GEOLOGICAL SURVEY OF CANADA

OPEN FILE 2008

Geological Setting of Pre-carboniferous Mineral Deposits in the Western Cape Breton Highlands, Nova Scotia

R.A. Jamieson, P.C. Tallman, H.E. Plint, and K.A. Connors

1989

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Canada

This document was produced by scanning the original publication.

Ce document est le produit d'une numérisation par balayage de la publication originale.

Nova Scotia
Department of Mines and Energy

Contribution to Canada-Nova Scotia Mineral Development Agreement 1984-89, a subsidiary agreement under the Economic and Regional Development Agreement. Project funded by the Geological Survey of Canada.

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

GEOLOGICAL SURVEY OF CANADA

OPEN FILE 2008

Geological Setting of Pre-carboniferous Mineral Deposits in the Western Cape Breton Highlands, Nova Scotia

R.A. Jamieson[1], P.C. Tallman[1], H.E. Plint[2], and K.A. Connors[3]

[1]Department of Geology, Dalhousie University, Halifax, Nova Scotia, Canada B3H 3J5
[2]Department of Geology, University of Alberta, Edmonton, Alberta, Canada
[3]Department of Geology, Monash University, Melbourne, Australia

E.M.R. Contract #27ST23233-5-0403

Contribution to the Canada-Nova Scotia Mineral Development Program 1984-1989. Project carried by the Geological Survey of Canada, Mineral Resources Division, Project 860008.

1989

TABLE OF CONTENTS

TABLE OF CONTENTS i
LIST OF FIGURES ii
LIST OF TABLES iii
ABSTRACT 1
INTRODUCTION 2
    Previous Work 5
    Acknowledgements 7
LITHOLOGY AND STRATIGRAPHY 7
    Nomenclature 7
    Jumping Brook metamorphic suite 8
        Faribault Brook metavolcanics 10
        Barren Brook schist 14
        Dauphinee Brook schist 18
        Corney Brook schist 18
        Fishing Cove River schist 22
        George Brook amphibolite 22
    Central Cape Breton Highlands 22
STRUCTURE AND METAMORPHISM 23
    Deformation 24
    Metamorphism 25
    Implications for mineral deposits 25
AGE 33
    Age of the Cheticamp Pluton 33
    Age of Deposition of the Jumping BrooK metamorphic suite 37
    Age of deformation and metamorphism 38
    Age of mineral deposits 40
REGIONAL CONSIDERATIONS 40
    Cape Breton 40
    Northern Nova Scotia 42
    Newfoundland 42
    Regional tectonic models 43
MINERAL DEPOSITS 44
    Faribault Brook area 44
    Aspy Zone 49
CONCLUSIONS 50
REFERENCES 51
APPENDIX 57

LIST OF FIGURES

Figure 1. Pre-Carboniferous tectonostratigraphic zones in Cape Breton Island 3

Figure 2. Jumping Brook metamorphic suite and associated rocks north of the Cheticamp River ..... in pocket

Figure 3. Jumping Brook metamorphic suite and associated rocks south of the Cheticamp River ..... in pocket

Figure 4. Geology of the Faribault Brook area, showing location of sulphide occurrences and diamond drill holes 4

Figure 5. Cross-sections from the Faribault Brook area based on drill core studies 11

Figure 6. Geochemistry of metavolcanic rocks in the Jumping Brook metamorphic suite and correlative rocks in the Southern Highlands .. 13

(a) Pearce and Cann (1973) diagram.

(b) Winchester and Floyd (1977) diagrams.

Figure 7a,b,c,d. Photomicrographs of Barren Brook schist 15

Figure 8a,b,c,d. Metamorphic textures illustrating structural development of the Faribault Brook area 19

Figure 9a,b. Tourmaline-rich shear zone overprinting chloritic shear zone in metabasite, DDH AMC-6, Faribault Brook area .. 31

Figure 10a,b,c,d. Photomicrographs of sulphides, Faribault Brook area 34

Figure 11. $^{40}Ar/^{39}Ar$ spectra from the Jumping Brook metamorphic suite 39

Figure 12. Sphalerite (a) and arsenopyrite (b) compositions from the Faribault Brook area ... 47

LIST OF TABLES

Table 1. Summary of important units in the Cheticamp area 9

Table 2. Main features of sulphide occurrences in the Faribault Brook area 27

Table A1. Geochemical analyses from the Faribault Brook metavolcanic rocks and equivalent units 58

Table A2. Geochemical analyses from the Barren Brook schist, Dauphinee Brook schist, and equivalent units 65

Table A3. Geochemical analyses from the Sarach Brook area, southern Cape Breton Highlands ... 67

Table A4. Geochemical analyses of Silurian metaplutonic rocks, western and central Cape Breton Highlands 71

ABSTRACT

Small polymetallic sulphide deposits in the Faribault Brook area, near Cheticamp, western Cape Breton Highlands, Nova Scotia, occur within the Jumping Brook metamorphic suite. Regional mapping suggests that this suite consists of a lower tholeiitic metabasite unit (Faribault Brook metavolcanic rocks), overlain by felsic tuffs and silicic, locally volcanogenic, sedimentary rocks (Barren Brook schist), and turbiditic metasedimentary rocks (Dauphinee Brook schist), with higher grade equivalents of these rocks (Corney Brook schist, Fishing Cove River schist) to the north and east of the Faribault Brook area. The geological mapping and geochronological data from the study area and correlative rocks to the south suggest that the Jumping Brook metamorphic suite represents a Silurian volcanic arc complex that was subjected to high grade metamorphism and intense polyphase deformation in late Silurian to early Devonian times. These metamorphic rocks are younger than the Cambrian Cheticamp Pluton, which bounds them on the west.

Two generations of sulphide mineralization have been recognized. An early Cu-Pb-Zn association pre-dates garnet porphyroblasts formed during prograde metamorphism, and may thus be syngenetic or early epigenetic. This association occurs near the metabasite-metasediment transition and has been intensely deformed and remobilized during metamorphism. A later arsenopyrite-dominated association, which forms veins and disseminations in metasedimentary rocks and metabasites, appears to be syntectonic, and may have been introduced by the intrusion of felsic dykes or sills. The concentration of deposits in the Faribault Brook area appears to be related to the stratigraphic transition from mafic volcanism to marine clastic sedimentation at the distal edge of a felsic volcanic pile, and the intense structural, metamorphic, and hydrothermal reworking of the area during collision of the volcanic-sedimentary sequence with North America.

INTRODUCTION

The western Cape Breton Highlands, Cape Breton Island, Nova Scotia, are underlain mainly by metamorphic and plutonic rocks, with minor sedimentary and volcanic rocks. In the vicinity of Cheticamp, numerous polymetallic sulphide occurrences have been documented (e.g., Ponsford and Lyttle, 1984). However, the age, geological setting, and origin of the sulphides are not clear, and their metallogenic affinities and possible extent elsewhere in the Cape Breton Highlands are not known.

In 1985, a study of the metasedimentary and metavolcanic rocks of the western Cape Breton Highlands (Figure 1) and their associated mineral deposits was begun under the terms of the Canada - Nova Scotia Mineral Development Agreement. The goals of the study were to characterize the mineral deposits of the area in terms of their geological setting, metallogeny, and age. Mapping was carried out at 1:10000 and compiled at 1:25000. The area north of the Cheticamp River was mapped in 1985 by H.E. Plint and K.A. Connors (Figure 2), and the area between the Cheticamp River and the Margaree River was mapped in 1986 by R.A. Jamieson, P. Tallman, and J.A. Marcotte (Figure 3). In 1986, reconnaissance work at 1:25000 was also carried out in the central Highlands between the Margaree River and Highland Road. This work has been reported in Current Research (Plint et al., 1986; Jamieson et al., 1987; Tallman et al., 1988), one M.Sc. thesis (Plint, 1987), and two B.Sc. theses (Connors, 1986; Marcotte, 1987).

The most important sulphide occurrences are hosted by the Jumping Brook metamorphic suite in the vicinity of Faribault Brook, west of Cheticamp (Figure 4). This report focuses on the lithology, stratigraphy, structure, metamorphism, age, and regional correlation of this unit, emphasizing factors bearing on the origin and distribution of the mineral occurrences. Other units mapped in the course of this study have been described elsewhere (Plint et al., 1986; Jamieson et al.,

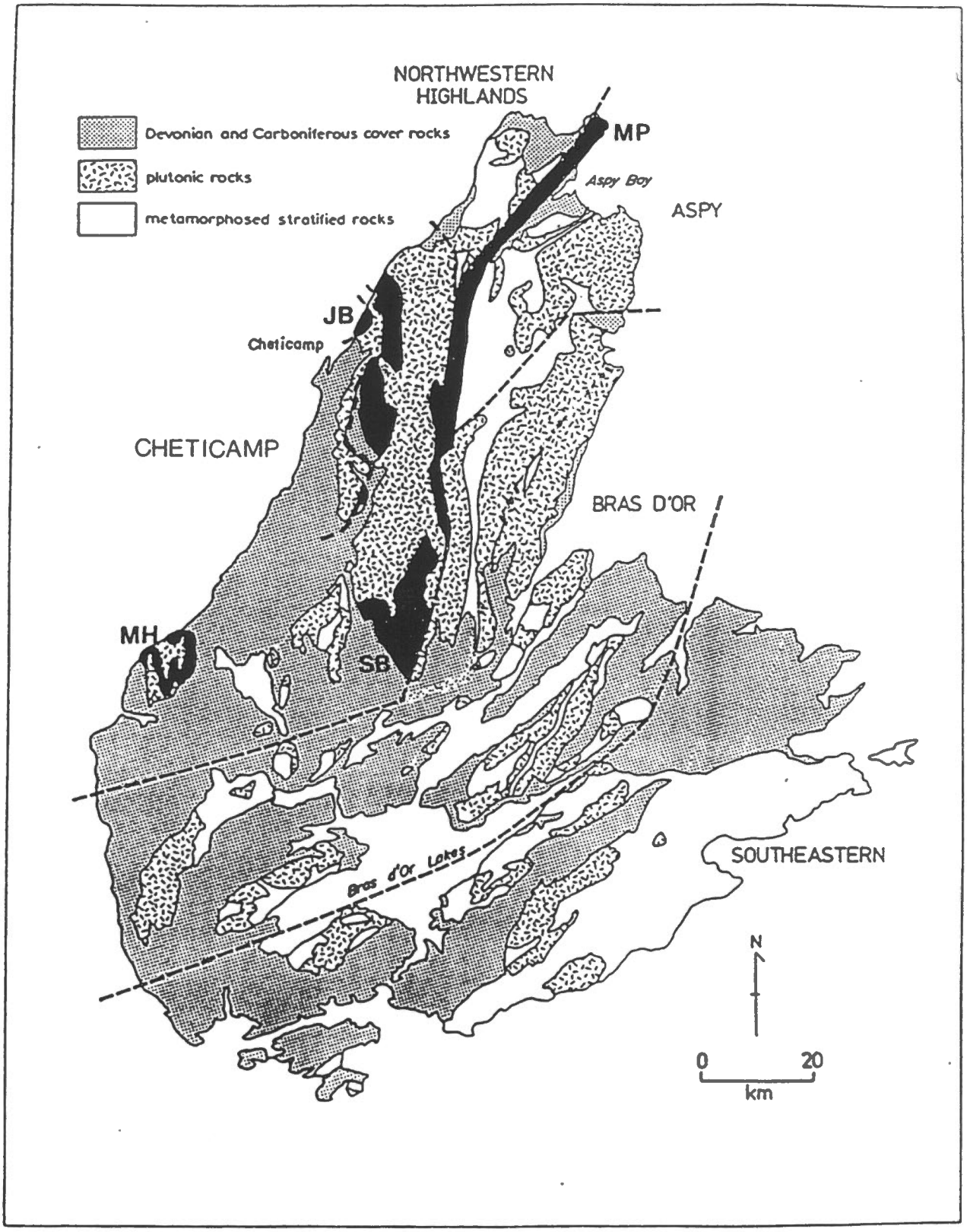


Figure 1. Pre-Carboniferous tectonostratigraphic zones in Cape Breton Island (modified after Raeside and Barr, 1987, and Reynolds et al., in preparation). Jumping Brook metamorphic suite (JB) and correlative units in Aspy Zone shown in black. (MP = Money Point; SB = Sarach Brook; MH = Mabou Highlands)

