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GEOLOGY OF THE WOODBURN LAKE MAP AREA, DISTRICT OF KEEWATIN

J.A. Fraser

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F.C. Taylor

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GEOLOGY OF WOODBURN LAKE MAP AREA, DISTRICT OF KEEWATIN

Abstract

The area is underlain mainly by a thick sequence of supracrustal rocks, by granitic intrusions and gneisses, and by syenite intrusions, which range in age from Archean to Aphebian.

The Woodburn Lake Group comprises a lower(?) sequence consisting chiefly of intermediate to basic volcanics, komatiitic flows, pelitic and psammitic metasediments, and banded iron (magnetite) formation, and an upper(?) sequence consisting chiefly of quartzite (quartz arenite), metagreywacke, meta-argillite and carbonate/calc-silicate rocks, all of which are intruded by granitic plutons of late Archean age and transformed in part to gneisses and migmatites. Metamorphism associated with granite emplacement is recorded by subgreenschist to amphibolite facies assemblages stable at low to intermediate pressures. The gneisses grade into a granulite complex metamorphosed in late Archean time and correlative in part with the Woodburn Lake Group.

The supracrustal strata were isoclinally folded around northeasterly trending axes and displaced along northwesterly directed thrust faults, north to northwest trending cross faults, and strike faults.

Stocks, sheets, and dykes of pyroxene syenite and related dykes of lamprophyre belonging to the late Aphebian Martell intrusions postdate deformation.

Pyrite and chalcopyrite may occur in the metavolcanics and banded iron-formation of the lower(?) part of the Woodburn Lake Group and in the metagreywacke of the upper(?) part.

Résumé

La région repose essentiellement sur une épaisse séquence de roches supracrustales, sur des gneiss et intrusions granitiques et sur des intrusions syénitiques, dont l'âge varie de l'Archéen à l'Aphébien.

Le groupe de Woodburn Lake comprend une séquence inférieure(?) constituée principalement de roches volcaniques neutres à basiques, de coulées komatiitiques, de métasédiments pélitiques et psammitiques et d'une formation de fer rubanée (magnétite), et une séquence supérieure(?) dans laquelle on reconnaît surtout du quartzite (arénite quartzifère), du métagrauwacke, de la méta-argilite et des carbonates/silicates calciques, qui sont tous pénétrés par des plutons granitiques de l'Archéen supérieur et transformés en partie en gneiss et migmatites. Le métamorphisme associé à la granitisation est représenté par des assemblages variant du sous-faciès des schistes verts au faciès des amphibolites et stables à des pressions faibles à moyennes. Les gneiss passent progressivement en un complexe de granulite qui s'est métamorphisé vers l'Archéen supérieur et qui peut être mis en corrélation, en partie, avec le groupe de Woodburn Lake.

Les strates supracrustales présentent des plis isoclinaux autour d'un axe nord-est et un déplacement le long de failles de poussée de direction nord-ouest, de failles transversales de direction nord à nord-ouest et de décrochements.

Après ces déformations se sont formés des batholites, des nappes et des dykes intrusifs de syénite à pyroxène et des dykes apparentés de lamprophyre appartenant aux intrusions Martell de la fin de l'Aphébien.

De la pyrite et de la chalcopyrite se rencontrent parfois dans les roches métavolcaniques et la formation de fer rubanée de la séquence inférieure(?) du groupe de Woodburn Lake et dans le métagrauwacke de la séquence supérieure(?).

INTRODUCTION

Woodburn Lake map area is situated in the central part of the District of Keewatin. It extends from latitude 65°N northward to latitude 66°N and from longitude 94°W westward to longitude 96°W. Tybach Lake in the south-central part of the area is about 100 km NNE of the village of Baker Lake, the nearest supply base.

Elevations range from 119 m on Meadowbank River to more than 360 m in the north-central regions. Locally, hills rise more than 100 m above adjacent terrain but over much of the area, relief is much less. The area is drained by two river systems. Quoich River, in the east, drains Tybach, Fractal, and Tehek lakes, and flows southward into Chesterfield Inlet. Meadowbank River, in the west, drains Woodburn Lake and flows northward into Back River.

The map area lies northwest of the Keewatin Ice Divide (Lee et al., 1957; Lee, 1959). Movement of glacial ice across the area was therefore northwesterly to northerly, directions confirmed by esker distribution patterns, drumlinoid ridges, crag and tail structures, and rare striae on bedrocks surfaces. Small easterly to northeasterly trending morainal ridges are common northwest of Fractal Lake and west of Meadowbank River. Drift cover is particularly widespread in the region extending from Woodburn Lake to the eastern boundary of the area. Elsewhere bedrock exposure is generally fair to good. The area is virtually barren of trees.

The bedrock geology of central District of Keewatin, including the Woodburn Lake map area, was mapped on a reconnaissance scale by Wright (1955, 1967) and the glacial features were reviewed by Fyles (in Wright, 1955). A report on the Pleistocene geology of Arctic Canada (Craig and Fyles, 1960) also presents material relevant to the present map area. The surficial geology of the Woodburn Lake area has been recently published at a scale of 1:250 000 (Thomas, 1981). The bedrock geology of areas adjacent to Woodburn Lake map area has been investigated by Heywood

(1961, 1967, 1977), Tella and Heywood (1978), Heywood and Schau (1978, 1981), Ashton (1981, 1982, 1985), Schau et al. (1982), and by Tella (1983). Aeromagnetic maps published by the Geological Survey of Canada (1973, 1974) cover the entire region (NTS 56E) at scales of 1:63 360 and 1:250 000 respectively.

The base camp for the present work was established on 19 June 1981 on Tybach Lake at 65°07'N, 94°51'W. At that time lake ice was still thick enough to support landings of a single engine DeHavilland Otter aircraft for offloading of equipment and supplies. Break-up of the ice took place early in July. Food and supplies required during the field season were brought from Baker Lake by helicopter, as Tybach Lake generally proved to be too shallow for beaching aircraft. Aviation fuel was cached before break-up at Tybach Lake, and after break-up at Woodburn Lake (65°29'N, 95°23'W), and at Outcast Lake (65°18'N, 94°47'W). The latter two lakes and Longpast Lake (65°38'N, 94°27'W) are suitable for landing and beaching float equipped aircraft and also offer level, sandy, camp sites. Geological coverage of the southwest and south-central, and northeasternmost parts of the area was effected by ground traverses. Coverage elsewhere was accomplished by parallel helicopter traverses run north and south at 4 km intervals, with stops for ground observations made every 3 to 8 km. Following completion of the fieldwork on August 25 personnel and gear were moved to Outcast Lake by helicopter and thence to Baker Lake by DeHavilland Twin Otter.

Thanks are due to W.W. Heywood and F.C. Taylor of the Geological Survey of Canada for their part in scouting the Tybach Lake camp site. Dr. Taylor also conducted several of the helicopter traverses. It is a pleasure to acknowledge the assistance of I.R. Annesley, G.N. Mannard, M.G. Besso, Rene Albert, D.A. Smith, and that of our cook, Martha Fahrig. The helicopter, provided by Liftair International Limited, was ably piloted and maintained by Paul Minto.

GENERAL GEOLOGY

Woodburn Lake map area lies partly within the Armit Lake Block and partly within the Committee Bay Block (Heywood and Schau, 1978) of the Churchill Structural Province of the Canadian Shield. The oldest rocks are hypersthene granulites, basic to intermediate volcanics with associated metasediments, and platform metasediments. These are intruded by late Archean granitic to tonalitic plutons and rare bodies of diorite and gabbro. The youngest rocks are intrusive pyroxene syenite and related lamprophyre dykes, of late Aphebian age. These relationships are summarized in the table of formations (Table 1).

