REGIONAL GEOLOGY OF THE MICHIKAMAU LAKE MAP AREA, CENTRAL LABRADOR

by

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INTRODUCTION

1:100,000 mapping of the adjacent western corners of 1:250,000 NTS sheets 13E and 13L was commenced this summer and resulted in the completion of map areas 13E/13, 13E/14 and a part of 13L/3. These form the southern portion of a regional study located south and east of Michikamau Lake (now a part of the Smallwood Reservoir) which will be completed next year.

Access to the region is by tote road from Churchill Falls and crosses 13E/14. Mapping of the Michikamau Lake shore was performed by boat and that of the inland area by helicopter with some canoe and ground traverse backup. Exposure around the main lake shore, on several adjacent ridges, and around the edge and on islands within some of the inland lake basins is good. Inland, however, exposure is generally very poor and the terrain consists of an undulating plateau of extensive woodland with string bogs and moraine fields. Definition of geological contacts is therefore a major problem and many of those inland are very approximate.

PREVIOUS WORK

Early reconnaissance studies of parts of the area were made by Low (1895, 1897) and Thompson (1949, 1953) and were followed by Findlay (1957) and Sanderson and Jones (1958) who carried out follow-up studies to an airborne electromagnetic survey by the Labrador Mining and Exploration Company. Emslie (1964b, 1965, 1969, 1970, 1978) has extensively described the Michikamau anorthositic Intrusion which lies to the northwest of the area. A study of the metasedimentary units was included in this work (Emslie, 1970; 1978 and Emslie, in Wanless and Loveridge, 1978, pages 45-46).

The area is covered by the GSC 1:250,000 maps of Emslie (1964a) and Stevenson (1969) and also by a provincial compilation of the geology of Labrador at 1:1,000,000 by Greene (1972).

OBJECTIVES

The aims of the project were to elucidate the stratigraphy, structure and mineral potential of the area on a regional basis and in particular to:

(i) clarify the present confusion among the supracrustal sequences in the area;

(ii) map the extent of, and try to establish a stratigraphic and relative age framework for the Petscapiskau Group;

(iii) trace possible extensions of the Seal Lake Group westwards into the area in view of its potential for copper and uranium mineralization (Brummer and Mann, 1961; Gandhi and Williams, 1970; Marten and Smyth, 1975).

REGIONAL GEOLOGY

Previous work established the presence of three major lithological associations within the map area. A sequence of metamorphic rocks form the gneisses of the Churchill Province which are exposed in the northeastern part of the area. The igneous association is made up of two units of Helikian plutonic rocks; the Michikamau anorthositic Intrusion in the northwest and a granitoid suite that underlies much of the southern portion of the area. Throughout the area various poorly defined supracrustal sequences of possible Aphebian, Helikian and Hadrynian age constitute the third association.

The major sedimentary sequence in the area has been referred to as the Petscapiskau Group. This group was named by Emslie (1970) from Petscapiskau Hill in 23I/8 and applied to other small areas of metasediment adjacent to the Michikamau Intrusion in 13L/4 and 13L/5 and regarded as Paleohelikian in age. The sequence was described as including paragneiss, schist, quartzite, metatuff and amphibolite, and their contact metamorposed equivalents. It was assumed to rest unconformably upon the gneisses and to be intruded by both Helikian plutonic suites. Emslie (1978) extended the group to include similar sequences in 13L/3. He suggested a tentative division of the group into a lower meta-aluminous sedimentary succession, and an upper volcanic or tuffaceous division. These he respectively correlated with the Aphebian Moran Lake Group and the Paleohelikian Bruce River Group of Smyth *et al.* (1975, 1978).

Green (1972) has also suggested that a large area of metasediment, previously assigned to the Seal Lake Group by Stevenson (1969), in the north of 13E/14 and which is contiguous with Emslie's extension in 13L/3, might also be equivalent to the Petscapiskau Group.

Also reported from the area was a sequence of younger sediments which were varyingly attributed to the Cambrian (Low, 1897), the Hadrynian (Stevenson, 1969), the Neohelikian or Hadrynian (Greene, 1972) and the Upper Proterozoic (Emslie, 1970). These occur in the west of the area, mostly on islands in Michikamau Lake.

