REGIONAL GEOLOGY EAST OF MICHIKAMAU LAKE, CENTRAL LABRADOR

by

G.A.G. Nunn and N. Noel

INTRODUCTION

NTS map areas 13L/3, 4, 5 and 6 and the shore of Windbound Lake in map area 13E/14 were mapped during the summer of 1981. Together with 13E/13 and the remainder of 13E/14, these areas complete the regional mapping program to the east of Michikamau Lake. In addition, reconnaissance visits were made to areas of known sedimentary lithology up to 30 km west of Michikamau Lake.

In 1972, parts of the area were flooded to form part of the Smallwood Reservoir. The map has been corrected to show the approximate extent of this flooding. The flooding provides continuous lakeshore access throughout the south and central parts of the map area. The eastern portion of the map area is mostly accessible from a tote road which winds northeastwards from Churchill Falls as far as Sail Lake. More remote areas in the west, north and east are accessible only by helicopter.

The area is an undulating plateau varying from approximately 540 m in the north to 500 m in the south (now flooded). This plateau is covered by glaciofluvial outwash northwest of Sail Lake and by a blanket of moraine over most of the remaining area. Residual hills and massifs of higher erosion levels occur in areas underlain by intrusive lithologies. Abundant outcrop occurs in the belt of hornfels (1) and adjacent anorthositic rocks (5), and as lakeshore exposures of the eastern supracrustal belt (1) and some of the granitoid rocks (4). The volcanics (3a) and isolated areas of Units 2, 4a and 4c to the east of Sail Lake are also well exposed in isolated moraine stripped patches. Unit 6 is well exposed in river gorges.

Mapping was undertaken using 1:50,000 or 1:250,000 topographic base maps together with aerial photographs at a variety of scales from 1:80,000 to 1:40,000 for compilation at 1:100,000. The bulk of the area was covered by helicopter reconnaissance, supplemented by lakeshore boat traversing, and ground traversing using helicopter or road access.

PREVIOUS WORK

Reconnaissance visits to southern portions of the area were made by Low (1895, 1897) and Thompson (1949, 1953). The Michikamau Intrusion (5) has been mapped and described in detail by Emslie (1964b, 1965, 1969, 1970) and little further work on the intrusion was undertaken during this mapping program. Emslie's work also included studies of the metasedimentary lithologies (1970, 1978 and Emslie in Wanless and Loveridge, 1978, pages 45-46).

The area is also covered by the Geological Survey of Canada 1:250,000 map of Emslie (1964a) and the 1:1,000,000 provincial compilation of Labrador by Greene (1972).

The previous work in the area indicated that a metamorphic complex (the Churchill Province gneisses) and a supracrustal sequence (the Petscapiskau Group, Emslie, 1970) were intruded, firstly, by the Michikamau anorthositic Intrusion (Emslie, 1965) and, subsequently, by a granitoid suite that is temporally and spatially related to the anorthositic rocks (Emslie, 1978). Both intrusive units have been placed in the Elsonian plutonic event (Emslie, 1964b, 1978). Red beds of the Neohelikian Seal Lake Group, which is unconformable upon Elsonian plutons to the east of the map area (Brummer and

Mann, 1961; Greene, 1974; Marten and Smyth, 1975), occur in the northeast of the map area. In their southern part, the red beds were folded during the Grenvillian Orogeny. Other red beds in adjacent areas, some of which are flat lying and undeformed, have been varyingly assigned: (i) a Helikian age, and tentatively correlated with the Seal Lake Group (Emslie, 1970), (ii) a Hadrynian age (Low, 1897) or (iii) either (Greene, 1972).

Considerable uncertainty is present in the literature concerning the age and extent of the Petscapiskau Group. The Petscapiskau Group was named after Petscapiskau Hill in map area 23I/8 (Emslie, 1970). The name was applied to the belts of supracrustal hornfelses bordering the southeastern and western margins of the Michikamau Intrusion and described as including paragneiss, schist, quartzite, metatuff and amphibolite and their contact metamorphosed equivalents. Emslie has proposed both Aphebian (1964a, 1965) and Paleohelikian (1978, in Wanless and Loveridge, pages 45-46) ages for the group. Greene (1972, 1974) indicated an Aphebian or Paleohelikian age and most recently Emslie (1978) proposed that the group is composite with lower Aphebian and upper Paleohelikian components. A recalculated Rb-Sr whole rock isochron of 1558 $\pm$ 60 Ma has been obtained for the volcanic portion of the upper Petscapiskau Group (given by Emslie, 1978, from an initial age of 1473 $\pm$ 60 Ma in Wanless and Loveridge, 1978).

Work in the adjacent map area (Nunn, 1981a) showed that: (i) supracrustal rocks in 13L/3 that have been correlated with the Petscapiskau Group are Aphebian and are the oldest rocks in the area; (ii) the quartzo-feldspathic orthogneisses of the Churchill Province in this area were emplaced into the supracrustal rocks before and during the Hudsonian Orogeny; (iii) isolated patches of sedimentary rock in the north of 13E/14 appeared to be Paleohelikian or younger; (iv) Neohelikian red beds occur in the Windbound and Michikamau Lake basins and are probably correlative with the Seal Lake Group.

With the above points in mind, this season's objectives were to continue studies of the supracrustal sequences in the area in order to elucidate their stratigraphy, structure and mineral potential; and in particular to:

(i) look at the type sections of the Petscapiskau Group in an effort to establish its structural and chronological relationships to these sequences;

(ii) look for mineralization in the Seal Lake Group (Cu- and U-bearing to the west of the map area, Brummer and Mann, 1961; Gandhi and Williams, 1970; Marten and Smyth, 1975);

(iii) look for basement cover relationships within the Churchill Province gneisses and/or in relation to the Petscapiskau Group;

(iv) determine the northern limit of Grenvillian deformation in the area and also to determine the age of early north-northeast trending fabrics found in the granitoid rocks.

GENERAL GEOLOGY

APHEBIAN

Unit 1 - Petscapiskau Group

The term Petscapiskau Group, as defined in this report, is restricted to pre-Hudsonian supracrustal rocks. Various post-Hudsonian red beds and volcanics included in the group by Emslie (1978) have been assigned to Unit 3 of this report. The Petscapiskau Group embraces a variety of Aphebian, greenschist to amphibolite facies supracrustal rocks along with some equivalent hornfels. These include a range of mafic to felsic volcanics with associated intrusive, fragmental and sedimentary rocks. The metasedimentary rocks include quartzite, metagraywacke, psammitic to pelitic schists and gneisses.

The Petscapiskau Group outcrops as two discontinuous curvilinear belts. The first, oriented north-south, extends along the eastern portion of the map area whereas the second belt which trends north-northeast - south-southwest is found in the western part of the area. The outcrop pattern is controlled mainly by the later intrusions of Units 2, 4 and 5 but is, in part, of tectonic origin.

The following description of the Petscapiskau Group is divided into lithological subunits. These are generally too limited in extent to show on the accompanying map, but will be delineated in future map publications.

