GEOLOGY AND GEOCHEMISTRY OF THE ACKLEY GRANITE, SOUTHEAST NEWFOUNDLAND

by

W.L. Dickson, P. Elias*, and R.W. Talkington*

INTRODUCTION

During the 1979 field season an extensive reconnaissance geological, geochemical, and spectrometer survey of the Devonian Ackley Granite was carried out. The batholith is located in southeastern Newfoundland with the northern margin approximately 65 km south of the town of Gander (Map 1). The project area is covered by parts of the following 1:50,000 N.T.S. sheets 1M/10, 11, 14, 15, 16, 2D/1, 2, 3, and 7.

The purpose of the project is to outline the major phases within the batholith. Using petrochemical data it is hoped to gain an understanding of the petrogenesis of the batholith and define phases having economic potential.

The general geology of various parts of the batholith has been described by Bradley (1962), Jenness (1963), Anderson and Williams (1970), Williams (1971), and O'Driscoll and Hussey (1978). Recent geochemical studies include a reconnaissance rock geochemical study by Strong et al. (1974), uranium analyses of the rocks collected by Strong et al. (Davenport, 1978), and analyses of lake sediments by Butler and Davenport (1979). Whalen (1976) carried out a detailed geological and geochemical study of the Rencontre Lake molybdenite showings localized near the southern margin of the batholith.

Colman-Sadd (1976) mapped the area (1M/13) adjacent to the southwest margin of the project area and showed that the southeast corner of map area 1M/13 is underlain mainly by deformed granitoid rocks. Therefore, the area between the southwestern edge of the batholith, as shown by Anderson (1965) and the western edge of map area 1M/14 was included in this project in order to define the junction between deformed granitoids and the massive granite of the Ackley Granite (Map 1).

Sampling Methods

The sampling method follows that of Garrett (1979). The area enclosing the Ackley Granite, deformed granitoids, and the country rocks up to 2 km from the previously defined margin were divided into a 4 km^2 grid using the U.T.M. grid system. A randomly chosen sample point was obtained for each square and where outcrop permitted a sample was taken at, or as close as possible to that point. Replication of samples and squares was carried out at the end of the sampling program when the various phases of the batholith had been outlined.

Samples were mainly collected using a float equipped helicopter. 8 lb sledge hammers were used to obtain 2 to 5 kg samples which were then placed in polythene bags. Rock sample size increased with grain and phenocryst size. 757 samples including replicates were obtained from the approximately 960 squares which covered the project area (Map 2). 640 granite samples will be analysed for SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, K_2O, TiO_2, MnO, P_2O_5, Loss on Ignition, Ba, Rb, Sr, Zr, F, Cu, Zn, Mo, Pb, Li, V, U, and Be.

* Department of Geology, Memorial University, St. John's, Newfoundland A1B 3X5.

GEOLOGY

The Ackley Granite is a large irregular body of massive coarse grained biotite granite which is intrusive into late Precambrian volcanic and sedimentary rocks of the Avalon Zone and pre-Middle Ordovician metasediments and Devonian and older granitoids of the Gander Zone (Williams, 1978). The Dover-Hermitage Bay Fault forms the boundary between the Gander and Avalon Zones (Blackwood & O'Driscoll, 1976).

Unit 1 (Late Precambrian metavolcanic and sedimentary rocks - Avalon Zone)

Unit 1 includes all the country rocks to the southeast of the Dover - Hermitage Bay fault. This unit is composed of parts of the Love Cove, Long Harbour, and Musgravetown Groups (Williams, 1971; O'Driscoll and Hussey, 1978). The Love Cove and Long Harbour Groups are composed dominantly of acid pyroclastic and related epiclastic rocks with minor basic flows and clastic sediments. The Musgravetown Group is composed mainly of well sorted, medium grained, crossbedded sandstone and siltstone with minor basic volcanics. These rocks were deformed and metamorphosed to lower greenschist facies probably during the Acadian Orogeny. Contact metamorphism of Unit 1 has produced cordierite porphyroblasts in the Musgravetown Group and biotite porphyroblasts in the Love Cove Group metasediments. The acid volcanic rocks show recrystallization textures and the basic volcanics have been metamorphosed to produce an amphibolite. There is evidence of partial melting and gneissification of the rocks near the contact on Route 102.

