and migmatites of granitic to granodioritic composition. The augen gneiss is mostly granitic, buff to pink on the weathered and fresh surface and made up of potash feldspar augen megacrysts in a matrix of quartz, plagioclase and biotite. Less commonly muscovite, ilmenite, magnetite, epidote pyrite and garnet are present. The degree of K-feldspar flattening varies from undeformed equidimensional flasered K-feldspar megacrysts to highly flasered aggregates exceeding 5:1 length to width. The more deformed gneiss contains ribbons of quartz. Generally the degree of flattening is greater toward the Slave Structural Province boundary and grades to a massive type within 8 km of it.

West of Norris Lake granitoid gneiss is less megacrystic and more granodioritic in composition and cut by abundant aplitic and alaskitic pegmatite and migmatitic patches. Biotite schlieren are common, suggesting a possible association with Archean migmatites derived from metasedimentary paragneiss.

The augen gneiss west of Mattberry Lake unconformably underlies basal Proterozoic conglomerates (Frith et al., 1977). These rocks grade to more massive (on the outcrop scale) megacrystic granite and granodiorite that are compositionally and texturally similar to archean granites and granodiorites that make up parts of the Basler pluton east of Mattberry Lake and Cotterill Lake, however they lack cross-cutting relationships with the Snare Group and have been mapped as Archean metasediments.

(3) Paragneiss and migmatite of uncertain age

The rust coloured paragneiss in and around the Emile River gneiss domes consist of biotite gneiss, schist and migmatite with an overall granodioritic composition, which according to Nielsen (1977) may be derived from rocks equivalent to the Yellowknife Supergroup metasediments. The paragneiss was metamorphosed to the granulite facies, similar to the Archean, orthopyroxene-bearing, gneiss dome cores (Nielsen, 1977). A Rb-Sr study of the paragneiss around the Emile River gneiss domes suggests that parts of the granulite facies terrain are older than 2.11 Ga and hence basement to the 1.9 Ga basal Coronation Supergroup (Hoffman and Bowering, 1984). However, even though Archean granulite metamorphism is present regionally (Robertson & Folinsbee, 1974) the geochronology is imprecise and can not be used to date

the age of the metamorphism in the Emile River region. Furthermore the rocks form a cohesive sequence that grades from a granulite facies "hot-spot" in rocks of uncertain age to greenschist facies rocks that are as young or younger than the basal Snare Group. It may be argued that all of the exposed rocks in the vicinity of the gneiss domes are allochthonous, including the gneiss domes, as the basement gneiss elsewhere in the Wopmay Orogen is cooler than the allochthonous overlying thrust prism.

Proterozoic Rocks

Coronation Supergroup

Initial mapping of the region placed all Proterozoic supracrustal rocks in the Snare Group (Lord, 1942). The group extended from the Slave boundary, westward and beyond the Wopmay fault, north to the boundary of the map area and south, to Marion Lake, near Great Slave Lake.

Other workers in the area correlated the Snare Group with the Epworth Group (McGlynn and Fraser, 1972; McGlynn, 1977). More recent work has reduced the area previously included within the Snare Group and various parts have been correlated with either the Akaitcho, Epworth or Labine groups (Hildebrand, 1981; Hoffman, 1978). In this report, all Proterozoic rocks have been assigned to the Coronation Supergroup, and all Proterozoic supracrustal rocks within the map area have been mapped as Snare Group.

The Proterozoic sedimentary basins around the Slave craton are similar in many respects. The Epworth Group was found to be stratigraphically equivalent, to parts of the Goulburn Group (Fraser and Tremblay, 1969) and the Great Slave Supergroup (Hoffman, 1973). Revised stratigraphy has placed the Epworth Group in the Coronation Supergroup along with the Akaitcho and Recluse groups (Hoffman, 1981).

The Snare Group adjacent to the Slave Province boundary share many of the characteristics common to rocks of the Goulburn Group and the Epworth Group found to the north such as: they lie unconformably on Archean basement; they are floored by quartzite or conglomerate; they are overlain by argillites, siltstones, and arkosic sandstone; the rocks are all interstratified with less voluminous quartzite and dolomite; and all have been intruded by gabbro sills and dykes that have been deformed with the sedimentary rocks. The stratigraphically older Akaitcho Group, occurs along the northwest margin of the map area (St-Onge, personal communication) and these units may be extrapolated into the map area but the volcanic rocks which characterize the group to the north, are absent, except as rare clasts within conglomerates of the group. No demarcation between the Epworth-like rocks (unit PE) and the Akaitcho-like rocks (unit PA) was feasible, rather all were included within the Snare Group. The sillimanite isograd separates one type from the other, but it is recognized that this separation is artificial and the rocks on each side may have originally been similar.

Snare Group

The Snare Group consists mostly of argillites, siltstones and sandstones interlayered with dolomite, and quartzites which were intruded by gabbro sills and later retrograded to amphibolite. The detrital rocks are commonly limey and contain calc-silicate minerals. Thin, quartz pebble conglomerate and quartzite

may occur at or near the base of the Snare, where they unconformably overlie the Archean craton, most notably in the Mattberry Lake area. The stratigraphic thickness of the Snare Group is unknown, but its folded thickness may be significant, as shown by aeromagnetic maps of the area, which are anomalously low over the tightly folded zone north of Arseno Lake.

The supracrustal rocks grade from greenschist facies, simply folded rocks at the Slave Province boundary, to complexly folded and highly metamorphosed rocks westward. The transition occurs at the sillimanite isograd which separates porphyroblastic rock types of dominantly amphibolite facies grade from greenschist grade rocks. Metamorphism also increases in grade north-northeast from Arseno Lake so that the sillimanite isograd approaches the Slave craton rocks in the Capitan Hill region.

Where the rocks are very high grade, ready association with rocks of lower grade is not always possible. Some rock types, such as quartz-pebble conglomerates and orthoquartzites have no equivalents in the Slave Province and it is assumed that these rocks are Proterozoic and part of the Snare Group. Similar correlations for dolomitic rocks are more ambiguous, as dolomitic rocks may occur in the Slave, albeit rare. These rocks have been included within the Snare as they are associated temporally with the conglomerates and orthoquartzites. The high grade rocks have been mapped separately, but much of the area outlined by this map unit (PM) may be derived in part from Snare Group arkoses.

Conglomerates and orthoquartzites:

The conglomerate and sandstone in the Emile River area (Fig. 16) are made of well washed cobbles that range in size from 20 cm to grit sized particles and are composed predominantly of vein and aggregate quartz with lesser clasts of quartzite, granite, aplite, rhyolite and amphibolite. The matrix is mostly quartz with some K-feldspar, biotite and muscovite. Some sandy beds have a carbonate matrix. Cobbles are commonly stretched as much as 10:1. In the Acasta River area, conglomerate beds are as much as 100 m thick and locally contain granitoid clasts that make up to 20% of the rock. Some of the clasts are tonalitic.

Bedding traces of the thicker conglomerate beds are faint. Where bedding traces can be determined, 1-2 m thick beds are not uncommon. The overlying beds are usually rusty biotite gneiss, but in places banded iron formation is present (north of Acasta River).

Conglomerate and orthoquartzite near the Slave craton serve as marker beds to outline a tight isoclinal style of folding which extends from the area west of Mesa lake to Norris Lake. The rocks are interstratified with siltstones, sandstones and limey clastic rocks, but unlike their equivalents to the west are relatively thin. This is not a tectonic thinning, as many of the clasts are not as compressed as those around the gneiss domes.

From Norris Lake to Mattberry Lake, conglomerate occurs mostly along the basal unconformity where it fills depressions in the Archean basement (Frith et al., 1977). There are some reasons to suggest that much of this region is autochthonous, except for some minor southeast directed thrusts mapped in the Mattberry Lake area (Smith, 1966).

Orthoquartzite occurs as basal units 1 to 4 m thick in trough-like remnants in the Mattberry lake anticlinorium. The orthoquartzite is massive, bluish grey and is

made up almost entirely of fine to medium grained quartz that weathers resistantly.

Arkosic sandstones:

The metamorphosed Snare Group in the map area is made up mostly of rusty coloured medium to coarse grained, bedded gneiss and schist made up biotite, quartz, plagioclase and K-feldspar and commonly (depending on metamorphic grade) andalusite, sillimanite, cordierite, staurolite and/or garnet. The bedding is defined by variations in the proportion of leucocratic minerals.

The metasedimentary rocks in the Emile River area are tightly folded and thinned by tranposition along fold limbs, but in tectonic shadow zones, they appear well bedded and similar in many respects to the Yellowknife Supergroup metasediments with which they are easily confused. The rocks around the Emile River gneiss domes and adjacent to the Rodrigues granodiorite have been deformed by two penetrative sets of folding, followed by gneiss doming and strike-slip faulting.

The cordierite, sillimanite and garnet bearing gneiss is common in the high grade zones and near the contact with granitoid rocks. Some of the mantling gneiss is distinctly migmatitic. Layered migmatite with discontinuous banding is also found near the margins of the Rodrigues Granodiorite. Some of the arkosic sandstones have been metamorphosed to the granulite facies and have polygonal granular outlines in thin section. Retrograde metamorphism has resulted in the local presence of secondary muscovite.

Minor calc-silicate rock occurs along the southwest margin of the Inbetween dome and around the margins of the small basement masses that lie east of the Rodrigues Granodiorite. The distribution of the dolomite bearing rocks suggests they formed thin, basal, sheet-like strata that may have extended, intermitantly over much of the area now underlain by younger Proterozoic rocks.

Dolomite:

The unit consists of dolomite, argillaceous dolomite and carbonate-bearing siltstone and argillite. Metamorphism has recrystallized and obliterated most primary structures and deformation has locally obscured bedding thicknesses, except in the Norris Lake area, where deformation is less pronounced and beds up to 100 m thick occur, with individual beds measuring 3-40 cm. The dolomite is dark to medium grey, fine grained and contains layers of shale, siltstone and sandy argillite that may account for 10 percent of the rock.

Dolomite is also interstratified with other units of the Snare Group. Limey arkose and argillite beds 10-20 m wide are folded in tight isoclinal folds in the Arseno Lake area, whereas dolomite occurs in the cores of synclines. Dolomite is more abundant toward the top of the sedimentary succession where it thins toward the Slave craton. From regional tectonics (Hoffman, 1984) it may be assumed that compression from the west, folded the rocks and possibly thrust them along a decollement surface, where they abut against the Slave craton.

Antigorite is locally present against slickenside surfaces at the contact, but kinematic indicators showing eastward thrusting were not observed.

Gabbro Sills

Diabase, gabbro and diorite occur as sills or sub-parallel dykes within the Snare Group. They have been folded with rocks of the Snare Group so they predate deformation and post-date sedimentation which took place between 1.89 and 1.88 Ma (Hoffman and Bowering, 1984). Group, suggesting they followed closely on deposition.

Elongated bodies of diabase, gabbro or diorite intrude the Proterozoic rocks in the Grand and Little Crapeau Lakes area and northwest of Robesca Lake to the Wopmay River (Lord, 1942). These intrusions are a few metres to several kilometres wide and of uncertain thickness. The intrusions are common below the volcanic flows of the Akaitcho Group to the north of the map area (Easton, 1981). Lord (1942) suggested a genetic relationship between the flows. A further correlation is proposed between these and the northwest trending Indin Diabase. Metamorphism, about 1960 Ma ago, has locally changed the rocks to a hornblende and plagioclase bearing rock.

Hepburn Intrusive Suite

The Rodrigues pluton is the principle intrusion of the Hepburn Intrusive Suite in the map area. It is a large granitic to granodioritic body that underlies a plateau area from Brownwater Lake to the Acasta River. It intrudes rocks of the Coronation Supergroup, both in this map area and in the region to the north up to the Coronation Gulf (St-Onge et al., 1983). The pluton is bounded to the east by steep, commonly sheared contacts with the Snare Group. It is cut by several east-northeast trending dextral strike-slip faults. Other small intrusions of similar lithology, occur southwest of Brownwater Lake. The core of the anticlinorium that stretches from the north end of Norris and Castor Lakes to Mattberry Lake is made up of augened granitoid gneiss that is similar in composition and over all appearance to the Rodrigues pluton but the lack of cross-cutting relationships suggests it is older.

The pluton is comprised predominantly of granite, but also contains granodiorite and quartz diorite. Typically, the granite is a homogenous, coarse grained rock that contains random to slightly oriented 2 to 6 cm long megacrysts of microcline. The matrix is grey to buff brown, equigranular and made up of grey to smokey quartz, biotite and plagioclase. The megacrysts may be Rapakivi textured. Individual, more heterogenous plutons of quartz diorite composition intrude the Snare Group between the Acasta River and Exmouth Lake. These rocks contain fewer or no megacrysts and locally exhibit a layered migmatitic appearance.

The contacts with the metamorphosed Snare Group are intrusive, as apophyses of aplite emanating from the pluton intrude the host rocks. However, the contact is commonly sheared and, in places, elongated quartz clasts that were possibly derived from conglomerate occur at the contact plunging steeply away from the pluton.

Where megacrysts are oriented, it suggests flow orientation. However, at some contacts megacrysts of microcline occur in the host paragneiss, suggesting they formed in situ. Rapakivi textures and megacryst zoning suggest there were at least two stages of megacryst growth.

Host paragneiss may occur as inclusions. Medium, equigranular diorite and quartz diorite, with rounded outlines are observed near the margins, suggesting some digestion of host rock. Assimilation probably took place near the contacts of

the pluton. The host paragneiss commonly contains garnet porphyroblasts. Nearby plutonic phases are locally garnet bearing, possibly due to assimilation of all the metasediment, except for refractory garnet.

Pegmatite

Pegmatites are common in Snare Group rocks of amphibolite and granulite facies grade, where they cut across foliation and intrude parallel to it. Pegmatites commonly stand out as white coarse rocks comprised mostly of white plagioclase, K-feldspar and quartz. Less commonly, pegmatites contain muscovite, biotite, tourmaline needles and rose quartz.

Age of the pegmatite:

Rb-Sr isotope studies of whole rocks from pegmatite along the southeast margin of the Brownwater Lake gneiss dome yielded an approximate age of 1.8 Ma (Frith et al., 1977). However, this age is too young, as there is no reason to believe that the pegmatites are not syn- to late-tectonic and comparable to the 1.89 Ga Hepburn Intrusive Suite (Van Schmus and Bowering, 1980).

STRUCTURAL GEOLOGY

Slave Structural Province

Deformation in the Slave Structural Province took place in three separate events associated with the following: (1) Archean, pre-Yellowknife Supergroup magmatism and possible regional metamorphism/metasomatism; (2) deformation related to the Archean "Kenoran" Orogeny; (3) deformation related to Proterozoic tectonic events.

(1) Pre-Yellowknife Supergroup events

Geochronological studies of the basement granitoid rocks have shown that plutons of tonalite intruded 2989 +/- 6 Ma ago (Frith et al., 1986). This intrusive event and earlier magmatism have been recorded elsewhere in the Slave (Krogh and Gibbons, 1979; Sharer and Allegre, 1982; Nicic et al., 1972). In the Grenville Lake area plutonism was accompanied or followed shortly after by metasomatism of potassium and rubidium bearing fluids channeled along fissures now filled with aplitic dyke rocks (Frith et al., 1973).

The basement granitoids were penetratively deformed during "Kenoran" Orogeny (Stockwell, 1964) along with the Yellowknife Supergroup supracrustal rocks and amphibolite dykes that cut the basement gneiss, presumed to be feeders to the Yellowknife volcanic rocks.

Textures associated with the 2.9 Ga thermal and metasomatic event, were mostly obliterated by later more penetrative deformation, during syn-volcanic deformation and subsequent "Kenoran" orogenesis. Deformation produced a steep planar fabric in the amphibolite dykes which cut the basement. In the Cotterill Lake area, similar amphibolite dykes contain basement gneiss inclusions that contain a fabric that may pre-date the Kenoran (Photo 2).

(2) "Kenoran" deformation

Deposition of the Yellowknife Supergroup took place at 2669 +/- 15 Ma (Frith and Loveridge, 1982). The thermal peak of the "Kenoran" Orogeny took place at 2596 Ma (dated by U-Pb techniques on monazite, Frith et al., 1986). Deformation associated with the orogeny took place in two stages, D1 and D2, that are likely part of a single continuous phase of deformation that gave rise to ENE-WSW trending structures, followed by NNE-SSW trending structures.

D1 structures:

The presence of large scale isoclinal structures within supracrustal rocks may be deduced from top determinations, bedding to foliation relationships and the presence of rare F1 fold hinges, in metasedimentary rocks (Fig. 16). Around Indin Lake, F1 folds and their associated fabric are best recognized where F1 and F2 can be distinguished in the regions of low grade regional metamorphism. West of the Indin Lake basin, schistosity is defined by chlorite or biotite in the metasediments and by actinolite, chlorite and hornblende in volcanic flows and pyroclastics. More argillaceous greywackes and mudstones became slaty and pillow structures in volcanic rocks were flattened and elongated sub-vertically by D1.