Mafic volcanic rocks

Mafic volcanic rocks are the most abundant components of Unit 1. These outcrop throughout the eastern belt and in the southernmost part of the western belt and consist mostly of olive green to dark gray weathering, fine to medium grained amphibolite. Locally, they exhibit pillow structures (up to 2 m across); however, severe deformation during the Hudsonian Orogeny has obliterated most primary features. Recognition of these rocks is therefore based on a combination of textural, mineralogical and primary structural features as well as field relations.

The volcanic rocks commonly contain interbeds of thin (1-2 m), fine grained, green to gray weathering, banded amphibolite, many of which appear to be metatuffaceous rocks and may include crystal-lithic tuff horizons. However, in some cases where pillow lavas are strongly deformed, the metatuffaceous amphibolites may be confused with layers of highly flattened pillow material. Locally, zones of pillow lava contain layers of amphibolite with an abundance of angular blocks or fragments which are interpreted as pillow breccias.

Pillow interstices usually consist of saussuritized feldspathic material; however, both calcite and quartz have also been found northwest of Mackenzie Lake.

Thicker (greater than 10 m) layers of tuffaceous rocks are present in addition to the thin horizons noted above. These are lithologically similar to the smaller layers and are commonly interbedded with intermediate crystal-lithic tuffaceous rocks. Where thinly laminated, it is difficult to distinguish between these rocks and volcanogenic sediments.

Elsewhere thin discontinuous mafic layers, presumably of tuffaceous origin, are found within the metasediments and pelitic to psammitic higher grade equivalents.

Leucocratic volcanic rocks

In parts of both the northern and southern areas of Unit 1 in map area 13L/3, a few thin bands of light green to gray pillow lava outcrop. The pillows in these bands are small (15 x 10 cm) and strongly deformed. The pillows are composed mostly of light green minerals which are probably saussuritized plagioclase; they lack obvious mafic phases. Probable pillow breccias of the same composition are also abundant in these localities and they are interlayered with light coloured crystal-lithic tuffaceous rocks containing abundant plagioclase phenocrysts. The leucocratic rocks may represent a more intermediate phase of volcanism, possibly of andesitic composition.

LEGEND

NEOHELIKIAN

6 **Seal Lake Group and equivalents:** Red beds; arkosic and subarkosic arenites; siltstone; granule to boulder conglomerate and breccia; minor fine grained metabasic flows.

PALEOHELIKIAN

5 **Michikamau anorthositic Intrusion.**

4 **Michikamau plutonic suite*:** 4a, Gabbro, metagabbro and amphibolite; 4b, quartz diorite and quartz monzodiorite; 4c, undifferentiated, predominantly K-feldspar megacrystic quartz monzonite, quartz syenite and granite; 4d, granite.

3 3a, Acid to basic volcanics, predominantly andesitic; 3b, arkosic red beds; thinly bedded siltstone; tuffaceous grit, sandstone and siltstone; eolian sandstone; tuff; sedimentary and granitoid hornfels.

APHEBIAN

2 **Churchill Province gneisses:** Predominantly foliated tonalitic and granodioritic plutonic rocks and well to diffusely layered, veined and granite sheeted, gneissic equivalents; foliated and veined granitic rocks; fine grained porphyroclastic granitoid rocks; contact metamorphic pyroxene granulite. Contains disrupted mafic dykes and inclusions of paragneiss and amphibolite (Unit 1).

1 **Petscapiskau Group and equivalents:** Mafic and felsic pillow lava, tuff and volcaniclastic sediment with gabbro intrusions; pelitic to psammitic schists and their contact metamorphosed equivalents; quartzite; quartz-pebble and rhyolite-porphyry boulder conglomerate.

NOTES: Unit subdivisions are not necessarily in chronological order.

*Granitoid terminology, adapted from IUGS guidelines using mineral proportions of quartz, plagioclase and K-feldspar, is based on field observations.

Provisional base map compiled from 1:50,000 air photo mosaic. Lakeshore outline preliminary and most small islands omitted.

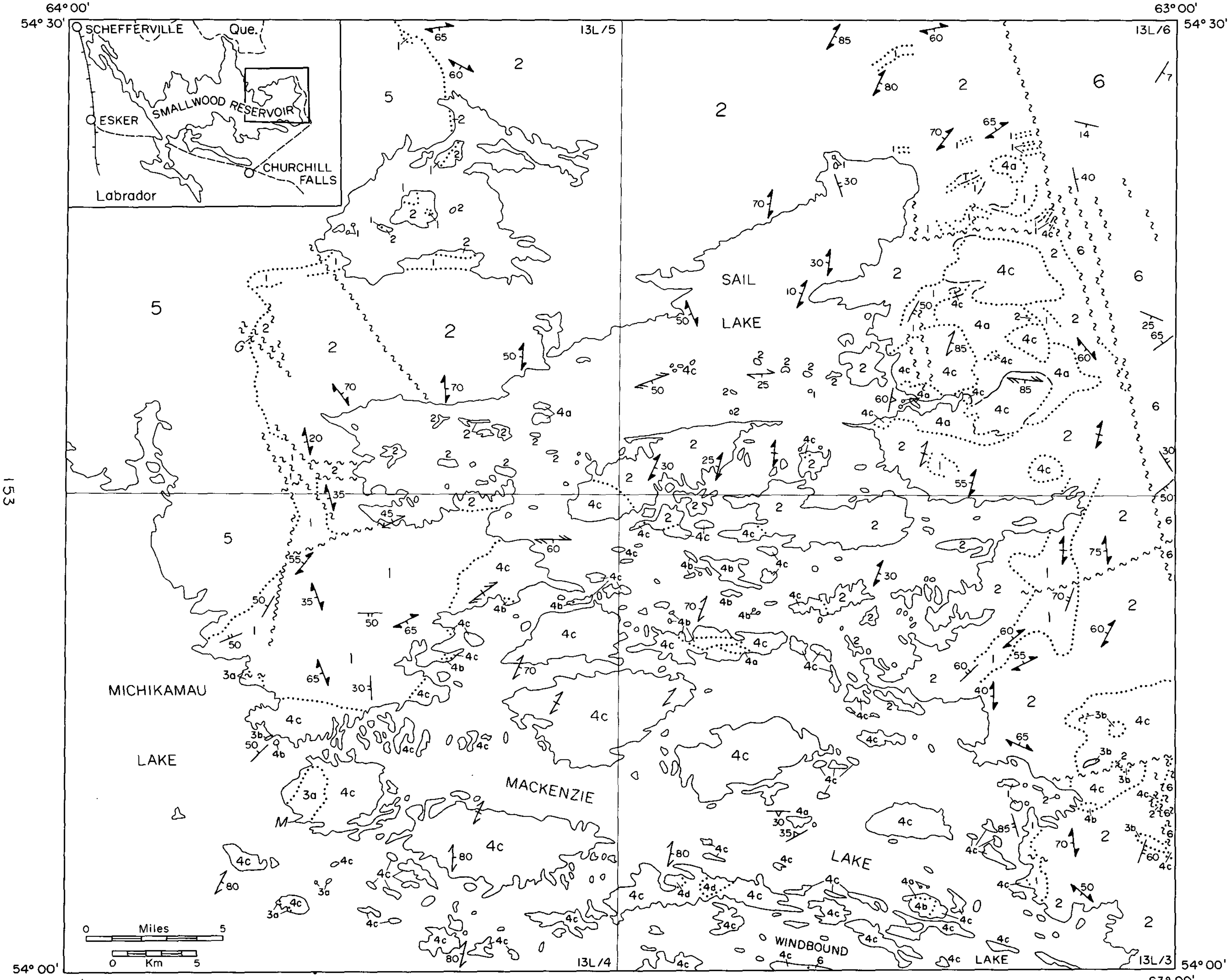
SYMBOLS

Foliation and Gneissosity (Hudsonian) . . . .