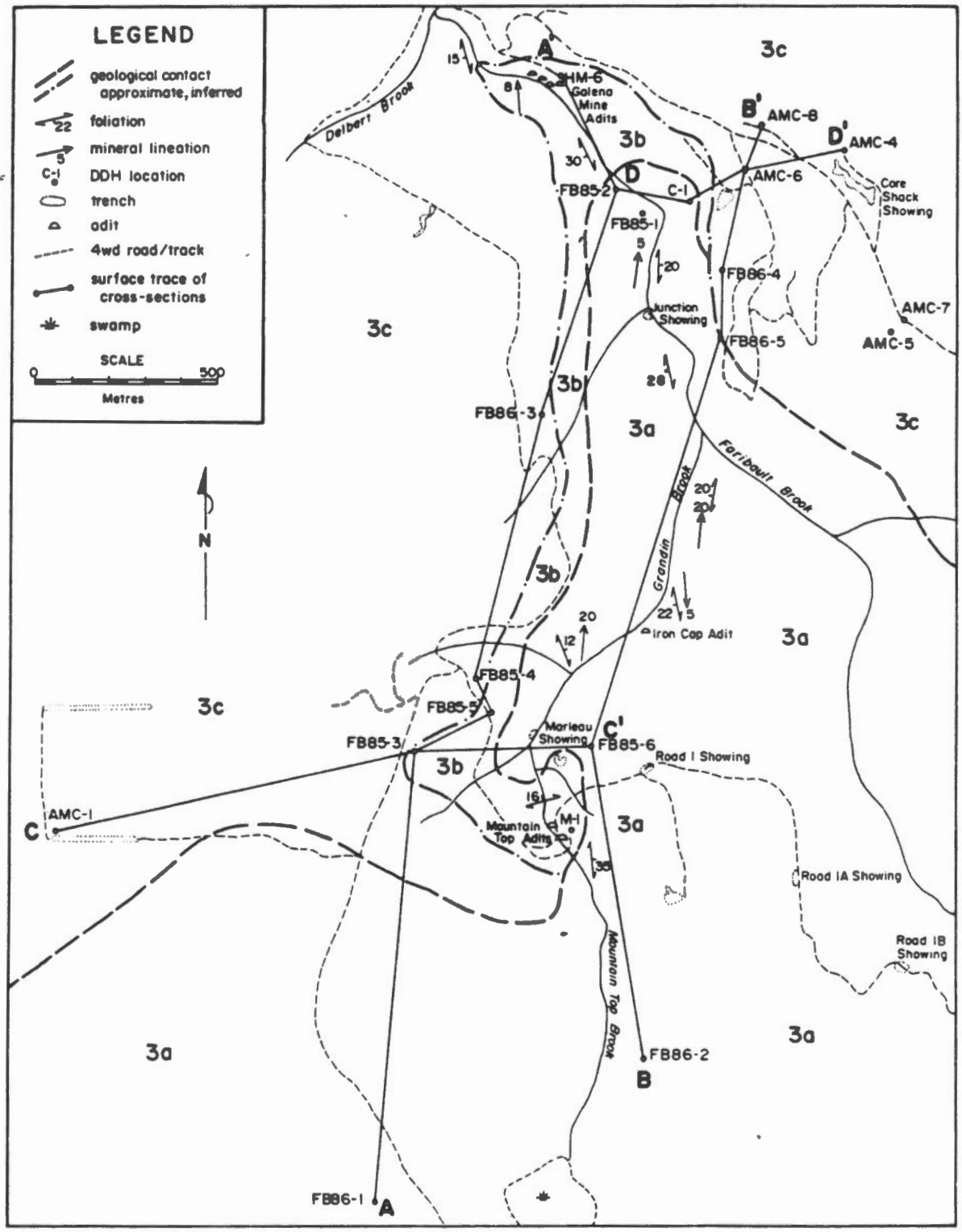


Figure 4. Geology of the Faribault Brook area, showing location of sulphide occurrences and diamond drill holes (Tallman et al., 1988). Unit 3a = Faribault Brook metavolcanic rocks; Unit 3b = Barren Brook schist; Unit 3c = Dauphinee Brook schist.

1987; Plint and Jamieson, in press; marginal notes to Open File maps) and are discussed here in terms of their relationship to the Jumping Brook metamorphic suite and its mineral deposits. Geochemical analyses done in the course of this study are compiled in Appendix 1, Tables A1-A4.

Previous work

Although early maps of Nova Scotia showed the Cape Breton Highlands to be underlain by metamorphic and plutonic rocks (e.g., Fletcher, 1885), the first systematic reconnaissance work was not done until the 1950's and early 1960's (McLaren, 1955; Neale, 1963). At this time, the metamorphic rocks of the region were regarded as Precambrian, and correlations with southwestern Newfoundland were suggested (e.g., Neale and Kennedy, 1975). Milligan (1970) regarded the rocks of the Cheticamp area as part of the Precambrian "George River Series" recognized in central Cape Breton Island, and included them in his survey for the Nova Scotia Department of Mines. Part of this project included some detailed work on the sulphide occurrences of the Faribault Brook area (Chatterjee, 1980).

Currie (1975, 1982, 1987b), in a study of the igneous and metamorphic rocks of the Cheticamp area, divided the metamorphic rocks into two main units, the high-grade Pleasant Bay complex, which he regarded as Late Precambrian, and the lower grade Jumping Brook complex, which he regarded as Ordovician - Silurian. He concluded that there were two important episodes of regional metamorphism separated by emplacement of the Cambrian Cheticamp Pluton, and that both Grenvillian and Avalonian tectonic elements were present in the older rocks (Currie, 1982, 1987 a,b).

Jamieson and Craw (1983), Craw (1984), and Conrod (1984) conducted both reconnaissance and detailed mapping in the Cheticamp - Pleasant Bay region, but failed to confirm an unconformity between the lower grade and higher grade rocks. Using structural and metamorphic criteria, they suggested that

the Pleasant Bay gneisses were the high grade equivalents of the lower grade Jumping Brook rocks. The whole sequence was interpreted as Precambrian based on a presumed intrusive contact between the relatively undeformed Cambrian Cheticamp Pluton and the metamorphic rocks.

The mineral deposits of the Faribault Brook region have been known since the 1890's, and investigated intermittently until the mid-1980's (e.g., Ponsford and Lyttle, 1984). Locally significant but highly variable Zn-Pb-Cu-Ag-Au-As-Bi values have been documented in metasedimentary and metavolcanic host rocks (Figure 4). Several showings, notably the Galena Mine, Silver Cliff, Core Shack, and Mountain Top occurrences, were investigated in some detail by Milligan and Chatterjee (Milligan, 1970) and Chatterjee (1980). Chatterjee (1980) focused on the alteration associated with the deposits, documented hydrothermal and replacement effects, and concluded that they represented polycyclic hydrothermal deposits that post-dated the metamorphic host rocks.

In the most recent phase of exploration, carried out concurrently with this study, Selco-BP (Woods, 1986, unpublished manuscript) emphasized the proximity of the deposits to the Cheticamp Pluton, and concluded that the mineralization was superimposed on the host rocks, probably during the early stages of deformation. The association of many deposits with a zone of felsic schist near the transition from metabasites to metavolcanic rocks recognized by previous workers (e.g., Covey, 1979; Chatterjee, 1980) was confirmed. This transition zone was interpreted as mylonite, derived in part from granitic rocks, including offshoots from the Cheticamp Pluton.

Thus, by the early 1980's, there were two different interpretations of the regional geology of the western Cape Breton Highlands, and a number of models for the mineral deposits, of which the hydrothermal origin was the most popular. The regional studies had not systematically investigated the mineral deposits, and the mineral deposit

studies lacked a regional structural and metamorphic context. Existing radiometric dates had not resolved the problem of the age of the metamorphic rocks or of the deposits (see Jamieson et al., 1986, for review). Both the regional controversy and the most recent mineral deposit models focused on the relationship of the Cheticamp Pluton (e.g., Barr et al., 1986) to the metamorphic rocks of the region. The primary goals of this study were thus to put the mineral deposits of the Faribault Brook area into their regional context, by documenting the stratigraphy, structure, metamorphism, and age of the rocks in the Cheticamp area, with particular emphasis on the role of the Cheticamp Pluton, and to relate the timing of sulphide deposition to the timing of depositional, structural, or metamorphic events that could be recognized on a regional scale.

Acknowledgements

This project has been done under the auspices of the Canada - Nova Scotia MIneral Development Agreement through a contract from the Department of Energy, Mines, and Resources to R.A. Jamieson and M. Zentilli. Further financial support has been provided by the Natural Sciences and Engineering Research Council and Dalhousie University. The work has benefited greatly from discussions in the field with G. Woods (Selco-BP) and A. Sangster (GSC). Numerous discussions over many years with S. Barr, R. Raeside, A. Macdonald, D. Craw, K. Currie, B. Poole, and others, and the work of students at Dalhousie including J. Marcotte, D. Conrod, S. Dudka, and P. Doucet, have contributed to the regional interpretations presented here.