Intrusive contacts between the Ackley Granite and the Precambrian rocks were observed at (i) Long Harbour, (ii) Route 102 about 20 km northeast of Terrenceville, (iii) Dunns Mountain, (iv) a locality 15 km northeast of The Tolt, (v) Belle Harbour, (vi) Rencontre Lake, (vii) Wylie Hill molybdenite showing, (viii) Motu molybdenite showing and (ix) Ackley City molybdenite showing. Contacts are generally sharp and crosscut the main fabrics in the country rocks. There is only minor screen formation and assimilation of the country rocks.

A series of roof pendants which trend south from The Tolt are probably part of the Precambrian Andersons Cove Formation of the Long Harbour Group (Williams, 1971) and not Cambrian and Ordovician as suggested by Bradley (1962). (See O'Brien and Nunn, this volume).

Unit 2 (Middle Ordovician and older metasedimentary rocks - Gander Zone)

Unit 2 is composed mainly of semi-pelitic to psammitic, low to medium grade polyphase deformed schists and minor metavolcanic rocks. This unit is located to the northwest of the Dover - Hermitage Bay Fault and forms part of the Middle Ordovician and older Gander and Baie D'Espoir Groups. These rocks form the eastern part of the Gander Zone (Williams, 1978). Metamorphism of Unit 2 decreases from amphibolite facies schists and migmatites in the southeast to lower greenschist facies slates in the northwest over a distance of 15 km or less.

No intrusive contacts between the Ackley Granite and Unit 2 were observed. The effects of contact metamorphism, however, are clear in the Kepenkeck Lake area where up to 1 cm long porphyroblasts of cordierite have developed in the metasediments. In the deformed granite terrain (Units 4, 5, and 6) the metasediments are cut by numerous granite sheets so that subdividing this region into areas of metasediment and granite is difficult at this scale of mapping. One possible roof pendant of metasediment within the Ackley Granite was observed 5 km south-southwest of Jubilee Lake.

MAP 1 - GEOLOGY OF THE ACKLEY GRANITE

LEGEND

Devonian or younger
Ackley Granite - Units 7-9

9. Medium grained massive uniform biotite-muscovite granite.

8. Massive uniform biotite granite - generally coarse grained.

8a Big Blue Hill Pond Facies

$8a^1$ Medium grained variety

8b Long Harbour Facies

$8b^1$ Medium grained variety

$8b^{11}$ Fine grained porphyritic variety

7. Coarse grained massive K-spar porphyritic biotite granite.

7a Tolt Facies

7b Jubilee Lake Facies

Devonian or older

6. Foliated medium to coarse grained muscovite granite.

5. Foliated medium grained biotite granite.

5a Foliated medium grained biotite-muscovite granite.