Granulite complex (Ah)

Rocks that contain orthopyroxene are with few exceptions confined to the northern half of the map area and are most abundant in the northeastern quarter. Spatially associated with these are granulites of comparable appearance and mineralogy except for the absence of orthopyroxene. Despite wide variations in composition and texture most of these rocks exhibit the distinctive greenish or brownish wax-like lustre of typical granulites. Also included in the complex are intrusions or segregations of granite, granitic gneiss, and migmatite (Ahm) which could not be shown at the present scale of mapping.

The granulites can be subdivided into three groups on the basis of grain size and differences in mafic content. The first group is represented by medium- to coarse-grained, massive to foliated or layered granulites of granite (Ahg), granodiorite or tonalite (Aht) compositions that contain 10 to 30% quartz and 1 to 12% mafics. Plagioclase compositions fall in the range An_{25} to An_{35}. Specific gravities range from 2.68 to 2.79.

In the second group are granulites resulting from metamorphism of sediments and/or volcanic rocks (Ahn), with little or no admixed granitic material. These are fine- to medium-grained, laminated to layered rocks with compositions approaching that of granodiorite, tonalite, or diorite. Compositions show considerable variation but in general quartz ranges from 10 to 20% or more, and mafics from 10 to 15%. Plagioclase composition ranges from An_{31} to An_{35}. Specific gravities range from 2.74 to 2.82.

The third group of granulites consists of fine- to medium coarse-grained, massive to foliated diorities and gabbros (Ahd) that contain less than 5% quartz and 7 to 40% mafic minerals. Plagioclase ranges from An_{30} to An_{50}. Specific gravities range from 2.77 to 3.05. These rocks are much less abundant than those of the other two groups.

Mafic minerals in each group may include biotite and hornblende in addition to hypersthene. In rocks of the first two groups the K-feldspar is almost invariably perthitic and the plagioclase antiperthitic. The association of clinopyroxene with hypersthene is characteristic only of the third group. Serpentine, a common alteration product of orthopyroxene, has been identified in several rocks, possibly retrograded granulites, that do not contain orthopyroxene.

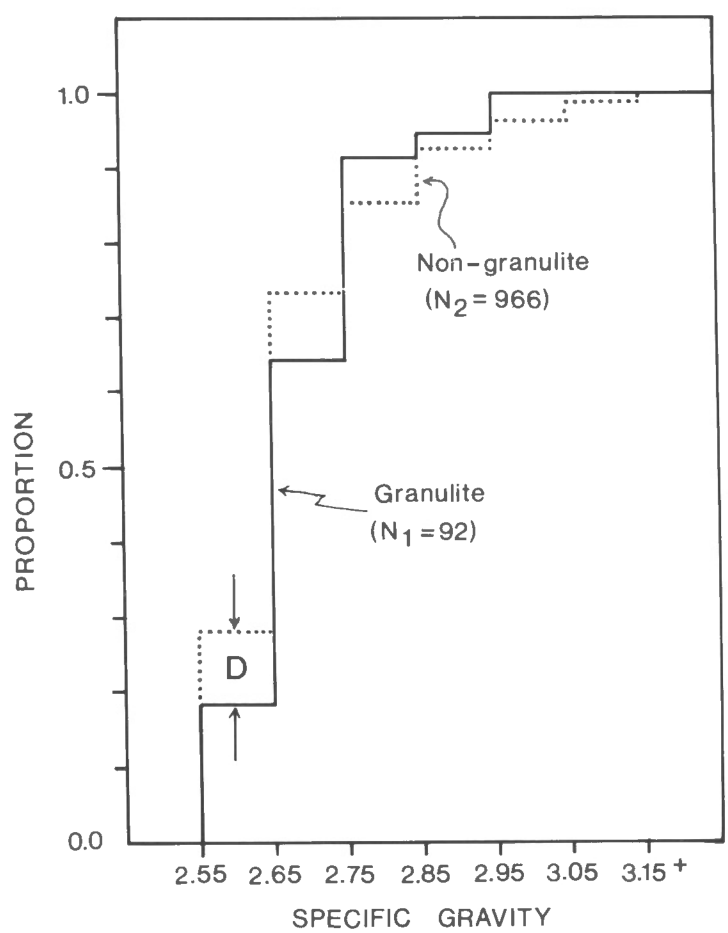

Figure 1. Cumulative frequency distributions of specific gravities.

The relationship of the granitic rocks and migmatite (Ahm) to other rocks of the granulite complex is uncertain. In some cases contacts are sharp, in other cases, they are gradational. It is possible that some or all of the granitic fraction was remobilized from rocks within the complex.

In the northeast corner of the map area the granulite complex includes hypersthene bearing iron-formation and serpentinite possibly derived from komatiitic flows. As these lithologies are typical of the 'lower' succession of the Woodburn Lake Group in the Farside Lake area it is reasonable to infer that the granulites are correlative, at least in part, with strata of that group.

Specific gravity data

Specific gravity determinations were made routinely on all rock specimens collected in the map area. These proved helpful in classifying fine grained rocks, especially those of volcanic and cataclastic origin. Frequency distributions of specific gravities are further useful in comparing rocks from different map units or from different regions. If correlation of rocks of the granulite complex with the Woodburn Lake Group is valid, then frequency distributions of specific gravities of representative suites of specimens from the granulite terrane and from the non-granulite terrane should not be significantly different.

The cumulative frequency distributions (Fig. 1), based on data in Table 2, when tested by the Kolmogorov-Smirnov method (Cheeney, 1983) showed no significant difference at the 95% confidence level. In this test the actual value of the statistic D (Fig. 1) of 0.097 is compared with a critical value of D computed for a desired level of confidence. For the 95% level $D = 1.36/(1/N1 + 1/N2)$, which in the present example is 0.148. Because this value is higher than the actual value of D the distributions are not proven to be different.

It should be noted that the comparison is made between the total granulite terrane and the total non-granulite terrane as each is composed of granitoids and metamorphosed supracrustal strata. The 92 granulite specimens include 51 that contain hypersthene. The latter have a mean value of 2.75 and a standard deviation of 0.094.

Table 1. Table of Formations

Age	Group/Formation	Map unit	Lithology
Aphebian	Dubawnt Group: Martell intrusions	AMy	pyroxene syenite, quartz syenite
		AMl	lamprophyre
	Intrusive contact		
Archean		Af	fluorite granite
		Ag	granite, granodiorite, tonalite
		Ad, Ap	metagabbro, metapyroxenite
	Intrusive and gradational contact		
		An	granite gneiss, granodiorite/tonalite gneiss, diorite/gabbro gneiss, biotite schist/gneiss, paragneiss, hornblende schist/gneiss, chlorite schist, amphibolite, migmatite
	Gradational contact		
	Woodburn Lake Group	AWm	migmatite
		AWc	carbonate/calc-silicate rock
		AWk, AWl	quartzite, metagreywacke, biotite-quartz schist, meta-argillite, phyllite
		AWq	quartzite, muscovite-quartz schist
		Unconformity (?)	
		AWv	metavolcanics, metasediments, metagabbro
		AWp	pelitic schist/gneiss
		AWr	calc-silicate rock
		AWw	metagreywacke
		BIF	banded iron formation
		AWu	metaperidotite, serpentinite
		AWi	intermediate metavolcanics
		AWb	basic to intermediate metavolcanics
	Gradational contact		
	Granulite complex	Ah	hypersthene-bearing granite, granodiorite, tonalite, diorite, and gabbro; hypersthene-bearing metasediments and metavolcanics; granite and migmatite

Table 2. Frequency distributions of specific gravities

S.G. Class interval	Numbers of specimens	
	Granulite terrane	Non-granulite terrane
2.55-2.64	17	272
2.65-2.74	42	435
2.75-2.84	25	116
2.85-2.94	3	72
2.95-3.04	5	35
3.05-3.14	0	16
3.15 +	0	20
	Total 92	Total 966
	Mean 2.73	Mean 2.73
	Std. dev. 0.09	Std. dev. 0.14

Woodburn Lake Group (AW)

The informal name 'Woodburn Lake Group' was applied by Ashton (1981, 1982) to a succession of metavolcanic and metasedimentary rocks that occurs northwest of Tehek Lake, in the southeast corner of the Amer Lake map area, an area previously mapped on a reconnaissance scale by Tella and Heywood (1983). Similar and presumably correlative strata have been mapped in nearby areas by Nadeau (1981), Schau et al. (1982) and Taylor (1985).