This summer's work indicates that the earliest rocks, the gneisses of the Churchill Province, consist of an orthogneiss component (1c) emplaced into supracrustal (1a) or mafic intrusive (1b) rocks. These rock types were deformed during the Hudsonian orogeny and are therefore Aphebian or older. The orthogneisses are intruded by Helikian granitoid rocks (3) and overlain by the Seal Lake Group (5).

The type areas of the Petscapiskau Group, as defined by Emslie (1970), were not visited this year. The extensions of the group described by Emslie (1978) in 13L/3 and suggested by Greene (1972) in 13E/14 have been found to be largely underlain either by a part of the pre-Hudsonian supracrustal terrain (1a) or by Helikian granitoid rocks (3) respectively. Small occurrences of sediment (2) have been found in the latter area which may be equivalent to the Petscapiskau Group in its type areas (Emslie, 1970). For the present, however, their age and correlation is uncertain.

The Helikian granitoid suite (3) underlies the major part of the area and has been divided into a number of phases. Other Helikian intrusives are respresented by the gabbros and ultramafic rocks (4) which occur on two islands in Michikamau Lake and belong to the Michikamau Intrusion.

The younger sediments (6) of the western part of the area (13E/13 west) are believed to be of Neohelikian age and are correlated with the Seal Lake Group (5) which is exposed on the eastern margin of the area (13L/3).

UNIT DESCRIPTIONS

Unit 1 - Churchill Province Gneisses

These occur in the northern part of the area, mostly in 13L/3. Two components constitute the unit: a paragneiss and basic intrusive

LEGEND

NEOHELIKIAN

7 Diabase dikes

6 **Red Beds:** Medium to coarse grained, crossbedded, gray and red subarkosic and arkosic arenites with interbedded fine grained yellow sandstones, red siltstones, pebble to boulder conglomerates and minor slate

5 **Seal Lake Group:** Fine grained metabasic rocks interbedded with massive gray feldspathic quartzites

PALEOHELIKIAN

4 **Michikamau Intrusion:** Massive mafic gabbros and ultramafics with layered gabbro and leucogabbro and dikes of hornblendite and graphic granite

3 **Plutonic Suite**

3a **Ptarmigan Gabbro?** Equigranular medium grained leucogabbro

3b **North Pole Brook Intrusive Suite:** Gray granodioritic to quartz monzonitic suite (see Thomas, adjacent area)

3c Gray, medium grained diorite, quartz diorite and quartz monzodiorite ± scattered K-feldspar megacrysts. Probably equivalent to North Pole Brook Intrusive Suite

3d Pink weathering, gray, medium grained, plagioclase porphyritic quartz monzonite with scattered K-feldspar megacrysts

3e Undifferentiated; predominantly pink or red, medium grained, K-feldspar megacrystic quartz monzonite and adamelllite. Gradational into 3c, 3d, 3f and 3g

3f K-feldspar megacrystic rich quartz syenitic and granitic variety of 3e

3g Fine to medium grained, pink or buff predominantly non-porphyritic granites. Mostly strongly deformed

3h Fine to medium grained, pink, red and orange microgranites. Some porphyritic, many miarolitic and subaplitic

3i **Shabogamo Intrusive Suite:** Subophitic textured fine to medium grained gabbro

3j **Shabogamo Intrusive Suite?** Coarse grained plagioclase porphyry

Gabbro sheets (3i and 3j)

2 **Sediments of uncertain age:** Isolated outcrops and patches of dark gray cleaved or massive quartzite of unknown relationship to the plutonic rocks

APHEBIAN

1 **Churchill Province gneisses**

1a Massive, fine to medium grained, hornblende porphyroblastic amphibolites and metagabbros; fine grained, banded amphibolites; fine grained tuffaceous? and semipelitic? paragneisses and minor sillimanite quartzites

