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PRECAMBRIAN GEOLOGY OF THE TULEMALU LAKE - YATHKYED LAKE AREA, DISTRICT OF KEEWATIN

K.E. EADE

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F.C. Taylor

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PRECAMBRIAN GEOLOGY OF THE TULEMALU LAKE – YATHKYED LAKE AREA, DISTRICT OF KEEWATIN

Abstract

Most of the map area is underlain by Archean rocks. They comprise supracrustal metavolcanics, metagreywackes and migmatized equivalents of the Henik Group; gneisses of various origins; and plutonic rocks ranging in composition from quartz monzonite to gabbro, including late Archean metagabbro Kazan Dykes. Easterly trending, early Aphebian, Tulemalu gabbro dykes are a prominent feature of the area. Aphebian gneisses, consisting of reworked Archean rocks, are confined to the southeast part of the map area. A small down-faulted block of metamorphosed Aphebian Hurwitz Group rocks is present in the area. Small, syntectonic, Aphebian, syenitic to granitic plutons occur throughout the area. Unmetamorphosed, late Aphebian Dubawnt Group volcanics, volcaniclastic sediments, and minor plutonic rocks occur, chiefly in three basins. Late Aphebian, posttectonic granite is prominent in the northwest part of the map area.

The area is intersected by major northeast, east, north or northwest faults. Vertical movement is predominant on all faults. Northeast-trending faults are probably the oldest and northwest-trending faults the youngest. Readjustments have occurred on all the faults from time to time. Most of the Archean gneisses and supracrustals have been folded along northeast axes and refolded along northwest axes. This folding was Archean. Structural-lithological domains are outlined and form part of a subdivision of all southern District of Keewatin.

Isotopic age determinations date the Archean rocks, the Tulemalu Dykes and the post-Dubawnt Group granite. They also show that one structural-lithological domain is little affected by post-Archean orogeny.

Uranium mineralization is in many places associated with the contact of the Archean rocks and the Dubawnt Group. Sulphides commonly occur with the metavolcanics of the Henik Group, but no deposits of present economic value are known.

Résumé

Des roches archéennes, soit des roches métavolcaniques, des métagrauwackes et des équivalents migmatisés du groupe de Henik supracorticaux, des gneiss d'origine variée et des roches plutoniques dont la composition varie de la monzonite quartzifère au gabbro, notamment des filons de métaggabro de Kazan de l'Archéen récent, reposent sous la plus grande partie de la région cartographique. Les filons de gabbro de Tulemalu de l'Aphébien ancien, orientés vers l'est, sont un phénomène caractéristique de la région. Les gneiss aphébiens, composés de roches archéennes remaniées, se limitent à la partie sud-est de la région cartographique. Un petit bloc affaissé de roches aphébiennes métamorphisées du groupe de Hurwitz se présente dans la région. Des petits plutons syntectoniques d'origine aphébienne, dont la composition varie de la syénite au granite, sont très répandus dans la région. Des sédiments volcaniclastiques, des petites quantités de roches plutoniques et des roches volcaniques non métamorphisées du groupe de Dubawnt de l'Aphébien récent se manifestent surtout dans trois bassins. Du granite post-tectonique de l'Aphébien récent se trouve dans la partie nord-ouest de la région cartographique.

Des failles majeures orientées vers le nord-est, l'est, le nord ou le nord-ouest traversent la région. Le déplacement y est surtout vertical. Les failles orientées vers le nord-est sont vraisemblablement les plus anciennes et les failles orientées vers le nord-ouest, les plus récentes. Il y a réajustement périodique de toutes les failles. La plupart des roches supracorticales et des gneiss archéens ont été plissés le long d'axes nord-est et replissés le long d'axes nord-ouest. Ce dernier plissement date de l'Archéen. Les zones structurales et lithologiques présentées font partie d'une sous-division de toute la partie sud du district de Keewatin.

L'âge des roches archéenes, des filons de Tulemalu et du granite formé après le groupe de Dubawnt a été déterminé par datation isotopique; cette méthode indique également qu'une des zones structurales et lithologiques est peu touchée par l'orogénèse post-archéenne.

Ade nombreux endroits, la minéralisation en uranium est associée au contact entre les roches archéennes et le groupe de Dubawnt. Des sulfures se présentent souvent dans les roches métavolcaniques du groupe de Henik, mais aucun gisement économiquement rentable n'a été identifié.

INTRODUCTION

The map area (NTS 65 J, 65 I west half) is in the southern part of the District of Keewatin approximately 478 km north-northwest of Churchill, Manitoba, 331 km west of Rankin Inlet on the Hudson Bay coast, and 234 km south-southwest of the settlement of Baker Lake. Churchill has air and rail facilities and Rankin Inlet and Baker Lake are served by scheduled air service from Churchill. All three points have charter aircraft available on an irregular basis. A private airstrip at a tourist lodge between North and South Henik lakes is only about 40 km south of the south boundary of the area. There are no permanent residents in the region.

Travel in summer is by float-equipped aircraft, helicopter, small boats or canoes on the lakes, or on foot. With the exception of Kazan River, rivers and streams are not easily navigable.

Relief is commonly less than 40 m throughout the area, with a maximum relief of approximately 90 m. Pleistocene deposits are extensive and rock exposures in much of the area are scarce. The area is beyond the treeline and only in a few scattered localities are there some stands of stunted spruce and tamarack. As is common elsewhere in the barren grounds, outcrop surfaces are covered with a coat of lichen.

The area was mapped in 1952 by the Geological Survey as part of the geological reconnaissance of southern District of Keewatin (Lord, 1953; Wright, 1955, 1967). Lee (1959) studied the Pleistocene geology as part of the regional reconnaissance. A detailed map (scale 1:125 000) of the surficial geology of Ferguson Lake (NTS 65 I) has been published (Aylsworth et al., 1979). Aeromagnetic maps covering the region at scales of one inch to one mile and one inch to four miles have been published by the Geological Survey.

The work in the NTS 65 I (W½) area described in this report was done between July 19 and August 22, 1973 by F.W. Chandler and K.E. Eade. NTS 65 J was mapped in the 1975 and 1976 field seasons by the author. Smaller lakes and rivers were clear of ice on approximately June 21, but larger lakes were not clear until early July. A Bell 47-G4A was used each field season for regular air traverses spaced at intervals of approximately 5 km to outline the main bedrock geology, for check traverses in areas of complicated geology with scant outcrop, and to position crews both from base camps and in fly camps, for ground traverses to fill in more details of the bedrock geology. Able assistance in the field was provided by the following: D.S. Faust, D.R. Troyer, W.R. Skinner, and J.C. White in 1973; J.K. Knowles, G.M. Stott, D.W. Brown, J.A. Percival, and M.R. St-Onge in 1975; M. Raudsepp, P.J. Chernis, A.G. Galley, S.J. Mole, and P. Ruck in 1976. D.H. Blake of the Australia Bureau of Mineral Resources, Geology and Geophysics, worked approximately five weeks in the Tulemalu Lake area (NTS 65 J) in 1976 as part of a study of the Dubawnt Group rocks in the region.

GENERAL GEOLOGY

The area (see Map 1604A, in pocket) is a part of the Churchill Province of the Canadian Shield. The oldest rocks are the metamorphosed volcanic and sedimentary rocks of the Henik Group and the amphibolite and gneisses derived from them. Old plutonic rocks range in composition from quartz monzonite to gabbro, and some orthogneiss is derived from these plutonic rocks. All these supracrustal, metamorphic and plutonic rocks are considered to be Archean.

An important swarm of east-trending diabase dykes (Tulemalu Dykes) are early Aphebian age, probably older than the Aphebian sedimentary Hurwitz Group. The Hurwitz Group rocks are limited to a small area in the southern part of NTS 65 I (W½). Aphebian gneissic rocks in the southeast part of that area appear to be largely reworked Archean gneisses and plutonic rocks, with some introduced Aphebian quartz monzonite. Scattered syntectonic Aphebian plutons range from quartz monzonite to syenite in composition. Late Aphebian Dubawnt Group rocks, largely trachytic volcanics and volcaniclastic sediments, with some sediments and small plutons and dykes of syenite composition related to the trachytic volcanics, are most abundant in NTS 65 J. Posttectonic fluorite-bearing, rapakivi-textured granite postdates the Dubawnt Group volcanics and sediments. The youngest rocks are Helikian Mackenzie Swarm diabase dykes.

Henik Group

Metamorphosed Archean volcanic and sedimentary rocks are part of the Henik Group, the name applied to similar rocks in adjoining map areas to the south (Eade, 1974; Eade and Chandler, 1975).

Volcanic rocks ($\bar{A}m$, $\bar{A}f$, $\bar{A}mf$)

A major band of metavolcanic rocks, east of Tyrrell Arm on the south end of Yathkyed Lake, extends southwest through the map area, continuing southwest into the Kognak River and Watterson Lake (W½)map areas (Eade, 1974; Eade and Chandler, 1975), and then swinging northward into the southwest corner of the map area at Angikuni Lake. Scattered amphibolite occurrences trending northeast from Angikuni Lake to the north end of Yathkyed Lake may be remnants of the same volcanic band. A band of volcanics trending west from the central part of Yathkyed Lake may be a part of the same volcanic band.

The basic metavolcanic unit ($\bar{A}m$) includes lavas and pyroclastic rocks that are for the most part basalt to andesite composition, with rare dacite to rhyolite. Small hypabyssal intrusive bodies of diorite-gabbro composition, occurring with the volcanic rocks, are included in this unit, as well as a single small serpentinite pluton, and minor undifferentiated iron formation bands. Thick, massive volcanic flows comprise an estimated 75 per cent of rocks in this map unit, but locally, good pillow structures are present. Scoriaceous flow tops and flow breccias occur also, as well as quartz or calcite amygdules and rare vesicles. The rocks are typically fine grained, dense, dark green on weathered surfaces, green to grey green on fresh surfaces, and locally have a pronounced schistosity.

Plagioclase, a major constituent of the basic lavas, is altered to very fine grained epidote and zoisite. Actinolite or secondary chlorite, depending on the extent of regional metamorphism, is the other major constituent of the metamorphosed basic lavas. Tiny interstitial grains of quartz and carbonate are present in most of these rocks but fine to medium grains of biotite are found only in some of the lavas; magnetite and pyrite are normal accessory minerals, and less commonly, sphene.

Minor flows of dacite associated with the basic lavas are typically grey to greenish grey on weathered surface, dark grey to greenish on fresh surface, and contain up to 10 per cent quartz.

Pyroclastics associated with the lavas range from coarse agglomerates to fine grained tuffs. The agglomerates consist of dark green basaltic or andesitic matrix with lighter coloured clasts of andesite, dacite, or rhyolite composition, averaging 12 cm diameter. Tuffs, commonly occurring with the agglomerates but also as intercalated lenses in the lavas, are massive to well bedded clastic rocks, for the most part fine grained, but medium grained in some places. They are grey to green on weathered surface and dark grey to green on fresh surface. The tuffs consist of subrounded to subangular

TABLE OF FORMATIONS

EON	ERA	GROUP, FORMATION OR MAP UNIT	LITHOLOGY
	Helikian	Hdb Mackenzie Dykes	Diabase dykes
		intrusive contact	
PROTEROZOIC	Aphebian	Ag, Agpr, Agp	Granite, in part with rapakivi texture or porphyritic and fluorite-bearing
		intrusive contact	
		Dubawnt Group AD	
		ADM Martell inrusives	Syenite, monzonite; lamprophyre, syenite, syenodiorite dykes
		ADC Christopher Island Formation	Mafic and felsic trachyte, rhyolite, pyroclastic rocks, vent breccia agglomerate, volcaniclastic sedimentary rocks
		ADS South Channel Formation	Conglomerate, sandstone, siltstone, mudstone
		ADA Angikuni Formation	Arkosic sandstone, siltstone, mudstone, and sandstone
		Aqm, Ay	Quartz monzonite, granite, syenite, granodiorite
		intrusive contact	
		Ango, Ann, Anl	Orthogneiss, nebulitic and swirled gneiss, layered gneiss with sills, dykes and irregular bodies of quartz monzonite
		Hurwitz Group AH	
		AHT Tavani Formation	Arkose, meta-arkose, impure quartzite, schists
		AHW, AHW' Watterson Formation	Dolomite, phyllite, argillite; calc-silicate and quartz-mica schist
		AHK Kinga Formation	Orthoquartzite
		Adb Tulemalu Dykes	Diabase, gabbro
		intrusive contact	
ARCHEAN		Ādb, Ādb' Kazan Dykes	Metagabbro, amphibolite; hornblendite
		Āb, Āb'	Gabbro, metagabbro, diorite
		Āqm, Āgg	Quartz monzonite, granodiorite
		intrusive contact	
		Āng, Āng', Āngo, Āngr Ānga, Āngm, Āngb	Granodiorite gneiss; quartz diorite gneiss; orthogneiss; pyroxene-bearing granodiorite gneiss; augen gneiss; granodiorite gneiss with abundant amphibolite inclusions; granodiorite gneiss cut by dykes and irregular masses of gabbro
		Ānl	Layered to irregularly layered gneiss, migmatite, banded or nebulitic gneiss
		Henik Group	
		Āsn, Āsn', Āsnt, Āsnr	Migmatized paragneiss, migmatized amphibolite, migmatized paragneiss derived from tuffs, pyroxene-bearing migmatized paragneiss
		Āmm	Amphibolite, amphibolitic greenstone, amphibole schist and gneiss
		Ās	Metagreywacke, metatuff
		Ācif, Āmtp, Āmtm	Carbonate iron formation, chert-pyrite iron formation, chert-magnetite iron formation
		Ālm	Limestone
		Āq	Arkose, quartzite, quartz pebble conglomerate, black slate
		Āmf	Mixed basic and intermediate metavolcanics and gabbro
		Āf	Intermediate to felsic metavolcanics
		Ām	Basic metavolcanics

grains of altered plagioclase, rock fragments and quartz in a very fine grained mass of secondary chlorite, epidote, zoisite and carbonate.

East of the north end of Yathkyed Lake the east-trending metavolcanic band is largely basic volcanic tuff with abundant gabbro masses. South of Angikuni Lake, sills and dykes of gabbro are abundant in the metavolcanics. Small irregularly shaped masses of medium grained gabbro in the basic metavolcanics are both chilled and grade into the fine grained rocks.

A small exposure of serpentinite is present near the centre of the east-trending metavolcanic band southwest of Yathkyed Lake, 4.5 km west of Kazan River. Contacts with the metavolcanics are not exposed but it is probably a small pluton.

Mixed basic and intermediate volcanics (Āmf), andesite and dacite, with some basalt and rhyolite, are present on the north and south sides of Angikuni Lake. The rock types are similar to those in the basic metavolcanic unit (Ām) but dacite comprises probably 40 per cent of this unit. Whereas most of the rocks are massive, a few are pillowed, and pyroclastic rocks are less abundant than in the basic map unit (Ām).

Intermediate to felsic metavolcanics (Āf) southwest of Tyrrell Arm consist largely of tuff, with some agglomerate and flows. Many of the tuffs are finely layered, suggesting they are water-laid. They are fine- to medium-grained, light grey or greenish grey on weathered surface and grey on fresh surface, and a pronounced schistosity is prevalent. Lavas are fine grained, massive, grey dacite. Agglomerate consists of a greenish grey dacitic matrix containing light grey weathering dacite to rhyolite clasts up to 20 cm in diameter. Intermediate to felsic metavolcanics on the northwest side of Angikuni Lake are largely tuffs, with only minor agglomerate and flow rocks. The flows are dacite, and the agglomerates typically have a dacitic matrix with rhyolite to dacite clasts. The tuffs are variously massive and layered and although pronounced schistosity destroys textures in many places both lapilli and crystal tuffs are discernible. Compositionally tuffs range from rhyolite to dacite, with the former most abundant. Typically, they consist of quartz, plagioclase (albite commonly) and rock fragments in a very fine grained mass of quartz, epidote, zoisite, carbonate and chlorite. Where schistosity is prevalent, muscovite and some biotite are present also. Zircon, sphene and pyrite are accessory minerals.

The metavolcanic units as portrayed on the geological map are of necessity generalized, as the scale of map, and in some areas lack of outcrop precludes showing detailed subdivisions. In places, however, mafic, felsic, and intermediate volcanics and gabbro bodies are intercalated. The geology of the area south of Angikuni Lake is shown in more detail in Figure 1 and the interfingering of mafic and intermediate volcanics and sill-like gabbro bodies is apparent. The felsic volcanics south of Angikuni Lake are largely massive flows of rhyolite composition. This fine grained to glassy rhyolite is light brown on weathered surface and white to grey on fresh surfaces and forms distinctive, smooth, rounded outcrops. Determination of 'tops' with any certainty in any of these rocks was not possible, hence the stratigraphy of the subdivisions shown in Figure 1 is unknown.

The metavolcanic rocks are everywhere regionally metamorphosed, for the most part in the greenschist facies, but ranging to lower amphibolite facies. In some places regional metamorphism is overprinted by contact metamorphism such as in the volcanic band extending northeast from east of Tyrrell Arm, Yathkyed Lake. There, basic flows with some intercalated mafic to acid tuffs (Ām) are intruded by a quartz monzonite (Āqm) pluton, and at the contacts the basic volcanics are metamorphosed to amphibolite and amphibolite gneiss.

Iron formation (Āmtp, Āmtm, Ācif)

Both chert-pyrite iron formation (Āmtp) and chert-magnetite iron formation (Āmtm) are present in the belt of metavolcanic rocks east and southwest of Tyrrell Arm, north of latitude 62°10'N. Iron formation is not known in the metavolcanics farther southwest, in the southeast of NTS 65 J or in the map area to the south. A band of recrystallized chert-magnetite iron formation is present in amphibolite (Āmm) at latitude 62°40'30"N and the east boundary of the map area. Minor chert-magnetite iron formation occurs in a small band of migmatized paragneiss (Āsn) near 62°32'N, 98°30'W, about 10 km west of Kazan River. A single band of carbonate iron formation (Ācif) is present west of Angikuni Lake.

The major iron formation occurrences lie along the southeast side of the volcanic band southwest of Tyrrell Arm. Based on pillow top determinations, the iron formation is in the lower part of the sequence where it is represented intermittently for 7 km, with a variable thickness up to 170 m. It does not outcrop well but frost-heaved boulders are abundant. The iron formation consists of white to grey, fine to very fine grained quartz, apparently recrystallized chert, interbanded with pyrite. The bands range from 0.25 to 1.25 cm thick. The host rock consists of fine grained, light to dark green or greyish green, partly bedded, schistose tuff of felsic to intermediate composition. The overlying volcanics are chiefly massive or pillowed mafic lavas, with minor intermediate lavas and some mafic tuffs. Higher in the volcanic sequence, near the southeast shore of Tyrrell Arm, beds of finely bedded (0.2 to 1 cm), fine grained quartz (recrystallized chert)-magnetite iron formation are present within mafic tuffs and lavas. This upper oxide facies iron formation probably represents a second cycle of deposition of iron formation.

Southwest of the above described occurrences, short and narrow chert-pyrite iron formation lenses, with some carbonate, are present in several places in the lower part of the volcanic sequence, associated with intermediate or felsic tuffs. Similarly, lenses of quartz-magnetite iron formation, associated with mafic volcanics, are present higher in the section.

The iron formation southeast and southwest of Tyrrell Arm probably represents the distal exhalite of Ridler and Shilts (1974). The present iron formation, although similar, is much less extensive than that associated with the Kaminak Group volcanics (Ridler and Shilts, 1974).

A folded band of siderite-chert iron formation (Ācif) on the west side of Angikuni Lake occurs within the arkose, quartzite, black slate unit (Āq) that overlies volcanic rocks (Ām). The fine grained, finely bedded (0.3 to 0.5 cm) rock is brown on weathered surface and grey to greenish grey on fresh surface. It consists of about 75 per cent carbonate-siderite, 20 per cent very fine grained quartz (recrystallized chert), and about 5 per cent chlorite and accessory opaque minerals. Interbeds of grey slate and rare arkose are present within the iron formation. Complex minor folds with axial traces trending 020° are abundant in the iron formation.

Amphibolite (Āmm)

Several bands of amphibolite (Āmm) in the southeast quarter of NTS 65 J are chiefly fine grained, less commonly medium grained, dark green on both fresh and weathered surfaces, and range from massive to well foliated. Composition is consistent, being 62 to 73 per

cent hornblende, 25 to 35 per cent calcic plagioclase, and 2 to 3 per cent quartz. All the bands except the most westerly also contain approximately 2 per cent sphene and minor carbonate, both apparently absent in the western band. The eastern amphibolite bands are considered to be derived from volcanic rocks, either flows or tuffs. At one place in the amphibolite band adjacent to Kazan River, thin beds of very fine grained quartz, probably recrystallized chert, occur in the amphibolite. The most westerly of these bands differs from the others, which are recrystallized and display mineral foliation, in that it has a relict gabbroic texture, particularly evident on the weathered surface. It also lacks sphene and carbonate but contains sufficient magnetite to produce a distinct high aeromagnetic anomaly. This band is considered to be derived from a gabbro sill or dyke.

Two areas of amphibolite (Āmm), one large and one small, occur within basement rocks separating the two areas of Dubawnt Group rocks in the west-central part of the area. This amphibolite is fine to very fine grained, dark green to dark grey, with a fine mineral foliation and some cleavage. Hornblende (60 to 65 per cent) and calcic plagioclase (25 to 30 per cent) are the major constituents, with rare quartz and abundant accessory opaques. Some secondary biotite, chlorite and epidote present in the amhibolite indicate minor retrogressive metamorphism.

