The Deformational History of the South Central Portion of the Munro Lake Greenstone Belt, Northern Manitoba.

by

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

Master of Science

ABSTRACT

The rocks of the Gods Lake Subgroup and the overlying Knee Lake Subgroup have undergone a complex structural history in the south-central portion of the Munro Lake greenstone belt of northern Manitoba.

During D_1 a strong tectonic foliation (s_1) was developed by recrystallization, clasts (dc_1) were flattened parallel to the s_1 foliation plane, and minor shear folds (f_1') were developed in bedding (s_o) with the s_1 foliation axial planar to them. The deformation during D_1 may have been the result of pure shear accompanied by recrystallization and followed by passive slip (simple shear) or it may have been the result of simple shear accompanied by recrystallization and a minor component of flattening (pure shear).

Flexural slip folding of bedding (s_o) and foliation (s_1) occurred during the second period of deformation. Foliation was the active surface in this deformation. At least two orders of flexural folds (f_2', f_2'') are associated with D_2. Deformed clasts (l_2) and mullions (m_2) are are second event b-lineations and plunge parallel to the f_2' fold axes.

The third period of deformation resulted in gentle folding about an axis approximately perpendicular to the earlier axial planes. This caused a slight reorientation of D_2 linear structural elements and folding of bedding and foliation where they are subhorizontal.

The fourth period of deformation was a period of minor faulting which displaces the earlier structural elements.

The mode of origin of the Munro Lake syncline is open to speculation. It may have formed during the first or second period of deformation documented within the study area.

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CHAPTER I

INTRODUCTION

Statement of Problem

This study presents an interpretation of the deformational history of the south central portion of the Munro Lake greenstone belt of northern Manitoba. The analysis includes an interpretation of the character, geometry, and strain of each of the superimposed deformational events that have been recognized in the area.

Location and Access

The study area, centered about Lake "X", covers 30 square kilometers on the southern flank of the Munro Lake greenstone belt. The area is approximately 480 kilometers north-northeast of Winnipeg (Figure 1). The area is accessible by charter flights from Thompson, Ilford, and Gods Lake Narrows. It is also connected to Gods Lake Narrows by a canoe route.