LITHOLOGY AND STRATIGRAPHY

Nomenclature

Rocks in the study area were termed the "Jumping Brook complex" by Currie (1982; 1987b) and included within the informally named "western Highlands volcanic-sedimentary

complex" by Barr et al. (1985). Jamieson et al. (1987) proposed the name "Jumping Brook metamorphic suite" for the metavolcanic and metasedimentary rocks of the western Highlands, including within the suite the Jumping Brook complex of Currie (1982; 1987b) and correlative rocks to the south and east. The Jumping Brook metamorphic suite was divided into five sub-units by Jamieson et al. (1987) (Table 1; Figure 2, 3). A closely related unit, the George Brook amphibolite, is recognized in the region north of the Cheticamp River (Plint, 1987), where it locally crosscuts, but has been deformed with, the Jumping Brook metamorphic suite. Most of the lithologies of the Jumping Brook metamorphic suite are well exposed on the Cheticamp River its tributaries to the south, and the Cheticamp River was proposed as a reference section. Jamieson et al. (1987) retained the term Pleasant Bay complex (Currie, 1982; 1987b) for the gneissic rocks of the region, although the boundaries between the Jumping Brook metamorphic suite and the Pleasant Bay complex are poorly defined in some areas (Plint, 1987). Two sub-units within the Pleasant Bay complex, the Belle Cote Road orthogneiss and the McKenzie Mountain megacrystic orthogneiss, have been recognized (Plint, 1987; Jamieson et al., 1987; Marcotte, 1987), but most of the Pleasant Bay complex has not been mapped in enough detail to be subdivided (Figure 2).

Jumping Brook metamorphic suite:

The Jumping Brook metamorphic suite comprises a belt of low-, medium-, and high-grade metasedimentary, metavolcanic, and metaplutonic rocks extending from north of Jumping Brook to the Central Highlands west of Highland Road (Figure 2, 3). It is bounded on the west by faults against the Cheticamp Pluton and late Devonian to Carboniferous volcanic and sedimentary rocks, on the east by complex tectonic and locally gradational contacts with gneissic and plutonic rocks of the Pleasant Bay Complex (Currie, 1975, 1987b; Craw, 1984; Plint et al., 1986),

Table 1. Summary of important units in the Cheticamp area (see also Figure 2, 3).

LATE DEVONIAN / EARLY CARBONIFEROUS

Fisset Brook Formation (Upper Devonian - Tournaisian plant and fish fossils; e.g., Blanchard et al., 1984)
Salmon Pool Pluton (365 +10/-5 Ma, U-Pb zircon; Jamieson et al., 1986)

DEVONIAN

Margaree Pluton (380 Ma $^{40}Ar/^{39}Ar$ biotite cooling age; 343 $\pm$ 17 Ma Rb-Sr isochron probably reflects alteration; O'Beirne-Ryan et al., 1986)

SILURIAN

Taylors Barren Pluton (419 $\pm$ 17 Ma, Rb-Sr whole rock isochron; Gaudette et al., 1985)

George Brook amphibolite (mafic intrusions possibly co-genetic with Jumping Brook metamorphic suite)

Jumping Brook metamorphic suite: includes
- Fishing Cove River schist
- Corney Brook schist
- Dauphinee Brook schist
- Barren Brook schist
- Faribault Brook metavolcanic rocks

[Correlative units in the Cape Breton Highlands include the Money Point Group (Macdonald and Smith, 1980); Sarach Brook - Middle River metamorphic suite (Jamieson and Doucet, 1983) which includes rhyolite recently dated at 433 Ma, U-Pb zircon (Barr et al., 1988); Mabou Highlands complex (Barr and Macdonald, in preparation).]

SILURIAN OR OLDER

Pleasant Bay complex: includes
- Belle Cote Road orthogneiss (433 $\pm$ 20 Ma, U-Pb zircon; Jamieson et al. (1986); syntectonic tonalitic intrusion coeval with metamorphism of Jumping Brook Metamorphic Suite)
- Undivided gneissic rocks including orthogneiss and minor enclaves of amphibolite and schist that may in part pre-date the Jumping Brook Metamorphic Suite

CAMBRIAN

Cheticamp Pluton (550 $\pm$ 8 Ma, U-Pb zircon; Jamieson et al., 1986; 545 Ma $^{40}Ar/^{39}Ar$ muscovite cooling age, Reynolds et al., in preparation)

and separated from probably equivalent rocks of the Sarach Brook - Middle River area (Jamieson and Doucet, 1983) by shear zones and later intrusions.

The sulphide deposits occur mainly in the region bounded by the Cheticamp River on the north, the Cheticamp Pluton and Fisset Brook Formation on the west and south, and the Salmon Pool pluton and the Northeast Margaree Fault Zone on the east (Figure 3, 4). In this area, metamorphic grade is in the upper greenschist to lower amphibolite facies, and a general lithological sequence can be recognized on a regional scale. However, detailed core logging (Figure 5; Tallman et al., 1988) has demonstrated that there is far greater lithological complexity in detail, owing to original interfingering of units, structural repetition, or both. As discussed below, owing to complex deformation, the relationship of the present sequence to an original stratigraphic succession is not clear.

Faribault Brook metavolcanic rocks:

Fine-grained, massive to well-foliated, mafic to intermediate metavolcanic rocks form the structurally lowest unit of the Jumping Brook metamorphic suite. In the middle reaches of Faribault Brook, metabasalts predominate, and possible relict pillow structures are preserved (Connors, 1986; Plint et al., 1986). In drill-core there are significant intervals of metagreywacke and silicic metasedimentary rocks even in parts of the sequence dominated by metabasite (Figure 5; Tallman et al., 1988). Further south, in the area between Turner Brook and Rocky Brook South, massive mafic rocks pass upwards into intermediate metavolcanic rocks with associated fine-grained sedimentary rocks and minor lapilli tuff.

The geochemistry of the mafic rocks in a section along Faribault Brook was investigated by Connors (1986) who concluded that they were tholeiites formed in an island arc setting. The compositions of mafic rocks from the southern part of the study area are also consistent with this conclusion (Figure 6), although there is considerably more

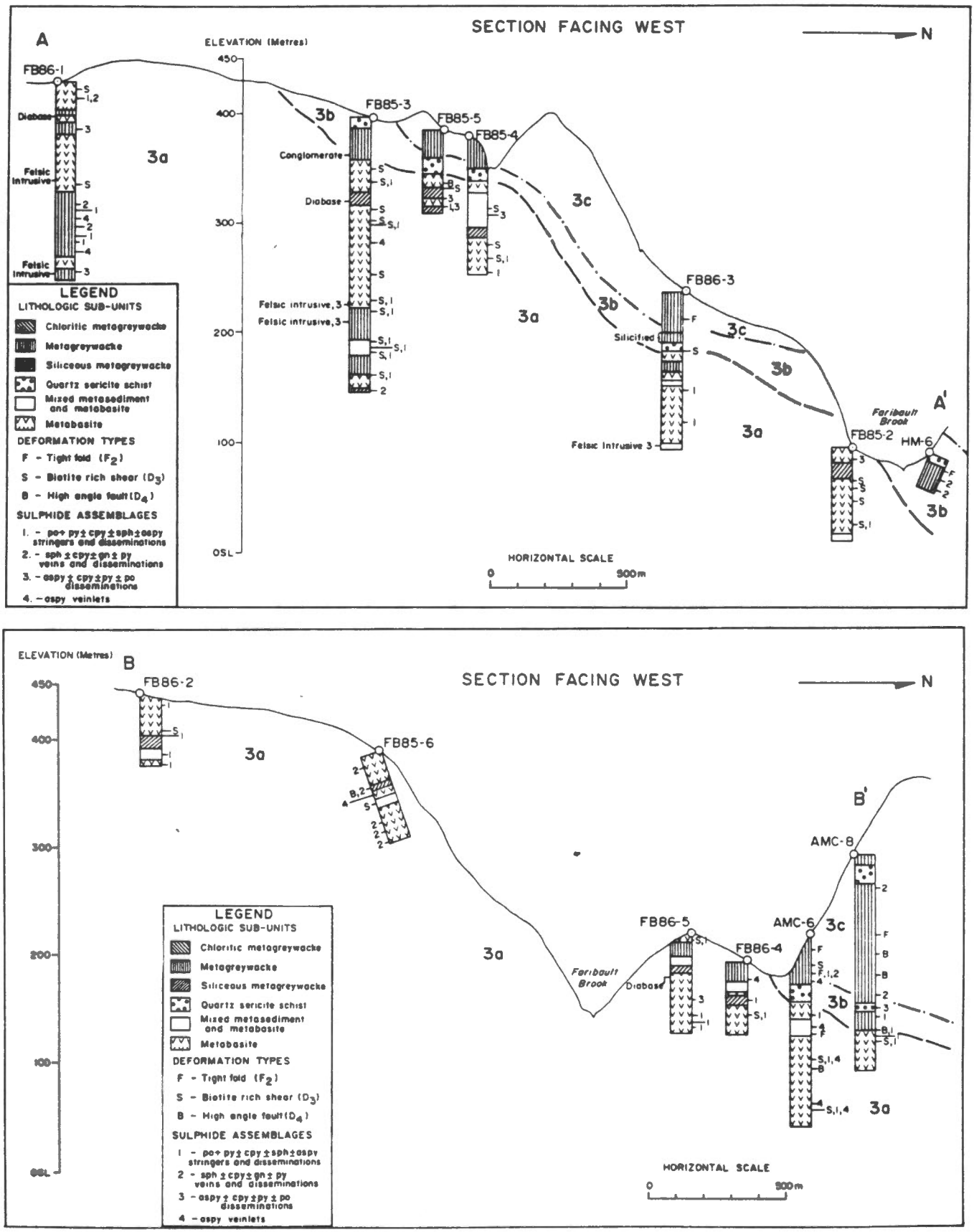
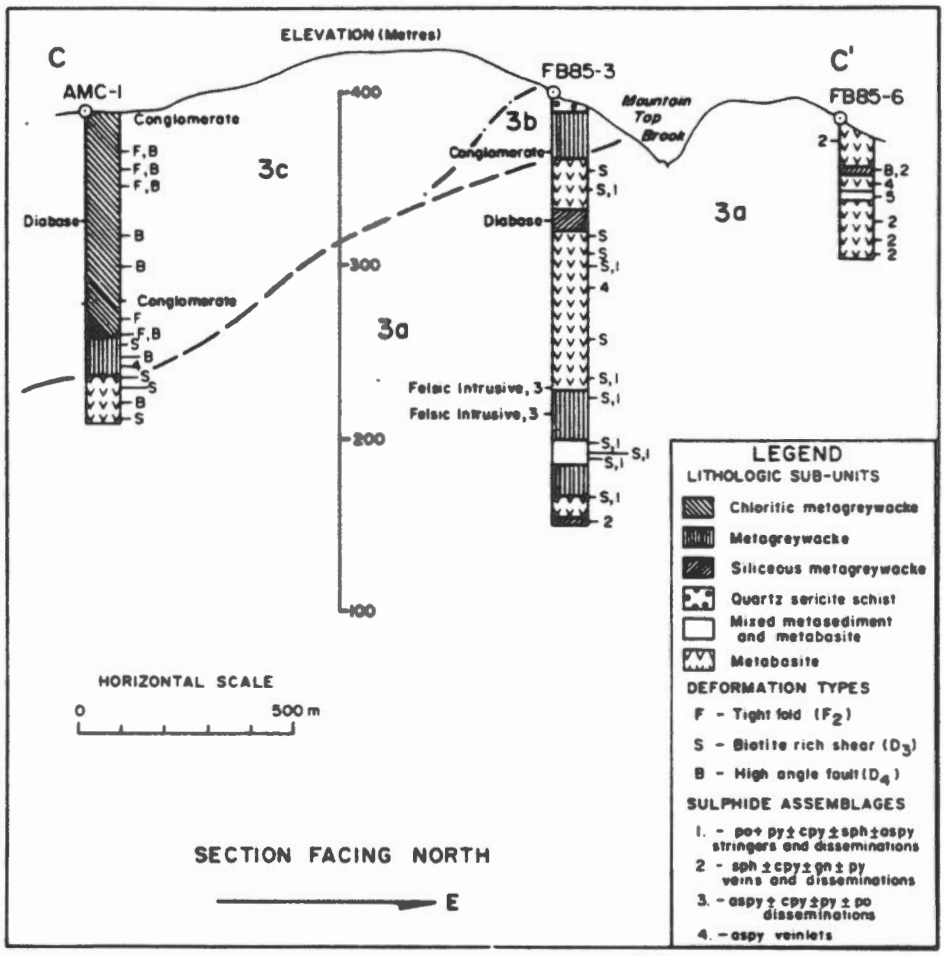
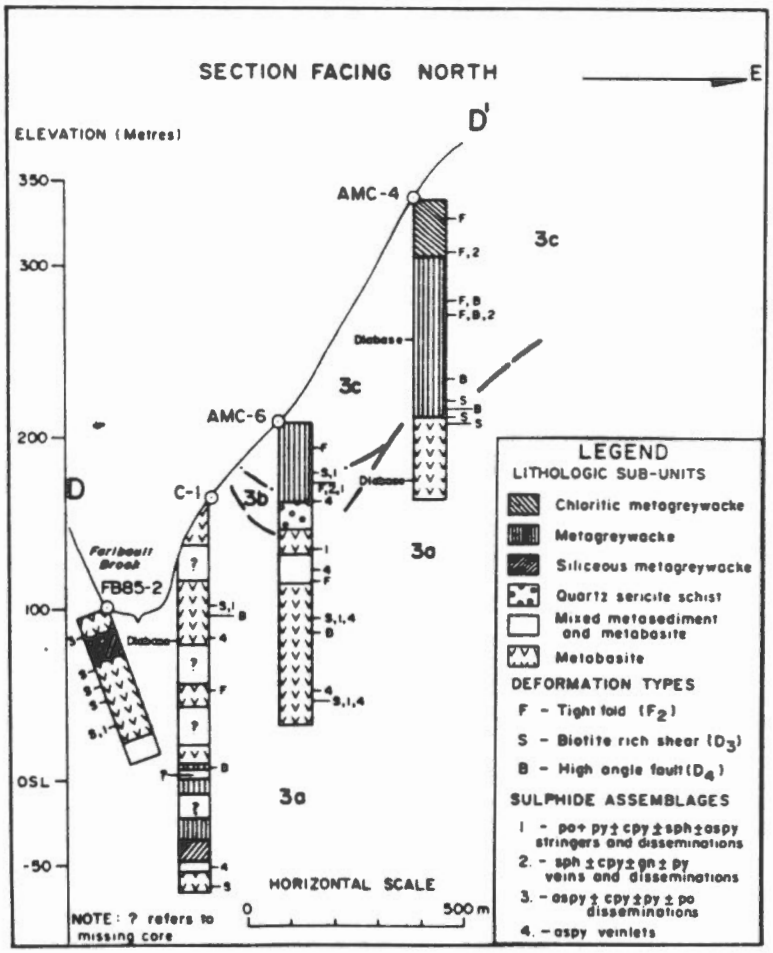