Planar fabric in metasedimentary rocks of the Yellowknife Supergroup, consistently dips away from granitoid bodies, but commonly dips toward volcanic belts. The southern part of the Ranji Lake area contains metasediments with F1 fold axes and related planar fabrics that are oriented in westerly directions. Volcanic rocks south of Spider Lake and in the Grenville Lake area have bedding and foliation planes that parallel volcanic margins.

D1 folds with east and northeast trending axes are refolded by more northerly D2 folds in the Float Lake area (Tremblay, 1948). This style of folding interference is observed within areas of low grade regional metamorphism and where folding was not controlled by more competent volcanic rocks. Elsewhere, D1 folds were commonly further compressed during D2 so that their axes are essentially co-linear.

Areas of high grade regional metamorphism, such as the gneissic terrain south and east of the Basler Lake Pluton, contain leucosome segregations that developed parallel to S1 that were subsequently folded into tight isoclines by D2. To the north of Indin Lake, volcanic and sedimentary rocks were folded in an anticlinorium. The morphology of these folds and the occurrence of thin volcanic bands sandwiched between metasedimentary rocks (east of the northeast arm of Indin Lake) suggest that sedimentary rocks underlie the volcanic rocks which thin toward the east from Chalco Lake to Strachan Lake. These F1 fold traces curve from north-northeast to north to northwest (south of Truce Lake) aligned by northwest trending D3 folds.

North of Chalco Lake, volcanic rocks face eastward and are overlain by carbonaceous bearing metasediments. The overlying rocks are deformed in three distinct phases. D1 and D2 form co-planar to near co-planar isoclinal folds with near vertical axial-planes and foliations which are cut by a sub-vertical northwest trending cleavage (S3).

The Cotterill Lake basement gneiss contains an easterly trending fabric, locally accentuated by leucocratic and mafic mineral segregations. This gneissosity is cut by a north-northeast trending gneissosity that parallels the

volcanic margin rocks and the the D1 - D2 folds within the Indin Lake basin. If these north-northeast trending folds and gneissosity are co-eval, then the basement gneissosity is older (Photo 1).

In the Mesa Lake area two-phase Archean deformation of the Yellowknife Supergroup is not easily recognized (Ross, 1965) due to co-axial deformation. However, on the northeast shore of Mesa Lake, an S1 gneissosity parallels easterly trending beds, which is in turn cut by a north-northeast S2 crenulation cleavage.

Volcanic rocks were not generally folded by D1, but were thinned by pure shear, as seen in the stretching out of pillows in sub-vertical orientations (Photo 4). However, where sedimentary rocks are interlayered with relatively thin tongues of volcanic rock, two generations of folding have been preserved. Detailed mapping south of Spider Lake shows volcanic bedding traces snaking from east to west, even though the belt itself is oriented parallel to the NNE-SSW, D2 folding direction. The enclosing metasedimentary rocks have deformed readily, and their foliation is dominated by D2 structures. In the volcanic rocks, foliation parallels bedding and the F1 and S0 structures. D2 structures in volcanic rocks are only evident where limbs of folds have been drawn into co-planar directions and S1 is essentially parallel to S2.

D2 structures:

The dominant deformation in the Yellowknife Supergroup is an east-west compression that gives rise to a steep foliation within the volcanic rocks and ubiquitous northerly trending isoclinal folding in the metasedimentary rocks. The folding of the metasedimentary rocks is probably controlled by a buttressing effect of volcanic rocks on the one hand and penecontemporaneous emplacement of granitoid domes and plutons on the other. The sedimentary rocks were far more readily deformed than either the volcanic rocks (pure shear) or the granitoid rocks (which have shapes that suggest they intruded and pushed out the surrounding host rocks similar in concept to the Ramsay balloon). Where the volcanic rocks are northerly trending, D2 structures generally parallel D1 structures and are further flattened.

D2 structures are found in the central part of the Indin structural basin. Slaty cleavage is common in the mudstones and isoclinal folding refolds earlier isoclines (Fig. 16).

Cleavage associated with D2 may cut across cordierite porphyroblasts developed in areas of high grade regional metamorphism, suggesting that deformation accompanied the close of thermal metamorphism. Locally, porphyroblasts are alligned parallel to S2 and it has been shown that cordierite, sillimanite, a second phase of andalusite and biotite grew during D2 (Frith, 1978).

Smith (1966) has shown that the Basler Pluton intruded during the second phase of regional deformation, as segregation veining developed during D1 is folded into tight isoclines along the south margin of the intrusion. Similarly, along its east margin, S1 fabric is folded along northerly trending axes, preserving a well developed S2 schistosity or gneissosity in the metasedimentary rocks. Porphyroblasts of garnet and sillimanite formed in the thermal aureole during the late stages of Basler plutonism outlasted D2. Garnet overgrows cordierite remnants as well their pressure shadows in the metamorphosed gneiss (Smith, 1966). Fabric formed during D2 has conformable counterparts within the pluton, that suggests parts of the pluton intruded during D2. Some of this fabric is attributed to syn-kinematic emplacement of partly solidified magma.

Most of the preferred orientation in the pluton is oriented northeasterly, which contrasts with the S2 NNE-SSW direction observed in the central Indin structural basin where D2 orientation was partly controlled by the northerly trend of the basin structure. Outside of the Indin structural basin, S1 and S2 structures are hard to distinguish, but from folded S1 segregations are approximately coplanar. Structures within the Indin structural basin may have been rotated during Proterozoic brittle deformation of the basin, as described below.

Linear fabric formed by the intersection of S1 and S2 foliations is generally steep and measures between 60 degrees and vertical. Pillows and clasts in volcanic rocks and pebbles in volcanic conglomerates are consistently stretched into similar orientations.

(3) Proterozoic deformation

D3 structures:

A third deformation is evident as penetrative upright cleavage in the marginal parts of the Strachan Lake stock, the metasedimentary rocks and in some of the thinner volcanic strata. The northwest cleavage planes are locally defined by chlorite. Some warping along axes parallel to the cleavage occurs south of Truce lake and northwest of Strachan Lake. The folding and cleavage is likely linked to the main phase of deformation in the Wopmay Orogen. This has been dated at 1.88 Ga, the age of the Hepburn Intrusive Suite, which intruded folded rocks of the Akaitcho and Epworth Groups.

The rocks of the Indin Structural Basin have been cut by left-oblique faults. These faults approximate the trends of the ~ 1.84 Ga., northwest oriented faults in the Wopmay Orogen (Hoffman, 1984) where they have been reported as conjugate with dextral strike-slip faults cutting Proterozoic and Archean rocks in the northwest part of the map area. These are the same as similarly oriented faults that cut every zone of the Wopmay Orogen. However, nowhere are the northwest faults in the Slave known to cut the unconformity between the Coronation Supergroup and the Slave basement, not in the Indin Lake area, nor to the south where similar left-lateral faults cut the rocks of the Yellowknife Bay area (Henderson, personal communication) and do not extend into any of the Great Slave Supergroup in the east arm of Great Slave Lake (Hoffman, personal communication, 1985).

The northwest faults are likely older and related to northwest folding and to the depression of the Indin structural basin. Geochronological studies of rocks from the Indin structural basin indicate the depression of the basin took place about 2.0 Ga, as dated by a whole rock K-Ar isochron obtained from near the centre of the basin. These rocks were dated using these techniques to overcome the presence of excess argon in rocks of the region, caused by outgassing of deeper rocks within the basin due to temperature increase.

Deformation of the Archean basement in the Mattberry Lake area deformed Snare Group quartz pebbles in conglomerate into vertical to steeply oriented disks. Due to more brittle deformational conditions, rocks in the Indin structural basin deformed by faulting, The Indin structural basin rock are heavier, relative to the granitoid rocks on each side of it, and they were depressed or down-faulted at the same time as the northwest faulting. The distribution and orientation of the faults was controlled in part by the shape of the Indin structural basin and possibly

associated north-south basin-granitoid bounding faults. The brittle deformation also displaced the east adjacent basement, the supracrustal rocks, the anorogenic Strachan lake and associated stocks and the shear zone separating the east margin volcanic rocks from the basement granitoids. Lineations in the volcanic rocks along the shear zone indicate that the east granitoid rocks moved up relative to the basin rocks. The amount of vertical displacement is not known. A small intrusion, correlated with the Strachan Lake stock, on a peninsula at the south end of the northeast arm of Indin lake shows north-south shearing probably associated with this depression.

North-south shearing is also evident along the east margin of the Basler Pluton. The west linear is parallel to the east shear zone. The shape of the basin as a whole and the distribution of the basement rocks on each side of it suggest the shearing may have re-activated an older zone of structural weakness, such as the margins of a rift zone or graben. East of the Indin structural basin granitoid rocks were faulted, but the faults peter out and are deflected into the older foliation directions of the basement.

Reverse faulting is evident from subsurface drilling in the Lex Lake, region (Sargeant, personal communication, 1985). The fault is NNE-SSW trending and dips westerly, suggesting east-west compression. The fault is older than the northwest left-lateral set, but post-D2.

D4 Structures

The widespread conjugate faults of the Wopmay Orogen accommodated east-west compression by north-south extension. There is a preponderance of dextral slip over sinistral, which Hoffman (1984) suggests is due to clockwise rotation of the Coronation Supergroup, relative to the anchored Slave Province. Within the map area, the same explanation may be used to explain the right-lateral strike-slip faulting that affects the Coronation Supergroup, the Hepburn Intrusive Suite, the Slave Structural Province margin and the Archean rocks east of the Slave margin.

Tectonic interpretation of the Indin Structural Basin

Archean Deformation

The Indin structural basin is filled mostly by supracrustal rocks of the Yellowknife Supergroup. It is a rectangular shaped structure bounded on the west by plutonic and migmatitic complexes and to the east, north and south by migmatites derived, in part, from pre-Yellowknife basement rocks and by migmatites and gneiss derived, in part, from Yellowknife metasediments. Reconstruction of the basin by un-faulting the northwest trending faults suggests that the granitoid regions were uplifted relative to the basin, which is made up of denser volcanic and sedimentary rocks.

Textures in the supracrustal rocks indicate that most volcanic and sedimentary deposition was sub-aqueous, but the local presence of granitoid and volcanic provenance in conglomerates near the inter-face between volcanic and sedimentary deposition, suggest that emergent land was locally present during both volcanism and sedimentation.

Bedding (S0) and early foliation (S1) directions indicate east-northeast striking structures, such as F1 folds near the centre of the belt. Similar orientations are preserved in the adjacent Basler Pluton and the enclosing migmatite east of Strachan Lake, but these structures and their fabrics were developed during D2, that are presently co-planar with those of D1.

The change in orientation from a east-northeast direction for D1 structures to a north-northeast direction for D2 structures is most evident in the basin, where supracrustal accumulation is thickest. The orientation of D2 and their foliations was partly controlled by the north-south re-orientation of the basin structure during D3. Relatively straight basin boundaries are evident from pre-northwest faulting. East-northeast trending volcanic rocks were deformed into large scale anticlinorial structures, which with D3, sinistral, oblique-slip faulting, dominate the volcanic outcrop pattern. The overlying metasedimentary rocks were more readily deformed and have smaller wavelengths.

The volcanic rock in the western half of the section from Spider Lake to Strachan Lake trend mostly to the north-northeast. However, east of the north arm of Indin Lake, volcanic rocks are folded with the metasediments, suggesting that volcanic rocks were thinner and that metasediments locally underlie the volcanic rocks, as they do in the Mesa Lake area (Ross, 1966). Metasediments are in contact with the basement granitoid rocks in the Cotterill Lake area. If the rocks are similar to the basal Yellowknife metasediments as above, then the metasediments may overly the basement gneiss in this region where they form thin distal parts of a prism-shaped wedge that thickens to the west.

Proterozoic Deformation

The last stage of deformation took place in response to the Calderian Orogeny, an easterly directed compression of the Coronation Supergroup and the underlying Slave craton. The effect on the craton was not as pronounced as the effect on the cover rocks, as the bulk of the rocks of the Slave craton were comprised of rheologically competent granitoids. An exception to this are the supracrustal rocks in the Indin Structural Basin which were folded along axes that trend to the northwest or they deformed by brittle deformation and were faulted (D3). The bulk of the strain in the Indin Lake structural basin was taken up by north-south extension along northwest striking oblique strike-slip faults. Similar fault patterns and north-south extension took place in some the granitoid regions, but the vertical component led to uplift, rather than depression of these regions.

Slave Structural Province Boundary

Previous studies of the Slave Structural Province boundary were carried out by Ross and McGlynn (1965). Their work confirmed Lord's observation that the Snare Group unconformably overlies Archean metasedimentary rocks similar to those of the Slave Structural Province. The underlying and unconformably overlying rocks are deformed by structures related to Aphebian deformation (here the Calderian Orogeny) and according to Stockwell's (1964) definition, lie within the Bear Structural Province (here the Wopmay Orogen). The actual boundary from the south margin on Basler and Mattberry Lakes, through Norris Lake, Arseno Lake to near Mesa Lake is a normal fault. North-northeast of here the Slave craton occurs at higher structural levels and the Archean-Proterozoic transition follows the basal unconformity.

A structural province boundary, as defined by (Stockwell, 1964), denotes a change from one dominant structural trend to another. This 'overprinting' by younger deformation is transitional up to where younger penetrative structures

becomes dominant. The boundary in the Indin Lake area is well defined using this approach, as a gravity fault, denoted by steep plunging slickensides on the fault trace, separates deformed, possibly allochthonous, Proterozoic rocks from Archean rocks, which at the present level of erosion, have poorly developed Proterozoic fabric. In the Mattberry lake area steep south-east directed thrusts were recognized by Smith (1966) but these likely pre-date normal faulting. North of Emile River, near El Capitan Hill, the recognition of Archean vs. Proterozoic structures is ambiguous and the boundary is best defined along the trace of the Proterozoic/Archean unconformable contact. North of the map area a decollement was recognized between an allochthonous Coronation Supergroup and the basement which likely extends to the Indin Lake map area (St. Onge, personal communication, 1985).

Southwest facing Yellowknife Supergroup volcanic and sedimentary rocks near Chartrand Lake were affected by three phases of penetrative deformation; the first and second by the "Kenoran" Orogeny and the third during the Proterozoic. Early isoclinal folding of sedimentary rocks was accompanied by recrystallization and stretching along planes that now strike north to northwest and dip at or near the vertical. Stretched volcanic pebbles in atochthonous overlying paraconglomerate indicate a 50 to 75 percent compression. The Snare Group conglomerate pebbles to the west (although possibly allochthonous) are only compressed 20 to 30 percent.

The boundary fault at Arseno Lake is gently curved and its southward extension passes along the east side of Mattberry Lake. The carbonates and sandstones west of the fault are little metamorphosed and folded into open concentric folds (Ross and McGlynn, 1963). The unconformity in the Mattberry Lake area has been tilted from what is presumed to have been near horizontal to about 60 degrees west. The boundary fault in this area is a single plane, but on the Slave side it is comprised of composite movement planes of dominantly left-lateral strike-slip, similar to faulting of the Indin structural basin, caused by east-west compression that was taken up by strike-slip fault movement. The uplift of unconformable surfaces along the west margin of the intrusion, also suggest some vertical component, which like the Indin structural basin, indicate a clockwise rotation of the Slave Structural Province and a complimentary sinistral strike-slip movement sense along the boundary fault. The fault is probably not very deep, as there is little or no fluctuation of aeromagnetic patterns across it. If the faulting is related to brittle deformation of the Indin structural basin, it is likely that the vertical movement took place during D3.

Metamorphic grade generally increases from south to north in the Snare Group. Slickenside minerals along the boundary fault face indicate that greenschist conditions prevailed during deformation. The fault face near Arseno Lake, contains rosettes of chlorite developed from dolomitic siltstone. Folding of the Snare Group changes rocks from a concentric style, in the Mattberry Lake area, to a tightly folded style in the Dune Lake area (Ross and McGlynn, 1965). This change in style may be attributed to depth caused by north-south unidirectional Tree River folding, as described below.

Archean supracrustal rocks in the Mesa Lake Slave Province boundary area have been folded during the Proterozoic as well as the Archean. This deformation took place under amphibolite facies conditions, as shown from mineral assemblages in the rocks of the Snare Group. The folds are similar and have upright to overturned axial planes. Shallow north plunging folds at Arseno Lake, reverse

plunge near Mesa Lake, perhaps due to the uplift of granitoid regions to the north associated with Tree River folding, a series of broad flexures of the basement and cover oriented on ENE trending axes (St-Onge et al., 1984).

Wopmay Orogen

The Snare Group is deformed by two or more sets of folding, except near the Slave boundary. The first, by isoclinal folding accompanied by penetrative axial planar foliation. The second, refolds earlier folds and is contemporaneous with uplift of large areas which include; the Mattberry Lake anticlinorium, the Emile River gneiss domes and the Rodrigues granite (Hepburn Batholith). A third set, parallel to the second set is locally present. All sets are probably part of a continuous phase of deformation, similar to that observed in the Wopmay Orogen to the north, where intrusion of the Hepburn Intrusive Suite is considered syn-tectonic (Hoffman, 1983). Dextral strike-slip faulting marks the close of tectonism in the area, which along with earlier structures, is dominated by east-west compression caused by converging plate margins.