Previous Work

Regional mapping by Wright in 1931-32 first indicated the

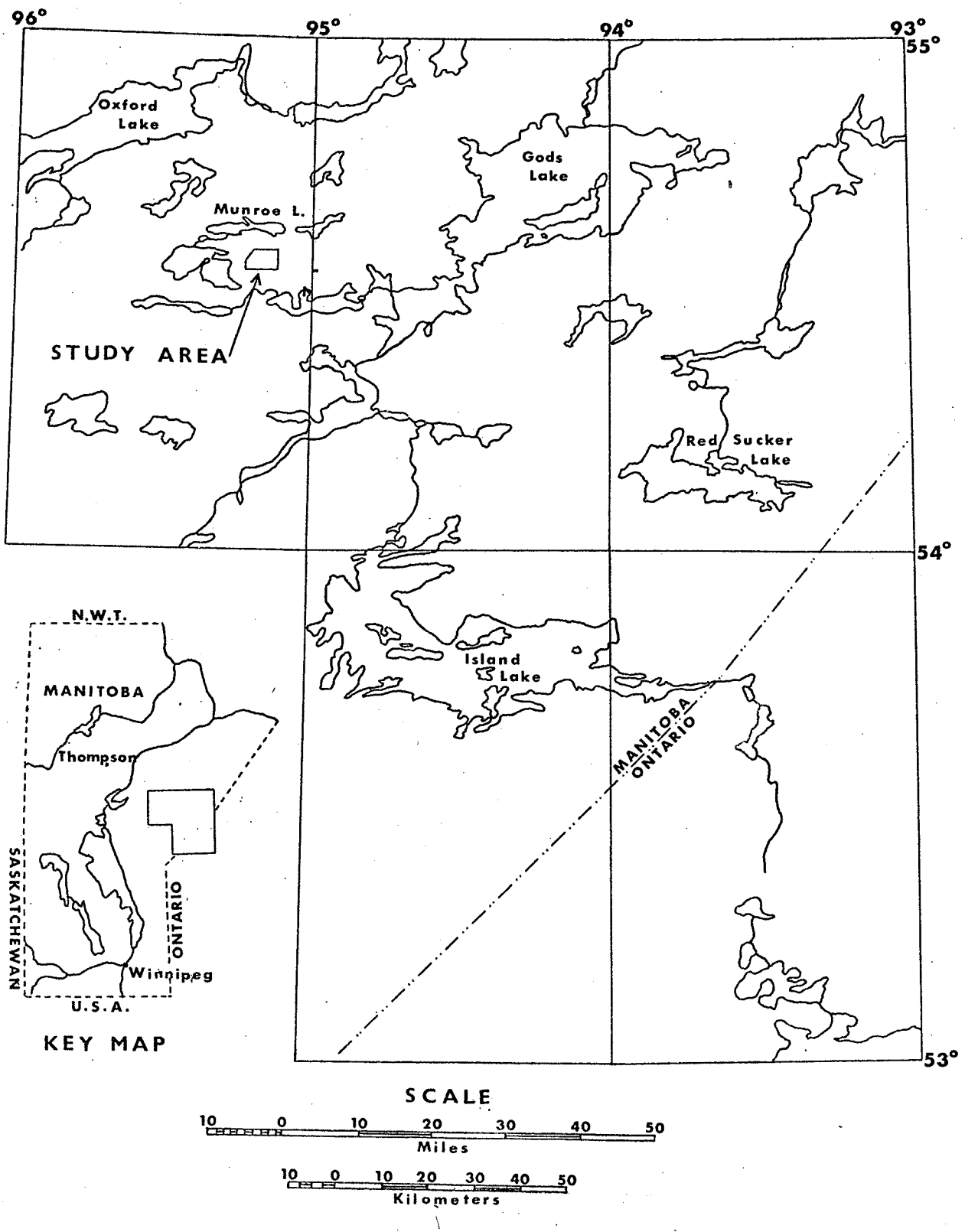

Figure 1. Location of area of study.

presence of a greenstone belt in the Munro Lake area (G.S.C. Map 305A, 1:253,440). A regional compilation by Quinn in 1956, at a scale of 1: 253,440, also covered the area. In 1960, Barry mapped a 30 minute map sheet (53L/11 east), at a scale of 1:63,360, that encompasses the present area of study.

Present Work and Acknowledgements

This study represents the results of 10 days of field work carried out during July of 1972. The shoreline of Lake X and Reekie Lake was mapped at a scale of 1:31,680 using aerial photographs for control. Four inland traverses were conducted using the pace and compass method. Most of the structural data was obtained along the shoreline where exposure quality was better.

The field mapping was carried out while employed as a senior geological assistant by the Manitoba Department of Mines, Resources and Environmental Management. The writer would like to acknowledge the excellent advise and assistance provided by Dr. W.C. Brisbin (University of Manitoba), Dr. F.J. Elbers (Manitoba Mines Branch), and Dr. A.C. Turnock (University of Manitoba). Much help was received from junior assistants G. Witcher and E. Hasiuk (Brandon University) and K. Schmidt (University of Manitoba).

CHAPTER II

GENERAL GEOLOGY

Regional Geology of the Munro Lake Greenstone Belt

The Munro Lake greenstone belt is an easterly trending greenstone belt in the northwestern part of the Superior structural province of the Canadian shield. The belt is 20 kilometers long and has an average width of 6 kilometers. The greenstone belt consists of rocks of the Gods Lake Subgroup and the overlying Knee Lake Subgroup, both of which form a portion of the Hayes River Group (Elbers and Gilbert 1972a).

Structure

Barry (1962), in a brief discussion of the structure of the Munro Lake greenstone belt postulated an anticline-syncline pair structure for the belt. He also indicated the possibility that the greenstone belt consists of a single syncline. On the basis of top determinations within the belt, repetition of units within the belt, and the basic to acidic metavolcanic sequence on the southern flank of the belt, the latter interpretation is favoured in this study. Bedding and foliation are almost invariably parallel, trend WNW-ESE parallel to the axis of the greenstone belt, and are generally steeply dipping.

