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THE DEVONIAN - CARBONIFEROUS WENTWORTH PLUTONIC COMPLEX (FOLLY LAKE & HART LAKE - BYERS LAKE PLUTONS) OF THE CENTRAL COBEQUID HIGHLANDS, NOVA SCOTIA

by

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THE DEVONIAN - CARBONIFEROUS WENTWORTH PLUTONIC COMPLEX (FOLLY LAKE & HART LAKE - BYERS LAKE PLUTONS) OF THE CENTRAL COBEQUID HIGHLANDS, NOVA SCOTIA

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CONTENTS

TEXT
GENERAL INTRODUCTION
1. Introduction 4
2. Location and access 4
3. Purpose of present work 5
4. Organisation of this report 5

PART A. FOLLY LAKE DIORITE/GABBRO
1. Introduction
    1.1 Generalities 6
    1.2 Previous work 6
2. Field Geology
    2.1 Major map units 7
    2.2 Mesoscopic and macroscopic relationships between granite and diorite/gabbro 7
    2.3 Geographic variation in rock type and mesoscopic relationships
        2.3.1 Sugarloaf Mountain-Rose area 8
        2.3.2 Portapique River area 9
        2.3.3 Rockland Brook-Transmission Line section 9
        2.3.4 Northwest Folly Lake area 10
        2.3.5 Rory Pond area 11
    2.4 Sequence of igneous events 12
3. Petrography
    3.1 Gabbros
        3.1.1 Fine grained gabbro 12
        3.1.2 Coarse grained gabbro 13
    3.2 Diorite/Gabbro 13
    3.3 Hybrid rocks 14
    3.4 Granodiorite 14
    3.5 Granite
        3.5.1 Granite veins 14
        3.5.2 Granite pods 15
    3.6 Porphyritic mafic dykes 15
    3.7 Rhyolite 15
    3.8 contacts between mafic and felsic rocks
        3.8.1 Granite cut by gabbro dyke 15
        3.8.2 Embayed diorite/gabbro-granite contact 16
        3.8.3 Granite veins in diorite/gabbro 16
        3.8.4 Enclaves 16
4. Notes on geochemistry
    4.1 Granitoid rocks
        4.1.1 Chemical classification of the granitoid rocks 17
        4.1.2 Granite type 17
        4.1.3 Tectonic environment 17
        4.1.4 Geochemical trends with age 17
    4.2 Mafic rocks

4.2.1 Chemical classification and tectonic environments 18
5. Chemical mineralogy 18

PART B- HART LAKE - BYERS LAKE GRANITE
1. Introduction
1.1 General statement 19
1.2 Previous work 19
2. Field Geology
2.1 Major map units 19
2.2 Contact with the Fountain Lake Group 19
3. Petrography 20
4. Notes on geochemistry 21
5. Chemical Mineralogy
5.1 Amphiboles: introduction 22
5.2 Amphibole composition trends 22
5.3 Magmatic-subsolidus and oxidation trends in composition of amphiboles 23

DISCUSSION AND CONCLUSIONS
1. Pluton emplacement 24
2. Age interpretation and correlation with the Fountain Lake Group 24
3. Structural environment during emplacement 24

Acknowledgements 25

References 26

Figure captions 29

TABLES

Part A- FOLLY LAKE DIORITE PLUTON
Table 1A. Modal compositions of representative mafic plutonic rocks from the Folly Lake pluton 30
Table 1B. Modal compositions of representative samples from the felsic dykes and pods in the Folly Lake pluton 31
Table 2. Whole-rock chemical analyses of representative samples (Folly Lake pluton) 32
Table 3. Representative electron microprobe analyses of feldspars 37
Table 4. Representative electron microprobe analyses of biotite 40
Table 5. Representative electron microprobe analyses of amphiboles 41
Table 6. Representative electron microprobe analyses of clinopyroxene 45
Table 7. Representative electron microprobe analyses of chlorite 45

PART B- HART LAKE - BYERS LAKE GRANITE PLUTON
Table 8. Modal compositions of the Hart Lake - Byers Lake pluton 46
Table 9. Whole-rock chemical analyses of representative samples 47

Table 10. Representative electron microprobe analyses of feldspars 51
Table 11. Electron microprobe analyses of amphiboles in representative rock lithologies 52

FIGURES

Fig. 1. General map showing location of the Wentworth pluton 56
Fig. 2. Photographs showing mesoscopic relationships between gabbro and granite. 57
Fig. 3. Field sketches of mesoscopic relationships between gabbro and granite 60
Fig. 4. Photographs of macroscopic relationships between granite and diorite in the Folly Lake quarry . . 61
Fig. 5. Sketch of macroscopic relationships between granite and diorite in the Folly Lake quarry 62
Fig. 6. Si+Na+K vs $^{4+}$Al+Ca for Si-rich amphiboles from Hart Lake - Byers Lake granites 63
Fig. 7. Si vs Na+K for Si-poor calcic amphiboles from Hart Lake - Byers Lake granites 65

APPENDICES

Appendix 1. Catalogue of hand specimens (Folly Lake pluton) 66
Appendix 2. Catalogue of hand specimens (Hart Lake - Byers Lake pluton) 73

MAPS

The following 1:20 000 maps are provided as paper plots and as digital files:
11E/11R, 11S, 11T
11E/12S, 12T, 12V, 12W

A Fieldlog data base is also available in support of this mapping

GENERAL INTRODUCTION

1. Introduction

The Cobequid Highlands are a block of Precambrian and Paleozoic igneous and low-grade metamorphic rocks exposed immediately north of the Cobequid fault zone in northern Nova Scotia. They are bounded to the north by the Carboniferous Cumberland basin and to the south by Carboniferous and Triassic rocks of the Minas basin. Voluminous plutons were emplaced at about the Devonian - Carboniferous boundary (Murphy et al., in press) and associated volcanic rocks of the Fountain Lake Group are several kilometres thick. In the first systematic mapping of the Cobequid Highlands, Donohoe and Wallace (1982, 1985) distinguished two major plutons in the central highlands, the Folly Lake diorite pluton and the Hart Lake - Byers Lake granite pluton. With the Folly Lake pluton, granitic bodies on a variety of scales are common. These granites are geochemically similar to the Hart Lake - Byers Lake pluton. With the Folly Lake pluton, granitic bodies on a variety of scales are common. These granites are geochemically similar to the Hart Lake - Byers Lake pluton. We suggest that all these plutons distinguished by Donohoe and Wallace (1982) are part of a single plutonic complex, which we term the **Wentworth pluton**. The evidence supporting this interpretation is presented later in this report. This report describes the rocks of all but the westernmost part of the Wentworth pluton.

The Wentworth pluton is bounded to the southeast by the Rockland Brook fault, a major crustal lineament with a north-vergent thrust component during pluton emplacement (Pe-Piper and Koukouvelas, 1994), accompanied or followed by significant dextral strike-slip (Miller et al. 1995). The Rockland Brook fault is one of a series of faults forming flower structures that controlled magma pathways and pluton emplacement (Pe-Piper and Koukouvelas, 1994; Koukouvelas et al., 1995). To the northeast, the Wentworth pluton is in contact with a several kilometre thick sequence of felsic and mafic volcanic rocks and interbedded sediments. The rocks are generally steeply dipping and are probably part of a north-vergent thrust sheet (Piper et al. 1996). The Wentworth pluton is bounded to the west by block-faulted late Precambrian basement and minor gabbro intrusions of the Wyvern diorite pluton (Pe-Piper et al., 1994). The relationship of the Wyvern diorite pluton to the Gilbert Mountain granite pluton to the northwest is analogous to the relationship between the Folly Lake diorite pluton and the Hart Lake - Byers Lake granite pluton.

2. Location and access

The Wentworth pluton straddles the southeastern boundary of Colchester County and Cumberland County, Nova Scotia (Fig. 1). Highway No. 104 cuts a north-south cross-section through the pluton, passing through the Folly Lake diorite and its northern contact with the Hart Lake - Byers Lake granite. Numerous north-south trending unpaved roads traverse the pluton; access is also possible along the Canadian National railroad and several electrical transmission lines. Bedrock exposures are found along the highway, roads, transmission lines and streams.

The hills of the Wentworth pluton average 130 meters above the valley floors, with steep valley sides particularly near the southern margin of the Cobequid highlands. Many small lakes and ponds dot the pluton and numerous north-south trending brooks traverse it as well. Much of the area of the pluton is overlain by less than one meter thickness of till, but major valleys have much thicker drift deposits that obscure bedrock.

3. **Purpose of present work**

The purpose of the present work was to map in detail (scale 1:20,000 and in places 1:5,000) the Wentworth plutonic complex; to describe the petrography and mineralogy of the various plutonic phases; and to obtain a set of well-located analytical samples, representative of both lithology and stratigraphy, that will be used in the future for the geological and geochemical evolution of this pluton. These various data are important for assessing the mineral potential of the pluton and surrounding rocks.

4. **Organisation of this report**

In part A of this report, petrological, and geochemical data of the Folly Lake diorite of Donohoe and Wallace (1982) are presented with a short discussion on key field, geochemical and structural observations. In part B, I present petrological and geochemical data of the Hart Lake - Byers Lake pluton granites of Donohoe and Wallace (1982) and give a short discussion on the significance of the amphibole chemistry of these granites. This is followed by a more general discussion and conclusions regarding the broader Wentworth plutonic complex.

Sixty four samples from the Folly Lake pluton and seventy one samples from the Hart Lake - Byers Lake pluton were analyzed for major and trace element and sixteen representative sample from both plutons for REE (analytical methods as in Pe-Piper and Piper, 1989) (Tables, 2 and 9). The detailed interpretation of the geochemistry of these plutons is the subject of an Honours thesis by C. Doucette and will be submitted to the Department of Geology of Saint Mary's University later this year. In this report we present all the analytical data and we will give only a brief account of the general geochemical characteristics of these rocks. No geochemical plots are presented.

A. FOLLY LAKE DIORITE/GABBRO

1. **Introduction**

1.1 General statement and rock nomenclature

The Folly Lake diorite/gabbro is a 30 x 8 km mafic pluton with minor granitic phases, located immediately north of the Rockland Brook fault. It forms the southwestern part of the Wentworth pluton.

The terms diorite and gabbro are both used for mafic plutonic rocks with < 5% quartz and < 10% alkali feldspar in the IUGS nomenclature system. Typical diorite, when compared with typical gabbro, tends to contain hornblende rather than pyroxene and has plagioclase with An < 50% and colour white or nearly so. Diorite commonly has more silica than gabbro (de la Roche et al. 1980). Diorite is generally associated with the calc-alkaline rock series, whereas gabbro is associated with tholeiitic magmas. There is no single agreed criterion for defining whether a rock is gabbro or diorite. The common occurrence of hornblende in mafic phases of the Folly Lake pluton led Donohoe and Wallace (1982) to define the rock as diorite. On the other hand, the bulk chemistry of the pluton is tholeiitic (Pe-Piper et al., 1989); hornblende is commonly secondary after pyroxene, and the plagioclase composition is quite variable. In many instances the rocks have the mineralogical characteristics of diorite, but the chemistry of gabbro. This is probably because an original gabbroic magma crystallised under unusually hydrous conditions. In this report, we use the term diorite/gabbro as a general term for the mafic rocks, reserving gabbro for rocks that in handspecimen have pyroxenes as the dominant ferromagnesian mineral and diorite for certain late-phase rocks that contain primary hornblende.

The Folly Lake pluton is predominantly a diorite/gabbro pluton which locally has granite and hybrid phases that make up 10-40% of the outcrop. The hybrids are the products of mixed mafic and felsic magmas and are identified by their inhomogeneous compositions and gradational relationship to the mafic and felsic rocks in the area.

1.2 Previous Work

The "Folly Lake diorite pluton" was originally mapped by Donohoe and Wallace (1982) at a scale of 1:50,000. The relationships between the diorite/gabbro and minor granite phases are complex and Zeeman (1992) investigated whether these relationships were due to mingling of co-existing immiscible mafic and felsic magmas or sequential intrusion of alternating mafic and felsic magmas. She concluded that the former was the general case. Koukouvelas and Pe-Piper (1995) described large scale structural and petrological relationships between gabbro and granite near the northern margin of the Folly Lake diorite/gabbro in quarry sections at Folly Lake. The main conclusions of this work were: a) much of the observed mylonitic deformation is concentrated in the earliest granite phase, indicating that the granite may have lubricated motion on the fault zone and northward thrusting of the diorite and b) granitic magmas that escaped from the fault zone show complex crosscutting relationships with diorite that indicate continued deformation throughout granitic magma emplacement.

J. Nearing has just completed a series of Ar^{40}/Ar^{39} dates of the various plutonic phases of the Folly Lake pluton as part of his M.Sc thesis: this data was summarised by Nearing (1995). Biotite from diorite/gabbro from the quarry at the north end of Folly Lake gave a flat spectrum and a total gas age of 350 Ma. Isotopic correlation gave an age of 352 Ma. Hornblende in granodiorite from Higgins Mountain road gave a flat spectrum corresponding to 343 Ma.

2. **Field Geology**

2.1 Major map units

The following map units are distinguished:

1. An area in the western part of the pluton consists almost entirely of gabbro/diorite, with granitic phases virtually absent.

2. Most of the eastern part of the pluton consists predominantly of gabbro/diorite, with lesser bodies of granite and minor hybrid lithologies. Map units have been distinguished on the basis of the abundance of granite.

3. The southern margin of the pluton, along the Rockland Brook fault, consists in many places of mylonite. The mylonite is juxtaposed against gneissically deformed late Precambrian metasediments and calc-alkaline plutons (Pe-Piper et al. 1995).

4. At the northern margin of the Folly Lake diorite/gabbro, mafic and felsic intrusive rocks are present in subequal abundances.

2.2 Mesoscopic and macroscopic relationships between granite and diorite/gabbro

Many outcrops show diorite/gabbro-granite contacts that are irregular with lobate contacts (Figs. 2A, 2B, 2C) in which the gabbro is chilled against the granite (Figs. 2A, 3B), or less commonly granite chilled against gabbro (Pe-Piper et al., 1996). Gabbro enclaves in the granite are rounded and many have irregular contacts (Fig. 2B). A few contacts show some mixing between the granite and gabbro phases. The granodiorites are inhomogeneous, exhibiting more felsic and more mafic areas typical of a mixed rock. Some gabbro bodies have net-like dyking by granite with both irregular lobate (Fig. 2C) and straight contacts (Fig. 2D). More voluminous granite intrusion results in the formation of mafic enclaves (Koukouvelas and Pe-Piper, 1996). All these meso-scale textural relationships are similar to those described by Wiebe (1993) as representing injection of mafic magma into a silicic magma chamber.

In places, evidence is seen for syn-magmatic deformation of the plutonic rocks. Pre-full crystallisation fabrics, generally recognisable from aligned feldspars, are seen in some granodiorite near contacts with both gabbro and granite. One outcrop on the Rory's Pond road (Fig. 3B) shows irregular granite veins against which gabbro shows chilled lobate margins shows strong orientation of feldspars in the granite veins, suggesting deformation while the granite was more plastic than the gabbro. In many outcrops, some granite dykes are offset along other dykes, suggesting relative movement of host gabbro blocks during granite intrusion.

Observations in the Permanent-LaFarge quarry north of Folly Lake (Koukouvelas and Pe-Piper, 1995) allow these mesoscopic observations to be placed in a macroscopic context. Here, granite bodies decameters in size have intruded diorite. Although igneous relationships are modified by later faulting, the granite appears to form sheets (Figs. 4A, 5) and domes (Fig. 4B). Several of the granites appear to have been emplaced along SW-dipping thrust faults. The granites contain enclaves of diorite (Fig. 5) and many of the contacts are lobate.

2.3 Geographic variation in rock type and mesoscopic relationships

Several critical areas have been investigated and sampled in detail and a brief account of some of them is given below:

2.3.1 Sugarloaf Mountain-Rose Area: The northwest area of the Folly Lake pluton in the Sugarloaf Mountain-Rose region is a very fine to medium-grained diorite/gabbro with aphanitic to coarse-grained granitic phases which locally make up 20% of the rock. Aphanitic diorite/gabbro and granite are both found on Sugarloaf Mountain. Some of the granite veins in the diorite/gabbro are irregular and have a zone of mixing between them. There are a variety of granitic veins found in the diorite/gabbro, including aplite, porphyritic granite, hybrid, equigranular and pegmatitic granite. The aplite, porphyritic granite and pegmatitic granite all appear to be late veins. Angular inclusions or patches of hybrid rock were found in some granite veins. In one area, vesicular gabbro (sic) has been injected by fine-grained aphanitic gabbro.

Observed structural deformation consists of minor blocky fracturing of the diorite/gabbro and granite, with offsetting of aplite veins. Xenoliths of metasediments in the diorite/gabbro and diorite/gabbro veins in the metasediments are evidence of igneous contacts between the Folly Lake diorite/gabbro and the metasedimentary rocks. Locally, epidote is the main alteration product particularly along fractures.

2.3.2 Portapique River Area: The Portapique River area of the Folly Lake pluton consists of fine grained diorite/gabbro with granite veins, sills and dykes intruding up to 50% of the outcrop. The granite is fine to medium-grained and at several localities pegmatitic.

A few granitic outcrops have a variation in hornblende content from 20-40% suggesting some assimilation of a mafic magma. An inhomogeneous diorite/gabbro with a variation in K-feldspar content and a variation in grain size from fine to medium-grained is evidence of some assimilation of a felsic magma. The mixing of granite and diorite/gabbro magmas produced a hybrid rock. A few of the granite bodies have xenoliths of diorite/gabbro which have been partly digested.

Dykes of contaminated granite (hybrid) are in sharp contact with diorite/gabbro with no chilling of the diorite/gabbro. Granite veins are found in both diorite/gabbro and hybrid rocks. Both angular and partially digested xenoliths of diorite/gabbro have been found in granitic veins and dykes. Only one fine- grained mafic dyke in diorite/gabbro was found with sharp contacts and no granitic veining.

The contact of the Folly Lake diorite/gabbro and Fountain Lake Group rhyolite is sheared and cataclastic in one area, but in another area it was noted that the diorite/gabbro became finer grained towards the contact suggesting that the diorite/gabbro intruded the rhyolite. A fracture was found along a contact between granite and diorite/gabbro but the contact is sharp and may have only provided a zone of weakness. Locally a few shear zones were found in the granite and diorite/gabbro. Localized epidote alteration is found along fractures and shear zones.

2.3.3 Rockland Brook-Transmission Line Section: The middle section of the pluton along Rockland Brook and a local transmission line consists of fine to medium grained diorite/gabbro with hybrid and granite phases locally making up 10-30% of the outcrop. Several granitic pods occur along this section, the largest (400 m across) being in the north half of the section. Gabbroic intrusives were also found in this area. The latter are difficult to distinguish macroscopically from the diorites/gabbros but from the samples taken are generally slightly coarser grained and slightly darker.

The granitic veins and pods vary in composition, texture and grain size. The granite suite includes fine to coarse-grained K-feldspar granites and hybrids (quartz-monzodiorites, tonalites and quartz diorites) with equigranular, inequigranular, porphyritic and pegmatitic textures. Some granitoid veins contain diorite/gabbro xenoliths that are finer grained than the surrounding diorite/gabbro. A diorite/gabbro outcrop exhibited an increase in K-feldspar grains towards a large granitic body, with small granite offshoot veins intruding the diorite/gabbro along straight fractures. There are lobate contacts between the granite and diorite, and in one case chilling of diorite against granite was noted. In most places contacts were gradational between the diorite/gabbro and granitic veins, with the gradational sections of tonalitic composition. Many granitic veins have a mafic reaction rim near the contact.

The southern contact of the largest granite pod in the north is better exposed and exhibits lobate sinuous contacts between the granite and the diorite/gabbro. Near the contact the diorite has plagioclase phenocrysts and the granite has K-feldspar phenocrysts. The granite is classified as a quartz monzodiorite near the contact, becoming more felsic away from the contact, indicating that there was introduction of mafic material from the diorite/gabbro into the granite in the contact zone. The granite pod has areas of reddened granite which generally have more mafic minerals. Other areas of the granite pod are reddened near recognizable fractures.

There is evidence in this area of multiple injection, such as diorite/gabbro cut by hybrid veins and dykes, diorite xenoliths in hybrid rock and an area where there is hybridization of granite and diorite/gabbro contacts in the vicinity of a large granite sill with sharp planar boundaries against the diorite/gabbro. There are many granite veins with sharp straight contacts with the enclosing diorite/gabbro with chilled margins in the granite.

Several gabbro dykes crosscut both diorite/gabbro and granite veins. Aplite veins also crosscut diorite/gabbro and granite veins, having sharp contacts with the diorite/gabbro but locally gradational contacts with the granitoids. The gabbro is fine to coarse grained, locally porphyritic or pegmatitic. Generally, the gabbro has sharp contacts with the granite, with a chilled margin in the gabbro, and gradational contacts with granitic veins. One gabbro body intrudes and crosscuts granitic veining in a hybrid. Two gabbro phases occur in this area, one of which is slightly coarser grained and more mafic and another which looks very similar to the diorite in the area and can only be distinguished microscopically. There is not enough data to determine the relationship between these two gabbros. Alteration in this area consists of minor local epidote alteration in the diorite/gabbro and granite and very local silicification along north-south fractures.

2.3.4 <u>Northwest Folly Lake Area:</u> The diorite/gabbro at the northwest end of the Folly Lake is fine grained with granitic veining. The diorite/gabbro near the contact with the Hart Lake-Byers Lake pluton is very altered but with little granitic veining and little deformation. The contact itself is not exposed.

The contacts between the diorite/gabbro and the granitic veins show lobate relationships, hybridized contacts and the diorite/gabbro in some places appears to fine towards the granitic veins. Cross-cutting the diorite/gabbro and hybrid rocks are aplitic sheets showing pull-apart structures. A mafic dyke crosscuts the diorite/gabbro, hybrid and granite. There is a mild shear zone in this area affecting everything including the late mafic dyke. The only evidence for possible structural deformation during magma emplacement is some alignment of minerals found at a contact between the diorite/gabbro and granite.

2.3.5 <u>Rory Pond Area:</u> The eastern section of the Folly Lake pluton in contact with the Hart Lake-Byers Lake pluton on its north, east and south boundaries and it has been mapped in great detail along Rory Pond area.

The outcrop exposed in the Hart Lake-Byers Lake pluton is mainly granite with some gabbro dykes; the Folly Lake pluton consists of diorite/gabbro and 20-40% granite outcrop.

The granite in the Folly Lake pluton varies from coarse-grained to fine-grained with porphyritic, pegmatitic, aplitic and equigranular textures. The diorites/gabbros are medium to fine grained with 10-20% granitic veining near the contact and 2-5% granitic veining away from the Hart Lake-Byers Lake pluton. Most of the gabbros here appear to intrude the granite with minor assimilation but in two instances an aplitic granite intrudes a gabbro and a gabbro inclusion with irregular margins occurs in a granite.

Many of the diorite/gabbro-granite contacts are very irregular with lobate contacts (Fig. 2A) in which the diorite/gabbro is chilled against the granite (Fig. 2E) or both are chilled against each other. Diorite/gabbro xenoliths in the granite are rounded and many have irregular contacts (Figs. 2C, F). A few contacts have some mixing between the granite and diorite/gabbro phases. The granodiorites are inhomogeneous with one outcrop exhibiting felsic and mafic areas typical of a mixed rock.

This area exhibits many multiple injection features. A hybrid with a diorite/gabbro xenolith is in contact with diorite/gabbro in which the diorite/gabbro has a chilled margin against the hybrid but this diorite/gabbro is also intruded by granite veins. A fine grained diorite/gabbro has rounded inclusions of porphyritic diorite/gabbro and a granite has the same porphyritic diorite/gabbro inclusions. Another outcrop consists of diorite/gabbro with a chilled margin against a hybrid rock that has an irregular contact with a coarse grained granite vein which cross-cuts across both the diorite/gabbro and the hybrid (Fig. 3A). Some of the diorite/gabbro outcrops have net veins with lobate and straight contacts (Fig. 2D) and granite veins offset along another vein.

There is some evidence of structural deformation during magma emplacement. A fine grained granite with pegmatitic pods is intruded by a porphyritic diorite/gabbro in which the diorite/gabbro fines towards the contact with less phenocrysts and with closely spaced fractures parallel to the contact.

There is a granite in contact with what is assumed to be a porphyritic hybrid rock which has an alignment of K-feldspar phenocrysts in the hybrid lithology parallel to the contact. The outcrop as a whole is strongly fractured with random orientation. The same porphyritic hybrid is in contact with diorite/gabbro, in which the contact is lobate. Again there is a fabric near the contact which resembles shearing.

A diorite/gabbro outcrop near the Hart Lake-Byers Lake pluton is chilled against granite veins. The granite veins show an oblique mineral fabric that suggests shearing, and the diorite/gabbro has tension gashes, and is cut by a late granite vein (Fig. 3B). Many of the late straight sided granite veins show dextral offsets.

The granite is locally fractured in many areas but there is no evidence that this is due to magma emplacement. Fracturing is more likely due to movement on the Rockland Brook fault which is in relatively close proximity. In general the granite outcrops look more altered and deformed than the diorite/gabbro which suggests that the granite is older. In one fractured granite outcrop there are rare altered mafic stringers near a diorite contact. There are mafic inclusions in the diorite which are either diabase or the Folly schist. An inhomogeneous granodiorite and a fractured granite are cut by a diabase dyke. The only notable alteration is local epidotization of the granite.

2.4 Sequence of igneous events

In the Rory's Pond and Higgins Mountain areas, the following sequence of igneous phases can be inferred (Pe-Piper et al., 1996), from oldest to youngest:

1. An early granite phase on Rory's Pond road that is altered and fractured.
2. The main diorite/gabbro phase
3. Granite that shows lobate contacts with main diorite/gabbro phase and is thus probably synchronous. The hybrid rocks and granodiorites may also be synchronous.
4. Granite forming cross-cutting dykes and containing diorite/gabbro enclaves. Pegmatites and aplites are probably synchronous.
5. Coarse hornblende gabbro dykes and minor porphyritic gabbro dykes.
6. Small diabase dykes.

3. **Petrography**

The Folly Lake pluton is made up mainly of mafic lithologies: gabbros and diorites. Subordinate lithologies include hybrid rocks (tonalites, granodiorites, monzodiorites and granites) and felsic rocks (alkali-feldspar granites). Modal analyses of the representative lithologies are given in Tables 1A and B.

3.1 Gabbros

3.1.1 Fine-Grained Gabbro: This gabbro is fine to medium-grained with subophitic texture and is composed of augite, plagioclase and varying amounts of actinolite. The augite grains are anhedral to subhedral and commonly rimmed with actinolite. Actinolite alteration of the augite varies from weak to strong, with most of the actinolite in the form of fine grained aggregates. The plagioclase grains are euhedral to subhedral and moderately to strongly altered to clay minerals. Many of the plagioclase crystals are zoned. A few of the samples have large plagioclase xenocrysts with strong sericite alteration and surrounded by a corona of actinolite. The opaque minerals form 5-15% of the rock and consist of anhedral to euhedral grains of magnetite and lesser pyrite. Some of the opaque minerals exhibit skeletal crystal form. Accessory minerals include prismatic apatite, sphene, biotite, zircon, quartz and chlorite.