Foliation (Paleohelikian or younger) . . . .

Gossan . . . . G

Megacrystic dike . . . . M



Regional geology east of Michikamau Lake, Central Labrador

Volcaniclastic siltstone and sandstone

Unit 1 locally consists of a gray weathering, rusty, thinly bedded siltstone-sandstone sequence which occurs in both the eastern and western belts of Unit 1 and is interbedded with the volcanic portion of the unit.

The volcaniclastic sequence is best developed on the two small islands at the northernmost tip of Sail Lake and in the northern portion of the 13L/3 map area. In both of these areas the rocks form a quartzofeldspathic siltstone-sandstone sequence with minor amphibolite and pyritic layers. On the islands in Sail Lake the volcaniclastic sequence is interbedded with mafic volcaniclastic rocks (water-lain tuffs?) and several thin horizons of crystal-lithic tuff. In the northern part of map area 13L/3, one outcrop contains a thick horizon of possible mafic to intermediate agglomerate or redeposited volcanogenic sediment.

Similar occurrences are found throughout 13L/3 and in the area northwest of Mackenzie Lake. At the latter locality, more mafic varieties of siltstone and sandstone occur closely associated with mafic volcanics.

Pelitic to semipelitic paragneiss

Layers of semipelitic to pelitic paragneiss and metasediment are discontinuously exposed throughout the eastern belt of Unit 1.

In the northeast, these outcrop as a well banded, rusty weathering, quartz-feldspar-biotite-almandine gneiss, containing biotite and quartz-rich layers and thin discontinuous bands of amphibolite. Locally, metatexite is developed and is characterized by garnetiferous granitic material of heterogeneous grain size forming layers or zones within the paragneiss and containing small restite schlieren.

In the central portion of the eastern belt, these rocks outcrop as rusty weathering metasediment containing garnet and porphyroblasts of sillimanite in addition to thin quartzite layers and sweats. These rocks show evidence of static recrystallization which may be due to the thermal effect of a later, nearby gabbro-granite intrusive complex (Unit 4) situated a few kilometres to the east-southeast. In one location in this area, these rocks can be seen to grade westward into interbanded pelite and mafic metatuffs and then into interbanded tuff and mafic pillow lava.

In the southern portion of the eastern belt, these rocks are mostly semipelitic and commonly contain thin quartzite and tuffaceous bands. Garnet has only rarely been observed in this area.

Quartzite and conglomerate

Two large occurrences of quartzite were mapped and included in Unit 1 near the northern edge of the 13L/3 map area. The quartzite outcrops as a well bedded, mostly white weathering orthoquartzite with minor pyritic and grit bands. The northernmost occurrence of quartzite grades southward along strike into a quartz pebble conglomerate. The quartzite appears to underlie mafic volcanic rocks of Unit 1 but contains no evidence of syndepositional volcanic activity.

In addition to the quartz pebble conglomerate mentioned above, a few local occurrences of conglomerate were found within the eastern belt of Unit 1. One occurrence outcrops as a 3 m wide band overlying mafic pillow lava. Clast lithology is dominated by microgranite with a few minor amphibolite clasts. The matrix is composed mostly of fine grained, quartzofeldspathic (?tuffaceous) sandstone detritus. Minor bands of conglomeratic material also occur within other areas of outcrop of volcaniclastic rock. Clasts range from

1-8 cm long by approximately 1 cm; however, some have been flattened and stretched to such a degree that they have the appearance of discontinuous bands. Some of the conglomerates may be pyroclastic in origin.

Rhyolite porphyry conglomerate

Rhyolite porphyry conglomerate has not been previously reported from this area. It outcrops in the centre of the southern portion of the western belt of Unit 1 and consists of pink to green weathering conglomerate with clasts of pink, quartz and K-feldspar porphyritic rhyolite, microgranite and minor clasts of pink nonporphyritic rhyolite. The matrix appears to be a plagioclase rich sandstone and may be in part tuffaceous. Clasts are well rounded to subrounded and average 10 cm in diameter. Occasionally, clasts of fine grained mafic volcanic material are also found. The conglomerate grades eastwards over a distance of 2-3 km into a mixture of finer grained conglomerate and possible fragmental tuff containing abundant, rhyolitic, shard-like fragments concentrated in discrete horizons.

Five kilometres further east, the conglomerate has been replaced by a quartz-feldspar-muscovite ± chlorite-bearing metagraywacke. The graywacke is characterized by abundant, highly deformed, discontinuous quartz sweats. A zonation of chlorite, andalusite and possibly cordierite porphyroblasts overprints the cleavage with progressive proximity to the inferred Unit 4 contact.

The relationship of these clastic rocks to the rest of the supracrustal sequence is still unclear; however, facing directions obtained from nearby mafic pillow lavas along with some possible graded bedding in the conglomerates, suggests that it underlies the mafic volcanics found to the west. No comparable rock type was found in the eastern belt of Unit 1.

Subophitic - ophitic metagabbro

Outcrops of metagabbro belonging to Unit 1 are found throughout the eastern belt as part of larger, possibly subvolcanic, intrusions. In the western belt the metagabbro is restricted to thin (1-2 m) dikes. In outcrop the metagabbro is a green to dark gray weathering, fine to coarse grained rock with relict subophitic to ophitic texture. In the more massive outcrops, quartzofeldspathic net veining is common. Contacts between these gabbroic rocks and the rest of the supracrustals are rarely seen.

Plagioclase cumulate metagabbro

This metagabbro is restricted to the central and northern portions of the eastern belt of Unit 1. It consists of large, saussuritized plagioclase crystals (up to 10 cm long) set in a fine grained, amphibolite matrix. Where deformed, this rock may be distinguished by the presence of a light apple green mica, possibly fuchsite, and small plagioclase-rich polycrystalline aggregates which represent relict plagioclase cumulate crystals.

Hornfels

A belt of hornfels occurs adjacent to the Michikamau anorthositic intrusion (5). The aureole is over 3 km wide and reached pyroxene hornfels facies nearest to the anorthositic intrusion. Pyroxene, cordierite, sillimanite and andalusite are the main index minerals. Garnet is not abundant in the hornfelses indicating a generally low Fe-Mg ratio in the sediments.