4. Foliated coarse grained K-spar porphyroclastic biotite granite.

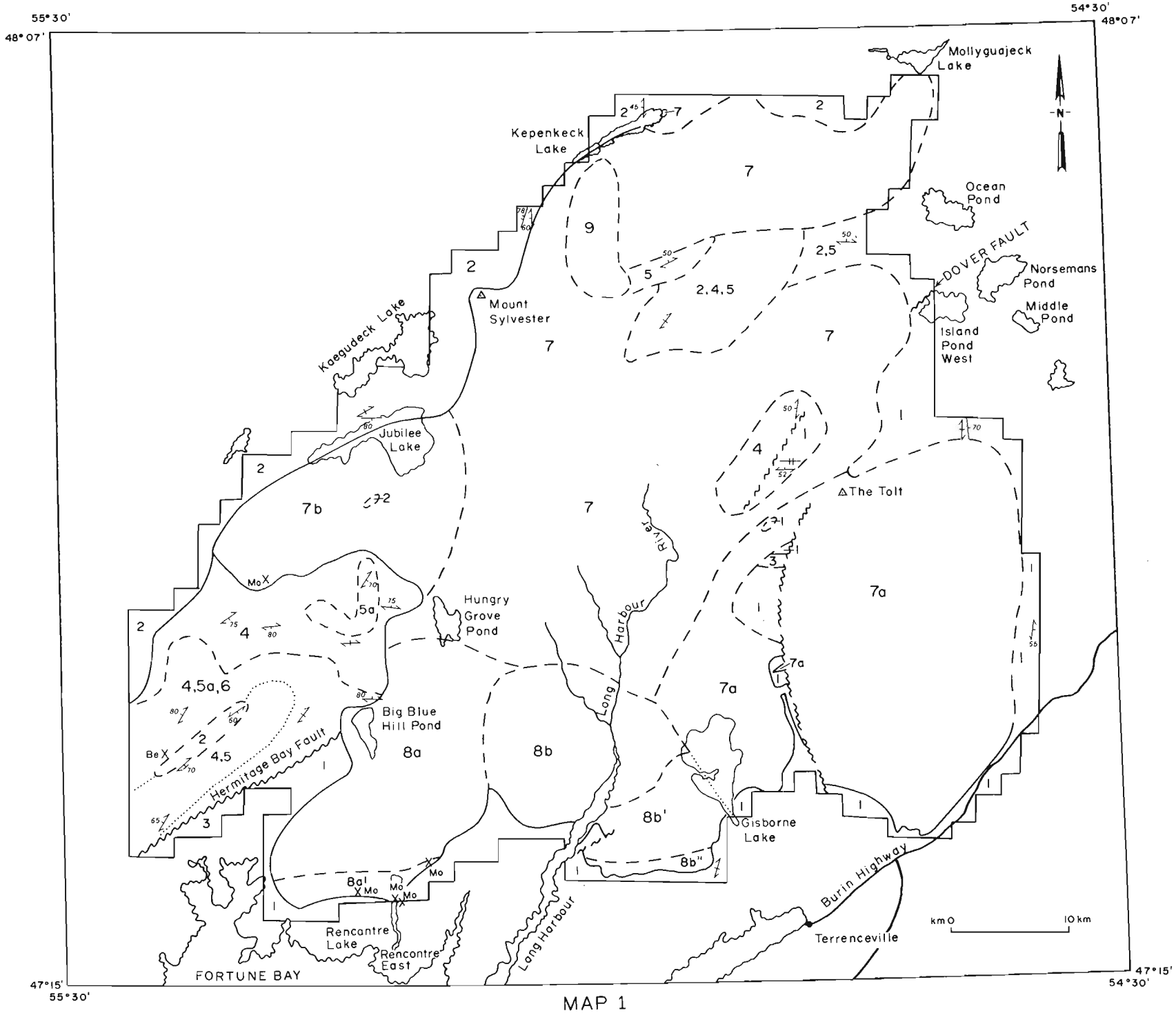
3. Slightly foliated coarse grained hornblende-biotite granodiorite and monzodiorite.