3.1.2 Coarse Grained Gabbro: This gabbro is medium to coarse-grained with subophitic to seriate texture and is composed of plagioclase, actinolite and augite. It is distinguished from the previous gabbro by its coarser texture and lesser amount of augite. The augite is subhedral with weak to moderate actinolite alteration along fractures and on its periphery. The plagioclase is subhedral to euhedral and moderately to strongly altered to clay minerals. Some of the feldspar has a distinctive tartan pattern under crossed nicols indicative of microperthite. Greenish-blue actinolite commonly occurs as fine grained aggregates, probably formed at the expense of hornblende since remnant hornblende can be seen in these aggregates. Opaque minerals form less than 5% of the rock and are composed of magnetite, some with skeletal crystal form. Accessories include prismatic apatite, hornblende, biotite, sphene, chlorite and epidote.

3.2 Diorite/Gabbro

The diorite/gabbro of the Folly Lake pluton is fine to medium-grained with subophitic texture and consists of plagioclase, hornblende and lesser biotite. Plagioclase occurs as subhedral to euhedral grains commonly partially altered into sericite and clay minerals, and up to 10% are zoned with altered cores. Porphyritic diorite/gabbro samples have subophitic to seriate texture and contain large plagioclase phenocrysts, which are more altered than the smaller grains. Hornblende occurs as anhedral to subhedral olive green grains with biotite overgrowths and actinolite alteration around the edges. The biotite is dark brown and anhedral to subhedral. Magnetite and minor pyrite crystals, many with dendritic and skeletal crystal form, compose the opaque minerals which occur with the biotite and hornblende. Some of the magnetite is titanomagnetite. Prismatic crystals of ilmenite are often associated with magnetite in the amphiboles. Ilmenite also occurs as isolated anhedral crystals. Chalcopyrite is present in small amounts, occurring as small anhedral crystals associated with pyrite. Accessory minerals include needle-like apatite crystals (quenched), minor chlorite patches, weak pervasive epidote alteration, minor interstitial quartz and traces of rutile, sphene, zircon and augite.

3.3 Hybrid Rocks

The hybrid rocks are fine to medium-grained and composed mainly of quartz and feldspar with lesser amounts of hornblende and biotite. The numerous textures exhibited, such as subophitic, ophitic, granular and consertal with two or more in each sample, supports the conclusion they are hybrid rocks. The feldspars are all strongly altered, particularly within the plagioclase cores. Some of the quartz and alkali-feldspar exhibit micrographic texture typical of the granite in the area. Some of the quartz grains exhibit coronas of epidote indicating some disequilibrium. The hornblendes are typical of those found in the diorite/gabbro, with moderate to strong actinolite alteration and biotite overgrowths. Opaque minerals form less than 5% of the rock compositions and they are magnetite with some titanium enrichment. Accessory minerals include needle-like apatite, sphene, zircon and epidote and chlorite alteration. The better homogenized hybrid rocks resemble tonalites and granodiorites.

3.4 Granodiorite

The granodiorites very closely resemble the diorites in handspecimen and it is difficult to distinguish the two. Here the distinction is made on the basis of the ratio of plagioclase to quartz and alkali-feldspar. The colour index and relative abundance of the other minerals is basically the same. They show a variable grain size (very fine-grained to medium-grained) and they are either equigranular or porphyritic. Plagioclase forms an interlocking framework of prismatic crystals with interstitial quartz and alkali-feldspar (orthoclase) which commonly show graphic intergrowths within the pore space. The granodiorites often appear to be hybrid phases.

3.5 Granite

The typical granite away from the influence of the diorite/gabbro is medium to coarse-grained with micrographic texture and consists of alkali-feldspar, quartz, plagioclase and microperthite. Mafic minerals compose less than 5% of the rock and consist of opaque minerals and hornblende altered to actinolite. Accessory minerals include apatite, sphene, epidote and chlorite. Closer to the diorite/gabbro, the quartz-feldspar intergrowth texture decreases and mafic minerals such as hornblende increase slightly. The granites in this pluton occur mainly as veins and pods.

3.5.1 Granite veins: These are rocks very leucocratic with a colour index of 5. Some of these veins are hybridized. They are generally fine to medium-grained with a granitic texture. Alkali-feldspar is present in the form of subhedral grains of perthite and accounts for 65-70%. Anhedral quartz is also fairly abundant, but subhedral twinned plagioclase is rare. Accessory minerals include: hornblende, opaques, biotite, chlorite, zircon, sphene and epidote.

3.5.2 Granite pods: Such pods are very common in the Rockland Brook and Higgins Mountain Road. These granites have a characteristic fine-grained texture with very acicular hornblende crystals. In thin section, they commonly have granophyric or granitic textures and are alkali-feldspar rich granites. Alkali-feldspar is most commonly present in the form of orthoclase-bearing perthite, but may also be found as subhedral orthoclase grains or rims on plagioclase crystals. Quartz is usually anhedral, sometimes cubiform intergrowths with feldspar (usually perthite). Plagioclase content is very variable, sometimes present only in perthite, sometimes reaching as much as 30% in zoned subhedral crystals. Microprobe analysis indicates that it is albite. Olive green actinolitic hornblende is present as imperfect, very elongate crystals. These usually contain complete or partial inclusions of feldspar, quartz, and/or zircon. Rarely, feldspar and quartz inclusions have graphic texture. In some crystals, hornblende has unmixed to form blue-green actinolite. Green biotite occurs in clusters, sometimes having radiating habit. Brown biotite is present in subhedral isolated crystals. Accessory minerals include apatite, opaques, zircon, subhedral sphene, zoned tourmaline, rutile and hematite. The opaques appear to be exclusively magnetite with exsolution of ilmenite. Alteration of hornblende to epidote, plagioclase to clay minerals, orthoclase and perthite to muscovite, and biotite to chlorite is common. Epidote also occurs in secondary veins. Modally they classify as alkali-feldspar granites (Table 1B).

3.6 Porphyritic mafic dykes

These dykes show seriate porphyritic texture produced by zoned plagioclase and clinopyroxene phenocrysts. Unusual megacrysts of plagioclase are strongly altered and partly resorbed or digested by the mafic matrix. The groundmass is predominantly actinolite, plagioclase and tabular opaques.

3.7 Rhyolite

The rhyolites found in the area of the Folly Lake pluton are aphanitic rhyolites, often with a concave fracture. They are either red or grey in colour.

3.8 Petrographic study of contacts between mafic and felsic rocks

3.8.1 Granite cut by gabbro dyke: A straight, sharp contact between a gabbro dyke and granite exhibits no microscopic change in the granite but the mafic rock becomes denser and darker looking towards the contact indicating a chilled margin. The number of large plagioclase grains increases towards the contact and they orient themselves subparallel to the contact. The fine grained groundmass consists of actinolite and epidote with minor opaque minerals. This dyke obviously intruded the granite after the granite cooled. An offset fracture cuts the mafic-felsic contact at an angle but it is a much later feature having no impact on the composition of the rock.

3.8.2 Embayed diorite/gabbro-granite contact: Embayed contacts between diorite/gabbro and granite show margin effects in both lithologies (Plate 8). The diorite has a glomeroporphyritic to seriate texture and becomes finer towards the contact. The granite has 20% or less of quartz-feldspar intergrowth texture and although there is no noticeable decrease in grain size towards the contact, a rim of hornblende crystals follow the contact.

3.8.3 Granite Veins in Diorite/Gabbro: Granite veins in the diorite/gabbro have less than 10% micrographic texture with a mafic rim near the contact. The contacts are irregular and cuspate. Generally there was only a slight increase in mafic content in granite adjacent to the contact, but in one sample hornblende content increased to 20% and formed xenocrysts in the quartz and feldspar grains. The diorite /gabbro host was porphyritic or seriate-textured and became denser and darker towards the vein. The mineralogy of the diorite/gabbro remained unchanged in spite of this apparent contact effect.

3.8.4 Enclaves: Diorite/gabbro enclaves in the granite vary from partially assimilated to distinct blocks. The partially assimilated enclaves have a gradational contact and are composed of quartz, feldspar and hornblende. The feldspar and quartz exhibit intergrowth textures typical of the surrounding granite and the hornblende is rimmed with biotite. The more distinct enclaves exhibit some mixing at the contacts with mafic clots and stringers in the granite and felsic grains with very fine grained mafic coronas in the diorite/gabbro (Plate 9). One observed gabbro enclave in diorite/gabbro has very little mixing but has numerous granite veins intruding it. The contacts between the veins and the diorite/gabbro are irregular and the gabbro is chilled against the veins. The gabbro is composed of porphyritic plagioclase and fine grained actinolite clusters which still retain prismatic shapes of the mineral from which they were formed. There is no appreciable amount of quartz which would indicate mixing with the granite. The granite veins are composed of quartz and feldspar with some micrographic texture but few mafic minerals.

4. **Notes on geochemistry**

For all the following geochemical descriptions we do not present diagrams for two reasons: a) all the discussed diagrams now are well known standard diagrams and b) a subset of this data set has been treated in the same way and the appropriate diagrams can be found in a B.Sc. honours thesis by M.M. Zeeman (1992).

4.1 Granitoid rocks

4.1.1 Chemical classification of the granitoid rocks: Granitoid rocks comprise granites and hybrids. Using the chemical classification system of Streckeisen and LeMaitre (1979) half of the granites plot in the K-feldspar granite field and half plot in the granite field. The early granites, late granites and aplites all plot in both fields. The hybrids plot in the granite and quartz-monzonite fields. Most of the granites are metaluminous in the system of Shand (1951) and only a few are peraluminous. The hybrids are all metaluminous. The molecular proportions of Al_2O_3, Na_2O, and K_2O were plotted on a ternary diagram and all but the hybrids classify as alkali granites using Hermes et al. (1978) fields.

4.1.2 Granite type

Chappell and White (1974) subdivided granites into S-type and I-type. Loiselle and Wones (1979) further recognised A-type granites, which are derived from anhydrous lower crust. Typical features of an A-type granite are micro-graphic intergrowths of quartz and K-feldspar, albite-orthoclase intergrowths and the most common feldspar is K-feldspar (Collins et al., 1982). The granites in the study area have these features. Chemically A-type granites have higher abundances of Nb, Ga, Y and the rare earth elements (REE) and lower abundances of Al, Mg, and Ca with Ga/Al diagnostic (Collins et al., 1982). Whalen et al. (1987) compared various types of granites and plotted Ga/Al values against Zr, Nb, Ce, and Zn to determine fields for A-type granites. Zr versus Ga/Al values were plotted and compared to the field as outlined by Whalen et al (1987) and all plotted in the A-type field. Highly fractionated I-type non-peralkaline granites can be mistaken for A-type granites, but A-type granites have Zr+Nb+Ce+Y values over 375 ppm (Whalen et al., 1987) and the granites in the study area have Zr+Nb+Y values over 375 ppm for all but very few samples.

4.1.3 Tectonic Environment

Using the tectonic environment discrimination diagram and the ocean ridge spidergrams of Pearce et al. (1984) all the studied granitoid rocks classify as within plate-granites.

4.1.4 Geochemical trends with age

No systematic geochemical changes have been recognised between granites interpreted as early and those interpreted as late. Both show fractionation trends similar to those inferred for other Devonian-Carboniferous granites of the Cobequid Highlands (Pe-Piper et al. 1991). This suggests that they were all derived by a similar process from a common source and are not the product of high-level anatectic melting.

4.2 Mafic rocks

4.2.1 Chemical classification and tectonic environments

The mafic rocks include gabbros, diorites and diabases. On an AFM diagram after Irvine and Baragar (1971), most of the diorites plot in the Fe-rich tholeiite field with a few in the calc-alkaline field and in the Mg-rich tholeiite field. The gabbros plot in the Fe-rich and Mg-rich tholeiite field and the calc-alkaline field. The diabases plot in the Mg-rich tholeiite field.

On a TiO_2 versus Zr/P_2O_5 discrimination plot (Floyd and Winchester, 1975) most of the mafic rocks plot in the tholeiite field except for few gabbros which plot outside both fields and some diorites which plot in the alkali basalt field.

On the Zr versus Y discrimination plot of Pearce and Norry (1979) all mafic rocks plot in the within plate basalt field, except for very few diorites that plot in the mid-oceanic ridge basalt (MORB) field.

Finally, spidergrams of representative samples plotted with normalizing values of Thompson et al. (1984) have patterns similar to the olivine-normative continental tholeiites of the West moose River pluton (Pe-Piper et al., 1991).

5. **Chemical Mineralogy**

Mineral analyses of amphiboles, biotite and feldspar across mafic-felsic boundaries are reported by Pe-Piper et al. (1996). Samples from enclaves showed no systematic trends in mineral chemistry. Samples from lobate contacts showed progressive increase in Fe/Fe+Mg in the amphiboles and biotite from within the mafic side, across the contact and into the felsic rock. Similarly, the An content of the plagioclase decreased from the mafic to the felsic rock.

B. HART LAKE - BYERS LAKE GRANITE

1. **Introduction**

1.1 General statement

The Hart Lake - Byers Lake granite forms the northeastern part of the Wentworth pluton. Its southern margin is marked by the Rockland Brook fault. In the southwest, it has a gradational contact with the Folly Lake diorite/gabbro, that has been described in part A of this report. The northern margin of the pluton against the Fountain Lake Group is very poorly exposed and consequently not well understood.

1.2 Previous Work

The petrography and the geochemistry of the Hart Lake - Byers Lake granites have been described by Clarke et al. (1980) and Pe-Piper et al. (1989). Donohoe et al. (1986) obtained a Rb/Sr isochron of 348 ± 5 Ma from the granite and Doig et al. (in press) obtained a U/Pb age on zircon of 362 ± 2 Ma. Nearing (1995) has obtained an $^{39}Ar/^{40}Ar$ age of 363 Ma with a flat spectrum from arfvedsonite in granite.

2. **Field Geology**

2.1 Major map units

The following map units are distinguished:

1. The main granite is a medium-grained orange K-feldspar-rich granite.
2. Locally, pods of coarse granite a few hundred metres in maximum dimension can be mapped.
3. A zone of mylonite several hundred metres wide is developed immediately north of the Rockland Brook fault.
4. Fine grained granite and porphyritic rhyolite occur as E-W striking sheets tens to hundreds of metres wide, particularly at the eastern end of the pluton.

2.2 Contact with the Fountain Lake Group

The western part of the Hart Lake - Byers Lake granite is exposed in the headwaters of the West Branch and Middle Branch of North River. In this region, the transition to Fountain Lake Group is best exposed. The northern margin of the granite is represented by sheets of homogenous very fine granite and porphyritic rhyolite with contacts that dip steeply to the south. North of these rhyolites are porphyritic rhyolites of rather different character, that are locally flow banded, and minor interlayered pyroclastic and volcaniclastic sediments and basalt flows. These volcanic rocks also show steep dips, but younging directions are uncertain.

3. **Petrography**

The Hart Lake-Byers Lake pluton consists principally of several types of granitoid rocks. These granites have been subdivided into ten subgroups on the basis of grain size, texture, colour and mineralogy, all of which are discussed briefly below.

1) The most abundant granite type appears to be the K-feldspar rich medium-grained orange granite which may be found in several localities throughout the pluton. This rock type is relatively equigranular and generally possesses 50-60% K-feldspar. Slight recrystallization is visible in several samples, indicating that these samples have been subjected to ductile deformation. Biotite and hornblende are visible in several samples, but these minerals are not found in all samples.

2) Another abundant granite type is the medium-grained orange quartz-rich granite which is similar to the previously discussed granite. The only visible difference is the relative amount of quartz within the two rock types. The quartz rich type consists of at least 25% quartz grains.

3) Fine-grained orange granites are also relatively abundant in the Hart Lake-Byers Lake pluton. This granitic type is K-feldspar rich and is similar in composition to its medium-grained counterpart.

4) Another type of orange granite is the red-orange granite. It is K-feldspar rich, fine to medium- grained granite with a dark red to red-orange colour. All samples are relatively equigranular and several of the samples appear to be slightly recrystallized .

5) Medium grained white-grey granite. This granitic type is plagioclase rich and appears relatively equigranular in hand specimens. Quartz makes up approximately 20-35% of the samples studied. Hornblende is visible in small amounts in several of the samples.

6) Similar to the white-grey granite is the fine to medium-grained purple-grey granite. Excluding colour, these two rock types appear to be relatively similar. As with its white-grey counterpart, the purple-grey granite is plagioclase rich and is relatively equigranular. Slight recrystallization is visible in several of the samples collected.

7) The most deformed of the granitic types is the altered white granite. These rocks are fine to medium-grained and possess a "chalky" appearance. Due to the fact that these samples are highly altered, it is not possible to estimate composition.

8) Hornblende-rich granites constitute another granite type. This rock type is composed of mostly medium to coarse-grained orange granites, all of which contain at least 20% hornblende. K-feldspar and quartz are

relatively abundant in most samples, making up 50-60% and 25-40% respectively of the samples studied.

9) Another granite found in this pluton is the fine to medium-grained porphyritic granite. These rocks are pink-orange in colour and appear to be slightly recrystallized. All samples contain relatively large feldspar phenocrysts which constitute approximately 10-25% of the granites' total volume.

10) Pegmatitic granites. These rocks are porphyritic, coarse grained orange granites and contain large (2 mm - 2 cm) quartz and feldspar grains.

Along with the granites present, a variety of other rock types are also found within the Hart Lake-Byers Lake pluton. These include: diorites, granodiorites, microgranites (i.e. porphyritic rhyolites), rhyolites, mafic rocks, mylonites, and hybrids. The diorites studied are fine to medium-grained and are relatively equigranular. About half of the samples contain small feldspar phenocrysts which make up less than 10% of the samples' total volume.

The granodiorites present within this pluton are white-grey to dark grey in colour and are fine to medium-grained. Large feldspar phenocrysts, which make up approximately 5-15% of the total sample volume, are visible in about one quarter of the specimens. Quartz grains appear relatively abundant in all rocks of this section.

Fine grained microgranites (i.e., porphyritic rhyolite) are also present within the Hart Lake-Byers Lake pluton. The majority of these rocks are purple to purple-brown in colour and contain 5-15% feldspar phenocrysts.

The rhyolites of this area are fine-grained equigranular and are generally brown-grey in colour. All samples examined are aphanitic.

Various types of mylonites also exist within this pluton. These mylonites appear to be derived from either granite or diorite/gabbro precursors. Elongated plagioclase grains and amphibole grains are visible in several of the samples studied.

Hybrids containing orange granite and diorite/gabbro are also present in the Hart Lake-Byers Lake pluton. These rocks are fine to medium-grained and are generally porphyritic.

The final rock type found within this pluton are deformed mafic rocks. These samples are fine- grained and are relatively equigranular.

4. **Notes on geochemistry**

Geochemically, most Hart Lake - Byers Lake granites are similar to the granite phases of the Folly Lake pluton. A few granites are mildly peralkaline. The geochemistry of these granites will be reported in more detail in a B.Sc. honours thesis by C. Doucette (in preparation).

5. **Chemical Mineralogy**

5.1 Amphiboles: introduction

The Hart Lake-Byers Lake pluton granites contain subhedral-euhedral amphibole grains that generally make up approximately 10% - 30% of the total volume of the rock. These grains are relatively large in most cases, ranging from 0.5 mm to 7 mm in length. No optical zoning is visible in the amphiboles within these granites which commonly possess a graphic texture.

The amphiboles from six fine to medium to coarse grained A-type granites of the Hart Lake-Byers Lake pluton (Samples 35-7-1, 6419, 6970, 6971, 7630 and 7658, Table 2, Appendix 2) have been studied in detail by electron microprobe. The analyzed amphiboles from these samples have been divided, on the basis of their Si, into two groups: Si-poor amphiboles with Si contents ranging from 6.00 to 7.01 and 2) Si-rich amphiboles with Si contents ranging from 6.86 to 8.00. The Si-rich amphiboles (samples 35-7-1, 6419 and 6971) are all found in the coarse grained granites that occur as pods within the pluton. These amphiboles lie in the arfvedsonite field (35-7-1, 6419), the riebeckite field (35-7-1, 6419), the winchite field (6971), the richterite field (35-7-1, 6419, 6971) or the katophorite field (35-7-1) (Fig. 6). The Si-poor amphiboles are all found in fine-medium grained orange granites and they plot in the edenitic hornblende field (7630, 7658), the hornblende field (6477, 6970), or the actinolite field (6970) (Fig. 7).

The Si-poor amphiboles generally possess 42-46 wt% SiO_2 which is accompanied by relatively large concentrations of CaO (10-12 wt%) and MgO (3-9 wt%). FeO_t concentrations within these samples vary from 22 wt% to 27 wt%. A slight rimward decrease in Si content is visible in several samples. This rimward decrease in Si is accompanied by a rimward decrease in Mg in most samples (i.e. normal zoning). The Si-rich amphiboles possess a SiO_2 concentration of 47-53 wt%. In the case of these samples, MgO concentrations are much lower than the Si-poor amphiboles and are centred around 2 wt%. CaO concentrations are also much lower, ranging from approximately 2 wt% to 7 wt%. Na_2O concentrations are relatively high within these samples, centred at approximately 5.5 wt%. Chemical zoning is demonstrated in these amphiboles by a rimward decrease in Fe content and a rimward increase in Mg content.

5.2 Amphibole compositional trends

The type of amphibole present in plutonic rocks is usually characteristic of its chemical composition. Thus, in the silica-saturated to oversaturated rocks two amphibole trends may be found. The first trend occur in the mafic and intermediate rock types (gabbros, monzonites) in which the amphiboles present show a decrease in $Ca+Al^{4+}$ without any change in Si+Na+K (Giret et al., 1980). Here, the principal substitution which takes place is $NaAl^{4+}$ for Si. The second trend occurs in differentiated rocks (peralkaline syenites and granites) which possess amphiboles ranging from katophorite-winchite-richterite-arfvedsonite. The principal substitutions which form the previously discussed solid solution series from katophorite to arfvedsonite are $CaAl^4$ for NaSi and Fe^{3+} for $NaFe^{2+}$. The studied samples 35-7-1, 6971 and 6419 fall into this trend.

5.3 Magmatic-subsolidus and oxidation trends in composition of amphiboles

Two main patterns of compositional variation are associated with the Si-rich amphiboles found in the coarse grained orange granites of the Hart Lake-Byers Lake pluton: 1) a continuous change from katophorite or winchite to richterite to arfvedsonite and 2) a change towards riebeckite. The first pattern involves the change from a magmatic to a subsolidus amphibole and generally utilizes the substitution $Al^{4+}Ca$ for Si(Na,K) in the process (Strong and Taylor, 1984). This pattern is called the magmatic-subsolidus trend. The second pattern represents the hydrothermally formed amphiboles of Strong and Taylor (1984) and involves the substitutions $Fe^{2+}Si$ for $Fe^{3+}Al^{4+}$ and $(K,Na)Fe^{2+}$ for Fe^{3+}. Due to the fact that these two substitutions are oxidation reactions, this trend is called the oxidation trend (Strong and Turner, 1984). The magmatic-subsolidus trend probably developed during the early and late crystallization of the granitic magma followed by the formation of hydrothermal amphiboles at a later stage.

The amphiboles in the sample 6419 lie on both the magmatic-subsolidus trend and the oxidation trend (Fig. 6). This indicates that the amphiboles within this sample were formed by both processes at probable different times throughout the rocks evolution. This trend is more visible in sample 35-7-1 where about half of the amphibole analyses lie on the magmatic-subsolidus trend and half on the oxidation trend.

DISCUSSION AND CONCLUSIONS

1. Pluton emplacement

As the result of our field and petrological work on both the Folly and the Hart Lake-Byers Lake plutons in the last few years, we believe at present that the Folly Lake gabbro and the Hart Lake-Byers Lake granite, as defined by Donohoe and Wallace (1982), together form a large composite pluton, that is the largest igneous body in the Cobequid Highlands. This composite pluton was emplaced along the Rockland Brook fault in latest Devonian time. The Folly Lake gabbro occupies most of the southern and western part of the pluton and the Hart

Lake-Byers Lake granite the northern and eastern part of the pluton. In the contact zone between these two lithologies, mesoscopic and map scale cross-cutting relationships and hybrid phases are observed. Detailed mapping of the pluton shows that along the regional SW-dipping contact of gabbro with granite, granite dykes with mafic enclaves have intruded older gabbro, but locally this gabbro clearly intrudes older granite. In several places the zone between the two lithologies is defined by petrologically transitional phases such as tonalite and granodiorite, some of which are homogeneous (derived from intermediate magma) and others of which show complex mingling of lithologies resulting from mixing of crystal mushes. Homogeneous intermediate rocks commonly form dykes, both parallel to and sub-orthogonal to the mapped contact. In these dykes, or close to the contact, mafic enclaves are abundant. Mafic enclaves are also common in granite veins cutting gabbro near the contact of the major granite and gabbro bodies.

2. **Age interpretation and correlation with the Fountain Lake Group**

The main phase of pluton emplacement in the Cobequid Highlands has been dated at 358-363 Ma by U/Pb on zircon (Doig et al., in press) and by $^{39}Ar/^{40}Ar$ (Nearing, 1995). Rocks yielding these ages are principally granites (including the main Hart Lake - Byers Lake granite) but also include some gabbros in the Cape Chignecto, Pleasant Hills and Wyvern plutons. The only ages from the voluminous diorite/gabbro of the Wentworth pluton are about 350 Ma. Granodiorite from the pluton is as young as 344 Ma.

The Fountain Lake Group consists of several kilometres of Byers Brook Formation, principally felsic volcanic rocks with minor basalt, overlain by < 2 km of Diamond Brook Formation consisting principally of basalt flows. Sedimentary rocks interbedded with or conformably overlying the Diamond Brook Formation contain Tournaisian palynomorphs. U/Pb dates from rhyolites of the Byers Brook Formation range from 356-358 Ma. We suggest that the Byers Brook Formation may be the extrusive equivalent of the main Late Devonian plutonic phase with the Diamond Brook Formation equivalent of the younger voluminous Folly Lake diorite/gabbro.

3. **Structural environment during emplacement**

Mafic enclaves in granite provide a marker for inferring strain during magma emplacement and cooling. Three types of enclaves in granitic dykes are distinguished (Koukouvelas and Pe-Piper, 1996): (I) "chocolate-bar" enclaves with angular margins resulting from extensional disruption; (II) ellipsoidal enclaves forming from type I by shear deformation in granitic dykes and (III) large plastically deformed stoped rafts of gabbro. Type I enclaves show a progressive change to type II as a result of shear deformation in granite dykes. Synmagmatic shear deformation has taken place in shear zones subparallel to the Rockland Brook fault and overall the deformation of ellipsoidal enclaves decreases northward from the Rockland Brook fault. Type III enclaves developed under higher temperature conditions and show plastic deformation and partial mingling with felsic magma.

The multiple injection series of the various phases that make up the Folly Lake pluton have contact features indicating mingling and mixing, mixing of magma with previously solidified rocks and normal intrusive relationships (Pe-Piper et al., 1996). Where there are embayed contacts between mafic and felsic phases mineralogical data indicate that the rocks in both sides were in a fluid state when they came into contact. The early granites, later granites and aplites are all geochemically similar supporting the hypothesis that they were all derived by a similar process from a common source.

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FIGURE CAPTIONS

Fig. 1. General map showing location of the Wentworth pluton and its relationship to previously described plutonic bodies.

Fig. 2. Photographs showing relationships between gabbro and granite, Rory's Pond road (A-D from Pe-Piper et al., 1996). (A) lobate contact between granite and gabbro. (B) irregular contact of gabbro and granite, with the gabbro showing chilling, and a gabbro xenolith in granite. (C) irregular veins of granite in gabbro. (D) Net veining of granite in gabbro (chocolate bar structure of Koukouvelas and Pe-Piper, 1996). (E) Irregular contact between diorite/gabbro and granite, with a chilled margin to the diorite/gabbro. (F) Rounded mafic xenoliths in granite.