Discontinuous bands of amphibolite are scattered on the west side of Yathkyed Lake and extend southwest. The most southwesterly of these consists of a fine grained, poorly foliated to massive rock with prominent cleavage,

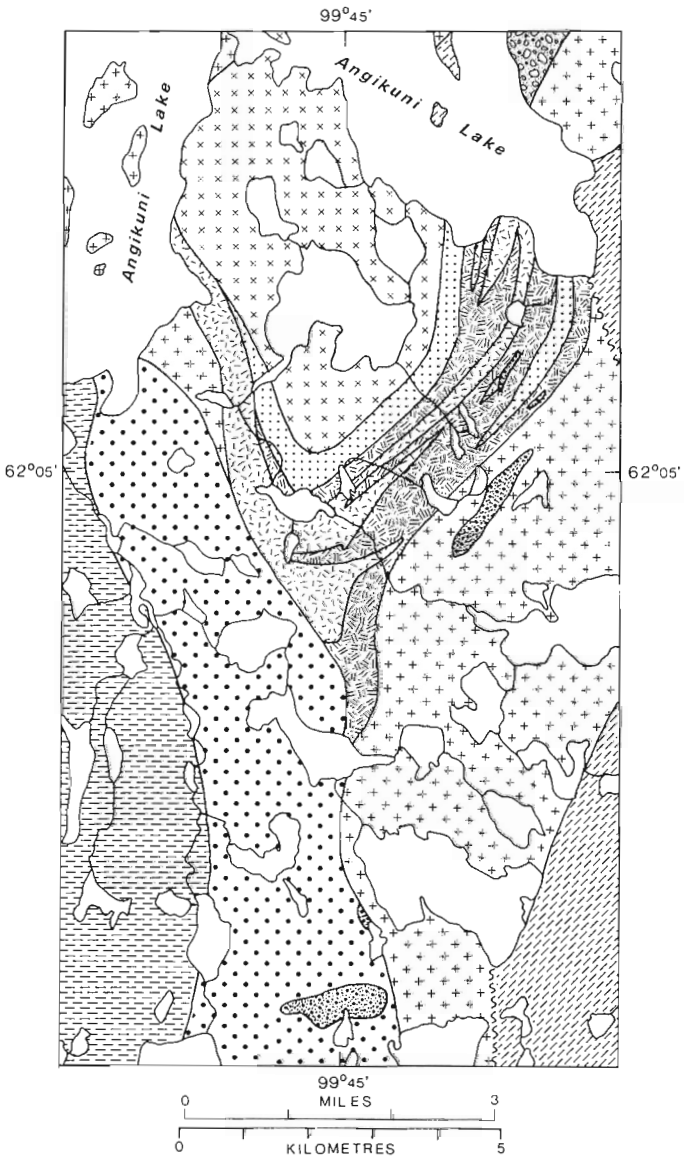

Figure 1. Detailed geology south of Angikuni Lake.

LEGEND

Gabbro, metagabbro.

Quartz monzonite to granodiorite, massive to slightly foliated.

Granodiorite gneiss, tonalite gneiss; includes some orthogneiss.

Migmatized paragneiss, with minor granodiorite gneiss; minor dykes and sheets of quartz monzonite.

Paragneiss, in part migmatized, with minor granodiorite gneiss and amphibolite, apparently derived from intermediate to felsic tuff.

Metagreywacke, with some metatuff.

Felsic and intermediate volcanic rocks, largely felsic pyroclastic rocks, volcanic breccia, tuff-breccia, lapillistone, lapilli-tuff and tuff; minor hypabyssal intrusions and intrusive breccia; bedding crude to absent; minor reworked equivalents; includes some intermediate composition rocks, gradational into the felsic volcanics.

Gabbro to diorite sills, dykes and plutons, intimately interlayered with mafic flows; sills are locally differentiated; intrusive equivalents of mafic flows.

Intermediate pyroclastic rocks and minor flows; tuff, lapilli-tuff, lapillistone, crystal tuff and minor volcanic breccia and tuff breccia; rare massive flows. Pyroclastic rocks are much reworked and are well bedded. Includes some clastic sedimentary rocks.

Mafic flows and rare pyroclastic rocks; massive amygdaloidal flows, minor pillowed flows, rare pillow breccia and/or flow foot breccia; rare well bedded tuff, probably gradational into intermediate pyroclastic rocks.

composed mostly of amphibole (largely actinolite) and calcic plagioclase. It also contains approximately 10 per cent each of biotite and epidote. It is probable that these rocks have undergone considerable retrogressive metamorphism. The nearby orthogneiss (Āngo) is apparently derived from a granodiorite to tonalite pluton and metamorphism associated with intrusion of this pluton may be responsible for the abundant biotite and epidote present in the amphibolite.

The small amphibolite bodies on the west and north shores of Yathkyed Lake are fine grained and very well foliated. The foliation is probably related to original layering in the rocks and the proto-rock was probably tuff with some layers of sediment. Beds of recrystallized chert, with abundant pyrrhotite, occur within the amphibolite. At one locality on the north shore of Yathkyed Lake, calc-silicate layers consisting of diopside, hornblende, plagioclase and epidote, occur in the foliated amphibolite.

The amphibolite bands close to the west and north shore of Yathkyed Lake may be derived from volcanics that originally linked up with the west-trending band of metavolcanics to the south and west of the lake.

The amphibolite extending east from the northeast corner of Yathkyed Lake is fine- to medium-grained and massive to well foliated. The composition is similar to amphibolite elsewhere, with hornblende and calcic plagioclase the main constituents. Relict pillows and flow breccias are preserved in a few places in the amphibolite and much of it is undoubtedly derived from basic volcanic rocks. The texture in some of the medium grained amphibolite is gabbroic, and therefore some of the amphibolite may be derived from gabbro or coarse grained volcanic rocks. Pyrrhotite-rich segregations or bands occur within this amphibolite.

Near latitude 62°40'N, east of Yathkyed Lake, there are two small areas of amphibolite (Āmm). The westerly body, trending northwest and bounded on one side by a northwest-trending fault, ranges from amphibolite to metagabbro. This rock is grey green to black, massive, medium grained, and is composed of calcic plagioclase, amphibole, augite remnants and scattered quartz grains, with minor secondary penninite and biotite. Although most of the minerals are recrystallized, some relict gabbroic texture remains and the rock is similar in places to the gabbro, metagabbro (Āb). The amphibolite body to the east trends northeast, and is fine grained and well foliated. Minor quartz and abundant accessory magnetite are present in the amphibolite and intercalated with it are felsic layers composed of quartz, plagioclase, biotite and tremolite. A single band of strongly recrystallized quartz-magnetite iron formation and several lenses of massive pyrite-pyrrhotite also occur within the amphibolite. This amphibolite is probably derived from basic volcanic tuff, with some interbedded felsic tuff and iron formation.

Migmatized amphibolite (Āsn')

At Tyrrell Arm, on the northwest side of the major metavolcanic (Ām) band, a northeast-trending band of migmatized amphibolite (Āsn') consists of amphibolite with some intercalated migmatized paragneiss, cut by sills and dykes of white, coarse grained to pegmatitic quartz-plagioclase. The quartz-feldspar bodies, thought to be neosome, are irregularly distributed in the amphibolite, in places forming 30 per cent of the outcrop, but elsewhere, rare or absent. Typically, they occur in discontinuous, concordant layers in the amphibolite but discordant bodies are also present. The fine- to medium-grained amphibolite has a pronounced mineral foliation. The major constituents, hornblende and plagioclase, are normally accompanied by some quartz, in amounts ranging from 2 to 20 per cent. Garnet is present in many of these amphibolites and diopside, less commonly. Some of the fine grained amphibolite is thinly layered and this is interpreted to be relict bedding. The typical mineral assemblage in the amphibolite is: hornblende-plagioclase-quartz+(garnet, magnetite, biotite, or diopside).

Scattered layers of medium grained, migmatized paragneiss are irregularly distributed within the amphibolite. The typical mineral assemblage in the paragneiss layers is: quartz-plagioclase-biotite+(garnet or muscovite and sillimanite).

The irregular quartz-feldspar segregations are remarkably felsic and contain only scattered hornblende and/or, rarely, biotite grains. The contacts with amphibolite are sharp but have no sign of chilling. The segregations are assumed to be neosome or mobilizate derived largely or wholly from the surrounding rocks during regional metamorphism. The irregular distribution in the amphibolite may be a function of the composition of the original rocks, which are thought to have been basic to intermediate tuffs with minor intercalated felsic tuffs.

Two small areas of migmatized amphibolite (Āsn') are present north of Angikuni Lake. The medium-to fine-grained, massive to slightly foliated amphibolite consists of plagioclase and hornblende, with minor augite and chlorite. The westerly occurrence includes some intercalated quartz-plagioclase-biotite-hornblende paragneiss. Concordant lenses of coarse grained, white, quartz-plagioclase rock occur throughout. Scattered dykes of pink quartz monzonite cut these rocks.

Sedimentary rocks

Sedimentary rocks of the Henik Group, conformably overlying the volcanic rocks, or in part intercalated with volcanic rocks, consist of limestone (Ālm), a mixed unit comprised of arkose, quartzite, conglomerate and slate (Āq) and greywacke to tuff (Ās), in increasing order of abundance.

Limestone (Ālm)

A single small area of limestone lies 4 km south of the point where Kazan River exits from Angikuni Lake. It conformably overlies felsic, crystal tuff, which in turn overlies basic metavolcanic rocks. About 18 m of thinly bedded limestone are exposed, with some intercalated acid tuff in the upper part. It is grey on fresh surfaces, brown on weathered surfaces, strongly sheared with fragments of chert lenses scattered throughout, and consists of approximately 85 per cent carbonate (calcite), with some diopside and tremolite-actinolite, and minor quartz and opaques. The associated tuff is massive, grey on both fresh and weathered surface, and consists of quartz (35 per cent), feldspar (45 per cent), biotite (10 per cent), muscovite (6 per cent) and carbonate (4 per cent). Some carbonate-rich tuff contains up to 17 per cent diopside. The limestone was probably deposited in a very local and small basin associated with late felsic volcanism in the upper part of the volcanic pile.

Arkose, quartzite, slate, conglomerate (Āq)

The mixed sedimentary unit comprising arkose, quartzite, conglomerate and slate occurs in the southwest of the map area, on the west side of Angikuni Lake, and on some small islands in the lake north of Angikuni Lake. The rocks conformably overlie the metavolcanics (Ām and Āmf) and in the lower part of the sequence, arkose to quartzite is intercalated with acid to intermediate tuffs of the volcanic units. In many places the tuffs and sedimentary rocks are lithologically similar as the latter are probably volcanogenic

in the lower part of the unit. The grey to white, medium grained arkose to quartzite is well bedded, typically in beds 2 to 4 cm, but variable. Composition varies, from 80 per cent quartz to 45 per cent feldspar. Rock fragments, chiefly felsic tuff, form up to 25 per cent. Sericite and very fine grained quartz comprise the matrix. The rocks are characterized by poor sorting as to size and shape of grains and by variation in the ratio of grains to matrix. Some of the quartz grains are mosaics of very fine grains, probably recrystallized chert. The feldspar is all plagioclase, ranging from albite to andesine. A distinctive component of many quartzite beds is disseminated pyrite that may be detrital. Quartz-pebble conglomerate, in beds up to 1 m thick, occurs in the quartzite here and there but is not abundant.

At some localities, in the upper part of the arkose to quartzite section, there are intercalated beds of grey to black slate. It consists of very fine grains of sericite and quartz, plus an opaque mineral, possibly graphite, scattered medium grained quartz and feldspar, and a few flakes of chlorite or biotite. In one place, fine grained acid tuff overlies the slate, but elsewhere the slate is the top of the section.

All the sedimentary rocks west of Angikuni Lake are highly folded and sheared similar to the underlying volcanic rocks. Quartz veins and stockworks are abundant in the sheared sedimentary rocks and in these, scarce pyrite, chalcopyrite and galena are scattered.

These sedimentary rocks were probably deposited in small local basins, on the volcanic rocks, and largely derived from the felsic tuffs. Similar sedimentary sequences associated with Archean metavolcanics are not known in southern District of Keewatin. Detrital pyrite in quartzite is a characteristic of the Montgomery Lake Group (Eade, 1974) but that group is early Aphebian age and unconformably overlies Henik Group metavolcanics. The sedimentary rocks have a superficial resemblance to the Mackenzie Lake metasediments in the Kaminak Lake map area (Davidson, 1970) that apparently unconformably overlie metavolcanics of the Kaminak Group. As the present rocks are conformable with the Henik Group volcanic sequence, they are probably not equivalent to the Mackenzie Lake metasediments.

Metagreywacke, metatuff ($\bar{A}s$)

At the south boundary of the map area, near 99°10'W a band of metagreywacke to metatuff ($\bar{A}s$) extends southwest into the Watterson Lake (W ½) map area. These rocks show a diverse lithology. Bedding, ranging from 0.5 cm to 1 m or more, is well developed in most outcrops. The majority of the rocks are medium grained but fine grained or slaty interbeds are scattered throughout. Composition ranges from mafic types containing up to 50 per cent hornblende and 25 per cent calcic plagioclase (amphibolites) to felsic types, with 35 per cent quartz and 45 per cent plagioclase. Biotite is present in all the felsic beds, in some places as porphyroblasts. Sericite and chlorite are other constituents, along with rock fragments and recrystallized chert. A few beds contain what are probably stretched lapilli. Traces of sillimanite and scattered fine grained garnets are present. Scattered, coarse grained to pegmatitic quartz-feldspar veins are present, but are much less common than in the nearby migmatized paragneiss ($\bar{A}sn$). Folding and strong shearing occur throughout and some felsic beds are converted to quartz-feldspar-mica schist. These rocks are probably tuffs or volcanogenic sediments.

This unit ($\bar{A}s$) east of Angikuni Lake, areally associated with and probably overlying basic metavolcanics ($\bar{A}m$), includes greywacke, tuff, and volcanogenic sediments. This greywacke, grey on fresh surface and brown to grey on weathered surface, is medium grained but contains some fine grained slaty interbeds. The tuff is typically thick-bedded to massive, fine- to medium-grained, greenish to grey on weathered surface. The composition of the rocks in this unit east of Angikuni Lake is more homogeneous than those near the south boundary. Average composition is: quartz, 30 to 35 per cent, plagioclase, 35 to 45 per cent, biotite, 12 to 18 per cent, some rock fragments and grains of recrystallized chert, and small amounts of sericite and carbonate. Garnet, staurolite and sillimanite are present scatteredly, indicating middle amphibolite facies metamorphism. Dykes and sills of white, coarse grained to pegmatitic quartz-feldspar tonalite cut the greywacke and tuff. Some pink quartz monzonite dykes cutting the greywacke-tuff are related to the quartz monzonite ($\bar{A}qm$) plutons.

The material composing the greywacke-tuff was largely derived from volcanogenic sources similar to the metavolcanic rocks ($\bar{A}m$, $\bar{A}f$, $\bar{A}mf$).

Migmatized paragneiss ($\bar{A}sn$, $\bar{A}snr$)

Migmatized paragneiss with scattered amphibolite layers occurs abundantly in northeast-trending bands in the southern part of the map area. This very well foliated, migmatized paragneiss consists of grey, medium- to fine-grained, quartz-plagioclase-biotite paleosome, and white, medium grained to pegmatitic quartz-plagioclase neosome. The amount of neosome is variable, but it commonly constitutes at least 25 per cent of the paragneiss, typically as continuous, concordant layers from 2 to 20 cm thick within the paleosome, but in part as discordant, irregular masses. In some felsic paragneiss with low biotite content, the foliation or layering is much less pronounced although there is a very thin (3 mm) light and dark layering. Elsewhere, neosome forms as much as 80 per cent of the outrop and in reality the rock is an agmatite.

The amphibolite bands in the migmatized paragneiss are similar to the previously described migmatized amphibolite ($\bar{A}sn'$). Amphibolite bands comprise approximately 5 per cent of this unit.

Dykes, veins and irregular masses of pink quartz monzonite occur with the migmatized paragneiss, most abundantly in the west. Whereas in some places quartz monzonite forms as much as 30 per cent of the outcrop, commonly it is 10 per cent or less. A medium grained rock is typical but locally pegmatitic or aplitic phases are present. It consists of quartz, oligoclase, microcline and biotite, with scattered garnet. Although quartz monzonite forms discrete bodies in the migmatized paragneiss, no chilled contacts exist and there is minor mixing at the contacts. The injection of the quartz monzonite took place over a period of time. As discussed in the "Structural Geology" section, the paragneiss is folded and refolded, and quartz monzonite was injected into paragneiss throughout the deformation. The potassium feldspar-bearing quartz monzonite cuts, and is quite distinct from, the white quartz-plagioclase neosome of the migmatized paragneiss.

The small band of migmatized paragneiss north of Kazan River at 99°15'W longitude that is bounded on the northwest by metavolcanics ($\bar{A}m$) is distinguished by the presence of abundant sphene in the quartz-plagioclase-biotite-hornblende paleosome.

Amphibolite layers are irregularly distributed throughout the migmatized paragneiss, typically forming 5 per cent or less of the unit, but in some places up to 20 per cent. These amphibolites range from 3 cm to 50 m thick, are fine to medium-grained and dark green to greyish green on fresh and weathered surface. Lenses of white, medium grained to pegmatitic quartz-plagioclase neosome are less abundant in the amphibolite layers, than in the normal paleosome.

Quartz, plagioclase and biotite, major constituents of the paragneiss, have accompanying metamorphic minerals in some places. Mineral assemblages in the paragneiss unit are:

quartz-plagioclase-biotite-garnet

quartz-plagioclase-biotite-garnet-sillimanite

quartz-plagioclase-biotite-muscovite

quartz-plagioclase-biotite-muscovite-garnet

quartz-plagioclase-biotite-garnet-microcline-sillimanite

quartz-plagioclase-biotite-garnet-muscovite-microcline

quartz-plagioclase-biotite-muscovite-microcline-sillimanite

quartz-plagioclase-biotite-hornblende-sphene

quartz-plagioclase-biotite-hornblende-epidote

quartz-plagioclase-biotite-cordierite-garnet-sillimanite

quartz-plagioclase-biotite-garnet-staurolite-sillimanite

quartz-plagioclase-biotite-cordierite-sillimanite

quartz-plagioclase-microcline-cordierite-garnet

plagioclase (andesine)-hornblende-biotite-quartz-sphene

plagioclase-hornblende-epidote-quartz-sphene

The plagioclase is commonly andesine but oligoclase is present in some rocks. Staurolite occurs in a single locality, in paragneiss close to the contact with metagreywacke (Ās) at a point 7.5 km south of Kazan River and 13.5 km east of Angikuni Lake. The last two assemblages are typical of the amphibolite layers in the paragneiss.

These mineral assemblages indicate that most of the rocks in this unit are in the lower amphibolite metamorphic facies. An exception, where metamorphic grade is higher, occurs in the migmatized paragneiss band west of Kazan River between approximately 62°19'N and 62°30'N. There, potassium feldspar is present along with cordierite and garnet, quartz and plagioclase, but no muscovite. This northeast-trending band, with higher metamorphic grade, may be in an uplifted block from a deeper crustal level as it is bounded on the north and south by major east-trending faults.

Included in the migmatized paragneiss unit (Āsn) are some distinctive rocks too limited in extent to separate on the map. The small area of paragneiss near 62°32'N, west of Kazan River, includes bands of quartz-magnetite iron formation (Āmtm) composed of approximately 25 per cent magnetite plus quartz, hornblende, grunerite and rare hypersthene. The paleosome of the accompanying paragneiss is variable in the ratio of quartz and plagioclase, quartz content from 20 to 30 per cent and plagioclase 35 to 55 per cent. Biotite is the other major constituent, with muscovite present rarely. Although the iron formation does not outcrop well, anomalies on aeromagnetic maps (GSC maps 6874G and 6875G) suggest its presence within the paragneiss and for several kilometres to the west beneath Dubawnt Group rocks.

In the southern part of the area, at 62°04'N, 98°44'15"W, minor amounts of basic and ultrabasic volcanic rocks occur within paragneiss. An ultrabasic flow, from 9 to 30 m thick, is separated by 11 m of paragneiss from a 3 m basaltic flow. The dark green ultrabasic flow displays large rounded pillows with vesicular-like outer rims, and light grey, 5 to 12 cm thick chilled selvages showing shrinkage features (Fig. 2). The rock consists of actinolite-tremolite, serpentine, and abundant magnetite. The basalt to the northwest consists of a fine grained groundmass of plagioclase, augite altered to hornblende, and opaques with coarser euhedral augite pseudomorphs consisting of tremolite-actinolite aggregates.

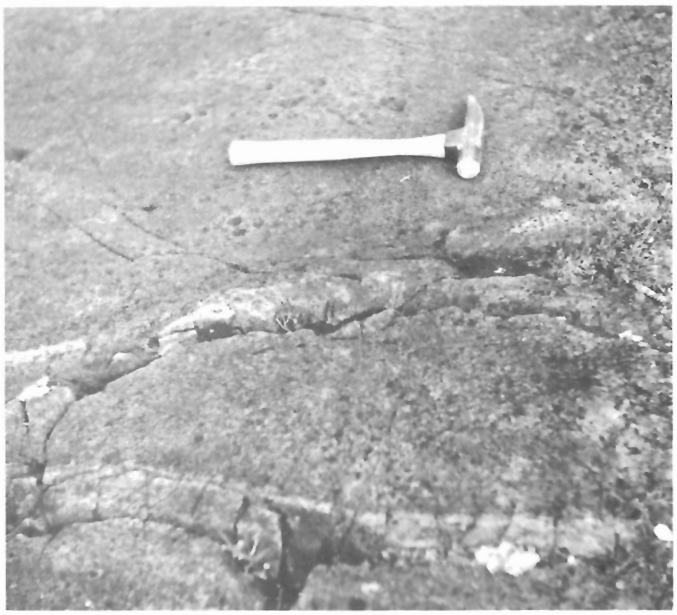

Figure 2. *Ultrabasic pillow with vesicular outer rim showing shrinkage fractures, occurring in migmatized paragneiss. GSC 165850*

Approximately 0.7 km northeast of the ultramafic flow a large hornblendite boudin, 35 m wide and at least 100 m long, is present within the migmatized paragneiss. Consisting chiefly of coarse grained hornblende, it is gabbroic or dioritic around its margins. Whereas rock in the central part of the boudin is massive, a good foliation is present near the margins. The boudin is transected by coarse grained, white quartz-feldspar and quartz veins. This large inclusion in the paragneiss is possibly derived from a small ultrabasic flow or pluton.