The Wopmay Orogen in the map area may be divided into several structural domains, each characterized by a different style and complexity of folding. A convenient dividing line between two of these domains is the andalusite to sillimanite isograd which separates an upright to easterly verging fold region adjacent to the Slave Province margin where single axial planar deformation is present, from the Emile River gneiss dome and plutonic region, characterized by uplift of basement granitoid rocks and intrusion of the Hepburn Batholith. To the north of the map area, part of the cover and the Hepburn Batholith are allocthonous, derived from the west by shallow overthrusting (St-Onge et al., 1984). If similar conditions prevailed in the Indin Lake map area, the most likely rocks would be the Snare Group and associated rocks from north of Norris Lake.

South of Arseno Lake, similar eastward directed thrusting may have taken place, but no movements of any magnitude were recorded. West of Norris Lake and Mattberry Lake (Mattberry Lake anticlinorium) the cover rocks are thin and were deformed during the Wopmay orogeny along with the basement. Proterozoic deformation and metamorphism overprinted the unconformably underlying Archean rocks and structures to the same degree as the Proterozoic rocks.

Archean Deformation

Proterozoic deformation commonly thinned similarly oriented Archean fold structures and stretched linear fabrics. In the Mesa Lake boundary area, Proterozoic fold planes are parallel or sub-parallel to Archean fold planes (Ross, 1966), so that angular discordance between the Snare Group and the Yellowknife Supergroup is slight or absent. Similarly, Proterozoic deformation of Archean basement rocks in the Norris and Mattberry Lake areas has superimposed a steep foliation, which is oriented parallel to the Slave Province boundary. Archean planar features evident in migmatites derived from rocks equivalent to the Yellowknife Supergroup have been folded and leucosome layers boudinaged (Frith, 1978).

Proterozoic Deformation

(1) Folded rocks adjacent to the Slave Province boundary:

The Snare Group along the west margin of the Slave Structural Province from Mesa Lake to Mattberry Lake is folded in a concentric to similar style, from south to north (Ross and McGlynn, 1975). Within the zone of similar folds, a single axial planar foliation is evident.

The folding style is outlined by quartzite marker beds in Figure 17. The fold axes and axial planar foliations strike north-northeast and the foliations dip steeply to the west. Since the folds are oriented parallel to the Bear-Slave boundary it is likely the Slave buttressed eastward directed compression. Fold axes plunge gently to the north from Mattberry Lake to Mesa Lake and southerly from that point north.

(2) Inter-domal paragneiss structures:

The paragneiss in the inter-domal areas and the gneiss domes were studied in detail by Leatherbarrow (1975) and by Frith and Leatherbarrow (1975). The observations, analyses and conclusions outlined below are digested from their work:

Much of the paragneiss in and around the gneiss domes are deformed by F1 and F2. The second folding, although variable, generally has axes that trend in a northerly direction. Bedding (S0) and the initial isoclinal folding and its axial planar foliation (S1) are mostly parallel, except at fold hinges, where S1 cuts across S0.

F2 folds generally trend in a northerly direction. Micaceous growth occurs along F2 axial planar directions (S2) parallel to planes containing sillimanite, inferring that F2 was contemporaneous with the peak of regional metamorphism.

In the Brownwater gneiss dome, F2 folds are tight to isoclinal, with overturned axial planes that tend to drape over the gneiss domes. In the inter-domal regions the fold axes are upright and cross-section axial planes fan out toward the domal areas.

Quartz pebble beds are present as intraformational markers within the schistose Snare Group, which would otherwise be a monotonous sequence of similar rusty biotite granite paragneiss. The conglomerate outlines the folding style of both F1 and F2 and the analysis of elongated pebbles allows a measure of the fold geometry.

The Brownwater gneiss dome (Figure 17) is almost completely surrounded by quartz pebble conglomerate marker beds, which describe a large loop in outcrop pattern, suggesting an almost continuous sheet of conglomerate. The first folds are tight cylindrical to isoclinal in style.

Three types of D1 linear features are present; minor fold axes, mineral lineations and pebble elongations. Where all three are present they are more or less parallel, indicating that deformation was intense enough to rotate quartz pebbles into positions approaching the orientation of non-material lines, such as minor fold axes. Lineations plunge, about 40° westward, but local reversals due to second phase folding also occurs.

Stretched quartz pebbles enable F1 folds to be distinguished from F2, as the pebble elongation directions vary on different parts of F2 fold limbs. F2 has warped major, F1 axial planes, as well as their foliations. The curved axial

planes, as well as several microscopic superimposed folds, describe type-three interference patterns (Ramsay, 1967). Gentle warping of the existing foliation occurred, but was found to be most common in the immediate vicinity of the gneiss domes. Curvature of F1 axial planes by the gentle warping, enabled F2 axial traces to be distinguished by outcrop pattern alone.

Where, F1 and F2 are co-planar, further closing of fold limbs and renewed bedding compression took place (doubly transformed beds).

(3) Gneiss dome structures

Six centriclinal gneiss domes are located within the map area which range in size from 2 to 10 km across. The domes are ovoid to irregular in shape and three of them are arrayed in a row parallel to the Slave Province boundary. The cores of the gneiss domes are made up of granodiorite, tonalite and granite pegmatite of Archean age (Frith et al., 1977). The northernmost domes are emplaced into paragneiss, derived either from the Snare Group or possibly re-worked Archean metasedimentary rocks. Most contacts are conformable with host bedding and foliations. The Baldeagle dome has a variable gneissosity, but near the margins the core gneissosity is concentric and is developed parallel to the metasedimentary host rocks. The granitoid gneiss near the contact contains more biotite than the central parts. In general, contacts are sharp and the granitoid core gneiss locally contains 'xenoliths', of amphibolite, possibly derived from dismembered diabase dyke rocks and other rocks that are similar to the host paragneiss. The 'xenoliths' are usually elongated parallel to the gneissosity. No 'xenoliths' of granitoid gneiss were observed within the mantling paragneiss. From the age, structural relationships and density determinations carried out on the core and mantling paragneiss (Leatherbarrow, 1975) the domes have been classified, according to the scheme proposed by Salop (1971) as mantled gneiss domes.

Model mantled gneiss domes (Ramberg, 1967) may have discordant contacts between the core and cover rocks and the latter may be overturned at or near the contact. The domes in this map area do not show any obvious discordant relationships, but local shearing was observed to have taken place. In places (the 'Inbetween' dome, Fig. 16) the host rocks are derived from marbles, common to the lower Snare Group in the area. This suggests that these strata were dragged up with the rising core gneiss, possibly detached from the basal succession. The mantling gneiss, according to Ramberg, is commonly migmatized near the core-mantle contact, a feature that is well developed in the gneiss domes of this map area. The leucosome in migmatites along the southeast contact of the Brownwater Dome have been dated by Rb-Sr whole rock methods at 1808 ± 43 Ma (Frith et al., 1977). The isochron has a high initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio, which suggests that the leucosome formed in situ. Since the mobile phase is folded by F2, it is concluded that the thermal peak associated with migmatization, took place prior to F2.

Leatherbarrow's (1975) study of the Emile River gneiss domes indicate they rose under the influence of gravity but he suggested that the doming was also controlled by rheological changes due to regional metamorphism of the host rock and by F1 and F2 interference folding.

(4) Mattberry anticlinorium

The structure extends from Lac Castor, south to the margin of the map area. The bulk of the rocks in the structure are Archean gneiss, migmatite derived mostly from 'Yellowknife Supergroup' paragneiss and granitoid rocks similar to

those in the Slave Structural Province. The structure contains several infolded keels of Proterozoic metasedimentary rocks, with locally preserved basal conglomerates resting on an unconformable surfaces.

Axial planar structures near the Slave Province boundary, west of Mattberry Lake verge eastward and locally, folds are thrust along planes that dip about 45 degrees to the northwest (Smith, 1966).

The augen gneiss that makes up the bulk of the granitoid rocks of the structure are highly augened in the eastern part, but toward the west the augens become less deformed and near the western map boundary the rocks are megacrystic, massive and have similar textures to those of the Rodrigues pluton.

METAMORPHISM

Slave Province

The Slave Structural Province has been metamorphosed by at least four separate events: the first only affected pre-Yellowknife, granitoid rocks; the second was associated with the "Kenoran" Orogeny; the third and fourth were associated with events in the Wopmay Orogen and the affect is most evident near the Slave Structural Province boundary.

Pre-Kenoran metamorphism of the basement

Evidence of thermal events in the granitoid basement rocks comes only from isotopic studies. Rb-Sr whole rock isochron age determinations show an age of 2939 +/- 50 Ma. (Frith et al., 1977) and U-Pb determinations on zircons give an age of 2989 +/- 6 Ma (Frith et al., 1986). The isochron dates a metasomatic event that took place shortly after intrusion and caused the usually Rb depleted tonalite rocks to become enriched in K and Rb.

Metamorphism of the Yellowknife Supergroup metasediments

Metamorphism of the Yellowknife metasedimentary rocks grades from green-schist facies, found mostly in the central parts of the Indin structural basin, to upper amphibolite facies, found adjacent to migmatite complexes and igneous intrusions. A few kilometres southeast of the map area, orthopyroxene bearing granulite facies rocks were reported (Robertson and Folinsbee, 1974; Folinsbee, 1940).

Isograds have been drawn between biotite-bearing and non biotite-bearing rocks in the Ranji Lake area (after Tremblay et al., 1953) and between those containing cordierite and staurolite and those with out (pocket map). These subdivisions comply with the metamorphic map of Canada (Fraser and Heywood, 1977) and are essentially the same as those of others in the area (Frith, 1977; Wright, 1950; Tremblay, 1948). No systematic study of metamorphism in the map area was done, but detailed study of the metamorphic transition between biotite and cordierite-staurolite grades was carried out from the west arm of Indin Lake (Frith, 1977). Other studies were done on porphyroblastic metasediments near Mesa Lake area. The following account is drawn from these studies and from thin-section studies of the Chalco Lake-Ranji Lake by Wright (1950) and Tremblay (1948).

Isograds

The isograds used in this map are the same as those for the mile to the inch maps of the Chalco to Ghost Lake area which were based on the visual presence or absence of biotite or porphyroblasts (eg. cordierite or staurolite). A third zone, outlined for rocks metamorphosed to higher degrees, was not incorporated due to inadequate control outside of areas mapped in detail. These included migmatitic gneiss and migmatite derived in part from the Yellowknife metasediments.

Mineral Assemblages

Mineral assemblages in the least metamorphosed Yellowknife Supergroup metasediments invariably contain quartz, biotite and plagioclase. Porphyroblastic rocks are present where sufficient argillaceous components were present. Common porphyroblasts are; staurolite, cordierite, garnet, andalusite and sillimanite. All of these minerals with exception of staurolite, are stable together. Chiastolite was noted in the area north of Chalco Lake, where carbonaceous mudstones are present (Tremblay, 1948).

High grade rocks commonly contain leucosome segregations of quartz and feldspar, some of which may have formed from the breakdown of muscovite. Porphyroblasts of cordierite and andalusite are commonly highly retrograded in these rock types.

Prograde metamorphism of argillaceous rocks commonly contain microscopic biotite, which becomes slaty toward the biotite isograd (Tremblay et al., 1953) where visible 'spots' of biotite become apparent. Andalusite is commonly the next prograde porphyroblast to occur which may occur within the biotite zone. The next prograde mineral is commonly cordierite near staurolite and sillimanite. In the Ranji Lake and Mesa Lake areas andalusite, cordierite, staurolite and sillimanite have been observed in the same rock.

Garnet is the most widespread porphyroblast because of its wide stability range. It occurs in the biotite zone and as a late stage mineral in the migmatitic gneiss east of the Basler Pluton. It is present in volcanic tuffs, along with actinolite and carbonate. Garnet is invariably the almandine variety and is normally unaltered, except at Mesa Lake, near the Bear-Slave boundary, where retrograde margins were observed in thin-section.

Cordierite is commonly poikiloblastic, incorporating early clastic and metamorphic grains. Elongated quartz parallel to S1 may be the only evidence of earlier fabric in the nodular schists. The cordierite forms ovoid knots 2-4 cm long but may be up to 10 cm in length. The porphyroblasts weather differentially and the poikiloblastic textures are visible to the naked eye. Cordierite may overgrow staurolite and garnet suggesting it locally grew after these minerals. Clear gem-quality cordierite is a late forming mineral in the high grade regionally metamorphosed rocks of the Ghost Lake area (Folinsbee, 1940). More typically, cordierite contains an aggregate of micaeous minerals, pinite and is commonly chloritized.

Andalusite, like cordierite, is mostly poikilitic, but it may form blades up to 15 cm in length, and is chiastolitic in places. Poikilolitic varieties may contain quartz and biotite in parallel allignment. Where sillimanite is present as a second polymorph, andalusite occurs as retrograded grains, indicating instability toward

higher temperature conditions. Two phases of andalusite have been noted from the west arm of Indin Lake (Frith, 1978). The first is poikilitic and the second is clear. The andalusite may have formed from the following reactions:

chlorite + muscovite + quartz --f andalusite + cordierite + water ..(1)

andalusite + biotite + water ..(2)

Staurolite is less abundant than other porphyroblasts. In thin-section it is yellow, euhedral and commonly occurs as tiny twinned grains in the more quartzofeldspathic metasediments. Where regional metamorphism is higher it is retrograded to ragged relicts.

Sillimanite occurs as mimetic, aggregate bundles that parallel compositional planes or as aggregated knots, probably after andalusite. Coarse, non-fibrolite varieties are less common and are generally restricted to the higher grades of regional metamorphism. More commonly, it is associated with schists containing retrograded cordierite and staurolite. In migmatitic terrain it occurs in granitic textured rocks and is associated with leucosome segregations which may also contain tourmaline and mica. Some typical metamorphic mineral assemblages are shown in Table 6.

Contact Metamorphism

Along the east margin of the Sphinx Lake Pluton, basic volcanic contact rocks are fractured and infilled with and the rock partly replaced by zoisite, epidote and fine mica. Secondary quartz is present that must be derived extraneously, as there is none in the modal. Near the contact the volcanic rocks have been recrystallized to a dioritic, coarser grained texture and along parts of the contact, shearing has produced a schistose appearance.

In thin-section; epidote, sphene, biotite, zoisite, magnetite and pyrite were observed. Much of the epidote is in fracture fillings. Two generations of hornblende are present in the volcanic rocks. A younger hornblende fills fractures and like the epidote, it surrounds older hornblende in a needle-like matt reminiscent of augen texture. Biotite and chlorite increase progressively away from the contact, whereas hornblende and epidote decrease. Carbonate is commonly present in these rocks, but is notably absent at the contact. Despite the obvious mineralogical changes at the Sphinx Lake Pluton-volcanic contact, pillow structures are still preserved, indicating regional thermal metamorphism was locally more important than deformation.

Where metasedimentary rocks are in contact with the Sphinx Lake Pluton, nodules consisting of pseudomorphs of cordierite, are generally absent. They may be conspicuous 60 m from the contact, but they diminish progressively toward the contact. Similarly, contact metasediments become more massive, coarser grained and gneissic. Garnets, are more common and modal feldspar increases toward the pluton contact, as well as the proportion of leucosome veins.

Stanton (1947) noted that the main period of thermal metamorphism in the Chalco Lake area produced one or more phases of biotite. Andalusite and cordierite is commonly overgrown by a second biotite fabric and cordierite may be retrograded to pinite, suggesting that regional metamorphism continued after deformation. Even though several phases of the same mineral, such as biotite or andalusite may be present, it is likely that they formed during one major phase of Archean metamorphism (Tremblay, 1950; Thompson, 1978).

Contact rocks along the east margin of the Basler Pluton are not hornfelsed, rather they are similar to other paragneiss in the area that have been regionally metamorphosed to upper amphibolite facies. Both contain mica, feldspar and ribboned quartz that have a single dominant foliation, which has been refolded by later deformation associated with plutonic emplacement. On the west margin of the Basler Pluton, Smith (1966) noted that early cordierite and mica in the host metasediment predated emplacement of the pluton. Later increase of temperature and the degree of deformation, penetratively deformed these early minerals and resulted in recrystallization of quartz and plagioclase. In some localities garnet and sillimanite grew after emplacement. Other porphyroblasts, such as sillimanite, were folded prior to emplacement and re-oriented into D_2 related lineation directions. Smith recognized that thermal overprinting outlasted deformation, resulting in an annealing of cataclastic, pre-emplacement textures in quartz and plagioclase. The post-emplacement quartz and plagioclase is unstrained and similar to the degree of strain within the pluton. The most deformed plutonic rocks have an east-northeast fabric which parallels the paragneiss gneissosity. This gneissosity becomes north-south oriented along the east margin and is parallel to D_2 structures in the paragneiss.

Wopmay Orogen

The rocks on each side of the Slave Structural Province boundary are similar, consisting of arkose, sub-greywackes, argillites and calc-silicate rocks on the Wopmay side and greywacke-siltstones on the Slave side. Each side is characterized by Abakuma-type metamorphism; one during the Archean (2.59 Ga.) and the other during the Proterozoic (1.89 Ga.). Toward the west, the Coronation Supergroup becomes more flysch-like and is comprised mostly of sub-greywackes that are so similar to those of the Yellowknife, that rock distinction in the region of high grade metamorphism can only be made by examining subtle geochemical changes or by inference, where associated rocks are present, such as dolomitic interlayers. The Archean rocks are commonly more complexly deformed. The presence of K-feldspar is not diagnostic, as much of the area is on the high temperature side of the muscovite breakdown to K-feldspar.