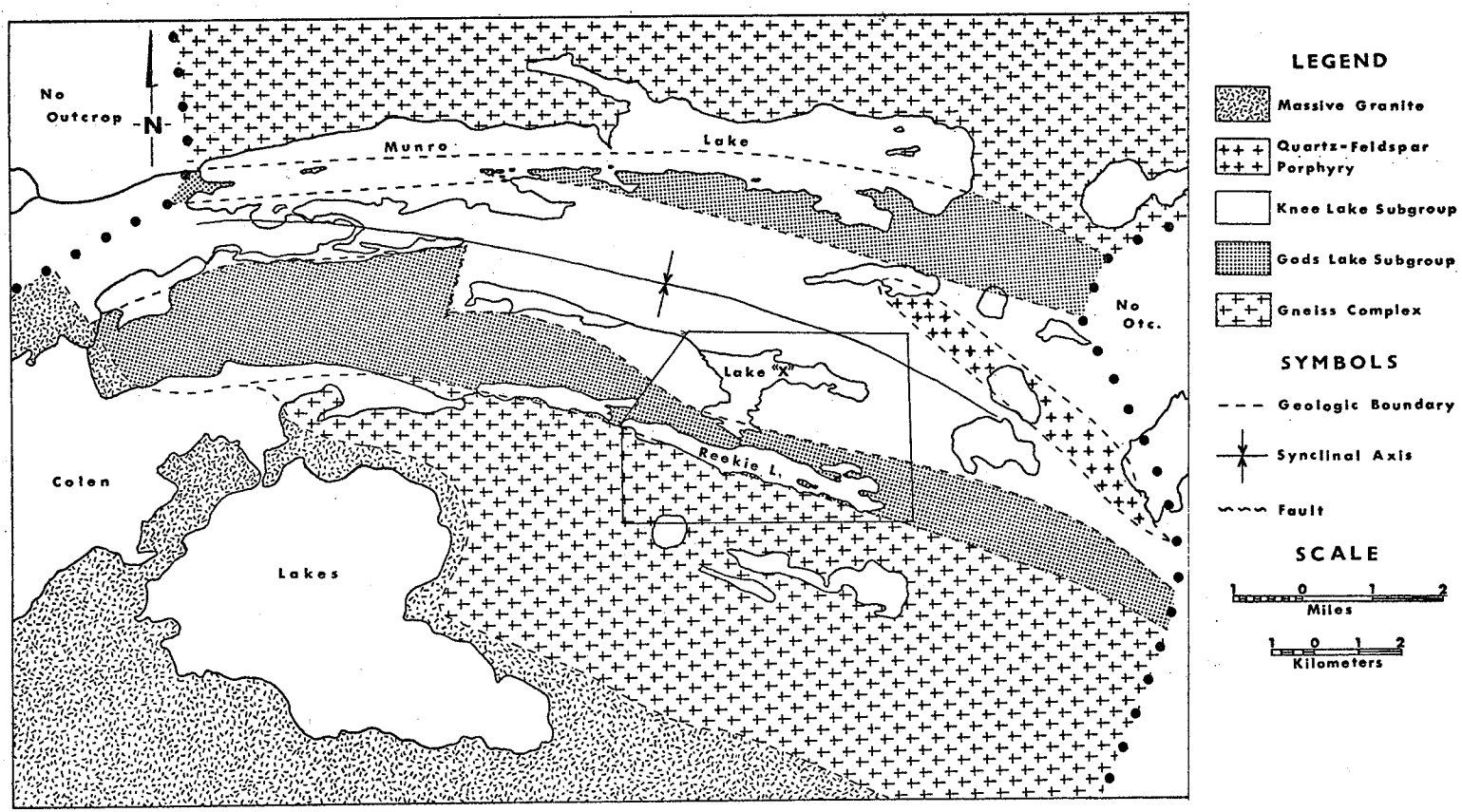

Figure 2 Geologic setting of the Munro Lake greenstone belt (after Elbers and Gilbert 1972). Box represents the area of study covered by Map 1.

Distribution of Rock Types

The Gods Lake Subgroup which consists of basic metavolcanic rocks with a minor amount of acidic metavolcanic material, occurs along the northern and southern flanks of the greenstone belt (Figure 2). The Gods Lake Subgroup is overlain by the Knee Lake Subgroup consisting of a lower metasedimentary sequence overlain by basic metavolcanic rocks; the latter form the core of the Munro Lake greenstone belt. Metagabbro sills are common throughout all the rock types of the greenstone belt. Two occurrences of serpentinized ultramafic rocks were observed within the belt also.

The Munro Lake greenstone belt is bordered on the north and south by layered gneiss interlayered with amphibolite, which underly the rocks of the greenstone belt. The layered gneiss has the chemical composition of a tonalite. Along its southern boundary the greenstone belt is separated from the layered gneiss by a 10 to 25 meter wide unit of intercalated feldspathic gneiss, amphibolite and quartzite.