Rocks of the Woodburn Lake Group extend from the Amer Lake map area eastward into the southern and central parts of the Woodburn Lake map area. Two major belts, one situated mainly in the southwest and the other in the south-central regions, have been outlined. Their distribution is marked by strong positive magnetic anomalies. Isolated occurrences of comparable strata and derived gneisses (Anp, Ana, Anm) in the central, eastern, and northern parts of the map area suggest that the group originally occupied a much broader region.

The Woodburn Lake Group comprises an apparently conformable succession which is divisible into a 'lower' sequence consisting of metavolcanics and associated metasediments, and an 'upper' sequence composed mainly of platform type metasediments. The designations 'lower' and 'upper' are largely arbitrary as structures suitable for top determinations are rare. Strata of the group are intersected by granitic (Ag, Af) and syenitic (AM) intrusions. Basement to the supracrustal rocks has not been found.

Metavolcanics and associated metasediments (AWv)

The south-central belt, exclusive of the platform metasediments, is about 7 km wide and runs from Quoich River 40 km westward along the northern margin of Tehek Lake. It is essentially a homoclinal succession that dips about 30° to the south and has a maximum thickness of about 3000 m.

In the section near Tehert River, 9 km southeast of Tybach Lake, metasediments with some interlayered volcanic strata, having a combined thickness of about 100 m, are structurally and conformably overlain by predominantly metavolcanic rocks about 1200 m thick. These estimates are approximate and refer to gross rather than primary thicknesses. The base of the section is not exposed but the metasediments are bordered on the north by granitic gneisses (An) containing remnants of metasediments which can be traced across strike for a distance of almost 2 km. If these are included in the total the thickness of metasediments would be at least 500 m. The metasediments which occupy the northern margin of the belt and dip southward under volcanic strata may be stratigraphically younger than the volcanics.

The metasediments are composed of alternating layers of biotite-quartz schist, metagreywacke, minor grey slate and argillite or meta-argillite, and banded iron-formation. They are intruded by sills of muscovite granite and pink pegmatitic granite and grade northwards into migmatite (Anm) where they are locally intercalated with dark green to yellowish green metavolcanic rocks.

Metavolcanics near the base of the Tehert River section are deformed into small recumbent folds and pass upwards into dark green to yellowish green, regularly laminated to thinly layered volcanics containing small scattered lenses of carbonate. Adjacent to sills of pegmatitic granite and rare sills of metagabbro, the volcanics have been transformed into black, speckled amphibolite. The southernmost part of the section is composed of laminated to thinly layered volcanics containing as much as 20% carbonate as lenses up to 3 cm thick and 50 cm long. Volcanics at the southern margin of the belt have been intruded by pink granite (Agr) and converted to dense black hornfels.

The volcanics are dark green to black, fine- to medium-grained foliated metabasalts or meta-andesites, composed of quartz (less than 10%), plagioclase (An_{30-40}; almost 60%) and hornblende (30-40%). Accessory minerals may include epidote (1-10%), carbonate (1-5%), and traces of sphene, apatite, and opaques.

The south-central belt is interrupted by a transverse fault near Fractal Lake, but continues westward along the northern shore of Tehek Lake, where metasediments composed mainly of poorly exposed greywacke and pelitic schists appear to predominate. The presence of iron-formation is inferred from local deviations of the magnetic compass which may be as much by as much as 80° from magnetic north.

The southwestern metavolcanic belt can be traced from the vicinity of Farside Lake north to Meadowbank River and northeastward to the region between Woodburn and Fractal lakes. The easternmost part of the belt appears to be isoclinally folded and has a maximum thickness of about 1600 m. Metavolcanics and metasediments are distributed throughout this belt in irregular fashion, presumably reflecting the intimate interlayering of these rocks as well as the complexity of their structure. Metabasalts and meta-andesites (AWb) constitute the greater part of the volcanics exposed. Except for a well developed schistosity that commonly parallels the compositional layering they are similar in mineralogy and structure to the metavolcanics (AWb) in the Tehert River section. Like their counterparts in that belt they may be intruded by rare sills of dark green to black medium grained, foliated or layered metagabbro which probably served as feeders to the flows, and near granite have been converted to amphibolite.

Intermediate metavolcanics (AWi) of metadacitic composition, although less abundant than metabasalts and meta-andesites are found throughout the belt and are particularly characteristic of the region south and west of Farside Lake. They are pale green to pinkish, laminated, locally porphyritic, fine grained rocks which are in places difficult to distinguish from the metasediments with which they are commonly associated. The metadacites typically consist of quartz (20%), plagioclase (60%) ranging in composition from albite to andesine, and mafic minerals (about 20%) that include biotite and hornblende with minor epidote. Potassium feldspar, if present, is less than 5%. Sphene, apatite, zircon, chlorite, carbonate, sericite and opaques are accessory minerals. Porphyritic varieties contain insets of plagioclase ranging from 0.3 to 2 m in diameter in a fine- to very fine-grained groundmass composed of quartz and feldspar.

Metasediments associated with the volcanic rocks in the southwestern belt comprise metagreywacke (AWw), banded iron-formation (BIF), calc-silicate rocks (AWr), and pelitic schist (AWp).

The metagreywacke (AWw) is the most abundant of the metasediments exposed in the south-central and southwestern belts. It is a light to medium grey to greenish, less commonly pale pink, fine- to medium fine-grained and foliated to schistose granoblastic rock composed of quartz (30-75%), albite or oligoclase (15-60%), and muscovite, biotite, and chlorite, which together make up about 10%, and in some cases, 30% of the total volume. Accessory minerals may include sphene, apatite, zircon, tourmaline, carbonate and opaques.

Iron-formation (BIF) in the southwestern belt occurs as beds which range from 1 to 3 m thick. It is not known if these beds represent more than one stratigraphic horizon. Throughout the map area the appearance of this rock is fairly uniform but the composition shows considerable variation. The rock characteristically consists of alternating white quartzose laminae and blue-grey mafic laminae each from 1 to 3 mm thick composed of medium- to fine-grained quartz (65%), biotite (10%), magnetite (approximately 25%) and accessory apatite. However quartz content ranges from 60 to 80%, and mafics, including biotite and hornblende, from 3 to 10%. Magnetite ranges from 10 to 40%. The highest magnetite content (40%) was found in iron-formation exposed west of Meadowbank River. Accessory minerals may include apatite, epidote, plagioclase, muscovite and carbonate.

Only a few occurrences of pelitic schists (AWp) are known in the southwestern belt. Aluminous schist west of Meadowbank River near latitude 65°20'N is composed of fine- to coarse-grained quartz, muscovite, biotite, garnet, sillimanite and andalusite, with trace amounts of andesine, accessory apatite, zircon, tourmaline, and opaque(s). East of the river, near latitude 65°15'N, is a small exposure of cordierite schist, and about 3 km to the south of this occurrence is garnetiferous schist interlayered with iron-formation. The former is composed of fine grained quartz, muscovite, biotite, and cordierite, with apatite, sericite, and opaque(s) as accessory minerals. The latter is fine- to coarse-grained and composed of quartz, biotite, cummingtonite, and garnet.