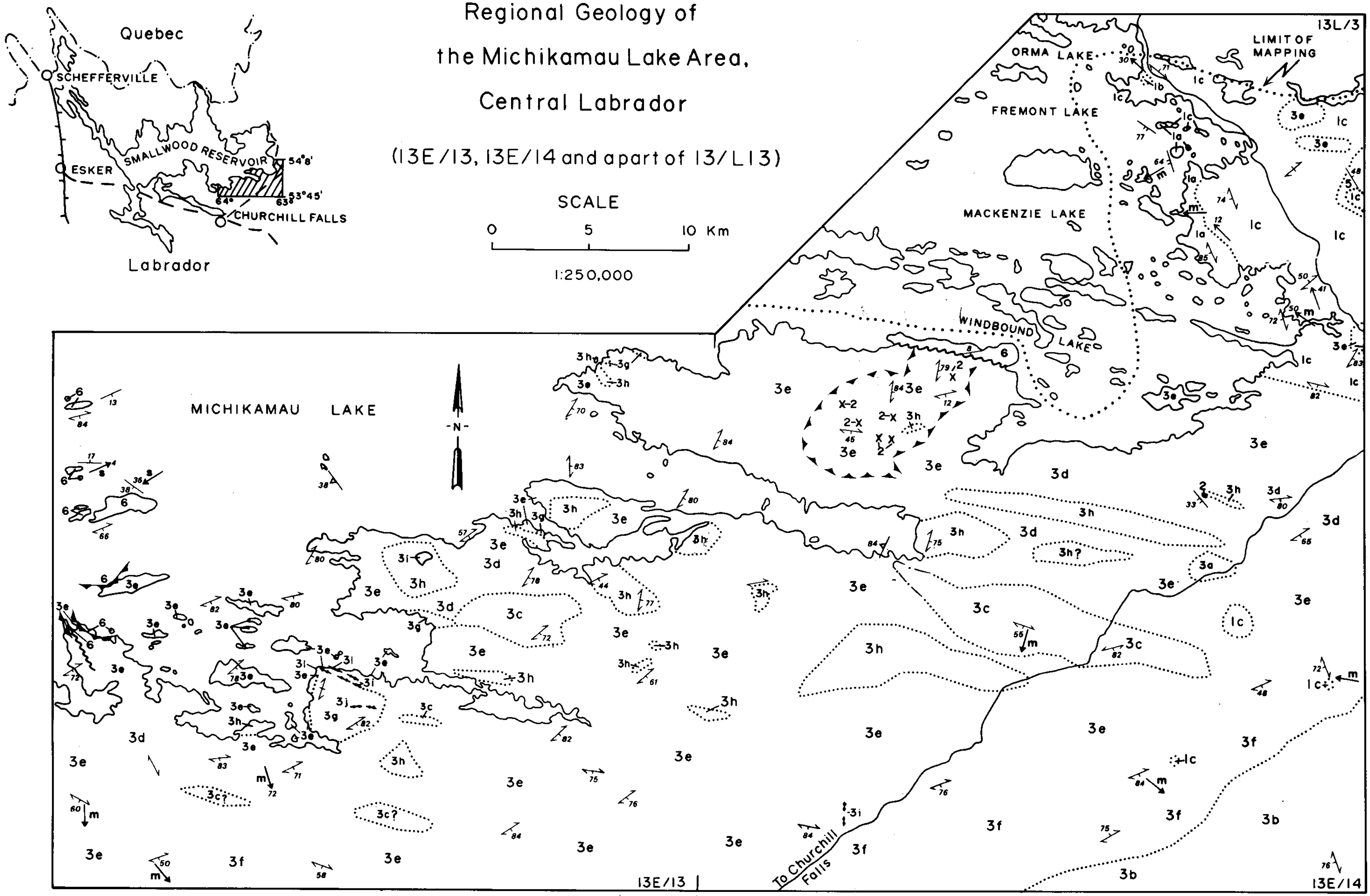
1b Massive, medium to coarse grained, hornblende porphyroblastic amphibolites and ultramafics ± relict layering

1c Dioritic, tonalitic and granitic orthogneisses of pre- and synkinematic intrusion into 1a and 1b

NOTE: Unit subdivisions are not chronological.

Regional Geology of the Michikamau Lake Area, Central Labrador

(13E/13, 13E/14 and a part of 13/L13)



association (1a, 1b) which was intruded pre- to syntectonically by a tonalitic to granitic plutonic suite (1c).