Fig. 3. Field sketches of relationships between gabbro and granite, Rory's Pond road (from Pe-Piper et al., 1996). (A) Gabbro with chilled margin against slightly foliated granodiorite, cut by discontinuous coarse granite dykes. (B) Gabbro with chilled margin against granitic veins. Granite veins show a strong mineral fabric. Gabbro cut by tension gashes filled with felsic minerals.

Fig. 4. Photographs of relationship between granite and diorite in the Permanent-LaFarge Folly Lake quarry. (A) N-dipping sheet of granite in diorite; (B) irregular domes of granite in diorite.

Fig. 5. Sketch of relationship between granite and diorite/gabbro in the Folly Lake quarry (from Koukouvelas and Pe-Piper, 1995). At the base of the body (NNE) are 4-m-wide granite dykes including large diorite enclaves. This is separated by 4 m of diorite/gabbro from the main granite body, which is 14 m wide. At the base of this body are numerous small granite dykes into diorite (B). The lower part of the main body includes a lens-shaped zone 6 m in length with abundant small diorite/gabbro enclaves (A). In the upper part of the main body is a larger subcircular diorite enclave. The south-southwestern contact of the granite is irregular.

Fig. 6. (a) Si+Na+K *vs.* $^{4+}$Al+Ca for Si-rich amphiboles from Hart Lake - Byers Lake granite. Ta = taramite; Ba = barroisite; Kt = kataphorite; Wi = winchite; Rt = richterite; Ar = arfvedsonite. Samples: X = 35-7-1; ◊ = 6419; □ = 6971. Fields after Giret et al. (1980).

Fig. 6. (b) Same plot as in Fig. 6a, showing magmatic/subsolidus and oxidation (hydrothermal) trends in amphiboles from silica-saturated peralkaline rocks. Trends after Strong and Taylor (1984).

Fig. 7. Si *vs.* Na+K for Si-poor calcic amphiboles from Hart Lake - Byers Lake granite. Pg = pargasite; Pg Hb = pargasitic hornblende; Ed Hb = edenitic hornblende; Ts Hb = tschermakitic hornblende; Hb = hornblende; Act Hb = actinolitic hornblende; Act = actinolite. Fields after Leake (1978). Samples: X = 6970; + = 7630; □ = 6477; ◊ = 7658.

Table 1A: Modal compositions of representative mafic plutonic rocks from the Folly Lake pluton[1]

Sample	27-1-2	28-7-1	30-1-1	31-4-1	35-8-2	45-4-1
Plagioclase	54.3	48.1	49.8	45.9	43.7	18.5
Plagioclase Phens[2]	-	-	-	-	9.4	39.9
Quartz	1.7	-	-	-	3.3	-
K-feldspar	3.2	2.6	0.5	0.2	-	-
Hornblende	10.5	-	-	10.9	26.2	6.4
Augite	12.5	21.2	14.4	11.5	-	2.0
Actinolite	5.0	6.5	10.1	11.3	4.1	20.1
Biotite	3.6	0.5	11.1	10.9	9.2	3.8
Opaques	5.1	7.4	13.9	6.8	4.0	8.5
Chlorite	3.5	12.7	-	0.8	-	0.7
Epidote	0.8	0.7	0.2	0.3	-	0.2
Apatite	-	0.3	-	1.5	-	-
Total	100.2	100.0	100.0	100.1	99.9	100.1
Colour Index	41.0	49.3	49.7	53.9	43.6	41.6
Field Name[3]	mgdt	mgm	fgm	dt	dt	vpm
IUGS Nomenclature Components						
Plagioclase	91.7	94.9	99.0	99.6	93.0	100.0
Quartz	2.9	-	-	-	7.0	-
Alkali feldspar	5.9	5.1	1.0	0.4	-	-
IUGS Name[4]	DT/GA	GA	DI	GA	QDT/GA	GA

<u>**Notes**</u>

[+] The distinction between gabbro and diorite is based on Colour Index (CI>45 for gabbro) and anorthitic component of the plagioclase (An>50% for gabbro).

[2] Phens = phenocrysts.

[3] For field name abbreviations see appendix 1.

[4] DT = Diorite; GA = Gabbro; DI = Diabase; QD = Quartz diorite.

Table 1B: Modal compositions of representative samples from the felsic dykes and pods in Folly Lake pluton

	dykes		pods		hybrids					sheared inhomog
Sample	28-9-1	29-8-5	28-6-1	31-6-2	28-7-2	28-9-2	31-1-1	32-1-1	33-2-2	32-4-1
Plagioclase[1]	0.72	0.62	-	-	41.3	25.7	41.2	41.8	45.6	41.8
Plagio Phens	-	-	-	-	-	-	-	-	3.4	-
Albite[2]	23.0	27.1	26.5	16.8	-	-	-	-	-	-
Quartz	31.9	28.5	23.7	41.9	13.9	26.9	16.5	21.1	5.4	21.1
K-feldspar	41.5	39.5	44.4	36.3	17.6	27.8	2.8	10.7	17.6	10.7
Hornblende	0.6	3.4	3.0	3.3	9.2	16.1	10.2	1.5	11.7	1.5
Actinolite	-	-	-	-	2.1	2.5	-	4.1	4.0	4.1
Biotite	-	0.5	-	-	7.8	-	6.8	15.1	-	15.1
Opaques	1.3	0.2	1.5	0.5	2.0	0.5	3.5	4.2	3.7	4.2
Chlorite	0.7	0.3	0.7	-	0.6	-	1.7	0.8	1.4	0.8
Epidote	0.2	-	-	1.1	-	0.1	-	0.3	2.4	0.3
Apatite	-	-	-	-	-	-	-	-	5.9	-
Zircon	0.3	-	0.2	-	0.3	-	-	-	-	-
Sphene	-	-	-	-	-	0.3	0.5	0.3	-	0.3
vein/xenolith	-	-	-	-	5.1	-	16.9	-	-	-
Total	100.2	100.1	100.2	99.9	99.9	99.9	100.1	100.0	100.1	99.9
Colour index	3.1	4.4	5.4	5.0	22.0	19.5	22.7	43.8	31.4	26.4
Field Name[3]	f-mgpgg (h)	cgpg	mgopg	f-mgpg	f-mggd	f-mggd	f-mggd	dt(h)	cm	f-mggd
IUGS Nomenclature Components										
Plagioclase	0.7	0.6	-	-	56.7	32.0	68.0	74.4	66.5	56.8
Quartz	32.9	29.8	25.1	44.1	19.1	33.5	27.3	20.1	7.9	28.7
Alkali-feldsp[4]	66.4	69.6	74.9	55.9	24.2	34.6	4.6	5.5	25.7	14.5
IUGS Name[5]	AFG	AFG	AFG	AFG	QMDT/G	G	T	T	QM	G

Notes

[1]: Plagioclase refers to individual plagioclase grains of which composition is unknown

[2]: Plagioclase in perthite structure and as individual crystals

[3]: For field name abbreviations see appendix 1.

[4]: Albite is counted as alkali-feldspar in IUGG calculations

[5]: AFG = Alkali-feldspar granite; QMDT = Quartz monzodiorite; G = granite; T = tonalite; QM = quartz monzonite

Table 2: Whole-rock chemical analyses of representative samples[1]

Sample Number	27-1-2	27-4-1	28-7-2	29-4-1	31-3-1	31-3-2	31-5-1	31-10-1	36-4-1	44-9-2	45-3-1	4620
Major elements by XRF (wt%)												
SiO_2	51.25	50.72	59.43	50.26	51.98	76.27	50.84	49.36	47.63	75.87	47.20	49.83
TiO_2	2.10	1.82	1.38	0.73	2.43	0.24	2.10	1.95	1.99	0.16	3.01	2.16
Al_2O_3	14.37	14.42	14.89	16.27	13.99	12.37	14.66	14.69	15.37	11.78	14.13	14.87
Fe_2O_{3t}	11.05	10.74	8.11	8.75	12.06	0.88	11.33	11.37	11.82	1.90	14.13	11.33
MnO	0.19	0.16	0.14	0.16	0.23	0.02	0.17	0.22	0.22	0.03	0.24	0.18
MgO	5.76	6.49	2.88	7.84	4.64	0.67	5.54	6.44	7.31	0.64	5.75	6.23
CaO	8.36	9.16	3.86	9.69	7.36	0.82	8.38	9.41	9.11	0.09	8.31	9.50
Na_2O	3.15	2.41	3.47	2.85	4.11	2.78	2.74	3.49	2.85	3.51	2.68	3.36
K_2O	1.41	1.19	3.57	0.82	1.61	5.55	1.59	1.28	1.25	4.83	1.37	1.05
P_2O_5	0.36	0.30	0.34	0.12	0.49	0.03	0.35	0.25	0.30	0.02	0.50	0.37
L.O.I	0.70	1.50	1.00	1.50	0.50	0.20	0.80	0.70	1.00	0.20	0.70	0.20
Total	98.70	98.91	99.07	98.99	99.40	99.83	98.50	99.16	98.85	99.03	98.02	99.08
Trace elements by XRF (ppm)												
Ba	402	190	871	265	540	176	291	213	443	40	400	285
Rb	55	55	125	20	62	138	71	62	59	186	65	36
Sr	341	293	239	414	319	77	288	290	362	5	341	349
Y	36	50	61	14	48	92	39	36	30	66	48	34
Zr	260	231	516	62	334	643	290	182	148	303	250	226
Nb	16	23	26	<5	21	46	20	15	10	46	21	16
Th	<10	<10	<10	<10	<10	39	<10	<10	<10	16	<10	<10
Pb	14	<10	<10	<10	47	88	<10	15	20	13	116	<10
Ga	22	21	21	18	21	23	20	22	21	24	25	19
Zn	144	120	95	85	213	57	125	164	155	36	295	117
Cu	57	67	28	92	54	30	42	72	74	<5	58	44
Ni	51	79	25	130	37	7	71	92	91	7	53	68
V	266	240	151	268	304	9	247	315	275	<5	355	255
Cr	152	182	46	498	86	33	150	183	185	41	76	166
REE and selected trace elements by INAA (ppm)												
La	24.10	n.d.	45.90	n.d.	n.d.	n.d.	n.d.	n.d.	13.60	n.d.	n.d.	n.d.
Ce	56.30	n.d.	102	n.d.	n.d.	n.d.	n.d.	n.d.	33.50	n.d.	n.d.	n.d.
Nd	31.00	n.d.	50.70	n.d.	n.d.	n.d.	n.d.	n.d.	18.90	n.d.	n.d.	n.d.
Sm	6.93	n.d.	10.60	n.d.	n.d.	n.d.	n.d.	n.d.	4.73	n.d.	n.d.	n.d.
Eu	1.99	n.d.	2.27	n.d.	n.d.	n.d.	n.d.	n.d.	1.73	n.d.	n.d.	n.d.
Tb	1.10	n.d.	1.64	n.d.	n.d.	n.d.	n.d.	n.d.	0.92	n.d.	n.d.	n.d.
Yb	3.52	n.d.	5.47	n.d.	n.d.	n.d.	n.d.	n.d.	2.70	n.d.	n.d.	n.d.
Lu	0.55	n.d.	0.84	n.d.	n.d.	n.d.	n.d.	n.d.	0.43	n.d.	n.d.	n.d.
Co	37.40	n.d.	19.10	n.d.	n.d.	n.d.	n.d.	n.d.	47.90	n.d.	n.d.	n.d.
Hf	5.66	n.d.	12.10	n.d.	n.d.	n.d.	n.d.	n.d.	3.54	n.d.	n.d.	n.d.
Sc	30.40	n.d.	18.50	n.d.	n.d.	n.d.	n.d.	n.d.	32.00	n.d.	n.d.	n.d.
Ta	1.14	n.d.	1.82	n.d.	n.d.	n.d.	n.d.	n.d.	0.83	n.d.	n.d.	n.d.
Th	4.21	n.d.	11.00	n.d.	n.d.	n.d.	n.d.	n.d.	1.53	n.d.	n.d.	n.d.
U	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Table 2 (continued)

Sample Number	4640	4641	4642	4648	4649	4650	4651	4652	4653	4654	4656	4657
Major elements by XRF (wt%)												
SiO_2	70.88	70.04	71.78	73.62	44.83	73.03	73.48	73.52	44.53	76.07	76.34	75.81
TiO_2	0.49	0.45	0.43	0.21	3.13	0.20	0.22	0.20	3.06	0.14	0.15	0.21
Al_2O_3	13.87	14.25	13.55	13.58	14.57	13.75	13.45	13.61	14.36	12.87	11.88	12.32
Fe_2O_{3t}	3.49	3.48	3.27	2.22	14.24	2.33	1.94	2.10	13.78	0.80	1.77	2.30
MnO	0.07	0.07	0.06	0.05	0.37	0.06	0.03	0.06	0.30	0.02	0.03	0.04
MgO	1.01	1.05	1.10	0.84	6.16	0.83	1.04	0.77	6.61	0.85	0.69	0.70
CaO	1.29	0.92	0.74	0.52	8.31	0.57	0.34	0.64	9.50	0.43	0.16	0.31
Na_2O	4.65	2.07	3.59	3.95	2.67	3.84	4.28	4.05	3.11	3.77	3.31	3.57
K_2O	4.39	5.36	4.94	5.21	1.69	5.14	5.03	5.21	1.08	4.58	5.32	5.92
P_2O_5	0.11	0.10	0.10	0.04	0.84	0.05	0.04	0.04	0.82	0.03	0.01	0.02
L.O.I	0.40	0.90	0.80	0.40	1.80	0.20	0.50	0.20	1.80	0.60	0.00	0.00
Total	100.65	98.69	100.36	100.64	98.61	100.00	100.35	100.40	98.95	100.16	99.66	101.20
Trace elements by XRF (ppm)												
Ba	642	599	555	168	524	204	158	248	394	133	57	125
Rb	166	212	210	272	191	240	211	258	114	205	206	169
Sr	109	91	88	34	262	39	30	37	282	55	11	13
Y	48	53	50	84	49	84	124	88	43	82	78	85
Zr	295	324	250	268	309	286	298	268	273	218	276	370
Nb	23	20	19	49	26	51	56	51	24	67	46	45
Th	14	17	29	33	<10	21	19	27	<10	31	19	15
Pb	<10	41	23	22	<10	<10	<10	17	15	119	11	<10
Ga	19	19	19	24	20	25	23	21	22	23	25	25
Zn	51	72	50	37	159	32	27	34	249	33	40	70
Cu	<5	<5	<5	<5	30	<5	<5	<5	40	17	<5	<5
Ni	6	<5	9	<5	78	9	9	8	85	8	7	6
V	15	15	6	<5	320	<5	<5	<5	316	<5	<5	<5
Cr	32	34	40	24	137	40	34	27	110	24	34	34
REE and selected trace elements by INAA												
La	n.d.	n.d.	n.d.	n.d.	30.01	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ce	n.d.	n.d.	n.d.	n.d.	68.86	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nd	n.d.	n.d.	n.d.	n.d.	38.64	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sm	n.d.	n.d.	n.d.	n.d.	8.94	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Eu	n.d.	n.d.	n.d.	n.d.	3.24	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Tb	n.d.	n.d.	n.d.	n.d.	1.12	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Yb	n.d.	n.d.	n.d.	n.d.	3.92	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Lu	n.d.	n.d.	n.d.	n.d.	0.60	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Co	n.d.	n.d.	n.d.	n.d.	44.17	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Hf	n.d.	n.d.	n.d.	n.d.	6.57	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sc	n.d.	n.d.	n.d.	n.d.	35.43	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ta	n.d.	n.d.	n.d.	n.d.	1.61	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Th	n.d.	n.d.	n.d.	n.d.	1.25	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
U	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Table 2 (continued)

Sample Number	4658	4660	4662A	4662B	5052	5053	5054	5055	5056	5059	5060	5061
Major elements by XRF (wt%)												
SiO_2	77.33	75.38	54.29	72.14	46.30	47.16	48.29	51.37	64.43	54.32	76.62	47.26
TiO_2	0.11	0.20	2.42	0.33	3.12	3.06	2.81	2.50	0.86	1.33	0.15	2.93
Al_2O_3	11.64	12.34	14.56	14.37	13.79	14.26	14.08	14.26	15.80	14.93	11.80	14.63
Fe_2O_{3t}	1.87	2.25	10.98	1.65	15.35	15.38	14.38	13.35	5.37	9.44	1.79	15.15
MnO	0.03	0.04	0.20	0.05	0.33	0.26	0.22	0.24	0.07	0.18	0.02	0.25
MgO	0.72	0.68	3.53	1.11	5.96	5.49	5.91	5.02	1.05	5.57	0.00	5.88
CaO	0.15	0.18	5.41	1.11	8.49	8.42	8.50	8.09	2.62	6.99	0.10	8.73
Na_2O	3.42	3.99	3.47	4.69	2.58	2.93	2.94	3.10	3.44	2.69	3.02	3.00
K_2O	4.74	5.06	2.47	4.61	1.99	1.38	1.54	1.55	5.47	2.51	5.09	1.21
P_2O_5	0.01	0.02	0.73	0.07	0.55	0.51	0.43	0.36	0.20	0.23	0.01	0.48
L.O.I	0.00	0.20	0.60	0.20	0.80	0.50	0.90	0.60	0.60	1.80	0.00	0.40
Total	100.02	100.34	98.66	100.33	99.26	99.35	100.00	100.44	99.91	99.99	98.60	99.92
Trace elements by XRF (ppm)												
Ba	24	113	465	650	283	393	365	323	669	468	47	384
Rb	197	178	139	83	265	72	97	66	176	131	201	52
Sr	9	9	255	162	272	359	325	253	148	233	7	369
Y	63	60	73	31	54	50	44	54	93	45	57	50
Zr	371	369	488	196	259	255	225	323	579	297	276	239
Nb	73	44	39	19	28	22	21	23	50	25	71	18
Th	15	12	11	<10	<10	<10	<10	<10	19	<10	16	<10
Pb	34	<10	38	<10	52	55	16	27	30	36	20	82
Ga	26	24	23	12	24	23	26	25	23	18	22	24
Zn	55	90	270	90	508	262	160	145	68	122	47	256
Cu	5	<5	40	<5	73	74	52	39	10	53	6	64
Ni	9	6	17	6	56	38	55	47	6	101	<5	52
V	<5	<5	212	15	306	359	341	286	49	161	<5	324
Cr	32	21	19	28	54	74	74	62	12	158	19	64
REE and selected trace elements by INAA (ppm)												
La	n.d.	n.d.	n.d.	n.d.	26.16	24.53	23.90	29.73	n.d.	n.d.	n.d.	21.73
Ce	n.d.	n.d.	n.d.	n.d.	58.55	57.89	55.03	66.97	n.d.	n.d.	n.d.	51.26
Nd	n.d.	n.d.	n.d.	n.d.	38.27	36.40	27.61	32.03	n.d.	n.d.	n.d.	30.85
Sm	n.d.	n.d.	n.d.	n.d.	8.56	7.96	7.34	8.40	n.d.	n.d.	n.d.	7.34
Eu	n.d.	n.d.	n.d.	n.d.	2.77	2.69	2.36	2.32	n.d.	n.d.	n.d.	2.62
Tb	n.d.	n.d.	n.d.	n.d.	1.50	1.55	1.24	1.28	n.d.	n.d.	n.d.	1.31
Yb	n.d.	n.d.	n.d.	n.d.	5.25	4.49	4.17	5.07	n.d.	n.d.	n.d.	4.19
Lu	n.d.	n.d.	n.d.	n.d.	0.74	0.61	0.59	0.72	n.d.	n.d.	n.d.	0.54
Co	n.d.	n.d.	n.d.	n.d.	56.25	58.44	49.44	45.10	n.d.	n.d.	n.d.	54.82
Hf	n.d.	n.d.	n.d.	n.d.	6.16	6.35	4.98	6.75	n.d.	n.d.	n.d.	5.70
Sc	n.d.	n.d.	n.d.	n.d.	33.16	36.94	33.96	32.87	n.d.	n.d.	n.d.	35.10
Ta	n.d.	n.d.	n.d.	n.d.	2.18	1.42	1.22	1.38	n.d.	n.d.	n.d.	1.39
Th	n.d.	n.d.	n.d.	n.d.	4.25	2.97	2.84	3.29	n.d.	n.d.	n.d.	2.15
U	n.d.	n.d.	n.d.	n.d.	1.46	0.61	0.91	0.98	n.d.	n.d.	n.d.	n.d.

Table 2 (continued)

Sample Number	5062	5066	5067	5068	5069	5070	6384	6387	6390	6761	6780	6796
Major elements by XRF (wt%)												
SiO_2	46.96	46.78	77.06	48.08	59.77	49.98	47.36	46.86	47.10	46.80	52.40	46.68
TiO_2	3.10	3.02	0.15	2.98	1.22	1.88	1.93	3.67	2.61	1.77	2.63	1.77
Al_2O_3	14.09	14.30	11.35	14.08	14.65	15.06	15.32	11.67	14.36	16.66	13.66	16.88
Fe_2O_{3t}	15.46	15.65	1.78	15.02	8.20	12.16	12.11	17.22	13.82	11.15	14.13	12.15
MnO	0.24	0.48	0.02	0.43	0.13	0.28	0.20	0.33	0.20	0.41	0.31	0.21
MgO	5.65	5.87	0.00	5.45	3.32	5.78	7.25	3.98	5.80	7.36	2.99	7.66
CaO	8.93	7.38	0.25	8.13	5.14	9.07	10.06	8.96	10.78	7.57	5.72	10.16
Na_2O	3.02	3.35	2.79	3.19	3.38	2.45	2.50	3.40	2.31	3.00	3.88	2.72
K_2O	1.12	1.10	5.11	1.51	3.03	1.56	0.95	1.63	1.11	1.63	2.56	0.71
P_2O_5	0.48	0.50	0.01	0.50	0.19	0.25	0.30	1.71	0.44	0.31	1.25	0.27
L.O.I	0.90	1.00	0.10	0.90	0.50	0.70	0.90	0.40	1.40	2.50	0.83	1.44
Total	99.95	99.43	98.62	100.27	99.53	99.17	98.88	99.83	99.93	99.16	100.36	100.65
Trace elements by XRF (ppm)												
Ba	289	268	45	346	250	634	231	1080	174	610	749	348
Rb	52	57	201	98	125	68	43	82	93	99	94	27
Sr	336	275	10	286	199	301	343	319	298	343	309	386
Y	58	70	87	56	74	33	32	76	40	30	80	24
Zr	238	244	282	256	336	200	162	369	222	169	303	127
Nb	19	21	61	23	42	15	15	28	18	14	34	11
Th	<10	<10	19	<10	15	<10	<10	<10	<10	<10	<10	<10
Pb	29	63	23	59	19	73	45	16	54	49	101	113
Ga	24	23	22	29	23	18	18	24	21	23	25	20
Zn	170	601	42	529	120	218	106	154	169	727	233	229
Cu	63	65	<5	56	13	86	70	21	63	82	41	100
Ni	43	47	<5	44	38	52	94	11	61	95	<5	107
V	361	372	<5	354	124	270	209	133	304	202	121	245
Cr	65	70	39	64	64	134	179	<5	161	170	<5	181
REE and selected trace elements by INAA (ppm)												
La	41.64	31.82	n.d.	29.31	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ce	66.96	58.26	n.d.	63.83	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Nd	36.81	36.61	n.d.	33.99	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sm	9.13	9.33	n.d.	8.96	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Eu	2.69	2.47	n.d.	2.71	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Tb	1.41	1.75	n.d.	1.52	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Yb	4.41	5.43	n.d.	5.38	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Lu	0.63	0.77	n.d.	0.71	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Co	55.21	52.25	n.d.	52.50	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Hf	5.70	5.97	n.d.	6.32	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sc	36.72	37.34	n.d.	38.24	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ta	1.68	1.50	n.d.	1.76	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Th	2.49	2.34	n.d.	4.19	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
U	0.61	1.07	n.d.	1.16	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	3.20	1.30

Table 2 (continued)

Sample Number	6827	6828	6840	6903	7359	7360	7361	7363	7372	7373	7374	7375
Major elements by XRF (wt%)												
SiO_2	47.60	43.87	47.66	45.18	76.63	77.53	46.94	50.55	76.20	75.72	75.44	52.79
TiO_2	2.11	2.76	1.98	3.01	0.14	0.10	1.70	2.31	0.22	0.25	0.27	1.82
Al_2O_3	15.12	14.30	14.18	15.44	12.45	12.45	16.77	14.72	11.99	12.09	11.86	15.49
Fe_2O_{3t}	13.11	20.62	15.04	15.03	0.77	0.49	11.84	12.62	1.82	2.35	3.08	10.89
MnO	0.30	0.35	0.27	0.48	0.01	0.01	0.20	0.20	0.04	0.05	0.03	0.17
MgO	6.48	4.02	6.85	6.77	0.03	0.06	7.86	5.53	0.31	0.28	0.25	5.13
CaO	10.44	6.20	11.11	9.22	0.24	0.51	10.64	8.89	0.30	0.71	0.73	8.44
Na_2O	2.53	0.55	2.33	2.56	2.33	3.68	2.59	3.19	3.63	3.78	2.89	3.34
K_{20}	1.29	4.33	0.44	1.45	7.06	4.80	0.60	1.41	4.81	4.69	5.49	1.48
P_2O_5	0.29	0.37	0.18	0.61	0.02	0.02	0.25	0.40	0.03	0.03	0.03	0.30
L.O.I	1.27	2.57	0.70	0.99	0.29	0.36	1.21	0.74	0.46	0.29	0.32	0.76
Total	100.54	99.94	100.74	100.74	99.97	100.01	100.60	100.56	99.81	100.24	100.39	100.61
Trace elements by XRF (ppm)												
Ba	421	1898	235	463	554	111	343	463	126	127	208	395
Rb	117	66	8	65	189	144	22	52	200	189	218	60
Sr	347	123	195	384	113	38	368	344	26	36	52	325
Y	34	39	31	39	26	25	22	42	96	95	119	47
Zr	165	190	126	203	81	107	118	277	488	482	693	281
Nb	13	17	10	16	29	24	10	20	70	59	57	24
Th	<10	<10	<10	<10	<10	13	<10	<10	11	<10	15	<10
Pb	47	<10	<10	91	19	<10	55	14	<10	<10	15	17
Ga	21	18	20	22	20	15	19	22	27	27	25	21
Zn	202	94	190	235	43	43	204	150	70	98	75	151
Cu	137	45	221	78	17	22	90	92	45	26	16	107
Ni	51	66	87	76	27	<5	106	47	<5	<5	<5	50
V	282	378	366	334	<5	14	242	294	13	21	16	244
Cr	217	174	157	134	<5	<5	220	158	<5	14	<5	157