Calc-silicate rocks (AWr) are relatively rare. Most are greenish to greyish, medium- to coarse-grained, equigranular, massive to foliated rocks containing quartz (less than 10%), plagioclase (albite, andesine or labradorite; 20-70%), mafic minerals (phlogopite, amphibole, or clinopyroxene; 30-80%) with carbonate, sphene and opaques as accessory minerals. The albite bearing rocks consist of albite (68%), amphibole (30%), sphene (2%) and traces of opaque(s).

Ultramafic rocks (AWuk, AWus)

Ultramafic rocks have been identified at four localities. Three of these are in the southwestern belt of metavolcanics and the fourth in the granulite terrane in the northeast corner of the map area. In each case the ultramafic rock is interlayered with metavolcanic and/or metasedimentary strata.

The ultramafic body (AWuk) on the west shore of Meadowbank River was first mapped and described by Wright (1967). Exposed in several rounded outcrops that occupy an area a few hundred metres in diameter, it consists of a layered sequence estimated to be at least 50 m thick. The layers are gently inclined in a southeasterly direction, concordant with adjacent strata and with intercalated beds of banded iron-formation. One layer of the body contains crude, stretched(?) pillow structures 2 m or more in length, but no conclusions could be drawn regarding facing direction. The contact with the adjacent fine grained felsic paragneiss was not observed. The ultramafic rock is dark green to grey, weathering rusty brown and is strongly foliated to schistose. It is composed of olivine (25%) as ovoidal phenocrysts 1 cm or more in diameter, set in a fine grained groundmass of clinopyroxene (25%), cummingtonite (15%), serpentine (12%), chlorite (20%), and magnetite (3%).

About 6 km north of the northwest end of Fractal Lake ultramafic rock (AWuk) occurs at the contact between intrusive granite and metavolcanics. This rock, which is well foliated, is concordant with the overlying volcanic strata but its thickness and extent are unknown. The rock is dark green, weathering rusty brown or green, laminated and foliated, and consists of medium- to fine-grained chlorite (75%), cummingtonite (23%), serpentine (1%), olivine (less than 1%), and traces of opaque minerals. No primary volcanic structures were observed.

Komatiitic ultramafic rocks (AWuk) within the metavolcanic sequence (AWi) near the contact with quartzite (AWl) 6 km north-northwest of Farside Lake comprise a series of pillowed flows each from 2 to 3 m thick, making up a section about 75 m thick. The pillows are deformed and of no use as top indicators. The rock is dark green to grey, weathering dark brown to dull green and composed of fine grained talc (45%), carbonate (30%), chlorite (20%), and magnetite (5%).

A further occurrence of ultramafic rocks (AWus), also mapped by Wright (1967) but not examined during the present investigation, was reported 35 km north of Longpast Lake. The following description is compiled from the field and laboratory notes of C.H. Smith (unpublished data). The ultramafic body is a lens, up to 200 m thick, of a medium grained, brown weathering, grey rock composed of serpentine (60%), cummingtonite (36%), and spinel (4%). The serpentine is an antigorite showing mesh structure inherited from olivine. Overlying the ultramafic body is iron-formation composed of orthopyroxene, magnetite, and quartz.

The characteristics of each of the four ultramafic bodies are consistent with an extrusive origin and although no spinfex textures were noted a komatiitic affinity is suggested by their structure, composition, presence of pillows and lithological association. Similar rocks in the Amer Lake map area, recognized as komatiites (Heywood, 1977; Ashton, 1981, 1982), are the subject of study by Annesley (1981a, b) and will form the basis of his Ph.D. thesis at the University of Ottawa.

The position of the ultramafics in the stratigraphic sequence is uncertain. However, the interlayering of two bodies with iron-formation which, in the section near Tehert River, marks the approximate boundary between volcanics and metasediments, may mean that the ultramafics follow the main extrusion of intermediate to basic flows. This suggestion assumes that iron-formation is confined to only one stratigraphic horizon, and also that the volcanics in general predate the sediments.

Platform metasediments (AWq, AWk, AWl, AWc, AWm)

Metasediments typical of shallow water deposition constitute the 'upper' part of the Woodburn Lake Group. They are found mainly in the southernmost quarter of the map area, occupying much of the region between Farside Lake and Meadowbank River, and the region between Tybach and Mislay lakes. Scattered exposures occur in the vicinity of

Cladhan Lake and minor exposures, northeast of Fractal Lake. The principal lithologies are quartzite, metagreywacke, meta-argillite, and carbonate/calc-silicate rocks.

Northwest of Farside Lake, quartzite is exposed in prominent ridges bordered by grey meta-argillite and biotitic phyllite or metasiltstone. In the contact zone quartzite beds up to 1 m thick are intercalated with the argillaceous rocks. The quartzite is a very fine- to medium-grained, white to pink, or pale grey rock, weathering white to buff or greyish. It is composed chiefly of quartz (85-95%) with accessory microcline (5-10%), and traces of oligoclase, muscovite, biotite, sphene, zircon, tourmaline, and opaque(s). The green chromium mica fuchsite occurs in quartzites near Fractal Lake and near Farside Lake.

Highly sheared quartzite exposed about 5 km north of Farside Lake contains up to 3% kyanite, aligned parallel with the cataclastic foliation. Heavy mineral analysis of a till sample from the Farside Lake-Meadowbank River region yields an unusually high kyanite concentrate (Paré, 1982) which suggests that the mineral is more widespread than outcrop indicates. Muscovite-quartz schist from the same area is composed principally of cataclastic quartz (75%) and muscovite (25%). Similar schists are found in quartzite in other parts of the map area and in all such occurrences the planes of schistosity are approximately parallel with the bedding attitudes of the adjacent metasediments.

Primary structures in the quartzite are few. Although much of the quartzite is massive, it may be thinly to thickly bedded. Bedding planes are defined by interbedded layers of meta-argillite or phyllite, and by parting planes, some of which are traversed by current ripple marks. Four such sets of ripple marks, rotated to the horizontal, range in azimuthal trend from 133° to 147° with a mean of 139°. Quartzite at the quartzite-metavolcanic contact 6 km north of Farside Lake is separated from the metavolcanics by a layer of quartzite conglomerate. Strata on either side of the contact appear to be conformable. The metavolcanics within tens of metres of such contacts are commonly chloritic and schistose.

Quartzite and associated metasediments are widely exposed on the east side to Tybach Lake and on the north side of Mislay Lake. In each of these regions the strata form a homoclinal succession, dipping about 25 to 30° southwards, which is bounded by faults and surrounded by granitic gneisses.

The lower part of the Tybach Lake section is composed chiefly of quartzite (AWq) succeeded by biotite-quartz schist, metagreywacke, and quartzite (AWk), in beds 1 to 2 m thick. These strata are followed by about 20 m of carbonate (AWc) which is overlain by a 1.5 m bed of metagreywacke capped by migmatitic paragneiss (AWm).

The section at Mislay Lake also consists of interbedded quartzite, meta-argillite, and metagreywacke, overlain by poorly exposed carbonate rocks followed by metagreywacke capped by migmatitic paragneiss. It is not certain whether this gneiss, which is apparently conformable with the underlying strata, was formed in situ or whether it was thrust to its present position. If the gneiss be excluded from the section the maximum thickness of strata in the homocline is about 1200 m.

Quartzite in these sections closely resembles that observed near Farside Lake but subhedra of pink potassic feldspar are more consipicuous in the Tybach and Mislay quartzites. These range up to 2 mm in diameter and constitute 5 to 10% of the rock.

The metagreywacke is a grey weathering, grey, fine- to medium fine-grained, massive rock composed of quartz (15%), andesine (75%), biotite (8%), hornblende and blue green amphibole (2%), traces of K feldspar and accessory apatite, zircon, prehnite, and opaque(s).