Ordovician and older

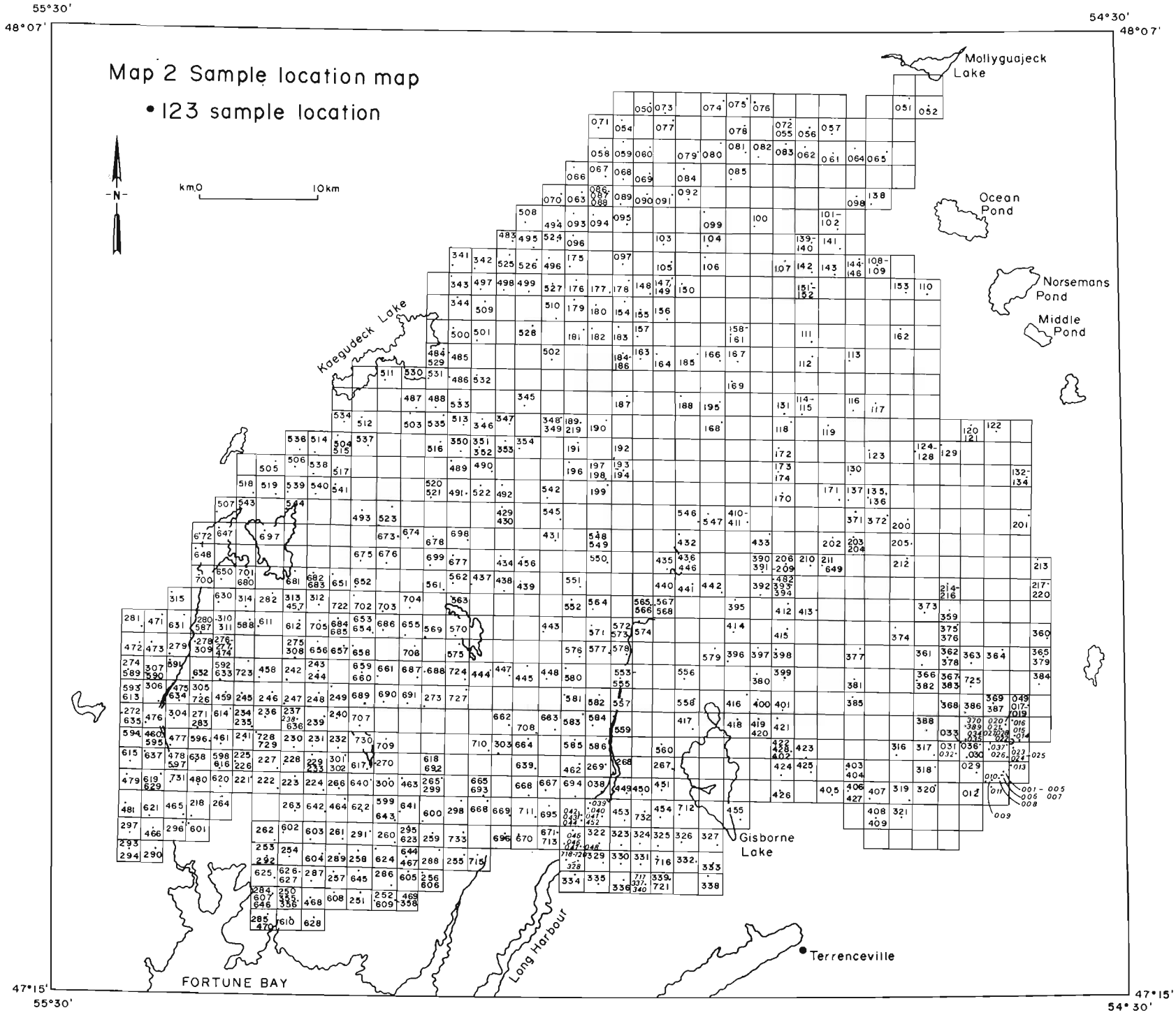
2. Gander and Bay D'Espoir Groups - metasediments.

Precambrian

1. Love Cove, Musgravetown and Long Harbour Groups - metavolcanics and metasediments.



MAP 1



Unit 3 (Pre-Ackley Granite Intrusions - Avalon Zone)

This unit occurs in widely separated outcrops and includes part of the Simmons Brook Batholith. The unit occurs to the southeast of the Dover - Hermitage Bay Fault. The Simmons Brook Batholith has been described by Williams (1971). In summary, it consists of "medium to coarse grained, altered gray to pink granite and granodiorite, fine to medium grained diorite and quartz diorite". Two occurrences of weakly deformed and metamorphosed hornblende-biotite granodiorite and monzodiorite occur in the northernmost roof pendant southwest of The Tolt (Pin Hill) and also 10 km due west of The Tolt. The rocks at these localities fit the descriptions of the Simmons Brook Batholith and therefore may be related. Clear intrusive contacts were observed at Pin Hill where the monzodiorite has intruded acid volcanic rocks. Contacts were not found at the pendant west of The Tolt.

Units 4, 5, 6 (Pre-Ackley Granite deformed granitoids - Gander Zone)

These units occur in the southwestern part of the survey area with two other major remnants located 30 km to the northeast of Big Blue Hill Pond. Units 4, 5, and 6 occur to the north of the Dover - Hermitage Bay Fault.

Unit 4 consists of variably deformed medium to coarse grained, K-spar porphyroclastic, biotite granite. The K-spar porphyroclasts form augen which vary in length from 5 mm to 3 cm. Flattened and granulated quartz and feldspar along with micaceous layers define the main fabric.

Unit 5 consists of strongly foliated, medium grained biotite granite which may grade into biotite-muscovite granite (Unit 5a). Unit 5 is equivalent to Colman-Sadd's (1976) "garnetiferous leucocratic granite and related rocks". Colman-Sadd (1976) has suggested that the garnetiferous leucocratic granite is Middle Ordovician or younger as the lithologically similar North Bay Granite is intrusive into the fossiliferous Riches Island formation of probable Middle Ordovician age.