The main body of subunit 1a consists of concordantly interlayered banded amphibolites, tuffaceous and semipelitic paragneisses and minor sillimanite bearing quartzites which are intruded by massive amphibolites, locally containing relict igneous textures, and plagiophyric and amphibolite dikes. A small area north of Fremont Lake is composed of massive amphibolites and layered ultramafic rocks (1b).

The intrusive lithotypes represent a sequential plutonic event. This commenced with intrusion of hornblende-biotite tonalite into amphibolites and was followed by the sequential intrusion of early diorite, biotite $\pm$ hornblende tonalite (the most voluminous phase) and a later dioritic phase. This group was succeeded by a younger biotite-hornblende tonalite, an irregular, cream weathering felsic veining and a suite of crosscutting pink aplites, granites and pegmatites. The latter are probably coeval with granite and pegmatite net-veining seen in the small amphibolite/ultramafic body (1b). Amphibolite dikes cut the main tonalite and have been deformed with it. Much of this intrusive history has been established in a small area around Orma Lake but the early diorite and the main tonalite are recognizable in widely separate areas where exposure is good.

Orthogneisses also occur as inclusions in the plutonic suite in 13E/14 east.

Unit 2 - Sediments of Uncertain Age

This unit only occurs as a few isolated outcrops surrounded by unit 3. Those within the area of the thrust sheet in 13E/14 west are pale gray, feldspathic quartzites. The quartzites have been intercalated in imbricate fashion with tectonic slices of granitoid rocks. An exposure east of this locality, in 13E/14 east, is a massive, parallel laminated, dark gray quartzite.

Unit 3 - The Plutonic Suite*

This unit is a collection of variable plutonic lithotypes including gabbros and a range of intermediate to acid granitoid rocks. They are primarily grouped by spatial association and may belong to more than one intrusive episode.

An outcrop of leucogabbro (3a) is exposed by the roadside, in the centre of 13E/14 east. The gabbro is a medium to coarse grained equigranular aggregate of plagioclase with patches of disseminated ferromagnesian minerals. It is unlike other gabbros in the map area and has been provisionally correlated, on textural grounds, with the Ptarmigan Gabbro Suite of Thomas *et al.* (this volume) where its relationship to the surrounding granitoids is also uncertain.

A group of dioritic to quartz monzodioritic rocks (3b, 3c) outcrop in the southeast corner and across the centre of 13E/14, and as a number of smaller bodies throughout 13E/13. The diorite in the southeast (3b) is a gray-brown, medium grained rock and has only been observed at this one locality. The other rock types (3c) are white or gray plagioclase rich diorites and quartz diorites with elliptical clots of hornblende and biotite, minor amounts of pink intergranular, or gray porphyritic K-feldspar up to 0.5 cm in length, and color indices that are typically >10. Subunits 3b and 3c are correlated with

* Granitoid terminology used in this paper has been taken from the I.U.G.S. Subcommission recommendations, but is based on field identification only.

the more basic facies of the North Pole Brook Intrusive Suite in adjacent areas to the east (Thomas *et al.*, this volume).

Subunit 3c underlies topographically low-lying areas and lake basins with abundant lakeshore exposure, in contrast to subunit 3e which underlies higher areas, but is more poorly exposed. It is therefore possible to define the limits of subunit 3c more closely than the other members of unit 3. However, in outcrop the contact between 3c and 3e is usually either compositionally gradational or is marked by irregular changes in the K-feldspar megacryst content. The irregular changes take the form of dikes of 3e in 3c, of an interbanding, or of inclusions or schlieren of 3c in 3e. The inclusions may be the locus of magnetite concentrations.

The quartz monzonites (3e) contain similar proportions of palgioclase and K-feldspar, the former mainly as phenocrysts with scattered megacrysts and the latter as megacrysts and groundmass. Biotite is an additional phenocryst phase and the main primary ferromagnesian mineral. Hornblende is also present in some areas. Comspicuous magnetite grains, up to 7 mm across, are associated with the mafic minerals and may be locally concentrated.