Migmatized paragneiss (Fig. 3) 1 km south-southeast of the above described ultrabasic volcanics is typical of quartz-plagioclase-biotite-garnet-sillimanite paleosome with white quartz-plagioclase neosome. The paleosome in places shows relict bedding (Fig. 4) with sandy quartz-plagioclase-biotite layers interbedded with more biotite-rich quartz-plagioclase-biotite-garnet-sillimanite layers. Within the migmatized paragneiss are some rusty weathering lenses or layers, up to 1 m thick, composed of quartz and pyrite with some magnetite, intercalated with garnetiferous paragneiss. This latter rock may have been quartz-pyrite-magnetite iron formation in volcanogenic sediments.

About 1.5 km north-northwest from the basic-ultrabasic flows, relict rhyolite occurs in paragneiss where it forms a band approximately 1 m thick. A cherty, aphanitic light brown rock, with a white to buff weathered surface, is characteristic. The groundmass consists of turbid alkali feldspar microliths, sericite flakes, interstitial alkali feldspar, and minor quartz and opaques in which sparse euhedral phenocrysts of quartz and turbid oligoclase rimmed by alkali feldspars are set.

Pyroxene-bearing, granulite facies migmatized paragneiss (Āsnr) occurs in a small area east of Kazan River near 62°32'N latitude. Mineral assemblages here are:

quartz-andesine-microcline-biotite-hypersthene-garnet

quartz-andesine-augite-hornblende-biotite

quartz-plagioclase-microcline-biotite-garnet

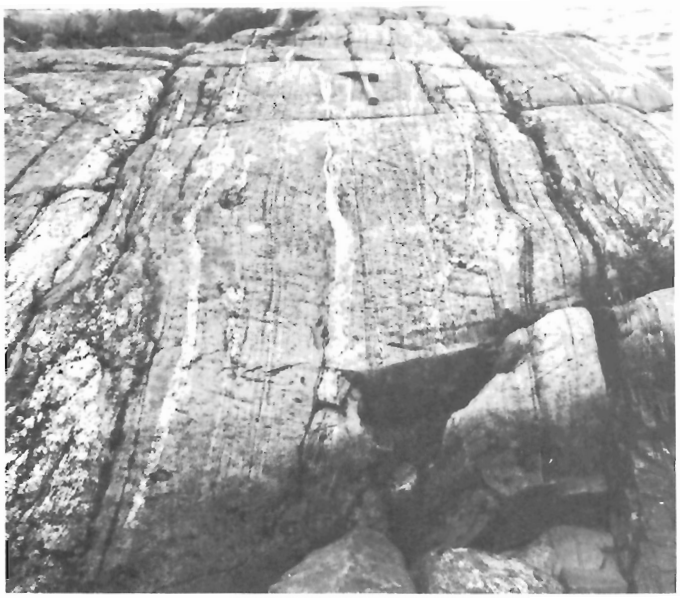

Figure 3. *Migmatized paragneiss. GSC 165847*

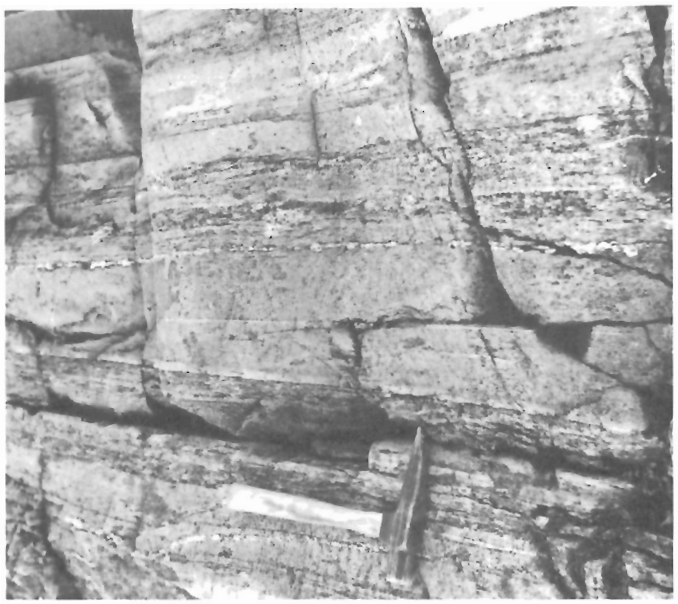

Figure 4. *Migmatized paragneiss showing relict bedding in the paleosome. GSC 165848*

In thin sections, biotite in these rocks is typically red and much of the hypersthene is partly altered. The rocks are medium grained, light to dark grey on fresh surfaces, with characteristic rusty brown weathered surfaces. The neosome, white, medium-to coarse-grained quartz-plagioclase, occurs as streaks or lenses within the paleosome rather than in layers typical of the lower grade migmatized paragneiss.

The majority of the migmatized paragneiss ($\bar{A}$sn, $\bar{A}$snr) is probably derived from greywacke and pelitic sedimentary rocks. Graded bedding is apparent rarely in the migmatized paragneiss, with sandy, quartz-feldspar layers grading upward into garnet-biotite-rich layers which are coarser and more recrystallized. However, the intercalation of some volcanic flow rocks within the migmatized paragneiss unit indicates that, in part at least, volcanogenic sediments comprised part of the protolith. The finely intercalated paragneiss and amphibolite layers found locally suggest a protolith of interbedded felsic and mafic tuff.

Migmatized paragneiss derived from tuff ($\bar{A}$snt)

Areas of migmatized paragneiss derived almost wholly from volcanogenic sediments and tuffs occur in a northeast-trending band, approximately 1 km wide, in the south-central part of the map area. It consists of massive to well banded rocks with paleosome ranging from intermediate to mafic composition and white quartz-feldspar neosome. In part, rocks in this unit resemble the migmatized amphibolite ($\bar{A}$sn') but in this map unit ($\bar{A}$snt) thin amphibolite layers are intercalated with intermediate composition layers. Rocks in the southern part of this band are less migmatized than in the northern part and are thinly banded (1 to 3 cm). The protolith was probably thinly banded tuff. Rocks in the north part of the band are coarsely layered, with layers to 4 m of quartz-feldspar-biotite paleosome and thinner (1 m) amphibolite paleosome, both containing lenses of white quartz-feldspar neosome. These rocks are probably derived from thick-bedded tuffs. Pyrite-rich layers in some of the paleosome are thought to be relict sulphide iron formation. In this band of migmatized paragneiss derived from tuff, 75 to 80 per cent of the paleosome is intermediate composition, the remainder amphibolitic. Typical mineral assemblages in the intermediate composition paleosome are:

quartz-andesine-biotite-garnet-cordierite

quartz-andesine-biotite-muscovite-cordierite

A discontinuous band of paragneiss derived from tuffs (Asnt) extends from south of Angikuni Lake, northward on the islands in the lake, and to the north of the lake. Dykes, veins and irregular bodies of pink quartz monzonite cut the paragneiss. South of Angikuni Lake the paragneiss, felsic to intermediate in composition, is prominently but variably banded in a 3 to 6 cm range. Bands of intermediate composition consist of quartz, plagioclase, biotite and hornblende or muscovite, whereas the felsic bands are quartz and feldspar with very few mafic minerals. Many of these rocks are strongly sheared. The quartz monzonite consists of quartz, microcline, plagioclase and approximately 6 per cent biotite, and is more abundant in the westernmost paragneiss.

On the islands in Angikuni Lake well banded paragneiss, in part migmatized, has a ratio of 70:30 of intermediate-felsic paleosome to mafic paleosome, with both containing scattered lenses of white quartz-plagioclase neosome. The intermediate to felsic paleosome consists of quartz, plagiocalse, biotite and garnet and the mafic paleosome, hornblende, plagioclase and minor quartz. Pink quartz monzonite veins and dykes cut the migmatized paragneiss.

At the north end of Angikuni lake the migmatized paragneiss is similar to that on the islands but it is more varied in composition and character than that southward. There is more amphibolite (mafic) paleosome, probably a ratio of 1:1 with the intermediate paleosome. There also, the metamorphic grade is higher, in part reaching lower granulite facies. The mafic portion of the gneiss is comprised of hornblende, plagioclase, quartz (8 per cent) and augite (4 per cent). The intermediate to felsic paragneiss is typically quartz-plagioclase-biotite-hornblende-garnet gneiss, with scattered grains of hypersthene. A less common type of intermediate gneiss is distinguished by clots of hornblende-garnet in a quartz-plagioclase groundmass. Banding ranges

from 1 cm to several metres thick, with an average of 1 m. The white coarse grained neosome occurring in the migmatized paragneiss as layers or lenses contains scattered hornblende grains.

Archean Gneisses

Migmatite, irregularly layered, banded or nebulitic gneiss (Ānl)

This mixed unit, variable in appearance and composition, is present in limited areas. Rocks included in this mixed gneiss unit are largely derived from metasediments and metavolcanics. Recrystallization and metamorphic differentiation are more intense than in the migmatized paragneiss and amphibolite (Āsn, Āsn'). Many of the rocks also show evidence of injection of granitic phases and have a generally higher potassium feldspar content. Migmatite, with prominent light and dark layers from 2 to 14 cm thick, is the most abundant rock type in the unit. In places, the layering is irregular or nebulitic and diffuse. Some agmatite is included, with angular to subangular blocks up to 1 m of intermediate to mafic composition in a felsic matrix. Some of the banded gneiss is comprised of interlayered granodiorite gneiss, paragneiss and amphibolite, the latter two probably equivalent to those of the Henik Group. The rocks are cut by veins, dykes or sheets of pink quartz monzonite, particularly in NTS 65 J.

Rocks in the part of this unit extending northeast from Tyrrell Arm of Yathkyed Lake are rich in amphibolite inclusions and the gneiss is composed of quartz, plagioclase, hornblende, with epidote commonly present. Diopside is present in a few places in this area.

Bordering Ferguson Lake and on the east side of Yathkyed Lake, gneisses in this unit contain both biotite and hornblende and some mirocline accompanies the quartz and plagioclase. Similarly, in the western part of the area, the gneisses of this unit contain up to 5 per cent microcline and some hornblende is present with the abundant biotite.

Granodiorite gneiss (Āng)

Granodiorite gneiss is widely distributed throughout the map area in northeast-trending bands and in smaller, isolated masses. There is some variation in the rocks of this unit but typically they are grey, medium grained, foliated, granitoid gneisses of granodiorite composition, but composition ranges from quartz monzonite to quartz diorite and tonalite. Areas of granodiorite gneiss (Āng), include small areas of orthogneiss (Āngo), quartz diorite gneiss (Āng') or augen gneiss (Ānga), and inclusions or schlieren of amphibolite, paragneiss, or biotite-rich gneiss. Foliation ranges from pronounced to poor and is marked by alignment of mineral grains, schlieren or inclusions, or by incipient layering. Biotite is by far the most common mafic mineral, but in places hornblende accompanies the biotite, and rarely, hornblende is the sole mafic mineral. Plagioclase composition is commonly oligoclase but locally andesine is present. Garnet and sillimanite present in some granodiorite gneiss probably result from assimilation of paragneiss inclusions or bands. Less than 7 per cent microcline is typical of most of this gneiss, but in some localities sufficient is present so that compositionally it is quartz monzonite. Secondary chlorite and epidote occur in limited amounts, and plagioclase is moderately saussuritized, indicating minor retrogressive metamorphism. Dykes, sills or sheets of medium grained to pegmatitic, pink quartz monzonite cut this rock, forming as much as 30 per cent of the outcrop in some places.

Pyroxene-bearing granodiorite gneiss (Āngr)

Pyroxene-bearing gneiss occurs on the large island in Yathkyed Lake, and in small areas on the east shore of the lake and southwest of the south end of the lake. This medium grained, well foliated gneiss, grey to dark grey on fresh surface and with rusty brown weathered surface, contains abundant mafic schlieren or lenses in many places, similar to the granodiorite gneiss containing abundant amphibolite inclusions (Āngm). Both mineral foliation and alignment of inclusions mark the foliation of this gneiss. The composition ranges from granodiorite to quartz diorite or tonalite, and constituents are quartz, plagioclase (oligoclase to andesine), microcline, augite and/or hypersthene, biotite and/or hornblende. The mineral assemblage (typical of the granulite metamorphic facies), the abundance of mafic inclusions and schlieren, and the rarity or absence of intruding quartz monzonite, distinguishes these rocks from those of the granodiorite gneiss (Āng) unit. The area of pyroxene-bearing granodiorite gneiss (Āngr) coincides reasonably well with a gravity high (Open File, Manuscript Map No. 60096, for Gravity Map of Canada, 1980, Earth Physics Branch).

Quartz diorite gneiss (Āng')

Areas of quartz diorite gneiss (Āng') have been delineated north of Imikula Lake and in the south half of NTS 65 J where several small bodies are present. This quartz diorite gneiss, grey to dark grey on fresh surface and grey to brown on weathered surface, is a weakly to moderately foliated, medium grained rock containing scattered mafic inclusions or schlieren. Quartz, andesine, and hornblende are the major constituents, although near Yathkyed Lake, augite is present also. The small bodies of quartz diorite gneiss in the southern part of NTS 65 J are cut by veins or dykes of pink quartz monzonite. Rocks in this unit are probably orthogneisses derived from small plutons of quartz diorite composition.

Granodiorite orthogneiss (Āngo)

Granodiorite orthogneiss is poorly to moderately foliated and contains few inclusions or schlieren except close to some contacts. Composition of these grey, medium grained rocks ranges from granodiorite to quartz diorite or tonalite. Most rocks included in this unit are sheared, with recrystallization and mineral foliation the result of deformation. Cataclastic zones occur here and there. Orthogneiss intrudes migmatized paragneiss (Āsn) and where they are in contact, inclusions of paragneiss are present in orthogneiss. Contact relations of the orthogneiss with granodiorite gneiss (Āng) are uncertain; in some places the orthogneiss probably intrudes granodiorite gneiss but elsewhere contacts are gradational. Variable amounts of pink quartz monzonite, in sills, dykes and sheets, cuts this orthogneiss.

Two small areas of orthogneiss occur east of Yathkyed Lake. The rocks are moderately foliated biotite-hornblende gneiss of granodiorite composition and contain secondary epidote and carbonate due to retrogressive metamorphism.

The largest body of orthogneiss is west of Yathkyed Lake and consists of poorly to moderately foliated biotite granodiorite or tonalite, in part hornblende-bearing. Microcline is present, up to 15 per cent in some places, but typically less. Feldspar augen occur adjacent to the northwestern fault contact of the body. Strong shearing and recrystallization are commonly evident throughout the rock and pink granite pegmatite veins cutting it are also sheared. Development of secondary epidote and carbonate,

saussuritization of plagioclase and partial chloritization of biotite, are common in this body of orthogneiss, indicative of retrogressive metamorphism.

Orthogneiss occurring adjacent to the prominent northeast-trending fault, in the central part of NTS 65 J, is strongly sheared and injected by quartz monzonite to granodiorite that is in turn sheared. The small areas of orthogneiss in the western and southwest part of the area are less intensely sheared.

Augen gneiss (Ānga)

Porphyroblastic augen gneiss is confined to a few islands in Angikuni Lake and the northwestern border of the map area. This grey to pink augen gneiss contains white to slightly pinkish porphyroblasts, 1 to 2 cm long, of plagioclase or potassium feldspar. Composition ranges from granodiorite to quartz monzonite. Commonly both biotite and hornblende are present, in part as minor amphibolite and biotite-rich inclusions or schlieren. These rocks are strongly sheared but typically scattered zones display intense shearing or cataclasis. Alteration or retrogressive metamorphism has resulted in abundant epidote and chlorite. This augen gneiss is probably derived from the quartz monzonite to granodiorite (Āqm), by deformation, as a relict porphyritic texture is preserved in a few places.

Granodiorite gneiss intruded by gabbro (Āngb)

Southwest of Ferguson Lake, a small area of granodiorite gneiss intruded by irregular bodies and dykes of gabbro and metagabbro that form approximately 25 per cent of the rock mass, is distinguished as a subunit (Āngb). Numerous small faults cut the rock and gabbro has been emplaced as multiple intrusions, in a sequence of faulting and intrusion that can be traced by crosscutting relations. The granodiorite gneiss is strongly sheared and has abundant secondary chlorite and epidote present. The gabbro is similar to that in small plutons of gabbro (Āb).

Granodiorite gneiss with amphibolite inclusions (Āngm)

The rocks included in this unit, present only in one area southwest of Yathkyed Lake, are a complex mixture. In its simplest form it is an agmatite, consisting of fine- to medium-grained inclusions of widely varying size, for the most part of amphibolite composition, distributed through a medium grained, grey granodiorite groundmass. The amount of mafic material ranges from 5 to 50 per cent or more. This agmatitic type of gneiss grades into a migmatite, with thinly layered or nebulitic, medium grained, biotite- and hornblende-rich layers, lenses, schlieren and small fragments within medium grained granodiorite. The mafic fragments are thinly injected by granodiorite. Elsewhere, it is a mixture of stromatic to banded migmatite, consisting of medium grained amphibolite and leucocratic tonalite cut by a medium- to coarse-grained neosome of biotite granodiorite. The complexity of textures and structures in this unit is its chief characteristic. Foliation in rocks of this unit ranges from a pronounced mineral foliation to a vague, nebulitic layering or banding. Composition is variable, with quartz, plagioclase (oligoclase to andesine), biotite and hornblende in variable proportions. Minor amounts of microcline are present and augite occurs in some places in the northern part of this unit. Opaques, zircon, apatite and sphene are accessory minerals.

The origin of rocks included in this unit is unclear. In part, they bear considerable resemblance to rocks of the migmatized amphibolite (Āsn') unit and could in part at least be derived from volcanic rocks, tuffs, pyroclastics and flows, with neosome developed during metamorphism and perhaps injection of granodiorite. Elsewhere, the rocks appear to be formed from basic rocks intruded by granodiorite with the basic rocks forming rafts or inclusions in the felsic intrusive.

Archean Plutonic Rocks

Granodiorite to quartz monzonite (Āgg)

An area of granodiorite to quartz monzonite (Āgg) is outlined within the quartz monzonite (Āqm) pluton in the southwest corner of the map area. The contact between them is gradational. A medium grained, grey to pinkish grey granodiorite, massive and free of inclusions, containing 7 to 10 per cent biotite is typical. This biotite content is greater than in the surrounding quartz monzonite. Scattered phenocrysts of microcline occur in this granodiorite, but potassium feldspar content is such that only rarely is the rock quartz monzonite composition.

Granodiorite to quartz monzonite (Āgg) is also present north of Yathkyed Lake and extends west and southwest of the lake. There the rocks are characteristically strongly sheared by a northeast-trending fault. Although presently medium grained and grey to pink, a mineral foliation and lineation is developed. Only on or near the shore of Nutarawit Lake is a massive rock prevalent. Compositionally a quartz monzonite is typical, but granodiorite is well represented. The biotite (7 to 10 per cent) is highly altered to chlorite in the sheared granodiorite and feldspar is saussuritized and turbid whether occurring in phenocrysts, porphyroblasts or the matrix. Secondary epidote stringers and grains are abundant.

Quartz monzonite to granodiorite (Āqm)

Scattered plutons of quartz monzonite occur throughout NTS 65 I (W ½). The rocks typically are pink, medium grained, equigranular and massive, although in places scattered feldspar phenocrysts or a vague foliation or shearing, are present. Inclusions or schlieren are rare except close to contacts with older rocks. Compositionally, the rocks are quartz monzonite for the most part, with 5 to 7 per cent biotite, the remainder a biotite granodiorite. The pluton east of Tyrrell Arm contains minor amounts of hornblende as well. Alteration or retrogressive metamorphism is common, as displayed by chloritization of biotite, saussuritization of feldspar, development of scattered secondary epidote grains, and of sericite associated with shearing. The quartz monzonite near the southeast border of the area, a part of the large Maguse Batholith (Bell, 1971), is characterized by subhorizontal sheeting or jointing.

The scattered plutons of the quartz monzonite to granodiorite in NTS 65 J occur for the most part in the southern half of the area. Chiefly of quartz monzonite composition, these rocks are pink, medium grained, massive to very slightly foliated, and contain few inclusions, except adjacent to contacts. Biotite is the common mafic mineral but hornblende accompanies it in some places. Although the feldspar is somewhat sericitized and biotite partially altered to chlorite, the alteration or retrogressive metamorphism is less intense than in similar rocks in NTS 65 I (W ½). Certain of the plutons differ from the above general description. For example, the plutons in the southwest corner of the map area, intruding migmatized paragneiss (Āsn), are medium grained, white to pink quartz monzonite to granodiorite, with abundant inclusions or layers of migmatized paragneiss. The quartz monzonite-granodiorite resembles the neosome portion of the intruded migmatized paragneiss, but potassium feldspar is far more abundant than in the neosome, biotite is present, and the plutons are definitely intrusive.