The carbonate strata (AWc) are pale green or white, weathering buff or white. Beds are 10 to 60 m thick and massive, comprising fine- to medium-grained dolomite and limestone, intercalated with layers and lenses of white chert which commonly enclose pods of green coarsely crystalline diopside. Plagioclase, epidote, actinolite, sphene, and serpentine may accompany the diopside. Buff weathering dolomite near the top of the carbonate section contains diopsidic concretionary masses up to 60 cm in diameter.

Migmatitic gneiss (AWm) that caps both the Tybach and Mislay sections is grey to pink, weathering pink to pale brown, fine- to medium fine-grained, foliated and laminated. The composition is that of granodiorite with a biotite content that ranges up to 15%.

In the regions east and west of Cladhan Lake ridges of white quartzite are enclosed in granite and granite gneiss and intruded by sills of granite and pegmatitic granite. Remnants of associated meta-argillite and calc-silicate rock grade locally into migmatitic gneiss (Anm) and paragneiss (Anp).

Gneiss and migmatite (An)

This map unit consists mainly of weakly to strongly foliated and layered rocks but locally includes occurrences of massive plutonic rocks (Ano) that are too small and too isolated to be depicted at the map scale. Massive rocks make up less than 5% of the unit.

The gneisses occupy much of the central part of the map area, separating the granulites of the north from the supracrustal and massive plutonic rocks of the south. They consist chiefly of biotite-rich rocks derived mainly from sediments (Anp), and amphibole-rich rocks (Ana), derived mainly from volcanics. Both of these types are commonly mixed with granitic material, to form a wide variety of migmatites (Anm). At a regional scale the gneisses are heterogeneous in appearance and composition. At outcrop scale they may be either heterogeneous or homogeneous.

The paragneisses (Anp) are mostly medium- to fine-grained, finely laminated dull greyish rocks with a biotite content that may reach 15% or more. With increasing content of quartz and feldspar the paragneisses grade into lit-par-lit migmatitic gneiss (Anm). Grey lit-par-lit gneisses are particularly well exposed in low, flat topped, outcrops near the eastern boundary of the map area northeast of Cladhan Lake.

Contorted lit-par-lit garnet-biotite paragneisses and migmatite occur in the vicinity of the gneiss-granulite contact at Hermann River. The gneisses are characteristically white to grey, weathering rusty brown to white, and contain thin layers and massive irregular segregations of white, medium- to coarse-grained granite. The same type of granite is also distributed in the gneiss as laminae or lit and as massive irregular segregations.

Gneisses in which hornblende is the dominant mafic mineral (Ana) are much less abundant than those characterized by biotite. Hornblende gneisses are typically black, massive to foliated and/or lineated rocks in which hornblende composes as much as 40%. Like the biotitic gneisses these also grade into migmatites but the transition is more abrupt and the migmatite is more likely to be agmatitic than lit-par-lit. Hornblende-rich gneisses grading into granitic gneisses are found in the gneissic terrane east of Cladhan Lake and in the region between Woodburn and Fractal lakes.

The migmatites grade, with an increase in felsic components, into layered and foliated granitoid gneisses of granite, granodiorite, and tonalite composition. Granite gneiss (Ang), the most common gneiss contains up to 7% mafic minerals, commonly biotite with or without hornblende. Granodiorite and tonalite gneisses (Ant) are more abundant in the northern reaches of the gneiss terrane. The mafic content of these ranges up to 25%, and consists of hornblende as the principal mineral in addition to biotite, accompanied in some cases by cummingtonite and/or clinopyroxene. Antiperthite, a component of at least half of the gneisses examined in thin section, is confined chiefly to the northern three quarters of the map area. Diorite and gabbro gneisses (And) are of sporadic occurrence. Hornblende and/or clinopyroxene are present in these rocks in amounts up to 40%. It is not clear whether these rocks were derived, like the other gneisses, from sedimentary or volcanic antecedents or whether they were derived from sills or dykes of basic composition.

Cataclastic gneisses occur throughout the map area in close proximity to faults. East of Meadowbank River and also in the northwest corner of the map area cataclastic gneisses occur in belts, 3 km or greater in width. Both belts appear to consist mainly of rocks that range in composition from granite to granodiorite. The structures are those of mylonites and protomylonites.

Gradational contacts between the gneisses and the metavolcanic rocks and associated metasediments (AWv) occur in many localities east and west of Meadowbank River and north of Fractal Lake. Examples of gradational contacts between the gneisses and the platform deposits (AWk) are present at Cladhan Lake. Contacts between the gneisses and younger granitic rocks are either gradational or sharp. Commonly the gneisses are invaded both along and across foliation planes. The extension of garnetiferous gneisses into garnetiferous granulites near Hermann River suggest that the gneiss-granulite contact is gradational and defined principally by metamorphic rather than lithological differences.

Metagabbro (Ad) and metapyroxenite (Ap)

This map unit comprises bodies of basic to ultrabasic composition which were emplaced as stocks, sheets or dykes. They are not known to be genetically related. All but one are in the central and northern parts of the map area. Metagabbros found within the metavolcanic (AWv) belts are not included in the unit.

Metagabbro (Ad) 10 km east-southeast of Woodburn Lake is exposed in five stock-like bodies, each about 10 by 10 m in area, which weather with positive relief relative to the surrounding cataclastic pegmatitic granite and migmatite. They are dark grey to black, massive, medium- to coarse-grained rocks composed of poikiloblastic garnet anhedra (2%) enclosed by reaction rims of andesine (50%) which in turn are rimmed by dark green poikiloblastic hornblende (38%). Unstrained quartz (5%), biotite (3%), opaque anhedra (2%) and trace amounts of clinopyroxene, apatite, and zircon are also present.

Metagabbro (Ad) in migmatite terrane just south of the contact with granulite (Ah) near longitude 95°45' W is dark green to black, medium grained and massive to weakly foliated. It is composed of andesine (60%), clinopyroxene (20%) partly replaced by hornblende (almost 20%) and blue-green amphibole. Also present are traces of chlorite, epidote, sphene, apatite, carbonate, and opaque(s).

Bodies of hornblende metadiorite or metagabbro (Ad) that occur in migmatite 4 km west-southwest of Longpast Lake and also in migmatite 8 km northeast of Nanau Lake are themselves gneissic and migmatized in part. They are light grey to bluish, weathering dark grey, medium- to coarse-grained, and consist of calcic oligoclase (65%), hornblende (10-30%), clinopyroxene (0-15%), biotite (3%) and accessory minerals including apatite, sphene, zircon, epidote, and opaque(s).

Metagabbro (Ad) in granulite terrane, 26 km north of Longpast Lake is rusty brown and black, weathering dark grey, medium grained, and foliated subparallel to the regional foliation. The texture is weakly diabasic. The rock is composed of labradorite (40%), clinopyroxene (30%) and hornblende (almost 30%), and traces of cummingtonite, biotite, carbonate, apatite, and opaque(s). Contacts with the surrounding rocks are not exposed and the shape of the body is unknown. The texture and absence of orthopyroxene imply that the rock is possibly a diabase dyke or sill that postdates granulite metamorphism.

The metapyroxenite (Ap) body situated in the granitic terrane 7 km southeast of Mislay Lake is exposed across an area of 100 by 50 m. Contacts with the country rocks are drift covered. It is dark green to brown, massive and composed entirely of equant pyroxene-like subhedra 2 cm or more in diameter. The pyroxene(?) has been completely replaced by coarse grained phlogopite (about 47%) and amphibole (about 47%) consisting of cummingtonite and actinolite, opaques (5%), and trace amounts of apatite.