Archean metamorphism:

Due to penetrative Proterozoic deformation and metamorphism, most Archean fabric and textures have been obliterated or rendered more complex during the Calderian Orogeny (St. Onge et al., 1984). "Yellowknife Supergroup" metasedimentary migmatites west of Mattberry Lake have been boudinaged by Proterozoic deformation and remnant porphyroblasts have been retrograded to grades comparable to those of Proterozoic regional metamorphism.

In the Emile River gneiss dome area some of the gneiss around the domes and megacrystic plutons of the Hepburn Suite contain spinel, which along with other minerals is attributed to granulite facies metamorphism (Nielsen, 1977). Rocks of the region have Abakuma facies mineral assemblages, which are zoned as follows:

Biotite – Adalusite – Cordierite – Sillimanite – Almandine garnet

These minerals suggest 2 to 4 kbar of pressure and temperatures between 350 and 700°C, but with little or no melting. The crystal chemistry indicates a lack of metamorphic equilibrium. However, a metamorphic grade based on

distance from a thermal dome to the almandine – K-feldspar isograd, may be used in conjunction with mole percent ghanite in spinel (which equilibrates readily to thermal conditions, Nielsen, 1977) and allows a metamorphic zonation beyond the almandine – K-feldspar isograd (Fig. 18).

Biotite in the Archean zone contrasts from biotite in the Snare Group. Tetrahedral Al₄ and the Si/Al₄ ratio, increases with metamorphic grade, but there is no systematic change in the Y-site, as there is for the Snare Group biotites. Cordierite, in contrast to biotite, has increased Al₄ and Mn and decreased Mg, due to exchange during Calderian metamorphism. Spinel grains in cordierite change from low ghanite with 0.73% ZnO to 16.53% ZnO.

Remnant orthopyroxene may be observed in the greenish coloured gneiss making up part of the Baldeagle gneiss dome (Frith, 1978). This orthopyroxene likely formed during granulite facies metamorphism under P-T conditions similar to those found in the Ghost Lake area to the south of the map area, which came to a close approximately 2580 Ma ago. (Robertson and Folinsbee, 1974). The uplift of the granitoid domes into a lower P-T regime gives a retrograded appearance to the granitoid Baldeagle gneiss, which has been locally hydrated, changing feldspar from a green hue to pink.

Proterozoic metamorphism:

Archean rocks on both sides of the Slave Structural Province boundary give K-Ar and Rb-Sr "dates" that indicate a thermal event at about 2.2 Ga. (Frith, 1978). Rocks equivalent to the Yellowknife Supergroup metasediments were re-equilibrated at this time in the region west of Mattberry Lake (Frith et al., 1977) and around the Emile River gneiss domes (Nielsen, 1977). Megacrystic granodiorite, derived from remobilized Archean granitoid rocks, yielded similar ages (Frith et al., 1977). Sixty km south of the map area, in the Bigspruce Lake area, alkaline intrusions of 2150 Ma have been reported (Martineau and Lambert, 1974).

The "Yellowknife" metasediments west of Mattberry Lake are boudinaged by the same deformation that has folded and tectonically thinned the unconformably overlying Snare Group. Porphyroblasts developed in some of the rocks have been retrograded, where regional Aphebian metamorphism is of lower amphibolite grade.

The nature of this metamorphism is not understood; indeed it is possible that these "dates" are mixed Archean and Proterozoic isotopic systems. High precision U-Pb dates from zircons in the Wopmay Orogen have dated the Calderian Orogeny at 1885 Ma. (Hoffman and Bowering, 1984). Muscovite pegmatite in the Slave Province, 10 km from the boundary was dated by Rb-Sr muscovite at 2573 +/- 39 Ma. (Van Breeman, pers. comm. 1985) suggesting that a ca. 2.2 Ga. metamorphic overprint, if present at all, was variable and did not take place everywhere along the boundary.

Calderian metamorphism:

Metamorphism grades from greenschist facies where the uppermost Snare dolomites are in fault contact with the Slave Structural Province boundary fault near Norris Lake to upper amphibolite facies, where the Snare Group is in contact with rocks of the Hepburn Intrusive Suite. The rocks grade from east to west

according to Nielsen (1977) through; (a) chlorite zone; (b) biotite zone; (c) cordierite - andalusite zone; (d) cordierite - sillimanite zone; and (e) cordierite - almandine - K-feldspar zone (Pocket map and Fig. 18).

(a) Chlorite zone:

The chlorite zone is up to 2 km wide and extends from north of Arseno Lake to Norris Lake. Pelites contain chlorite, sericite, quartz, feldspar and minor ilmanite and pyrite. Grains are commonly in a re-crystallized quartzofeldspathic matrix the upper limit is defined by the biotite isograd.

(b) Biotite zone:

Biotite is present in all rocks of the Snare Group, except for those in the chlorite zone. The upper limit of the zone is defined by the cordierite isograd.

Metapelites are characterized by chlorite and sericite phylitic minerals, and by quartz and feldspar. Porphyroblasts of biotite with rutile needles cut the cleavage planes; otherwise the mineralogy is similar to the chlorite zone. Graphite was noted in some samples from this zone.

Sub-greywackes have the same mineralogy as the metapelites but have more quartz and feldspar. Biotite is less abundant and plagioclase is more recrystallized toward the cordierite - andalusite zone. Spessartine garnets are present locally.

(c) Cordierite - andalusite zone:

Cordierite - andalusite zone rocks contain cordierite poikiloblasts, euhedral andalusite porphyroblasts in a matrix of biotite, muscovite (or chlorite), feldspar and quartz. The rocks are mostly sub-greywackes which are more massive and the foliation is faint and defined by sub-parallel mica alignment. The upper cordierite zone is defined by the presence of garnet in association with cordierite and biotite.

(d) Cordierite - sillimanite zone:

Sillimanite first appears where the gneiss becomes rusty. It replaces andalusite. A second sillimanite is formed with K-feldspar by the breakdown of muscovite and quartz. In general the rock is a rusty gneiss with cordierite porphyroblasts. The sillimanite may occur as bundles of fibrolite or as coarse prismatic grains. The rocks locally form banded migmatites.

(e) Cordierite - almandine - K-feldspar zone:

This is the highest grade attained by the Snare Group in the map area. Common minerals in the gneiss of this zone are; cordierite, garnet, biotite, quartz, ilmenite, rutile, plagioclase, and sillimanite. Sillimanite occurs within cordierite but is never found in contact with garnet. Migmatites are common, usually associated with abundant garnet. Anhedral garnet is locally rimmed with biotite and plagioclase due to the retrograde reaction: garnet + K-feldspar + water = biotite and plagioclase.

Nielsen (1977) recognized 6 isograds in the Arseno Lake - Brownwater Lake area where:

- 1 biotite is produced;
- 2 andalusite is produced;
- 3 cordierite is produced and both muscovite and chlorite are consumed;

- 4 sillimanite is produced and andalusite is consumed;
- 5 sillimanite and K-feldspar are produced and both muscovite and quartz are consumed;
- 6 almandine and K-feldspar are produced (with or without cordierite) and both biotite and sillimanite are consumed.

To avoid congestion, only isograds 1 and 4 have been drawn on the pocket map for the Wopmay Orogen. The others have been included in Figs 17 and 18. Isograd 1 and 3 for the Wopmay are essentially the same as those drawn on the pocket map for metasedimentary rocks of the

ECONOMIC GEOLOGY

History of Exploration:

Gold was discovered at Indin Lake in the summer of 1938 by prospectors of the Territories Exploration Company Limited. Many claims were staked during the winter and summer of 1938-39. In early 1941, Frobisher Exploration Company Limited drilled the 'Brown' vein on the property which became North Inca Gold Mines Limited. Interest in the area waned until 1945 when renewed exploration outlined many prospects which led to underground exploration on three properties. No significant gold production ever materialized. Lord reported 2415g (83 oz) of fine gold recovered from the deposit as part of a feasibility study carried out during the winter of 1938-39 (Lord, 1942). After 1947, little or no work was done in the area until the 1970's when exploration for base metals took place.

Freeport Oil Company carried out work at the southern tip of Spider Lake on the PETER claims, the FARKLE claims at the northern end of Indin Lake, the JAN claims northeast of Lex Lake and on the VAN claims along the southeast margin of Indin Lake. Airborne EM and aeromagnetic surveys were carried out in 1970 and several targeted areas in felsic to basic volcanic and hypabyssal rocks, metasedimentary graphitic argillite and greywacke were drilled. Sphalerite and chalcopyrite were noted and assays of drill core from the VAN claims gave up to 1% Cu, 4% Zn, 5 oz of Ag, but no significant intersections were encountered. Au was negligible (J. Boldy, Assessment Reports, DIAND).

Other exploration for base metals was carried out on the JIG claims, east of Indin Lake by Great Plains Development Company in 1971. Ground and EM surveys were carried out but no follow up work has been reported.

In 1974 Cominco Ltd. drilled 20 holes in the Baton Lake area and in 1984 they acquired control of ground in and around the Colomac gold deposit. In the 1940's the property was thought to contain 9,720,000 metric tons of potential ore with gold content averaging 2.33 g/t (Northern Miner, May 30, 1985).

Echo Bay Mines Ltd. and partners announced a gold strike at Lex Lake on the KIM claim group in late 1984. The mineralization occurs mostly in recrystallized, pillowed andesite near a volcanic-sedimentary interface. At the time of writing, 37 holes had been drilled and further work is in progress. Preliminary results suggest mineralization along a strike length of about 600 m over 2 to 30 m widths and grading up to 17 g of Au/t, with common grades of 8 g/t in seven of the better holes. In 1985 a reverse fault was discovered, extending the known reserves to greater depth. The success of Echo Bay Mines increased interest in the area and in 1985 and 1986 several major and junior companies were active exploring and acquiring new ground.

Characteristics of the gold deposits

At present there are many known gold occurrences in the map area (see pocket map). The following general description of gold mineralization is based mostly from internal reports of the Geological Survey of Canada by L.P. Tremblay and others from work carried out between 1948 and 1954.

Gold occurs in the free state in grey quartz veins. The gold is mostly fine and not readily observed by the naked eye. Where present, gold is commonly associated with arsenopyrite and pyrite. Many of the associated veins are carbonate-bearing.

Gold-bearing quartz veins occur individually or as stockworks. In the main zone of the North Inca gold deposit, zones of gold-bearing quartz veins 2 metres wide are present, locally thickening to 5 metres. Antimony-bearing minerals, common to the Yellowknife area deposits, have not been reported from Indin Lake.

Gold-bearing veins most commonly cut Yellowknife Supergroup rocks and have not been reported cutting diabase, gabbro or any granitoid rocks, except for the Colomac deposit where gold occurs in fractures developed in quartz-albite rock that is presumed to be of synvolcanic, hypabyssal origin and related to volcanism. Gold-bearing veins within volcanic strata generally have higher gold contents than within metasedimentary rocks. The highest grade veins within metasedimentary rocks are those closest to the volcanic-sedimentary interface, suggesting that the gold is spacially related to volcanism. Shearing is common along the interface, but is more common in metasedimentary rocks.

The earlier, more promising gold mineralization localities (1951) are found along the same shear zone, which may have localized the gold. These include the Diversified shaft, the North Inca shaft and the Lexindin deposit. Other deposits in the area are located along fractured or shattered zones associated with northerly trending shears, possibly associated with regional folding of the supracrustal rocks in the Indin structural basin (see Synthesis section). It is noteworthy that few if any of the showings in the area are associated with the northwest trending oblique-slip faults. Gold showings are most commonly associated with rocks of greenschist facies regional metamorphism.

Quartz veins and stringers are widely distributed through the area and in a few places they are grouped and abundant, forming zones up to 4 metres wide that extend up to 100 metres along strike. Most veins are lenticular, narrowing and swelling in irregular fashion, commonly pinching out at both ends. The lenses may be up to 2.5 metres wide and some have been measured up to 20 metres long. Groups of veins may occupy sheared rock, whereas large single veins are most commonly associated with bedding and joints. Although most veins parallel the bedding, a few trend northwest with steep to vertical dips, modified locally by late folding.

Field examinations of auriferous veins in the Float Lake, Chalco Lake and Leta Arm regions concluded that most veins were developed along cleavage planes formed during D2. Apart from the preferred orientation of these quartz veins, fractures were best developed in brittle rock. The quartz-albite dyke on the Colomac prospect is a case in point. The concentration of gold along the interface between the volcanic and sedimentary rock may indicate a preferred migratory route for gold-bearing solutions. Gold may also migrate, not only along S2 fracture planes or shears, but along volcanic contacts, such as inter-flow tuffs and volcanic breccias (Tremblay, 1953).

Auriferous quartz veins are only known to cut rocks of the Yellowknife Supergroup and genetically related synvolcanic dykes and sills. Barren quartz veins cut gabbro dykes and granitoid plutons and migmatites. Since the diabase and gabbro dykes are of Proterozoic age, it is evident that there are at least two ages of quartz veining. In Yellowknife, mineralization is associated with Archean regional metamorphism (Boyle, 1976). The general distribution of gold and its age suggest that the Indin Lake area showings are similar to those of the Yellowknife area and they probably share a common mode of origin.

Quartz in auriferous veins, stringers and lenses is most commonly white, milky white and grey. Less common are veins of light grey, bluish or brownish grey, rusty red and black. In some localities quartz is mottled or fractured, but mostly it is glassy, massive or sugary. White quartz may be vuggy. Locally, the white or milky variety cut the grey variety, but more commonly colour is gradational from one to another. Carbonate is usually present and may make up to 50% of vein material. It usually weathers out partly as a buff coloured residue. Tourmaline is locally present. Other minerals identified in the field or under the microscope include; pyrite, marcasite, pyrrhotite, arsenopyrite, chalcopyrite, galena and sphalerite. Arsenopyrite crystals may be several centimetres long.

Mineral Deposits

Only the principal mineral deposits are described here. The reader is referred to EMR Mineral Inventory Reports for a more complete description of gold and other economic minerals occurrences in the map area.

The Diversified Mine

In 1945 Diversified Mining commenced drilling on the company's ARSENO group claims. Gold-bearing quartz veins were thought to be sufficiently abundant to mine and in 1947 the Inca Mine was opened. Initial values of 15 g/t were reported. The mine never got past the development stage, even though 44 000 tons of blocked out ore at a grade of 22 g/t over a 60 metre length was reported. A 500 short ton per day mill was planned and construction started but production never got underway. By 1948 tonnage was shown to be 'medium' and market conditions were described as 'adverse'. As of October 1948, the gold bearing shear zone extended 88 metres over widths of 2.2 metres grading 12 g/t gold.

The Colomac Deposit

The gold occurrences in the quartz-albite dyke along the west side of Baton Lake are found on properties formerly owned by Colomac Yellowknife Mines Ltd., Indin Lake Gold Mines Ltd., Dyke Lake Gold Mines Ltd., Hearne Yellowknife Mines Ltd., Indyke Gold Mines Ltd., and Nareco Gold Mines Ltd. All of these companies are now defunct and the area is presently controlled by Cominco Ltd.

Gold was first found in 1945 in quartz veinlets in the quartz-albite dyke (Fig. 19). During 1946, 14,300 m of diamond drilling were carried out and an underground adit opened 175 m into the dyke. Total exploration drifts, both north and south totaled about 760m. About 65,000 metric tons of potential ore per vertical metre were outlined for a possible 9,720,000 metric tons of gold ore.

Bulk samples from the adit cuts were assayed at 2.4 g/t of gold and 2.1 g/t of silver. It is interesting to note that the bulk samples showed about 25% more gold than drill core assays. In 1974 Cominco Ltd. drilled an additional 20 holes over 2,865 m.

Lex Lake deposits

The recently announced gold re-discovery by Echo Bay Mines (Northern Miner, Oct., 1984) was originally described as the "A-zone" by Stanton (1946) near the presently positioned DDH 84-1. The gold occurs in quartz carbonate veinlets and stringers in recrystallized andesite. The contact between the volcanics is not exposed but lies beneath Lex Lake. Minerals include free gold, pyrhotite, pyrite and arsenopyrite up to several centimetres long (Stanton, 1946). Initial work included about 917 m of diamond drilling, trenching and assay work. Although the original work showed mineralization to extend over 140 m or more, gold values were thought to be too low for follow up work. As of May 30, 1985, 37 holes were drilled on the KIM claims that are reported in Table 7.

Other mineralization

Sulphide minerals are common within the Yellowknife Supergroup rocks. Near the contact between the volcanic and sedimentary rocks the rocks are commonly more mineralized. Felsic volcanic and porphyry rocks may contain as much as 5% pyrite.

In the Chalco Lake map area, molybdenite has been reported in pegmatites formed within nodular schists. Pegmatites in the western half of Ranji Lake contain abundant black tourmaline and beryl occurs in pegmatites in the east half of Ranji Lake, located approximately 64 degrees, 5 minutes - 115 degrees, 5 minutes (Mulligan, 1968).