Sample Number	7664	7710	7773	7774
Major elements by XRF (wt%)				
SiO_2	56.60	75.85	48.36	53.83
TiO_2	1.14	0.23	3.03	0.87
Al_2O_3	17.27	11.91	13.40	11.24
Fe_2O_{3t}	7.65	2.54	15.02	9.76
MnO	0.19	0.04	0.41	0.22
MgO	3.74	0.09	5.51	10.57
CaO	5.95	0.40	8.69	7.20
Na_2O	4.36	3.91	3.25	1.56
K_2O	2.02	4.77	1.00	1.46
P_2O_5	0.26	0.02	0.40	0.14
L.O.I	1.49	0.29	1.60	2.94
Total	100.67	100.05	100.67	99.79
Trace elements by XRF (ppm)				
Ba	958	125	551	441
Rb	65	213	34	46
Sr	423	18	354	173
Y	20	93	45	20
Zr	143	787	247	111
Nb	10	56	18	10
Th	<10	10	<10	<10
Pb	12	10	<10	18
Ga	18	29	22	13
Zn	169	138	153	147
Cu	159	18	130	38
Ni	25	<5	44	246
V	166	10	368	175
Cr	41	<5	111	896

Table 3: Representative electron microprobe analyses of feldspars

Sample Number	Rock[1]	Crystal	Pos'n	Min'l	An	Ab	Or
31-6-2	f-mgpg	C1	core	Ab	5.4	93.3	1.4
		C1	rim	Ab	2.6	96.4	1.1
		C2	core	Ab	2.1	96.6	1.2
		C2	core	Ab	0.8	98.7	0.5
		C3	core	Ab	1.4	97.3	1.3
		C3	rim	Ab	0.4	81.2	18.4
		C4	rim	Ab	5.3	94.0	0.7
		C4	rim	Ab	5.7	93.6	0.6
31-9-2	m-cgm	C1	core	Lab	57.0	41.9	1.1
		C1	rim	Lab	54.4	43.9	1.6
		C1	rim	Lab	55.0	43.6	1.4
		C2	core	And	47.7	50.3	1.9
		C2	rim	And	38.0	59.1	2.9
		C2	rim	And	49.9	48.3	1.8
		C3	core	Lab	52.0	46.3	1.7
		C3	inter	Lab	61.7	37.3	1.0
		C3	rim	And	49.0	49.2	1.7
35-7-1	cgpg	C1	core	Ab	0	99.4	0.6
		C1	rim	Ab	0	99.7	0.3
		C1	rim	Ab	0.05	99.6	0.4
		C2	core	Ab	0	98.8	1.2
		C2	rim	Ab	0	99.8	0.2
		C3	core	Ab	0	99.6	0.4
35-7-1	cgpg	C3	core	Ab	0	99.6	0.4
		C3	rim	Ab	0	99.8	0.2
		C4	core	Ab	0	99.5	0.5
		C4	rim	Ab	0	99.6	0.4
35-8-2	dt	C1	core	Olig	27.8	70.8	1.4
		C1	rim	And	40.3	58.6	1.1
		C2	core	And	33.2	64.1	2.7
		C2	rim	And	30.4	68.0	1.5
		C3	core	Byt	74.2	25.3	0.6
		C3	rim	Byt	74.8	24.8	0.9
		C4	core	Olig	24.3	72.9	2.8
		C4	rim	Olig	29.3	69.6	1.1
Sample Number	Rock	Crystal	Pos'n	Min'l	An	Ab	Or
		C5	core	And	31.2	66.0	2.8
		C5	core	And	37.6	60.6	1.9
		C5	rim	Olig	26.6	71.1	2.3
		C6	core	Byt	72.6	26.6	0.8
		C6	rim	Byt	73.3	25.8	0.9
		C7	core	And	44.4	53.9	1.7
		C7	rim	Olig	12.2	25.9	61.8
		C7	rim	Olig	29.8	68.1	2.1
		C8	core	Lab	51.8	46.7	1.5
		C8	rim	And	42.3	56.9	0.7
		C8	rim	Olig	29.2	69.0	1.8
		C8	rim	K-feld	12.5	34.7	52.8
5048	felsic	C1	core	Ab	5.4	94.6	0.0

(f-mgpgg)		C2	rim	Ab	5.8	93.9	0.3
		C2	rim	Ab	6.4	93.3	0.3
	contact	C3	core	K-feld	0.0	4.4	95.6
	contact	C3	rim	K-feld	0.0	6.4	93.6
	mafic	C4	core	Ab	6.9	92.7	0.4
		C4	rim	Olig	16.5	83.0	0.5
		C5	core	Olig	12.3	86.0	1.7
5052	dt(h)	C1	core	Lab	52.6	45.7	1.7
		C1	rim	Lab	61.0	38.5	0.5
		C2	core	Lab	54.2	44.4	1.4
		C2	rim	Lab	59.6	39.7	0.7
		C3	core	Lab	54.0	45.4	0.6
		C3	rim	Lab	60.3	39.0	0.7
		C4	core	Olig	11.5	87.0	1.5
		C5	rim	Olig	11.1	88.9	0
		C6	core	Olig	15.2	84.3	0.4
		C6	rim	Olig	15.3	84.3	0.4
5057	mafic	C1	core	Lab	60.1	39.5	0.5
(f-mggd)		C1	rim	Lab	58.0	38.8	3.2
	felsic	C2	core	K-feld	0.0	4.7	95.3
		C2	core	Ab	2.7	91.9	5.4
		C2	rim	K-feld	0.0	6.9	93.1
		C3	core	K-feld	0.0	6.4	93.6
	contact	C4	core	Ab	5.1	93.6	1.3

Sample Number	Rock	Crystal	Pos'n	Min'l	An	Ab	Or
		C4	rim	Ab	2.0	97.6	0.5
5059	mgm	C1		Olig	25.8	73.8	0.3
		C2		Olig	12.4	86.4	1.2
5062	dt	C1	rim	Olig	12.3	87.0	0.7
		C2	core	Olig	25.1	73.0	1.9
		C3	rim	Olig	24.0	74.4	1.6
		C4	core	Olig	18.8	80.6	0.7
		C5	rim	Ab	4.8	95.2	0.0
		C6	rim	Olig	25.0	74.2	0.8
		C7	core	And	41.1	58.6	0.3
		C8	core	Lab	59.5	40.1	0.4
		C8	rim	And	44.6	50.3	5.1
5122	felsic	C1	core	Ab	3.5	95.4	0.9
dt(h)		C1	rim	K-feld	0.0	33.1	66.9
		C2		K-feld	0.0	6.4	93.6
		C3	core	Ab	0.0	85.5	14.5
		C3	rim	K-feld	0.0	3.8	96.2
	mafic	C4	core	K-feld	0.4	2.6	97.0
		C4	core	K-feld	1.1	65.8	33.1
		C4	rim	Ab	3.8	95.5	0.7
		C4	rim	K-feld	0.0	4.6	95.4
7818	dt(meg)[2]	C1(m)[2]	rim	And	38.9	33.3	27.8
		C1	rim	Lab	66.1	33.1	0.8
		C2(m)	rim	Lab	64.2	35.0	0.7
		C2	inter	Olig	13.2	86.3	0.6
		C2	core	Olig	24.3	74.1	1.6
		C3(s)[2]	core	Lab	63.5	33.9	2.6
		C4(s)	core	Lab	54.8	32.1	13.1

	C5(m)	rim	Lab	63.0	34.4	2.6
	C6(m)	rim	Lab	64.1	34.7	1.3
	C6	inter	And	40.2	59.2	0.6
	C6	inter	And	34.2	64.8	1.0
	C6	inter	Olig	22.5	76.7	0.8
	C6	inter	Lab	59.0	36.9	4.1
	C6	core	Lab	50.5	79.7	0.5
dt(n-meg)[2]	C7(ph)[2]	rim	Olig	19.8	79.7	0.5
	C7	core	Olig	19.7	79.0	1.3
	C8(ph)	rim	Olig	22.2	76.7	1.1
	C8	core	Olig	22.1	76.5	1.4
	C9(g)[2]		Olig	20.9	78.2	0.9
	C10	rim	Olig	25.4	73.6	1.0
	C10	core	And	39.3	59.7	1.0
	C11(g)	core	Olig	22.0	77.1	0.9
	C12(ph)	rim	Olig	20.4	73.7	6.0
	twin.[2]	core	Olig	27.8	72.3	0.0
		rim	Olig	23.2	76.8	0.0
		core	Olig	25.4	73.7	0.9
		core	Olig	26.8	72.4	0.8

Note

[1]: For rock name abbreviations see appendix 1.

[2]: The abbreviations for this sample are as follows: meg. = megacrystic part; m = megacryst; s = smaller crystals; n-meg = non-megacrystic part; ph = phenocryst; g = groundmass; twin. = twinned crystal and the twins were analyzed as separate crystals.

Table 4: Representative electron microprobe analyses of biotite

Sample	5048					5052				5062
Pos[1]	C1	C1	C2	R2	R3	R1	C2	C3	C5	C1
	f-mgpgg(h)*					dt(h)				dt
SiO_2	35.15	35.90	37.40	37.42	37.49	36.56	35.46	36.88	36.37	37.28
TiO_2	2.70	3.22	3.32	3.36	3.48	2.91	2.65	2.79	3.22	3.81
Al_2O_3	13.03	12.75	12.40	12.32	12.86	13.65	13.61	14.09	13.11	12.13
FeO	24.76	23.86	21.50	21.02	23.71	19.57	19.04	19.71	21.44	23.28
MnO	0.38	0.18	0.00	0.00	0.11	0.17	0.22	0.19	0.00	0.28
MgO	10.59	10.63	11.61	11.50	9.19	11.73	10.92	11.47	8.86	10.28
CaO	0.00	0.00	0.00	0.00	0.17	0.24	0.17	0.00	0.00	0.00
Na_2O	0.22	0.24	0.26	0.20	0.23	9.51	0.29	0.26	0.20	0.25
K_2O	6.63	7.60	9.28	9.43	9.27	0.00	8.36	8.62	9.25	9.33
Total	93.46	94.38	95.77	95.25	96.51	94.34	90.72	94.01	92.45	96.64
Number of oxygens 22										
Si	5.577	5.633	5.747	5.773	5.772	5.543	5.688	5.699	5.798	5.737
Ti	0.322	0.380	0.384	0.390	0.403	0.332	0.320	0.324	0.386	0.441
Al	2.437	2.358	2.246	2.241	2.334	2.440	2.574	2.567	2.464	2.201
Fe''	3.286	3.131	2.763	2.712	3.053	2.481	2.554	2.547	2.859	2.996
Mn	0.051	0.024	0.000	0.000	0.014	0.022	0.030	0.025	0.000	0.036
Mg	2.504	2.486	2.659	2.644	2.109	2.650	2.610	2.642	2.105	2.358
Ca	0.000	0.000	0.000	0.000	0.028	0.039	0.029	0.000	0.000	0.000
Na	0.068	0.073	0.077	0.060	0.069	2.796	0.090	0.078	0.062	0.075
K	1.342	1.521	1.819	1.856	1.821	0.000	1.711	1.699	1.881	1.832

Note
In this and all subsequent tables: C = core; I = intermediate zone; R = rim; also each analyzed crystal is assigned a different number.
* These are the assigned field names (see Appendix 1)

Sample	5062						5122			5057
Pos	R1	C2	C3	R3	C4	R4	C1	R1	C2	C1
	dt						dt(h)			f-mggd
SiO_2	37.06	31.59	36.77	36.17	36.82	35.69	38.70	38.71	35.70	36.54
TiO_2	3.83	2.61	3.83	3.61	2.82	2.68	2.50	2.04	2.44	4.08
Al_2O_3	12.16	11.93	12.32	12.77	13.14	13.88	11.17	11.37	13.96	11.97
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.0	0.00
FeO	23.50	32.04	24.67	25.64	23.34	23.58	20.39	19.46	20.00	23.19
MnO	0.16	0.18	0.21	0.26	0.08	0.00	0.31	0.37	0.1	0.14
MgO	9.65	7.93	8.65	8.07	10.38	10.15	11.55	12.04	11.6	9.47
CaO	0.05	0.00	0.00	0.00	0.00	0.15	0.07	0.13	0.00	0.00
Na_2O	0.27	0.37	0.26	0.33	0.31	0.32	0.31	0.39	0.23	0.21
K_2O	9.33	7.18	9.00	8.30	9.03	8.34	9.32	8.62	8.48	8.98
Total	96.01	93.83	95.71	95.15	95.92	94.79	94.32	93.21	92.58	94.78
Number of oxygens 22										
Si	5.749	5.269	5.746	5.698	5.695	5.585	6.006	6.030	5.628	5.744
Ti	0.447	0.327	0.450	0.428	0.328	0.315	0.292	0.239	0.289	0.482
Al	2.224	2.346	2.270	2.372	2.396	2.561	2.044	2.088	2.595	2.218
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000
Fe''	3.049	4.469	3.224	3.378	3.019	3.086	2.646	2.535	2.637	3.049
Mn	0.021	0.025	0.028	0.035	0.010	0.000	0.041	0.049	0.023	0.019
Mg	2.231	1.971	2.015	1.895	2.393	2.367	2.671	2.795	2.725	2.219
Ca	0.008	0.000	0.000	0.000	0.000	0.025	0.012	0.022	0.000	0.000
Na	0.081	0.120	0.079	0.101	0.093	0.097	0.093	0.118	0.070	0.064
K	1.846	1.528	1.794	1.668	1.782	1.665	1.845	1.713	1.706	1.801

Table 5: Representative electron microprobe analyses of amphiboles

Sample	31-6-2									
Pos	C1	R1	C2	R2	C3	I3	R3	C4	I4	R4
	f-mgpg									
SiO_2	45.52	49.51	44.11	43.66	44.02	44.52	43.98	44.71	44.50	44.20
TiO_2	0.88	0.33	1.20	1.34	1.25	1.15	1.31	1.21	1.17	1.33
$Al2O_3$	5.10	3.61	5.55	6.06	5.64	5.45	5.84	5.48	5.43	5.98
Cr_2O_3	0.05	0.06	0.09	0.09	0.04	0.09	0.07	0.07	0.06	0.06
FeO_t	23.88	21.22	24.82	25.67	25.22	25.11	26.33	25.09	25.28	25.36
MnO	0.87	0.37	0.84	0.79	0.77	0.79	0.83	0.85	0.86	0.77
MgO	7.36	9.29	6.25	5.63	6.43	6.37	5.61	6.25	6.38	5.73
CaO	10.31	12.66	10.69	11.01	11.14	11.01	11.17	10.89	10.91	11.23
Na_2O	1.77	0.63	2.35	2.38	2.34	2.38	1.95	2.40	2.00	2.13
K_2O	0.59	0.55	0.85	0.93	0.95	0.82	0.99	0.75	0.77	0.91
Total	96.33	98.23	96.75	97.56	97.80	97.69	98.08	97.70	97.36	97.70

Number of oxygens 23

Si	7.158	7.472	6.997	6.907	6.931	6.999	6.932	7.019	7.014	6.957
Ti	0.104	0.037	0.143	0.159	0.148	0.136	0.155	0.143	0.139	0.157
Al	0.946	0.642	1.038	1.130	1.047	1.010	1.085	1.014	1.009	1.110
Cr	0.006	0.007	0.011	0.011	0.005	0.011	0.009	0.009	0.007	0.007
Fe''	3.141	2.678	3.292	3.396	3.321	3.301	3.471	3.294	3.332	3.338
Mn	0.116	0.047	0.113	0.106	0.103	0.105	0.111	0.113	0.115	0.103
Mg	1.725	2.089	1.477	1.327	1.509	1.492	1.318	1.462	1.499	1.344
Ca	1.737	2.047	1.817	1.866	1.879	1.855	1.887	1.832	1.842	1.894
Na	0.540	0.184	0.723	0.730	0.714	0.725	0.596	0.731	0.611	0.650
K	0.118	0.106	0.172	0.188	0.191	0.164	0.199	0.150	0.155	0.183

Table 5 (continued)

Sample	31-9-2						35-8-2	
Pos	I1	I1	R2	R2	C3	R3	R1	R1
	m-cgm							
SiO_2	52.07	49.17	53.67	53.87	52.95	52.64	46.87	47.29
TiO_2	0.13	0.16	0.10	0.14	0.11	0.09	1.48	1.59
Al_2O_3	1.50	3.37	0.91	0.90	1.05	1.26	6.30	6.55
Cr_2O_3	0.05	0.07	0.06	0.06	0.05	0.08	0.07	0.05
FeO_t	22.01	20.03	17.31	18.93	20.44	19.51	17.73	17.97
MnO	0.46	0.35	0.36	0.42	0.39	0.40	0.39	0.38
MgO	9.02	11.37	12.94	11.89	10.77	11.13	11.95	11.70
CaO	12.57	11.11	11.90	12.62	12.84	12.56	11.24	11.10
Na_2O	0.32	0.40	0.25	0.20	0.24	0.24	1.13	1.19
K_2O	0.04	0.17	0.03	0.03	0.05	0.11	0.56	0.60
Total	98.17	96.20	97.53	99.06	98.89	98.02	97.72	98.42

Number of oxygens 23

Si	7.823	7.489	7.900	7.879	7.833	7.824	7.016	7.025
Ti	0.015	0.018	0.011	0.015	0.012	0.010	0.167	0.178
Al	0.266	0.605	0.158	0.155	0.183	0.221	1.112	1.147
Cr	0.006	0.008	0.007	0.007	0.006	0.009	0.008	0.006
Fe''	2.765	2.551	2.131	2.316	2.529	2.425	2.220	2.233
Mn	0.059	0.045	0.045	0.052	0.049	0.050	0.049	0.048
Mg	2.020	2.581	2.839	2.592	2.374	2.465	2.666	2.590
Ca	2.024	1.813	1.877	1.978	2.035	2.000	1.803	1.767
Na	0.093	0.118	0.071	0.057	0.069	0.069	0.328	0.343
K	0.008	0.033	0.006	0.006	0.009	0.021	0.107	0.114

Table 5 (continued)

Sample	35-8-2									
Pos	R1 dt	R1	C2	R2	C3	C3	R3	I4	R4	I4
SiO_2	47.88	47.02	47.31	47.97	47.63	48.31	48.32	46.34	47.18	47.95
TiO_2	1.22	1.54	1.46	1.40	1.58	1.19	1.35	1.07	1.19	1.40
Al_2O_3	5.73	6.45	5.82	6.15	5.93	5.70	5.61	5.40	6.23	6.16
Cr_2O_3	0.00	0.06	0.06	0.06	0.05	0.03	0.05	0.06	0.08	0.06
FeO_t	17.81	18.42	17.62	17.20	17.78	17.40	17.36	17.93	17.61	17.28
MnO	0.37	0.37	0.39	0.36	0.40	0.41	0.44	0.29	0.39	0.37
MgO	12.49	11.68	12.51	12.20	12.15	12.25	12.32	11.30	11.94	12.11
CaO	11.19	11.23	10.84	11.31	11.27	11.31	11.31	11.30	7.68	11.70
Na_2O	0.98	1.15	1.13	1.20	1.29	1.05	1.28	1.01	1.44	1.24
K_2O	0.46	0.57	0.47	0.57	0.42	0.48	0.49	0.43	0.34	0.52
Total	98.13	98.49	97.61	98.42	98.50	98.13	98.53	95.13	94.08	98.79

Number of oxygens 23

Si	7.115	7.001	7.070	7.095	7.063	7.163	7.144	7.136	7.236	7.076
Ti	0.136	0.172	0.164	0.156	0.176	0.133	0.150	0.124	0.137	0.155
Al	1.004	1.132	1.025	1.072	1.037	0.996	0.978	0.980	1.127	1.072
Cr	0.000	0.007	0.007	0.007	0.006	0.004	0.006	0.007	0.010	0.007
Fe''	2.213	2.294	2.202	2.128	2.205	2.158	2.146	2.309	2.259	2.133
Mn	0.047	0.047	0.049	0.045	0.050	0.051	0.055	0.038	0.051	0.046
Mg	2.766	2.592	2.786	2.689	2.685	2.707	2.714	2.593	2.729	2.663
Ca	1.782	1.792	1.736	1.792	1.791	1.797	1.792	1.865	1.262	1.850
Na	0.282	0.332	0.327	0.344	0.371	0.302	0.367	0.302	0.428	0.355
K	0.087	0.108	0.090	0.108	0.079	0.091	0.092	0.084	0.067	0.098

Table 5 (continued)

Sample	35-8-2						
Pos	R4 dt	clot	clot	clot	C5	I5	R5
SiO_2	47.55	47.69	49.18	49.54	47.95	48.18	47.39
TiO_2	1.47	1.26	0.70	0.89	1.34	1.34	1.48
Al_2O_3	6.35	6.16	3.47	4.29	5.84	5.70	6.19
Cr_2O_3	0.07	0.30	0.02	0.06	0.05	0.04	0.05
FeO_t	17.60	16.52	15.81	16.49	17.27	17.20	17.22
MnO	0.36	0.35	0.46	0.45	0.38	0.37	0.36
MgO	11.39	11.89	13.80	13.19	12.61	12.24	11.83
CaO	11.77	12.34	10.98	11.61	11.61	11.51	11.60
Na_2O	1.20	0.96	0.84	0.87	1.22	1.20	1.24
K_2O	0.51	0.48	0.26	0.31	0.42	0.45	0.49
Total	98.27	97.95	95.52	97.70	98.69	98.23	97.85

Number of oxygens 23

Si	7.068	7.085	7.417	7.333	7.081	7.139	7.064
Ti	0.164	0.141	0.079	0.099	0.149	0.149	0.166
Al	1.113	1.079	0.617	0.749	1.017	0.996	1.088
Cr	0.008	0.035	0.002	0.007	0.006	0.005	0.006
Fe''	2.188	2.053	1.994	2.041	2.133	2.131	2.147
Mn	0.045	0.044	0.059	0.056	0.048	0.046	0.045
Mg	2.523	2.633	3.102	2.910	2.775	2.703	2.628
Ca	1.875	1.964	1.774	1.841	1.837	1.827	1.853
Na	0.346	0.277	0.246	0.250	0.349	0.345	0.358
K	0.097	0.091	0.050	0.059	0.079	0.085	0.093

Table 5 (continued)

Sample	5048								5052
Pos'n	C1	R1	C2	R2	C3	R3	C4	R4	R
	f-mgpgg(h)								dt(h)
SiO_2	45.30	46.32	48.93	49.37	46.10	46.81	47.72	46.38	45.23
TiO_2	1.43	1.14	0.41	0.43	1.08	0.90	1.22	1.57	1.07
Al_2O_3	6.24	6.04	3.94	3.89	6.81	6.57	6.37	7.44	8.24
Cr_2O_3	0.00	0.00	0.00	0.00	0.15	0.10	0.00	0.00	0.00
FeO_t	19.11	18.90	20.53	19.96	19.18	19.31	16.20	16.43	17.61
MnO	0.36	0.69	0.55	0.51	0.29	0.24	0.23	0.23	0.22
MgO	10.52	10.41	10.74	10.84	10.56	10.57	13.12	12.53	10.75
CaO	11.64	10.90	11.85	11.98	12.35	11.80	11.55	11.77	10.94
Na_2O	1.75	1.56	1.22	1.26	1.49	1.46	1.77	1.87	1.33
K_2O	0.81	0.67	0.56	0.41	0.70	0.62	0.48	0.55	1.23
Total	97.16	96.63	98.73	98.65	98.71	98.38	98.66	98.77	96.62

Number of oxygens 23

Si	6.926	7.076	7.340	7.380	6.921	7.024	7.025	6.853	6.872
Ti	0.164	0.131	0.046	0.048	0.122	0.102	0.135	0.174	0.122
Al	1.125	1.088	0.697	0.686	1.205	1.162	1.106	1.296	1.476
Cr	0.000	0.000	0.000	0.000	0.018	0.012	0.000	0.000	0.000
Fe''	2.443	2.415	2.576	2.495	2.408	2.423	1.995	2.030	2.238
Mn	0.047	0.089	0.070	0.065	0.037	0.031	0.029	0.029	0.028
Mg	2.397	2.370	2.401	2.415	2.363	2.364	2.879	2.759	2.434
Ca	1.907	1.784	1.905	1.919	1.987	1.897	1.822	1.863	1.781
Na	0.519	0.462	0.355	0.365	0.434	0.425	0.505	0.536	0.392
K	0.158	0.131	0.107	0.078	0.134	0.119	0.090	0.104	0.238

Table 5 (continued)

Sample	5057						
Pos'n	R1	C2	R2	C3	R3	C4	R4
	f-mggd						
SiO_2	45.93	48.19	44.65	47.74	45.76	46.98	46.90
TiO_2	1.38	0.68	1.27	0.99	1.68	1.23	1.44
Al_2O_3	6.87	4.42	7.50	5.42	6.21	5.55	5.93
Cr_2O_3	0.00	0.09	0.00	0.00	0.00	0.00	0.00
FeO_t	18.61	23.38	22.08	21.23	21.43	21.83	21.69
MnO	0.28	0.45	0.35	0.56	0.51	0.49	0.55
MgO	10.36	8.70	10.11	10.17	9.02	9.65	8.64
CaO	12.44	9.16	10.06	10.63	11.07	10.71	11.38
Na_2O	1.31	1.77	1.50	1.63	1.69	1.71	1.42
K_2O	0.75	0.46	0.63	0.52	0.75	0.64	0.66
Total	97.93	97.30	98.15	98.89	98.12	98.79	98.61

Number of oxygens 23

Si	6.932	7.387	6.804	7.165	6.979	7.099	7.100
Ti	0.157	0.078	0.146	0.112	0.193	0.140	0.164
Al	1.222	0.799	1.347	0.959	1.117	0.989	1.058
Cr	0.000	0.011	0.000	0.000	0.000	0.000	0.000
Fe''	2.349	2.997	2.814	2.665	2.733	2.759	2.746
Mn	0.036	0.058	0.045	0.071	0.066	0.063	0.071
Mg	2.330	1.987	2.296	2.275	2.050	2.173	1.949
Ca	2.012	1.504	1.643	1.710	1.809	1.734	1.846
Na	0.383	0.526	0.443	0.474	0.500	0.501	0.417
K	0.144	0.090	0.122	0.100	0.146	0.123	0.127

Table 5 (continued)

Sample	5062					5122				
Pos'n	C1 dt	R1	C2	R2	C3	C1 dt(h)	C2	R2	C3	R3
SiO_2	47.34	45.37	46.77	44.44	48.16	41.57	45.74	43.63	44.99	56.89
TiO_2	0.99	1.02	1.11	1.24	1.51	0.18	0.61	0.52	0.99	0.32
Al_2O_3	5.38	8.45	5.48	7.23	5.29	8.06	4.48	5.95	5.69	3.86
Cr_2O_3	0.00	0.00	0.08	0.13	0.00	0.00	0.07	0.00	0.00	0.00
FeO_t	20.09	19.52	22.04	21.83	18.24	27.10	26.12	25.46	20.80	17.26
MnO	0.61	0.46	0.92	0.76	0.39	0.79	0.89	0.96	0.49	0.48
MgO	10.67	8.59	9.23	8.48	12.02	4.22	5.88	5.13	8.61	7.76
CaO	11.41	10.63	10.78	11.03	11.70	11.18	9.54	10.70	10.87	9.81
Na_2O	1.60	1.42	1.66	1.77	1.50	1.63	1.83	1.59	1.78	1.02
K_2O	0.68	0.77	0.66	1.04	0.42	1.46	0.88	1.03	1.18	0.58
Total	98.77	96.23	98.73	97.95	99.23	96.19	96.04	94.97	95.40	97.98