Figure 5. Cross-sections from the Faribault Brook area based on drill core studies (Tallman et al., 1988). Unit names and location of cross-sections shown on Figure 4.


ELEVATION (Metres)
C
C'
AMC-1
FB85-3
FB85-6
Mountain Top Brook
Conglomerate
Diabase
Felsic Intrusive, 3
3a
3b
3c
400
300
200
100
HORIZONTAL SCALE
0
500 m
SECTION FACING NORTH
E
LEGEND
LITHOLOGIC SUB-UNITS
Chloritic metagreywacke
Metagreywacke
Siliceous metagreywacke
Quartz sericite schist
Mixed metasediment and metabasite
Metabasite
DEFORMATION TYPES
F - Tight fold (F2)
S - Biotite rich shear (D3)
B - High angle fault (D4)
SULPHIDE ASSEMBLAGES
1. - po+ py ± cpy ± sph ± aspy stringers and disseminations
2 - sph ± cpy ± gn ± py veins and disseminations
3. - aspy ± cpy ± py ± po disseminations
4. - aspy veinlets


SECTION FACING NORTH
E
ELEVATION (Metres)
D
D'
AMC-4
AMC-6
C-1
FB85-2
Faribault Brook
Diabase
3a
3b
3c
350
300
200
100
OSL
-50
HORIZONTAL SCALE
0
500 m
NOTE: ? refers to missing core
LEGEND
LITHOLOGIC SUB-UNITS
Chloritic metagreywacke
Metagreywacke
Siliceous metagreywacke
Quartz sericite schist
Mixed metasediment and metabasite
Metabasite
DEFORMATION TYPES
F - Tight fold (F2)
S - Biotite rich shear (D3)
B - High angle fault (D4)
SULPHIDE ASSEMBLAGES
1 - po+ py ± cpy ± sph ± aspy stringers and disseminations
2. - sph ± cpy ± gn ± py veins and disseminations
3. - aspy ± cpy ± py ± po disseminations
4. - aspy veinlets

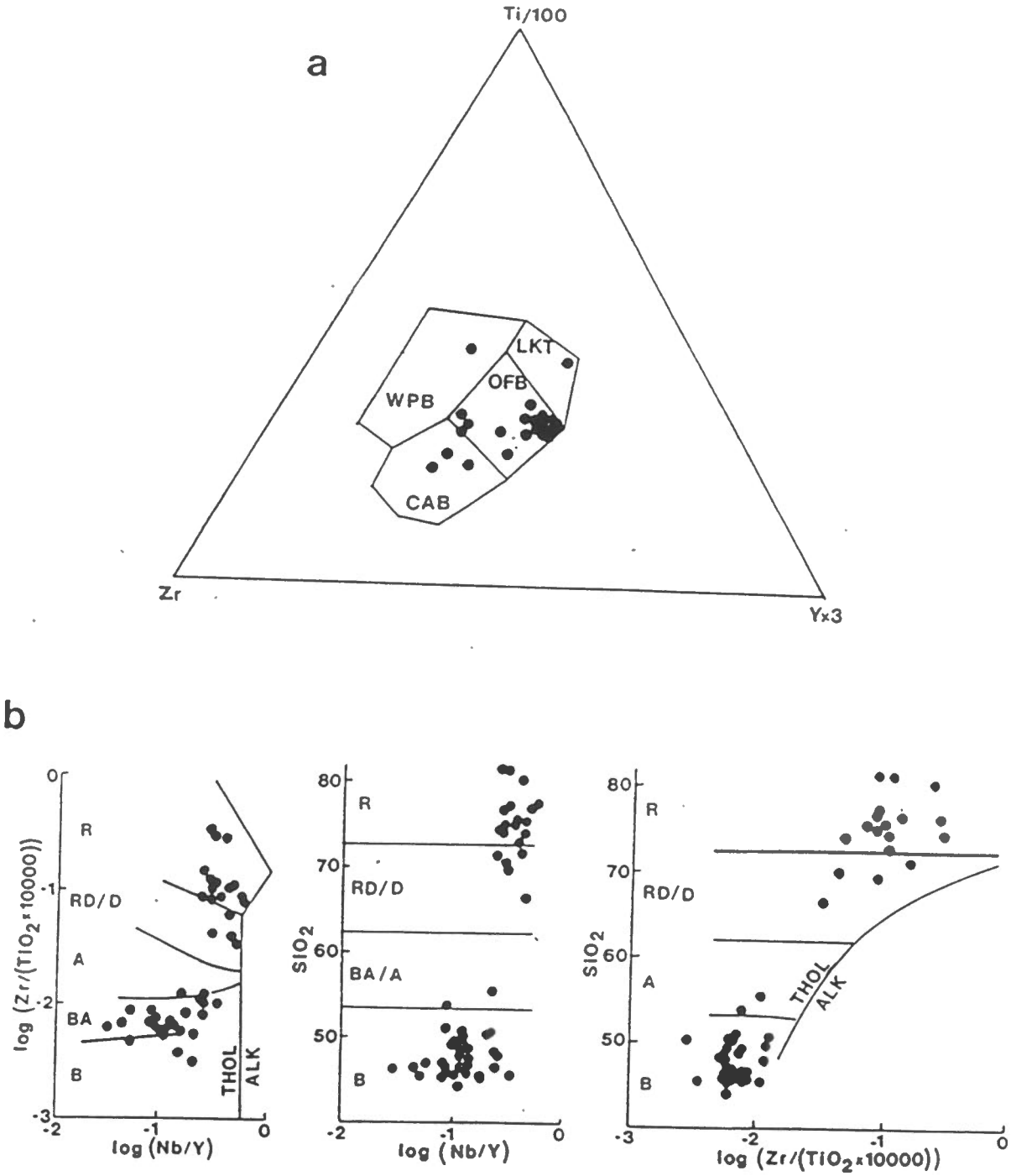


Figure 6. Geochemistry of metavolcanic rocks in the Jumping Brook metamorphic suite and correlative rocks in the Southern Highlands (data in Tables A1-A3).
(a) Pearce and Cann (1973) diagram showing that metabasites fall mainly in the ocean floor basalt field (after Connors, 1986). WPB = within plate basalt; LKT = low potassium tholeiite; OFB = ocean floor basalt; CAB = calc-alkaline basalt.
(b) Winchester and Floyd (1977) diagrams showing tholeiitic affinities and range of SiO_2 concentrations of both mafic and felsic rocks. Lack of intermediate compositions may correspond to pyroclastic rocks. B = basalt; BA = basaltic andesite; A = andesite; D = dacite; RD = rhyodacite; R = rhyolite; THOL = tholeiitic; ALK = alkalic.

compositional variation on a regional scale than was observed by Connors in the Faribault Brook area (Table A1).