The quartz monzonites (3e) are gradational into two other facies: 3d is a plagioclase porphyritic rock with minor indistinct K-feldspar megacrysts in a pink K-feldspar-quartz groundmass and probably ranges from quartz monzonite to quartz monzodiorite in composition; in contrast 3f contains an increased proportion of K-feldspar megacrysts and has a quartz syenite and syenite composition. Identification of 3f may be suspect in places due to reddening of plagioclase during deformation. 3d is abundant in northern areas of the plutonic suite while 3f is most common along the southern map boundary. These facies (3d, 3e, 3f) have a colour index of 2-8 and a quartz content of 10-25. Together they form the bulk of the suite in this map area.

In places fine to medium grained, commonly nonporphyritic granitic rocks are present (3g). These appear to be more quartz rich than the megacrystic rocks and are also more deformed, a feature which may obscure an originally porphyritic nature. The main plutonic phases are commonly cut by a suite of fine to medium grained granitic rocks (3h) ranging from small veins and dikes to large map-scale bodies. They are most abundant in the northwestern and northern parts of the unit. The medium grained parts of 3h are usually red or orange, recrystallized and contain scattered larger grains of quartz and feldspar. The microgranites may be miarolitic or seriate but are usually uniform, pink, and xenomorphic or sugary textured. Graphic granite or pegmatite dikes are associated with the aplites. Phases 3g and 3h have color indices of 0-2.

Fine to medium grained subophitic textured gabbros and leucogabbros (3i), which are correlated with the Shabogamo Intrusive Suite of southwestern Labrador (Wardle 1979c), are present in the southern and western parts of the map area within granitoid rocks of unit 3. They may be weakly banded or have a knobbly weathering texture due to grain size inhomogeneities. For the most part they occur as more or less tabular bodies and are presumed to be intrusive into the granitoid rocks. A body of similar tabular shape is a coarse (2-4 cm) plagioclase porphyry (3j) which occurs near the central eastern margin of 13E/13 west and is identical to the mafic porphyry of the Churchill Falls area (Unit 3, Wardle, this volume). This may also be associated with the Shabogamo Intrusive Suite.

Unit 4 - The Michikamau Intrusion

Lithologies belonging to this body were encountered on two small islands in Michikamau Lake in the northern part of 13E/13 east. They consist of layered leucogabbro and gabbro intruded by a hornblendite dike, successively overlain by massive mafic gabbros, ultramafic rocks and gabbros. The mafic gabbros show some rhythmic variation. The ultramafics and gabbros are characterized by orthocumulate plates of orthopyroxene enclosing clinopyroxene ± olivine and plagioclase cumulus phases. Biotite is an abundant accessory, also usually occurring as orthocumulate plates. In places the sequence consists of gabbro blocks in a finer grained gabbro matrix. Igneous lamination is poorly developed but rhythmic layering and truncations indicate that the body youngs southwest.

These rocks are pyroxene rich, a feature which is unusual for the Michikamau Intrusion (Emslie, 1970) and possibly represent the transition from the banded border gabbro into the olivine gabbro-pyroxene troctolite sections of the "marginal zone" (Emslie, 1970). This would imply that the contact lies less than 500 m to the northeast of the islands (Emslie, 1970).

The relationship of the Intrusion to the plutonic suite is uncertain.

Unit 5 - Seal Lake Group

The only outcrop of this major Neohelikian sequence is found on the eastern edge of 13L/3 where it is continuous with the main Seal Lake Group outcrop area covering large parts of 13L and 13K. The unit consists of a succession of pale gray, planar bedded, feldspathic quartzites and arkoses interbedded with fine or medium grained brown weathering metabasic rocks. This association suggests a correlation with the Bessie Lake Formation of the Lower Seal Lake Group of Robinson (1954) and Mann (1959).