The hornfelses are massive and resistant to weathering. They consist of thick homogeneous pelitic members, thinner psammitic members and a facies consisting of interbedded pelitic and psammitic layers. The sequence also contains amphibolite layers. Major bedding variations within the hornfels are still visible. A prominent feature of the pelitic layers is a pervasive quartz vein segregation which is similar to that found in the regional grade pelites of Unit 1. The segregations have clearly undergone at least two deformations prior to the contact metamorphic overprint. Other structures, such as cleavage, are sometimes mimetically overgrown by aluminosilicate minerals. In general, however, the hornfels is relatively isotropic.

Reconnaissance visits were made to the hornfels underlying Petscapiskau Hill and to other areas of greenschist to amphibolite facies metasedimentary rocks west of Michikamau Lake in map areas 13I/1, 2 and 8 (Emslie, 1963; Greene, 1972). The hornfels is correlated with these and other rocks of similar complexity in the map area (Unit 1).

Unit 2 - Churchill Province gneisses

Unit 2 is a foliated to gneissic suite of granitoid plutonic rocks. The granitoid lithologies range in composition from diorite to granite with tonalites and granodiorites the most abundant. The suite has not been subdivided on the accompanying map but will be in future map publications.

The earliest members of Unit 2 are gray, medium grained, biotite hornblende tonalites and diorites which form less than 5% of the unit. They occur only in the south of map area 13L/3 adjacent to, or enclosing, amphibolites of Unit 1. The early rocks and the amphibolites are intruded by dark gray, fine grained, trondhjemite-banded, biotite tonalite. The biotite tonalite may also occur as screens in younger phases throughout the south and eastern outcrop area of the gneisses and would appear to be a good time marker in the plutonic sequence. The main migmatitic banding in the biotite tonalite is cut by the enclosing lithologies. Some dark to light gray, generally fine grained tonalites and quartz diorites are presumed to be younger than the biotite tonalite because they lack any form of regular migmatitic banding. They may be homogeneous but are commonly spotted with plagioclase and/or hornblende. They occur as schlieren, inclusions and tabular xenoliths throughout the same area, and enclosed in the same phases, as the biotite tonalite. All these early lithologies are volumetrically insignificant.

By far the most voluminous members of Unit 2 are cream weathering, medium grained, biotite ± hornblende tonalite and cream or gray weathering, medium grained, biotite granodiorite. The former occurs most extensively throughout map area 13L/3 and to the northeast of Sail Lake; the latter occurs mostly around Sail Lake itself. Southwest of Sail Lake, adjacent to Unit 1, an adamellite is present due to a greater proportion of microcline. All three phases have been metamorphosed to granoblastic aggregates of quartz, plagioclase and microcline, although the microcline is commonly partially preserved as porphyroclastic relicts. The granoblastic aggregates and an alignment of the ferromagnesian minerals usually define a strong linear fabric throughout the gneisses. Posttectonic static recrystallization increases northwards throughout the map area and has commonly reduced the intensity of the linear fabric.

Both the tonalites and the granodiorites show the same intrusive and structural relationships. They are regarded as compositional variants of a temporally related intrusive stage within Unit 2. All older rocks are diked or enclosed by this period of granitoid emplacement. The two lithologies themselves generally contain a sparse leucocratic layering or granite sheeting. Locally, south and east of Sail Lake, these features intensify into a major gneissic layering. In places the development of the gneissosity is accompanied by partial melting and a biotite-rich paleosome may occur between the felsic layers. The gneissosity predates the rodding.

Three other volumetrically important lithologies in Unit 2 differ markedly from the above tonalites and granodiorites but were probably emplaced more or less contemporaneously with them. The first rock type, occurring east of Sail Lake, is a diffusely granitoid-banded, fine to medium grained, gray weathering, biotite-bearing, quartzofeldspathic gneiss. The gneiss contains inclusions of Unit 1 and older Unit 2 rock types. Though possibly younger than the main tonalite both the quartzofeldspathic gneiss and its layering also predate the foliation.

Northwest of Sail Lake, gray, fine to very fine grained granitoid rocks comprise the second lithology. They contain porphyroclastic relicts of potash feldspar and coarser grained quartzofeldspathic veins that are also strongly porphyroclastic. The regional lineation is well developed in the fine grained rocks and they appear to represent a broad, high strain (possibly mylonitic) zone developed pre- or synkinematically with respect to the main period of deformation.

The third rock type occurs in a belt of hornfels 1-2 km wide adjacent to the anorthositic intrusion (5). Possible predominantly granodioritic and coarse grained adamellitic rocks with minor tonalite, have been statically recrystallized during contact metamorphism to biotite ± pyroxene ± hornblende-bearing granulites.

The last group of intrusive phases in Unit 2 is also less than 5% in volume. Associated with the diffusely-banded gneiss east of Sail Lake is a leucocratic, white weathering, fine to coarse grained, mafic-spotted tonalite which occurs as discordant sheets. The mafic spots consist of greenish, intergranular patches of amphibole and black, posttectonic, porphyroblastic clots of biotite. In the southeastern part of the area, the main tonalites are intruded by two later phases. The first is a gray, white weathering, fine grained, biotite granodiorite. The second is a cream weathering, medium to coarse grained biotite ± hornblende granodiorite. Of these three phases, the first two are pre-foliation but do not display a strong rodding; the last is deformed, but the foliation is zonal and not as strong as that in the main phases. The coarser granodiorite is regarded as syntectonic with respect to the foliation development.

Throughout the intrusive and tectonic history of Unit 2 massive amphibolite and ultramafic members of Unit 1 have been deformed in a more brittle manner than the enclosing granitoid rocks. Fractures in these bodies have been intruded by white weathering, granitic and pegmatitic net-vein systems.

A set of pink, aplitic, micro-granite sheets, and granite and pegmatite dikes cut all rock types from Unit 1 to the later Unit 2 granodiorites. The main and late phases of Unit 2 are also cut by a set of cream weathering felsic veins. Both vein sets span the time of the main deformation.

In addition to their main mineralogy, all the members of this plutonic association (Unit 2) contain epidote, magnetite and allanite. Sphene and garnet may also be present.

PALEOHELIKIAN

Unit 3 - Volcanic and red bed sediment sequence

Unit 3 occurs in isolated patches throughout the two southern map areas, chiefly around the western and eastern flanks of the Unit 4 outcrop area. The unit is heterogeneous and comprises red beds and the felsic volcanics assigned by Emslie (1978) to the 'upper Petscapiskau Group'. In the west, the unit is composed predominantly of volcanic rocks (3a) which underlie two prominent hills on the east shore of Michikamau Lake and a group of lakeshore outcrops further south. Both the hills and the lakeshore outcrops are underlain by roof pendants, up to 3.5 km across, in Unit 4.

The largest outcrop area consists of andesitic volcanics. The andesites contain phenocrysts (50-60%) of plagioclase and ferromagnesian minerals in a fine grained, felsic groundmass. The main variants of this lithology are a densely plagioclase porphyritic facies and a fine grained rock in which the plagioclase and/or ferromagnesian phenocrysts rarely exceed 1 mm across. The plagioclase-rich rock commonly contains a fabric alignment of the feldspar phenocrysts and rarely a weak cleavage anastomoses around them in the groundmass.