Barren Brook schist:

Between Rocky Brook and Jim Campbell's Brook, a heterogeneous assemblage of relatively coarse-grained metasedimentary rocks, including boulder conglomerate, quartzite, quartz pebble conglomerate, and quartz-sericite schist, structurally overlies the Faribault Brook metavolcanic rocks (Jamieson et al., 1987). Granite boulders in conglomerate on Rocky Brook typically contain large, equant, bluish quartz phenocrysts that may be the source of the quartz "eyes" common in the associated finer grained metasedimentary rocks; some granite boulders closely resemble the nearby Cheticamp Pluton. This unit pinches out northwards; in the Faribault Brook area it forms a widespread but thin quartz-sericite schist horizon that is interlayered with other lithologies (Figure 4, 5; Tallman et al., 1988). These felsic schists are closely associated with the sulphides in many locations (Covey, 1979) and have been interpreted as mylonitic granitoid rocks (Woods, 1986, unpublished manuscript). In most cases, thin section observations suggest a relatively low degree of strain despite the strong foliation (Figure 7a,b,c). Based on relict volcanic quartz crystals, and by analogy with very similar units elsewhere in the Highlands, their protoliths probably included fine-grained felsic pyroclastic rocks and silicic volcanogenic sedimentary rocks (Connors, 1986). In some localities (e.g., Marleau occurrence) superficially similar foliated felsic rocks with crosscutting contacts (e.g., Woods, 1986, unpublished manuscript; Tallman et al., 1988), may represent syntectonic felsic dykes (Figure 7d).

The volcanic members of this unit are high silica rhyolites (Table A2), with highly variable alkali contents that may reflect geochemical mobilization before or during metamorphism, or in the case of silicic tuffs, the effects of

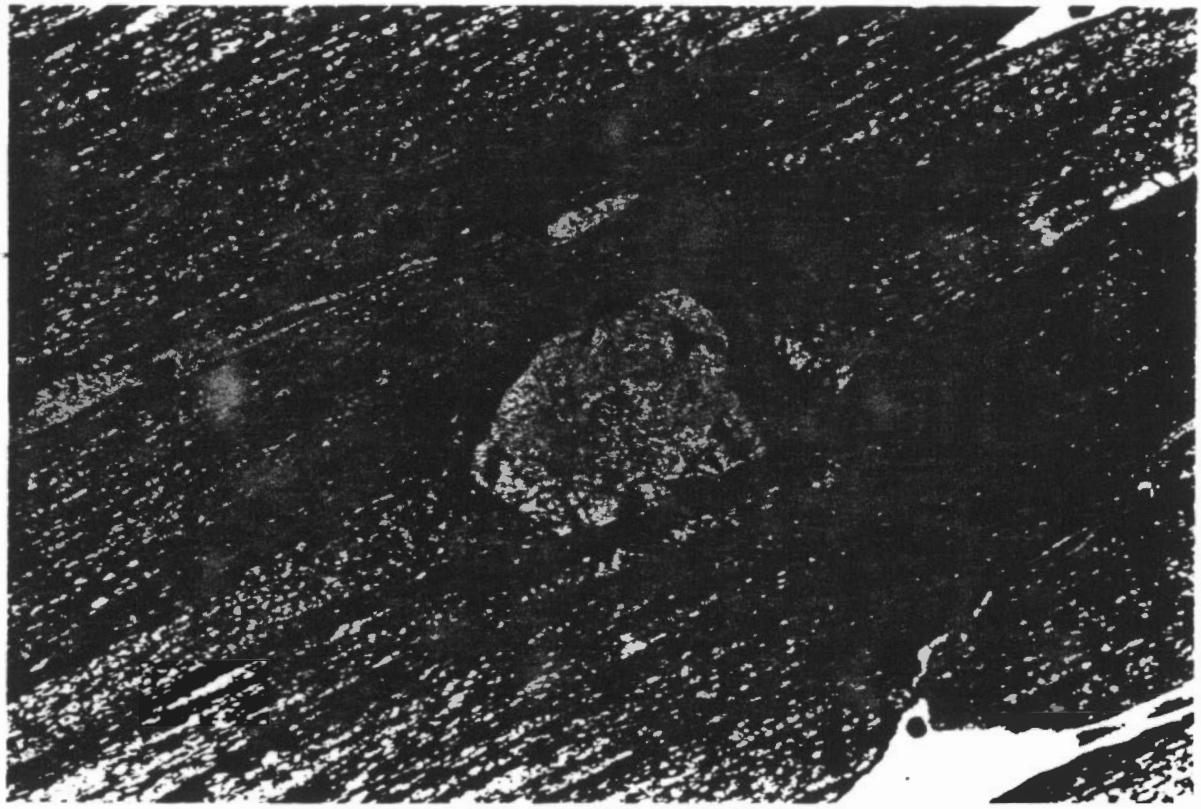
Figure 7. Photomicrographs of Barren Brook schist, showing relict primary features indicating volcanogenic origin. Field of view in all samples is 10 mm.

(a) Relict volcanic quartz in Barren Brook schist (Core Shack showing) shows prismatic termination and embayments characteristic of quartz phenocrysts in rhyolite porphyries. (PPL)

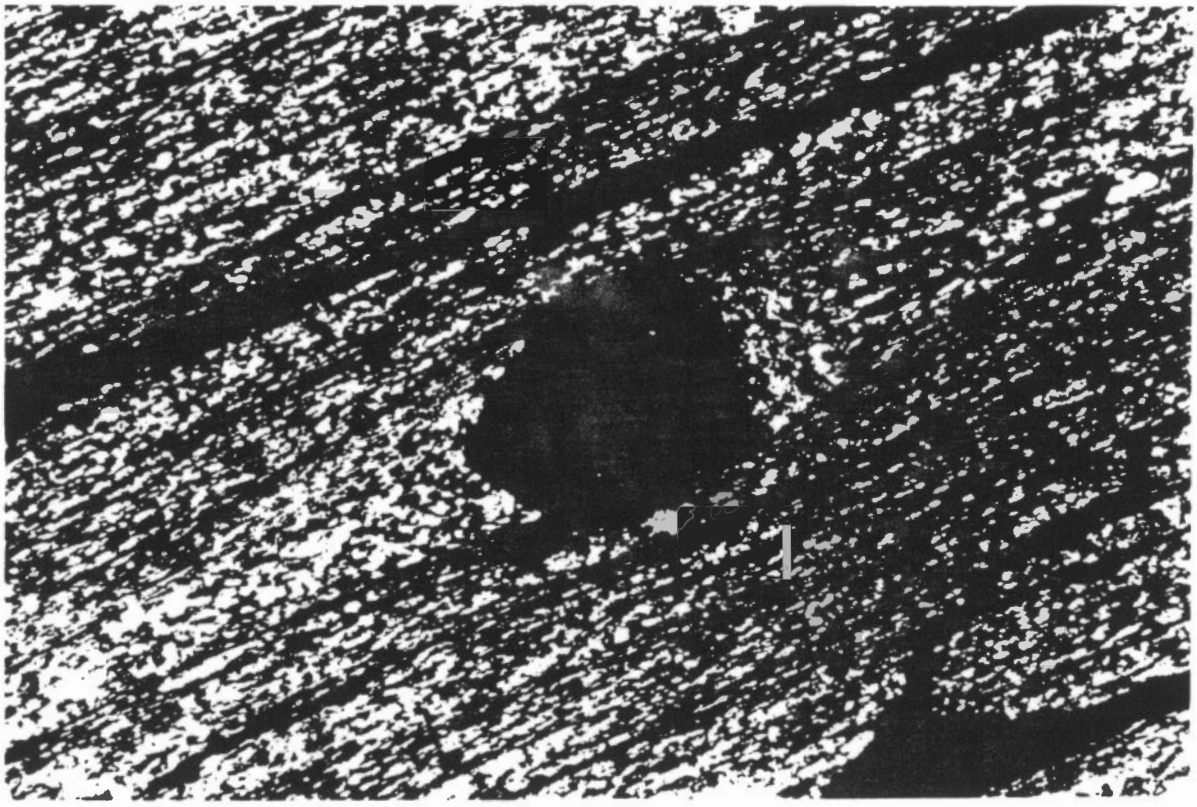
(b) The same crystal under crossed nicols shows that although the rock is fine grained and well foliated, the quartz is not strongly recrystallized, and is thus not mylonitic.

(c) Slightly deformed euhedral plagioclase phenocrysts in fine grained felsic horizon interlayered with Dauphinee Brook schist in lower reaches of Faribault Brook. This rock had been interpreted as mylonitized granite, but petrographic observations strongly suggest that it is a deformed felsic tuff. (XN)

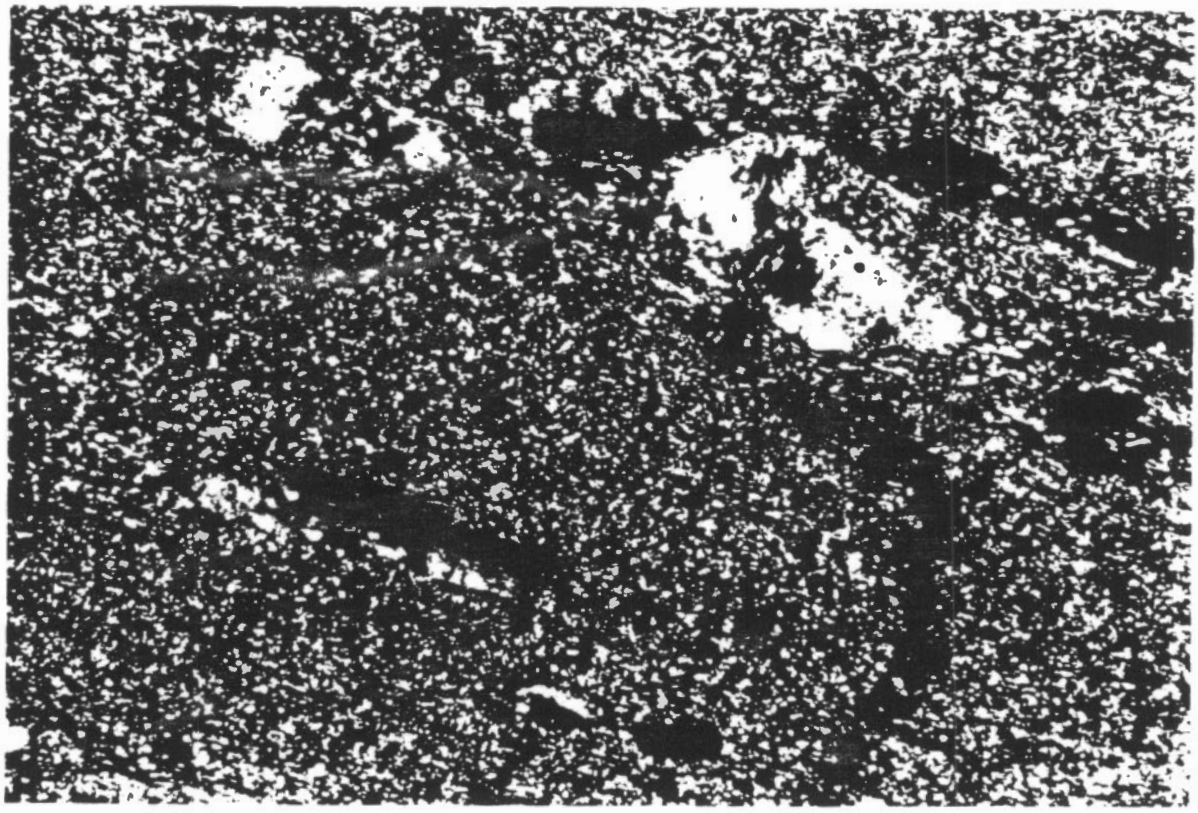
(d) Sheared felsic dyke from Marleau occurrence showing grain size reduction, sugary texture, and weakly developed C- and S-planes characteristic of sheared granitic rock. (XN) Compare with (a,b,c).