The pluton north of Kazan River, centred about 99°10'W longitude, is atypical of the rocks in this unit in that it is chiefly granodiorite, hornblende-rich and foliation is moderate to well developed. In addition, it includes dykes and stringers of medium grained to pegmatitic pink quartz monzonite, containing few mafic minerals and in part with aplitic texture. The foliation of rocks in this pluton suggests it could be included in the granodiorite orthogneiss (Ān̄go) and the composition of the rocks suggests it could be in the granodiorite to quartz monzonite (Āgg) unit. In composition and other characteristics, rocks in this pluton bear some resemblance to all three units.

Two different types of pluton are probably included in this unit. One type is perhaps slightly older, syntectonic, more granodioritic in composition, slightly more foliated and containing more inclusions, with slightly higher mafic content and minor hornblende with the biotite, than the other. The second type is slightly younger, probably late tectonic to posttectonic, more quartz monzonitic composition, with less foliation and rare inclusions, more felsic, with biotite only and probably a high level pluton as compared to the other.

Gabbro, metagabbro, diorite (Āb, Āb')

Most of the mafic plutons (Āb, Āb') range in composition from gabbro to diorite. In NTS 65 I (W ½) all rocks in this unit are metamorphosed or altered, but elsewhere some of these rocks are only very slightly altered. Typically these rocks are dark greenish grey to black, medium grained, massive to slightly foliated with equigranular, or less commonly, ophitic texture. In Ferguson Lake area common green hornblende and plagioclase (An_{40-60}) are the major constituents, with abundant secondary actinolite, epidote and chlorite. Only the large pluton northeast of Yathkyed Lake contains any augite.

Plutons cut Henik Group rocks (Āsn, Āsnt, Āmn), granodiorite gneiss (Āng) and east of Angikuni Lake, quartz monzonite (Āqm). However, one pluton may be older than the quartz monzonite.

Several small plutons outcrop in the southwest part of the map area, particularly on the islands in Angikuni Lake and on the west side of the lake. For the most part, these rocks are fresh gabbro or quartz gabbro, consisting of plagioclase, augite, hornblende, and rarely, quartz. A few of these rocks show some alteration, saussuritization of the feldspar and chloritization of hornblende. Field relations in some places indicate composite intrusions. For example, gabbro is cut by a second gabbro with chilled contacts. In places the older gabbro displays cleavage which may be related to movement on the northeast-trending fault that traverses the central part of Angikuni Lake.

A small gabbro body on the southeast shore of Tulemalu Lake consists of medium- to coarse-grained, ophitic to equigranular rock, that contains coarse grained plagioclase phenocrysts to 1.5 cm. In parts of this pluton plagioclase is so abundant the rock is an anorthositic gabbro. Augite and hornblende are the other major constituents and minor amounts of biotite are present. This rock is partially altered, showing extensive chloritization of the mafic minerals.

A small pluton 2 km north of Kazan River, centred about 98°33'W longitude, is also anorthositic gabbro consisting of approximately 85 per cent calcic plagioclase, accompanied by hornblende and chloritized augite. It is cut by veins of coarse grained, pink quartz monzonite, and is perhaps older than other gabbro plutons included in this unit.

West of the above described body, a large mass of basic rock crossed by Kazan River at its north end, centred about 98°43'W longitude, consists of diorite to quartz diorite (Āb'). It intrudes migmatized paragneiss (Āsn). The rock is comprised of andesine, hornblende, minor amounts of quartz and microcline and scattered biotite. Alteration resulted in sericitization of feldspar, chloritization of mafic minerals, and development of scattered epidote grains.

Metagabbro (Ādb) **and hornblendite dykes** (Ādb'); **the Kazan Dykes**

Certain of the northeast-trending dykes in NTS 65 J are considered to be Archean because they consist of metamorphosed gabbro, ranging to amphibolite or hornblendite, commonly with good foliation. These dykes are named the Kazan Dykes. Some small dyke segments, trending northeast and consisting of relatively fresh gabbro, are probably younger. The Archean dykes are confined to a zone parallel to the major northeast-trending fault zones.

A single hornblendite dyke (Ādb') near the northwest end of Yathkyed Lake consists of green hornblende, with approximately 15 per cent augite and accessory opaques. A granoblastic texture is characteristic of this rock. Minor chloritization of hornblende and augite indicates weak retrogressive metamorphism.

The metagabbro and amphibolite dykes are massive to foliated with a poorly to well developed granoblastic texture. Plagioclase (An_{45-60}) and green hornblende are the main constituents, but augite, garnet, and minor amounts of quartz are present in some dyke rocks. Sphene is a common accessory mineral in all these rocks, as well as opaque minerals. A strong cleavage, approximately parallel to the dyke trend, is present in many places. Except that cleavage is more prominent close to the major northeast fault zone, the variation in character of these dykes shows no areal consistency.

In the southwest quarter, in the vicinity of Angikuni Lake, northeast-trending dykes are probably more than one age. On one of the islands in Angikuni Lake a northeast-trending dyke cutting migmatized paragneiss derived from tuff (Āsnt) is probably pre-metamorphism as neosome segregations associated with the paragneiss cut the dyke. In the same area other northeast-trending dykes are less metamorphosed, show ophitic texture and cut quartz monzonite that occurs as sheets and sills cutting the migmatized paragneiss. These dykes resemble the younger Aphebian dykes (Adb), although in some places intense cleavage is present. Blake (1980) mentions rare north-northeast-trending diabase dykes that cut the Angikuni Formation, indicating still younger dykes with this trend that are perhaps equivalent in age to the Mackenzie Dykes (Hdb). Recurring movement on the fault zone, and possibly multiple intrusions in fractures related to the movements, may account for the variable metamorphism, deformation, and age.

A northeast-trending dyke in the northwest corner of NTS 65 I (W ½) is a meta-quartz gabbro. Plagioclase and hornblende, with minor amounts of quartz and accessory opaques comprising the rock, are in a granoblastic texture, but foliation is absent. The only other northeast-trending dyke in this part of the area occurs 23 km east of Yathkyed Lake where it cuts quartz monzonite (Āqm). This rock consists of plagioclase and hornblende, with rare epidote and sphene. There the texture is also granoblastic with no original igneous texture. The feldspar is intensely altered, possibly indicating strong alteration postdating the metamorphism of the dyke rock. This isolated northeast trending dyke is differentiated from the early Aphebian gabbro dykes (Adb) because of the metamorphism. It differs from the early Aphebian Kaminak Dykes occurring 80 km to the east (Davidson, 1970), which have a blastoporphyritic texture where metamorphosed.

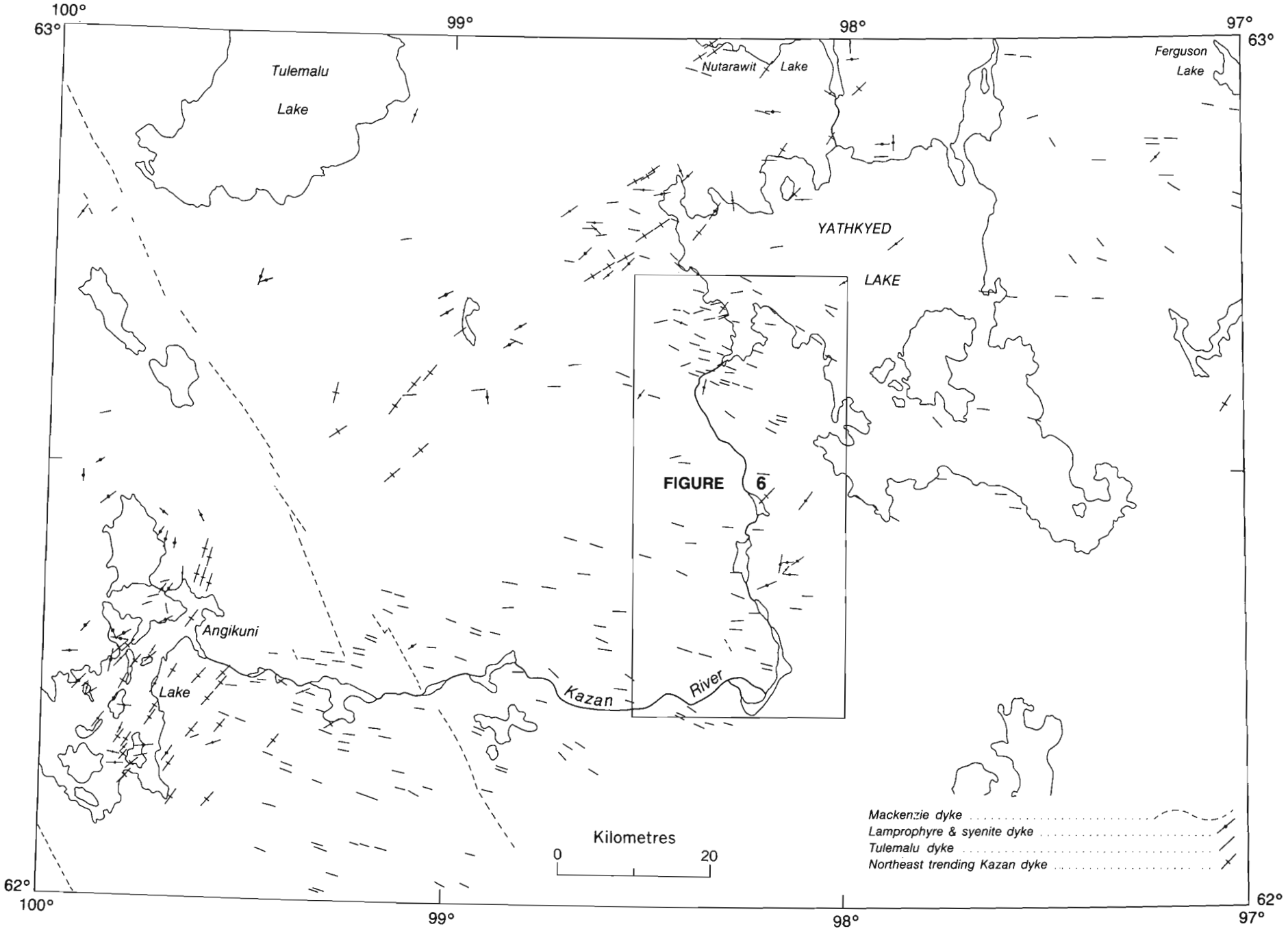

Figure 5. *Distribution of gabbro, metagabbro, syenite, and lamprophyre dykes.*

Aphebian Gabbro and metagabbro dykes (Adb); ***the Tulemalu Dykes***

A large swarm of early Aphebian gabbro dykes in NTS 65 J are named the Tulemalu Dykes. They are mostly confined to the southeast side of the Tulemalu Fault (Fig. 5). To the east, they extend into the north half of NTS 65 I (W ½) but there they are less abundant. Figure 5 shows the distribution of the dykes observed in the area. The distribution of the dykes is irregular, as the southeast corner of NTS 65 J and the south half of NTS 65 I (W ½) contain few or no dykes. Where dykes are abundant commonly two dykes occur separated by 500 m or less, then there is a gap of approximately 3 km to another pair of dykes.

Similar dykes occur to the south in adjoining map areas but their abundance decreases and they disappear not far to the south. To the north a few of these dykes occur in the extreme southeast corner of the Tebesjuak Lake map area (A.N. LeCheminant, personal communication, 1983). Hence the majority of the Tulemalu dyke swarm is in the report area.

The dykes do not show a consistent trend although the majority trend between 85 and 115°. At one locality a dyke trending 90° bifurcates into two dykes trending 92 and 110°. Certain of the dykes trending 90° are emplaced in fault zones with this trend and late movements on the faults result in intense cleavage in the dyke rock.

On detailed aeromagnetic maps anomalies caused by these dykes are readily identified. Through the courtesy of Pan Ocean Oil Ltd., unpublished detailed aeromagnetic maps of an area in the eastern part of NTS 65 J were examined and the location of dykes on these maps has been interpreted by W.F. Fahrig (Fig. 6).

In NTS 65 J these dykes are medium grained, dark grey to greenish grey on fresh surfaces, with textures ranging from ophitic to diabasic to equigranular. Very fine grained chilled margins are present. They are composed of 45 to 60 per cent labradorite, 25 to 35 per cent augite, and 3 to 10 per cent hornblende, the latter probably derived from pyroxene. Minor amounts of quartz are present in many of the rocks and opaques are a minor accessory in all dykes. Alteration of mafic minerals to chlorite and saussuritization of plagioclase is minimal in most of the dyke rocks. In contrast, in NTS 65 I (W ½) many of these dyke rocks are strongly altered and greenish hues predominate as only remnants of augite remain having been almost completely replaced by hornblende. There also, plagioclase is intensely altered and secondary epidote grains developed. The degree of alteration is variable from dyke to dyke, in no discernible pattern, but overall alteration of the rocks is markedly more intense than it is in NTS 65 J, although original rock textures are preserved. Unlike the Archean gabbro dykes, recrystallization, foliation and metamorphism are absent in the Tulemalu Dykes.

K-Ar geochronological data (Wanless et al., 1979) on the dyke rocks and country rock contacts indicate an age of approximately 2200 Ma for the intrusion of the Tulemalu Dykes. Eade (1976) established that undeformed Tulemalu Dykes cut folded, migmatized paragneiss with quartz monzonite sills and dykes (Āsn), hence the dykes postdate the major deformation of the Archean rocks. Locally, granite to quartz monzonite veins cut a few of the dykes but are probably related to a younger quartz monzonite (Aqm). As the dyke rocks are essentially unmetamorphosed in the west, although strongly altered in the east, and except for faulting all are undeformed, it is concluded the Hudsonian Orogeny has had slight effect in this region except for the intrusion of scattered plutons.

East of the map area, in the Kaminak Lake map area, Davidson (1970) described northeast-trending early Aphebian porphyritic diabase dykes, the Kaminak Dykes, which are fresh or deuterically altered and undeformed in part of the area but metamorphosed and deformed elsewhere. The dykes are considered to be 2300 Ma old (Christie et al., 1975). They are cut by a few east-trending, nonporphyritic diabase dykes, some of which are altered, in the vicinity of Kaminak Lake (Christie et al., 1975).

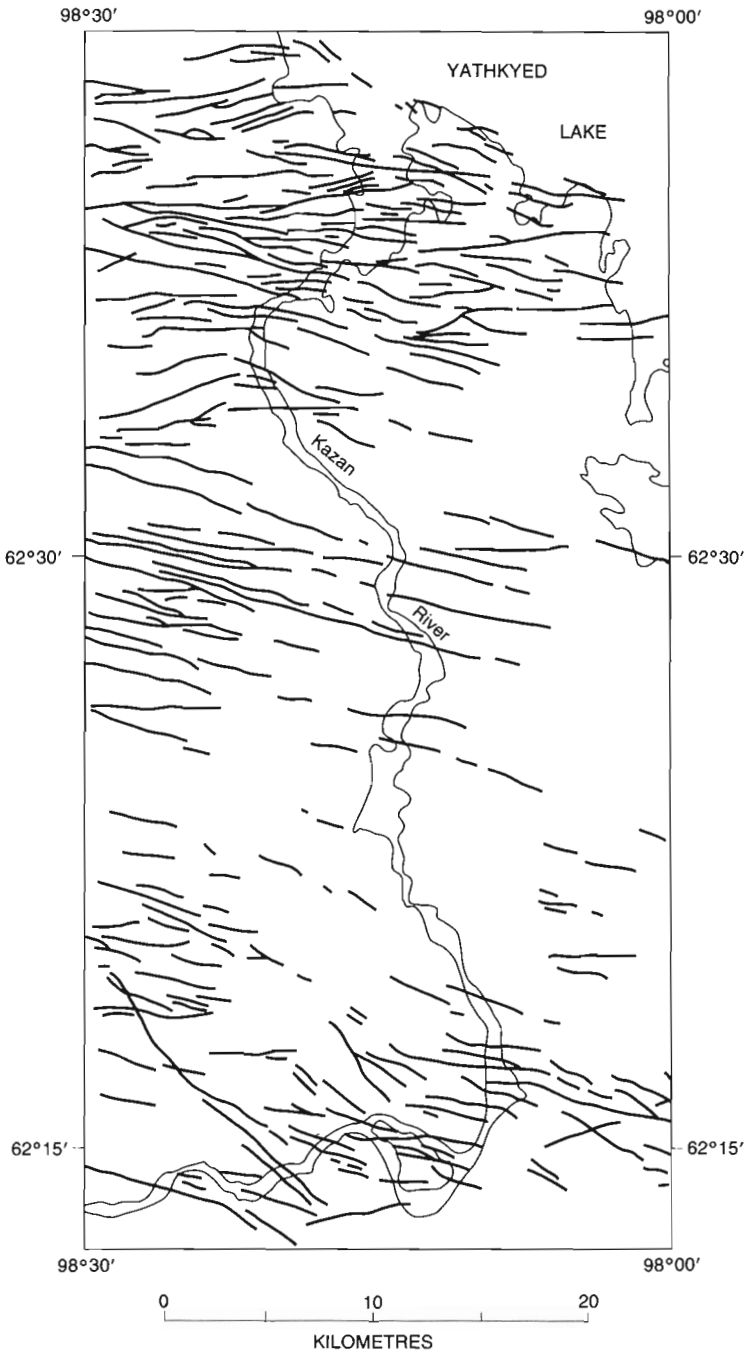

Figure 6. *Gabbro dykes (Adb) interpreted from a detailed aeromagnetic survey (scale 1:20 000, traverse interval 0.2 km, ground clearance 45-60 m, Kenting Earth Sciences Ltd., Ottawa). Interpreted by W.F. Fahrig. Aeromagnetic maps courtesy of Pan Ocean Oil Limited.*

In the Ferguson Lake (E ½) map area, which adjoins the Kaminak Lake map area on the west, Bell (1971) suggested that some of the dykes may be Kaminak Dykes, although there is a 15 to 20 degree difference in trend. Dykes south of Kogtok River (approximately 61°10'N) are porphyritic according to Bell (1971) and hence are probably Kaminak Dykes. To the north of Kogtok River, however, the dykes are probably part of the Tulemalu swarm and it is possible the east-trending diabase dykes cutting the Kaminak Dykes near Kaminak Lake are also Tulemalu Dykes.

The geometry and distribution of the Tulemalu Dykes is related to a post-Kenoran Orogeny, early Aphebian, tensional regime. The rarity of these dykes on the northwest side of the Tulemalu Fault indicates the tensional regime was primarily effective on the southeast side of the fault zone, although decreasing in effect to the east. The tensional regime may extend as far east as the Kaminak Lake area, although there, a different tensional regime, slightly older, in which Kaminak Dykes are emplaced, is far more pronounced. The tension fractures along which the Tulemalu Dykes are emplaced may be related to the east-trending faults that form prominent tectonic features in the Archean rocks in the map area.

The paleomagnetism of the Tulemalu dykes are described in a separate paper (Fahrig et al., 1984).

Hurwitz Group

Hurwitz Group rocks outcrop poorly in a fault-bounded wedge that extends northeast from Imikula Lake, a northern extension of a large area of these rocks in the Kognak River area to the south (Eade, 1974). The stratigraphic section in this area is restricted, as it is in the adjacent part of the Kognak River area, with only the Kinga, Watterson and Tavani formations represented.

Kinga Formation (AHK)

Orthoquartzite to quartzite (AHK) occurs over a strike length of approximately 5 km on the northwest side of the fault-bounded wedge, upthrust on a small subsidiary to the main bounding fault. The orthoquartzite is in fault contact with Tavani Formation and is conformably overlain by Watterson Formation rocks. This orthoquartzite consists of 85 to 90 per cent quartz, with feldspar, sericite and minor chlorite forming the remainder, along with accessory zircon and tourmaline. The original clastic texture of this fine- to medium-grained, white orthoquartzite is barely recognizable due to recrystallization and overgrowths. The orthoquartzite of the Kinga Formation in this area is not as pure a quartzite as that in the area to the south.

Watterson Formation (AHW, AHW')

Dolomite, with intercalated phyllite or argillite (AHW) occurs in the southern and central part of the fault-bounded wedge, but in the north calc-silicate and interlayered quartz-mica schist (AHW') constitute this formation. The lower part of this unit is principally dolomite or calc-silicate rock, with rare argillite, phyllite or mica schist. The fine grained dolomite is massive to thin bedded (1 to 2 cm), brown on weathered surface and light grey to cream on fresh surface. It consists chiefly of dolomite with scattered quartz and sericite grains although some beds contain up to 25 per cent quartz. The thinly bedded (0.5 cm) argillite is fine- to very fine-grained and grey on both fresh and weathered surface. The fine grained grey phyllite has prominent cleavage that commonly obscures the bedding. Both argillite and phyllite consist of tiny quartz grains with greenish biotite, sericite and chlorite and rare feldspar grains. The fine- to medium-grained calc-silicate rock, greenish grey to grey on fresh and weathered surface, consists of dolomite with tremolite and diopside and large porphyroblasts composed of small biotite flakes. The medium- to fine-grained mica schist, brownish grey on weathered surface and light grey on fresh surface, consists of quartz, biotite, muscovite and feldspar. Cleavage is pronounced in all the rocks of this unit.