Number of oxygens 23

Si	7.111	6.957	7.098	6.841	7.114	6.744	7.289	7.068	7.073	8.211
Ti	0.112	0.118	0.127	0.144	0.168	0.022	0.073	0.063	0.117	0.035
Al	0.953	1.528	0.981	1.312	0.921	1.541	0.842	1.136	1.055	0.657
Cr	0.000	0.000	0.010	0.016	0.000	0.000	0.009	0.000	0.000	0.000
Fe''	2.524	2.503	2.798	2.810	2.253	3.677	3.481	3.449	2.735	2.083
Mn	0.078	0.060	0.118	0.099	0.049	0.109	0.120	0.132	0.065	0.059
Mg	2.389	1.963	2.088	1.945	2.646	1.020	1.397	1.239	2.017	1.669
Ca	1.837	1.747	1.753	1.819	1.852	1.943	1.629	1.857	1.831	1.517
Na	0.466	0.422	0.489	0.528	0.430	0.513	0.565	0.499	0.543	0.285
K	0.130	0.151	0.128	0.204	0.079	0.302	0.179	0.213	0.237	0.107

Table 5 (continued)

Sample	5122							
Pos'n	C4 dt(h)	C5	R5	C6	C6	C7	R7	C8
SiO_2	45.06	45.15	44.04	44.39	44.93	51.89	44.56	43.47
TiO_2	0.93	0.97	1.23	1.28	1.13	0.00	1.13	1.25
Al_2O_3	5.63	5.60	5.97	6.26	5.98	1.06	6.16	6.90
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
FeO_t	19.96	21.16	22.44	20.75	21.04	19.91	20.28	21.34
MnO	0.63	0.61	0.80	0.52	0.58	0.61	0.50	0.57
MgO	8.66	8.64	7.35	8.43	8.48	10.13	8.85	7.78
CaO	11.01	10.62	10.74	10.54	10.60	11.82	10.88	11.11
Na_2O	1.71	1.88	1.85	2.31	2.10	0.61	2.00	1.97
K_2O	1.16	1.11	1.18	1.22	1.08	0.19	1.18	1.25
Total	94.75	95.74	95.60	95.70	95.92	96.22	95.54	95.74

Number of oxygens 23

Si	7.108	7.081	6.989	6.972	7.033	7.888	6.989	6.863
Ti	0.110	0.114	0.147	0.151	0.133	0.000	0.133	0.148
Al	1.047	1.035	1.117	1.159	1.103	0.190	1.139	1.284
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
Fe''	2.633	2.775	2.978	2.726	2.754	2.531	2.660	2.818
Mn	0.084	0.081	0.108	0.069	0.077	0.079	0.066	0.076
Mg	2.036	2.019	1.738	1.973	1.978	2.295	2.069	1.831
Ca	1.861	1.785	1.826	1.774	1.778	1.925	1.829	1.880
Na	0.523	0.572	0.569	0.703	0.637	0.180	0.608	0.603
K	0.233	0.222	0.239	0.244	0.216	0.037	0.236	0.252

Table 6: Representative electron microprobe analyses of clinopyroxene

Sample	5052 (dt(h))			
	1	2	3	4
SiO_2	50.51	51.14	50.19	51.68
TiO_2	0.75	0.68	0.99	0.00
Al_2O_3	3.70	3.31	3.05	0.89
Cr_2O_3	1.04	0.87	0.09	0.10
FeO_t	6.42	6.39	10.37	13.91
MnO	0.16	0.23	0.32	1.13
MgO	16.16	16.44	14.41	9.93
CaO	20.14	20.42	18.69	20.72
Na_2O	0.50	0.50	0.47	0.62
K_2O	0.00	0.00	0.00	0.18
Total	99.38	99.98	98.58	99.16
Number of oxygens 6				
Si	1.876	1.887	1.903	1.996
Ti	0.021	0.019	0.028	0.000
Al	0.162	0.144	0.136	0.041
Cr	0.031	0.025	0.003	0.003
Fe''	0.199	0.197	0.329	0.449
Mn	0.005	0.007	0.010	0.037
Mg	0.894	0.904	0.814	0.572
Ca	0.801	0.807	0.759	0.857
Na	0.036	0.036	0.035	0.046
K	0.000	0.000	0.000	0.009

Table 7: Representative electron microprobe analyses of chlorites

Sample	31-9-2	5048	5057
	m-cgm	f-mgpgg	f-mggd
	1	2	3
SiO_2	30.88	30.15	26.99
TiO_2	0.06	1.07	0.14
Al_2O_3	13.79	14.07	16.58
FeO_t	24.14	26.21	30.09
MnO	0.16	0.50	0.25
MgO	16.66	12.50	12.98
CaO	0.20	0.12	0.10
K_2O	0.09	0.90	-
Total	85.98	85.52	87.13

Table 8: Modal compositions (%) of the Hart Lake-Byers lake pluton

Sample	35-5-1	35-5-2	29-8-7	35-7-1	36-7-1	36-5-1	36-6-2	44-1-1
Plagioclase[1]	1.8	-	-	-	-	-	-	-
Albite[2]	20.9	26.7	30.1	23.6[3]	28.1	22.2[3]	18.5	28.6
Quartz	32.2	24.8	35.0	46.8	29.4	31.3	43.1	33.1
K-feldspar	39.5	43.0	31.6	23.7	40.2	44.5	37.4	36.2
Hornblende	2.2	1.6	0.6	0.6	-	0.3	-	-
Biotite	0.3	-	0.2	-	1.0	0.3	-	0.5
Opaques	0.4	1.1	0.7	0.8	0.5	1.5	0.8	0.8
Chlorite	1.0	0.6	1.7	-	0.9	-	-	-
Epidote	0.1	0.2	-	-	-	-	0.2	-
Zircon	-	0.2	-	-	-	-	-	-
Red. alt. min.	0.3	-	0.1	1.0	-	-	-	0.2
Fluorite	-	-	-	0.1	-	-	-	-
Arfvedsonite	-	-	-	3.5	-	-	-	0.6
Colour Index	4.3	3.7	3.2	6.0	2.3	2.0	1.0	1.9
IUGS								
Plagioclase	3.2	1.9	-	-	-	-	-	-
Quartz	33.6	25.8	36.2	49.7	30.1	31.9	43.6	33.8
Alkali-feldspar[4]	63.1	72.3	63.8	50.3	60.9	68.1	56.4	66.2
Name	AFG	AFG	AFG	AFG	AFG	AFG	AFG	AFG

Notes

[1]: Plagioclase refers to individual grains of which composition is unknown

[2]: Plagioclase in perthite structure and as individual crystals

[3]: Feldspars analyzed by electron microprobe

[4]: Albite is counted as alkali-feldspar in IUGS calculations

Table 9: Whole-rock chemical analyses of representative samples of the Hart Lake-Byers Lake pluton

Sample Number	4611	4612	4613	4614	4615	4616	4617	4618	4621	4623
Major elements by XRF (wt%)										
SiO_2	47.54	74.99	51.20	74.87	74.49	51.64	57.02	67.98	73.85	66.28
TiO_2	2.23	0.28	2.10	0.24	0.31	2.10	1.70	0.79	0.07	0.77
Al_2O_3	14.94	12.57	14.61	12.55	12.55	14.57	13.89	12.90	13.85	14.52
Fe_2O_3	12.23	1.79	11.07	2.25	1.46	11.12	8.63	5.01	1.26	5.07
MnO	0.19	0.03	0.26	0.04	0.04	0.18	0.21	0.11	0.02	0.09
MgO	6.49	0.81	5.19	0.82	1.01	5.55	3.93	2.27	0.69	1.50
CaO	10.09	1.21	7.77	0.77	1.37	8.20	5.92	2.73	1.75	1.79
Na_2O	3.26	4.18	3.50	3.66	3.21	2.96	4.22	3.72	4.06	4.31
K_2O	0.66	4.03	1.37	5.32	5.77	1.57	2.69	4.20	4.72	4.71
P_2O_5	0.37	0.04	0.37	0.03	0.05	0.37	0.33	0.14	0.02	0.18
L.O.I	1.40	0.20	1.50	0.20	0.30	0.80	0.90	0.30	0.40	0.70
Total	99.40	100.13	98.94	100.75	100.56	99.06	99.44	100.15	100.69	99.92
Trace elements by XRF (ppm)										
Ba	245	174	513	147	187	402	323	204	74	481
Rb	35	162	76	242	214	60	108	160	307	205
Sr	330	85	313	47	84	337	231	113	138	114
Y	31	83	38	93	98	40	61	90	84	79
Zr	192	698	250	710	1009	257	361	827	169	453
Nb	15	49	15	57	47	17	31	46	71	39
Th	<10	21	<10	25	25	<10	<10	11	26	11
Pb	<10	<10	15	<10	18	<10	<10	17	<10	44
Ga	19	22	21	25	21	20	22	21	28	24
Zn	128	25	301	49	39	119	184	128	13	95
Cu	60	<5	41	<5	<5	40	6	13	<5	<5
Ni	93	8	55	10	7	53	27	15	<5	6
V	287	10	280	<5	14	268	203	81	20	40
Cr	165	47	148	33	32	132	88	66	25	25

Sample Number	4625	4626	4628	4629	4630	4631	4632	4633	4634	4636
Major elements by XRF (wt%)										
SiO_2	53.89	73.56	48.85	69.95	67.91	68.29	65.66	64.69	66.19	76.15
TiO_2	2.37	0.32	2.56	0.46	0.42	0.38	0.88	0.83	0.49	0.17
Al_2O_3	14.05	12.95	14.27	14.19	14.80	14.68	14.29	14.63	15.02	11.58
Fe_2O_3	11.47	2.51	13.52	3.30	4.57	3.97	5.63	5.87	5.12	2.53
MnO	0.24	0.04	0.28	0.06	0.11	0.07	0.12	0.11	0.13	0.04
MgO	3.63	0.98	5.84	1.18	0.81	0.94	1.62	1.52	0.91	0.82
CaO	5.44	0.61	7.45	0.93	0.88	0.49	2.04	1.94	1.17	0.21
Na_2O	3.74	3.68	3.27	4.41	4.67	4.69	4.67	4.96	5.19	4.45
K_2O	2.77	5.31	1.64	4.90	5.63	5.85	4.60	4.92	5.71	4.65
P_2O_5	0.86	0.05	0.36	0.09	0.05	0.03	0.25	0.21	0.06	0.01
L.O.I	0.60	0.30	1.30	0.30	0.40	1.00	0.20	0.00	0.20	0.30
Total	99.06	100.31	99.34	99.77	100.25	100.39	99.96	99.68	100.19	100.91
Trace elements by XRF (ppm)										
Ba	974	287	671	468	161	140	640	651	209	39
Rb	93	223	121	217	169	194	152	159	174	224
Sr	330	59	313	76	26	20	116	100	30	10
Y	70	86	40	77	83	63	64	82	95	90
Zr	610	325	229	452	850	911	460	799	1087	552
Nb	36	45	16	41	41	34	34	36	76	69
Th	<10	24	<10	23	21	18	21	<10	15	16
Pb	76	24	79	22	18	28	15	<10	<10	<10
Ga	24	24	22	22	29	26	24	26	31	30
Zn	244	51	255	61	123	106	78	119	111	131
Cu	30	<5	66	<5	<5	<5	<5	<5	<5	<5
Ni	19	8	53	7	8	5	8	11	9	<5
V	201	10	378	15	5	<5	39	31	5	<5
Cr	16	24	107	32	26	31	25	27	17	32

Table 9 (continued)

Sample Number	4644	4645	4646	4647	4663	4664	4665	6370	6371	6373
Major elements by XRF (wt%)										
SiO_2	74.11	71.21	74.10	47.86	72.49	76.40	76.01	77.87	47.48	67.24
TiO_2	0.24	0.34	0.17	2.84	0.25	0.15	0.16	0.10	2.68	0.57
Al_2O_3	13.29	14.50	13.78	13.27	13.43	11.95	12.03	11.72	16.40	13.57
Fe_2O_3	2.11	2.18	1.25	14.21	2.40	1.90	2.09	1.75	13.91	7.69
MnO	0.03	0.06	0.03	0.53	0.05	0.04	0.04	0.01	0.26	0.17
MgO	0.76	1.00	0.86	5.10	0.90	0.71	0.62	0.00	5.27	0.06
CaO	0.50	1.04	0.74	8.95	0.74	0.34	0.20	0.26	8.45	1.27
Na_2O	4.07	4.06	4.30	2.70	4.09	4.05	4.16	3.71	3.24	4.53
K_2O	5.26	4.95	4.74	1.44	5.04	4.91	4.93	4.38	1.25	4.88
P2O5	0.03	0.08	0.04	0.44	0.06	0.01	0.02	0.01	0.65	0.06
L.O.I	0.20	0.10	0.20	0.80	0.60	0.50	0.10	0.20	0.96	0.13
Total	100.60	99.52	100.21	98.14	100.05	100.96	100.36	100.01	100.55	100.17
Trace elements by XRF (ppm)										
Ba	212	570	376	1006	190	52	37	<5	684	157
Rb	260	143	139	67	252	203	189	180	74	136
Sr	44	152	119	282	51	8	5	16	377	18
Y	82	38	26	48	84	51	95	112	50	144
Zr	253	198	97	255	306	311	364	271	373	981
Nb	52	20	14	18	47	57	63	87	30	74
Th	24	21	31	<10	26	25	27	22	<10	11
Pb	14	21	<10	26	13	136	43	<10	45	14
Ga	26	18	15	21	20	26	25	27	23	39
Zn	48	36	24	278	60	62	114	45	200	309
Cu	<5	<5	<5	127	<5	<5	<5	5	45	27
Ni	7	8	7	56	8	10	7	77	50	<5
V	7	16	7	326	8	0	0	0	241	<5
Cr	26	39	41	104	24	49	37	44	101	<5

Sample Number	6419	6477	6484	6485	6490	6518	6533	6588	6590	6591
Major elements by XRF (wt%)										
SiO_2	76.79	47.94	77.24	48.28	76.21	73.09	76.35	75.18	76.42	74.02
TiO_2	0.18	2.79	0.19	2.62	0.17	0.43	0.11	0.19	0.23	0.22
Al_2O_3	11.13	14.73	11.95	15.10	12.59	11.74	11.98	12.84	10.34	13.27
Fe_2O_3	2.82	14.39	1.21	13.71	1.67	4.54	1.62	1.58	3.11	1.94
MnO	0.05	0.40	0.02	0.29	0.03	0.10	0.03	0.02	0.01	0.03
MgO	0.02	5.89	0.07	5.91	0.04	0.02	0.00	0.00	0.00	0.09
CaO	0.18	8.06	0.79	7.87	0.45	0.56	0.19	0.42	0.23	0.56
Na_2O	3.75	3.20	3.32	3.08	3.50	4.25	3.57	3.55	2.49	3.90
K_2O	4.59	1.53	4.85	1.58	5.31	4.82	5.15	5.54	5.21	5.37
P_2O_5	0.01	0.47	0.03	0.51	0.02	0.02	0.00	0.02	0.03	0.03
L.O.I	0.40	1.21	0.40	1.60	0.28	0.20	0.40	0.00	0.00	0.30
Total	99.92	100.61	100.07	100.55	100.27	99.77	99.40	99.34	98.07	99.73
Trace elements by XRF (ppm)										
Ba	52	511	109	551	128	12	<5	123	38	173
Rb	257	81	188	77	170	170	296	229	180	192
Sr	13	318	46	320	21	12	18	16	18	31
Y	89	47	70	50	71	102	97	85	189	75
Zr	722	237	279	252	271	2136	262	292	1280	294
Nb	106	20	68	20	66	77	92	47	96	48
Th	21	<10	12	<10	14	21	28	25	27	28
Pb	29	47	65	129	12	14	34	19	26	16
Ga	34	23	24	24	26	34	26	21	20	21
Zn	181	262	50	230	77	138	90	16	135	53
Cu	40	74	19	62	23	22	<5	<5	10	<5
Ni	25	48	<5	55	<5	<5	5	<5	5	<5
V	13	332	18	283	<5	<5	7	<5	30	7
Cr	18	173	14	167	<50	7	<5	5	10	<5

Table 9 (continued)

Sample Number	6686	6688	6775	6808	6902	6970	6971	7290	7291	7368
Major elements by XRF (wt%)										
SiO_2	73.59	78.03	54.16	73.58	77.74	74.67	76.83	76.26	84.81	74.03
TiO_2	0.29	0.25	1.77	0.22	0.07	0.27	0.18	0.26	0.18	0.35
Al_2O_3	13.49	11.42	14.14	13.60	12.25	12.93	11.53	12.23	8.37	12.72
Fe_2O_3	2.88	2.26	10.77	2.57	0.89	2.18	2.18	1.48	0.97	3.14
MnO	0.07	0.07	0.19	0.02	0.02	0.04	0.05	0.03	0.02	0.08
MgO	0.02	0.07	5.09	0.15	0.00	0.09	0.07	0.04	0.08	0.09
CaO	0.63	0.28	6.56	0.45	0.32	0.34	0.29	0.25	0.11	0.43
Na_2O	5.24	4.58	3.07	4.07	3.92	3.69	3.77	4.66	0.38	3.11
K_2O	3.75	2.92	2.34	4.87	4.57	5.39	4.81	3.34	4.76	5.14
P_2O_5	0.02	0.03	0.30	0.02	0.01	0.03	0.02	0.03	0.03	0.04
L.O.I	0.29	0.19	2.28	0.74	0.33	0.55	0.35	0.20	0.90	0.75
Total	100.27	100.10	100.67	100.29	100.12	100.18	100.08	98.78	100.61	99.88
Trace elements by XRF (ppm)										
Ba	579	23	328	209	49	257	60	13	96	598
Rb	146	95	88	221	279	240	246	113	228	201
Sr	29	18	230	29	8	36	14	22	26	41
Y	115	137	52	66	79	70	107	150	112	96
Zr	625	1011	313	414	143	372	609	1004	959	627
Nb	62	84	28	44	65	61	85	70	75	64
Th	18	17	6	25	27	18	19	18	17	16
Pb	<10	13	47	43	18	<10	<10	10	10	17
Ga	26	22	22	22	25	27	33	30	18	16
Zn	82	52	177	63	46	52	122	21	23	45
Cu	17	<5	58	31	14	8	15	7	7	<5
Ni	<5	5	44	<5	<5	<5	<5	<5	<5	<5
V	<5	<5	210	<5	<5	<5	<5	<5	8	<5
Cr	0	5	185	0	0	0	0	5	5	0

Sample Number	7369	7371	7419	74.29	7629	7630	7646	7651	7658	7704
Major elements by XRF (wt%)										
SiO_2	75.69	73.55	75.08	74.16	76.55	72.76	61.05	46.48	72.62	83.35
TiO_2	0.25	0.45	0.22	0.10	0.19	0.30	1.22	2.63	0.32	0.15
Al_2O_3	12.13	12.24	12.83	13.91	12.21	13.87	12.66	14.72	13.60	7.97
Fe_2O_3	2.64	4.18	1.94	1.01	1.73	2.39	8.80	15.62	2.72	2.08
MnO	0.07	0.10	0.04	0.09	0.04	0.05	0.15	0.42	0.08	0.07
MgO	0.08	0.20	0.03	0.02	0.22	0.25	3.17	6.41	0.24	0.12
CaO	0.42	1.58	0.50	0.69	0.48	0.97	4.66	7.69	0.90	1.17
Na_2O	3.27	3.03	3.50	3.93	3.47	3.80	5.61	2.70	3.72	2.48
K_2O	4.98	4.14	5.58	4.59	4.77	5.17	1.91	1.55	5.24	2.25
P_2O_5	0.03	0.06	0.02	0.03	0.04	0.06	0.22	0.39	0.07	0.02
L.O.I	0.36	0.71	0.26	0.50	0.52	0.53	0.86	1.86	0.57	0.47
Total	99.92	100.24	100.00	99.03	100.22	100.15	100.31	100.47	100.08	100.13
Trace elements by XRF (ppm)										
Ba	684	700	230	613	185	383	164	742	365	187
Rb	174	143	249	113	181	201	69	82	253	73
Sr	40	103	23	155	37	66	145	331	65	62
Y	72	66	79	21	72	73	126	37	82	130
Zr	490	476	333	69	245	407	1087	218	383	943
Nb	47	39	56	22	47	44	69	14	47	51
Th	16	10	21	<10	16	26	15	<10	29	<10
Pb	<10	10	15	16	37	90	<10	129	29	48
Ga	20	19	21	15	21	22	29	22	24	17
Zn	33	65	61	19	62	82	174	329	81	88
Cu	<5	<5	20	<5	5	15	22	78	6	37
Ni	<5	<5	<5	<5	<5	<5	32	68	<5	<5
V	<5	<5	<5	8	10	10	126	344	11	20
Cr	10	<5	<5	5	<5	<5	80	147	<5	<5

Table 9 (continued)

Sample Number	7705A	7705B	7712	7714	29-8-5	30-1-1	35-5-1	35-7-1	36-2-1	36-5-1	36-7-1
Major elements by XRF (wt%)											
SiO_2	48.17	47.75	56.69	73.33	75.79	45.15	73.35	74.94	72.90	74.76	73.83
TiO_2	1.92	2.05	1.96	0.17	0.17	3.81	0.23	0.20	0.22	0.15	0.23
Al_2O_3	17.03	16.50	13.93	13.67	12.09	11.44	13.10	11.86	13.76	11.79	13.13
Fe_2O_3	11.48	12.22	10.67	2.31	1.68	16.74	2.14	2.79	1.85	1.85	2.04
MnO	0.37	0.28	0.18	0.05	0.04	0.43	0.04	0.05	0.03	0.03	0.03
MgO	5.80	6.09	3.81	0.03	0.77	3.80	0.82	0.83	0.89	0.73	1.06
CaO	8.46	9.01	6.27	0.52	0.43	8.74	0.46	0.30	0.44	0.16	0.43
Na_2O	2.57	2.54	3.11	3.14	3.92	2.73	4.29	3.44	4.00	3.91	4.10
K_2O	2.52	2.11	2.54	5.89	4.56	1.51	5.11	4.77	5.55	4.88	4.79
P_2O_5	0.25	0.26	0.21	0.01	0.03	2.10	0.03	0.03	0.03	0.03	0.05
L.O.I	2.11	1.75	1.51	1.17	0.10	2.20	0.10	0.20	0.40	0.30	0.30
Total	100.68	100.56	100.88	100.29	99.58	98.65	99.67	99.41	100.07	98.59	99.99
Trace elements by XRF (ppm)											
Ba	1795	1234	446	68	103	806	206	55	285	44	179
Rb	194	153	122	295	127	66	254	237	240	205	220
Sr	553	463	307	57	25	307	35	15	37	<5	33
Y	29	31	51	136	70	76	85	114	60	96	116
Zr	126	134	351	458	142	438	292	548	212	306	308
Nb	10	10	22	76	37	29	54	81	23	62	55
Th	<10	<10	<10	21	13	<10	20	17	22	15	24
Pb	179	132	10	<10	<10	244	25	21	17	<10	15
Ga	20	20	20	30	21	25	25	30	20	23	22
Zn	386	267	141	112	46	288	58	161	32	43	27
Cu	102	114	89	12	<5	31	6	<5	<5	<5	2
Ni	46	53	35	<5	5	10	7	6	5	5	7
V	257	279	246	<5	<5	128	<5	<5	21	<5	4
Cr	184	205	99	<5	59	7	32	31	21	38	31
REE and selected trace elements by INAA (ppm)											
La	n.d.	n.d.	n.d.	n.d.	28.80	n.d.	n.d.	65.30	46.00	57.51	n.d.
Ce	n.d.	n.d.	n.d.	n.d.	70.70	n.d.	n.d.	158	102	138	n.d.
Nd	n.d.	n.d.	n.d.	n.d.	38.00	n.d.	n.d.	n.d.	n.d.	65.50	n.d.
Sm	n.d.	n.d.	n.d.	n.d.	9.66	n.d.	n.d.	17.90	8.68	15.36	n.d.
Eu	n.d.	n.d.	n.d.	n.d.	0.44	n.d.	n.d.	0.91	0.62	0.61	n.d.
Tb	n.d.	n.d.	n.d.	n.d.	2.08	n.d.	n.d.	3.45	1.64	3.12	n.d.
Yb	n.d.	n.d.	n.d.	n.d.	6.86	n.d.	n.d.	12.40	5.80	10.09	n.d.
Lu	n.d.	n.d.	n.d.	n.d.	1.09	n.d.	n.d.	1.99	0.85	1.28	n.d.
Hf	n.d.	n.d.	n.d.	n.d.	6.14	n.d.	n.d.	20.50	7.94	13.86	n.d.
Sc	n.d.	n.d.	n.d.	n.d.	1.72	n.d.	n.d.	1.36	3.23	1.01	n.d.
Ta	n.d.	n.d.	n.d.	n.d.	2.38	n.d.	n.d.	6.96	2.57	6.27	n.d.
Th	n.d.	n.d.	n.d.	n.d.	16.80	n.d.	n.d.	26.10	28.90	20.81	n.d.
U	n.d.	1.00	2.60	2.90	n.d.	n.d.	n.d.	n.d.	n.d.	4.10	n.d.