Unit 6 - Red Beds

These outcrop on the southern shore of Windbound Lake (13E/14 west) and on islands in Michikamau Lake (13E/13 west). The sequence on the islands is composed mainly of red and pale gray, medium to coarse grained, crossbedded, subarkosic and arkosic arenites. These are interbedded with finer grained yellow sandstones and red siltstones. Minor lithologies include granule and boulder conglomerates and purple mudstones (slates). Bedding is tabular and channel forms are rare. The arenites are clean and well sorted and occur in massive or single set crossbedded sheets 10-40 cm thick (co-sets rare). Most current directions from foresets and ripple marks are towards the southwest quadrant. Load structures and small scale scours of an overlying bed into the oxidized top of an underlying one are common. South of Windbound Lake the arenites are of the same facies. The siltstones are parallel laminated, thinly bedded and disrupted by mudcracks and sand dikes. The conglomerates are rounded, well sorted and clast supported. The finer granule-pebble conglomerates are dominated by quartzite with chert and acid volcanic clasts. Some of these granule conglomerates and matrix supported pebbly sandstones contain granitoid, volcanic porphyry and large K-feldspar clasts. A single, boulder conglomerate horizon, more than 20 m thick, consists almost exclusively of feldspar porphyritic volcanic clasts with about 10% microgranite (typical of 3h) and minor sedimentary clasts.

The red beds are inferred to lie unconformably upon the plutonic suite due to the presence of granitoid and K-feldspar clasts in the conglomerates. The preponderance of volcanic porphyry over granitoid clasts and of microgranite (3h) over coarser grained granitoid types (*e.g.* 3e) suggests that this part of the red bed sequence is the product of erosion of a relatively high, subvolcanic level of the plutonic suite. However, the red beds have been seen only in fault contact with the granitoid rocks. South of Windbound Lake the fault is thought to be steep but in the western area a thrust contact has been seen at three localities and this displacement occurs prior to the main deformation. These stratigraphic and structural relationships are similar to those recognized between the Seal Lake Group and the plutonic suite to the east of this map area (*e.g.* Marten, 1975; Thomas 1979).

These rocks are interpreted as possible intertidal sediments deposited marginal to an arid landmass.

Red beds are present throughout the Seal Lake Group succession in the 13L east map area (Roscoe and Emslie, 1973) but are more prevalent towards the top of the sequence. Elsewhere in the sequence they occur interbedded with other rock types. The red beds of this area are therefore tentatively correlated with the upper parts of the Seal Lake Group elsewhere.

Unit 7 - Diabase Dikes

Several diabase dikes cut the plutonic suite. They vary from medium grained and ophitic textured to fine grained, cleaved, feldspar phyric rocks.

Pleistocene

The Pleistocene deposits unconformably overlie all other units and consist of a coarse clastic sequence (which follows the outline of the present lake basin in distribution), and an extensive glacial cover.

STRUCTURE AND METAMORPHISM

The map area has been affected by two orogenic episodes; the Hudsonian, *ca.* 1750 Ma, and the Grenville, *ca.* 1000 Ma.

The Hudsonian orogeny affected only unit 1 and resulted in a dominantly north-northwesterly structural grain in the unit which is due to the subparallel orientations of subunits 1a and 1c at map scale and the banding and fabric at outcrop scale. The early diorite contains a migmatitic banding which was cut by the main tonalite and its associated veins. The tonalite has a more poorly developed or incipient banding. Where the banding in the tonalite is more pronounced it may have been folded several times and refolded. The fabric is axial planar to the earlier folds.

Though interference folds in the migmatites and in some thinly banded paragneisses indicate several deformations there is only one major fabric development. The paragneiss association and the earlier group of intrusives contain a strong penetrative fabric. Some massive amphibolites and the later intrusives have only a weak or zonal fabric development which may indicate synkinematic intrusion for these rocks. The rocks are LS tectonites with a strong west to northwest plunging rodding that may well have transposed any earlier fabrics.

Accompanying metamorphism was at amphibolite facies and probably peaked fairly late during the fabric generation.

A host of small, variably oriented, dextral and sinistral shear zones, with small scale displacements, deflect the fabrics in the gneisses. Also the main structural trend was reorientated into an approximately east-southeast direction on the short limbs of a later asymmetric folding which plunges north-northwest. These folds occur at outcrop scale in the gneisses and as crenulations in some amphibolites but have no associated mineral growth.

Hudsonian textures and fabric elements are also preserved in gneiss inclusions in the plutonic suite (13E/14 east).