Tavani Formation (AHT)

Arkose or meta-arkose ranging to impure quartzite, with mica schists of the Tavani Formation (AHT), are the most widely occurring Hurwitz Group rocks in the map area. Mica schists, apparently derived from siltstones, are the most abundant rock type. Medium grained meta-arkose or impure quartzite is interbedded in the schists. Cleavage, present in all the rocks, is most pronounced in the finer grained rocks. Closely spaced bedding laminations (5 mm to 1.5 cm) are preserved in some of the fine grained grey rocks although cleavage obscures it in most places. The light grey arkose or meta-arkose to impure quartzite displays thicker laminae (3 to 10 cm). Outcrops of all rocks in this unit are, for the most part, badly broken and frost heaved, particularly the fine grained schistose rocks. Composition of rocks are variable with components showing these ranges: quartz, 25 to 60 per cent; feldspar (chiefly plagioclase), 5 to 25 per cent; muscovite, 8 to 35 per cent; biotite, 6 to 20 per cent. In all thin sections of these rocks that were examined, accessory minerals, opaques, tourmaline, apatite and sphene, are abundant. Zircon is less common. These rocks are all metamorphosed and recrystallized, with granoblastic textures and porphyroblastic growth of micas. Quartz veins are abundant, particularly adjacent to the east contact of the formation.

Aphebian Gneisses

In the southeast part of the map area a variety of gneisses (Anl, Anl', Ann, Ann', Ango) are present that are probably Aphebian, or more precisely, Archean gneisses in part at least, reworked during the Aphebian. The rocks are described in the following section and their possible origin is discussed.

Layered to irregularly layered gneiss with quartz monzonite (Anl, Anl')

Layered to irregularly layered gneiss, agmatite, and some migmatized paragneiss, containing up to 20 per cent pink quartz monzonite in dykes, veins, or irregular shaped masses forms the major part of this map unit. This rock is variable in character, from well layered or banded rocks (2 to 20 cm thick), with marked differentiation of felsic and mafic layers, to a vaguely or irregularly banded type. Quartz, plagioclase and biotite are the main constituents of the gneiss, with microcline and garnet present erratically. Amphibolite layers are abundant in the gneiss. In some places, irregular blocks of amphibolite in felsic groundmass compose agmatites. Quartz monzonite containing few mafic minerals cuts all these rock types. Rocks in part are very similar to migmatized paragneiss (Āsn) but elsewhere, particularly in the layered gneiss, they are more granitoid in character. Other differences are the consistent presence of minor microcline in the gneissic portion of these rocks and generally less alteration of the feldspars than in migmatized paragneiss (Āsn).

Rocks in unit Anl' contain more quartz monzonite, as much as 50 per cent, than in unit Anl. With greater quartz monzonite content, some of the gneiss is assimilated as well as dykes and veins formed. Small plutons of quartz monzonite, tens of metres across, occur within the gneiss. These plutons contain more biotite than the dykes or veins, possibly due to assimilation of gneiss.

The gneisses are folded and at least some of the accompanying quartz monzonite is folded also, although the larger quartz monzonite plutons are massive and undeformed.

On the south, the area of Anl' is in contact with Archean quartz monzonite (Āqm). It is probable that Archean quartz monzonite infiltrated the original Archean gneisses from which rocks in unit Anl' are derived, particularly in the area close to the contact. However, the quartz monzonite present now in Anl', even close to the contact, is typically fresh and unaltered, whereas the quartz monzonite in the pluton to the south, Āqm, is characterized by altered feldspars and chloritization of biotite.

Nebulitic and swirled gneiss with quartz monzonite (Ann, Ann')

Nebulitic to swirled gneiss cut by minor amounts of quartz monzonite (Ann) is a pink to grey rock with poor to moderate foliation. In part, this rock is nearly massive, displaying only a very fine mineral foliation, but elsewhere foliation is marked by distinct, dark, mafic-rich streaks or layers that tend to be swirled or highly folded and that have vague contacts with felsic layers. Near the contacts with layered gneiss (Anl, Anl'), some bands of layered gneiss and amphibolite inclusions occur within nebulitic gneiss and contacts between the units are gradational. This gneiss, of granodioritic composition, is cut and partially assimilated by up to 20 per cent quartz monzonite.

These rocks are gradational into the adjoining unit (Ann') that contains up to 50 per cent quartz monzonite. Much of the gneiss is partially assimilated by quartz monzonite. As a result, the overall composition of the unit is quartz monzonitic. These rocks are pink to greyish pink and the gneiss portion contains pink, potassium feldspar porphyroblasts in part tectonically deformed to augen. Biotite is the common mafic mineral although scattered hornblende accompanies the biotite. In general, these rocks are fresh, with only slight alteration of feldspars and chloritization of mafic minerals. Where shear zones are present, feldspars are strongly altered and augen and scattered epidote grains are developed.

Orthogneiss (Ango)

Orthogneiss is medium grained, pink to greyish pink, and has good foliation, either a pronounced mineral foliation, or in some places, mafic-rich layers, streaks or schlieren. It commonly contains scattered potassium feldspar porphyroblasts and is cut by dykes and stringers of quartz monzonite that constitute up to 15 per cent. Near the contact with layered gneiss (Anl) the orthogneiss includes minor amounts of layered gneiss. Quartz, plagioclase, microcline and biotite are the major constituents, with scattered muscovite present. Microcline content is variable so that much of the unit is quartz monzonite but some is granodiorite. Strong shearing is common and in places a cataclastic texture is present. The shearing may be related to the northeast-trending fault that forms much of the west contact of the main outcrop area of this unit. Similarly, mineral foliation is probably related to this fault. Feldspar and biotite in the orthogneiss are, typically, slightly more altered than in the layered gneiss and nebulitic gneiss. The increased alteration is probably related to the shearing.

Pink quartz monzonite, in dykes and stringers cutting the orthogneiss, has a low biotite content. A slight mineral foliation is evident in the quartz monzonite in a few places. A few scattered granite pegmatite dykes cutting orthogneiss are possibly a late phase of the quartz monzonite.

The recognition of Aphebian gneisses

The Aphebian gneisses are similar in many respects to some of the Archean gneisses and it is here suggested that the Aphebian gneisses are probably reworked Archean rocks. Reworked Archean rocks are defined as Archean rocks thermally and/or tectonically reconstituted during an Aphebian orogeny, with possibly the introduction of new components, so that compositionally and/or texturally they are recognizably changed. At the present time, geochronological data for these rocks are lacking so conclusions must be based on indirect evidence.

Although there are marked similarities in the Archean and Aphebian gneisses, the Aphebian gneisses are considerably richer in potassium feldspar, in some cases as porphyroblasts, but also in the groundmass. The Aphebian gneisses, with the exception of the tectonically deformed rocks, are less altered, that is feldspars are fresher and the biotite less chloritized. Furthermore, Aphebian gneiss units are more heterogeneous than their Archean counterparts suggesting, perhaps, they are composed of relict and new components. The new components occur as patches or irregular masses and stringers.

In the adjoining Ferguson Lake (E ½) map area, Bell (1971) has classified many of the gneisses as Aphebian, although he recognized the problem of separating Archean, reworked Archean, and Aphebian gneisses. Gabbro and metagabbro dykes cutting the gneisses may assist in the distinction. As previously mentioned, in the section describing gabbro and metagabbro dykes (Adb) it is believed that the Tulemalu Dykes extend into the northern part of Ferguson Lake (E ½) area and study of the degree of metamorphism of the dyke rocks should indicate whether or not the northern gneisses in Ferguson Lake (E ½) are Aphebian or Archean. Bell (1971) described a dyke cutting Mackenzie Lake metasediments near the east boundary of the report area near latitude 62°30'N as an amphibolite dyke thus definitely metamorphosed. This dyke is assumed to be a Tulemalu Dyke as he indicated no porphyritic or blasto-porphyritic dykes, which are equivalent to the Kaminak Dykes, occur north of Kogtok River (approximately latitude 62°15'N). This suggests the Mackenzie Lake metasediments are pre-Tulemalu Dykes and therefore either Archean or early Aphebian and have undergone Aphebian metamorphism, possibly overprinted on Archean metamorphism.

Tulemalu Dykes are not known in the Aphebian gneisses (Anl, Anl', Ann ,Ann', Ango) in the map area, although disrupted amphibolite bands trending ENE are present at several places and may be relict Tulemalu Dykes. If the amphibolite bands are remnants of Tulemalu Dykes then these gneisses have undergone considerable reworking during an Aphebian orogeny. A program of K-Ar geochronology would assist in delineating the effects of Aphebian orogeny as the K-Ar system is re-set at relatively low levels of metamorphism. In this regard, it is perhaps significant that a K-Ar determination on biotite from pyroxene-bearing granodiorite gneiss (Āngr) on the large island in Yathkyed Lake gave an age of 2425 ± 54 Ma, indicating that the K-Ar system in this gneiss was little affected by Aphebian metamorphism.

The distinction of Aphebian gneisses from Archean gneisses in the Churchill Structural Province is a major problem, one that is still largely unresolved. A multiphased approach, including geochronology (both K-Ar and Zr systems), geochemistry to outline areas of potash enrichment that seem to accompany Aphebian metamorphism, and detailed geological mapping with particular attention to such features as dykes and dyke remnants, may solve this problem.

Syntectonic Aphebian Plutonic Rocks

Quartz monzonite, granite, minor syenite (Aqm)

A large pluton of granite (Aqm), composed of medium grained rock, greyish pink to pink on fresh surface and white to light pink on weathered surface, occurs near the northeast boundary of the map area. Microcline phenocrysts up to 1.5 cm long are present in much of the rock. Composition is variable within the following ranges: quartz, 20 to 25 per cent; microcline, 35 to 40 per cent; plagioclase, 25 to 30 per cent; hornblende, 4 to 6 per cent; biotite, 5 to 6 per cent; sphene, 1 to 2 per cent; accessories are magnetite, apatite, and zircon. Scattered grains of secondary epidote are common. The rock is massive and inclusions are only present adjacent to the contacts. Shear zones cut the pluton in a few places, with some associated cleavage and fracturing of the typical granitic texture. Subhorizontal jointing results in a very characteristic sheeting of outcrops.

Approximately 13 km south of the above-described body an elongate pluton of quartz monzonite is parallel to and north of an east-trending fault. The rock is similar in many respects but this pluton contains more inclusions of both amphibolite and grey granodiorite gneiss. This medium grained, porphyritic, greyish pink, quartz monzonite contains microcline phenocrysts up to 1.5 cm long that in part contain cores of plagioclase – a rapakivi texture. Minor amounts of muscovite occur with abundant biotite, but hornblende and sphene are rare or absent in this pluton. Fracture zones and shearing are present throughout the pluton, probably related to recurring movement on the fault bounding the body on the south.

In the southeast part of the area two small bodies of quartz monzonite (Aqm) occur within the Aphebian gneisses. The rocks are massive, medium grained, pink, biotite quartz monzonite and contain scattered mafic schlieren, probably derived from the adjoining gneiss. Average composition of the rocks is: quartz, 25 per cent; microcline, 30 per cent; plagioclase, 40 per cent; slightly chloritized biotite, 5 per cent. Magnetite is an abundant accessory, along with some apatite and zircon. Subhorizontal sheeting is again characteristic of this quartz monzonite.

A pluton of quartz monzonite occurs on the southwest side of Tulemalu Lake and a larger, more complex, northeast-trending pluton parallels the Tulemalu Fault, lying chiefly on the northwest side. Within the latter pluton there is an area of syenite (Ay) and parts of the area of quartz monzonite approach syenite composition. The pluton on the southwest shore of Tulemalu Lake consists of medium grained to partially coarse grained, equigranular to slightly porphyritic, pink, hornblende quartz monzonite to syenite. Quartz content is variable and in the central part of the body only 5 to 7 per cent is present. Although much of the rock is equigranular, scattered white feldspar phenocrysts, up to 1 cm long, are present. Sphene is an abundant accessory mineral. Cleavage is common in many places and is probably related to the fault bounding the pluton on the south. Scattered small quartz veins, or more rarely, aplite, occur along some cleavages. The younger, coarse grained, fluorite-bearing, porphyritic granite (Agpr) intrudes the quartz monzonite pluton on the west side and some small dykes of the granite cut this quartz monzonite.

The large pluton paralleling the northeast-trending Tulemalu Fault ranges in composition from quartz monzonite to quartz syenite and syenite, but quartz monzonite is by far most abundant. Commonly medium grained, it is porphyritic in places, with microcline phenocrysts up to 1 cm long. Hornblende is the common mafic mineral but in parts of the pluton several per cent of biotite accompanies the hornblende. Sphene is present throughout, forming up to 2 per cent. Thin sections of the quartz monzonite show that both plagioclase and microcline are highly altered, that hornblende is chloritized and the rock granulated. Only in a few of the specimens examined are feldspars reasonably fresh and the equigranular texture undeformed. The alteration is probably related to the shearing and granulation of the rock. This pink to pinkish grey, medium grained rock is massive, except for local tectonic foliation. Cleavage is very abundant associated with the Tulemalu Fault and smaller parallel faults that cut the pluton. Quartz veins occur in some of the cleavage and fault zones, and these, in part, are brecciated and recemented, indicating recurrent movement. Although in several places quartz monzonite cuts syenitic phases of the pluton both are a part of the same intrusion. The early phases of the intrusion evidently solidified sufficiently to fracture. The fractures were later filled by quartz monzonite. Some of the late veins contain small amounts of fluorite. These may be related to a younger fluorite-bearing granite (Agpr) outcropping to the northwest.

A K-Ar determination on hornblende of this unit gave an age of 1984 ± 78 Ma (Stevens et al., 1982).

Syenite (Ay)

The main syenite pluton, east of Tulemalu Lake, is a part of the larger quartz monzonite pluton described above. A very small stock of syenite in granodiorite gneiss (Ang) is present on the south shore of Tulemalu Lake. This pink, hornblende syenite is medium grained and equigranular, for the most part, although scattered phenocrysts of microcline and hornblende are present. The rock is chiefly massive but a vague foliation is discernible in a few places. Inclusions or schlieren are rare. Cleavage is common, and in places the rock is intensely sheared. Thin sections show quartz is rare or absent, but near quartz monzonite contacts the quartz content increases. Plagioclase (An_{20-40}) and microcline are partially altered to sericite and hornblende is chloritized. Scattered flakes of chloritized biotite are present. Sphene, apatite and opaques are abundant accessories; allanite and zircon are rare.

Dubawnt Group (AD)

The abundant Dubawnt Group rocks in the area have been described in detail by Blake (1980) and only a summary is given here. With the exception of several small syenite plutons and some dyke rocks, Dubawnt Group rocks are absent in NTS 65 I (W ½).

The two large areas of Dubawnt Group rocks, one in the south, trending east-northeast between Angikuni Lake and Yathkyed Lake, the other in the north, trending northeast between Angikuni Lake and Nutarawit Lake, were laid down in two large valleys, partly fault controlled, within a mountainous terrain of crystalline basement rocks. Two smaller areas of Dubawnt Group rocks are present west and southwest of Tulemalu Lake. These extend into large areas of these rocks in adjoining map areas (LeCheminant et al., 1980; Tella and Eade, 1980). A few tiny outliers of Dubawnt rocks occur on the northwest side of Angikuni Lake and on an island in the lake.

Angikuni Formation (ADA)

This formation, known only in this area, occurs in a small area northeast of Angikuni Lake in the northern area of Dubawnt rocks. Its areal association with other Dubawnt Group rocks, its freshness, and its similarity in lithology and induration to other units of the Dubawnt Group, indicate the unit is part of the group. This formation comprises a lower sequence of at least 1400 m of arkosic sandstone, grading into a conformable upper sequence of at least 1500 m of thinly interbedded siltstone, mudstone, and fine

grained sandstone. Petrographic details of the rocks are reported by Blake (1980) and Mole (1977). Neither top nor base of the unit is exposed. Blake (1980) suggested that the rocks are fluvial deposits and that the upper sequence, with mud cracks and ripple marks, formed in shallow water conditions with periodic exposure during deposition.

The unit is in fault contact with basement rocks and South Channel and Christopher Island formations, although vent rocks of the Christopher Island Formation cut it. It contains no volcanic detritus and it has steeper dips than adjacent rocks of the South Channel and Christopher Island formations. This suggests the formation is older than the others.

South Channel Formation (ADS)

Rocks of this formation occur only in the main northern area of Dubawnt Group rocks where they lie on basement rocks and are overlain by Christopher Island Formation. In the northeast part, in the vicinity of Nutarawit Lake, this formation is at least 1000 m thick. Occurrences in the central part of the outcrop area show the formation approximately 100 m thick, but farther south the formation is thicker in several places. This formation consists of massive, poorly sorted, polymictic conglomerate with scattered lenses of fine grained clastic rocks. The conglomerate contains angular to rounded pebbles, cobbles, and boulders in a rather sparse arkosic matrix. The largest clasts are approximately 40 cm diameter. No Dubawnt Group volcanic clasts are present in the South Channel Formation and any conglomerate containing Dubawnt volcanic material by definition is included in the Christopher Island Formation. The majority of clasts are granodiorite gneiss, quartz monzonite to granodiorite, vein quartz and amphibolite, and in some places are obviously locally derived basement rocks. The scattered arkosic sandstone lenses in the conglomerate show the attitude of the beds.

Blake (1980) suggested the formation is probably an alluvial fan/braided river deposit, laid down close to a mountain front marked in places by fault scarps.

Christopher Island Formation (ADC)

This formation is by far the most abundant unit of the Dubawnt Group in the area where it overlies basement rocks unconformably and South Channel Formation conglomerates conformably. In the central part of the main northern area the formation is at least 2000 m thick. The main rock types are mafic trachyte, trachyte pyroclastic rocks of intermediate to mafic composition, and volcaniclastic sedimentary rocks. Felsic trachyte, rhyolite and vent breccia-agglomerate are minor components of the formation. The trachyte is a potassium-rich alkalic rock containing abundant phenocrysts of biotite and/or feldspar (plagioclase and/or K-feldspar). Pyroxene and quartz are less common phenocrysts. The pyroclastic rocks range from massive, medium- to coarse-grained, to fine- to medium-grained tuff with good laminations, to coarse fragmental rocks. In the coarse agglomerates most of the clasts are mafic trachyte. The volcaniclastic sediments range from conglomerate, containing clasts of both basement rocks and Dubawnt volcanic rocks, to finely laminated sandstone or siltstone, generally red. The felsic trachyte is only shown separately in a few places, but occurs elsewhere intercalated with mafic trachyte and pyroclastic rocks. The intercalation of all rock types, flows, pyroclastics and volcanogenic sediments is characteristic of the formation. Vent breccia-agglomerate, sites of former eruptive centres, consist chiefly of trachyte clasts and a neck of trachyte but, in a few places, basement clasts are present also in the agglomerate. Rhyolite is rare, occurring only in one locality south of Nutarawit Lake at the northeast end of the main northern area of Dubawnt rocks.

The interlayering of flow rocks with bedded pyroclastics, both tuff and agglomerate, typical of the unit throughout the area, indicates subaerial volcanism.

Rocks of the Christopher Island Formation are commonly deuterically altered but there is no evidence of regional metamorphism.

Martell Syenite (ADM), **lamprophyre and syenite dykes, and diatreme** (ADMd)

The Martell Syenite (ADM) intrusives consist of fine- to medium-grained, locally porphyritic rocks ranging from syenite to monzonite, and in one locality, alkali granite. Sills, dykes and irregularly shaped bodies that cut basement rocks, Angikuni, South Channel, and Christopher Island formations, are considered to be high level intrusive equivalents of the Christopher Island trachytes. Plutons are present in three main areas; northeast of Angikuni Lake at the southwest end of the main northern area of Dubawnt Group rocks, southwest of Tulemalu Lake, and as three small syenite-monzonite plutons that intrude basement rocks north of Yathkyed Lake. The alkali granite intrusion is centred around 62°27'N, 99°37'W.

The syenite to monzonite ranges from red to pink to grey or purplish grey. Essential constitutents are K-feldspar, biotite, augite, sodic plagioclase and hornblende, any of which may form phenocrysts. Quartz is also an essential constituent in the single occurrence of pink alkali granite. Apatite and opaques are accessories in these rocks. The rocks are commonly altered, with carbonate an abundant secondary mineral.

Dyke rocks (ADMd) associated with the Martell Syenite, mostly biotite lamprophyre with some syenite, are widespread. Most of the dykes are too small to show on the geological map. The distribution of some of the dykes is shown in Figure 5. Within areas of Christopher Island volcanic rocks, the dykes are more abundant than shown in this figure. Lamprophyre consists of a fine- to medium-grained, grey to greenish grey, groundmass comprised of K-feldspar, sodic plagioclase, biotite or chlorite, and minor quartz, with biotite phenocrysts up to 2.5 cm diameter. The rock is chiefly massive although in some places a mineral foliation is present. Cleavage cuts some of the dykes, particularly those close to major faults. Dykes commonly trend east to east northeast but other directions are well represented. Angular to rounded inclusions of basement rocks are characteristically present. Some inclusions are obviously locally derived, spalled off the dyke walls, but some are well rounded with partially assimilated margins and apparently come from depth. A K-Ar age determination (GSC 78-145) on biotite from a lamprophyre gives an age of 1687 ± 41 Ma (Wanless et al., 1979).

Syenite dyke rocks, pink to grey, range from fine- to medium-grained, with chilled margins. K-feldspar, plagioclase and partially chloritized hornblende are essential constituents of the syenite dykes. A few of the dykes have lower K-feldspar content and more hornblende and are syenodiorite in composition.

The migmatized paragneiss ($\bar{A}$sn) at 62°29'30"N, 98°24'50"W, north of an east-trending fault, is cut by a discontinuous breccia zone trending approximately 035°, that is about 30 m wide and is exposed for 50 m. This breccia is interpreted to be a diatreme. A small east-trending gabbro dyke (Adb) is cut off by the zone. Angular to subangular fragments, 5 to 15 cm in diameter, comprising approximately 70 per cent of the breccia, are set in a fine grained rusty brown weathering matrix. The majority of the fragments are mafic trachyte, some of which are porphyritic with biotite and/or feldspar phenocrysts, and the remainder are granodiorite gneiss or paragneiss. Some of the gneiss clasts

are cut by dykelets of biotite porphyry trachyte. A thin section of the matrix shows it is porphyritic, with tiny phenocrysts of pale yellow-brown biotite (approximately 5 per cent), augite, veined and altered by carbonate (approximately 5 per cent), and pseudomorphs after olivine composed of chlorite and calcite rimmed by opaques (approximately 1 per cent). Vesicles in the matrix are filled with calcite and possibly some zeolite. The phenocrysts and vesicles are in a very fine grained matrix of unidentifiable opaque grains and rods, flecks of brownish green biotite and near isotropic feldspar. This diatreme is probably genetically related to the lamprophyre dykes.