Unit 6 is a foliated, medium grained, uniform, muscovite granite. This rock type commonly occurs as dikes, within the deformed terrain but also as large isolated outcrops. Garnet was found in a few isolated outcrops and is commonly associated with 1 to 4 cm irregular poikilitic tourmaline. Garnet was never found in association with biotite in the granitic rocks.

Units 4, 5 and 6 are cut by numerous granitic and graphic textured pegmatites some of which are deformed. The pegmatites are generally barren but at one locality beryl was discovered.

The separation of rocks into Units 5 and 6 is tenuous because of possible gradational changes within biotite-muscovite granites from a biotite-free marginal zone to a muscovite-free core (see Colman-Sadd, 1976; Currie and Pajari, 1977). Also complex intrusive relationships between Units 2, 4, 5 and 6 make it difficult to define the main rock type in an area.

Unit 4 is considered to be older than Units 5 and 6 as dikes of biotite granite (Unit 5), biotite-muscovite granite (Unit 5a) and muscovite granite (Unit 6) commonly cut Unit 4. These units (4, 5, 6) are deformed with a well developed L-S fabric which is generally steeply dipping. The fabric generally trends northeast but in the area north of Big Blue Hill Pond the fabric trends towards the east. In a few places there is a poorly developed fracture cleavage which cuts the main fabric. The overall fabric in the granites is parallel to that of the metasediment screens and suggests that all were deformed together probably during the Acadian Orogeny.

Units 7, 8, 9 (Ackley Granite)

These units form what is here defined as the Ackley Granite. The rock is generally fresh and massive and clearly crosscuts the regional fabric. The Dover-Hermitage Bay Fault is truncated by the batholith. A possible roof pendant 5 km west of The Tolt may contain a remnant of the originally continuous Dover-Hermitage Bay Fault. Dallmeyer has dated the eastern part of the Ackley Granite using $^{40}Ar/^{39}Ar$ incremental release age spectra on primary hornblende and obtained an age of 356±10 Ma (Geochronology report, this volume).

Unit 7 is composed of generally coarse grained massive porphyritic biotite granite. Phenocrysts consist of 2 to 5 cm long K-spar crystals which commonly show albite mantles. The granite is generally hypidiomorphic granular and locally grades into lenses and small sheets of pegmatitic and aplitic granite. The northern part of the batholith, which is undivided because of poor outcrop, contains small areas of uniform, coarse grained, biotite granite.

Unit 7a, The Tolt facies, is characterised by generally coarse to very coarse grain size, large (>2 cm) phenocrysts and an abundance of miarolitic, aplitic and porphyritic alaskite veins, pods, and dikes.

Unit 7b, the Jubilee Lake facies, is also coarse grained, porphyritic biotite granite but pods of aplite and alaskite are rare. Low gamma-ray spectrometer counts are characteristic of this phase. A prominent aeromagnetic anomaly which trends southwards for 15 km starting from just east of Jubilee Lake to Hungry Grove Pond may represent the contact between Unit 7 and Unit 7b.

Unit 8 consists of generally coarse grained uniform biotite granite. Towards the southern margin Unit 8 becomes finer grained, extremely friable, and may contain rare 1 cm K-spar phenocrysts. The unit is subdivided into facies 8a and 8b mainly on the basis of gamma-ray counts with Unit 8b generally twice as high as Unit 8a. Also, lake sediment geochemistry (Butler and Davenport, 1979) shows the area underlain by Unit 8a to be higher in Zn, Pb, and Mo than that of 8b. A prominent northerly trending aeromagnetic lineament coincides with this subdivision.

Unit $8a^1$ is a finer grained variety of 8a. Towards the contact with the country rocks, $8a^1$ becomes alaskitic and locally fine grained. These rocks are the host for the main molybdenite showings in the batholith. Units $8b^1$ and $8b^{11}$ are sucessively finer grained varieties of Unit 8b. Locally pods of $8b^1$ and $8b^{11}$ are found in 8b.

Near the margin, the granite is highly miarolitic and locally tuffisite has developed. This suggests that the granite crystallized at a high level in the crust probably less than 3-4 km (see Hughes, 1971). The decrease in grain size may be related to rapid nucleation caused by rapid loss of volatiles and thus a decrease in pressure.