Quartz - feldspar porphyry veins and sills occur within the layered gneiss and also within the greenstones on the southern shore of Munro Lake. A 9 kilometer by 1 kilometer body of intrusive quartz-feldspar porphyry occurs within the eastern part of the greenstone belt.

Massive granite is intrusive into the area to the south and west of the greenstone belt. The granite is primarily intrusive

into the gneissic sequence but also cuts off the western end of the greenstone belt. Pegmatitic phases are common and are injected into the greenstone belt along the western contact.

Metamorphism

The metamorphic grade remains consistent throughout all the rocks of the area. Both the layered gneiss and the greenstones contain metamorphic mineral assemblages indicative of the lower to middle amphibolite facies (Elbers 1972b). Within the layered gneiss the assemblage consists of hornblende, oligoclase, epidote, sphene, biotite, and quartz. Within the greenstone belt, basic volcanic rocks and gabbro have been recrystallized to amphibolites; acidic metavolcanic and metasedimentary rocks contain garnet porphyroblasts; basic metasedimentary rocks contain cordierite, andalusite, and garnet porphyroblasts.

The Area of Study

The study area covers only a small portion of the southern flank of the Munro Lake greenstone belt (Figures 1 and 2). The study area includes the complete section across the southern limb of the Munro Lake syncline, from the layered gneiss in the south, to the basic metavolcanic rocks of the core of the syncline in the north. The relationships between the different rock units of the area is given in the Table of Formations (Table 1). The petrology and the distribution of each of these rock units is discussed in the following section.

TABLE I

TABLE OF FORMATIONS

RECENT AND PLEISTOCENE		silt, clay, sand, gravel
		UNCONFORMITY
PRECAMBRIAN		Post Knee Lake Intrusive Rocks *(5b) Metagabbro *(5a) Serpentinized ultramafic rocks
		INTRUSIVE CONTACT
	HAYES RIVER GROUP	Knee Lake Subgroup *(4d) Massive and pillowed metabasalt (4c) Metagraywacke, meta-argillite, metasiltstone; minor cordierite gneiss and metagabbro (4b) Intraformational pebble metaconglomerate (4a) Meta-argillite metagraywacke; minor metabasalt and metagabbro
		Gods Lake Subgroup *(3b) Massive metabasalt; minor pillowed metabasalt, basic metatuff and metagabbro *(3a) Basic metatuff; minor metabasalt, metagabbro, metagraywacke and quartzite
		Contact Unit (2) Feldspathic gneiss, amphibolite, and quartzite
		Gneiss Complex (1) Layered gneiss with amphibolitic interlayers

*Age relations not definite due to interbedding

Description and Distribution of Rock Types Within the Study Area

Gneiss Complex

Layered Gneiss (1) - distribution of rock types is shown on Map 1.

Layered gneiss occurs in the southernmost portion of the study area. The gneiss is well layered and weathers buff-white, grey, and pink (Figure 3). Individual layers range from 5 centimeters to 50 centimeters thick and are emphasized by differential weathering. In places the gneiss is interlayered with amphibolitic layers. A strong foliation is present characterized by the alignment of mafic minerals, especially biotite. In places the plagioclase grains also exhibit a preferred orientation. Layering and foliation are parallel.

Contact Unit

The boundary between the Munro Lake greenstone belt and the underlying gneiss complex is exposed along the southern shore of Reekie Lake. A 10 to 25 meter wide contact unit consisting of interlayered feldspathic gneiss, amphibolite, and quartzite occurs between the gneisses and the greenstones. This unit is neither part of the gneiss complex nor part of the greenstone belt.

Feldspathic Gneiss, Amphibolite, and Quartzite (2)

The contact unit consists of feldspathic gneiss, amphibolite,

and quartzite. All these rock types are found invariably as a layered sequence where the contact between the gneiss complex and the greenstone belt is observed. The layering within the contact unit is conformable with layering within the gneiss complex and bedding within the metatuffs of the greenstone belt. The feldspathic gneiss weathers light to dark grey, the amphibolite weathers dark grey-green to black, and the quartzite weathers pinkish or greenish white (Figures 4 and 5). All of the rock types within the contact unit are fine grained. Layering within the unit ranges from 5 centimeters to several meters in thickness. Foliation is well developed in all of the rock types of the unit and is parallel to the layering. Within the feldspathic gneiss the foliation is produced by the alignment of hornblende grains and minor biotite wrapping around the larger feldspar grains with some weak alignment of the feldspars. In the amphibolite the foliation is due to the preferred orientation of hornblende. In the quartzite the foliation is produced by the preferred planar orientation of muscovite and minor biotite.