Posttectonic Aphebian Granites (Ag, Agpr, Agp)

Three granite plutons in the north and northwest parts of the area are similar and are a part of the same intrusive suite. However, each differs in some respects. The easterly pluton, at about 98°45'W, is mainly within the Tulemalu Lake area, but extends northward into the Tebesjuak Lake map area (LeCheminant et al., 1980, 1981). It is a porphyritic, fluorite-bearing granite (**A**gp), pink, medium to coarse grained, with K-feldspar phenocrysts up to 2 cm long. Biotite is the main mafic mineral, with scattered minor amounts of hornblende. Fluorite is an abundant accessory mineral, with zircon, opaques and allanite less common. Both the K-feldspar (microcline and perthite) and oligoclase are strongly altered and biotite is partially chloritized. The granite has fine grained contact zones adjacent to Christopher Island Formation and minor granite dykes cut Christopher Island rocks close to the contact. At approximately 62°57'N, 98°49'W, the granite is cut by a barren white quartz vein about 60 m thick and trending northeast.

East of Tulemalu Lake is the southern part of a large granite (**A**g) pluton that has been named the Pamiutuq Granite by LeCheminant et al. (1979) in the Tebesjuak Lake map area. A small area of the same granite occurs 9 km south. The main part of the pluton has been described elsewhere (LeCheminant et al., 1979, 1980; LeCheminant, 1982; Booth, 1983) and within the report area the granite is largely a marginal phase. The rock is a pink to red, fine- to medium-grained, porphyritic granite with phenocrysts up to 8 mm of subrounded, embayed quartz, alkali feldspar (both albite and K-feldspar) and amphibole (commonly sodic) in a finer grained groundmass of quartz, turbid alkali feldspar and chlorite. The phenocrysts have "fretted" margins intergrown with the groundmass crystals. The small body of granite south of the Pamiutuq pluton is similar to this marginal phase of the pluton.

West of Tulemalu Lake, a coarse grained, porphyritic granite with rapakivi texture (**A**gpr), is part of a much larger pluton extending north into Tebesjuak Lake map area (LeCheminant et al., 1981) and westward into Kamilukuak Lake map area (Tella and Eade, 1980). This pink to grey porphyritic granite is distinctly different in lithology from the two previously described granites. Rapakivi texture is not present everywhere but it is characteristic of the pluton. Pink, ovoid phenocrysts of K-feldspar, up to 3 cm long, are scattered through the medium- to coarse-grained, white to grey, quartz-feldspar groundmass. Biotite and hornblende comprise approximately 5 per cent of the rock. Fluorite is an abundant accessory mineral and is slightly more abundant than in the eastern pluton (**A**gp) previously described. Apatite, sphene, opaques, and zircon are the other accessories. This granite intrudes Christopher Island Formation, displaying a slightly finer grained rock close to the contact and small dykes cutting it. An age determination on zircon from these rocks in Kamilukuak Lake map area gave an age of approximately 1803 Ma (W.D. Loveridge, personal communication, 1983). This granite is very similar in appearance, mineralogy and age to the Nueltin granite, about 200 km to the south (Wright, 1967; Eade, 1973).

Mackenzie Dykes (Hdb)

A few northwest-trending diabase dykes of the Mackenzie diabase swarm are present. The largest dyke is 50 m thick, dips vertically, has chilled margins and is a medium grained, dark grey to greenish grey diabase with a typical brown weathered surface. The diabase is fresh for the most part, but shows weak deuteric alteration.

STRUCTURAL GEOLOGY

Faults

Faults are a major structural feature of the map area, chiefly in the Archean rocks, but also in the younger rocks. The principal faults are shown in Figure 7. The precise location of many of the faults is uncertain but lineaments, both topographical and aeromagnetic, assist in locating them in poor outcrop areas. Faults are marked by intense shearing or cataclastic and mylonitic zones. The northeast-trending fault zones are 3 km or more wide in some places. The nature of the faults and the relative movement on them is, for the most part, difficult to determine because of a lack of distinctive map units and sufficient outcrop to determine offsets. Many faults are probably Archean that have been reactivated from time to time during the Aphebian and later. For the sake of discussion faults are separated into the following groups on the basis of their trend: 1. Northeast; 2. East; 3. Northwest; 4. North.

Northeast faults: Tulemalu Fault is a major regional break, part of a system extending from northern Saskatchewan to Baker Lake. A parallel fault, approximately 20 km to the southeast, is a subsidiary of the Tulemalu Fault as to the west, in the Kamilukuak Lake map area, it changes trend to join the Tulemalu Fault. On a regional basis, the geology indicates the southeast side of the Tulemalu Fault is down relative to the northwest. On the southeast side Archean supracrustal rocks are preserved, whereas on the northwest, high grade gneisses indicative of a deeper crustal level, are characteristic. The area between the two faults within the Tulemalu Lake area constitutes a graben. On the extension of the Tulemalu Fault to the southwest, the offset of a paragneiss band suggests there is right lateral separation on the fault but vertical displacement is far more pronounced.

The Tulemalu Fault forms the boundary between the Western Craton to the northwest and the Dimma Domain to the southeast, as discussed in the following section on Regional Synthesis. Furthermore, this fault and subsidary parallel faults largely controlled the location of the basins of deposition of Dubawnt Group rocks.

A second major zone of northeast-trending faults occurs in the southeastern part of the map area. There they form a graben in which the Hurwitz Group rocks are preserved. The main fault in this zone extends southwestward into the Kognak River area (Eade, 1974) and probably northeast into the Ferguson Lake (E ½) map area, although Bell (1971) does not show a prominent fault there. Relative movement on the fault is southeast side down with lateral movement indeterminate. This fault forms part of the boundary between Archean gneisses (Āng) and Aphebian granitoid gneiss (**A**ngo) and also the southeast boundary of the Dimma Domain with the Maguse Domain.

It is postulated that these northeast-trending faults were intiated in middle to late Archean times. Probably some northeast-trending amphibolite dykes (Ādb) were

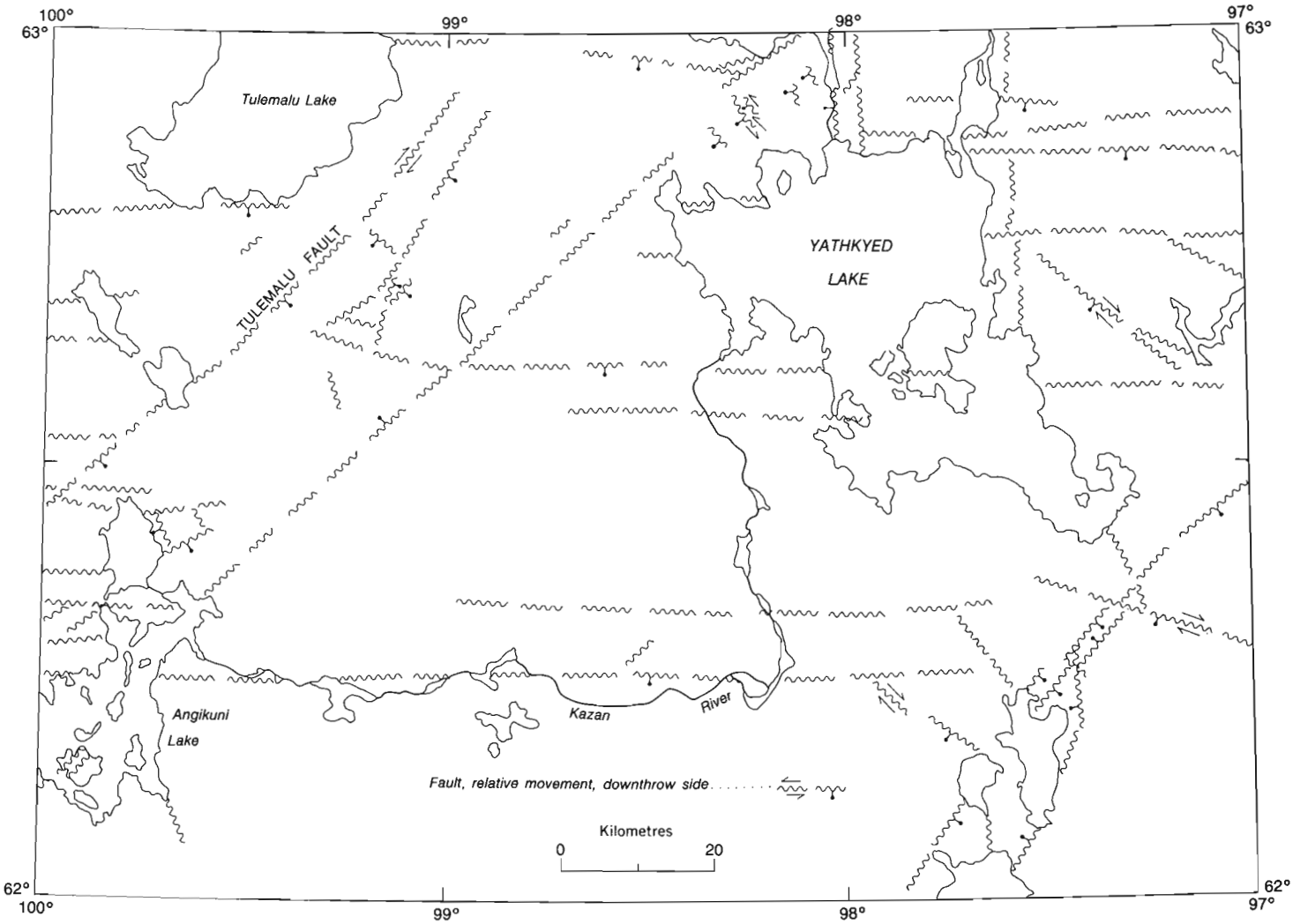

Figure 7. *Principal faults in the report area.*

injected in fractures associated with these faults and hence faulting preceded late Archean metamorphism. Reactivation of the faults occurred at least as recently as the late Aphebian, as Dubawnt Group rocks occurring adjacent to the faults are in some places intensely sheared.

East faults: East-trending faults are the most abundant group and are characteristic of the map area. East-trending faults are not nearly as common in the map areas to the north and south. Where any evidence exists, the south side of the fault is down relative to the north side. Lateral movement is unknown but is probably minimal compared to vertical movement. These faults are vertical to steeply dipping southward, and hence, normal faults. The faults may be very late Archean to earliest Aphebian, and probably younger than the northeast faults as in two localities, in detail, there is a suggestion of offset of the northeast faults. The east trending Tulemalu Dykes (Adb) may occupy fractures related to these east-trending faults.

In a regional context, these east trending faults may be related to, or subsidiary to, the regional east trending Chesterfield Fault (Heywood and Schau, 1978), an important tectonic boundary. Within the map areas the fault at the north side of Yathkyed Lake forms the boundary between the Dimma Domain and the Kaminuriak Domain.

Northwest faults: Northwest- to west-northwest-trending faults are considerably less prominent than those previously described. In the east the relative movement on these faults is southwest side down, with right lateral movement. It is suggested that in this area these are conjugate faults with the east-trending faults.

Northwest of Yathkyed Lake, northwest-trending faults displace the contact between the Dubawnt Group and basement rocks. Although these near-vertical faults cannot be followed far, all have a prominent left lateral strike separation. It is unknown whether the post-Dubawnt Group movement took place on pre-existing faults, possibly conjugate faults with the east-trending faults, or if the faults were initiated in the late Aphebian.

North faults: These faults, which are limited in number and extent, occur chiefly in NTS 65 I (W ½). The north-trending fault forming part of the east contact of the

Hurwitz Group shows west side down with respect to the east side. The same relative movement is indicated on the north-trending fault in the extreme northeast corner of the NTS 65 J. However, the north-trending fault on the east side of Yathkyed Lake shows the opposite movement. The age of the north faults is unknown, although they may have been initiated prior to the east-trending faults, as in places they are offset by them. Late movement has occurred as Dubawnt Group rocks are affected in the northeast part of NTS 65 J.

Folds

In the metavolcanic and metasedimentary rocks of the Henik Group the tops of beds can only rarely be determined as primary structures, such as graded bedding and pillow tops, are scarce. Hence, only synforms or antiforms can be recognized. Similarly, in the gneisses, where axial traces are drawn between opposite dipping foliations, the crude regional trends of synforms can be determined, and hence a regional fold pattern. Where outcrop is plentiful, it is possible to determine the scale of the folding.

The northeast-trending band of metavolcanics in the southern part of NTS 65 I (W ½) forms the eastern limb and the metavolcanics south of Angikuni Lake form the western limb of a large synclinorium that extends into the map areas to the south. The metagreywackes near the midpoint of the southern boundary of the area are approximately along the axis of the synclinorium. At the south boundary of the map area this structure is approximately 95 km from limb to limb. Thus, most of the migmatized paragneiss and associated granitoid gneisses in the south-central part of the map area occur within this synclinorium. Two periods of folding are recognized in these rocks. The first trends northeast from 045 to 060°, with much of the foliation and the prevalent axial plane cleavage following this trend. These folds are typically open and plunge to the northeast. Quartz monzonite sheets, veins and stringers were emplaced during the late stages of this folding and generally are parallel or subparallel to it, although in some places they are cross-cutting. However, within the quartz monzonite there is some mineral foliation and flattening of the bodies due to deformation and the sheets are folded with the older rocks in many places. In some places, boudinage of amphibolite layers during deformation was followed by infilling around boudins by quartz monzonite.

The second folding resulted in broad open flexures, with only minor axial plane cleavages striking approximately 150° with steep dips. The quartz monzonite and the gneisses it intrudes are warped by these flexures but some shears associated with the southeast-trending folds are also filled by quartz monzonite veins. This indicates some quartz monzonite was still mobile during the second episode of folding and that probably the younger southeast-trending folding closely followed the dominant northeast trend.

The Archean rocks occurring to the northwest of the Tulemalu Fault are in a different structural domain as the folds and foliation trend north to north-northwest. This trend may be related to the proximity of the fault and possible drag associated with lateral movement on it, but the same north to north-northwest foliation trend extends westward in the Kamilukuak Lake map area (Tella and Eade, 1981). This structural trend, in the domain northwest of the Tulemalu Fault, is related to different stress conditions and/or the presence of deeper level Archean crustal rocks.

In the area of Aphebian gneisses in the southeast quarter of the map area the trend of folding is northeast, plunging northeast and with minor cross folding trending northwest to north-northwest. These trends are the same as those in the area to the west, with minor variation. However, in these gneisses the folds tend to be more closed or asymmetrical, and in part, perhaps, overturned. This contrasts with the typical open folding of the rocks within the synclinorium to the west. The variation in fold trend in the gneisses adjacent to the north boundary of the Maguse Batholith ($\bar{A}$qm) may in part reflect the intrusion of the large pluton. The Aphebian gneisses are considered to be reworked Archean rocks and the fold pattern is probably an Archean trend with little or no modification during the Aphebian.

North of 62°45'N latitude in NTS 65 I (W ½) there is a very pronounced change in trend of foliation in the gneisses. An east-trending fault marks the boundary. To the south of the fault the northeast trend prevails, but north of the fault foliation and folds trend east to east-northeast. The change in trend is more conspicuous northward from the fault. A similar change in foliation trend is apparent in the area to the east (Bell, 1971). This change in trend is probably related to the Dimma Domain boundary which has been placed along a second east-trending fault 17 km farther north. The domain boundary is based on regional lithological considerations but perhaps in this area should be moved southward to take into account the distinct differences in structural trend.

The Aphebian Hurwitz Group rocks, in the southern part of NTS 65 I (W ½), constitute the faulted-off west limb of a north plunging anticline that extends into this area from the Kognak River area to the south. The trend of the Aphebian folding is northeast to north-northeast, very similar to the trend of the Archean folding. It is suggested the Aphebian deformation is superimposed on the older Archean deformation with very little change in trend.

The Dubawnt Group rocks are a flat lying to gently dipping cratonic cover that has not been folded. Dips close to some faults are steeper than elsewhere and minor warps are associated with some faults. However, there is no major fold deformation of the Dubawnt Group rocks.

SUMMARY AND INTERPRETATION OF ISOTOPIC AGES

Isotopic ages determined for rocks in the area are listed in Table 1. The K-Ar determinations have been published and discussed in detail and a report on the U-Pb results is in preparation. The following summarizes the interpretations.

The three zircon ages on Henik Group rocks are so different that external influences must be considered. The youngest age, 2449 Ma, a ^{207}Pb-^{206}Pb minimum age, on rocks from the south part of NTS 65 I (W ½), is based on zircons extracted from a very sheared rock, felsic tuff ($\bar{A}$f), in part a muscovite schist. The 2449 Ma minimum age is considered to be much younger than the age of extrusion of this felsic volcanic rock. A K-Ar age (1616 ± 49 Ma) on muscovite from this volcanic schist is younger than most other K-Ar ages in the map area. The strong shearing has possibly resulted in loss of argon and this age dates the tectonic event rather than the igneous event.

The other two zircon ages from two closely spaced samples of volcanic tuff ($\bar{A}$f) from west of Angikuni Lake are very different. The younger, 2643 Ma, is the age to be expected, based on data from elsewhere in District of Keewatin. For example, Ridler and Shilts (1974) quote an age of 2660 Ma for the Kaminak Group volcanics, that are considered to be correlative with the Henik Group volcanics. The old age, 3037 Ma, can be interpreted in two ways. One, it could be the age of an older volcanic group, but nothing in the field relations suggests the existence of volcanic rocks older than the Henik Group. Furthermore, the rocks sampled are indistinguishable and form part of the same felsic volcanic tuff unit. A second interpretation is that zircons giving the old age are derived from a pre-volcanic

Table 1. Isotopic ages (in Ma), Tulemalu Lake-Yathkyed Lake area

Lithology	Location	U-Pb zircon, upper concordia inter.	^{207}Pb-^{206}Pb zircon (minimum age)	K-Ar hornblende	K-Ar biotite	K-Ar muscovite	K-Ar whole-rock
Felsic volcanic tuff (Āf)	62°13'45"N, 97°50'10"W (65 I)		2449[6]			1616 ± 49[4]	
Felsic tuff (Āf)	62°20'31"N, 99°53'12"W (65 J)	3037[7]					
Felsic tuff (Āf)	62°19'12"N, 99°57'00"W (65 J)	2643[7]					
Pyroxene-bearing granodiorite gneiss (Āngr)	62°05'17"N, 97°45'54"W (65 I)		2642[7]		2425 ± 54[4]		
Quartz diorite gneiss (Āng')	62°31'30"N, 98°04'00"W (65 J)				2364[2]		
Granodiorite gneiss (Āng)	62°17'53"N, 98°44'58"W (65 J)				2300 ± 53[4]		
Granodiorite orthogneiss (Āngo) at contact with dyke, (Adb)	62°18'00"N, 98°35'50"W (65 J)	2671[7]		2473 ± 184[4]			
Granodiorite orthogneiss (Āngo) at contact with dyke, (Adb)	62°18'00"N, 98°35'50"W			2471 ± 62[4]	2118 ± 47[4]		
Granodiorite orthogneiss (Āngo) 6 m from dyke contact	62°18'00"N, 98°35'50"W			2431 ± 61[4]			
Quartz monzonite vein cutting orthogneiss (Āngo)	62°18'00"N, 98°35'50"W			2485 ± 62[4]	2293 ± 51[4]		
Gabbro dyke (Adb)	62°18'00"N, 98°35'50"W						1955 ± 106[4]
Migmatized para-gneiss (Āsn), at contact with dyke (Ādb)	62°09'39"N, 99°29'22"W (65 J)				1939 ± 34[4]		
Metagabbro dyke (Ādb)	62°09'39"N, 99°29'22"W			1925 ± 157[4]			2067 ± 226[4]
Migmatized para-gneiss derived from tuff (Āsnt) at contact with dyke (Ādb)	62°16'03"N, 99°44'30"W (65 J)				1779 ± 42[4]		
Metaggabro dyke (Ādb)	62°16'03"N, 99°44'30"W			1891 ± 169[4]			1814 ± 165[4]
Metagabbro dyke (Ādb)	62°47'N, 99°52'W						1483 ± 46[4] 1451 ± 45
Granodiorite** (Maguse Batholith) (Āqm)	62°04'30"N, 96°50'30"W (65 I)		2472[6]				

Quartz monzonite ($\bar{A}$qm) at contact with dyke (Adb)	62°20'57"N, 99°08'07"W (65 J)			2270 ± 100[4]			
Quartz monzonite ($\bar{A}$qm)	62°20'57"N, 99°08'07"W	2659[7]		2429 ± 203[4]			
Foliated grano-diorite ($\bar{A}$qm) at contact with dyke (Adb)	62°20'57"N, 99°08'07"W			2242 ± 114[4]			
Gabbro dyke (Adb)	62°20'57"N, 99°08'07"W						1869 ± 220[4]
Gabbro dyke (Adb)	62°20'57"N, 99°08'07"W						1999 ± 213[4]
Gabbro dyke (Adb)	62°25'45"N, 98°13'00"W, (65 J)						2275 ± 59[4]
Gabbro dyke (Adb)	62°12'20"N, 98°17'20"W (65 J)						2230 ± 59[4]
Gabbro dyke (Adb)	62°08'35"N, 99°20'30"W (65 J)						2549 ± 265[4]
Quartz monzonite (Aqm)	62°43'15"N, 99°22'30"W (65 J)			1984 ± 78[5]			
Mafic trachyte (ADCm)	62°35'N, 99°35'W (65 J)				1521[1]		
Lamprophyre (ADMd)	62°16'15"N, 99°49'30"W (65 J)				1687 ± 41[4]		
Lamprophyre*** (ADMd)	63°33'44"N, 99°43'41"W (55 M)			1745 ± 75[3]			
Porphyritic, fluorite-bearing rapakivi texture granite* (Agpr)	62°51'05"N, 100°11'25"W (65 K)	1803+16/-13[7]		1793 ± 53[5]			
Porphyritic, fluorite-bearing granite (Agp)	62°59'43"N, 98°42'49W" (65 J)				1747 ± 32[5]		

(1) Lowdon, 1960
(2) Lowdon et al., 1963
(3) Wanless et al., 1978
(4) Wanless et al., 1979
(5) Stevens et al., 1982
(6) Wanless and Eade, 1975
(7) W.D. Loveridge, personal communication, 1983

* From Kamilukuak Lake map area, to the west
** From Ferguson Lake (E ½) map area, to the east
*** From McQuoid Lake map area, to the northeast

All K-Ar ages are based on the following constants:

Potassium

$\lambda(^{40}K_{\beta})=4.962\times10^{-10}a^{-1}$

$\lambda(^{40}K_e)+\lambda'(^{40}K_e)=0.581\times10^{-10}a^{-1}$

$^{40}K=0.01167$ atom %

Argon

atomic ratio $^{40}Ar/^{36}Ar$ atmospheric = 295.5

All determinations by Geochronology Section, Geological Survey of Canada

All zircon ages are based on the uranium decay constants:
^{238}U, $1.55125\times10^{-10}a^{-1}$ and ^{235}U, $9.8485\times10^{-10}a^{-1}$

granitoid basement. Scattered fragments observed in the tuff may be grey granitoid gneiss rather than volcanic clasts, and it is possible the zircons are from a pre-Henik Group basement rock.