Unit 9 is located in the northern part of the batholith and is possibly the youngest unit of the Ackley Granite. The unit is unique in that it is the only massive megascopically muscovite-bearing granite in the survey area. Unit 9 is generally medium to coarse grained, massive, uniform to locally porphyritic, biotite-muscovite granite. The muscovite content varies from less than 1% to about 3%. The unit probably underlies a much greater area than is shown by surface outcrop as a corresponding pronounced aeromagnetic low covers an area at least twice that delimited by surface outcrop.

Diabase Dikes

Diabase dikes are common in the Precambrian terrain (Unit 1) but are

rare in both the deformed granitoids and the Ackley Granite. Dikes are more abundant in the deformed granitoids than the Ackley Granite. Within the Ackley Granite the diabase dikes are generally massive and slightly metamorphosed. Jayasinghe (1978, 1979) has suggested that diabase dikes which cut similar granites in the Wesleyville area, 125 km to the north are probably late Devonian or early Carboniferous in age.

SPECTROMETER SURVEY

At most sample localities either a scintillometer reading (Scintrex BGS-1) or spectrometer (Scintrex GIS-4) reading was taken. "Total Counts", "U+Th", and "Th" were the channels recorded using the spectrometer. Only "Total Counts" were recorded with the scintillometer.

The average results for the project area are:

1.	Total Counts	170 counts per second (cps)
2.	U+Th	1.5-2 counts per second
3.	Th	1

The deformed granitoids and the Jubilee Lake facies (Unit 7b) yield average readings of approximately 130 cps. Unit 8 gave the highest readings of 250 to 400 cps. The more differentiated granitic rocks of the Ackley Granite (*e.g.* aplites, granitic pegmatites) give above average readings. The pegmatites in the deformed granitoid terrain yield below average readings.

High "U+Th" counts were shown to be directly correlatable with high "Total Counts". The Long Harbour facies and subfacies showed the highest "U+Th" readings, with up to 15 cps in subfacies $8b^{11}$. Davenport (1978) reports uranium contents of granite samples from the Ackley Granite are highest (ave. 12 ppm) in the Long Harbour area. Whalen (1976) reported microscopic uraninite from the Rencontre Lake molybdenite showings (Unit $8a^{1}$). However, spectrometer readings taken at these showings are similar to the batholith "average" and about half that obtained from Unit 8b (Long Harbour facies).

MINERALIZATION

The Ackley Granite is well known for the molybdenite mineralization in the Rencontre Lake region. There are four significant molybdenite showings of which the Wylie Hill, Ackley City and Motu are of the porphyry type and the Crow Cliff-Dunphy Brook showing is a vein-type occurrence. These four showings occur very close to the contact between Unit 8a and Precambrian volcanic rocks. No molybdenite is found within the country rocks near the showings (see Whalen, 1976 for full description). Contact zones between the batholith and country rocks in other areas were examined for mineralization. Mineralization was found in small quartz veins with 2 to 5 mm crystals of molybdenite in the Jubilee Lake area. Mineralization is apparently restricted to the quartz veins in this area. The occurrence is close to the contact between the deformed granitoids and the Jubilee Lake facies (Unit 7b). Molybdenite mineralization was found also in small quartz veins about 12 km south-southeast of The Tolt. The veins and the molybdenite are both of limited extent and occur in The Tolt facies (Unit 7a). This area contains anomalous Mo in lake sediment samples (Butler and Davenport, 1979).

Beryl was found in pegmatite veins in deformed muscovite-biotite granite west of the Bay du Nord River. Faceted crystals up to 1 cm were obtained. The extent of the mineralized veins is not known.

SUMMARY

1. The Ackley Granite is a posttectonic high level Devonian intrusion.
2. The batholith cuts deformed granitoids south of Jubilee Lake and is intrusive into the metasediments and metavolcanics of the Gander and

Avalon Zones.

3. The Dover-Hermitage Bay Fault is truncated by the batholith.
4. The batholith can be divided into 3 major units based on mineralogy and texture.
5. Gamma radiation is highest in the Long Harbour area.
6. Minor molybdenite mineralization was found in quartz veins south of Jubilee lake.
7. Beryl was found in pegmatites in deformed leucogranite west of the Bay du Nord River.

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