Outcrops of acidic volcanic rocks map out as a roughly north-south orientated band within the andesites. They are plagioclase porphyritic (up to about 40%) with a fine grained, usually aphanitic groundmass. Locally the groundmass is streaky or the plagioclase aligned, and zones of the rock also contain quartz eyes up to 8 cm across. The eyes are elliptical and recrystallized and this deformation fabric parallels the streakiness and the aligned plagioclase laths. The quartz eyes, together with the streaky groundmass, suggest that these rocks may be pyroclastic flows. The acidic volcanics are intruded by glassy dikes.

The more northerly of the two prominent hills is also underlain by andesitic rocks. Vug-like patchy development of amphibole ± plagioclase ± epidote and isolated or clustered hornblende porphyroblastesis have imparted a spotty appearance to some areas of outcrop. Stellate growths of plagioclase and the randomly developed patches suggest that the rock is a hornfels.

Several small islands, south of the main volcanic hill, consist of green weathering, fine grained, dominantly aphyric rocks of metabasaltic appearance. They may contain tiny plagioclase needles or scattered hornblende phenocrysts up to 3 mm long. The outcrops on the larger islands are andesites.

In all three outcrop areas, the andesitic rocks contain dikes of Unit 4 lithologies. The increased intensity northwards of the irregular spotting in the northern area and the absence of such features in the other areas indicates that the hornfels was produced by the Michikamau anorthositic Intrusion (5) rather than the granitoid plutons of Unit 4. The general absence of cleavage in all the rocks of this unit might be due to contact metamorphism which is manifested only on a microscopic scale.

Two outcrops of sedimentary rock (3b) also occur in the western area. The first is a sequence of siltstone and fine grained sandstone interbedded with grit. The beds are planar topped and bottomed and even the thinnest beds are continuous over the outcrop strike length of about 18 m. The beds seem relatively quartz-poor, feldspar-rich and immature. Magnetite is a major heavy mineral component in the sediments. The sediments are probably of tuffaceous or volcanic derivation. In their fresh state, the rocks are dark gray and recrystallized and appear to be undeformed hornfels.

The second outcrop consists of crossbedded, pink, orange and gray weathering, subarkosic arenites. Major truncations bound slightly steeper-dipping cosets. Individual sets within the cosets range from 5 to 30 cm. These red beds are possibly eolian. Fresh surfaces are homogeneous, dark gray and recrystallized and these rocks are also hornfelses. At the western end of this outcrop the arenites are intruded by Unit 4 quartz monzonite.

In its eastern outcrop areas, Subunit 3b is dominated by sedimentary hornfels. These lie nonconformably upon tonalitic rocks of Unit 2 or occur as inclusions and pendants, up to 1 km across, within Unit 4. The sediments are mostly fine to medium grained sandstone interbedded with minor quartzites and grits. The bedding in the red beds is usually obscure due to the effects of contact metamorphism. They also contain small granite veins and dikes of pink aplitic to anhedral microgranite and quartz monzonite (Unit 4). It is difficult to differentiate between mottled, salmon pink and white, recrystallized arenites and similarly coloured, subaplitic microgranites. In map area 13E/14, the two lithologies may be intermixed with both irregular and lit-par-lit granitic veining. The hornfels ranges from a chlorite porphyroblastic rock where the red beds are nonconformably on the tonalites, to hornblende-bearing hornfels in some of the pendants and inclusions.

The northernmost outcrop of Unit 3 in the eastern area comprises a sequence of thinly bedded siltstones and a boulder conglomerate. The sequence contains dikes of quartz monzonite and diabase and is bounded to the east by quartz monzonite of Unit 4 in which it is a roof pendant. On its western side a shear zone brings mylonitized quartz monzonite up against the sediments. The granitoid rocks have contact metamorphosed the sediments, which, with the exception of the conglomerate which lies within the shear zone, have remained relatively unaffected by subsequent deformation and greenschist facies metamorphism.

The volcanic rocks in the western area have given a recalculated Rb-Sr isochron age of 1558 $\pm$ 60 Ma (Wanless and Loveridge, 1978). The unit is a distinctly younger succession than the type localities of the Petscapiskau Group from which it is temporally separated by the Hudsonian Orogeny. It is proposed that the designation of upper Petscapiskau Group for this sequence be discontinued. A new name will be proposed in a subsequent publication.

Unit 4: Michikamau plutonic suite

Unit 4 underlies the bulk of the southern part of the map area. The earliest members of the unit (4a) are gabbros and their metamorphosed equivalents. Some gabbros are rhythmic and cumulate layered. Typically the gabbros are either hypersthene-bearing, with igneous lamination of plagioclase and hypersthene; or hornblende gabbros, with poikilitic plates of hornblende up to 2 cm across. Diopside may be present as well as augite in some of the gabbros. In places anorthositic layers are present; a particularly thick (3-400 m) anorthosite layer occurs in the outcrop 6 km from the western margin of map area 13L/3.

Most of subunit 4a consists of fine to medium grained, high-level gabbros with intergranular to subophitic textures. There is a range from gabbro and metagabbro to amphibolite in which igneous textures have been all but obliterated and the minerals converted to shape aggregates of plagioclase and amphibole. These variations are typical of the gabbros in map area 13L/6 where the southwestern portion of this outcrop area comprises layered hypersthene gabbros, dipping (and younging) moderately to the east. They are overlain by gabbro and equivalent metagabbro and amphibolite which contain steeply lineated mineral aggregates. The gabbros in the south of map area 13L/3 are quartz-bearing. Those in map area 13L/6 appear to have been a carapace intruded by the later granites which they now ring.

Subunit 4b consists of quartz diorite, quartz monzodiorite and minor diorite. Hornblende usually predominates over biotite and these minerals, together with plagioclase, form the phenocryst phases. The groundmass consists of quartz, microcline, intergrowths of plagioclase and mafic minerals, and opaques. The colour index is 10-25. In most areas Subunit 4b is the first of the granitoid phases to intrude the gabbros (4a) and locally may be gradational into them (*e.g.* in the southern part of map area 13L/3). Subunit 4b has been intruded by dikes of Subunit 4c. However, the northwestern outcrops of quartz monzodiorite are intrusive into, and contain xenoliths of, the quartz monzonites (4c).

The most abundant rocks of Unit 4 are medium to coarse grained, K-feldspar megacrystic quartz monzonite, quartz syenite and granite (4c). These rocks are massive and pink to gray weathering and characteristically contain feldspar megacrysts. The feldspar is a pink, purplish or gray, usually 0.5 - 3 cm, microcline perthite, with a zoned euhedral form and tiny euhedral inclusions of plagioclase. The megacrysts may reach 7 cm across and often have pink overgrowths which may be continuous into groundmass plates of microcline. Plagioclase is a major phenocryst phase forming euhedral, rectangular laths up to 8 mm in length. The colour index is usually 5-10. The ferromagnesian minerals are biotite and/or hornblende which occur as phenocrysts and in groundmass aggregates with plagioclase. Other groundmass minerals consist of large plates of microcline and anhedral quartz or quartz-microcline intergrowths.