The two zircon determinations on Archean gneisses, 2642 and 2671 Ma, are similar. The former is a ^{207}Pb-^{206}Pb minimum age that is probably slightly younger than the age of formation of the pyroxene-bearing granulite gneiss (Ānqr). The latter age is considered to be the age of emplacement of the granodiorite pluton from which the orthogneisses (Āngo) were derived. Younger K-Ar ages on these rocks, 2425 ± 54 Ma on biotite and 2473 ± 184 Ma on hornblende, represent cooling ages of these rocks. The zircon age of 2659 Ma from quartz monzonite (Āqm) is similar to the age of the gneisses. It is suggested the quartz monzonite is a late tectonic pluton intruded in the late stages or soon after the major metamorphic event producing the gneisses. The 2472 Ma age (zircon) from granodiorite of the quartz monzonite (Āqm) Maguse Batholith in the Ferguson Lake (E ½) area is a minimum age that is too young to represent the age of intrusion of the batholith.

K-Ar determinations on samples of chilled margins of three northeast-trending metagabro dykes (Ādb) give a range of ages. A small dyke segment (Ādb) near Tulemalu Lake, with whole-rock ages of 1483 ± 46 and 1451 ± 45 Ma, consists of strongly sheared and altered metagabbro and undoubtedly some radiogenic argon has been lost due to tectonism and metamorphism. Samples from a dyke (Ādb) on an island in Angikuni Lake give a whole-rock age of 1814 ± 165 Ma and a hornblende age of 1891 ± 169 Ma. A dyke (Ādb) 12 km east of Angikuni Lake has a whole-rock age of 2067 ± 226 Ma and a hornblende age of 1925 ± 157 Ma. It is suggested the younger age obtained from the dyke on the island is related to increased radiogenic argon loss due to proximity to the northeast-trending fault in Angikuni Lake (Wanless et al., 1979). The ages obtained on these northeast-trending dykes are not the age of intrusion, as the ages are younger than those obtained for most of the younger dykes (**A**db), but the ages reflect later events.

K-Ar whole-rock determinations on chilled margin samples of five of the younger east-trending gabbro dykes (**A**db) and country rock at the contacts of the dykes, have been described and discussed previously (Wanless et al., 1979). In summary, it is suggested the age of intrusion of these dykes would appear to be approximately 2250 Ma.

A K-Ar age on hornblende from quartz monzonite (**A**qm), 1984 ± 78 Ma, is a cooling age and hence a minimum age of intrusion. Although there is no doubt this is an Aphebian pluton, a zircon age would give a closer approximation to the time of intrusion.

A K-Ar age on biotite from Christopher Island Formation mafic trachyte, 1521 Ma, was obtained in the very early stages of the Geological Survey's geochronological studies when accuracy was less dependable and the results from altered samples less understood. It is probably too young. A loss of radiogenic argon from the sample may be due to the alteration of most of the trachytes. Similarly, the K-Ar biotite age of 1687 ± 91 Ma on lamprophyre, considered to be genetically related to the trachytes, is perhaps too young even for a cooling age and any loss of argon may be due to alteration.

A K-Ar age on biotite of 1747 ± 32 Ma, from the fluorite-bearing granite (**A**gp) east of Tulemalu Lake, is a cooling age and therefore a minimum age of intrusion. Although no determinations on the fluorite-bearing granite with rapakivi texture (**A**gpr) exist within the present map area, a sample from 8 km to the west gives a zircon age of 1803 + 16/-13 Ma (K-Ar on hornblende, 1793 ± 53 Ma). This indicates the age of intrusion of this granite, which cuts the Christopher Island Formation volcanics.

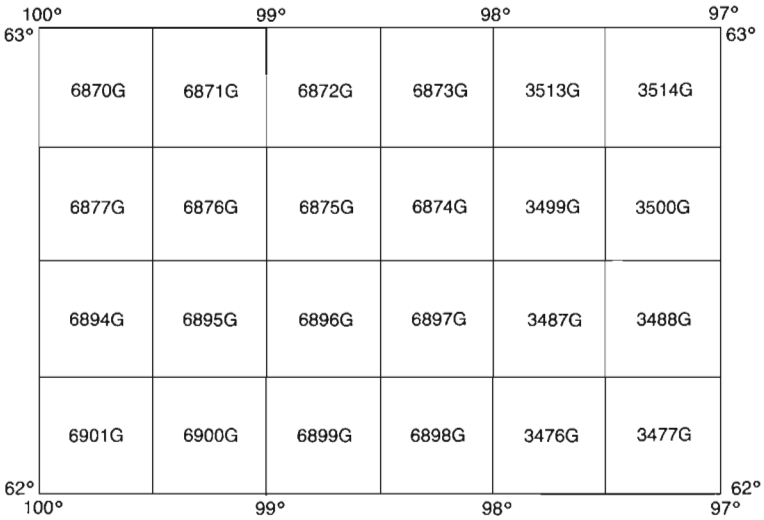

Figure 8. *Index of 1 inch to 1 mile and 1 inch to 4 mile aeromagnetic maps.*

GEOPHYSICS

Aeromagnetic maps published by the Geological Survey of Canada cover the map area at scales of 1:63 360 (1 inch to 1 mile), 1:253 440 (1 inch to 4 miles) and 1:1 000 000 (GSC Map 1567A). Figure 8 is an index of the detailed aeromagnetic maps for the area.

A gravity map at a scale of 1:500 000 (Gravity Map Series, No. 130, Gibb and Halliday, 1974), covers the area and it provides a small-scale gravity coverage in this region.

A reconnaissance airborne gamma ray (spectrometric) survey, with line spacing at 28 to 30 km intervals, includes the map area. The results, published at a scale of 1:1 000 000 (GSC Map 37065G) show four east-west lines are within the boundaries of the map area. The results of a more detailed airborne gamma ray (spectrometric) survey, with 5 km line spacing, covering the Ferguson Lake map area (NTS 65 I) have been published (GSC Map 35965G).

In NTS 65 J, exploration companies carried out detailed airborne radiometric and aeromagnetic surveys of many areas of potential economic interest. For the most part these geophysical results are confidential and unavailable. As mentioned previously in the section on gabbro dykes (**A**db), the results of one such survey were consulted and locations of east-trending gabbro dykes determined using these more detailed maps.

The pervasive northeastern structural trend is prominently reflected on the aeromagnetic maps. The important structural parallel faults, that is, faults parallel to the structural trend, are less easily recognized although the pronounced change in aeromagnetic gradients indicates the presence of some of them. In part, gravity map contours also follow the northeast structural trend. The best example is probably the contours over the metavolcanic band just southeast of Tyrrell Arm.

East-west faults show as cross-structural lineaments where anomaly terminations occur on the aeromagnetic maps. Some gravity contours also show cross-structural lineaments particularly east of the central part of Yathkyed Lake.

The contours of the gravity map show a marked parallelism with the Dubawnt Group basins. In the northwestern part of the area and extending into adjoining map areas, areas underlain by young granite plutons (Āg, **A**gp, **A**gpr) are characterized by gravity lows. In southwestern NTS 65 I (W ½) the Archean Maguse Batholith shows as a

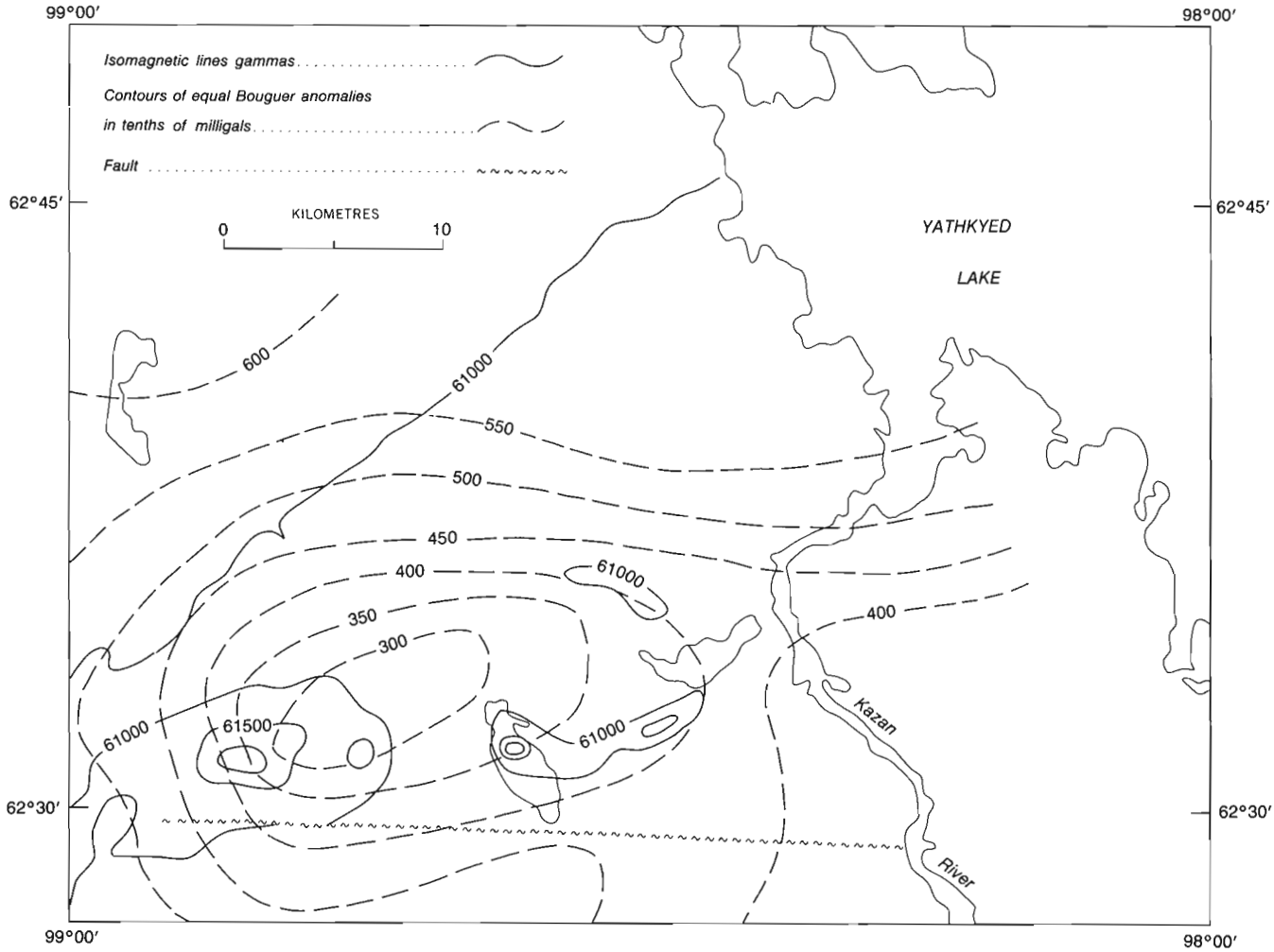

Figure 9. *Geophysical anomaly southwest of Yathkyed Lake.*

gravity low and this low extends much farther west, suggesting that the batholith underlies the rocks currently exposed.

Approximately 45 km southwest of Yathkyed Lake a prominent oval magnetic anomaly is slightly offset from a marked gravity anomaly (Fig. 9). This oval magnetic anomaly is about 1200 gammas above the relatively magnetically flat surrounding area. The gravity anomaly is offset to the ENE from the magnetic anomaly and shows an increase in response from the regional background of about -50 mgal. to -30 mgal. over the anomaly. To the east of the main anomaly a small magnetic anomaly is more elongated. Bands of quartz-magnetite iron formation occurring in paragneiss may account for the small, linear-shaped anomaly.

The area covered by the magnetic anomaly is underlain by Christopher Island Formation rocks that typically have a flat magnetic and gravity pattern. The Christopher Island Formation has here a thickness from drillhole data of 270 m. Preliminary studies (P.H. McGrath, personal communication, 1983) suggest the large magnetic anomaly is approximately 660 m below the surface and the small elongate anomaly to the east is about 75 m below.

The offset of the gravity and magnetic anomalies is possibly due to plunge to the east-northeast of the rock mass responsible. The degree of plunge is unknown. It is postulated that a plunging basic body in granodiorite gneiss (Ang), that was unexposed even prior to deposition of the Dubawnt Group rocks, is the cause of the anomalies. The basic pluton would occur between two prominent east-trending faults.

The scale of presently available gamma ray (spectrometric) maps is too small to aid in the interpretation of the regional geology. A detailed map may assist in delineating the Christopher Island Formation.

REGIONAL SYNTHESIS

Southern District of Keewatin is divided for the first time into structural-lithological domains and Figure 10 shows the domain boundaries in the Tulemalu Lake-Yathkyed Lake area. The Dimma, Kaminuriak, Maguse and Western Craton domains are considered to be Archean features, probably blocks developed in the Archean craton as the result of major fractures. The Mandreville Domain is a younger feature, the result of metamorphic-plutonic overprinting on the Maguse Domain during the Hudsonian Orogeny. The Angikuni Lake Basin, the Yathkyed Lake Basin and the dismembered remnants of the southwest end of the Baker Lake Basin present in the northwest corner of the area, contain unmetamorphosed cratonic cover rocks laid down in the final stages of the Hudsonian Orogeny. The names of the domains, with the exception of Western Craton Domain (Lewry et al., 1978), are new.

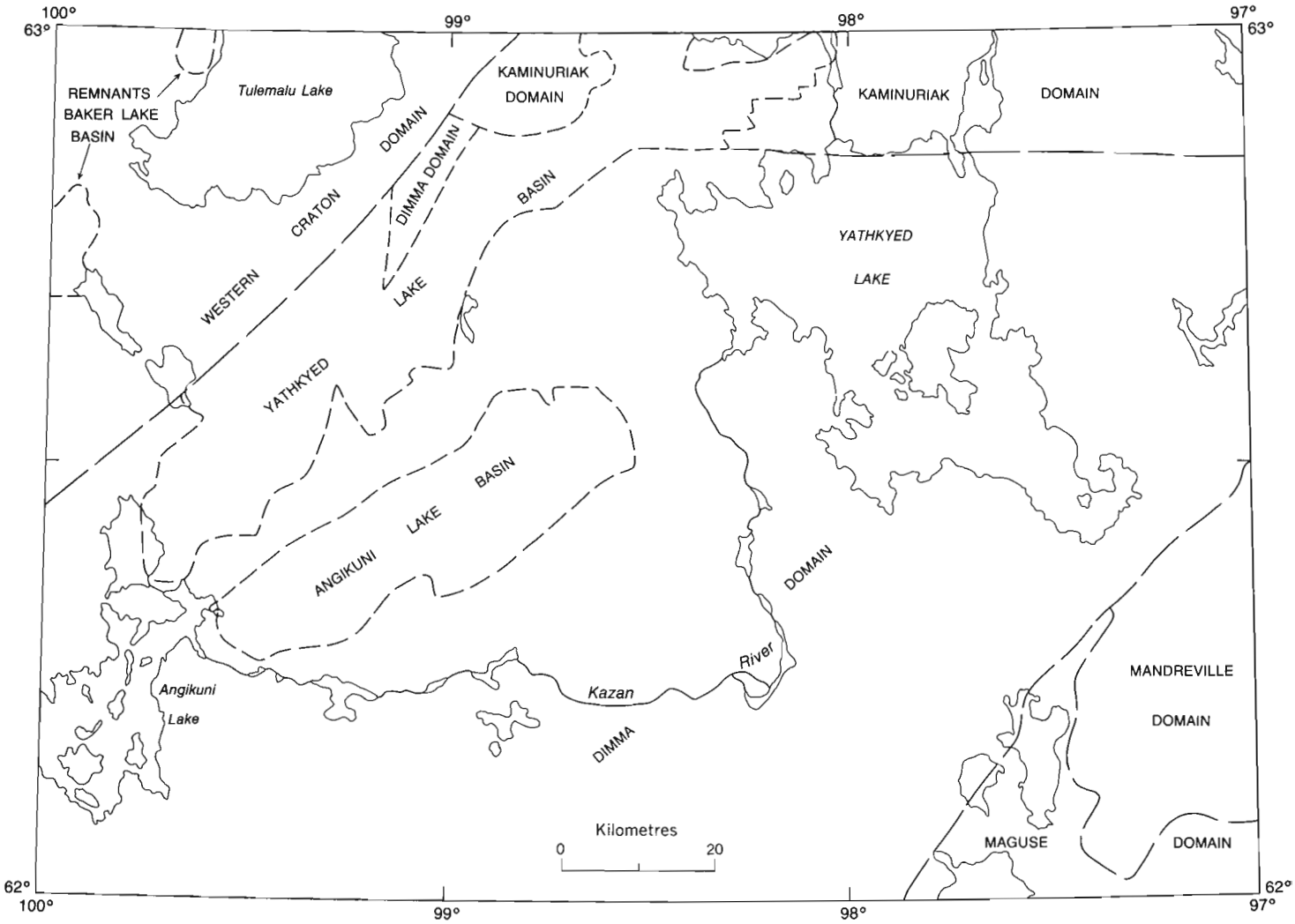

Figure 10. *Domains and basins in the Tulemalu Lake – Yathkyed area.*

Table 2 summarizes the characteristics of the domains in the map area but not all of the distinguishing features of the domains are represented here. On a regional basis there are additional distinctions or, in some cases, variations from these local characteristics.

The map area is part of the Archean craton present in the southern District of Keewatin. The Dimma and Maguse domains are composed of granite and greenstone belts typical of parts of the Archean cratons present in the Superior and Slave structural provinces. The Kaminuriak Domain, largely granitoid with remnants of amphibolite and paragneiss, is very similar to gneiss belts present in the Superior Province. The Western Craton Domain is composed of granitoid rocks representative of a deep crustal level, such as augen gneiss, migmatized orthogneiss, and orthogneiss with some retrograded granulite facies rocks that are cut by younger plutonic rocks. It is analogous to the southern part of the English River Belt of the Superior Province.

The domains result from block tectonism of the craton, with great faults dividing it into blocks that constitute the domains. In shape, the blocks are subrectangular or polygonal. The blocks have maintained their individuality since inception. Some have been depressed with sedimentary basins formed on them, others elevated and subjected to extensive erosion. The Archean lineament systems have been sites of renewed structural adjustment during the Aphebian, and probably the Helikian as well. Movement on the rejuvenated faults, however, was probably not as great as the early movement.

The Tulemalu Fault, which forms the boundary of the Western Craton and Dimma domains, is parallel to the structural trend in Dimma Domain, but the structural trend of the Western Craton Domain in the northwest part of the area deviates from this northeast trend to north-northwest. This major fault and subsidiary northeast-trending faults, such as the one traversing Angikuni Lake, are considered to be the earliest major fractures developed in the craton and have continued as zones of weakness that have been subject to reactivation from time to time. Under tensional stress conditions, fractures associated with these faults were intruded by the northeast-trending, late Archean gabbro dykes ($\bar{A}$db). Emplacement of the dykes probably took place in the early to middle stages of the Kenoran Orogeny. In the latter stages of the orogeny, these dykes were metamorphosed to amphibolite, hence the date of intrusion of the dykes cannot be determined isotopically.