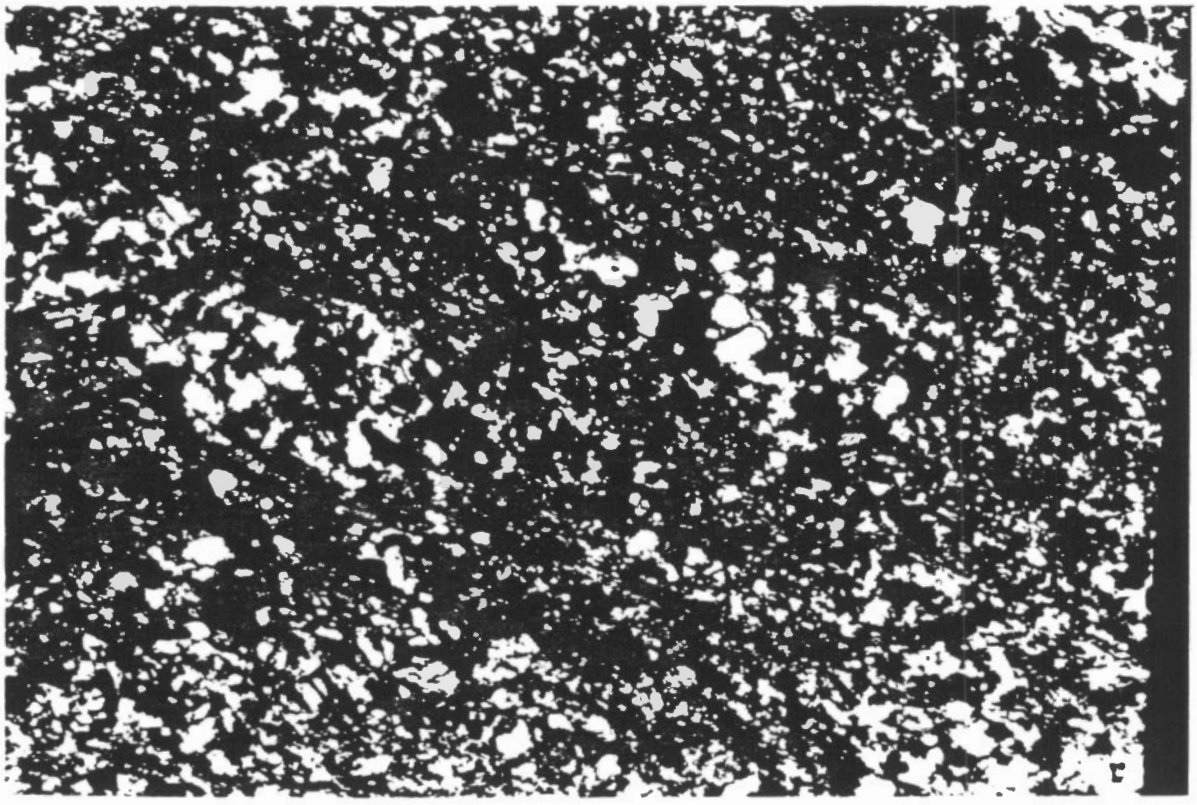
7a



7b



7c



7d

dilution by other material. It is nearly impossible to distinguish the silicic rhyolites from silicic sedimentary rocks on the basis of geochemistry alone, except for the high alkali contents of the former (e.g., Table A2, A3).

Dauphinee Brook schist:

Well foliated, grey, fine- to medium-grained pelitic, semi-pelitic, and psammitic schists form the upper part of the Jumping Brook metamorphic suite in the Faribault Brook area, and dominate the lower grade sequence to the north (Currie, 1982, 1987b; Conrod, 1984; Plint et al., 1986; Plint, 1987; Plint and Jamieson, in press; Figure 8). On Faribault Brook, these metasedimentary rocks structurally overlie metabasalts and quartz-sericite schists, although drill-core observations show that metagreywackes are also interlayered with metabasites at lower levels of the sequence (Figure 5; Tallman et al., 1988). The original sedimentary layering in these schists has been strongly modified by tight to isoclinal folds (Connors, 1986; Jamieson et al., 1987; Plint, 1987; Figure 8a) and the observed interlayering with metavolcanic rocks is at least partly attributable to folding. North of the Cheticamp River, these schists grade into higher-grade rocks on the east (Figure 2), but in the Faribault Brook region this transition is obscured by the younger Salmon Pool pluton (Figure 3; Jamieson et al., 1987).

Corney Brook schist:

Medium to high grade pelitic and semi-pelitic schists, with minor marble and psammite, form a north-trending belt extending from the Cheticamp River towards Pleasant Bay (Figure 2; Plint et al., 1986; Plint, 1987; Plint and Jamieson, in press). Pelitic and semi-pelitic members of the unit characteristically contain staurolite, biotite, and garnet porphyroblasts, with kyanite at the highest grade, in a phyllitic to schistose matrix. This unit does not occur in the Faribault Brook area, and no significant mineral occurrences

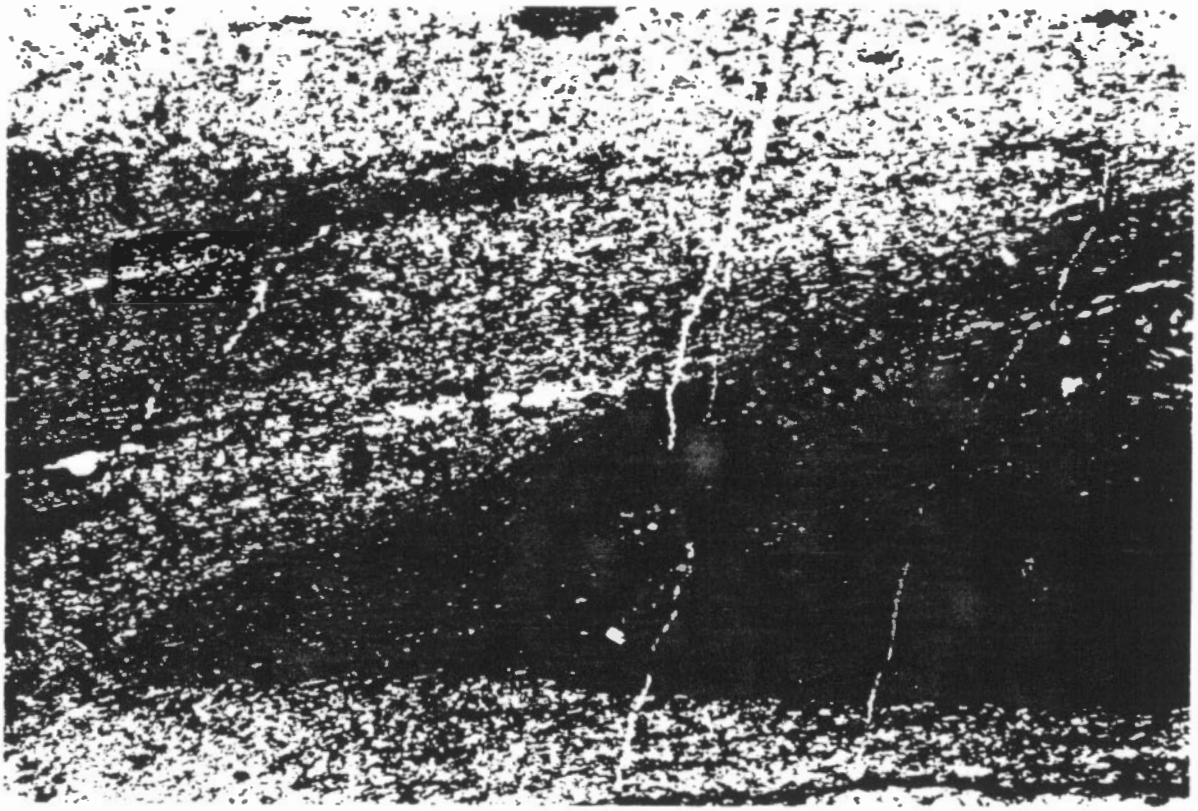
Figure 8. Metamorphic textures illustrating structural development of the Faribault Brook area.

(a) F_2 fold in Dauphinee Brook pelites (DDH AMC-2). Strong foliation (horizontal) is S_2 crenulation foliation, overgrown by garnets at right. Dark area in lower right is graphitic pelite folded by F_1 (oblique to photo) and transposed along S_2. Post-S_2 veins cut the foliation and the garnets. (PPL, field of view 10 mm)