Hints to gold prospectors

Grey quartz or quartz-carbonate are the most common gold-bearing veins. They usually contain some pyrite and arsenopyrite. Quartz veins within volcanic carry more gold in most cases. Sheared and silicified shear zones within metasedimentary rock near the volcanic-sedimentary contact warrant careful attention, as many gold occurrences are found in this type of locale. The northwest trending faults and associated structures in the Indin structural basin and the dykes that make up the Indin Diabase dyke swarm are late geological features and are unlikely to contain any appreciable gold, despite the local abundance of pyrite.

TECTONIC SYNTHESIS

A summary of the relationships between the early granitoid crust, supracrustal deposition, deformation, metamorphism and plutonism of rocks within the map area is presented in Table 8.

Pre-Yellowknife granitoid rocks

The oldest rocks of the region are found in irregular areas of tonalite gneiss (now granite to granodiorite in composition) found underlying the lowermost volcanic rocks in the Grenville Lake region (Frith et al., 1986). Zircons separated from the tonalite give U-Pb zircon dates of 2989 \pm 5 Ma., comparable to a Rb-Sr whole rock isochron from the same area (2939 \pm 51 Ma; Frith et al., 1977). The tonalite gneiss has been metasomatized and the Rb-Sr isochron measures when Rb was introduced.

Zircons in the tonalite, although of differing shapes and sizes, are concordant and show no overgrowths, suggesting they formed magmatically. Since the zircon date is within the bounds of Rb-Sr experimental error, it is concluded that metasomatism followed close behind plutonism.

The extent of the tonalite and granite rocks before volcanism is unknown, but there are several factors that point to widespread distribution. The migmatitic complexes contain gneiss similar to gneiss shown to be older than the volcanic rocks. This gneiss (eg. Snare Lake and Drumlin Lake) are structurally more complex than other granitoid rocks of the area and it is not unreasonable to assume that much of the more granitoid migmatite gneiss and the plutonic rocks within these areas are derived from basement rock that has been remobilized during subsequent orogeny. Banded and schlieren migmatite results from high grade regional metamorphism of layered rocks, but the same process on massive granitoid gneiss causes batch melting and plutonism of granodioritic and granitic composition.

Outside of the map area other factors suggest that basement gneiss covered much of the area presently underlain by Yellowknife supracrustal rocks and younger granitoid rocks:

- 1 The sedimentary rocks of the Slave Province are of granodiorite composition and are too quartz-rich to have been derived from the type of volcanic rocks present in the volcanic belts exposed at the present surface and must have been derived from another quartz rich provenance (Henderson, 1975 and Pettijohn, 1970). Recent work suggests that felsic volcanic as well as granitoid rocks were likely source rocks (see below).
- 2 The presence of readily recognized basement gneiss in the Slave Province is rare. However, known occurrences are widespread and always structurally underlie the oldest volcanic rocks of the region.
- 3 The oldest flows are of tholeiitic composition, but the younger parts are calc-alkaline, such as in the Yellowknife volcanic belt (Condie and Baragar, 1974). In some belts calc-alkaline compositions make the bulk of the rocks, such as the Hackett River greenstone belt. Calc-alkaline volcanic rocks were likely melted from the crust (Frith and Fryer, 1985).

- 4 The age of the basement gneiss varies from place to place, but values older than the Yellowknife Supergroup are now commonplace (Nikic et al., 1980; Frith et al., 1974; Sharer and Allegre, 1982; Krogh and Gibbons, 1978; Chamberlain and Lambert, 1984; King and Bowering, 1986) with dates ranging from 2.7 to 3.5 Ga. This is comparable to older rocks found in other Archean terrains, indicating widespread occurrence of 2.7+ Ga plutonism.

Supracrustal Deposition

The Yellowknife Supergroup was deposited about 2669 \pm 16/-14 Ma ago (Frith and Loveridge, 1982). The metasedimentary rocks were derived from a volcanic and granitoid source. The contribution of granitoid rocks to the sediments that make up the Yellowknife Supergroup, need not be excessive. Frith and Fryer (1985) have pointed out from rare earth element and mass balance studies of the granitoid and volcanic rocks of the northeast Slave Province, that much of the sediment is likely derived from felsic, volcanic, pyroclastic rocks. This makes a granitoid provenance less important than earlier views (McGlynn and Henderson, 1970). Where mafic volcanic rocks predominate over felsic ones, as in the Indin Lake map area, source rocks were eroded or were derived from a more felsic volcanic provenance outside of the map area, such as the High Lake area, to the northeast.

The preponderance of turbiditic metasediments in basins underlain partly by volcanic flows and pyroclastics suggest that erosion and deposition was rapid. The presence of volcanic conglomerate at the interface between the volcanic and sedimentary rocks implies high energy wave or stream action and the local emergence of volcanic terrain. The present pattern of volcanic rocks overlain by these conglomerates, suggests the main Indin belt thinned toward the northeast, underlain not by basement, but by metasediment, as suggested for some of the volcanic flows in the Mesa Lake area (Ross, 1966).

Volcanic flow lines in the more felsic rocks south of Spider Lake indicate that bedding trends were east-northeast, similar to the orientation of the volcanic belt south of Hewitt Lake. The volcanic rocks were subsequently deformed by north-northeast trending folds (F1) and then re-folded by more northerly trending folds (F2). The fabric and form present in the Basler plutonic complex implies that it intruded during the first phase of folding and was uplifted during D2 and subsequent deformations. Both the basin supracrustal rocks and the plutonic rocks along the Slave boundary were faulted in patterns that accommodated uplift of the Graitoid areas along the boundary and depression of the heavier supracrustal rocks of the Indin structural basin during two events associated with 1.89 Ga tectonic events in the Wopmay Orogen.

Deformation and metamorphism

Pre-Yellowknife deformation and metamorphic fabrics from basement areas were mostly destroyed by "Kenoran" Orogeny overprinting. Archean deformation followed the deposition of the Yellowknife Supergroup. Deformation (D1) was locally contemporaneous with the peak of thermal metamorphism, as determined from the age of readily equilibrated basement monazite (2596 \pm 4 Ma, Frith et al., 1986), whereas the close of thermal metamorphism, measured from the age of crystallization of undeformed pegmatite, took place at 2573 \pm 39 Ma

(Van Breeman, personal communication, 1985). This time spread between D1 and D2 is consistent with the view that the two are broadly contemporaneous (Thompson, 1978).

Although the timing of the thermal peak of regional metamorphism probably varied from place to place, close study of contacts showed that thermal metamorphism outlasted plutonism, except possibly where low grade regionally metamorphosed rocks were the host rocks (northeast Basler Pluton). If there is a second thermal 'peak', as suggested by Frith (1978) it would also be broadly coeval with deformation and plutonism. Regions of high grade metamorphism were likely hotter for longer and the tailing effect on cooling may be reflected in younger K-Ar blocking temperatures determined from rocks of these regions.

Textures within intrusions vary and rocks such as the marginal phases of the Origin plutonic complex are more gneissic and possibly older than the more massive, central portions. Plutons, such as the massive megacrystic granites of Cotterill Lake, gave a Rb-Sr whole rock isochron age of 2532 +/- 132 Ma., similar to late "Kenoran" muscovite, separated from metasediments in the Indin structural basin which gave a Rb-Sr mineral age of 2528 Ma (Frith and Loveridge, 1978; Frith et al., 1977).

Penetrative Proterozoic deformation (D3) is most evident in the Indin structural basin. The age of D3 may be obtained from regional tectonic patterns. If the age of the northwest cleavage is related to similarly oriented folds in the Calderian Orogeny, then D3 took place after the emplacement of the Indin Diabase that may be correlated with the age of the sills in the Epworth Group and Snare Group that are post 1.89 Ga. Chlorite is developed along some of the S3 cleavage planes indicating that low grade regional metamorphism was associated with the event. Many of the mica ages along the Slave boundary were reset from ~2500 to 1900 Ma. Rocks in the central parts of the Indin lake structural basin give abnormally high K-Ar whole rock dates due to excess argon (3120 and 3175 Ma, Frith, 1978). However, a whole rock ^{40}Ar - ^{40}K isochron age approximates an age of thermal re-equilibration that is likely associated with the D3 metamorphism if not the age of the depression of the basin at 1.89 Ga. Plutonism and diabase dyke emplacement were broadly contemporaneous at this time. This is detailed further on.

Plutonism and development of migmatites

Pre-"Kenoran" plutonism occurred in the region approximately 3.0 Ga ago. Although rocks of this age are widespread, they are over-shadowed, volumetrically, by "Kenoran" plutonism and migmatization, forming rocks derived in part by melting of these rocks at lower structural levels (described below). Proterozoic magmatism associated with the Calderian Orogeny is not widespread within the Slave Province, but Proterozoic uplifts of older granitoids along the margin of the Slave occur over the length of the map area. The "Kenoran" Orogeny: During the "Kenoran" Orogeny two principal phases of deformation with associated metamorphism and plutonism took place. The first involved widespread tholeiitic and intermediate to felsic calc-alkaline volcanism, and less voluminous synvolcanic intrusions of gabbro, tonalite and granodiorite. The age of the more gneissic plutonic rocks of the region, such as the Sphynx lake pluton, is uncertain, but marginal studies indicate the pluton post-dated the adjacent volcanic rocks. The presence of granitoid cobbles in paraconglomerates of the Grizzly Lake area, indicate that plutonic rocks similar to the Sphynx Lake pluton were present during

their deposition. However synvolcanic intrusions of similar size have not been recognized in the map area. Smaller, generally elongated felsic sills and small round mafic plugs are present, but these make up a small part to the total volume of eroded rocks.

The second phase of orogeny followed crustal thickening and thermal build-up in the crust. This may have affected the crust in three ways: 1) granitoid rocks in the catazone were melted and intruded into the mesozone; or 2) rocks in the catazone were desiccated, producing alkalies and water and leaving residual granulites; 3) hybrid rocks were formed at mesozonal levels from catazonal and possibly mantle products.

- 1) Bridgewater and Collerson (1976) suggested that alkalies such as Rb and K may be derived from the mantle during melting which would provide the parent nuclides that are needed to give "mantle derived" $^{87}\text{Rb}/^{86}\text{Sr}$ ratios, yet satisfy the constraints that require calc-alkaline magmas to be generated within the crust (Wyllie et al., 1976). This would explain the occurrence of rocks with "mantle" $^{87}\text{Rb}/^{86}\text{Sr}$ ratios.

Partial melting of rocks to produce granitoid plutons is not a viable process due to the high viscosity of granitic liquids (Rice, 1981). Batch melting, on the other hand, would produce rocks of the same composition as the source rock. Melting of granitoid basement gneiss has been proposed as a likely source of plutonic rocks in the northeastern part of the Slave Province (Frith and Fryer, 1984). They suggested that single composition magmas formed from batch melting of low-Rb tonalites would, when mixed with mantle-derived alkalies, forming a suite of plutonic rocks that differentiated to give compositions that varied from quartz diorite to granodiorite. Rocks more felsic than granodiorite were thought to have formed from the melting of metasediments, similar in composition to those of the Yellowknife Supergroup and mixed with mantle-derived alkalies, particularly K. These more potassic and rubidium rich rocks have higher starting initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios than tonalite progenitors, which result in the higher $^{87}\text{Sr}/^{86}\text{Sr}$ ratios observed from Rb-Sr whole rock isochron studies of granites in the Indin Lake map area (Frith et al., 1977).

- 2) South of Daran Lake in the Ghost Lake area, basement gneiss has been metamorphosed to the granulite facies. A Pb-Pb whole rock isochron from these rocks of 2580 Ma, indicates the rocks were metamorphosed at this time which is consistent with the age of regional metamorphism determined from U-Pb monazite age determinations (2595 Ma, Frith et al., 1986).
- 3) The production of alkalies and water from the mantle and the catazone during orogeny would accumulate in the mesozone. The introduction of these constituents would affect the mesozonal rocks in different ways. Massive granitoid rocks would be metasomatized in situ and have irregular contacts (Cotterill Lake megacrystic granites) or if buoyant, would intrude in viscous spherical shapes (Whitewolf granite).

Alkalies and water from the catazone and mantle would collect in the leucosome phase of migmatites formed by metamorphic segregation (Kretz, 1977?) or partial melting. The migmatites in the map area are commonly more felsic than the paragneiss that constitutes the likely

source rocks of the area, particularly where the paleosome is more closely linked to volcanic rocks than to metasedimentary rocks. The concentration of granitic components in the leucosome reflects liquidus conditions and the vertically oriented, planar channel-ways in migmatites through which mobile constituents migrated. Since leucosome veins are commonly folded or otherwise deformed it is concluded the migmatites formed during the peak of thermal metamorphism, prior to D2.

Hybrid rock types make up the bulk of the granitoid rocks formed in the mesozone, currently exposed at the erosion surface. These include the following:

- (i) Migmatites - from tonalite basement.
- (ii) Migmatites - from paragneiss, mostly from metasediments.
- (iii) Megacrystic granodiorites - from K-metasomatism of homogenous tonalite formed in place or intruded to higher levels.
- (iv) Granites - from metasomatized and subsequently batch melted metasedimentary rocks.

Regional thermal metamorphism also changed the rheology of the enclosing rocks, allowing less dense granitoids to rise in core zones where rocks are hottest and wettest. This gives a false impression that plutonic rocks are providing the heat for regional metamorphism. There is no evidence from plutons of the region that they produced the heat required to metamorphose the country rocks of the region, except where late, still hot plutons were gravitationally emplaced into lower metamorphic grade country rock.

Indin Structural Basin

The more northerly trend of F2 folds within the Indin structural basin contrasts with S2 foliation traces found elsewhere in the Indin Lake map area. This was most likely controlled by the more northerly trend of the Indin structural basin developed initially during the "Kenoran" Orogen. Deformation along the marginal zones of the basin is more ductile than near its centre.

Textures in the supracrustal rocks indicate that most volcanic and sedimentary deposition was sub-aqueous, but the local presence of granitoid and volcanic clasts in conglomerates near the inter-face between volcanic and sedimentary deposition, suggest that emergent land was present during both volcanism and sedimentation. Bedding (S0) and early foliation (S1) directions indicate east-northeast striking structures.

East-northeast trending folds (F1) in the Indin Lake structural basin occur as remnants near the centre of the belt where regional metamorphism is low (Tremblay, 1953). Similar foliation trends are preserved in the Basler Pluton and the enclosing migmatites east of Strachan Lake. The change in orientation may have been controlled by deep-seated local structure, such as graben or single fissure faults that fed homoclinal volcanism or by the buttressing effect of the refractory volcanic segments. East-northeast trending volcanic rocks were deformed into large scale anticlinorial structures that dominate the outcrop pattern in the Indin structural basin.

Volcanic rocks from the west margin of the Indin structural basin are presumed to be thicker than those near the east margin. The volcanic rocks were folded into a broad synclinorium that has dominant north-northeast trend. East of the north arm of Indin Lake the volcanic rocks are folded at decreasing wavelengths along with the overlying and underlying metasediments. This also suggests the volcanic rocks were thinner toward the east. Metasediments are in contact and may have overlain basement gneiss in the Cotterill Lake area. In the Mesa Lake area, metasediments underlie volcanic rocks where they were folded with the metasediments (Ross, 1966). These relationships suggest that the volcanic rocks toward Truce Lake and Cotterill Lake were more distal, possibly overlying Archean granitoid basement that has since been uplifted to higher structural levels.

Plate Tectonics

The Wopmay Orogen has been interpreted as a classic "Wilson Cycle" (Hoffman, 1980) with deposition, deformation and intrusion along plate margins. The cycle began with development of north-south rifts which filled with bi-modal volcanic rocks and turbiditic sediments (Akaitcho Group). These deposits subsided and were overlain by west facing continental margin deposits (Epworth Group). Extension turned to compression and the Slave Plate subducted beneath the Bear Plate, scraping the rift and continental margin deposits on to the Slave craton. Continued subduction caused magmatism over the Bear Plate and eastward directed thrusting of supracrustal rocks over the Slave continental crust.

The chronologic relationship of events in the Wopmay Orogen (Hoffman and Bowering, 1984) to Proterozoic events in the Slave Structural Province is summarized below and in Table 6.

The earliest Proterozoic events to take place in the Slave Province are recorded in Rb-Sr whole rock isotopic systems which date the time of isotopic re-equilibration of the Dune Lake pluton and the Archean granitoid basement west of Mattberry Lake at 2204 and 2210 Ma. respectively. The significance of these dates has not been established (Frith et al., 1973). Similar dates have been reported from alkaline intrusions from the Bigspruce Lake area (Martineau and Lambert, 1974). However even though the data suggest rifting may have started as early as 2.2, with the intrusion of alkaline intrusions and local regional metamorphism, active deposition of rift-related sediments and volcanic rocks around the Slave craton did not take place until 1.9 Ga Ma, as determined from U-Pb zircon age determinations of volcanic rocks from the Akaitcho Group and from the Wilson Island Group (Bowering and others, 1984).