Granite (Agr), granodiorite (Agd), and tonalite (Agt)

The massive to weakly foliated granitic rocks that make up this map unit are most abundant in the southern and southwestern part of the map area. The largest pluton extends from Tehek Lake more than 30 km northwestwards to the volcanic belt in the vicinity of Farside Lake and Meadowbank River, and from Tehek Lake, southwards into the adjoining map area. Smaller and less well defined bodies occur within the gneisses (An) in the central part of the map area. Exposures of massive granitic rocks, too small to be delineated on the map, are common in the gneisses and in the granulites (Ah). All these granitic rocks are tentatively assumed to be manifestations of the same intrusive event.

The granitic rocks are characteristically pink to white or cream, equigranular, and medium- to coarse-grained. Porphyritic and augenitic textures are local variations and gradation into very coarse grained pegmatitic phases is common. Fine grained varieties include rare aplites and granites that have been subjected to cataclasis. Almost 50% of the granitic rocks show moderate to strong cataclasis. Modal compositions are those of granite (Agr), granodiorite (Agd) and tonalite (Agt)[1]. Most of the tonalites are trondhjemitic. Granite is in general predominant in the south whereas granodiorite and tonalite are more common in the north.

The granite (Agr) is commonly composed of quartz (20-35%), perthitic microcline (30-60%), and calcic oligoclase (15-30%), but albite or sodic oligoclase are characteristic of granite exposed 15 km west-northwest of Woodburn Lake. Biotite, commonly partly altered to chlorite, rarely constitutes as much as 5%. Hornblende is generally found only in the granites in the northern part of the area. Accessory minerals, each present only in trace amount, include muscovite/sericite, epidote, apatite, sphene, zircon, myrmekite, and opaque(s). Serpentine is a rare constituent of granite occurring within the granulite terrane.

In the granodiorite (Agd) and the tonalite (Agt) quartz ranges from 10 to 20%, perthitic microcline from 0 to 20%, and calcic oligoclase from 55 to 70%. Biotite and hornblende

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[1] The classification used is that of Streckeisen (1976).

together make up 1 to 10%. The hornblende is commonly altered in part to blue-green amphibole and accompanied by cummingtonite. Accessory minerals may include epidote, apatite, sphene, zircon, opaque(s), and serpentine.

The granitic rocks (Ag) intrude all other rocks in the map area except the fluorine granite (Af) and the syenite intrusions (AM). Granitic rocks intrude not only paragneiss (Anp) but also the derived migmatite (Anm). Thus xenoliths of paragneiss constitute as much as 10% of the massive pink and grey granite (Agr) exposed 16 km west of Woodburn Lake, and fine- to medium-grained granite 16 km northwest of Woodburn Lake contains blocks of migmatitic gneiss. Some granite outcrops are domes thinly or partly mantled by paragneiss (Anp). Both granite and overlying gneiss are characteristically cut by aplitic and pegmatitic dykes. Examples of such relationships occur 10 km southeast of Woodburn Lake and near the southeast end of Nanau Lake.

Granitic intrusions in the form of dykes and sheets or sills are of widespread occurrence. The intrusive rocks may be white, massive, and pegmatitic or pink, massive and fine grained to pegmatitic. Tonalite and adjacent paragneisses in the central and eastern parts of the map area are locally composed up to 5% of white, coarse grained dykes and sills up to 2 m thick. Metasediments 19 km east of Meadowbank River are intersected by fine grained massive pink granite dykes, 5 m thick, and paragneiss (Anp) on the west shore of the river is cut by dykes of pegmatite and pegmatitic granite 1 m thick.

Fluorite granite (Af)

Fluorite-bearing granite underlies an area of about 130 km^2 south of Farside Lake in the southwest corner of the map area and may extend south and west into adjoining areas.

The granite is a distinctive pale pink to yellowish rock that weathers pale pink. It is mainly massive and coarse- to very coarse-grained, particularly in the central parts of the pluton where feldspar crystals attain a length of 2 cm. Cataclastic textures are common in the vicinity of Tehek Lake.

The rock is composed of quartz (15-25%), microcline or perthitic microcline (50-65%), calcic oligoclase (15-30%), and partly chloritized biotite (1-2%). Accessory minerals may include hornblende, epidote, sphene, apatite, zircon, sericite, carbonate, and opaque(s). Southwest of Farside Lake the granite contains rare grains of purple fluorite up to 4 mm in diameter.

The granite intrudes the metavolcanic rocks (AWv) that border it on the west. Contacts with the medium grained granite (Agr) that border it on the east appear to be gradational. It seems probable that the fluorite granite is a late phase of this granite (Agr).

Martell intrusions (AM)

Pyroxene syenite (AMy)

All but one of the several bodies of pyroxene syenite mapped are in gneissic or granitic terrane in the southern half of the map area. Most are exposed on vertical scarps which, in the larger bodies, attain a height of 7 to 10 m and form the boundaries of drift covered, stepped terraces. Vertical joint sets and subhorizontal sheet joints are well developed as is a subhorizontal lineation defined by orientation of the mafic minerals. These features are characteristic of sheets or sills of shallow dip.

The largest body of syenite, which trends northeasterly from the north side of Fractal Lake, is about 6 km long and 2 km wide. Individual exposures are more than 100 m long. The body is surrounded by granitic and migmatic gneisses which trend northeasterly to easterly. Uniform and distinctive in appearance, the syenite is typically pink to reddish, medium grained, massive to lineated, and composed of poorly twinned, perthitic microcline (75-95%), mafic minerals (5-20%), chiefly augite which is rimmed by minor blue-green amphibole. Accessory minerals are oligoclase, biotite/phlogopite, sphene, apatite and opaques. All the minerals are fairly fresh.

Isolated occurrences of syenite are generally similar in appearance and modal composition to that of the Fractal Lake body. Syenite occurrences east of Tybach Lake are, however, locally more siliceous. Three of these, situated within 3 km of the lake, include rocks composed mainly of quartz (10-20%), microcline and/or orthoclase (60%) and albite (20%), augite (2%), biotite (2%) and muscovite (1%). Trace amounts of sphene, apatite, zircon, carbonate, and opaque minerals including magnetite and pyrite are also present. Minor alteration of biotite to chlorite, and clinopyroxene to blue-green amphibole is evident.

One of the Tybach Lake bodies is a dyke that strikes about 335° and dips steeply to vertical. The walls are drift covered but the thickness is at least 60 m and the exposed length is at least 100 m. Cross joints, presumed to be normal to the walls, dip 45° to the northwest and to the southeast. Dykes of pink, very coarse grained pegmatite grading to coarse grained granite, up to 35 cm in thickness occupy some of the joints.

Contacts between the syenite and rocks of other map units are not exposed. However the form of the syenite bodies relative to the surrounding gneises (An), the lack of significant granitic contamination, and the absence of appreciable cataclasis of the component minerals, all suggest that the syenites postdate not only the strata of the 'Woodburn Lake Group' and derived gneisses but also the younger granites (Ag, Af) and possibly also postdate the principal deformational events that affected the other rocks in the map area.

Lamprophyre dykes (AMl)

Only one lamprophyre dyke was found. The dyke, which intrudes argillaceous metasediments (AWl) northwest of Farside Lake, is 3 m thick, strikes north and is vertical.

The lamprophyre is dull grey to brown, weathering mottled grey to brown, fine- to medium-grained and porphyritic. It is composed of quartz (less than 5%), K feldspar rimmed by minor sodic plagioclase (60%), biotite or phlogopite (10%) as phenocrysts 1 to 2 mm in diameter containing rutile, clinopyroxene (1%), ragged amphibole (almost 20%), accessory apatite, and (3-5%) opaque(s).

Lamprophyre dykes and syenite intrusions, which are very common in central District of Keewatin, and especially in the region southwest of Baker Lake, belong to the Martell intrusions of late Aphebian age (Donaldson, 1965, 1966). The mineralogy, chemistry and genesis of these rocks are the focus of current studies (LeCheminant and LeCheminant, 1985, and personal communication, 1986) in which the lamprophyre dykes are regarded as the first products of the magma from which the syenite intrusions originated.