The main facies variants of these rocks are porphyritic or equigranular rather than megacrystic, with K-feldspar mainly restricted to the groundmass. In the westernmost areas of Unit 4, the typical phase is a quartz monzonite in which plagioclase is the prominent phenocryst and porphyritic microcline is very subordinate to groundmass microcline. In map area 13L/6, the rocks vary from coarse grained granite to quartz syenite in which large, anhedral, single or aggregate patches of quartz are similar in size to the microcline phenocrysts.

Magnetite, sphene, epidote and allanite are common accessory minerals in Subunits 4b and 4c. Both subunits are also characterized by small dioritic and tonalitic xenoliths and dikes of aplite and graphic granite.

Subunit 4d comprises two bodies of alaskite granite intruding the quartz monzonites (4c) in the south of map area 13L/3. K-feldspar occurs as porphyritic (3-5 mm) and occasionally megacrystic (to 2 cm) grains with the same characteristics as those in Subunit 4c. Biotite and magnetite are present only as accessory minerals. The granite bodies are roughly equant and appear to contain no dikes or xenoliths.

Throughout most of Unit 4 the textures appear undeformed. However, the occurrence of folded quartz or epidote veins and the ubiquitous flattened xenoliths attest to a folilation which in the host seems to be manifested only by aligned plagioclase phenocrysts. In areas of stronger deformation the K-feldspar megacrysts also become aligned and plagioclase-mafic and quartz groundmass aggregates are elongated. In map area 13L/6 and in some zones throughout the rest of the area, the aggregates become strongly linear. Partial chloritization of biotite and hornblende and saussuritization of plagioclase occur everywhere. Greenschist facies alteration is most complete in zones of greater deformation where microcline-albite-quartz-chlorite-epidote-magnetite is the resultant assemblage.

Unit 4 is intrusive into all of the older units. Small isolated plutons of both gabbro (4a) and quartz monzonite (4c) cut the gneisses (2) north and east of the main boundary between these two units. Some of the contacts are faulted.

Several dates are available for Unit 4. Quartz monzonites in the southern part, and immediately south, of the map area have given K-Ar ages of 1395 Ma (Fahrig, in Lowdon *et al.*, 1963, page 116) and 1320 ± 50 Ma (Stevenson, in Wanless *et al.*, 1972, pages 85-86) respectively. In contrast a preliminary

Rb-Sr errorchron on the same rocks has yielded 1700 Ma or older (personal communication, C. Brooks, 1981). Fahrig (in Lowdon *et al.*, 1963, page 116) interprets his age to be the superimposition of a Grenvillian event on older rocks. The older ages on Unit 4 conflict with the 1558 age from Unit 3 into which Unit 4 is intrusive. Isotopic dating of Unit 4 is presently underway and may resolve this problem.

Unit 5: Michikamau anorthositic Intrusion

Unit 5 was studied only near its contact with the country rocks. The anorthositic rocks are coarse to very coarse grained, augite leucotroctolites with equant to rectangular laths of gray plagioclase and poikilitic plates of brown weathering olivine and black augite. The ferromagnesian plates are up to 40 cm across. The colour index is usually 15-20 but both this and the grain size are very variable within and between outcrops. Igneous lamination is poor or absent near the contact but is apparently very well developed further west, as evidenced by transported anorthosite boulders. The leucotroctolites may be heteradcumulates.

Nodular troctolitic rocks outcrop along the shore of Michikamau Lake where they are cut by a host of variably orientated dikes of intergranular-textured, augite troctolite. The latter also contain folded xenoliths of fine grained feldspathic sediment.

The contact with the country rock was not found. No fine grained border phases (Emslie, 1970) were observed, nor were dikes of troctolitic rock found in the country rocks. Xenoliths of country rock are very rare. Much of the contact is probably faulted.

NEOHELIKIAN

Unit 6: Seal Lake Group and equivalent red beds

The red beds of Unit 6 outcrop in the east of the map area, where they are continuous with the main sedimentary basin of the Seal Lake Group, and at the southern boundary of map area 13L/3.

The red beds in the east of the map area are largely composed of well bedded sandstones with subordinate granule to pebble conglomerate. The sandstones are mainly red and pink, fine to coarse grained, quartz to arkosic arenites. The beds are usually 15-70 cm, plane sided, parallel laminated or crossbedded, tabular sheets. The arenites always display a dark red, recrystallized or well cemented appearance on fresh surfaces. Some sandstones are dark red, more thinly bedded (0.5 - 5 cm) and muddy with scattered medium to coarse sand grains. These finer parts of the sequence also contain dark red siltstones. The arenites are interbedded with gritty layers and matrix supported granule and pebbly sandstones.

The conglomerates consist of well rounded clasts, with moderate sphericity, of quartz, quartzite and minor granitoid rocks. Intraformational clasts of red, muddy sandstone may also be present. Internal characteristics of the conglomerates are large scale crossbed sets, grain size irregularity, and multiple amalgamation surfaces. Rare coarser grained cobble and boulder conglomerates also occur.

East of Mackenzie Lake the outcrops of Unit 6 at the map area boundary consist of gray, feldspathic quartzites interbedded with fine grained, much altered, metabasic flows. The sequence also contains metamorphosed gabbro sills.

At the boundary between 13L/3 and 13E/14, in the south of the map area, matrix supported, cobble to boulder conglomerates and breccias are interbedded with coarse grained, pebbly sandstone. Many of the clasts were apparently derived from Unit 4 lithologies. The clast-bearing beds are overlain by coarse grained, pink arenites with truncation surfaces bounding large scale, low angle, foreset bedding (?dune bedding). South of the map area this sequence passes up into a series of fining upward alluvial rhythmites (Nunn, 1981b).

An assemblage of calcarenites, stromatolitic limestone, algal-mat breccia, quartz pebble conglomerate, crossbedded quartzite and fine to coarse grained, yellow brown, crossbedded sandstones occurs as boulders of the present day beach deposits around one of the islands in Michikamau Lake. The island itself is underlain by Unit 4. This sequence was not seen *in situ* but stromatolitic limestones have been recorded from the area (Low, 1897). However, their restricted presence around only one island and the local derivation of much of the moraine material throughout the area indicate a nearby source to the west, probably underlying a part of Michikamau Lake. The recrystallized nature of these samples (reminiscent of the red bed arenites) and the nucleation of stromatolites on Unit 4 type granitoid boulders may indicate an association with Unit 6. The presence of stromatolitic limestones in the Seal Lake Group (Brummer and Mann, 1961) also supports a correlation of the Unit 6 sequences with the Seal Lake Group.

Contacts of Unit 6 with other units are largely unexposed. On the shore of Windbound Lake (13E/14), arenite unconformably overlies the granitoid plutonic suite (4) and clast petrology in all areas is consistent with derivation from Unit 4 or similar suites. The alluvial rhythmites just south of the map area boundary are overthrust by Unit 4. In the east of the area the contact with older rock types is fault controlled. The faults are subvertical, trend about 160° and downthrow to the east. The gently undulating red beds are locally steepened into a vertical orientation against the faults.