Volcanism, although typical of Wopmay Orogen rift deposition, did not occur in the Indin Lake map area, which implies a different depositional environment or that rocks mapped as Snare Group but possibly associated with the Akaitcho Group, have some other correlation. The rusty gneiss in the region from the east shore of Brownwater Lake to the west map limit are the same as rocks north of the map area mapped as Akatcho Group (St-Onge, personal communication) in the Exmouth Lake area, including the presence of thick beds of quartz pebble conglomerate and the local occurrence of sulphidic iron formation.

Proterozoic Deformation of the Indin Structural Basin

The geometry of the northwest trending sinistral-oblique-slip faults are best explained by a downward movement of the metasedimentary rocks of the basin, since the central low greenschist grade rocks were more than likely topographically higher than the upper amphibolite facies rocks on either side. The downward movement of the basin may be linked to events in the Wopmay Orogen in the following ways:

- 1) The east-west extension that gave rise to rifting of the west margin of the Slave craton stops at the Wopmay Fault (Hoffman, pers. comm.). However, early rifting was associated with alkaline intrusions such as those at Bigspruce Lake. The Indin Diabase dyke swarm intruded before east-west compression, and possibly correlative with sills in the Snare Group. The direction of emplacement of the north-northwest set of the Indin Diabase may have been controlled by east-west extension.
- 2) East-west compression in the Wopmay Orogen gave rise to upright to eastward verging folds in the Coronation Supergroup cover rocks and compression of the underlying basement. Temperatures were cooler in the basement, as isograds in the orogen always prograde away from it. East of the Slave boundary, the rocks failed by brittle deformation along fault patterns similar to those exhibited by the uplift of the Basler pluton and the depression of the Indin structural basin (Fig. 20). Vertical extension in both cases were partly controlled by the relative density of rocks in the region affected.
- 3) Eastward directed thrusting related to pan-Wopmay dextral strike-slip faulting (second collision, Hoffman, 1984) caused major dextral off-sets of the north-south trending Hepburn Intrusive Suite, the Snare Group, the Slave Structural Province boundary and Archean rocks along the western part of the Slave part of the map area. The faulting in the northern internal parts of the Wopmay Orogen is associated with left-lateral strike-slip faulting that is considered to be conjugate with east-northeast strike-slip faulting. These faults are considered to be contemporaneous with similar faults in the Great Bear magmatic arc where they cut 1.84 Ga plutons (Bowering and Hoffman, 1984).

The northeast faults in the Indin structural basin are of similar to slightly different orientation, but nowhere do these faults cut the Snare Group unconformity in the map area. Similarly, the northwest faults of the Yellowknife area offset the Yellowknife greenstone belt. These relationships suggest the northwest faults of the Indin structural basin are older than the circum-Slave, Proterozoic rocks, but post-"Kenoran".

- 4) North of the map area Tree River folding (Hoffman et al., 1983) is correlated with open ENE undulations of the region that likely continued south into the present map area, so that the area along the northern map margin, near the Slave boundary is a structural high, the Arseno Lake area a low and the Origin to Mattberry Lake area the another high. The faulting is also thought to be correlative with renewed movement on major circum-Slave transcurrent faults, such as the McDonald and Bathurst fault systems (Hoffman, 1984).

Wopmay Orogen

The part of the map area that lies within the Wopmay Orogen is deformed and metamorphosed by the Calderian. In some respect the orogeny is different from the type region to the north (Hoffman, 1984). Some of the major conclusions concerning the region are as follows:

- (1) Basement rocks include the full range of rock types observed in the Slave Province. Both the basement and the cover rocks are in place for the rocks between Norris Lake and the south margin of the map area, except for minor southeast directed thrusts near the Slave Province margin. Both were metamorphosed to greenschist facies during the Calderian. Deformation of the basement is higher than the cover rocks in the southern part of the map area, as it was deformed both during the Archean and Proterozoic.
- (2) Basement in the central part of the orogen was metamorphosed to the granulite facies. The age of the metamorphism is unknown. If it is Archean, as at Ghost Lake (which borders the southeast margin of the Indin structural basin) then the occurrence of a prograde Proterozoic regional metamorphism centred around the basement granitoids is hard to explain. If the metamorphism is Proterozoic, then the regional metamorphism must have involved the basement. This makes an allochthonous relationship for the cover rocks difficult to explain. Alternately, both the basement and the cover rocks are allochthonous. Although this concept is difficult to prove, it does explain a common regional metamorphism and a relatively sharp change of structural style in the southern part of the Arseno lake map area.
- (3) If the rocks in the Arseno Lake area west of the Slave boundary are mostly allochthonous and the basement is part of an allochthonous wedge all were transported to the east along a decollement surface(s) that have not been delineated. Such faults may steepen and coincide with the Slave boundary fault.
- (4) The emplacement of Archean cored gneiss domes within an allochthonous wedge took place under the influence of gravity, but their locations were possibly determined by interference fold patterns generated during early deformation (D1 of Hoffman, 1984). Apart from their non-intrusive mode of emplacement, the gneiss dome cores behaved in similar fashion to the plutons of the Hepburn Intrusive Suite.
- (5) Augen gneiss in the Mattberry anticlinorium are no longer correlated with the Rodrigues pluton of the Hepburn Intrusive Suite (Frith et al., 1974), as the Rodrigues Pluton intruded the Snare Group and was likely thrust from the west as described above. Parts of the Mattberry anticlinorium are massive porphyritic granites similar to rocks of the Rodrigues pluton, but these rocks are rooted to the basement as they can be traced across strike to augen gneiss deformed during the Calderian Orogeny. This gneiss the basal part of an unconformity that is overlain by similarly deformed conglomerates of the Snare Group (Frith et al., 1977).

REFERENCES

- Baragar, W.R.A.
1966: Geochemistry of the Yellowknife volcanic rocks; Canadian Journal of Earth Sciences, Vol. 3, pp. 9-30.
- Baragar, W.R.A. and McGlynn, J.C.
1976: Early Archean basement in the Canadian Shield: A review of the evidence; Geological Survey of Canada, Paper 76-14, 20p.
- Barth, T.F.W.
1962: Theoretical Petrology; 2nd edition, John Wiley and Sons, New York, 416p.
- Boyle, R.W.
1961: The geochemistry and origin of the gold deposits of the Yellowknife District; Geological Survey of Canada, Memoir 310.
- Bowering, S.A.; Van Schmus, W.R. and Hoffman, P.F.
1964: U-Pb zircon ages from Athapuscow aulocogen, East arm of Great Slave lake, N.W.T., Canada; Canadian Journal of Earth Sciences, Vol. 21, pp. 1315-1324.
- Bridgeman, P.W.
1915: Water in the liquid and five solid forms, under pressure; American Academy of Arts and Sciences, Proceedings, Vol. 407, pp. 441-558.
- Cloos, E.
1955: Experimental analysis of fracture patterns; Bulletin, Geological Society of America, Vol 60, p. 241.
- Collerson, K.D. and Fryer, B.J.
1978: The role of fluids in the formation and subsequent development of early continental crust; Contributions to Mineralogy and Petrology, Vol. 67, pp. 151-167.
- Condie K.L. and Baragar W.R.A.
1974: Rare earth element distributions in volcanic rocks from Archean greenstone belts; Contributions to Mineralogy and Petrology, Vol 45, pp237-246.
- Eade, K.E.
1948: Study of the diabase dykes of the Indin Lake area of the Northwest Territories; B.Sc. thesis, Queen's University.
- Easton, R.M.
1982: Tectonic significance of the Akaitcho Group, Wopmay Orogen, Northwest Territories, Canada; PhD thesis, Memorial University of Newfoundland.
1981: Stratigraphy of the Akaitcho Group and the development of an early Proterozoic continental margin, Wopmay Orogen, Northwest Territories; in Proterozoic Basins of Canada, F.H.A. Campbell ed. Geological Survey of Canada, Paper 81-10, pp. 79-95.
- Folinsbee, R.E.
1940: Gem quality cordierite from northern Canada; M.Sc. thesis, University of Minnesota.
- Fortier, Y.O.
1948: Indin Lake (east half) map-area, Northwest Territories; Geological Survey of Canada, Paper 49-10.

Fraser, J.A. and Tremblay, L.P.

1969: Correlation of Proterozoic strata in the northwestern Canadian Shield; Canadian Journal of Earth Sciences, Vol 6, pp. 1-9.

Fraser, J.A.

1964: Geological notes on northeastern District of Mackenzie, Northwest Territories; Geological Survey of Canada, Paper 63-40.

Frith, R.A.

1980: Rb-Sr age of the Cotterill lake granites, Indin Lake area; in Loveridge, W.D., Rubidium-strontium and uranium-lead isotopic studies, Report 3, in Current Research, Part C, Geological Survey of Canada, Paper 80-1C, pp. 234-236.

1978: Tectonics and metamorphism along the southern boundary between the Bear and Slave Structural Provinces; in Metamorphism in the Canadian Shield, Geological Survey of Canada, Paper 78-10, pp. 103-114.

1978a: Age determinations and Geologic Studies; K-Ar isotopic ages; Report 13, ed., R.K. Wanless, R.D. Stevens, G.R. Lachance and R.N. Delabio; Geological Survey of Canada, Paper 77-2, pp. 37-38.

1978b: Rb-Sr age of the Cotterill Lake granites, Indin Lake Area, District of Mackenzie; in Current Research, Part C, Geological Survey of Canada, Paper 80-1C, pp. 234-326.

1973: The geology of the Bear-Slave Boundary in the Indin lake area, District of Mackenzie; in Report of Activities, Geological Survey of Canada, Paper 73-1, Part A, pp. 146-148.

- Geology of the Hackett River map-area, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Memoir 417. (in press)

Frith, R.A., Frith, Rosaline, Helmstaedt, H., Hill, J. and Leatherbarrow, R.

1974: Geology of Indin Lake Area (86B), District of Mackenzie, in Current Research, Geological Survey of Canada Paper 74-1, Part 1A, pp. 165-171.

Frith, R.A., Loveridge, W.D. and Van Breeman, O.

- U-Pb zircon ages from basement granitoids of the western Slave Structural Province, northwest Canadian Shield; in Current Research, Geological Survey of Canada, Paper 86-1A. (in press)

Frith, Rosaline, Frith, R.A. and Doig, R.

1977: The geochronology of the granitic rocks along the Bear-Slave Structural Province boundary, northwest Canadian Shield; Canadian Journal of Earth Sciences, Vol 14, pp. 1356-1373.

Frith, R.A. and Leatherbarrow, R.

1975: Preliminary report of the geology of the Arseno Lake map-area (86B/12) District of Mackenzie; in Current Research, Geological Survey of Canada, Paper 75-1A, pp. 317-321.

Frith, R. A. and Loveridge, W.D.

1982: Ages of Yellowknife deposition, granitoid intrusion and regional metamorphism in the northeastern Slave Structural Province. Geological Survey of Canada, Paper 82-1A, pp. 225-237.

Frith, R.A. and Roscoe, S.M.

1980: Tectonic setting and sulphide deposits, Hackett River Belt, Slave Province, Canadian Institute of Mining and Metallurgy, Bulletin, Vol. 73, No. 815, pp. 143-153.

Frith, Rosaline

1974: Rb-Sr geochronological study of rocks of the Bear and Slave Provinces, Northwest Territories; MSc thesis, McGill University, Montreal, Quebec.

Gates, T.M. and Hurley, P.M.

1973: Evaluation of Rb-Sr dating methods applied to the Matachewan, abitibi, Mackenzie and Sudbury dike swarms in Canada, Canadian Journal of Earth Sciences, Vol 110, pp. 900-919.

Henderson, J.B.

1975: Sedimentology of the Archean Yellowknife Supergroup at Yellowknife, District of Mackenzie, Geological Survey of Canada, Bulletin 246.

1970: Stratigraphy of the Yellowknife Supergroup, Yellowknife Bay-Prosperous Lake area, District of Mackenzie; Geological Survey of Canada, Paper 7--26.

Hildebrand, R.S.

1981: Early Proterozoic Labine Group of Wopmay Orogen: remnant of a continental volcanic arc developed during oblique convergence; in Proterozoic Basins of Canada, ed F.H.A. Campbell, Geological Survey of Canada, Paper 81-10, pp. 133-156.

Hill, J.D. and Frith, R.A.

1982: Petrology of the Regan Intrusive Suite, in the Nose Lake - Beechey lake map-area, District of Mackenzie, Geological Survey of Canada, Paper 82-8.

Hoffman, P.F.

1973: Evolution of an early Proterozoic continental margin: the Coronation Geosyncline and associated aulocogen of the northwestern Canadian Shield; Philosophical Transactions of the Royal Society of London, Vol. 273, pp. 547-581.

1981: Revision of stratigraphic nomenclature, foreland thrust belt-fold belt of Wopmay Orogen, District of Mackenzie; Geological Survey of Canada, Paper 81-1A, pp. 247-250.

Hoffman, P.F. and Bowering, S.A.

1984: Short-lived 1.9 Ga. continental margin and its destruction, Wopmay Orogen, Northwest Canada; Geology, Vol. 12, pp. 68-72.

Hoffman, P.F., Geiser, P.A. and Gerhanian, L.K.

1971: Stratigraphy and structure of the Epworth fold belt, Geological Survey of Canada, Paper 71-1A, pp. 135-138.

Hoffman, P.F. and Pelletier, K.S.

1982: Cloos Nappe in Wopmay Orogen: significance for stratigraphy and structure of the Akaitcho Group and implications for opening and closing of an early Proterozoic continental margin; in Current Research, Part A, Geological Survey of Canada, Paper 82-1A, pp. 109-115.

- Hoffman, P.F., Tirrul, R. and Grotzinger, J.P.
 1983: The externalities of Wopmay Orogen, Point Lake and Kikerk Lake map areas, District of Mackenzie, in Current Research, Part A, Geological Survey of Canada, Paper 83-1A, pp. 429-435.
- Hoffman, P.F., Tirrul, R., Grotzinger, J.P., Lucas, B.B. and Eriksson, K.A.
 1984: The externalities of Wopmay Orogen, Takijuq Lake and Kikerk Lake map areas, District of MacKenzie; in Current research, Part A, Geological Survey of Canada, Paper 84-1A, pp. 383-395.
- Hutchinson, R.W.
 1955: Regional zonation of pegmatites near Ross Lake, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Bulletin 34.?????
- Jenner, G.A., Fryer, B.J. and McLennan, S.M.
 1981: Geochemistry of the Archean Yellowknife Supergroup; *Geochimica et Cosmochimica Acta*, Vol. 45, pp. 1111-1129. Krogh, T.E. and Gibbons, W.
 1978: U-Pb isotopic ages of basement and supracrustal rocks in the Point Lake area of the Slave Structural Province, Canada; Geological Association of Canada Abstracts, Vol. 3, p. 438.
- Lalonde, A.E.
 1984: The characterization and tectonic significance of plutonic suites within central Wopmay Orogen, N.W.T., Geological Association of Canada, Abstracts, p.80.
- Leatherbarrow, R.W.
 1975: Gneiss domes along the boundary of between the Bear and Slave Structural provinces (near Arseno Lake); M.Sc thesis, Carleton University, Ottawa.
- Leech, A.P.
 1966: Potassium-argon dates of basic intrusive rocks of the District of Mackenzie, N.W.T.; *Canadian Journal of Earth Sciences*, Vol. 3, pp. 389-412.
- Lord, C.S.
 1942: Snare River and Ingray map-areas, Northwest Territories, Geological Survey of Canada, Memoir 235.
- Martineau, M.P. and Lambert, R.
 1974: The Bigspruce Lake nepheline-syenite/carbonatite complex, N.W.T. (abstract); Geological Association of Canada, Annual Meeting, St. John's, Newfoundland.
- McGLynn, J.C.
 1972: Basler Lake granite, District of Mackenzie; in Rubidium-strontium isochron age studies, Report No. 1, ed. R.K.Loveridge; Geological Survey of Canada, Paper 72-23, p.15.
 1977: Geology of the Bear-Slave Structural Provinces, District of Mackenzie. Geological survey of Canada, Open File 445.