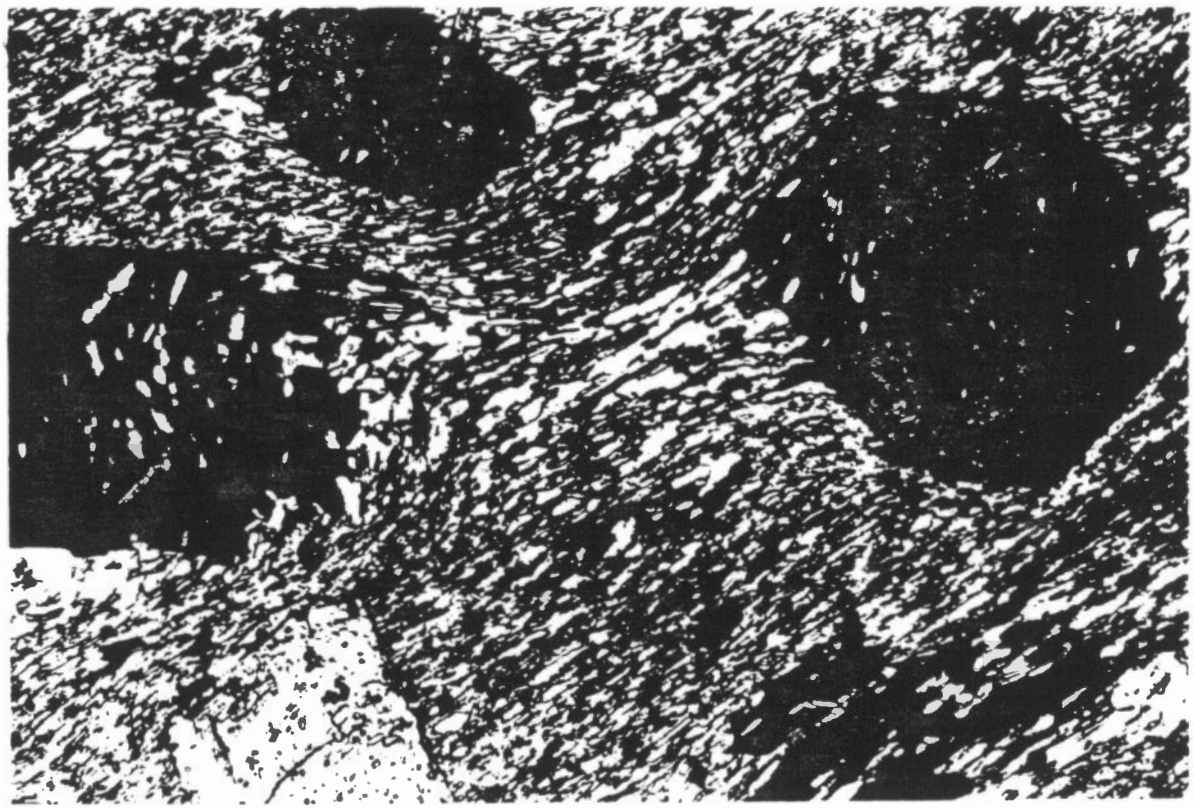
(b) Garnet (right) and biotite (left) porphyroblasts with sigmoidal inclusion trails, Dauphinee Brook schist (DDH AMC-4). Inclusion trails represent incipient development of S_2 (trending from lower left to upper right) from S_1 (originally nearly vertical). Main matrix fabric, defined by muscovite and chlorite, is S_2. (PPL, field of view 2.5 mm)

(c) F_3 crenulations (upper left to centre) affecting F_2 fold and S_2 foliation, Dauphinee Brook schist (DDH HM-2). Sulphide vein at left cuts F_2 but is folded by F_3 (centre left). Sulphides in folded layer in upper part of photograph are associated with a pre-F_2 quartz vein. (PPL, field of view 10 mm)

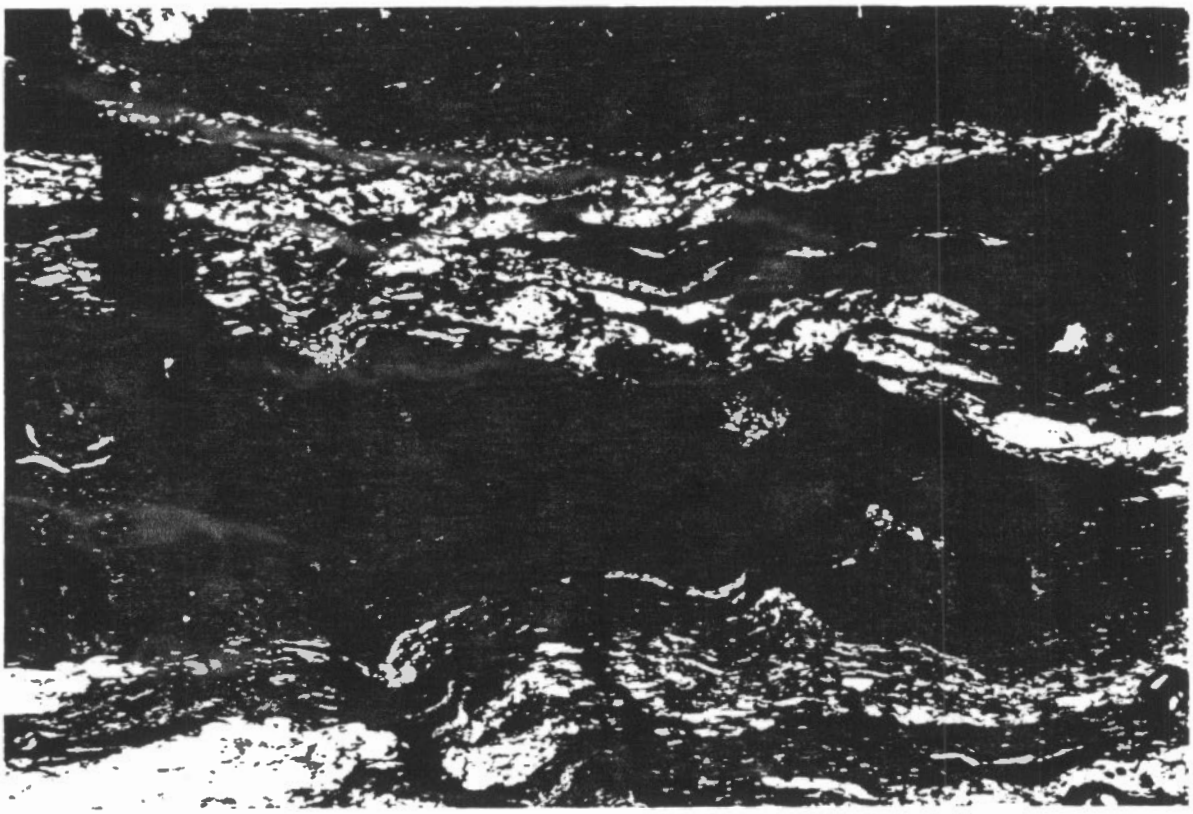
(d) Late folding (F_3?) of sulphide vein, Dauphinee Brook schist (DDH AMC-2). Vein cuts garnet porphyroblast, and is thus post-S_2. Post-F_2 flattening has folded the vein and tightened up the S_2 foliation. (PPL, field of view 10 mm)



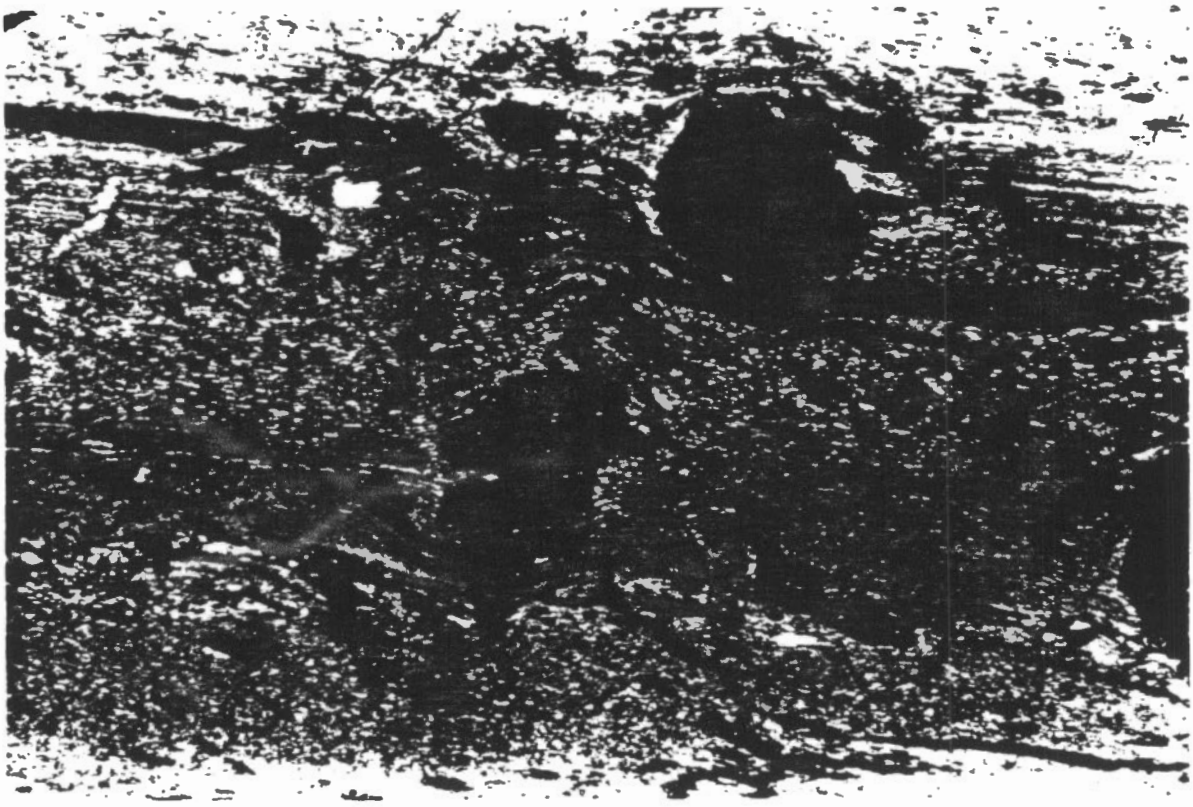
8a



8b



8c



8d

have been documented in the course of this study, although galena locally occurs on fracture surfaces, and sulphides are found as accessory minerals in some localities.

Fishing Cove River schist:

Plint (1987) referred to high grade, garnet-kyanite schists north of Cheticamp River as the Fishing Cove River schist. These rocks are interpreted as gradational into both the Corney Brook schist on the west and Pleasant Bay complex gneisses on the east, although the eastern boundary is not well exposed and is poorly located at present (e.g., Barr et al., 1987). This unit has no significant mineral occurrences and is not discussed further here.

George Brook amphibolite:

Medium- to coarse-grained foliated metabasite, commonly with relict dioritic texture, occurs within and on the margins of the Jumping Brook metamorphic suite (Figure 2). It typically contains coarse hornblende porphyroblasts in a finer-grained plagioclase-biotite-quartz matrix, and in some places has discordant contacts (Plint, 1987). The distribution and textures of these amphibolites suggests that they are the intrusive equivalents of the Faribault Brook metavolcanic rocks, although there are some geochemical differences (Table A1). The rocks locally contain sulphide minerals although no significant concentrations have been documented (Connors, 1986).

Central Cape Breton Highlands

Some elements of the Jumping Brook metamorphic suite, including the Dauphinee Brook schist and the Corney Brook schist, have been recognized in the central Cape Breton Highlands east of the Margaree Pluton, where they are highly disrupted along shear zones (Jamieson et al., 1987; Barr et al., 1987, in press). These rocks form a north-south trending belt that may once have continued into correlative rocks in

the Sarach Brook region. A major shear zone separating these rocks from the Late Precambrian Kathy Road Diorite (Barr et al., 1988) is currently the site of significant exploration activity.