The red beds of Unit 6 comprise a fluviatile sedimentary facies. The sedimentary structures are considered to represent distal piedmont fan and alluvial plain deposition in a desert environment. In the northeastern part of the map area currents consistently trend towards the southeast quadrant. Around Windbound Lake the source appears to be to the east-northeast. Parts of the sequence may however be eolian. The carbonate assemblage, which may underlie part of Michikamau Lake, indicates passage either laterally or upwards into marine lagoonal and littoral facies or a lacustrine environment.

Other red bed sequences were also examined at the northern and southwestern ends of Michikamau Lake. Petrology, sedimentary facies and relative structural and stratigraphic age relationships indicate that these sequences and the red beds around Windbound Lake should all be correlated with the red beds of south Michikamau Lake (Nunn, 1981a) and with the Seal Lake Group. Lack of facies changes related to the present faulted boundaries of the unit and consistent current directions across the intervening northern gneissic and southern granitoid terrains indicate a formerly continuous outcrop distribution for the unit.

Megacrystic dike

An undeformed, 4 m wide, approximately 065 trending, diabase dike with plagioclase megacrysts, cuts volcanic rocks on the shore of Michikamau Lake. The plagioclase crystals, up to 40 cm across, are broken and corroded. The precise age of the dike is unknown.

QUATERNARY

Surficial geology

Much of the map area is covered by a blanket of Pleistocene glacial till and outwash and broad bands of rib moraine. Stoss and lee features and striae give an easterly direction for the ice flow. Several northwest trending eskers issue from the higher ground in the northwest part of the area. These join other eskers representing the predominant eastward trend of the drainage during deglaciation.

STRUCTURE AND METAMORPHISM

Hornfelses of Unit 1 adjacent to the anorthositic rocks (5) and west of Michikamau Lake (13I/8) were polydeformed, with development of a strong fabric, prior to contact metamorphism. The fabric is manifested in the mimetic growth of biotite and aluminosilicate minerals and a major quartz segregation which underwent at least two further deformations. The structures, their orientations and the pre- Unit 3 age of these deformations indicate that they are Hudsonian. All the phases of Unit 2 are intrusive into Unit 1 at this crustal level and there is general structural conformity of the fabric across the contacts between the two units. Both Unit 1, which includes the type localities of the Petscapiskau Group, and Unit 2 have therefore been deformed and metamorphosed during the Hudsonian Orogeny and are Aphebian or older.

In the east of the map area the paragneisses are at least as structurally complex as the orthogneisses. No evidence was found of an unconformity between Units 1 and 2, or of older structures, orogenies or basement within the orthogneisses. Both units are therefore assigned to the Aphebian.

The Hudsonian orogeny was a multiphase plutonic and tectonic event. Ninety-five percent or more of Unit 2 appears to have been emplaced between an early deformation period and the main foliation producing episode. The early deformation resulted in development of migmatitic banding and folding (F_1) in the early, dark gray, biotite tonalite and in the Unit 1 paragneisses. These structures are cut by the main intrusive phases of Unit 2. The rocks then underwent major deformation which resulted, firstly, in an incipient to well developed layering and, secondly, in the production of penetrative LS tectonites throughout the area. The latter, the result of a strong constriction deformation, transposed any fabrics that may already have been present. Folds (F_2) of the layering associated with the rodding deformation are isoclinal. Recrystallization outlasted the deformation in many areas replacing linear mineral fabrics with near isotropic, granoblastic polygonal textures. The rodding is well preserved in rocks containing shape aggregates. The third deformation produced tight to isoclinal folds (F_3), coaxial with the second phase rodding and seems to have affected only areas of gneisses with well developed layering. F_4 structures are open folds with interlimb angles of 90° or more. All these structures have variable orientations due to later tectonic effects. It is not known whether these variations are also Hudsonian or belong to younger orogenic events.

In the eastern parts of the map area dynamothermal metamorphism that accompanied F_2 and the static recrystallization that followed it, occurred at amphibolite facies grade. Posttectonic almandine typically overgrows the biotite foliation in the paragneisses. Northwards, the metamorphic grade was greater and sillimanite grew during syn- and postkinematic crystallization.

In the western part of the map area, and away from the areas of hornfels, the regional grade of Unit 1 is greenschist facies and further north the gneisses of Unit 2 are at amphibolite grade. Other polydeformed sedimentary sequences with Hudsonian trends that occur to the west of Michikamau Lake are tentatively correlated with Unit 1 and show the same range of regional metamorphic grade.

No new mineral growth has been recognized associated with post-F_2 deformation. However, greenschist facies alteration is ubiquitous in the map area and though much of this relates to younger events, some may be due to late Hudsonian retrogression.

Units 3 and 4 contain post-Hudsonian fabrics. Unit 3 is weakly deformed because it was first contact metamorphosed by Unit 4 and thus made resistant to deformation. Unit 4 is also only weakly deformed due to its massive nature. However, both units contain zones of stronger deformation with development of a north-northeasterly trending, steeply dipping foliation. The foliation consists of an SL mineral fabric where it is weakly developed. With increasing deformation, the fabric becomes linear and some of the granites and amphibolites of Unit 4 in 13L/6 display a strong subvertical rodding. The north-northeasterly fabric is not seen in Unit 6 or the anorthositic rocks of Unit 5. As a result the deformation is no longer regarded as an early Grenvillian structure (*cf.* Nunn, 1981a) and is thought to be Paleohelikian. Unit 4 also contains several thin mylonites of northwesterly to northeasterly orientation that are probably Paleohelikian. The Paleohelikian deformations were accompanied by greenschist facies metamorphism.

Units 4 and 5 have both previously been assigned to the Elsonian plutonic event (Emslie, 1978). Despite the uncertainty of the age of Unit 4, both units predate the Neohelikian Seal Lake Group and are emplaced into and thermally metamorphose Units 1, 2 and 3. Unit 1 in particular displays several well developed contact metamorphic zones. At the contact the unit has been metamorphosed to pyroxene hornfels facies by Unit 5. Pyroxene disappears within about 300 m of the contact, cordierite and sillimanite after about 2 km and andalusite persists to at least 3 km. Within 4 km Unit 1 consists of regional grade, greenschist facies rocks. Unit 1 was metamorphosed to andalusite grade (hornblende hornfels facies) at the contact with Unit 4 and decreases to chlorite grade within 1 km of the contact. Pyroxene persists in the granulites of Unit 2 for 2 km from the contact with Unit 5 and perhaps more. This may be due to a flat-lying contact in this area. Unit 2 seems unaffected by the granitoid rocks. Three kilometres from the anorthosite contact, Unit 3a volcanic rocks are hornblende porphyroblastic. The presence of epidote and ?actinolite in patches in the same rock indicates a drop in temperature into the albite-epidote hornfels facies during the crystallization history of the patches. Unit 3 is metamorphosed from chlorite up to hornblende grades by Unit 4.