METAMORPHISM

Evidence of metamorphism is found in all rocks except the granites (Ag, Af) and syenite intrusions (AM). Mineral assemblages are characteristic of facies ranging from subgreenschist to granulite, and low to intermediate pressures.

Mineral associations in the 'lower' part of the Woodburn Lake Group include:

Intermediate to basic metavolcanics (AWb, AWi):
- andesine-hornblende-clinopyroxene-epidote-sphene
- quartz-andesine-biotite-hornblende-epidote-sphene
- quartz-K feldspar-albite-muscovite-epidote

Pelitic rocks (AWp):
- quartz-muscovite-biotite-andalusite-sillimanite-garnet-tourmaline
- quartz-muscovite-biotite-cordierite
- quartz-biotite-cummingtonite-garnet
- quartz-oligoclase-biotite-garnet
- quartz-oligoclase-muscovite-biotite-tourmaline

Metagreywacke (AWw):
- quartz-K feldspar-plagioclase-muscovite-biotite-epidote-sphene
- quartz-andesine-biotite-hornblende-epidote

Calc-silicate rocks (AWr):
- oligoclase-hornblende-cummingtonite-actinolite-clinopyroxene-epidote-sphene

Iron-formation (BIF):
- quartz-biotite-apatite-magnetite
- quartz-hornblende-epidote-apatite-magnetite
- quartz-carbonate-apatite-magnetite

Associations in rocks of the 'upper' part of the Woodburn Lake Group include:

Quartzite (AWq):
- quartz-fuchsite-biotite-sillimanite-sphene
- quartz-muscovite-kyanite-tourmaline

Metagreywacke (AWk):
- quartz-andesine-biotite-hornblende

Calc-silicate rocks (AWc):
- albite-hornblende-sphene
- oligoclase-phlogopite-actinolite-diopside-epidote-sphene

Mineral associations in granulite (Ah) include:
- quartz-perthitic microcline-antiperthitic oligoclase-muscovite-biotite-sillimanite-cordierite-garnet-spinel
- quartz-labradorite-biotite-hypersthene
- quartz-antiperthitic andesine-biotite-hypersthene
- antiperthitic labradorite-biotite-clinopyroxene-hypersthene
- quartz-perthite-antiperthitic andesine-biotite-hypersthene
- quartz-perthite-antiperthitic andesine-biotite-hypersthene-garnet
- quartz-perthite-antiperthitic andesine-biotite-hornblende-hypersthene-garnet
- quartz-perthite-antiperthitic andesine-biotite-hornblende-clinopyroxene-hypersthene
- quartz-orthopyroxene-magnetite

Metamorphic grade in the volcanics of the 'lower' part of the Woodburn Lake Group is that of greenschist to amphibolite facies. Greenschist assemblages are most common in the highly sheared strata of the Farside Lake region. Near contacts with intrusive granite volcanic strata may be recrystallized to medium- to coarse-grained amphibolite or to fine grained, dense amphibolitic hornfels, both of amphibolite facies grade.

The pelitic metasediments (AWp) associated with the volcanics clearly indicate metamorphism under lower to middle amphibolite facies conditions. The association of sillimanite and andalusite, if stable, would indicate pressures less than that of the aluminosilicates triple point. Metamorphic conditions recorded in metasediments of the 'upper' part of the Woodburn Lake Group range from those of the subgreenschist facies, as shown by the widespread occurrence of phyllite and phyllitic slates interbedded with quartzite at Farside and Mislay Lakes, to amphibolite facies, as indicated by sillimanite in quartzite near Fractal Lake and diopside in calc-silicate rocks near Tybach Lake. Kyanite in quartzite north of Farside Lake, presumably formed therefore at temperatures typical of greenschist or subgreenschist metamorphism and at relatively low pressures. Both 'lower' and 'upper' successions locally exhibit features characteristic of contact metamorphism.

Migmatitic gneisses (Anm) that underlie much of the central and eastern parts of the map area may be assumed to have formed under upper amphibolite facies conditions. The granulite facies rocks appear to have developed as a prograde transition northward from the gneisses. The assemblage containing sillimanite, cordierite, garnet and spinel, which occurs along the southern margin of the granulite terrane near Hermann River, is thus interpreted as stable in the lower temperature, and also perhaps in the lower pressure, zones of the granulite facies. The common association of biotite and hornblende is also characteristic of low temperature granulite. Plagioclase in the granulites (Ah), whether hypersthene-bearing or not, is almost invariably antiperthitic. The bordering gneiss (An) as has been noted previously may also contain antiperthite. Sphene, by contrast, is not found in any of the granulites but does occur in the gneisses.

Secondary alteration, although not ubiquitous, is found in rocks of all map units and is most noticeable in the mafic minerals, which may be replaced entirely or in part by chlorite, blue-green amphibole, epidote, serpentine, and carbonate. These minerals are not considered to be the products of a general retrograde metamorphic event but rather are associated with local cataclasis and/or, in intrusive rocks, with deuteric action. In rocks of basic or ultrabasic composition alteration may be linked with proximity to younger granitic intrusions.

Local contact metamorphic effects in metasediments and metavolcanics near granite contacts suggest that the main phase of metamorphism and granite emplacement may be of comparable age. Metamorphism apparently predates the mylonite that postdates the granite.

STRUCTURE

Evidence of deformation may be found throughout the map area and in rocks of all map units except the Martell syenite intrusions (AM). The dominant structural feature is a steeply to gently inclined foliation, defined by platy mineral orientation and by compositional layering. The foliation trends mainly easterly to northeasterly but regional and local variations in trend are numerous. In the region lying between Woodburn Lake and Hermann River trends are northerly, and in the northeastern granulite terrane foliation trends are commonly east to southeasterly. Foliation crudely parallels major geological contacts but in many places is more closely aligned with the strike of nearby faults.

Small scale secondary structures also include minor folds, lineations and kink bands. Crenulations on cleavage surfaces in quartzite and phyllite at Farside Lake and axes of small isoclinal folds in banded iron-formation near Farside Lake and north of Tehert River, commonly plunge southeasterly to southerly at angles of 30 to 55°. The axial planes of folds in the iron-formation are parallel with the bedding attitudes of the host metasediments, striking easterly and dipping about 55° in a southerly direction. Kink bands in phyllite near Farside Lake indicate an axis of principal stress oriented south-southeast.

Major folds in Woodburn Lake strata in the Farside Lake region, as might be expected from the small scale structures, are apparently isoclinal or almost isoclinal with axes that plunge southeast, and axial planes that dip south to southeasterly. The homoclinal sequences near Tehek Lake, Tehert River, and those near Tybach and Mislay lakes may also be part of major isoclinal fold structures with axial planes that dip south to southeasterly. Large folds in the northeastern granulite terrane have shallow plunges to the east and to the west, and steep to vertical axial planes.

An early episode of deformation may have preceded the main (isoclinal) folding. The distribution of lithologies in the metavolcanic sequence at Farside Lake, particularly that of the banded iron-formation, does not exhibit marked parallelism with the quartzite as might be expected if these formations had shared an identical deformational history. Furthermore a close spatial association of the 'lower' and 'upper' Woodburn Lake Group successions is not found in other parts of the map area, as for example in the regions near Tybach Lake, Mislay Lake, and Tehert River. The metavolcanics and related metasediments may therefore have been (gently?) folded and eroded prior to deposition of the quartzite and associated shallow water sediments. The apparent conformity observed between these two successions at Farside Lake would then be largely due to the masking effect of subsequent deformation.

Faults displace the fold structures as well as the granitic intrusions (Ag, Af) which are possibly associated with fold genesis. No faults are known that intersect the Martell syenite intrusions (AM). Most of the faults strike north to northwesterly; a few strike easterly to northeasterly. Northwesterly and northerly trending faults in the Mislay Lake, Fractal Lake, and Meadowbank River regions are transverse to the strike of the metavolcanics and metasediments but only in the latter two regions is it possible to measure parameters of displacement.