- McGlynn, J.C. and Henderson, J.B.
 1970: Archean volcanism and sedimentation in the Slave Structural Province; Geological Survey of Canada, Paper 70-40, pp. 31-44.
 1972: The Slave Province; in Variation in tectonic styles, Geological Association of Canada, Special Paper No. 11. McGlynn, J.C. and Ross, J.V.
 1963: Arseno Lake map-area, District of Mackenzie, 86B/12; Geological Survey of Canada, Paper 63-26.
- McGlynn, J.C. and Irving, E.
 1975: Paleomagnetism of early Archean Dykes from the Slave Structural Province, Canada; Tectonophysics, Vol. 26, pp. 23-38.
- Neilsen, P.A.
 1977: Metamorphic petrology and mineralogy of the Arseno Lake area, N.W.T., unpublished PhD. thesis, University of Alberta, 230p.
- Nikic, Z.
 1975: Diatreme containing boulders of 3030 m.y. old tonalite gneiss - Con Mine, Yellowknife, Slave Province; Geological Society of America, Annual Meeting Abstracts, p.1213.
- Nikic, Z., Baadsgaard, H., Folinsbee, R.E., Krupiksa, J. and Leech, A.P.
 1980: Boulders from the basement: the trace of an ancient crust?; Geological Society of America, Special Paper 182, pp. 169-175.
- Ramsay, G.R.
 1973: Controls of biotite zone mineral chemistry in Archean meta-sediments, near Yellowknife, N.W.T., Canada; Journal of Petrology, Vol. 14, Part 3, pp. 407-488.
- Ramsay, J.G.
 1967: Folding and Fracturing of Rocks; McGraw-Hill, New York, 568p.
- Rice, A.
 1981: Convective fractionation: a mechanism to provide cryptic zoning (macrosegregation), layering, crescumulates, banded tuffs and explosive volcanism in igneous processes; Journal of Geophysical Research, 86, pp. 405-417.
- Robertson, D.K. and Cumming, G.L.
 1968: Lead-isotope and sulphur-isotope ratios from the Great Slave Lake area, Canada; Canadian Journal of Earth Sciences, Vol. 5, pp. Robertson, D.K. and Folinsbee, R.E.
 1974: Lead-isotope ratios and crustal evolution of the Slave Craton at Ghost Lake, N.W.T.; Canadian Journal of Earth Sciences, Vol. 11, pp. 819-827.
- Ross, J.V.
 1966: The structure and metamorphism of Mesa Lake map-area, District of Mackenzie, Geological Survey of Canada, Bulletin 124.
- Ross, J.V. and McGlynn, J.C.
 1965: Snare-Yellowknife relations, District of Mackenzie, N.W.T., Canada; Canadian Journal of Earth Sciences, Vol 2, pp. 118-130.
- Salop, L.I.
 1971: Two types of Precambrian structures: folded gneiss ovals and gneiss domes; Bulletin of the Moscow Society of Naturalists, Geology Section, Vol. 46, NO. 4.

- Scharer, U. and Allegre, C.J.
 1982: Investigation of the Archaean crust by single-grain dating of detrital zircon: a greywacke of the Slave Province, Canada; Canadian Journal of Earth Sciences, Vol. 19, pp. 1910-1918.
- Smith, P.H.
 1966: The structure and petrology of the Basler-EauClaire granite complex, District of Mackenzie, N.W.T., Canada; PhD thesis, Northwestern University, Evanston, Illinois.
 1966: Mattberry Lake, District of Mackenzie; Geological Survey of Canada Map No. 44-1963.
- Stanton, M.S.
 1974: Chalco Lake Map-area, Northwest Territories (preliminary account); Geological Survey of Canada, Paper 47-18.
- Stanton, M.S., Tremblay, L.P. and Yardley, D.H.
 1954: Chalco lake, District of Mackenzie, Northwest territories; Geological Survey of Canada, Map 1023A.
- Stockwell, C.H.
 1933: Great Slave Lake-Coppermine River, District of Mackenzie; Geological Survey of Canada, Summary Report 1932, pp. 37-63.
 1964: Age determinations and geologic studies, Part II; Geological Survey of Canada, Paper 64-17.
- St-Onge, M.R., King, J.E. and Lalonde, A.E.
 1984: Deformation and metamorphism of the Coronation Supergroup and its basement in the Hepburn metamorphic-plutonic zone of Wopmay Orogen: Redrock Lake and the eastern portion of Calder River Map-areas, District of Mackenzie; Geological Survey of Canada, Paper 84-1A, pp. 171-180.
 - Geology of the Redrock Lake Map Area (NTS 86G); Geological Survey of Canada Open File Map No. _____. (in press)
- Streckeisen, A.
 1976: To each plutonic rock its proper name; Earth Science Reviews, Vol. 12, pp. 1-33.
- Thompson, P.H.
 1978: Archean regional metamorphism in the Slave Structural province - a new perspective on some old rocks; in Metamorphism in the Canadian Shield; Geological Survey of Canada, Paper 78-10, pp. 85-102.
- Tirrul, R.
 1983: Structure cross-sections across Asiatic Foreland Thrust and Fold Belt, Wopmay Orogen, District of Mackenzie; in Current Research, Part B, Geological Survey of Canada, Paper 83-1B, p. 253-260.
- Tremblay, L.P.
 1953: Ranji Lake map-area, Northwest territories (Preliminary Account); Geological Survey of Canada, Paper 48-10.
- Tremblay, L.P. and Wright, G.M.
 1953: Chalco, Ranji and Ghost Lakes map-areas, Northwest Territories; Geological Survey of Canada unpublished manuscript.

- Tremblay, L.P., Wright, G.M. and Miller, M.L.
1953: Ranji Lake, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Map 1022A.
- Van Schmus, W.R. and Bowering, S.A.
1980: Geochronology of igneous events in the Wopmay Orogen, Northwest Territories, Canada; in Abstracts with Programs, Geological Association of America, Volume 12, p.540.
- Wanless, R.K.
1970: Isotopic age map of Canada; in Geology and economic minerals of Canada, ed R.J.W. Douglas; Geological Survey of Canada, Map 1256A.
- Wright, G.M.
1954: Ghost Lake, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Map 1021A.
- Wyllie, P.J.
1984: Constraints imposed by experimental petrology on possible and impossible magma sources and products. Philosophical Transactions of the Royal Society of London, Volume A310, pp. 349-456.
- Yardley, D.H.
1951: The Geology of the northern part of the Chalco lake area, Northwest Territories; PhD thesis, University of Minnesota.

TABLE OF FORMATIONS

Age(Ga)		Formations	Relationships	Lithology
P R O T E R O Z O I C A M B R I A N A R C H E A N	1.9		intrusive	pegmatite, aplite
	1.9		intrusive	diabase and gabbro sills
	1.9	Hepburn Batholith Hepburn Batholith	intrusive into Archean and Snare Group	granite and granodiorite
	1.9	Coronation S.G. Coronation S.G. Coronation S.G. Coronation S.G.	unconformably overlies Archean basement rocks and is locally thrust to the east and SE	siltstone, argillite dolomite, quartzite, conglomerate, muddy dolomite, sandstone, arkose
	2.5+	Basement gneiss	derived from Archean (Bear - Slave boundary)	migmatite, gneiss hornblende gneiss granitoid gneiss, mig
	1.9	Indin Diabase	intrusive into YKS/YKV	diabase, gabbro
	1.9	Strachan L. grdr muscovite peg.	intrusive into YKS/YKV intrusive into YKS	granodiorite stocks pegmatite, aplite
	2.57	granitoid plutons	intrusive into YKS/YKV	megacrystic granite, granodiorite
		granitoid plutons	intrusive into YKS/YKV	granite, granodiorite tonalite
	2.57	granitoid plutons hybrid granitoids	intrusive derived partly from YKS	migmatite, gneiss quartz monzonite, granodiorite
2.67	Yellowknife S.G. metasediments volcanics	conformable with YKV uncertain	greywacke, mudstone basalt, andesite, and dacite	
2.99	basement complex		tonalite, granodiorite, amphibolite	

YKS = Yellowknife Supergroup metasediments;
YKV = Yellowknife Supergroup metavolcanics
Rock are classified according to Streckeisen, 1976.

Table 2. Chemical analyses of basement granitoids from the Grenville Lake and Cotterill Lake areas in weight percent.

	1	2	3	4	5	6	7
SiO ₂	75.20	70.50	69.40	73.50	70.70	62.10	66.40
TiO ₂	0.05	0.21	0.38	0.13	0.28	1.02	0.52
Al ₂ O ₃	15.00	15.60	16.80	15.30	15.00	16.80	14.80
FeO	0.20	1.30	1.80	0.40	2.40	4.10	1.70
Fe ₂ O ₃	0.40	0.50	0.60	0.60	1.50	2.40	2.00
MnO	0.02	0.03	0.05	0.02	0.06	0.08	0.08
MgO	0.40	0.53	1.38	0.33	0.64	1.93	2.00
CaO	2.55	2.04	2.57	3.09	3.03	4.61	3.14
Na ₂ O	5.50	5.00	5.30	4.90	4.80	4.20	5.40
K ₂ O	0.69	2.57	1.59	0.99	0.94	1.83	2.36
P ₂ O ₅	0.03	0.10	0.12	0.05	0.09	0.33	0.15
S ² O ₅	0.01	0.00	0.02	0.00	0.00	0.01	0.01
CO ₂	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.05	98.38	100.01	99.31	99.44	99.41	98.56

Cr*	F 1000	F1000	3400	F 1000	nf	nf	1900
Zr	nf	600	500	200	nf	2400	5000
Sr	1600	3300	2900	1100	5600	2200	4900
Rb	1000	900	900	1300	nf	200	200
Zn	nf	100	600	200	nf	500	900
Ni	nf	200	100	100	nf	100	200
Ba	700	10000	4100	920	7100	3200	7400
Y*	F 2000	nf	F 2000	F 2000	nf	3600	4000

NOTES

FeO was determined by conventional methods, all others were by XRF or as noted below.

nf = not found; * = determined by emission spectrometry.

1-3 Grenville Lake tonalites

4-7 Cotterill Lake tonalites.

Table 2a: Chemical analyses of Archean gabbro and diabase dykes from the Grenville Lake and Hewitt Lake areas in weight percent.

	1	2
SiO ₂	48.3	61.7
TiO ₂	0.96	1.08
Al ₂ O ₃	16.5	15.7
FeO	8.9	5.8
Fe ₂ O ₃	2.0	0.6
MnO	0.2	0.08
MgO	8.07	2.64
CaO	10.8	3.93
Na ₂ O	2.4	3.2
K ₂ O	0.45	2.79
P ₂ O ₅	0.09	0.25
S ₂ O ₅	0.03	0.03
CO ₂	0.0	nd
Total	98.7	97.85
Cr*	4100	3300
Zr	nd	1400
Sr	1200	2500
Rb	nd	1200
Zn	800	1000
Ni	1400	400
Ba	900	4600
Y*	2100	2800
Co*	500	3300

NOTES

FeO was determined by conventional methods, all others were by XRF or as noted below.

nd = not detected ; * = determined by emission spectrometry.

- 1 Grenville Lake gabbro
- 2 Hewitt Lake diabase

Table 3. Whole rocks analyses in weight percent from Yellowknife greywackes and mudstones from channel samples obtained by diamond drilling from a single outcrop located on an island in the northeast arm of Indin Lake, located near the cordierite-staurolite isograd.

	1	2	3	4	5	6	7
SiO ₂	69.90	69.00	64.70	60.10	71.60	67.10	67.07
TiO ₂	0.54	0.60	0.69	0.74	0.55	0.62	0.62
Al ₂ O ₃	13.10	14.30	16.30	18.50	14.50	15.00	15.28
FeO	3.00	2.30	4.30	5.30	3.10	4.20	3.70
Fe ₂ O ₃	0.80	2.30	1.00	0.70	0.50	0.90	1.03
MnO	0.06	0.04	0.05	0.06	0.03	0.05	0.05
MgO	2.12	2.40	2.87	3.34	1.95	2.80	2.58
CaO	1.34	0.73	0.71	0.61	0.41	1.00	0.80
Na ₂ O	3.00	3.40	4.10	3.10	3.80	3.00	3.40
K ₂ O	1.85	2.15	1.88	2.90	1.93	2.01	2.12
P ₂ O ₅	0.12	0.12	0.11	0.11	0.09	0.10	0.11
Cr ₂ O ₃	0.06	0.05	0.06	0.06	0.07	0.05	0.06
H ₂ O ^T	1.90	2.30	3.10	3.40	2.10	2.80	2.60
CO ₂	1.60	0.60	0.30	0.40	0.10	0.50	0.58
Total	99.39	100.29	100.17	99.32	100.73	100.13	100.63
Ba	0.030	0.044	0.030	0.050	0.032	0.036	0.037
Sr	0.022	0.018	0.021	0.020	0.019	0.018	0.020
Rb	0.004	0.014	0.004	0.006	0.003	0.004	0.005
Zr	0.005	0.007	0.003	0.002	0.004	0.002	0.004
Zn	0.003	0.006	0.008	0.011	0.004	0.008	0.007
Ni	0.007	0.008	0.010	0.009	0.007	0.007	0.008
S	0.100	0.140	0.130	0.070	0.080	0.070	0.098

Table 4. Whole rock analyses from the Origin plutonic complex and Sphynx Lake pluton.

	1	2	3	4	5	6	7
SiO ₂	73.00	66.40	71.50	65.20	64.30	68.30	71.20
TiO ₂	0.10	0.52	0.18	0.09	0.11	0.37	0.38
Al ₂ O ₃	14.10	14.80	15.40	19.90	19.10	15.10	14.20
FeO	0.70	1.70	0.80	0.30	0.00	2.00	1.70
Fe ₂ O ₃	0.30	2.00	0.40	0.40	0.80	0.60	0.80
MnO	0.02	0.08	0.02	0.09	0.11	0.37	0.38
MgO	0.36	2.00	0.45	0.49	0.67	1.19	0.73
CaO	1.37	3.14	1.88	0.26	0.19	3.36	2.19
Na ₂ O	5.50	5.40	6.50	8.90	10.70	4.50	3.90
K ₂ O	3.56	2.36	2.46	3.91	2.93	2.06	3.44
P ₂ O ₅	0.06	0.15	0.06	0.04	0.06	0.10	0.09
Cr ₂ O ₃	0.03	0.01	0.02	0.02	0.02	0.04	0.04
H ₂ O ^T	0.40	1.00	0.40	0.40	0.60	1.10	0.90
Total	99.50	99.56	100.07	100.00	99.59	99.09	99.95
Ba	0.080	0.047	0.100	0.075	0.064	0.078	0.071
Sr	0.041	0.063	0.058	0.018	0.013	0.032	0.021
Rb	0.021	0.006	0.012	0.007	0.013	0.003	0.010
Zr	0.000	0.003	0.000	0.000	0.000	0.006	0.009
Zn	0.000	0.003	0.000	0.000	0.000	0.004	0.005
Ni	0.001	0.002	0.001	0.000	0.001	0.002	0.001
S	0.020	0.010	0.030	0.000	0.020	0.020	0.000

	8	9	10	11	
SiO ₂	66.60	64.60	74.30	56.90	NOTES 1 = (T411-1) Origin L. 2 = (T319-1) 3 = (T402-1) 4 = (T305-1) 5 = (T305-2) 6 = (T307-2) 7 = (T407-2) 8 = (T593)Sphynx L. 9 = (T596) 10 = (T580) 11 = (T584)
TiO ₂	0.54	0.57	0.12	0.85	
Al ₂ O ₃	15.60	15.00	14.20	16.30	
FeO	3.00	2.50	0.10	4.20	
Fe ₂ O ₃	0.10	1.50	0.20	2.30	
MnO	0.07	0.08	0.02	0.13	
MgO	2.04	3.19	0.58	4.97	
CaO	2.44	2.74	0.56	5.45	
Na ₂ O	4.40	5.30	3.40	4.80	
K ₂ O	4.93	3.87	5.15	3.18	
P ₂ O ₅	0.21	0.24	0.09	0.28	
Cr ₂ O ₃	0.04	0.04	0.02	0.05	
H ₂ O ^T	0.70	1.20	0.70	1.30	
Total	100.67	100.83	99.44	100.71	
Ba	0.070	0.090	0.042	0.081	
Sr	0.054	0.041	0.009	0.075	
Rb	0.013	0.019	0.019	0.013	
Zr	0.023	0.009	0.000	0.015	
Zn	0.003	0.006	0.001	0.008	
Ni	0.003	0.006	0.001	0.007	
S	0.000	0.040	0.000	0.030	

Table 5: Modal analyses of diabase dykes from the Indin structural basin (after, Eade, 1948).

	1	2	3	4	5	6
Plagioclase	30-48	47-60	52-60	44-49	47	43
Pyroxene	7-28	22-33	25-34	1-3	33	6
Amphibole	30-38	6-8	2-16	39-45	11	44
Opagues	5-7	1-10	4-7	5-8	4	2
Olivine	*	2-11	*	*	5	*
Epidote	*	*	*	1-2	*	5
Apatite	*	*	*	1-2	*	*

* = not observed

- 1 = Northwest dykes containing plagioclase and pyroxene.
- 2 = Northwest dykes containing plagioclase, pyroxene and olivine.
- 3 = Northwest dykes containing plagioclase, pyroxene and quartz.
- 4 = North-northeast dykes containing plagioclase and pyroxene.
- 5 = Northwest dykes with waxy white plagioclase cut 1-4.
- 6 = Northwest dykes with plagioclase phenocrysts and pyroxene (possibly equivalent to the Mackenzie Diabase).

Table 6. Metamorphic minerals in the Yellowknife Supergroup metasedimentary rocks from the Ranji lake area (Tremblay, 1948).

QZ	MS	BO	GR	ST	PG	AD	CD	SL	TR
X	X	X			X	X	X		X
X	X	X			X		X		
X	X	X				X			
X		X		X					
X		X		X		X	X		
X		X		X			X		
X		X	X		X				
X		X	X		X	X		X	
X		X			X	X		X	
X	X								

QZ = quartz; MS = muscovite; BO = biotite; ST = staurolite
 PG = plagioclase; AD = andalusite; CD = cordierite;
 SL = sillimanite; TR = tourmaline

Table 7: Assay results from some of the better diamond drill holes from the KIM claim group, Lex Lake.