Grenvillian deformation extends to the north of the map area in Unit 6 where the red beds are gently undulating. Towards the south of the map area, the red beds develop pronounced folds with east-northeasterly axes and eventually become asymmetric with vergence to the north-northwest. No fabrics are associated with these folds.

In map area 13L/3 the red beds of Unit 6 are interbedded with metabasic rocks in which a good northeasterly trending cleavage is developed. A foliation in a zone of strong deformation, with the same northeasterly orientation, cuts the nearby outcrop of Unit 3 arkosic arenites and is also assigned to the Grenville Orogeny. The effect of the zone where it cuts the underlying Unit 2 gneisses is not known. The boundary of the Grenville Province has traditionally been drawn along the contact between the Seal Lake Group and the Unit 2 gneisses in 13L/6 and then arbitrarily extrapolated diagonally across the gneisses underlying 13L/3 before passing south of Michikamau Lake (Smyth and Greene, 1976). However, it has already been determined (Nunn, 1981a) that red beds underlying the southern portion of Michikamau Lake have been thoroughly deformed during a major east-northeasterly trending Grenville deformation. The granitoid rocks adjacent to these red beds are heterogeneously deformed in an anastomosing network of shear zones with augen preserving pre-Grenville, probably Paleohelikian, structures between them (Nunn, 1981a). This pattern continues to the north into the present map area where the shear zones are narrower and less abundant and the augen larger and coalescing. The Paleohelikian fabric is usually reorientated with a down-dip linear Grenvillian component superimposed on it. Locally, however, the fabric changes only orientation (and not shape) through a shear zone. Hudsonian structures are probably also similarly reorientated in Grenvillian shear zones. However, these Grenvillian reorientations are difficult to separate from earlier strike variations in the gneisses. Superimposed Grenville fabrics have been recognized as far north as Sail Lake. Approximately east-west trending, brittle structures in the area may belong to the same event and some of these may cut Unit 5. Accordingly, the area at least as far north as Sail Lake lies within the Grenville Front Zone (Gower *et al.*, 1980).

ECONOMIC GEOLOGY

A large gossan has been found where northwesterly trending faults cross the Unit 5 contact with the country rocks (Unit 2). The mineralization appears to be hosted by basic rocks; possibly intercalations of Unit 1 in Unit 2. The gossan occurs within an area approximately 1 km^2 and contains Fe and Cu mineralization. Pyrite is disseminated throughout the basic rocks and the hornfels of Unit 1, and the former also contains Cu staining. No mineralization was found in the rhyolite porphyry conglomerate or the volcanic rocks of Unit 3. The absence of Cu showings in the Seal Lake Group was attributed to the lack of basic intercalations. A hand held scintillometer survey failed to reveal any large areas of particularly anomalous radioactivity; however, localized at the Unit 2-Unit 3 contact in 13L/3, both the red bed hornfelses and the gneisses register two to three times background. A few Unit 2 pegmatites cutting mafic volcanics of Unit 1 also gave readings slightly above background. In general, Units 2 through to 6 seem to have little potential as exploration targets. Unit 1 might prove to have some base metal potential.

ACKNOWLEDGEMENTS

We wish to thank T. Van Nostrand, M. Spurrell, C. Ash and D. Lee for cheerful and willing assistance in the field. Messrs. E.W. and E.J. Tuttle and the personnel of Sealand Helicopters are thanked for their logistical support. R.J. Wardle and W.L. Dickson critically reviewed the manuscript.

REFERENCES

Brummer, J.J. and Mann, E.L.
1961: Geology of the Seal Lake area, Labrador. Geological Society of America, Bulletin 72, pages 1361-1382.

Emslie, R.F.
1963: Michikamau Lake, east half, Quebec-Newfoundland. Geological Survey of Canada, Paper 63-20, Map 31-1963.

1964a: Kasheshibaw Lake, west half, Newfoundland-Quebec. Geological Survey of Canada, Map 3-1964.

1964b: Potassium-argon age of the Michikamau anorthositic Intrusion, Labrador. Nature, Volume 202, pages 172-173.

1965: The Michikamau anorthositic Intrusion, Labrador. Canadian Journal of Earth Sciences, Volume 2, pages 385-399.

1969: Crystallization and differentiation of the Michikamau Intrusion. *In* Origin of anorthosite and related rocks. *Edited by* Y.W.

Isachsen. New York State Museum, Memoir 18, pages 163-173.

1970: The geology of the Michikamau Intrusion, Labrador (13L, 23I). Geological Survey of Canada, Paper 68-57, 85 pages.

1978: Elsonian magmatism in Labrador: age, characteristics and tectonic setting. Canadian Journal of Earth Sciences, Volume 15, pages 438-453.

Gandhi, S.S. and Williams, M.
1970: Economic potential of the central Labrador Mineral Belt. Unpublished private Report, G70012, Brinex Ltd.

Gower, C.F., Ryan, A.B., Bailey, D.G. and Thomas, A.
1980: The position of the Grenville Front in eastern and central Labrador. Canadian Journal of Earth Sciences, Volume 17, pages 784-788.

Greene, B.A.
1972: Geological map of Labrador. Newfoundland Department of Mines, Agriculture and Resources, Mineral Resources Division.

1974: An outline of the geology of Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Information Circular No. 15, 64 pages.

Low, A.P.
1895: The Labrador peninsula - S.E. Geological Survey of Canada Map.

1897: Report on exploration in the Labrador peninsula along the East Main, Koksoak, Hamilton, Manicouagan and portions of other rivers in 1892-93-94-95. Geological Survey of Canada, Annual Report Number 8 (L), page 223.

Lowdon, J.A., Stockwell, C.H., Tipper, H.W. and Wanless, R.K.
1963: Age determinations and geological studies (including isotopic ages - Report 3). Geological Survey of Canada, Paper 62-17, 140 pages.

Marten, B.E. and Smyth, W.R.
1975: Uranium potential of the basal unconformity of the Seal Lake Group, Labrador. *In* Report of Activities for 1974. *Edited by* J.M. Fleming. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 75-1, pages 106-115.

Nunn, G.A.G.
1981a: Regional geology of the Michikamau Lake map area, central Labrador. *In* Current Research. *Edited by* C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 81-1, pages 138-148.

1981b: Geology southeast of Michikamau Lake, central Labrador. Provisional Map 81-122 with marginal notes. *Edited by* C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Open File Report in press.

Smyth, W.R. and Greene, B.A.
1976: Isotopic age map of Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 764.

Thompson, A.R.
1949: Geological reconnaissance east of Michikamau Lake, Labrador. Private report, Labrador Mining and Exploration Company.

1953: The reconnaissance geology of the south Michikamau Lake area. Private report, Labrador Mining and Exploration Company.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Delabio, R.N.
1972: Age determinations and geological K-Ar isotopic ages, Report 10. Geological Survey of Canada, Paper 71-2, 96 pages.

Wanless, R.K. and Loveridge, W.D.
1978: Rubidium-strontium isotopic age studies, Report 2 (Canadian Shield). Geological Survey of Canada, Paper 77-14, 70 pages.