Table 10: Representative electron microprobe analyses of feldspars

Sample Number	Rock	Crystal	Pos'n	Min'l	An	Ab	Or
35-7-1	cgpgr	C1	rim	Ab	0	99.7	0.3
		C1	rim	Ab	0.05	99.6	0.4
		C1	core	Ab	0	99.4	0.6
		C2	rim	Ab	0	99.8	0.2
		C2	inter	Ab	0	98.8	1.2
		C3	inter	Ab	0	99.6	0.4
		C3	over	K-feld	0	1.6	98.4
		C3	rim	Ab	0	99.8	0.2
		C4	core	Ab	0	99.5	0.5
		C4	rim	Ab	0	99.6	0.4
36-5-1	f-mgpgr	C1	rim	Ab	0	99.5	0.5
		C1	rim	Ab	0	99.3	0.7
		C1	core	Ab	0	99.5	0.5
		C2	core	Ab	0	99.5	0.5
		C2	rim	Ab	0	98.9	1.1
		C2	core	Ab	0	99.4	0.6
		C2	incl	K-feld	0	7.4	92.6
		C3	rim	Ab	0	99.5	0.5
		C4	core	Ab	0	99.4	0.6
		C4	rim	Ab	0.1	99.1	0.8
		C5	rim	Ab	0	99.4	0.6
		C5	rim	Ab	0	99.4	0.6
		C5	core	Ab	0	98.8	1.2

Table 11: Electron microprobe analyses of amphiboles in representatives rock lithologies

Sample	35-7-1 cgpgr								
Number	C1					C2			
	rim	inter	inter	core	inter	rim	rim	rim	rim
SiO_2	47.30	49.80	48.74	49.14	48.91	49.16	49.28	50.21	48.71
TiO_2	1.17	1.50	1.12	1.58	1.60	1.58	1.56	0.58	1.47
Al_2O_3	2.70	1.19	1.50	1.20	1.16	1.18	1.26	0.95	1.37
Cr_2O_3	0.00	0.10	0.08	0.10	0.09	0.10	0.09	0.08	0.11
FeO_t	29.84	32.24	32.35	32.08	32.26	32.20	32.36	32.11	30.21
MnO	0.83	0.79	0.95	0.79	0.72	0.79	0.74	0.71	0.71
MgO	2.49	0.41	1.17	0.46	0.33	0.30	0.32	1.04	1.34
CaO	7.74	2.67	3.33	2.57	2.95	2.67	2.53	2.40	3.68
Na_2O	4.57	6.24	6.69	6.99	7.00	7.01	6.95	6.24	5.83
K_2O	0.83	0.90	0.77	0.82	0.93	0.79	1.02	0.50	0.92
Total	97.47	95.84	96.70	95.73	95.95	95.78	96.11	94.82	94.35
Atomic formulae on the basis of 23 oxygens									
Si	7.568	8.077	7.891	8.008	7.978	8.013	8.010	8.190	7.989
Ti	0.141	0.183	0.136	0.194	0.196	0.194	0.191	0.071	0.181
Al	0.509	0.228	0.286	0.231	0.223	0.227	0.241	0.183	0.265
Cr	0.000	0.013	0.010	0.013	0.012	0.013	0.012	0.010	0.014
Fe''	3.993	4.373	4.380	4.372	4.401	4.389	4.399	4.380	4.144
Mn	0.112	0.109	0.130	0.109	0.099	0.109	0.102	0.098	0.099
Mg	0.594	0.099	0.282	0.112	0.080	0.073	0.078	0.253	0.328
Ca	1.327	0.464	0.578	0.449	0.516	0.466	0.441	0.419	0.647
Na	1.418	1.962	2.100	2.209	2.214	2.216	2.190	1.973	1.854
K	0.169	0.186	0.159	0.170	0.194	0.164	0.212	0.104	0.193

Sample	35-7-1 cgpgr									
Number										
	C2	C3		C4			C5	C6	C6	C7
	core	core	rim	core	rim	rim	rim	core	rim	core
SiO_2	48.65	49.91	49.23	51.90	49.41	51.03	52.06	51.12	49.81	48.89
TiO_2	1.57	0.91	1.21	0.36	1.47	0.42	0.25	0.36	1.33	1.17
Al_2O_3	1.30	1.13	1.45	0.44	1.22	0.97	0.82	0.98	1.38	1.50
Cr_2O_3	0.06	0.10	0.10	0.08	0.07	0.06	0.07	0.10	0.11	0.10
FeO_t	30.08	30.59	31.18	32.82	33.01	28.82	26.55	30.58	30.05	30.98
MnO	0.69	0.74	0.81	0.53	0.78	0.71	0.45	0.68	0.68	0.95
MgO	1.26	1.60	1.18	1.58	0.47	3.53	4.53	2.31	1.80	1.15
CaO	3.71	3.13	3.09	1.26	2.60	2.90	1.57	2.47	3.27	3.36
Na_2O	6.34	6.84	6.82	6.87	6.72	6.47	7.58	6.12	6.42	6.46
K_2O	0.85	0.89	0.79	0.09	0.76	0.67	0.52	0.48	0.80	0.69
Total	94.51	95.84	95.86	95.93	96.51	95.58	94.40	95.20	95.65	95.25
Atomic formulae on the basis of 23 oxygens										
Si	7.975	8.058	7.979	8.316	8.002	8.136	8.273	8.216	8.022	7.973
Ti	0.194	0.110	0.147	0.043	0.179	0.050	0.030	0.044	0.161	0.143
Al	0.251	0.215	0.277	0.083	0.233	0.182	0.154	0.186	0.262	0.288
Cr	0.008	0.013	0.013	0.010	0.009	0.008	0.009	0.013	0.014	0.013
Fe''	4.124	4.131	4.226	4.398	4.471	3.843	3.529	4.110	4.047	4.225
Mn	0.096	0.101	0.111	0.072	0.107	0.096	0.061	0.093	0.093	0.131
Mg	0.308	0.385	0.285	0.377	0.113	0.839	1.073	0.553	0.432	0.279
Ca	0.652	0.541	0.537	0.216	0.451	0.495	0.267	0.425	0.564	0.587
Na	2.015	2.141	2.143	2.135	2.110	2.000	2.336	1.907	2.005	2.043
K	0.178	0.183	0.163	0.018	0.157	0.136	0.105	0.098	0.164	0.144

Table 11 (continued)

Sample Number	35-7-1 cgpgr C7		C8		
	inter	rim	core	inter	rim
SiO_2	48.38	48.69	50.54	49.31	49.02
TiO_2	1.25	1.43	0.97	1.48	1.46
Al_2O_3	1.46	1.38	0.89	1.24	1.25
Cr_2O_3	0.10	0.06	0.09	0.07	0.10
FeO_t	31.50	31.85	33.24	30.94	30.54
MnO	0.95	0.81	0.64	0.79	0.71
MgO	0.93	0.54	0.78	1.20	1.21
CaO	3.30	2.98	1.53	2.68	3.37
Na_2O	6.73	6.71	6.62	6.83	6.55
K_2O	0.77	0.83	0.56	0.81	0.90
Total	95.37	95.28	95.86	95.35	95.11

Atomic formulae on the basis of 23 oxygens

Si	7.924	7.976	8.178	8.017	7.994
Ti	0.154	0.176	0.118	0.181	0.179
Al	0.282	0.267	0.170	0.238	0.240
Cr	0.013	0.008	0.012	0.009	0.013
Fe''	4.315	4.364	4.498	4.207	4.165
Mn	0.132	0.112	0.088	0.109	0.098
Mg	0.227	0.132	0.188	0.291	0.294
Ca	0.579	0.523	0.265	0.467	0.589
Na	2.137	2.131	2.077	2.153	2.071
K	0.161	0.173	0.116	0.168	0.187

Sample Number	6419 cgoqzgr									
	core	rim	core	rim	core	rim	core	rim	core	rim
SiO_2	50.54	51.85	48.26	51.15	50.75	49.75	48.80	50.16	50.20	49.32
TiO_2	0.91	0.23	1.55	0.32	0.25	0.93	0.98	0.69	0.84	1.86
Al_2O_3	0.64	0.26	1.30	0.49	1.01	0.86	1.99	1.20	0.82	0.93
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO_t	35.98	36.03	34.47	36.90	35.94	34.45	29.76	31.44	35.07	33.96
MnO	0.40	0.45	0.78	0.18	0.55	0.58	0.69	0.42	0.47	0.75
MgO	0.76	0.68	0.69	0.40	0.75	1.34	4.37	2.95	0.82	0.31
CaO	1.06	0.10	2.76	0.36	0.36	1.76	3.66	1.91	1.71	1.97
Na_2O	7.03	7.37	6.95	7.42	7.07	6.99	6.82	6.27	6.61	7.62
K_2O	0.59	0.31	1.19	0.76	0.56	0.81	1.15	0.68	0.80	1.26
Total	97.90	97.28	97.93	97.97	97.24	97.48	98.21	95.72	97.33	97.98

Atomic Formulae on the basis of 23 oxygens

Si	8.104	8.312	7.811	8.209	8.168	8.007	7.696	8.063	8.085	7.939
Ti	0.109	0.027	0.189	0.038	0.031	0.113	0.117	0.084	0.102	0.225
Al	0.120	0.049	0.248	0.093	0.192	0.163	0.370	0.227	0.156	0.177
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe''	4.825	4.830	4.665	4.953	4.838	4.637	3.925	4.226	4.723	4.571
Mn	0.054	0.061	0.106	0.024	0.075	0.080	0.092	0.057	0.064	0.103
Mg	0.180	0.163	0.165	0.096	0.180	0.322	1.026	0.708	0.196	0.075
Ca	0.182	0.017	0.478	0.062	0.062	0.303	0.619	0.329	0.295	0.340
Na	2.185	2.290	2.181	2.308	2.206	2.183	2.085	1.954	2.064	2.377
K	0.121	0.064	0.245	0.155	0.116	0.166	0.231	0.140	0.163	0.258

Table 11 (continued)

Sample Number	6477 mgdt				6970 mgogr		6971 cgoqzgr			
	core	rim	core	rim	core	rim	core	rim	core	rim
SiO_2	49.13	48.49	48.59	46.25	51.91	45.90	48.19	48.15	47.03	46.48
TiO_2	1.04	1.07	1.18	1.75	0.00	2.58	1.26	1.29	1.24	1.09
Al_2O_3	4.06	4.97	4.99	6.85	1.27	2.95	1.70	1.37	3.15	3.05
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO_t	18.39	18.69	19.51	17.90	22.96	25.17	33.96	34.91	31.21	31.21
MnO	0.31	0.26	0.34	0.20	0.48	0.43	0.71	0.59	0.79	0.58
MgO	12.67	12.09	11.81	11.37	9.64	7.80	1.88	1.09	2.98	2.85
CaO	10.96	11.11	11.05	12.36	12.27	10.38	4.24	3.44	4.13	4.56
Na_2O	1.12	1.19	1.32	1.52	0.44	0.48	4.99	6.33	5.23	3.81
K_2O	0.30	0.35	0.47	0.57	0.00	0.18	0.98	1.14	1.09	1.02
Total	97.98	98.22	99.24	98.77	98.97	95.86	97.92	98.30	96.84	94.65
Atomic formulae on the basis of 23 oxygens										
Si	7.311	7.217	7.192	6.889	7.772	7.249	7.745	7.770	7.571	7.633
Ti	0.117	0.119	0.132	0.196	0.000	0.306	0.153	0.157	0.150	0.135
Al	0.713	0.873	0.871	1.203	0.224	0.549	0.323	0.260	0.598	0.591
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe''	2.289	2.326	2.415	2.229	2.875	3.325	4.564	4.712	4.202	4.285
Mn	0.039	0.033	0.042	0.025	0.061	0.058	0.097	0.081	0.108	0.080
Mg	2.810	2.682	2.604	2.525	2.152	1.836	0.450	0.261	0.714	0.697
Ca	1.748	1.771	1.752	1.973	1.969	1.756	0.729	0.595	0.712	0.802
Na	0.324	0.344	0.379	0.439	0.128	0.146	1.556	1.981	1.632	1.214
K	0.057	0.067	0.088	0.108	0.000	0.036	0.202	0.234	0.223	0.213

Sample Number	6971 cgoqzgr				7630 mgrogr					
	core	rim	core	rim	core	rim	core	rim	core	rim
SiO_2	47.85	47.07	49.13	48.72	42.96	43.49	42.93	43.06	42.55	43.01
TiO_2	1.14	1.22	1.17	1.30	1.66	1.52	1.50	1.72	1.62	1.56
Al_2O_3	2.29	1.92	1.37	1.47	7.00	7.46	6.84	6.89	7.20	6.64
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO_t	32.15	33.41	33.87	33.70	27.19	27.14	27.42	26.83	26.77	27.47
MnO	0.63	0.51	0.53	0.62	0.85	0.73	0.71	0.74	0.78	0.62
MgO	2.22	1.74	1.56	1.27	5.20	5.59	5.07	5.73	5.56	5.27
CaO	3.87	3.20	3.35	3.48	10.34	10.10	10.65	10.46	10.52	10.18
Na_2O	5.01	4.51	5.48	5.59	2.25	2.21	1.63	2.29	2.43	1.99
K_2O	0.96	0.97	1.03	1.23	0.91	0.79	0.82	0.88	0.94	0.88
Total	96.11	94.54	97.49	97.37	98.35	99.03	97.54	98.62	98.38	97.63
Atomic Formulae on the basis of 24 oxygens										
Si	7.762	7.802	7.896	7.863	6.775	6.778	6.819	6.760	6.711	6.829
Ti	0.138	0.152	0.142	0.157	0.196	0.178	0.179	0.203	0.193	0.186
Al	0.437	0.376	0.259	0.279	1.302	1.371	1.281	1.276	1.338	1.243
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe''	4.361	4.631	4.553	4.548	3.586	3.537	3.642	3.522	3.531	3.647
Mn	0.086	0.071	0.072	0.084	0.113	0.097	0.095	0.099	0.104	0.084
Mg	0.536	0.430	0.373	0.306	1.222	1.299	1.200	1.341	1.307	1.248
Ca	0.673	0.568	0.577	0.601	1.747	1.686	1.812	1.759	1.778	1.732
Na	1.577	1.450	1.708	1.749	0.689	0.666	0.501	0.698	0.744	0.613
K	0.198	0.204	0.211	0.253	0.184	0.156	0.165	0.176	0.189	0.179

Sample Number	7658 mgrogr	
	core	rim
SiO_2	42.23	41.95
TiO_2	1.22	1.62
Al_2O_3	6.90	7.63
Cr_2O_3	0.00	0.00
FeO_t	29.85	29.57
MnO	0.85	0.97
MgO	3.54	3.40
CaO	10.65	10.22
Na_2O	1.99	2.30
K_2O	1.09	1.07
Total	98.32	98.73

Atomic Formulae on the basis of 23 oxygens

Si	6.769	6.685
Ti	0.147	0.195
Al	1.304	1.434
Cr	0.000	0.000
Fe''	4.002	3.941
Mn	0.116	0.131
Mg	0.845	0.807
Ca	1.829	1.746
Na	0.618	0.712
K	0.223	0.217

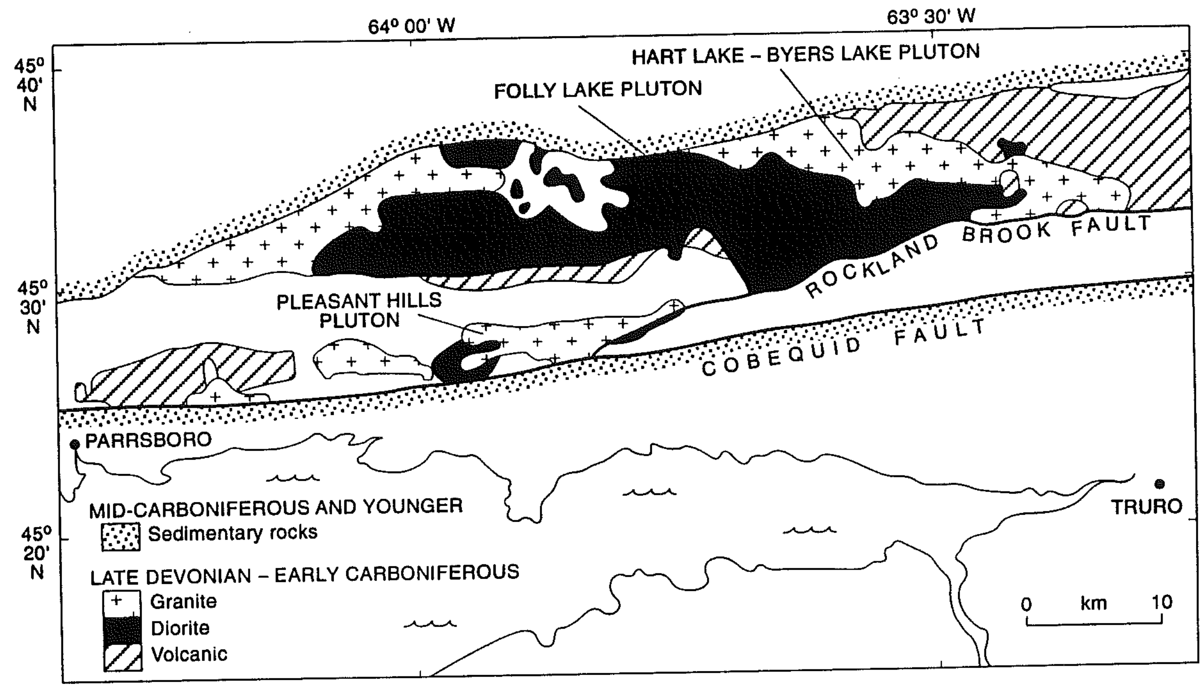

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Fig. 1. General map showing location of the Wentworth pluton and its relationship to previously described plutonic bodies.

A

B

Fig. 2. Photographs showing relationships between gabbro and granite, Rory's Pond road (A-D from Pe-Piper et al., 1996). (A) lobate contact between granite and gabbro. (B) irregular contact of gabbro and granite, with the gabbro showing chilling, and a gabbro xenolith in granite. (C) irregular veins of granite in gabbro. (D) Net veining of granite in gabbro (chocolate bar structure of Koukouvelas and Pe-Piper, 1996). (E) Irregular contact between diorite/gabbro and granite, with a chilled margin to the diorite/gabbro. (F) Rounded mafic xenoliths in granite.

C

D

E

F

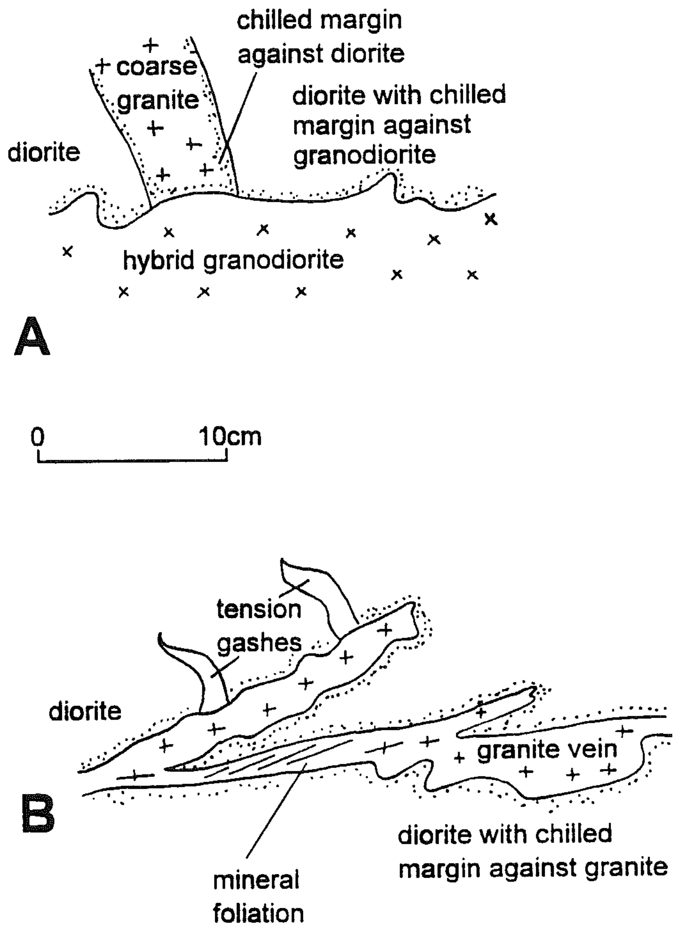


Fig. 3. Field sketches of relationships between gabbro and granite, Rory's Pond road (from Pe-Piper et al., 1996). (A) Gabbro with chilled margin against slightly foliated granodiorite, cut by discontinuous coarse granite dykes. (B) Gabbro with chilled margin against granitic veins. Granite veins show a strong mineral fabric. Gabbro cut by tension gashes filled with felsic minerals.

p. 61]

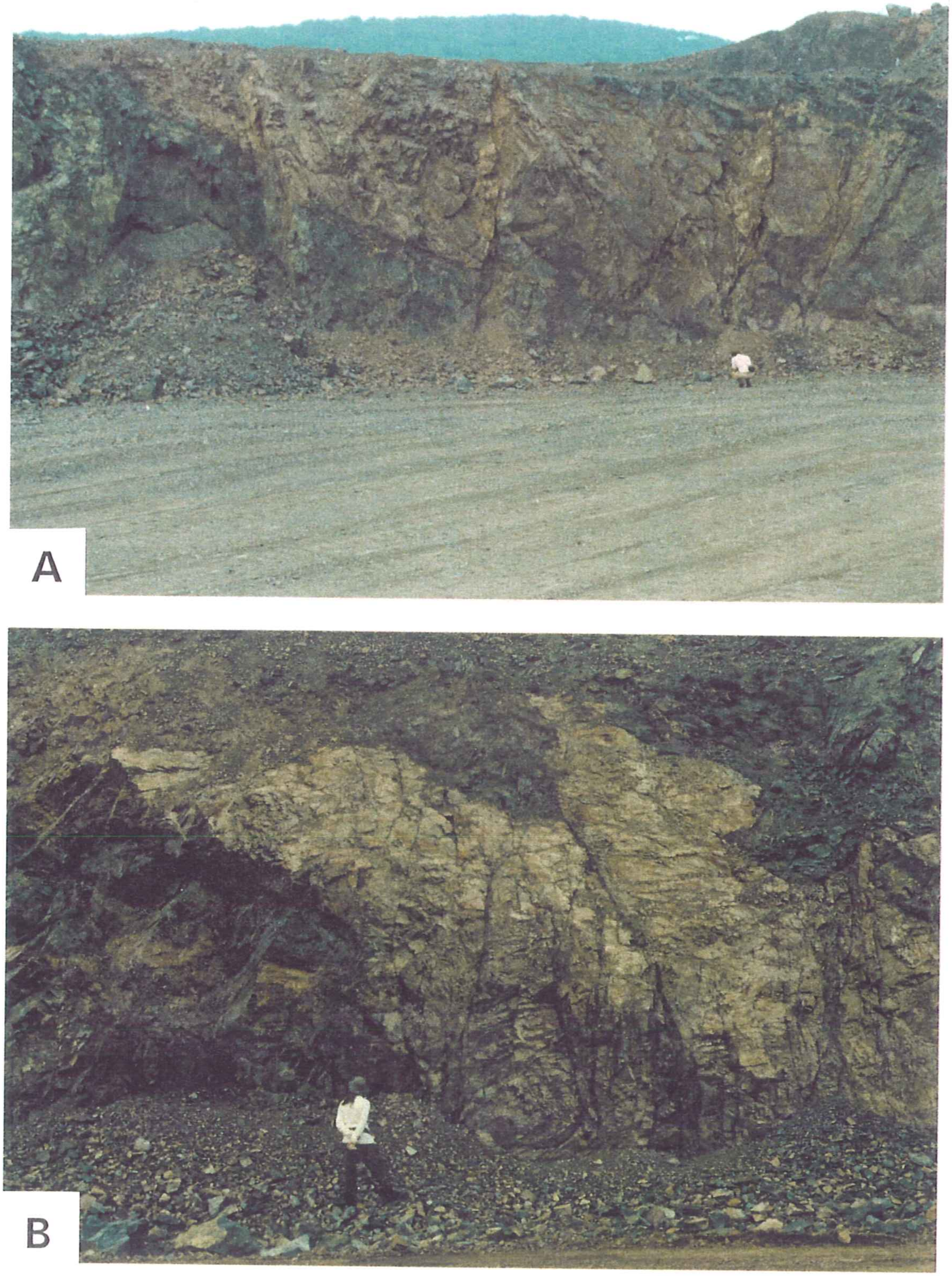


Fig. 4. Photographs of relationship between granite and diorite in the Permament-LaFarge Folly Lake quarry. (A) N-dipping sheet of granite in diorite; (B) irregular domes of granite in diorite.

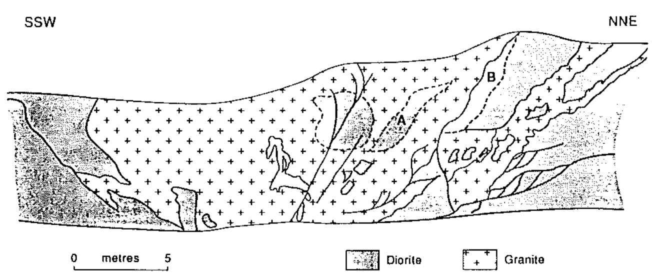


Fig. 5. Sketch of relationship between granite and diorite/gabbro in the Folly Lake quarry (from Koukouvelas and Pe-Piper, 1995). At the base of the body (NNE) are 4-m-wide granite dykes including large diorite enclaves. This is separated by 4 m of diorite/gabbro from the main granite body, which is 14 m wide. At the base of this body are numerous small granite dykes into diorite (B). The lower part of the main body includes a lens-shaped zone 6 m in length with abundant small diorite/gabbro enclaves (A). In the upper part of the main body is a larger subcircular diorite enclave. The south-southwestern contact of the granite is irregular.

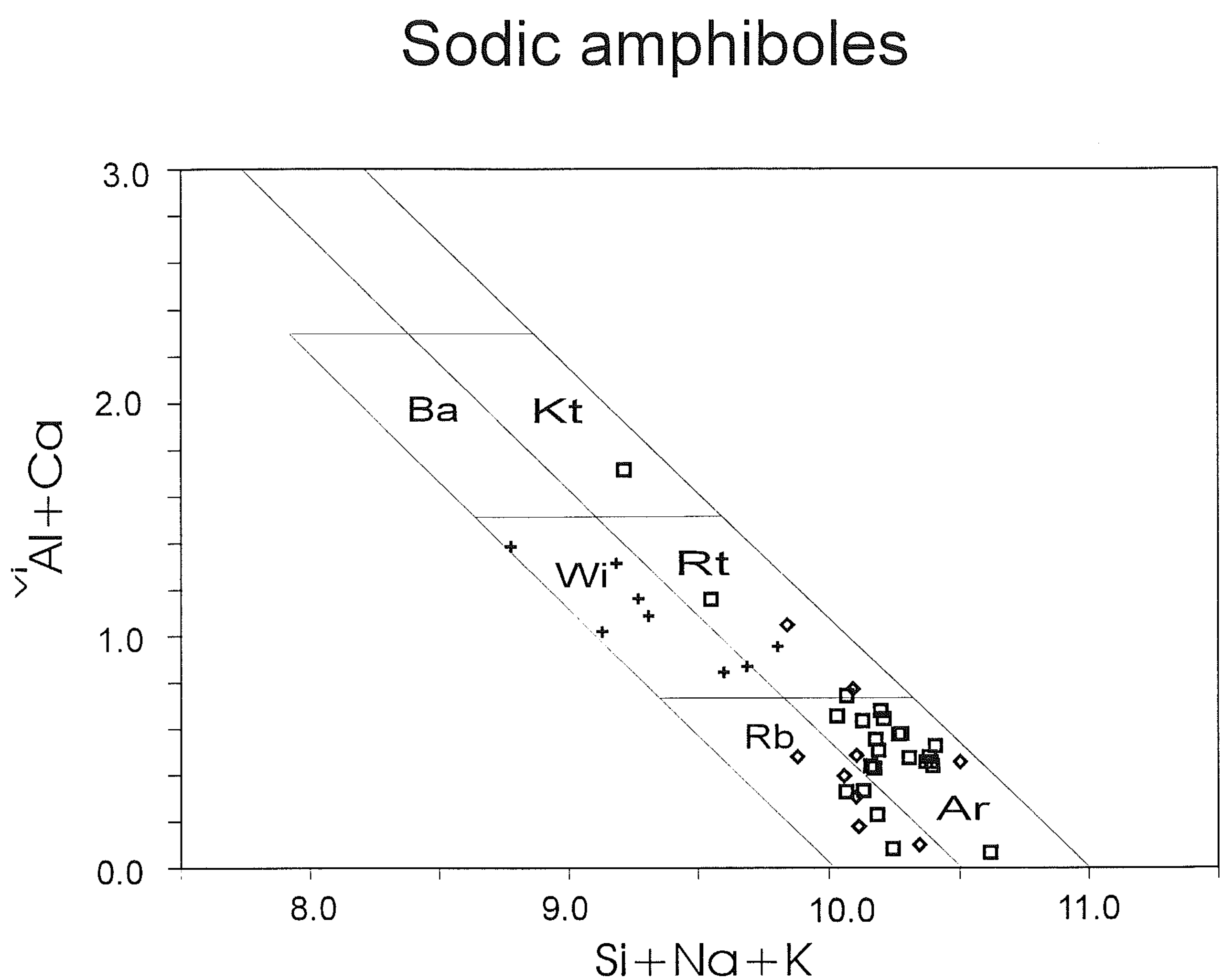


Fig. 6. (a) Si+Na+K *vs.* $^{4+}$Al+Ca for Si-rich amphiboles from Hart Lake - Byers Lake granite. Ta = taramite; Ba = barroisite; Kt = kataphorite; Wi = winchite; Rt = richterite; Ar = arfvedsonite. Samples: X = 35-7-1; ◊ = 6419; □ = 6971. Fields after Giret et al. (1980).