Gods Lake Subgroup

The Gods Lake Subgroup is a metavolcanic unit consisting primarily of basic metatuff and metabasalt. Within the study area the basic metatuff is found at the base of the Gods Lake Subgroup. However, there is considerable intercalation and large scale intertonguing of the metatuff and metabasalt (Map 1 in pocket). Therefore the metatuff and metabasalt are interpreted to be essentially of the same age and origin.

Basic Metatuff; Minor Metabasalt, Metagabbro, Metagraywacke, and Quartzite (3a)

The southern margin of the Munro Lake greenstone belt, adjacent to the contact zone, consists of metamorphosed basic tuffs with minor amounts of metabasalt, metagabbro, and metagraywacke. Close to the southern contact of this unit a few thin beds (3 centimeters to 35 centimeters thick) of quartzite are interbedded with the basic metatuffs (Figure 6). Typically the metatuffs weather dark grey-green and have a very massive appearance. On the fresh surface they are impossible to differentiate from basic metavolcanic flows. On the weathered surface the layered character of the rocks is indicated by differential weathering, variations in weathering colour, concentrations of lapilli, hornblende rich layers and changes in grain size. The layering has been interpreted to be bedding. The bedding ranges in thickness from 2 millimeters to 50 centimeters (Figure 7). A strong foliation, produced by the preferred planar orientation of hornblende crystals, is observed parallel to the bedding. In some massive outcrops the pyroclastic nature of the rock is indicated by the presence of fragments which have been interpreted as lapilli and volcanic bombs. One outcrop on the southwestern shore of Lake "X" contained some agglomerate.

Generally the metatuffs are very fine grained, massive, and basic in composition. They consist of hornblende and epidote with smaller amounts of plagioclase, quartz, and calcite. Basic crystal metatuff is the dominant rock type of the unit with minor amounts of basic lapilli metatuff and basic agglomeritic metatuff. Isolated

occurrences of metagraywacke indicate that some reworking of the tuffaceous material possibly took place. Minor amounts of metabasalt and metagabbro are found throughout the unit.

Massive Metabasalt; Minor Pillowed Metabasalt, Basic Metatuff, and Metagabbro (3b)

This unit outcrops north of Reekie Lake. The metabasalt is very massive and weathers dark greenish grey. The rock consists of hornblende and plagioclase with quartz biotite, epidote, calcite, magnetite, and pyrite as accessory minerals.

A few outcrops of pillowed metabasalt are present along the northern shore of Reekie Lake. In all cases the pillows have been strongly deformed. Their present length to width ratios in horizontal exposures are as great as 20 to 1 (Figure 8). The long dimension of the pillows in a horizontal exposure is parallel to the well developed foliation of the rock. The foliation is produced by the planar preferred orientation of hornblende.

Minor amounts of metagabbro and basic metatuff are found throughout the unit. There is considerable intercalation of the basic metavolcanic flows and the basic metatuffs as well as large scale intertonguing of these two rock types north of Reekie Lake (Map 1 in pocket).

Knee Lake Subgroup

The Knee Lake Subgroup outcrops in the northern half of the study area. It consists of a lower metasedimentary sequence

overlain by a metavolcanic unit. A minor amount of metavolcanic material is included within the metasedimentary sequence.

Meta-argillite and Metagraywacke; Minor Metabasalt and Metagabbro (4a)

This unit trends WNW-ESE straddling the southern half of Lake "X". The southern part of the unit primarily consists of meta-argillite whereas the northern portion of the unit consists of interbedded feldspathic metagraywacke and mafic metagraywacke. A few isolated occurrences of metabasalt and metagabbro are observed throughout the unit. One sill of metabasalt (4d) of mappable extent occurs to the east of Lake "X" within the unit.

The argillaceous metasedimentary rocks of the southern part of this unit are very massive in character. They weather dark grey-green to black. Bedding is usually very difficult to discern and varies in thickness from 5 centimeters to several meters. Foliation is generally well developed in the meta-argillite by the preferred planar orientation of hornblende and chlorite.