The northward trending fault near the east end of Fractal Lake having a horizontal, sinistral separation of about 5.5 km juxtaposes metavolcanic-metasedimentary terranes of contrasting lithology, which implies an appreciable dip-slip component of movement. Assuming the fault to be vertical or near vertical and the displaced strata to dip 35° south, and the faulted blocks not to have been appreciably deformed, the minimum value of slip, calculated for the direction normal to bedding, would be about 3 km, the east block having moved downward. The magnitude of net slip is unknown.

The fault that trends north along Meadowbank River has a horizontal dextral separation of about 3.5 km. The east side has obviously risen relative to the west side, but the inconsistency of bedding attitudes on either side of the fault precludes meaningful estimates of slip.

The east to northeasterly trending strike faults that displace the metasediments at Tybach and Mislay lakes are of two kinds. Faults of the first kind may be interpreted as thrusts on which movement was directed to the north or northwest. These faults, which are traced by cataclastic effects in the metasediments and in the country rocks, border the homoclinal successions on the up dip and down dip sides and possibly occur also within the successions as suggested by the occurrence of shallow dipping, strongly sheared muscovite quartzite within massive quartzite (AWq). The strike faults are apparently terminated along strike by the northwesterly trending transverse faults which separate the metasediments from the surrounding gneisses. Similar thrusts may be associated with isoclinal folding at Tehert River, Fractal Lake, and Farside Lake, and with the mylonite belt east of Meadowbank River. If the interpretation of thrusting is correct, part or all of the migmatitic gneiss (AWm), at present included in the Tybach and Mislay platform deposits, is probably allochthonous and therefore more appropriately included with the gneisses and migmatites (An).

East to northeasterly trending faults of the second kind are marked by strong topographic linear depressions. These are tentatively assumed to be high angle normal faults which would have been active following the cessation of thrusting. Repetition of marker horizons in the Mislay Lake succession is attributed to movement (north side down) on these faults.

The widespread occurrence of cataclastic rocks suggests that faults are more numerous than indicated on the map. Long straight lineaments discernible on air photographs may also indicate faults. The Meadowbank Fault, projected by Heywood and Schau (1978) to pass westward through the Woodburn Lake map area near latitude 65°30'N could not be recognized in the field, perhaps because bedrock exposures in this region are scarce. The strong discontinuity in the magnetic pattern along latitude 65°30'N, however, suggests the existence in this region of a major fault with a significant strike slip and/or dip slip component.

Mylonite zones are found east of Meadowbank River and in the northwest corner of the map area. The mylonite near Meadowbank River clearly postdates the granite (Agr) in that region. Mylonite in the northwest is an extension of the Amer mylonite zone (Tella and Heywood, 1978). This zone predates deposition of the Aphebian Amer Group but also records dextral strike-slip displacement that may be as young as 1.7 Ga (Tella, 1983).

AGE AND CORRELATION

The oldest rocks in the map area are those of the granulite complex (Ah) and those of the Woodburn Lake Group (AW) which on lithological grounds are inferred to be correlative, at least in part. Zircon from granulite northeast of Woodburn Lake gives U-Pb concordia intercepts of 2662 +78/-53 Ma and 1746 +86/-83 Ma. Although these are preliminary results they apparently represent magmatic and metamorphic zircons both of which perhaps formed beween 2680(?) Ma and 2620(?) Ma (W.D. Loveridge, personal communication, 1986).

Absolute ages for the Woodburn Lake Group are also provided from the dating of correlative rocks in other map areas. Dacite porphyry in the Amer Lake map area, assumed to be correlative with metavolcanics of the Woodburn Lake Group, has yielded a zircon U-Pb age of 2798 +24/-21 Ma (Tella et al., 1985a). Also, strata of the Woodburn Lake Group are in many respects similar in lithology to those of the Prince Albert Group, exposed in northern District of Keewatin (Heywood, 1967; Schau, 1982). Using zircon ages determined from acid volcanics, from derived gneisses, and from inferred basement geisses, Schau (1982) concluded that rocks of the Prince Albert Group are probably between 2700 and 3000 Ma in age.

A minimum age of 2605 Ma for the Woodburn Lake Group was obtained from intrusive granodiorite in the Amer Lake area (Ashton, 1985). Granitic rocks (Ag) which intrude strata of the group in the Woodburn Lake map area are probably late Archean also.

Mylonite (An) in the northwest corner of the map area extends southwestward into the Amer mylonite zone. (Tella and Heywood, 1978; Tella, 1983). Zircon from this zone has given an age of 2598 (S. Tella, personal communication, 1985).

The youngest rocks mapped are the pyroxene syenite intrusives (AMy). A syenite intrusion in the Amer Lake map area has yielded a zircon U-Pb upper concordia intercept age of 1850 +30/-10 Ma (Tella et al., 1985b). Similar syenite intrusions in the Woodburn Lake map area are assumed to be of comparable age.

The Woodburn Lake Group and the granite (Ag) are therefore late Archean and the pyroxene syenite (AMy), late Aphebian. The metamorphism of the granulite complex and the metamorphism of the Woodburn Lake Group are also late Archean.

ECONOMIC GEOLOGY

The Woodburn Lake map area is a part of the Baker Lake region that in the past two decades has been actively explored for uranium and gold. Most of this attention has been focussed on the supracrustal rocks. At present no economic deposits are known to occur in the map area.

The most promising localities for gold exploration are probably those where sulphide minerals are most abundant. Sulphide seams and gossans occur in the metavolcanic rocks, the banded iron-formation of the 'lower' part of the Woodburn Lake Group, and in the beds of biotite-quartz schist and metagreywacke interlayered with quartzite and carbonate in the 'upper' part. Sulphide minerals are also found in gneisses near contacts with the supracrustal rocks. The following occurrences may be of use in outlining target areas for further search.

Brecciated intermediate metavolcanics (AWi) and fuchsite-bearing quartzite at 65°18'N, 95°27'W, north of Fractal Lake, contain up to 2% (combined) chalcopyrite and pyrite as fracture fillings and fragment matrix. Within 20 m of younger intrusive granite, volcanic fragments are rimmed by epidote and chlorite and contain secondary malachite.

Small gossans in metavolcanics at 65°03'N, 95°57.5'W, southwest of Farside Lake are intruded by quartz veinlets containing as much as 1% disseminated pyrite.

A gossan in banded iron-formation at 65°12.5'N, 95°50'W, north of Farside Lake, contains seams of pyrite and chalcopyrite. Sulphides were also noted in banded iron-formation at 65°22.5'N, 95°15'W, southeast of Woodburn Lake.

Pyritic seams or zones occur at various horizons in the 'upper' Woodburn Lake Group section at 65°07.5'N, 94°49'W, east of Tybach Lake. Two such seams can be traced sporadically in beds of metagreywacke and biotite-quartz schist along a strike distance of about 60 m. The beds, which are about 1.5 m thick, are intercalated with quartzite that underlies carbonate strata. The metagreywacke bed which separates this carbonate from the overlying migmatitic gneiss is also pyrite-rich.

Disseminated pyrite is found also in quartzite at the contact with granodiorite at 65°07'N, 94°38'W, northeast of Mislay Lake.

The radioactivity of all specimens collected during routine mapping was tested by scintillometer. None indicated a uranium content significantly greater than background.

Banded iron-formation occurs at many localities but is generally poorly exposed. Beds range from 1 to 3 m in thickness and may contain from 10 to 40% (by volume) magnetite. Neither the number of stratigraphic horizons at which iron-formation occurs nor the persistence of individual beds along strike is known. Consequently it is not possible at present to comment on the feasibility of profitable recovery.

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