The effects of the Grenville orogeny are most clearly developed in the plutonic and sedimentary rocks of the southern part of the area. The rocks of units 1, 3, 5 and 6 in the north are relatively undeformed by this orogeny. However, the southernmost pluton of unit 3 emplaced into the gneisses has a well developed early Grenville fabric (see below). The effects of Grenvillian deformation on the gneisses are not known due to lack of exposure. It appears, therefore, that the northern limit of major ductile Grenville deformation lies somewhere in the region of Windbound Lake and trends more or less east-west.

An early Grenville fabric is seen in the northern part of the plutonic suite where it is developed as an SL mineral alignment in 3d and 3e, a shape fabric in 3g and a mineral fabric or fracture cleavage in 3h. This fabric strikes north-northeast, is subvertical and usually weak in the megacrystic granitoids but stronger in the finer grained rock types.

This period of early fabric development was followed by northerly directed overthrusting on shallow south dipping planes. In the north of map sheet 13E/14 west this has produced a klippe of granitoid rocks with isolated intercalations of sediment. Structures related to thrusting in this klippe are seen as south dipping zones of fracture cleavage in the granitoid lithotypes (3d, 3e) and as a penetrative mineral fabric in the quartzites (2). The thrust and the related structures are gently warped, possibly as a result of the later, main deformation. Locally this period of thrusting produced mylonites; as in 13E/13 west where the granitoid rocks were thrust over the red beds (6).

The early fabric has been reorientated into the predominant east-northeast Grenville structural trend during a later period of northerly directed ductile overthrusting characterized by steep, south-southeast dipping foliation surfaces. In the more strongly deformed rocks superimposition of the two deformations resulted in an LS shape fabric with a down dip lineation to the south-southeast. To the north of the unit 3 outcrop area this dominant Grenville fabric is localized into discrete shear zones. This inhomogeneity is reflected in the main body of subunit 3c (central 13E/14) where the northwestern part is only weakly deformed by the early fabric while the remainder contains a good mineral lineation or shape fabric related to the main deformation. The shear zones become increasingly pervasive towards the south of the area and much of the southern and south-eastern portions of the area are underlain by homogeneous strongly foliated granitoids (3e, 3f).

The mylonitized granitoid rocks and red bed sequences were deformed together during the main deformation episode. Throughout the island outcrops of unit 6, this deformation produced a grain elongation mineral fabric in the arenites, a pressure solution striping in the finer grained yellow sandstones, a penetrative cleavage in the mudstones (now slates), and a flattening of clasts in the conglomerates.

Late structures throughout the southern area include undulose warping of the main fabric, east-west orientated steeply north dipping shear zones with a downthrow to the north, and a transcurrent sinistral shear zone striking about 025.

Brittle fractures with significant displacements follow trends 110 and 150. Both are steep but the displacement vector within the fault planes is unknown. The former fracture trend is seen as the fault between units 3 and 6 south of Windbound Lake, and probably has a considerable vertical component with downthrow to the north. This fracture trend may also include a possible fault contact between units 1 and 3.

The Grenvillian deformation occurred under greenschist facies conditions. Effects related to the fabric developments are seen as partial to more complete chloritization of biotite in the early and main fabrics respectively. The deformed gabbros show linear mineral fabrics defined by fine grained amphibole and plagioclase, and the granitoid lithotypes contain the predominant assemblage K-feldspar + Na-plagioclase + quartz + chlorite + epidote + hematite. The mineralogy in the sediments is little changed except for recrystallization of phyllosilicates in argillaceous rocks.

ECONOMIC GEOLOGY

A hand held scintillometer survey failed to reveal anomalous radioactivity in any of the map units. Magnetite is rarely present as clustered crystal concentrations in the granitoid and gabbro lithotypes. A few grains of molybdenite were found in the granitic net veins in the small area of 1b near Fremont Lake. Pyrite in insignificant amounts is disseminated throughout the basic rocks of the area and also occurs in vugs and thin alteration zones within the granitoid rocks. A locality containing minor fluorite and also one bearing secondary muscovite alteration were found in unit 3.

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