Feldspathic metagraywacke, in which clastic feldspar grains are prominent on the weathered surface, is well bedded with individual beds ranging from 1 centimeter to 20 centimeters in thickness, weathers light grey, and contains graded beds which are consistent top indicators (Figure 10). Mafic metagraywacke which has a higher mafic mineral content than the feldspathic metagraywacke weathers darker grey with beds ranging from 5 centimeters to several meters in thickness.

Graded bedding is also observed within the mafic metagraywacke but is not as prominant. Foliation is very well developed within the metagraywacke by the planar preferred orientation of biotite, chlorite, hornblende, and muscovite.

Intraformational Pebble Metaconglomerate (4b)

A 100 meter thick unit of volcaniclastic pebble metaconglomerate outcrops 2 kilometers north of Reekie Lake. In the study area this unit forms a marker horizon within the metasedimentary rocks of the Knee Lake Subgroup. However, to the west of the study area, the metaconglomerate rests directly on the acid metavolcanic rocks of the Gods Lake Subgroup.

The metaconglomerate clasts are mainly of pebble and cobble size but smaller fragments grade down to the clay size of the matrix. Dark greenish grey basic metavolcanic clasts which are difficult to differentiate from the matrix are the most common. Clasts composed of metagabbro, acidic metavolcanic rocks, fine-grained metagraywackes, gneiss, and pure white quartz are also observed. Virtually all of the clasts have been deformed to triaxial ellipsoids with their long and intermediate axes parallel to the plane of the foliation. The foliation is produced by the planar preferred orientation of hornblende in the matrix as well as the preferred orientation of minerals in the clasts. Depending upon composition, the dimensional ratios (x:y:z) of the clasts range from 4:2:1 for the gneissic clasts or acid metavolcanic clasts to 15:5:1 for the more deformed basic metavolcanic clasts.

The matrix of the metaconglomerate generally makes up from 20 to 40 percent of the rock. The argillaceous matrix weathers dark greenish grey and can very easily be mistaken for a metavolcanic rock. It consists of mafic rock fragments, detrital feldspar and quartz, and hornblende, epidote, and carbonate. Beds of massive grey-green meta-argillite are contained within the metaconglomerate and are very similar in appearance to the matrix.

Metagraywacke, Meta-argillite, and Metasiltstone; Minor Cordierite Gneiss and Metagabbro (4c)

This unit trends WNW-ESE straddling the northern half of Lake "X". The southern portion of the unit consists of interbedded metagraywacke, metasiltstone, meta-argillite, and minor cordierite gneiss (Figure 10). The meta-argillite and metasiltstone are thin bedded (1 centimeter to 10 centimeters thick) and weather buff brown to dark grey-green. The rocks are well foliated due to the preferred planar orientation of hornblende and biotite. Meta-argillite with some metasiltstone is always found above (to the north of) the volcanoclastic pebble metaconglomerate (4b). Massive poorly bedded dark grey-green meta-argillite is also found within the metaconglomerate unit.

Cordierite gneiss occurs in two outcrops on the south shore of the east arm of Lake "X" as distinct bedded concentrations of cordierite nodules within the argillaceous metasedimentary rocks.

The nodules consist of single cordierite porphyroblasts and aggregates of cordierite porphyroblasts and often account for more than 50 percent of the beds. Individual nodules attain a size of up to 4 centimeters by 2.5 centimeters by 2.5 centimeters. Their resistance to weathering produces a distinctive knotty weathering surface (Figure 10). Inclusions of other minerals make up more than 50 percent of the individual poikiloblastic cordierite grains. The host rock is composed of biotite, actinolite, muscovite, detrital quartz and plagioclase, with secondary quartz and plagioclase, and minor epidote, calcite, magnetite, and pyrite. The nodules are ellipsoidal in shape and their long axes have a slight preferred orientation parallel to the foliation plane. The foliation, which is due to the planar preferred orientation of biotite, muscovite, and amphibole, wraps around the porphyroblasts.

Feldspathic metagraywacke and mafic metagraywacke occur within the northern portion of the unit as well as interbedded with the meta-argillite and metasiltstone to the south. The metagraywacke is well bedded with individual beds ranging from 2 centimeters to a few meters in thickness. The rock weathers grey and contains graded beds which are consistent top indicators. The metagraywacke has a well developed foliation produced by the preferred planar orientation of biotite, hornblende, and muscovite.

Massive and Pillowed Metabasalt (4d)

Massive and pillowed metabasalt of the core of the Munro Lake