Magmatic/subsolidus and oxidation trends in amphibole composition

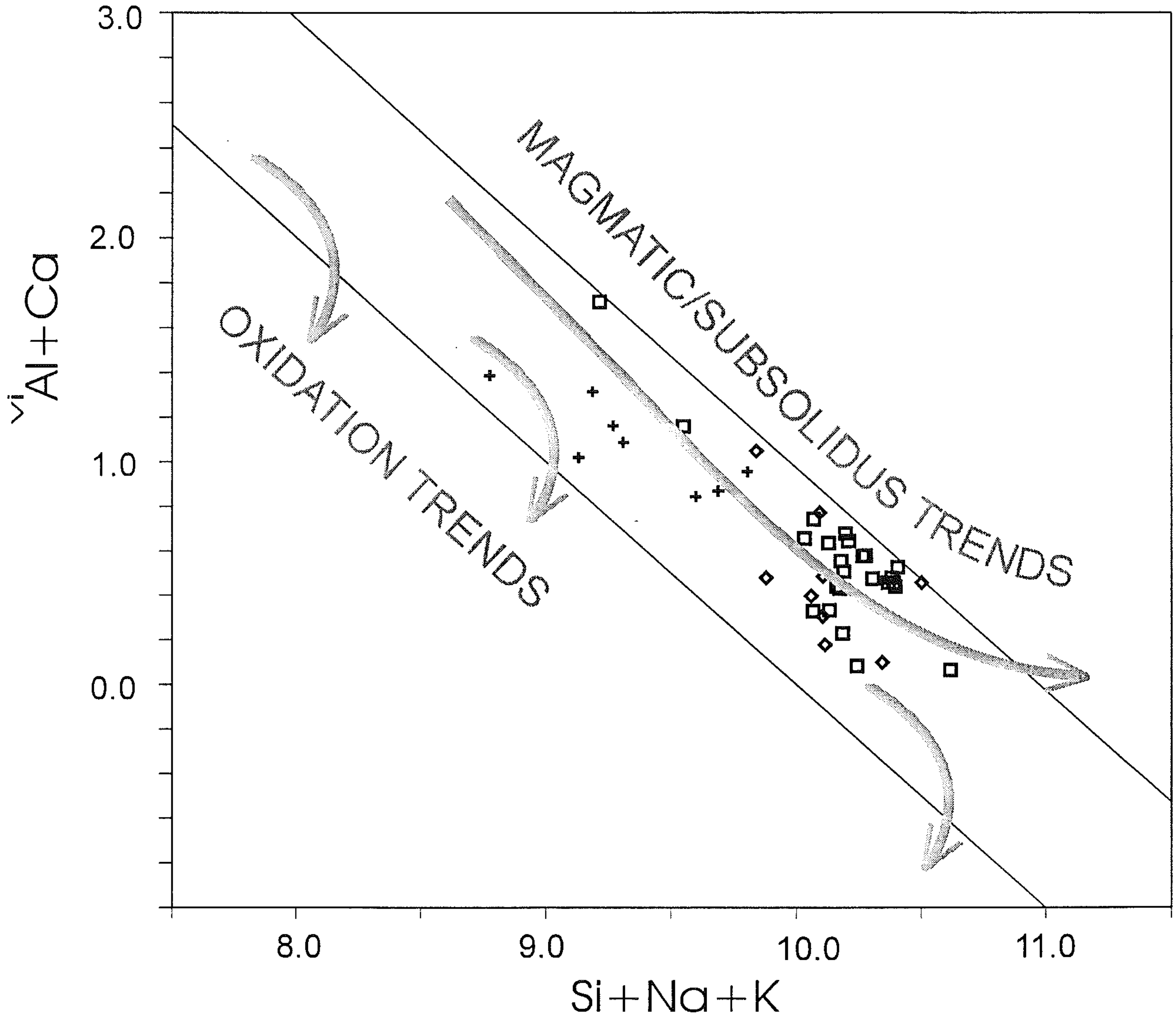


Fig. 6. (b) Same plot as in Fig. 6a, showing magmatic/subsolidus and oxidation (hydrothermal) trends in amphiboles from silica-saturated peralkaline rocks. Trends after Strong and Taylor (1984).

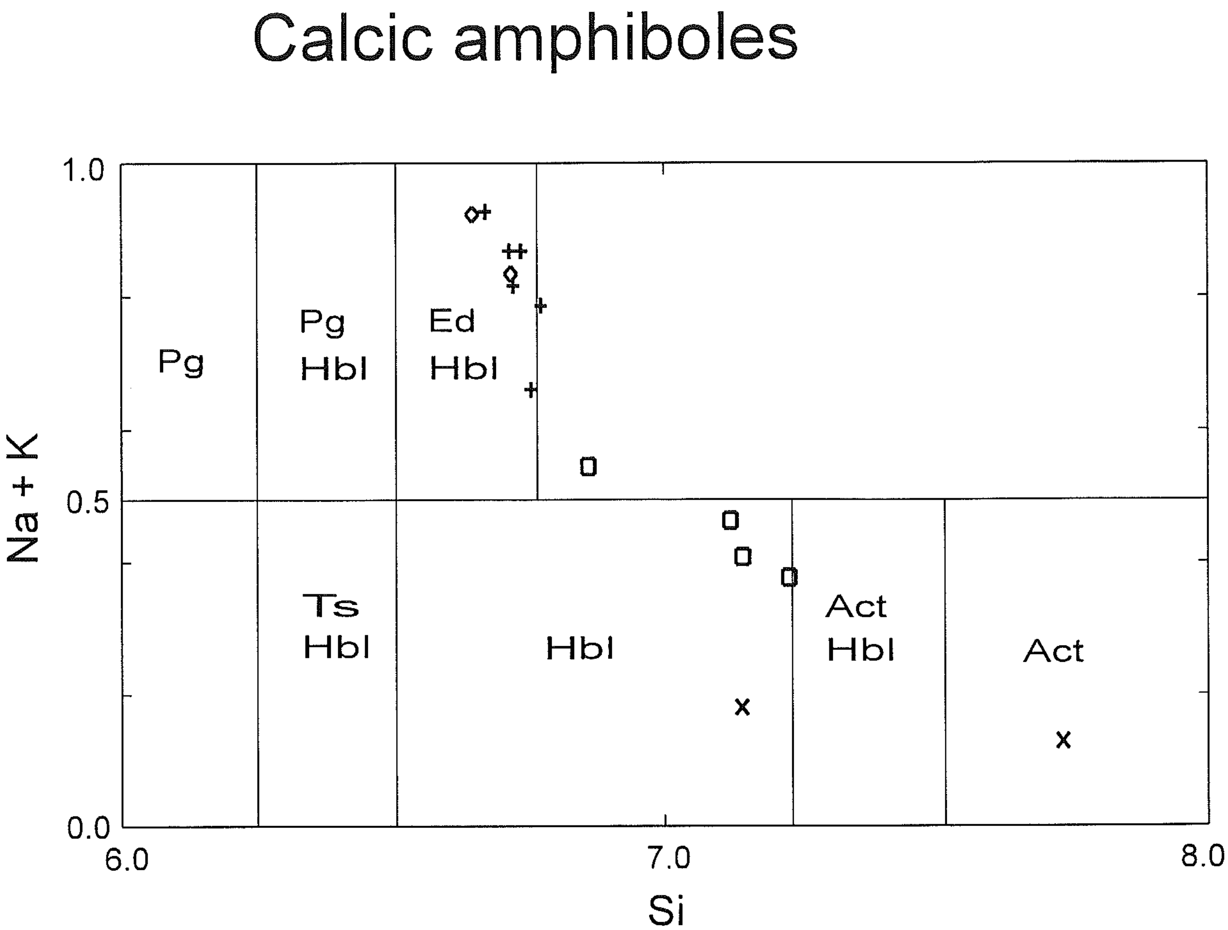


Fig. 7. Si *vs.* Na+K for Si-poor calcic amphiboles from Hart Lake - Byers Lake granite. Pg = pargasite; Pg Hb = pargasitic hornblende; Ed Hb = edenitic hornblende; Ts Hb = tschermakitic hornblende; Hb = hornblende; Act Hb = actinolitic hornblende; Act = actinolite. Fields after Leake (1978). Samples: X = 6970; + = 7630; □ = 6477; ◊ = 7658.

APPENDIX 1

Sample	Name	Analysis	Thin S.	Probe S.
27-1-2	mgdt	+	+	
27-2-1	mgopgr			
27-4-1	fgm	+	+	
28-4-1	dt			
28-6-1	mgopgr		+	
28-6-2	f-mgpgr		+	
28-6-3	f-mgpogr			
28-6-4	cgpgr			
28-7-1	mgm		+	
28-7-2	f-mggd	+	+	
28-7-3	dt		+	
28-7-4	dt		+	
28-9-1	f-mgpggr(hy)		+	
28-9-2	f-mggd		+	
28-9A-1	cgm		+	
28-9A-2	f-mgpgr			
29-1-1	dt		+	
29-2-1	f-mggd		+	
29-2-2	fgm		+	
29-2-3	porhy/mcgr		+	
29-4-1	fgm		+	
29-5-2	fgm/f-mgpgr			
29-5-3	f-mgpgr			
29-6-1	dt			
29-7-1	dt(hy)	+		
29-8-1A	f-mggd		+	
29-8-2	f-mgpggr(hy)		+	
29-8-2A	f-mgpgg(hy)		+	
29-8-3	gywk		+	
29-8-4	gywk		+	
29-8-5	cgpg		+	
29-8-6	f-mgpggr(hy)			
29-9-1	sst			
30-1-1	fgm		+	
30-3-1	mgopgr			
30-4-1	fgm			
31-1-1	f-mggd		+	
31-3-1	dt	+	+	
31-3-2	vfgpgr	+		
31-4-1	dt	+	+	
31-5-1	pom	+	+	
31-6-1	f-mgpgr		+	
31-6-2	f-mgpgr		+	
31-6-3	mggpggr(hy)			
31-8-1	slst	+		
31-9-1	cgpogr			
31-9-2	m-cgm		+	

31-10-1	dt	+				
32-1-1	f-mggd	+	+			
32-1-2	dt(hy)					
32-3-1	pe					
32-4-1	f-mggd	+				
32-5-1	shm					
33-1-1	fgm		+			
33-1-2	cm					
33-2-2	f-mggd					
33-2-3	f-mgpgr					
33-7-1	dt		+			
33-7-1A	f-mggd					
33-7-2	cm					
33-7-2A	cm		+			
33-7-3	flb		+			
34-2-1	f-mggd					
34-2-2	porhy/mcgr					
35-1-1	fgm					
35-5-3	f-mgpgr					
35-8-2	dt					+
36-2-3	f-mgrgr					
36-4-1	dt	+		+		
36-4-2	f-mgpgr		+			
36-7-2	dt(hy)					
36-7-3	mdt					
37-1-1	f-mgrgr	+				
37-2-1	fgm	+				
37-2-2	fgm					
37-2-3	porhy/mcgr					
44-1-2	dt					
44-2-1	f-mgggr					
44-2-2	dgrhy/mcgr					
44-2-4	mgopgr					
44-3-1	fgm					
44-4-2	fgm					
44-5-1A	dgrhy/mcgr	+				
44-5-1B	dgrhy/mcgr	+				
44-7-1	prhy/mcgr					
44-9-1	dt	+				
44-9-2	f-mgpgr	+			+	
44-10-1	dt					
45-2-1	f-mggd					
45-3-1	dt	+			+	
45-4-1	vpom		+			
45-A-4-1	gywk		+			
45-4-2	pom					
45-5-1	f-mggd					
45-A-5-1	shm					
45-A-6-1	dgrhy/mcgr					
45-11-1	dt					
45-12-1	myl(l)					

4620	dt	+			
4638	dt(hy)				
4639	dt(hy)				
4640	f-mgrgr	+		+	
4641	f-mgpgr	+			
4642	f-mgrgr	+			
4648	cgpgr	+		+	
4649	mga	+			
4650	cgpgr	+		+	
4651	cgpgr	+		+	
4652	cgpgr	+		+	
4653	ga	+			
4654	cgpgr	+		+	
4655	mgm				
4656	f-mgpgr	+			
4657	f-mgpgr	+		+	
4658	prhy/mcgr	+		+	
4659	pe				
4660	f-mgpgr	+			
4661	m(hy)		+		
4662A	cgpgr	+		+	
4662B	cgpgr	+		+	+
5048	f-mgpggr(hy)		+		
5049	f-mgpgr		+		
5050	f-mgrgr				
5051	pom				
5052	dt(hy)	+	+		+
5053	dt	+	+		+
5054	mgm	+	+		+
5055	mgm	+	+		+
5056	f-mggd	+	+		+
5057	f-mggd		+		+
5058	fgm				
5059	mgm	+	+		+
5060	f-mgpgr	+	+		
5061	dt	+	+		+
5062	dt	+	+		+
5063	dt(hy)				
5064	dt(hy)				
5065	f-mgpgr		+		
5066	dt(hy)	+	+		+
5067	f-mgpgr	+	+		
5068	mgm	+	+		
5069	f-mggd	+	+		
5070	m-cgdt	+	+		+
5115	fgm				+
5116	dt		+		
5117	dt				+
5118	f-mggd		+		
5119	f-mgpggr(hy)		+		
5120	pom		+		

5121	f-mgpggr(hy)		+	
5122	dt(hy)			+
5123	f-mgpgg(hy)		+	
5124	dt	+		+
5158	m-cgopgr			
5159	m-cgopgr			
5160	mgdt			
6289	myl(d)			
6381	fgga			
6383	mgdt			
6384	mgdt	+		+
6385	opg/dt(hy)			
6386	opg/dt(hy)			
6387	mgdt	+		+
6388	m-cgopgr			
6389	mgdt			
6390	fgdt	+		+
6391	f-mgwggr		+	
6397	m-cgopgr			
6398	m-cgdt			
6399	fgdt			
6401	m-cgopgr			
6403	opg/dt(hy)			
6404	opg/dt(hy)			+
6417	fgdt			
6420	fgdt			
6423	m-cgdt			
6424	mgdt			
6425	mgdt			
6426	dt			
6427	m-cgopgr			
6430	mgwggr			
6431	f-mgdt			
6434	fgdt			
6445	fgdt			
6451	grhy			+
6452	fgdt			
6453	opg/dt(hy)			
6455	mgdt			
6701	mgdt			
6731	fgdt			
6737	rrhy/mcgr			
6745	fgdt			
6746	mcgr			
6757	mgdt		+	
6758	m-cgopgr			
6759	m-cgopgr			
6760	mgpgr/mcgr		+	
6761	fgdt	+	+	
6764	fgdt			
6775	mgdt		+	

6779	mgdt			
6780	m-cgopgr	+	+	
6781	mgdt			
6782	fgdt			
6783	mgdt			
6785	fgdt			
6786	c-mgdt			
6789	m-cgdt(hb)			
6791	vfggd/dt		+	
6792	m-cgpdt			
6793	opg/dt(hy)			
6794	m-cgopgr			
6795	m-cgpdt			
6796	m-cgdt	+	+	
6797	m-cgpdt			
6798A	vfggd,dt			
6798C	mgdt			
6798D	mgdt			
6800	mgdt			
6801	m-cgopgr			
6802	dt			
6803	myl(l)			
6804	mgdt			
6805	dt			
6806	gd			
6807	dt			
6813	fgdt			
6814	fgdt			
6818	rrhy			
6819	rrhy			
6821	opg/dt(hy)			
6822	fgdt			
6823	fgdt			
6826	fgdt			
6827	fgdt	+	+	
6828	fgdt	+	+	?Prec
6829	my(d)			
6830	myl(l)			
6836	myl(d)			
6837	qzt		+	
6840	fgdt	+	+	?Prec
6858	m-cgwggr			
6868	mggr			
6870	mgdt			
6872	opg/dt(hy)			
6873	m-cgpogr			
6874	mgdt			
6875	mgdt			
6876	m-cgpdt			
6878	mgdt			
6879	m-cgwggr			

6880	mgdt		
6881	m-cgdt(hb)		
6882	mgdt		
6883	mgdt		
6884	mgdt		
6903(2)	fgdt	+	+
6967	mgdt		
6968	m-cgdt(hb)		
6972	opg/dt(hy)		
6973	mgdt		
6974	m-cgpggr (vuggy)		
7359	m-cgwggr	+	+
7360	m-cgopgr	+	+
7361	cgdt(hb)	+	+
7364	pom-cgdt		
7363	mgdt	+	+
7372	m-cgopgr	+	+
7373	m-cgopgr	+	+
7374	m-cgwggr	+	+
7375	mgdt	+	+
7452	mgdt		
7453	cgdt(hb)		
7517	myl	+	+
7518	myl(l)		
7519	fgdt		
7520	fgdt		
7521	mgpdt		
7523	m-cgdt		+
7541	fgdt	+	+
7610	fga		
7611	f-mgga		
7612	f-mgga		
7613	ga		
7615	porhy		
7616	porhy		
7617	gd		
7618	gd		
7637	pegr		
7662	fgmcgr		
7663	f-mgdt	+	+
7664	m-cggd		
7710	pgr(+xen)	+	+
7773	mgga	+	+
7774	mgdt(hb)	+	+
7818		+	+

<u>Legend:</u>
Pegmatite - pe
Aplite - ap

Granite - gr
Porphyritic - po
Rapakivi granite - rag
Fine-medium grained gray granite - f-mgggr
Fine-medium grained Red granite - f-mgrgr
Fine-medium grained pink granite - f-mgpgr
Very fine grained pink granite - vfgpgr
Medium grained orange pink granite - mgopgr
Fine-medium grained pink gray granite (hybrid) - f-mgpggr(hy)
Coarse grained pink granite - cgpgr
Granodiorite- gd
Rhyolite- rhy
Grey rhyolite- grhy
Red rhyolite- rrhy
Mylonite(light) - myl(l)
Mylonite(dark) - myl(d)
Fine grained mafic - fgm
Medium grained mafic - mgm
Coarse grained mafic - cgm
Porphyritic mafic - pom
Very porphyritic mafic - vpom
Sheared mafic - shm
Cataclastic mafic - cm
Mafic hybrid - m(hy)
Fine-medium granodiorite - f-mggd
Diorite - dt
Diorite (hybrid) - dt(hy)
Megacrystic diorite - mdt
Gabbro - ga
Foliated gabbro - fga
Fine grained gabbro - fgga
Megacrystic gabbro - mga
Diabase - db
Fountain Lake basalt - flb
Microgranite - mcgr
Dark gray rhyolite/microgranite - dgrhy/mcgr
Porphyritic rhyolite/microgranite - porhy/mcgr
Sandstone - sst
Siltstone - slst
Graywacke - gywk
Xenolith - xen
Quartzite - qzt

APPENDIX 2

Sample	Name	Analysis	Thin S.	Probe S.	
27-1-2	mgdt	+	+		
4611	fgm	+	+		Tr
4612	f-mgpggr (hy)	+	+		Tr
4613	dt	+	+		Tr
4614	f-mgpgr	+	+		Tr
4615	f-mgpgr	+	+		Tr
4616	dt	+	+		Tr
4617	f-mggd	+		+	Tr
4618	cgpgr	+	+	+	Tr
4619A	hy				Tr
4619B	f-mgpgr				Tr
4621	ap (cut.dt)	+	+	+	Tr
4622	fgm				HB
4623	f-mgpgr	+	+	+	HB
4624	cgpgr				HB
4625	dt	+	+	+	HB
4626	ragr	+	+		HB
4627	dt(hy)				HB
4628	dt	+	+		HB
4629	f-mgpgr	+	+		HB
4630	f-mgpgr	+	+		HB
4631	f-mgpgr	+	+		HB
4632	f-mgpgr	+	+		HB
4633	f-mgpgr	+		+	HB
4634	cgpgr	+	+	+	HB
4635	f-mgrgr			+	HB
4636	cgpgr	+		+	HB
4637	fgm				HB
4643	mgrogr				HB
4644	f-mgrgr	+			Hb
4645	f-mgrgr	+			HB/PC
4646	f-mgrgr	+			HB/PC
4647	ga(dy)	+			HB/PC
4663	mgogr	+	+		HB
4664	mgpgr	+	+		HB
4665	f-mgpgr	+			HB
6370	mgpuggr	+		+	Tr
6371	mgdt	+		+	Tr
6372	pogr				Tr
6373	popuggr	+		+	Tr
6374	gr/dt				Tr
6375	mgpogr				Tr
6376	mggd				HB
6377	mggr(hb)				HB

6378	ragr			HB
6378A	mggd			HB
6379	my			HB
6380	my			HB
6382	mggr(hb)			Tr
6392	mgogr			Tr
6393	mgogr			Tr
6394	fgogr			Tr
6395	fgogr			Tr
6400	mgpuggr			Tr
6402	cgwggr			Tr
6405	mgqzgr			Tr
6416	mgogr			HB
6419	cgoqzgr	+	+	HB
6421	cggr(hb)			?HB
6422	mgogr			?HB
6426	mgdt			Tr
6428	mgwggr			Tr
6429	dm			Tr
6432	mggd			Tr
6433	cgqzgr			Tr
6435	my(l,d)			Tr
6436	fgogr			Tr
6437	my(l)			Tr
6438	my(l,d)			Tr
6440	my(l)			Tr
6441	my(l,d)			Tr
6442	my(l,d)			Tr
6443	my(d)			Tr
6444	my(l)			Tr
6446	cgoqzgr			Tr
6447	fogr			Tr
6448	my(l)			Tr
6449	my(l)			Tr
6450	my(l)			Tr
6477	mgdt	+	+	Tr
6478	pegr			Tr
6479	mggr			Tr
6480	fgogr			Tr
6481	mgogr			Tr
6482	fgogr			Tr
6483	pegr			Tr
6484	pogr	+	+	Tr
6485	gd	+	+	Tr
6486	fgogr			Tr
6487	hy			Tr
6488	mgoqzgr			Tr
6489	mgwggr			Tr
6490	mgwggr	+	+	Tr
6491	altwgr			Tr
6492	altwgr			Tr

6493	pogd			Tr
6494	dt			Tr
6495	altwgr			Tr
6497	mgpg			Tr
6498	mgoqzgr			Tr
6499	dt			Tr
6518	m-cgopgr	+	+	HB
6530	fgogr			HB
6531	mggd			HB
6532	fgogr			HB
6533	fgogr	+	+	HB
6588	mgpugr	+	+	HB
6589	mgogr			HB
6590	fgpugr	+	+	HB
6591	mgrogr	+	+	HB
6592	mggpugr			HB
6593	mggpugr			HB
6594	mggpugr			HB
6595	mggpugr			HB
6686	mgpuggr	+	+	HB
6687	mgpuggr			HB
6688	puporhy	+	+	HB
6689	fgrogr			HB
6700	dt			HB
6738	mcgr			HB
6739	cgoqzgr			HB
6744	cgoqzgr			HB
6753	mgogr			HB
6762	dt			HB
6763	ogr(hb)			HB
6765	dt			HB
6766	hy			HB
6767	hy			HB
6768	mgogr			HB
6769	mgogr			HB
6773	gd			HB
6774	hy			HB
6775	dt	+	+	FLP
6776	mgoqzgr			HB
6777	dt			HB
6778	dt			HB
6787	gd			Tr
6790	gd			Tr
6808	mgogr	+	+	?Tr
6809	mgogr			?Tr
6810	mgwggr			
6811A	mcgr			
6812	mgogr			
6815	fggpugr			
6816	mgpgr			
6817	mcgr			

6820	rmcgr			
6824	fgpurhy			
6825	cggr(hb)			
6862	dt			?Tr
6864	mgoqzgr			?Tr
6865	mgpuggr			?Tr
6866	dt/gr(ct)			?Tr
6867	gd			?Tr
6871	my(hy)			
6877	gd			
6901	mgoqzgr			HB
6902	mgoqzgr	+	+	HB
6904	puggr			HB
6964	mggr(hb)			HB
6965	mggr(hb)			HB
6966	mcgr			HB
6969	altwgr			HB
6970	mgogr	+	+	HB
6971	cgoqzgr	+	+	HB
7285	fgpuggr			BBin
7286	mgogr			BBin
7287	fgogr			BBin
7288	fgpuggr			BBin
7289	popurhy			BBin
7290	popurhy	+	+	BBin
7291	pogrhy	+	+	BBin
7292	popgr			BBin
7293	popurhy			BBin
7366	my			
7367	my			HB
7368	porhy	+	+	BBin
7369	porhy	+	+	BBin
7371	pogrhy	+	+	BBin
7414	mgogr			HB
7415	fggpugr			HB
7416	mgogr			HB
7417	gmcgr			HB
7418	fggpugr			HB
7419	fggpugr	+	+	HB
7420	gmcgr			HB
7421	gmcgr			HB
7423	cgoqzgr			HB
7424	cgoqzgr			HB
7425	pgmcgr			HB
7426	cgoqzgr			HB
7429	fgwggr	+	+	HB
7548	fgogr			HB
7627	gr(my)			HB
7628	fpuggr			HB
7629	mgrogr	+	+	HB
7630	mgrogr	+	+	HB

7642	mgogr					HB
7643	rhy					HB
7644	gd					HB
7645	mgpuggr					HB
7646	pumcgr	+			+	HB
7647	wggr					HB
7648	mgogr					HB
7649	f-mggd					HB
7650	pogd					HB
7651	pogd	+			+	HB
7652	rhy					HB
7653	mgdt					HB
7654	fgmcgr					HB
7655	pormcgr					HB
7656	rogr					HB
7657	puggr					HB
7658	mgrogr	+			+	HB
7659	rhy					
7700	porhy/ga					BBin
7701	porhy/ga					BBin
7702	porhy/ga					BBin
7703	fgga					BBin
7704	pumcgr	+			+	BBin
7705	mgpodt	+			+	BBin
7709	gporhy				+	BBin
7712	mggd	+			+	HB
7713	rhy					BBin
7714	grhy	+			+	BBin
7715	f-mgwggr					BBin
7716	pugrhy					BBin
7717	pory					BBin
7735	forhy				+	BBin
7749	sst(hornf)					BBin
7752	grhy					BBin
28-2-1	f-mgrgr			+		Tr
29-5-1	f-mgrgr		+			Tr
29-8-5	cgpgr	+		+		
29-8-7	cgpgr			+		
30-1-1	fgm(dy)	+		+		
30-9-1	gr			+		
33-2-1	shgr			+		
35-4-1	f-mgpgr			+		
35-5-1	f-mgrgr	+		+		Tr
35-5-2	f-mgrgr			+		Tr
35-5-4	fgm(dy)					
35-7-1	cgpgr	+		+		
36-2-1	f-mgpgr	+		+		Tr
36-2-2	m(dy)					
36-5-1	f-mgpgr	+		+		
36-6-1	f-mgpgr			+		
36-6-2	porhy/mcgr			+		

36-7-1	cgpgr	+	+
44-1-1	f-mgpgr		
44-2-3	f-mgpgr/rhy		+
44-4-1	f-mggd		+
44-8-1	f-mgpgr		+

<u>Legend:</u>
Diorite - dt
Mafic - m
Gabbro - ga
Granodiorite - gd
Pegmatite - pe
Aplite - ap
Granite - gr
Microgranite - mcgr
Rhyolite - rhy
Porphyry - pory
Rapakivi - ra
Grained - g
Fine-grained - fg
Medium-grained - mg
Coarse-grained - cg
Porphyritic - po
Pink - p
Orange - o
Grey - g
Red - r
White - w
Purple - pu
Quartz-rich - qz
Hornblende - hb
Dyke - dy
Altered - alt
Hornfelsed - hornf
Mylonite (light) - my(l)
Mylonite (dark) - my(d)
Foliated - fo
Deformed - d
Sheared - sh
Hybrid (mechanical mixing...lobate contacts) - hy
Sandstone - sst