Hole	From	Length	Grade (g/t)
84-1	25.30	11.19	7.10
84-2	37.49	12.38	9.49
84-3	56.39	29.81	4.66
85-1	92.29	8.29	7.86
85-9	100.49	5.09	8.73
85-24	51.36	15.03	8.44
including	51.36	1.83	16.88
	54.80	1.65	11.06
	58.06	8.32	8.73
85-29	2.90	25.85	3.20
including	2.90	6.10	6.40
	44.20	8.38	2.91
	44.20	2.72	6.98
	74.49	2.50	8.15

Table 8. Correlation of supracrustal deposition, deformation and plutonism within the map area.

Age (Ga)	Supracrustal deposition	Deformation*	Metamorphism	Intrusion	Wopmay Orogen	Slave Structural Province
Proterozoic (1.84)	Great Bear SG	ENE dextral faulting		I-5	- NW and ENE conjugate faulting, Gt. Bear Bath.	- ENE dextral strike slip faulting of all
Proterozoic (1.9)	Coronation SG	C	M3	I-4	- intrusion of Hepburn Batholith - emplacement of gneiss domes - folding of Coronation S.G. - intrusion of diabase sills - deposition of Coronation S.G.	- northwest left-oblique faulting - depression of Indin S.B. uplift to west - local open folding, NE cleavage in YKS - intrusion of Indin Diabase - intrusion of Strachan granodiorite?
Proterozoic (2.2)	(none)		M?	outside the area	- Some Rb-Sr systems reset - Pre-O4 in Archean metasedimentary rocks	- Some Pb-Sr, K-Ar isotopic systems reset
Archean (2.58)		K	M2	I-3	- plutonic and migmatitic rocks present	- anorogenic plutons, anatectites, migmatites - orogenic plutons
(2.67)	Yellowknife metasediments			I-2	- equivalents to Yellowknife Supergroup are present	- synvolcanic intrusions
Archean (2.9)	Yellowknife volcanics					
	?	PK	M1	I-1	- pre-Yellowknife granitoids not identified	- K & Rb metasomatism (M1) - intrusion of tonalite pluton

*PK = Pre-Kenoran - only evident in the fabric of suspected syn-volcanic meta-gabbro dykes.

K = Orogeny analogous to the Kenoran - 2 sets of folding recognized:

F1 - ENE isoclinal folding of Yellowknife Supergroup identified mostly in areas of low grade regional metamorphism.

F2 - NNE isoclinal folding of Yellowknife Supergroup identified mostly in areas of medium to high grade regional metamorphism, such as the Indin structural basin.

C = Calderian Orogeny - 3 sets of folding are recognized:

F1 - ENE cylindrical to isoclinal folding of Coronation Supergroup rocks equivalent to brittle NW sinistral faulting of Indin structural basin and margins.

F2 - NNE isoclinal folding, re-folds F1 in regions of high grade regional Proterozoic metamorphism. This is the only folding recognized in low grade rocks.

F3 - N-S open folding and correlation of F1 and F2 - restricted occurrences.

Table 9 Geochronological studies of the Wopmay Orogen (Hoffman and Bowering, 1984) have shown a short duration between the time of the initial opening and final closing of the rifted continental margin. The following time framework is envisioned:

Interval (Ga.)	Wopmay Orogen	Indin Lake Map-area
1.85-1.81	- Collision of the west side of the Bear plate causing pervasive transcurent faulting throughout the Wopmay Orogen and reactivation of earlier fault structures such as the Bathurst and McDonald Fault systems.	- Extensive right-lateral faulting of the Hepburn Intrusive Suite, the Bear Slave Province boundary and Archean rocks within the Slave Province near the boundary (Mesa Lake area).
1.86-1.85	- Compression and right-lateral en echelon faulting of the Great Bear magmatic arc and intrusion of high level silica-deficient intrusions.	- Not evident
1.87-1.86	- Development of the Great Bear magmatic arc.	- Not evident
1.88-1.87	- Oblique folding of Slave cover rocks by NW - SE compression	- Not evident
1.89-1.88	- Calderian Orogeny - metamorphism.	- greenschist to granulite in the Wopmay, greenschist in the Slave -intrusion of the Hepburn Intrusive Suite - intrusion of the Hepburn Intrusive Suite and the emplacement of Archean gneiss domes in Wopmay.
	- eastward thrusting of the sedimentary prism	- Eastward fold vergence
	- sedimentation into eastward migrating foredeep basin,	- No documented thrusts present, but for minor SE thrusts in southern Slave margin area.
	- Intrusion of diabase & gabbro sills.	- Development of NW-SE folds and vertical cleavage in metasedimentary rocks of the Yellowknife S.G.
	- Deposition of the west facing Epworth Group shelf facies.	- NW sinistral oblique-slip faulting of Indin S.B.
	- Rift valleys formed and filled with the Akaitcho Group	- Not evident
1.90-1.89		- Intrusion of the Indin Diabase
		- Same
		- Same
2.05-1.90		- Possible extension of Indin structural basin and intrusion of the Strachan Lake stocks along its east margin.

Fig. 1 Geologic sketch map showing the principle rock types and the tectonic and geographic setting of the map area.

Fig. 2 Geologic sketch map showing the distribution and extent of the granitoid rocks of the map area.

- 14 Cordierite-staurolite isograd
- 13 Fault

ROCK TYPES

- 12 Proterozoic simple pegmatite
- 11 Proterozoic granodiorite
- 10 Megacrystic granodiorite or granitic pluton
- 9 Massive, granitic Archean pluton
- 8 Gneissic granodioritic or granitic pluton
- 7 Migmatite with metavolcanic restite
- 6 Migmatite with paragneiss restite
- 5 Migmatitic paragneiss
- 4 Yellowknife metasediments
- 3 Yellowknife metavolcanics
- 2 Undifferentiated Yellowknife Supergroup
- 1 Basement migmatite, gneiss/tonalitic gneiss

PLACE NAMES

DLP	Dune Lake pluton	OPC	Origin plutonic complex
SLP	Sphinx Lake pluton	MMC	Meyer migmatite complex
BPC	Basler plutonic complex	SLM	Snare Lake migmatites
TLC	Truce Lake migmatites	DLM	Drumlin Lake migmatites
SP	Snare plutons		

Fig. 3 Mesonormal plots for basement gneiss in the Grenville Lake and Cotterill Lake areas. The numbers refer to Table 2.

Fig. 4 Trace element vs. K₂O distribution in the basement gneiss of the Grenville and Cotterill lake areas. The numbers refer to analyses in Table 2.

Fig. 5 Distribution of volcanic and sedimentary rocks in the map area with place names as follows;

- 1 - Indin Lake volcanic belt
- 2 - Chartrand Lake volcanic belt
- 3 - Grenville lake volcanic belt
- 4 - Meyer migmatite complex
- 5 - Snare Lakes migmatite terrain
- 6 - Truce Lake - Drumlin Lake migmatite terrain
- 7 - Mattberry Lake anticlinorium - migmatite and gneiss.
- 8 - Emile River gneiss and migmatite terrain
- M - Migmatite with paleosome of metasediment (s); volcanics (v); basement granitoids (b).
- S - Yellowknife Supergroup metaediments; porphyroblastic (p); volcanogenic (g); migmatitic (m).
- Vh - Hypabyssal rocks associated with Yellowknife S.G. volcanics
- V - Yellowknife Supergroup pillow basalts; felsic flows and pyroclastics (f)

Fig. 6 $K_2O - SiO_2/10 - (FeO + Fe_2O_3 + MgO)$ plot for average whole rock analyses of Yellowknife Supergroup (with one standard deviation error envelopes) from Indin Lake, the Beechey Lake Group, northeast Slave Province and from the Burwash Formation, southern Slave Province (data from Frith, 1985 and Jenner et al, 1981).

Fig. 7 Trace element contents of Yellowknife Supergroup metasedimentary rocks from the north arm of Indin Lake.

Fig. 8 The Meyer migmatite complex and their normative compositions showing locations for:

- A A-grid 48 grid samples of gneissic granodiorite-solid triangles (Smith, 1966);
- B N-grid 24 close-spaced samples - solid squares (Smith, 1966);
- C Y-samples 6 samples 10-180m from the metasedimentary contact - open square;
- D whole rock analyses - large solid circles.

MAP LEGEND

- 1 Proterozoic Snare Group
- 2 Meyer migmatite complex, made up of granodiorite, tonalite gneiss and migmatite (gs) and local muscovite granite (gt).
- 3 Plutonic granodiorite; Sphynx Lake Pluton to the northeast and the Basler Pluton to the southwest.
- 4 Yellowknife Supergroup migmatitic paragneiss with local concentrations of pegmatite (ladders).
- 5 Yellowknife Supergroup volcanic rocks of the Chartrand Lake belt (north) and Indin Lake belt (southeast).

gs=gneissic texture; (gt)= granitic composition present locally
gs=gneissic; (gt)=local granite composition

- Fig. 9 Density contour map of the Origin plutonic complex, with a zero datum of 2.8 g/cc for the Yellowknife metasedimentary rocks. Stations are indicated by dots and the density contours are given as a negative percent difference from the datum. The volcanic rocks are 5-10% denser and the Snare Group metasediments are about the same density as the datum

MAP LEGEND

- A Yellowknife Supergroup volcanic rocks
- B Yellowknife Supergroup metasediments
- C Snare Group metasediments
- D Origin plutonic complex
- E Migmatite derived from Yellowknife S.G. metasediments

- Fig. 10 A Streckeisen diagram of the Origin plutonic complex and the Sphynx Lake pluton showing the range of composition from quartz diorite near the margins, through quartz monzonite and granodiorite to granite.

- Fig. 11 Trace element content of the rocks from the Origin intrusive complex and the Sphynx Lake pluton. The numbers refer to analyses listed in Table 4.

- Fig. 12 A map of the Basler intrusive complex showing the distribution and degree of gneissosity (or lack of it) and relative grain size within the complex, modified from Smith (1966)

- Fig. 13 A sketch-map of the Basler plutonic complex showing the location of detail sample grids for modal analyses plotted on Fig. 14 (after Smith, 1966).

- 1 Basement gneiss
- 2 Meyer migmatite complex
- 3 Metasedimentary rocks
- 4 Basler plutonic complex
- 5 Archean gneiss and migmatite unconformably underlying the Snare Group.

Faults are shown as bold solid lines.

- Fig. 14 Streckeisen diagram for rocks of the Basler plutonic complex and the east adjacent migmatitic metasediments of the Yellowknife Supergroup. Grid locations are shown on Fig. 13.

- Fig. 15 Diabase dykes in the Indin Lake area and in the south adjacent, Ghost Lake area. From an unpublished paleomagnetic study by Frith and Buchan, 1985. The cordierite-staurolite isograd is indicated

- Fig. 16 Interference patterns between F1 and F2 folds in vertically dipping greywackes and mudstones, east of Float Lake. F2 foliation directions and true top bedding traces are indicated (after Frith et al., 1974).

Fig. 17 Sketch-map of the gneiss domes in the Emile river area.

- 8 Garnet - k-feldspar and first sillimanite isograds
- 7 Hepburn megacrystic granodiorite and granite
- 6 Snare Group sub-greywackes siltstones and argillites
- 5 Dolomite and calc-silicate rocks of the Snare Group
- 4 Conglomerate and quartzite in the Snare Group
- 3 Proterozoic migmatite and migmatitic paragneiss
- 2 Archean granodiorite gneiss and migmatitic gneiss
- 1 Archean Yellowknife Supergroup rocks

Fig. 18 Prograde isograds in the Brownwater Lake region. Water saturated, stable minerals are noted on the hot side of each isograd. The contours are drawn from the ghanite content of spinel minerals (triangles) which prograde toward a granulite facies "hot spot". (adapted from Nielsen, 1977). Rock types are the same as for Fig. 17

CD = cordierite
SL = sillimanite

PF = potash feldspar
GT = garnet

Fig. 19 Geologic sketch-map of the Baton Lake area showing the relationships of the auriferous quartz-albite sill to the Yellowknife volcanic and metasedimentary rocks of the region.

- 5 = Metasedimentary rocks
- 4 = Quartz-albite rock
- 3 = Gabbro-quartz diorite
- 2 = Felsic volcanic rocks
- 1 = Mafic volcanic rocks

Fig. 20 Hypothetical east-west cross-sections of the (A) Basler Pluton and (B) the Indin Structural Basin. The vertical and horizontal scale is approximate.

- 1 = Unconformity between the Snare Group and the underlying Archean basement.
- 2 = Archean plutonic rocks.
- 3 = Yellowknife Supergroup metasedimentary rocks; with S0 signifying bedding. S1 the first foliation and S2 the second foliation.
- 4 = Yellowknife Supergroup felsic pyroclastic cap rocks.
- 5 = Yellowknife Supergroup pillowed basalts.
- 6 = Pre-Yellowknife granitoid basement rocks.
- 7 = The Archean Cordierite-staurolite isograd.
- 8 = Proterozoic reverse and gravity faults due to eastward directed thrusting during the Calderian Orogeny and gravitationally induced vertical movements.

(Note - photographs are not included in open file report)

Photo 1 Basement tonalite gneiss east of Cotterill Lake deformed by a northeast trending fold set (parallel to the hammer handle) which may be analgous to F1, making the east-west fabric pre-D1.

Photo 2 Basement tonalite gneiss east of Cotterill Lake in contact with foliated hornblende gneiss derived from a meta-gabbro dyke. Note the stretched augens and veins in the metagabbro and the older fabric in the basement inclusion.

Photo 3 Pillow basalt from a relatively undeformed region near Indin Lake.

Photo 4 Highly deformed pillows found near Grenville Lake.

Photo 5 Little deformed felsic volcanic flow breccia from an area south of Spider Lake.

Photo 6 Stretched felsic volcanic pebbles in a conglomerate overlying pillow basalts along the east margin of the southwest limb of the Indin Lake volcanic belt.

Photo 7 Typical graded bedding in sub-biotite grade greywacke-mudstone turbidites of the Yellowknife Supergroup near Damoti Lake.

Photo 8 Second fold (F2) of phorpblastic meta-greywackes along the northwest shore of the north arm of Indin Lake.

Photos 9 and 10 Examples of schlieren-type migmatite from the Snare Lake migmatite complex derived from rocks equivalent to the Yellowknife Supergroup.

Photo 11 Banded migmatite in an area south of Drumlin Lake. The paleosome is likely derived from in situ basic volcanic rocks, but the leucosome, composed mostly of plagioclase and quartz, was an extraneous source.

Photo 12 Breccia migmatite from south of Drumlin Lake intruded by granitoid leucosome. Note the reaction rim around the clasts and the fabric within the clast that pre-dates migmatization.

Photo 13 Folded, sillimanite grade, rusty sub-greywacke of the Snare Group, Brownwater Lake.

Photos 14 and 15 Snare Group conglomerate from the 'Clearwater' Lake area. Pebbles are made up mostly of quartz in a matrix of arkose, but with clasts of granitoid rock, volcanic rock and jasper noted locally.

Photo 16 Margin of the Rodrigues Granite showing inclusions of amphibolite and cross-cutting veins of aplite.

Photo 17 Margin of the Rodrigues Lake granite showing post-intrusive garnets in the host paragneiss of the (Snare Group or possibly metamorphosed equivalents of the Yellowknife Supergroup greywackes) and in the granite itself (from west of Brownwater Lake).

Photo 18 Second fold (F2) of porphyroblastic meta-greywackes along the northwest shore of the north arm of Indin Lake.

Photo 19 Third phase cleavage (S3) in metasedimentary rocks from a shore line area on the north arm of Indin Lake.

Photo 20 Third phase folding (F3) of metasedimentary rocks of the Yellowknife Supergroup with an upright axial plane that strikes in a northwest direction, southwest of Strachan lake.

Photo 21 Andalusite porphyroblasts near the cordierite-staurolite isograd, Indin Lake, showing a preferred orientation along the S2 cleavage direction. S1 is developed parallel to bedding (hammer handle).

Photo 22A Boudinaged quartz veins and tension gashes due to extension parallel to S2 foliation, from Snare Group south of Brownwater Lake.

Photo 22B Foliation cutting across remnant bedding of Snare Group greywackes, Brownwater Lake.

Photo 23 Andalusite porphyroblasts in Yellowknife Supergroup sediments from the north arm of Indin Lake, near the cordierite-staurolite isograd.

Photo 24 Retrograded cordierite porphyroblasts in Yellowknife Supergroup metasedimentary rocks from the Grenville Lake area.

Photo 25 Porphyroblasts of cordierite and staurolite concentrated near the top of the more argillaceous part of graded bedding.

Photo 26 Retrograded cordierite porphyroblasts in argillaceous beds of migmatitic metasedimentary rock, from the Hewitt lake area. The tree-line runs through the map area from Mesa Lake to Pate Lake. Barren lands contain isolated patches of scrub-spruce, as at Grenville Lake (A) and stunted birch and spruce as in the Indin Lake area (B). Migmatitic paragneiss derived from Yellowknife Supergroup rocks found near the west end of Indin lake. Most porphyroblasts of cordierite and staurolite have been retrograded, but sillimanite and garnet are