Scattered younger northeast-trending dykes ($\bar{A}$db) that are associated with the small gabbro ($\bar{A}$b) intrusions around

Table 2. Summary of domain characteristics, Tulemalu Lake-Yathkyed Lake area

Subdivision	Principal lithology	Structural trend and boundary relations	Intrusive, metamorphic and tectonic history
Western Craton Domain	Archean granodiorite gneiss and augen gneiss, minor quartz monzonite. Aphebian syenite to quartz monzonite plutons. Christopher Island Formation volcanics and volcaniclastic sediments. Late granite plutons.	North to north-northwest structural trend except adjacent to the Tulemalu Fault where trend is northeast parallel to the fault. Tulemalu Fault is the boundary with the Dimma Domain.	The Archean gneisses, probably largely orthogneisses, with some migmatization, are characteristic of middle to lower crustal levels. Upper amphibolite facies metamorphism has undergone some retrogression. The gneisses have experienced strong deformation, with cataclastic and mylonitized rocks common. The domain, on the upthrow side of the Tulemalu Fault has undergone long and deep erosion. Location of the syntectonic Aphebian syenite – quartz monzonite plutons in part controlled by the Tulemalu Fault, and major east-trending faults. Dubawant Group rocks are the dismembered southwest end of the Baker Lake Basin, cut off by young granite plutons.
Dimma Domain	Archean metavolcanics, metasediments, migmatized paragneiss, granodiorite gneiss and orthogneiss; minor granulitic gneiss, quartz diorite gneiss, and layered to nebulitic gneiss; granodiorite to quartz monzonite and minor gabbro plutons; minor northeast-trending amphibolite to metagabbro dykes. Aphebian east-trending gabbro dykes; minor quartz monzonite; Dubawnt Group, sandstone, siltstone, conglomerate, volcanics and volcaniclastic sediments; minor lamprophyre and syenite dykes; minor late granite plutons.	The northeast Archean structural trend is prominent; minor, slightly younger east to southeast deformation overprinting is evident. An east-trending fault constitutes the boundary with the Kaminuriak Domain and a northeast-trending fault is the boundary with the Maguse Domain to the southeast.	The greenstone-granodiorite association is typical of upper crustal levels in Archean cratons. The plutonic rocks were largely converted to orthogneiss during the early part of the Kenoran Orogeny. Following this phase of the orogeny, during a phase of tensional stress, northeast-trending gabbro dykes were intruded; during the late phase of the Kenoran, the dykes were metamorphosed to amphibolite and granodiorite to quartz monzonite, and gabbro plutons were emplaced. The northeast structural trend is predominant throughout the domain, with the slightly younger overprinted east to southeast trend present only in the central part. The early Aphebian east-trending dyke swarm is characteristic of the domain, and crosscuts the Archean deformation. East-trending faults and fractures probably developed in late Archean or very early Aphebian and tensional tectonics, following development of the fracture, permitted emplacement of the dyke swarm. Minor quartz monzonite plutons intruded later during the early phase of the Hudsonian along some east-trending faults. Metamorphism and deformation associated with the Hudsonian Orogeny is minimal in the domain. Tensional stress or incipient rifting in the late Aphebian resulted in the Angikuni Lake and Yathkyed Lake basins in which Dubawnt Group rocks were deposited. Later changes in stress are recorded by the lamprophyre-syenite dyke trends. Posttectonic granite plutons followed the basin development.
Kaminuriak Domain	Archean granodiorite gneiss, layered to nebulitic gneiss; minor metavolcanics and amphibolite; granodiorite to quartz monzonite and minor gabbro plutons. Rare early Aphebian east-trending gabbro dykes. Minor syntectonic Aphebian quartz monzonite plutons. Dubawnt Group sandstone, siltstone, conglomerate, volcanics, volcaniclastic sediments overlie basement rocks and Martell Syenite intrudes the basement.	The Archean structural trend is east to east-northeast. Dubawnt Group rocks occur in a northeast-trending basin, modified by east-trending faults.	The Archean gneisses, with minor metavolcanics and amphibolite, are characteristic of middle crustal levels. Archean metamorphism is middle amphibolite facies. The east to northeast structural trend of the basement rocks is distinctly different from the trend in the Dimma Domain. The rarity of both northeast- and east-trending gabbro dykes suggests different late Archean-early Aphebian stress conditions to those in the Dimma Domain. Metamorphism of east-trending dykes indicates some Hudsonian metamorphism in this domain.
Maguse Domain	Archean granodiorite gneiss and quartz monzonite to granodiorite plutons. Aphebian Hurwitz Group, quartzite, arkose to meta-arkose, dolomite, argillite, calc-silicate rocks.	The structural trend is northeast in this part of the domain, paralleling the fault contact with Dimma Domain. General trend of the domain is east to east-northeast.	Archean granodiorite gneiss is intruded by quartz monzonite to granodiorite, forming the northwest part of the large syntectonic Maguse Batholith associated with the Kenoran Orogeny. Hurwitz Group rocks, shelf-type cratonic cover, were deposited during the Aphebian and deformed, down faulted and metamorphosed during the Hudsonian Orogeny. Metamorphism ranges from upper greenschist-lower amphibolite in the south to lower middle amphibolite in the north.
Mandreville Domain	Orthogneiss, nebulitic to swirled gneiss, layered to irregularly layered gneiss, cut and partially assimilated by dykes, stringers, and irregular masses of quartz monzonite	Structural trend is northeast, parallel to contact with the Dimma Domain. The metamorphic-plutonic boundary with the Maguse Domain is not sharply defined.	The domain is characterized by the Hudsonian metamorphic and plutonic overprinting on Archean rocks, originally part of the Maguse Domain. The reworked Archean rocks are marked by quartz monzonitic intrusion and assimilation, with apparent introduction of K-feldspar and modification of the original fabric of the gneisses although Archean structural trends are preserved. Metamorphism is middle amphibolite facies. probably overprinted on similar Archean facies.
Yathkyed Lake Basin, Angikuni Lake Basin, outliers of Baker Lake Basin	Mafic trachyte lavas and pyroclastics, volcaniclastic sediments sandstone, siltstone, conglomerate, mudstone; minor felsic trachyte and rhyolite; syenite and lamprophyre dykes.	Essentially flatlying rocks in northeast-trending basins of deposition on the Dimma, Kaminuriak, and Western Craton domains.	Following the main plutonic and metamorphic activity of the Hudsonian Orogeny in this part of the craton, tensional stress with associated alkaline volcanism, resulted in thick accumulation of mafic trachytes in basins developed parallel to northeast faults. A thin veneer of sediment accumulated in parts of the basins prior to volcanism. Readjustments on northeast-and east-trending faults occurred during and after deposition in the basins. Alkaline volcanism was closely followed by calc-alkaline igneous activity, with large scale granite intrusions, particularly in the Western Craton. The granites dismembered the Baker Lake basin. The volcanics and sediments are altered but not regionally metamorphosed.

Angikuni lake, are only slightly metamorphosed and are probably late Archean. The gabbro plutons and dykes were probably emplaced during the final stages of the Kenoran Orogeny. As there are two ages of northeast-trending dykes, the older of which are metamorphosed, repetition of the tensional stress pattern during the late Archean is indicated. This same pattern of tensional stress was repeated in the Aphebian, as the Yathkyed Lake and Angikuni Lake basins have similar northeast trends.

No estimate of total vertical movement on the Tulemalu Fault is possible. The facts, however, that the upthrown side, the Western Craton Domain, is representative of lower crust and the downthrown side, the Dimma Domain, is representative of upper crust, indicates the sum of all the adjustments along the fault results in a very large vertical movement. Furthermore, it is suggested the block constituting the Dimma Domain, bounded by northeast-trending fractures on two sides, was tilted to the northwest. This suggestion is supported by the existence, west of Angikuni Lake, of the uppermost part of the Henik Group volcanic-sedimentary section comprising quartzite and slate. Nowhere else is this sequence known to occur and it is considered to exist there because tilting of the Dimma Domain preserved it from erosion.

The northeast-trending fracture forming the boundary of Dimma and Maguse domains is probably similar in age to the Tulemalu Fault and has the same relative movement with a southeast downthrown side. The vertical movement, however, is much less as both domains are characterized by upper crustal level rocks. Only a single northeast-trending Archean metagabbro dyke appears to be associated with the fracture forming the Dimma-Maguse contact. In the Maguse Domain adjoining the fault contact with Dimma Domain, the northernmost occurrences of Hurwitz Group rocks occur. They are probably preserved here in the down-dropped portion immediately adjacent to the fault, and therefore the Maguse Domain may also have a northwesterly tilt. The Hurwitz Group, Aphebian shelf type cratonic cover rocks, has been deformed by thin-skin type tectonics. The northeast-trending Archean structural grain has been imparted to the overlying Aphebian rocks during Hudsonian deformation that largely affected only the Aphebian cratonic cover rocks.

The east-trending contact between the Dimma and Kaminuriak domains is a major fracture. Several parallel faults occur to the south and all these faults are parallel to the regional Chesterfield Fault (Heywood and Schau, 1978) present approximately 250 km to the northeast. It is suggested the east-trending faults developed in the late stages of the Archean. An early Aphebian period of tensional stress was accompanied by intrusion of the swarm of east-trending Tulemalu Dykes (Adb), primarily in the Dimma Domain, but also with a few in the Kaminuriak Domain, especially near the boundary. An important feature of these early Aphebian dykes is that they show little or no deformation, indicating Hudsonian deformation in the Dimma Domain had slight effect on the basement rocks. The Kaminuriak Domain, on the upthrown north side of the east-trending faults, is characterized by middle crustal level rocks as compared to the upper crustal level rocks of the Dimma Domain. This suggests a moderate amount of vertical movement on the boundary fracture but less movement than on the Tulemalu Fault.

The southwest end of the Mandreville Domain is defined by Aphebian metamorphic-plutonic overprinting during the Hudsonian Orogeny. Prior to the overprinting, this area was a part of the Maguse Domain. The overprinting does not extend into the Dimma Domain to the degree present in the Mandreville Domain. In the Mandreville Domain, the Archean rocks have been reworked to the extent that rock units are for the most part classified as Aphebian. Potassium feldspar has been added to these rocks during the metamorphism associated with the Hudsonian Orogeny. Elsewhere in the Maguse Domain, in the map areas to the south, the Hudsonian Orogeny has resulted in updating of K-Ar dates in the Archean rocks (unlike the Dimma Domain) but the rocks themselves are not considered to be reworked. The boundary of the Mandreville and Maguse domains is largely a metamorphic boundary, with a fault only on part of the western contact. The metamorphic boundary is less well defined than the fault boundaries of other domains. The Mandreville-Dimma Domain boundary is a northeast-trending fault, a fault that predates the Aphebian overprinting characteristic of the Mandreville Domain. There is as well a distinct difference in metamorphism on either side of the fault boundary, with the southeast (Mandreville Domain) side of the fault uplifted to bare a deeper, more intensely metamorphosed level, although this metamorphism is Aphebian. The post-Hudsonian readjustment on the fault is the reverse of the earlier movement, with the southeast side down.

The Angikuni Lake and Yathkyed Lake basins, overlying basement rocks in the Dimma and Kaminuriak domains and the Baker Lake Basin, on the Western Craton Domain, may be indicative of incipient rifting of the craton adjacent to the Tulemalu Fault and parallel faults. The Angikuni Lake and Yathkyed Lake basins are smaller than the Baker Lake Basin which extends approximately 270 km to the northeast. Only remnants of the south end of the Baker Lake Basin occur in the map area, having been dismembered and separated from the main basin by late granite intrusions. If there was incipient rifting it was related to tensional stress in the late Aphebian that postdated the major metamorphism and plutonism at the peak of the Hudsonian Orogeny. The alkaline volcanism and plutonism (Christopher Island Formation volcanics and Martell Syenite) are perhaps associated with the postulated incipient rifting. A marked and sudden change in crustal conditions in this part of the craton followed, however, with extensive calc-alkaline plutonism (Ag, Agp, Agpr) in the Western Craton Domain and to a lesser extent in adjacent parts of the Dimma and Kaminuriak domains. To the north and northeast, in the Baker Lake Basin, calc-alkaline volcanism (Pitz Formation; LeCheminant et al., 1981) accompanied the plutonism. The causes of the major events in the Archean craton of southern District of Keewatin are speculative. Hoffman (1981) has suggested a more rigid Slave Province indented and cracked the Churchill Province and triggered the alkaline volcanism. This probably postdates the intraorogenic collisional suturing and microplate interaction postulated by Lewry (1981) to have taken place on the south and southeast sides of the craton. The latter may be correlative with the Hudsonian metamorphic-plutonic events that distinguish the Mandreville Domain. The need is obvious for much additional geochronological data from large areas before these curious events can be related one to another.

Readjustments on both northeast- and east-trending faults took place following intrusion of the late granites (Ag, Agp, Agpr) as they are cut by faults of both trends. During the Helikian, tensional stress affected all the western Precambrian Shield and permitted intrusion of the extensive swarm of Mackenzie Dykes. Although not apparent within the map area, the Western Craton Domain contains far more of these dykes than do the Dimma, Kaminuriak and Maguse domains, indicating that stress conditions can vary from domain to domain.

ECONOMIC GEOLOGY

The first exploration work of any magnitude in the map area started in 1963, around Angikuni Lake, where Canadian Nickel Co. Ltd., searched for base metals (Laporte, 1979). In late 1975, keen interest in the possibilities for uranium

mineralization associated with the Dubawnt Group rocks, in NTS 65 J, resulted in the start of extensive staking. During the following six years widespread ground exploration, geochemical programs, detailed airborne surveys and diamond drilling were carried out. Numerous pitchblende occurrences have been located in the area, but to the present none are considered rich enough or large enough to be classed as potential ore deposits. Detailed descriptions of some uranium occurrences have been published (Miller et al., in press) but in many cases the data are still confidential. Curtis and Miller (1980), Ruzicka (1978) and Laporte (1979, 1981) provide general descriptions of some of the occurrences.

The most important uranium mineralization occurs in veins related to fractures and breccia zones within the basement rocks – gneisses, amphibolites and metavolcanics – at or close to the unconformity with Dubawnt Group rocks. For the most part, the uranium apparently occurs as pitchblende and is commonly associated with minor amounts of pyrite and chalcopyrite. As well, lesser amounts of uranium occur disseminated in the sediments and volcaniclastic sediments of the South Channel and Christopher Island formations and in breccias or fracture zones.

In the eastern part of the map area, occurrences of pyrite, and less commonly chalcopyrite and pyrrhotite, associated with the Archean Henik Group volcanic rocks and amphibolites, have been shown on the map. In many places the sulphides occur as chert-pyrite iron formation or accompanying chert-magnetite iron formation. These sulphides are sulphide-oxide facies exhalite deposits.

The chert-pyrite and chert-magnetite iron formation present in the volcanic band east and southeast of Tyrrell Arm, was sampled and assayed. All assays and analyses that follow were done by Bondar-Clegg and Co. Ltd., Ottawa.

Location		Au	Ag	Cu
62°24'45"N	97°19'15"W	nil	nil	0.02%
62°23'10"N	97°22'05"W	trace	nil	0.02%
62°22'40"N	97°22'40"W	nil	nil	trace
62°21'50"N	97°30'00"W	trace	nil	0.03%
62°20'20"N	97°35'45"W	nil	nil	trace
62°20'05"N	97°31'05"W	trace	0.10 oz/ton	0.02%
62°19'15"N	97°31'30"W	trace	nil	0.04%
62°18'45"N	97°32'45"W	0.025 oz/ton	nil	trace
62°18'30"N	97°33'10"W	0.010 oz/ton	nil	trace

The above results indicate that the iron formations sampled have insignificant economic values but additional work may be warranted.

In the amphibolite ($\bar{A}$mm) – metavolcanic ($\bar{A}$m) band extending eastward from the northeast corner of Yathkyed Lake toward Ferguson Lake, sulphide occurrences are abundant. Assays from three grab samples gave the following results:

Location		Au	Ag	Cu
62°54'10"N	97°32'10"W	trace	0.06 oz/ton	trace
62°53'50"N	97°32'30"W	trace	0.16 oz/ton	0.05%
62°52'15"N	97°03'15"W	nil	nil	0.03%

A semiquantitative analysis of the third sample gave 0.03 to 0.1% Cu and 0.01 to 0.03% Zn.

Near the east boundary of the map area at about 62°40'N, the amphibolite ($\bar{A}$mm) contains both chert-pyrite iron formation and some pods of massive pyrite-pyrrhotite. An assay of the latter from 62°40'00"N, 97°00'30"W gave 0.05% Cu and a trace of Ni. Semiquantitative analysis of the same sample gave 0.03 to 0.1% Cu, the same value for Zn and 0.003 to 0.01% Ni.

Other pyrite occurrences shown in the eastern part of the map area, not associated with iron formation, are commonly in small shears or faults, in part with quartz veins in fractures. None were assayed.

Although no economically significant mineralization is known in NTS 65 I (W ½), the abundance of exhalite facies iron formation and other sulphide occurrences suggests additional work may be warranted.

In NTS 65 J, iron formation, both chert-pyrite and chert-magnetite, is associated with the Henik Group metavolcanics but it is less abundant and less continuous, being broken and boudinaged, than it is in NTS 65 I (W ½). In one locality, minor chert-magnetite iron formation occurs in migmatized paragneiss.

In the west-trending band of basic metavolcanics of the Henik Group south of Yathkyed Lake small remnants of chert-pyrite iron formation occur with the basic lavas and in some places associated with narrow bands of felsic volcanics within the basic lavas. For example, on the island near the west shore of Yathkyed Lake, close to the south boundary of the west-trending volcanic band, chert-pyrite iron formation, with minor magnetite, is interlayered with pillow lavas. This is probably an interflow exhalite. Similarly, 3 km east of Kazan River at 62°34'00"N, 98°17'15"W, a narrow 1 m band of chert-pyrite iron formation, in acid tuffs, occurs within the basic volcanics ($\bar{A}$m). On the east shore of Kazan River, near the south boundary of the west-trending volcanic band, felsic tuff horizons in the basic volcanics contain deformed and boudinaged chert-magnetite iron formation with small amounts of pyrite. The deformation of the iron formations results in a lack of continuity.

Sulphides also occur in quartz veins cutting the west-trending volcanic band south of Yathkyed Lake. Approximately 1.75 km west of Kazan River, at 62°35'35"N, 98°25'15"W, pyrite, chalcopyrite and galena are present in veins of milky quartz. Other sulphides occur in fracture zones, for example on one of the islands in Kazan River, within the volcanic band where streaks of massive pyrite occur in a very sheared and fractured felsic tuff horizon.

Scattered small occurrences of metamorphosed chert-pyrite iron formation are present in the northeast-trending amphibolite ($\bar{A}$mm) bands in the southeast quarter of NTS 65 J. For example, approximately 2 km east of the large bend in Kazan River, at 62°12'50"N, 98°11'35"W, pyrite, occurring with recrystallized chert in the amphibolite, is considered to be a remnant of iron formation. Similarly, pyrite and magnetite present in some layers of the narrow, northeast-trending amphibolite ($\bar{A}$mm) band, west of Yathkyed Lake, represent relict iron formation that occurred in mafic volcanic tuff or volcaniclastic sedimentary sequences. A good example occurs 10 km west of Yathkyed Lake, at 62°42'00"N, 98°33'25"W, where pyrite and/or magnetite-rich layers lie in a quartz-rich felsic band, 3 to 4 m thick, within the amphibolite band.

The metavolcanic rocks around Angikuni Lake ($\bar{A}$m, $\bar{A}$mf, $\bar{A}$f), in the southwest part of the map area, contain sulphide occurrences, some of which were targets of the early exploration program of Canadian Nickel Company Ltd. in 1963 and 1964. This company held two prospecting

permits, which were mapped at a scale of 1:63 360, and 50 claims were staked within the permit areas. Ground geophysical work was done on the claims and nine diamond-drill holes totalling approximately 570 m were drilled. Galena, chalcopyrite and sphalerite were found but not in economically significant quantities. Claims on the northeast shore of Angikuni Lake and on the large island in the lake, staked by Noranda Exploration Co. Ltd., in 1976, showed Au, Ag, Cu values (Laporte, 1979).

Near Angikuni Lake small bands of chert-pyrite iron formation outcrop in a number of places, particularly in the felsic tuff unit ($\bar{A}f$). As well, sulphides occur in quartz and quartz-carbonate veins cutting the tuff. For example, veins cutting felsic lapilli tuff, at 62°23'18"N, 99°50'40"W, contain galena and siderite. Shear zones adjacent to some of the faults cutting the metavolcanics or gneisses in this area commonly contain scarce sulphides. Brecciated granodiorite gneiss, at 62°28'12"N, 99°44'25"W, on the north side of an east-trending fault, contains abundant quartz veins with pyrite. Similarly, shear zones in the metavolcanics, both east and west of Angikuni Lake, contain abundant pyrite.

Quartz and quartz carbonate veins containing sulphides are common in the quartz arenite unit ($\bar{A}q$). On two of the islands in the lake north of Angikuni Lake, this impure quartzite is cut by quartz veins or fractures containing pyrite, chalcopyrite and galena. Similar rocks west of Angikuni Lake, at 62°16'08"N, 99°55'00"W, are cut by a quartz vein stockwork containing galena and chalcopyrite. Malachite stain is prevalent at this locality.

The metagreywacke or metatuff ($\bar{A}s$), in the central part of the map area at the south boundary, contains pyrite at a couple of localities, where it forms euhedral grains in quartz veins and thin quartz-pyrite layers.

As noted previously, sulphides occur with uranium in some occurrences in basement rocks and in the adjacent Dubawnt Group rocks. Sulphides also occur alone in a few places in the Dubawnt Group rocks. In the northeast corner of NTS 65 J, rhyolite of the Christopher Island Formation (ADCr) contains disseminated pyrite as well as abundant quartz veins in one locality. West of Nutarawit Lake, near the north boundary of the map area, disseminated pyrite occurs in sandstone and conglomerate of the South Channel Formation (ADS). Minor chalcopyrite is associated with mafic trachyte of the Christopher Island Formation in a few places, for example, at 62°55'20"N, 98°27'50"W, in agglomerate occurring with mafic trachyte lava.

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