HB: Hart Lake - Byers Lake pluton as mapped by Donohoe and Wallace (1982)

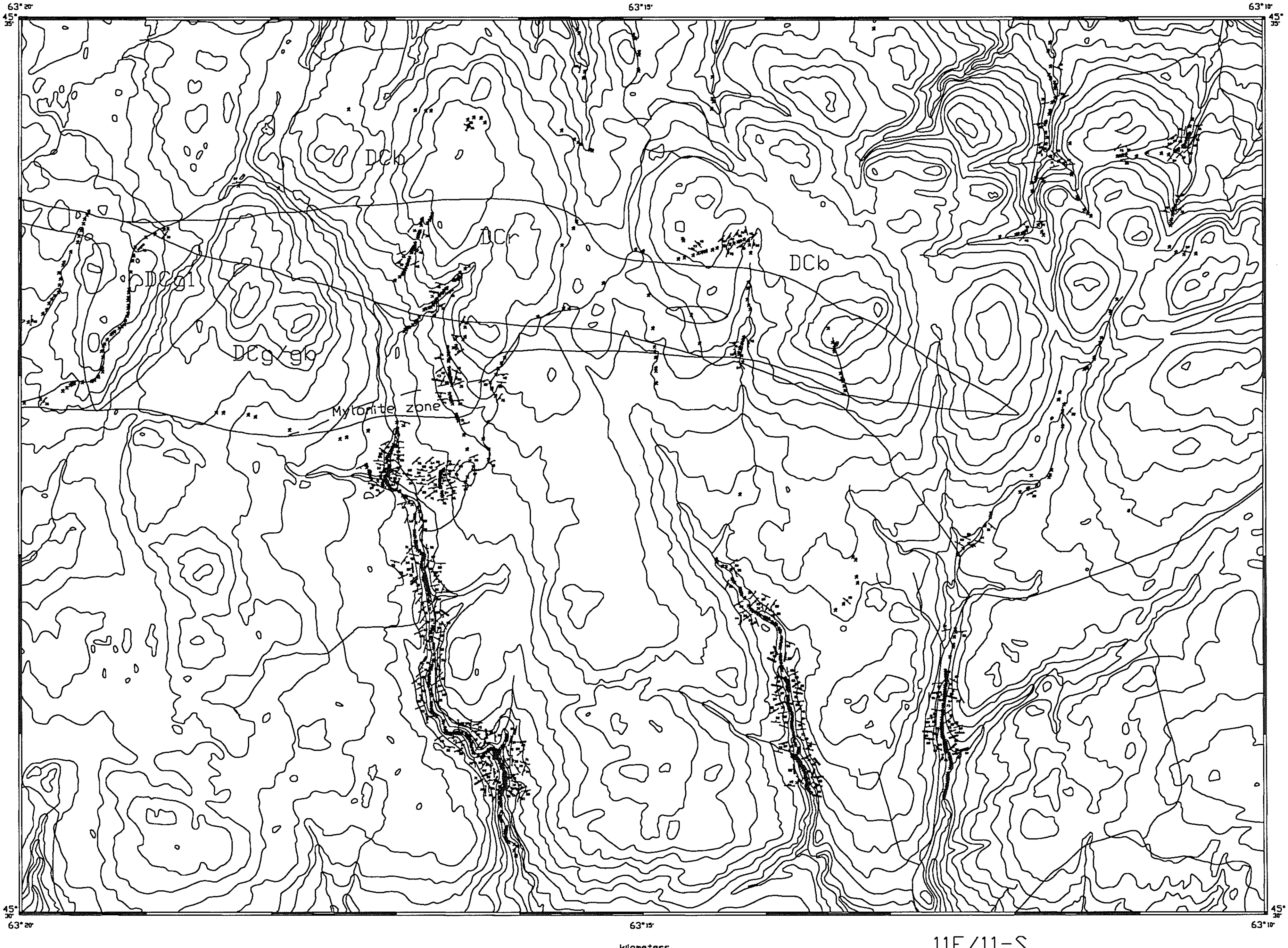
FLP: Folly Lake pluton as mapped by Donohoe and Wallace (1982)

Tr: Transitional zones between Hart Lake - Byers Lake and Folly

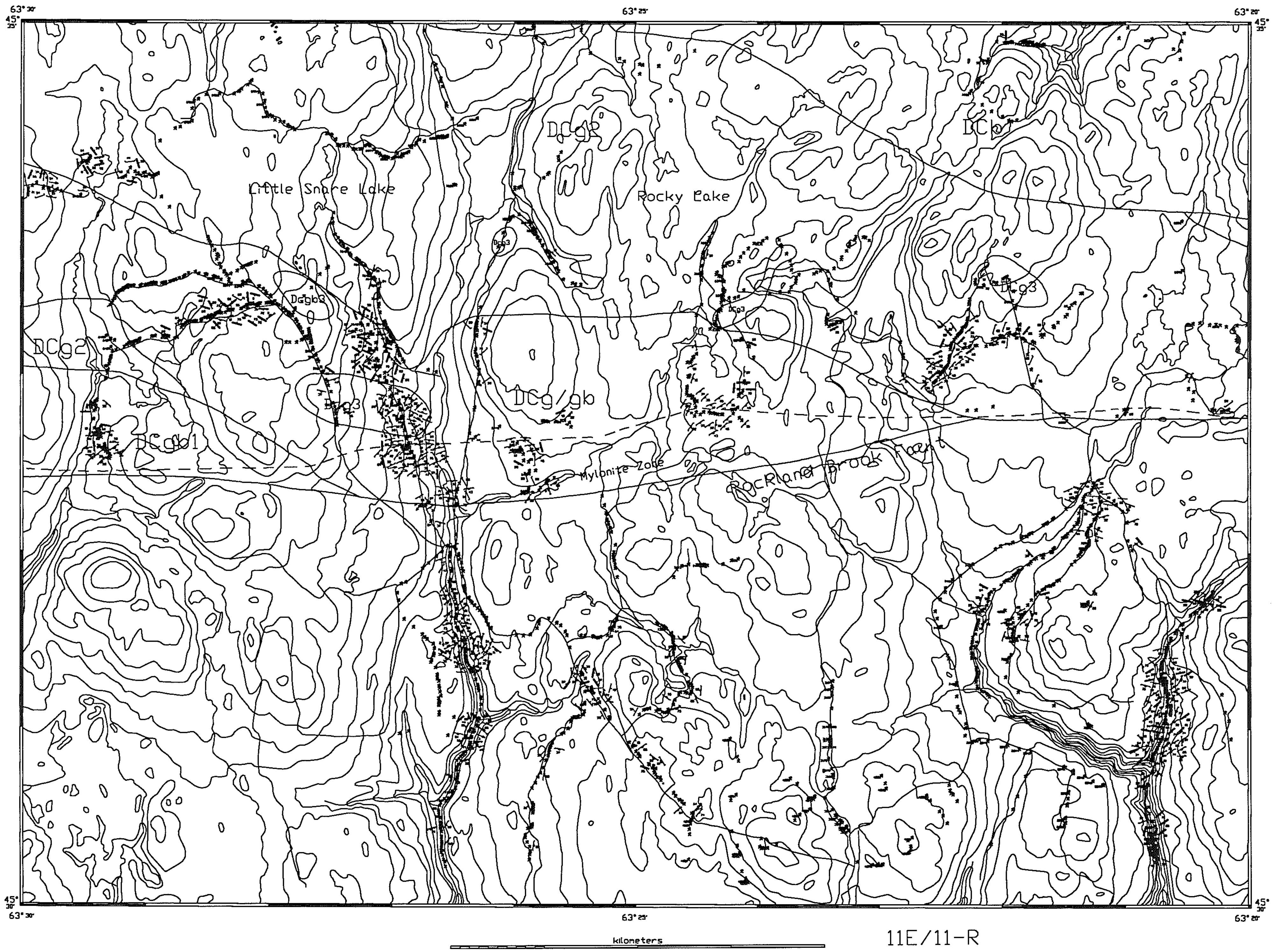
Lake plutons

BBin: Intrusive ?felsic rocks within the Hart Lake - Byers Lake pluton

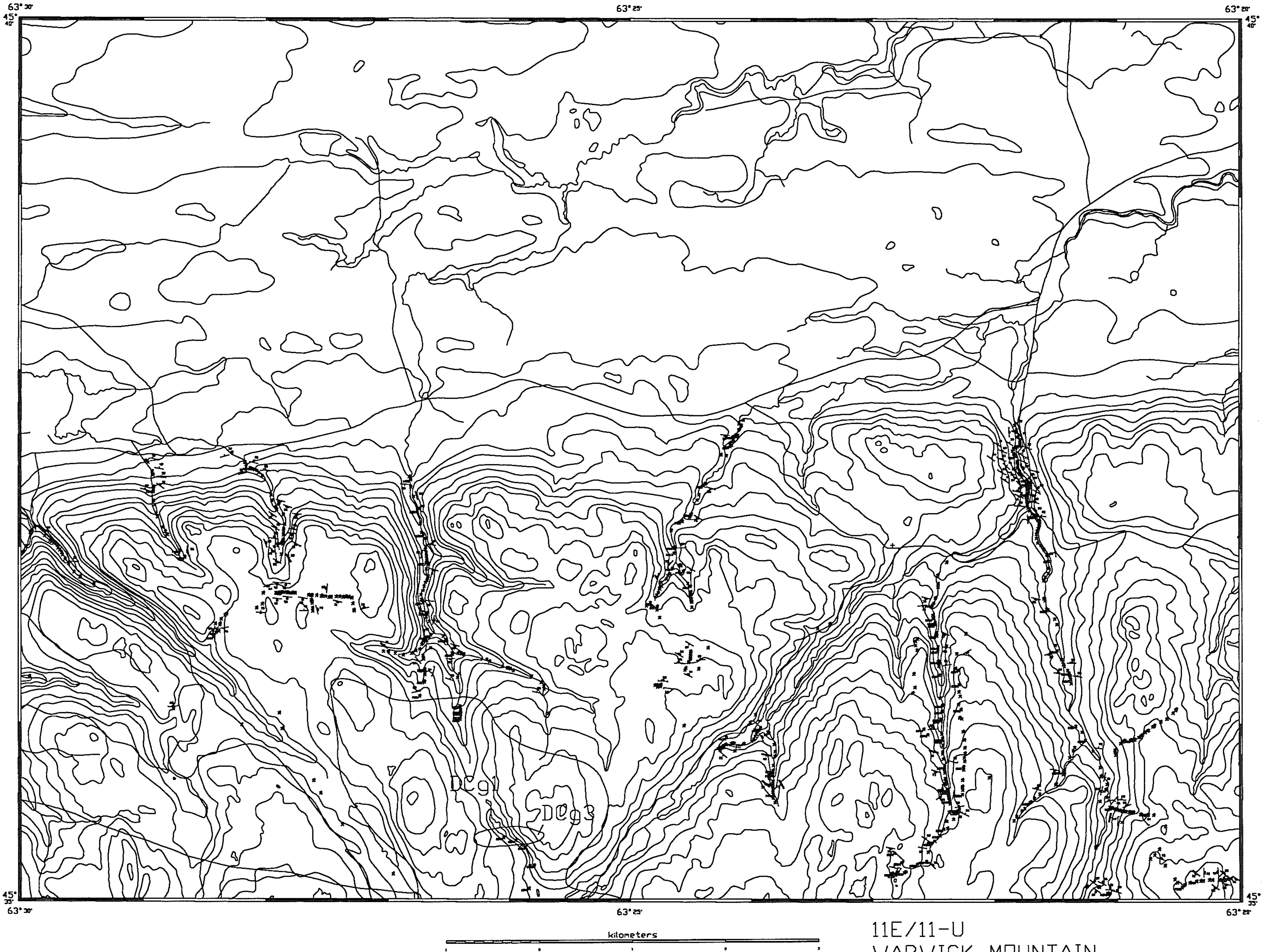
PC: Precambrian



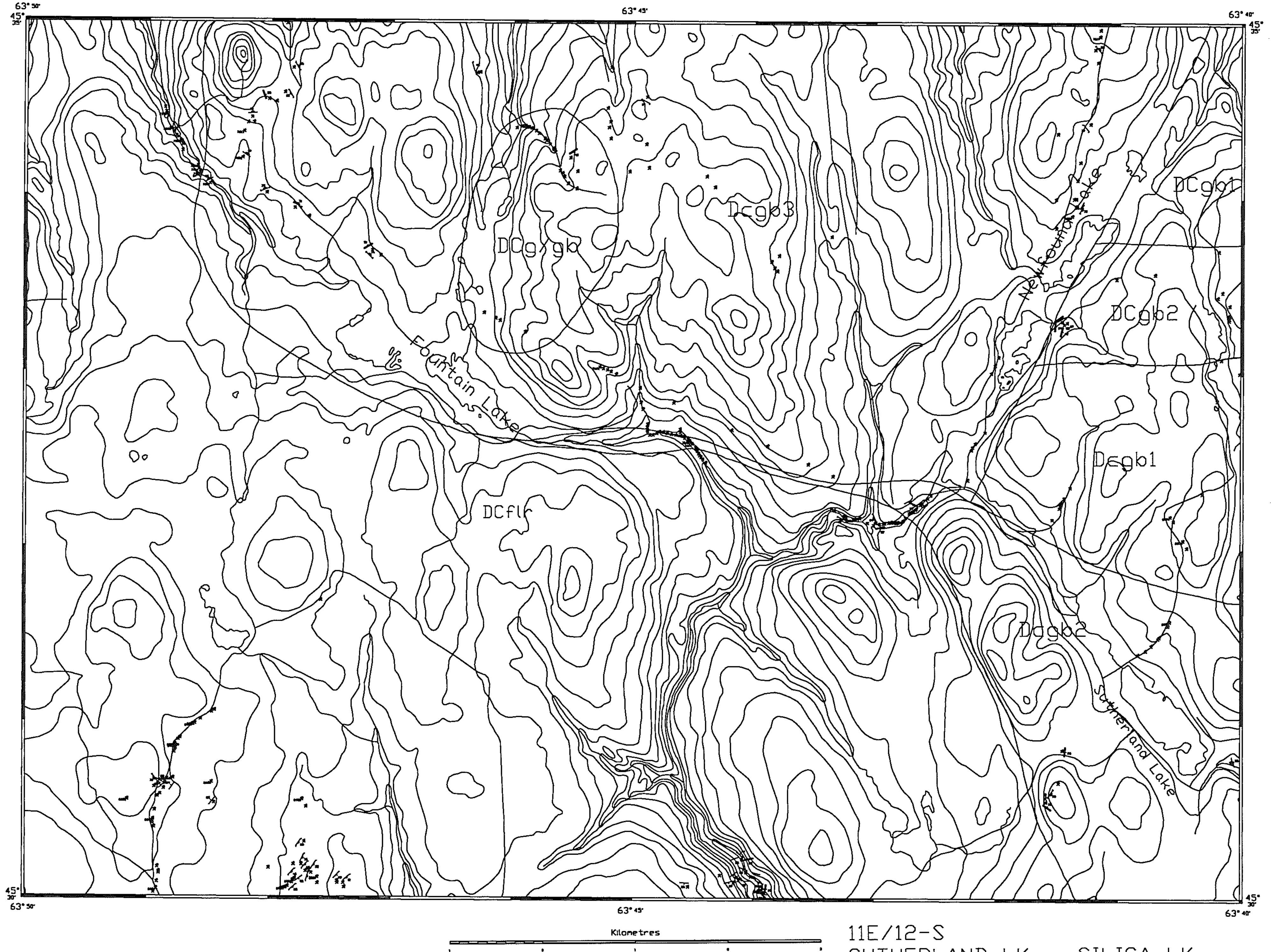
11E/11-S
North River



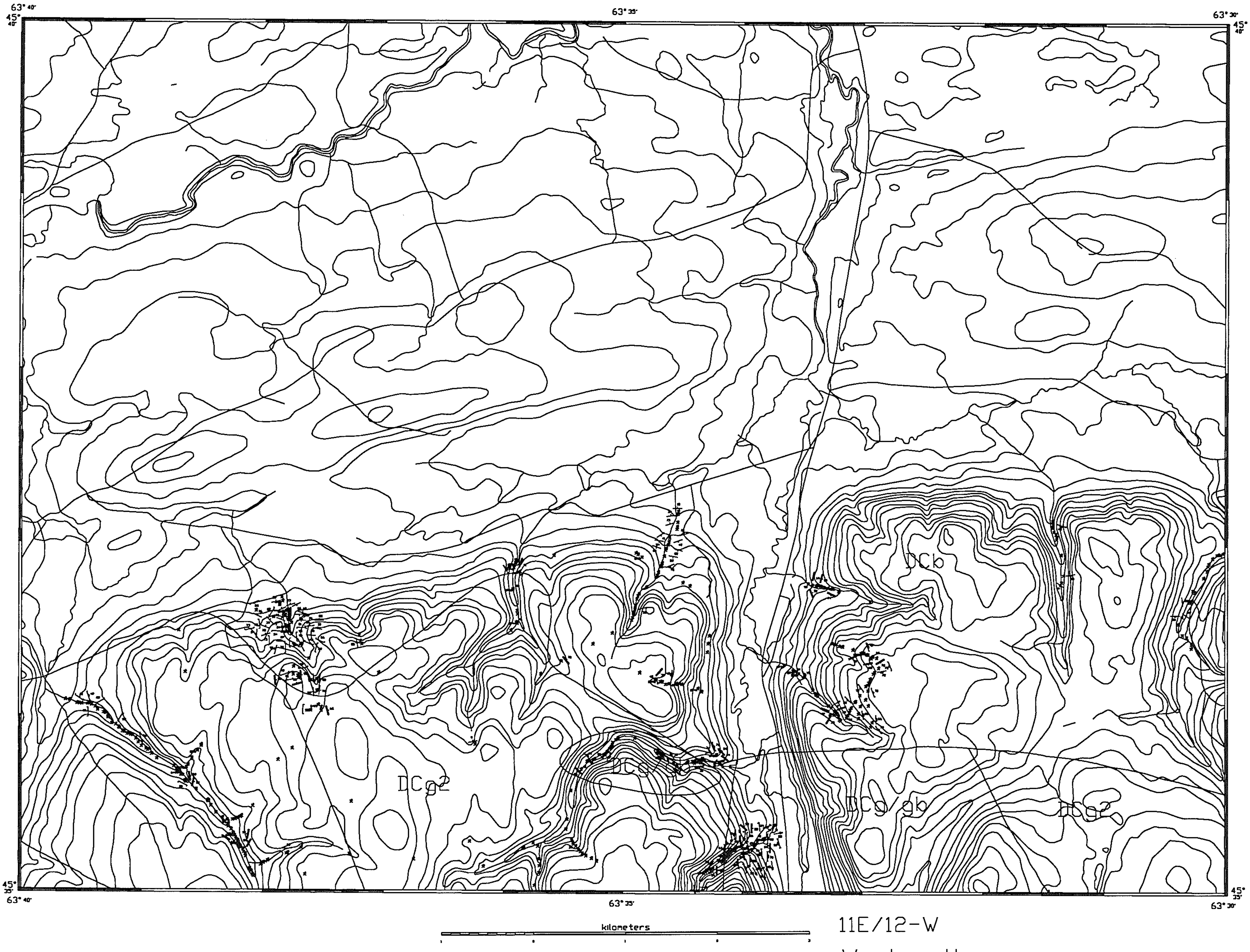
11E/11-R
Debert River - Frog Lake



11E/11-U
WARWICK MOUNTAIN

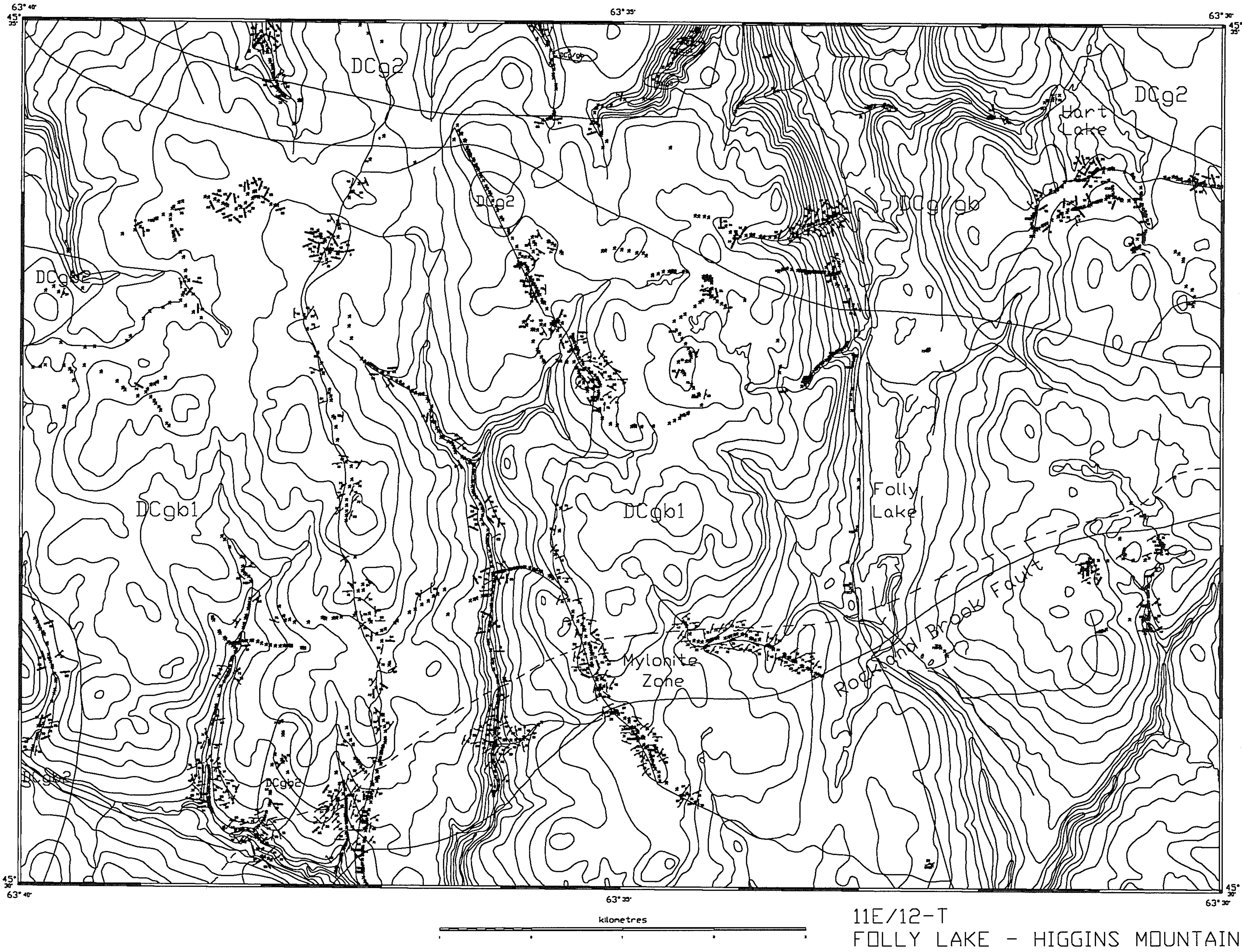


11E/12-S
SUTHERLAND LK. - SILICA LK.

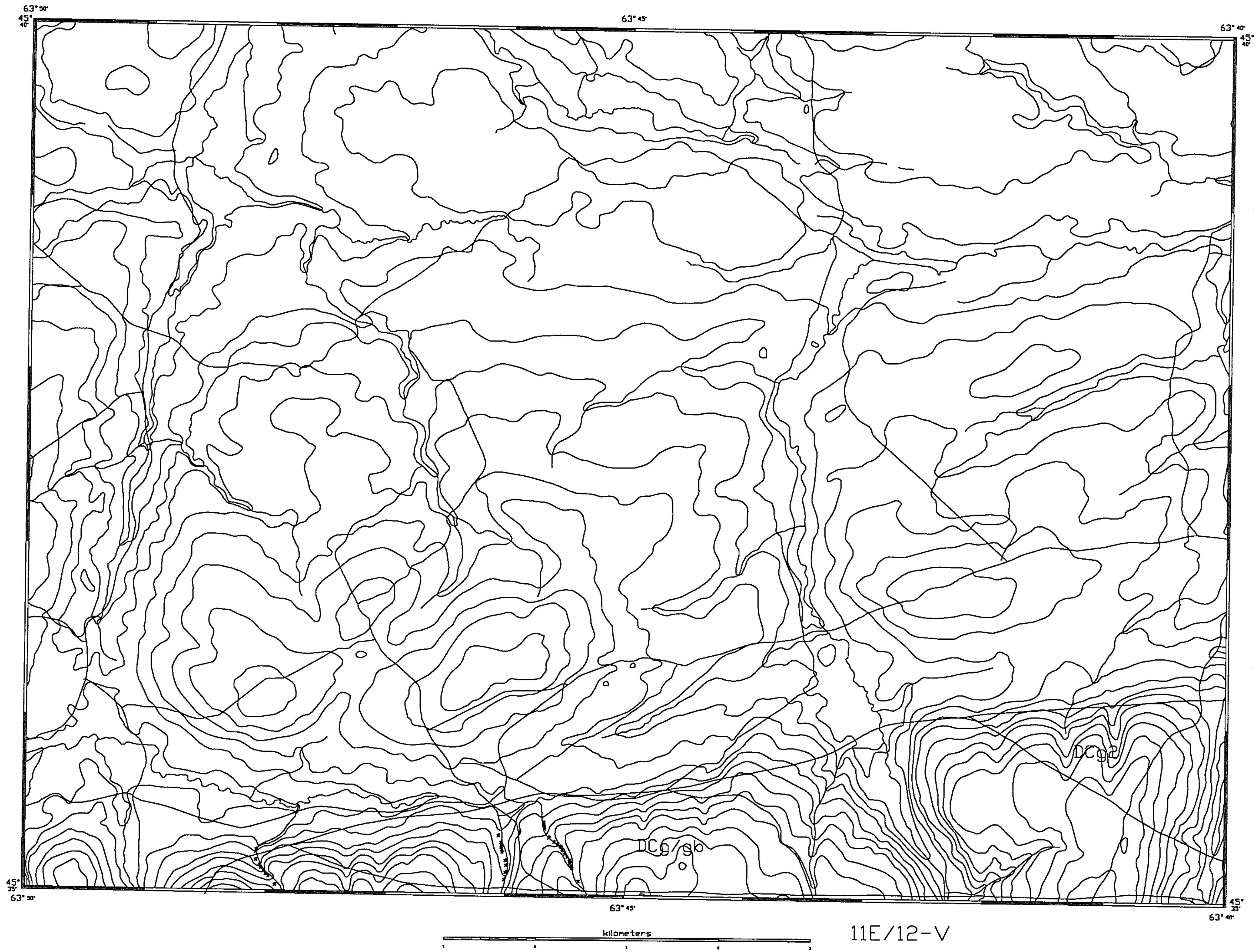


11E/12-W

Wentworth



11E/12-T
FOLLY LAKE - HIGGINS MOUNTAIN


63° 50'
45° 40'
63° 45'
63° 40'
45° 40'
45° 35'
63° 50'
63° 45'
45° 35'
63° 40'
DCg2
DCg/gb
kilometers

11E/12-V
Rose