STRUCTURE AND METAMORPHISM

Many of the conflicting hypotheses proposed for the origin and geological setting of the Faribault Brook deposits centre on different interpretations of the structural and metamorphic history of the region. There is general agreement that the deposits have been variably deformed and that sulphides have been remobilized at various stages, but little agreement as to the timing of sulphide deposition with respect to metamorphism, although the role of "alteration" has been emphasized in some studies (e.g., Chatterjee, 1980; Woods, 1986, unpublished manuscript). This section summarizes the structural and metamorphic history of the Jumping Brook metamorphic suite, and proposes a means of distinguishing different generations of sulphide deposition.

Deformation

Owing to complex deformation, primary structures preserved in the Jumping Brook metamorphic suite are useful more as a clue to the origin of the rocks than as indicators of stratigraphic younging directions. Up to three genera-tions of penetrative structures involving tight to isoclinal folding can be recognized in metasedimentary rocks of the Faribault Brook region. Prograde metamorphism to lower amphibolite facies accompanied the first two of these; later structures are associated with retrogression and "alteration" of earlier mineral assemblages.

The earliest stage of deformation produced tight folds of compositional layering and a penetrative axial planar foliation, S_1. This foliation was subsequently crenulated to produce S_2 (Figure 8a,b) which is the main foliation present in the rocks of the Faribault Brook area. Although Plint

(1987) and Jamieson et al. (1987) considered the main foliation in the lower grade rocks to be S_1, this interpretation is more consistent with microstructural evidence from the drill-core samples collected in 1987, and with material collected by Connors (1986). S_2 probably corresponds to the coaxial flattening phase of S_1 discussed by Jamieson et al. (1987). Garnet porphyroblasts containing straight to weakly sigmoidal inclusion trails appear to have grown at an early stage in the development of S_2 from S_1 (Figure 8b). West-to-east stacking of progressively higher grade rocks over lower grade ones along syn-metamorphic ductile shear zones (Craw, 1984; Marcotte, 1987) possibly occurred during the late stages of D_2. Biotite-chlorite shear zones cutting metabasites appear to have initiated prior to porphyroblast growth, but continued to act as zones of weakness and fluid flow during later stages of deformation.

D_3 deformation produced local tight folds of the S_2 foliation as well as the prominent north-south trending crenulation lineation (Figure 8c,d) characteristic of the Cheticamp River area (Connors, 1986; Woods, 1986, unpublished manuscript). The lineation post-dated porphyroblast growth and was accompanied by retrogression. It probably coincided with the development of major north-south trending antiforms (Conrod, 1984; Craw, 1984; Connors, 1986; Plint, 1987), although the relationship of the minor folds (seen mainly in unoriented drill core) to the large scale folding has not been determined.

Kink bands in the vicinity of Faribault Brook post-date the D_3 crenulation lineation and shear zones, but pre-date many of the faults in the region; they are thus assigned to D_4. Some retrograde ductile shear zones and quartz veins may have formed at about this time. The final stage of deformation, D_5, involved extensive faulting on northeast-southwest trending fault zones, of which the Northeast Margaree Fault Zone is the most important (Jamieson et al., 1987). The sense of displacement on these faults is not always

obvious and may have changed through time, although dextral displacements on the order of several kilometers can be inferred in some places (Jamieson et al., 1987). The age and significance of the numerous small faults within the study area with respect to the Northeast Margaree Fault Zone are not known.

Metamorphism

There has been one phase of prograde metamorphic mineral growth, producing garnet, chloritoid, biotite, and hornblende porphyroblasts in the Faribault Brook area, with higher grade assemblages to the north and east (Figure 8; Plint, 1987; Plint and Jamieson, in press). Peak metamorphic conditions in the study area probably did not exceed 500 ^{o}C and 5 kb, although near the Jumping Brook metamorphic suite - Pleasant Bay complex transition conditions of 650-700 ^{o}C and 8-9 kb have been inferred (Plint and Jamieson, in press). Porphyroblast growth occurred during the development of S_2 from S_1, and matrix re-orientation around the growing porphyroblasts resulted in included fabrics ranging from straight to weakly sigmoidal (Figure 8). Although the porphyroblasts overgrow foliations, they formed during the development of S_2 (Bell, 1985; Plint, 1987; Plint and Jamieson, in press) and are not related to contact metamorphism. This study has failed to confirm the presence of significant regionally developed andalusite, cordierite, and sillimanite in the Faribault Brook area (cf. Chatterjee, 1980; Currie, 1987a,b) although post-tectonic andalusite is associated with contact metamorphism in the vicinity of the Salmon Pool pluton (Plint and Jamieson, in press).

Implications for mineral deposits

The structural and metamorphic history outlined above, based as it is on detailed microstructural observations, may seem to be of limited practical importance. However, it goes a long way towards explaining why no single model can account

for all the deposits in the Faribault Brook region, and provides a potential means of separating various stages of sulphide deposition and remobilization (Table 2). The recognition of three phases of tight folding explains both the complexity of the lithologic sequence and the apparently different relations between deformation, metamorphism, and mineralization seen in different places. The distribution of fabrics is heterogeneous, and in poorly exposed rocks there is little geometrical control.

During the complex deformation, the metasedimentary rocks have responded by folding, whereas the more competent metabasites have concentrated the deformation in shear zones (e.g., Bell, 1981). The quartz-eye bearing felsic schists of the Barren Brook schist, near the stratigraphic transition from the metabasites to the metasedimentary rocks (Figure 5), have borne the brunt of this deformation. Dilatant structures have survived better in the more competent rocks, and the style of deformation in the more competent metabasites takes the form of ductile shear zones in the contact region. Movement on these shear zones both pre-dated and post-dated porphyroblast growth, suggesting that early shear zones acted as the loci for subsequent deformation.

Early quartz veinlets pre-dated porphyroblast growth (Jamieson et al., 1987), but the most important quartz veins in the region post-dated the peak metamorphism and were associated with retrogression and alteration of the earlier porphyroblasts. In many cases the alteration simply reflects interaction with cooler vein material (cf. Chatterjee, 1980); however, replacement of porphyroblasts by sulphidesand tourmaline, implying metasomatism, has been documented locally (Figure 9a,b).

The recognition of a single phase of prograde porphyroblast growth and its relationship to fabric development allows various stages of sulphide deposition to be separated on the basis of their relationship to the main metamorphic minerals, notably garnet (Table 2; Fig. 10). It

Table 2. Main features of sulphide occurrences in the Faribault Brook area. For locations, see Figure 4.

Occurrence:	**GALENA MINE**
Lithology:	Quartz-sericite quartz eye schist (Barren Brook schist), altered, metamorphosed greywacke; some relict prismatic quartz grains with resorption textures.
Sulphides:	Sph, gn, cpy, py.
Style:	Disseminated and vein.
Timing:	Syngenetic for disseminated sulphides. Vein-style sulphides may be syngenetic-hydrothermal or early epigenetic.
Notes:	Four adits were driven c.1897-1900, plus mill.
Occurrence:	**HIGHLAND MERCURY SHOWING**
Lithology:	Quartz-eye bearing quartz-sericite-chlorite schist (Barren Brook schist), metamorphosed greywacke.
Sulphides:	Sph, cpy, gn.
Style:	Vein and disseminations adjacent to vein.
Timing:	Epigenetic. Relatively late metamorphic vein.
Notes:	At water level in Faribault Brook beneath Galena Mine adit #4. Very minor vein occurrence, 2 to 5 cm wide, exposed over approx. 1m.
Occurrence:	**CORE SHACK SHOWING**
Lithology:	Quartz-sericite-garnet schist with quartz eyes (Barren Brook schist), altered, metamorphosed greywacke.
Sulphides:	Aspy, sph, gn, cpy, py as ragged, cleavage parallel grains, and on later fracture surfaces.
Timing:	Sph, gn, cpy, py are hydrothermal-syngenetic, but metamorphism has remobilized this assemblage into later fractures. Syngenetic aspy post-dates the base metal assemblage. Disseminated style aspy overprints base-metals and is synchronous with garnet growth. The sericitic lithology may be alteration related to the introduction of aspy. Aspy veins occur in disseminated zone with sericite, but extend into the chloritic metapelites and psammites to the east (UPPER CORE SHACK SHOWING).

Table 2 (cont'd)

Occurrence:	**UPPER CORE SHACK SHOWING**
Lithology:	Chlorite metapelite (Dauphinee Brook schist).
Sulphides:	Aspy.
Style:	Massive veins.
Timing:	Veins are open folded, continuous, and cross-cut cleavage at 15 degree angle, therefore synchronous with late-stage deformation. The veins may slightly post-date the disseminated-style aspy although they are considered genetically related.
Notes:	See CORE SHACK SHOWING.
Occurrence:	**SILVER CLIFF SHOWING**
Notes:	Not examined. Not presently exposed although descriptions exist in literature (Chatterjee, 1980).
Occurrence:	**JUNCTION SHOWING/FALLS SHOWING**
Lithology:	Garnet-metabasite (Faribault Brook metabasite).
Sulphides:	Cpy, sph, gn, po, py, aspy.
Style:	Disseminations and lenses, oriented parallel to foliation, as an- to subhedral grains. Locally remobilized to occur on late fracture surfaces.
Timing:	Shear zone-hosted mineralization, emplaced synchronous with deformation. Some or all sulphides may be remobilized from an unknown source.
Notes:	Metabasite is separated from pyritic, siliceous metagreywackes by a narrow, cross-cutting, low angle shear zone. Mineralization and garnet are developed in the sheared metabasite.
Occurrence:	**MARLEAU SHOWING**
Lithology:	Felsic intrusion (quartz-sericite-quartz-eye schist).
Sulphides:	Aspy, cpy, py, po.
Style:	Disseminated, and concentrated in competent margins.
Timing:	Intrusion is pre- S2 foliation. Aspy-bearing intrusions may be synchronous with initiation of deformation. Sulphides within the intrusion are syngenetic, and post-date the base-metal assemblage by some short period.
Notes:	Similar occurrences are found in drill cores.
Occurrence:	**GRANDIN CLIFF SHOWING**
Lithology:	Quartz-sericite schist with 10-40% quartz-eyes (Barren Brook schist), metagreywacke.
Sulphides:	Cpy, with very common malachite staining.
Style:	Ragged, cleavage parallel disseminations.
Timing:	Syngenetic, but deformed and remobilized.
Notes:	Similar to Mountain Top, Core Shack, and Fisset Brook Showings, but lacks alteration and arsenopyrite mineralization.

Table 2 (cont'd)

Occurrence:	**ROAD 1 SHOWING**
Lithology:	Metabasite (Faribault Brook metabasite).
Sulphides:	Aspy (massive vein).
Style:	5-10 cm vein of interlocking crystals of aspy. Bounded by sericite and biotite zones on margins. Garnet present at margins also.
Timing:	Aspy veins emplaced during late stage shearing.
Notes:	Not presently exposed. Trench filled 1987.
Occurrence:	**ROAD 1A SHOWING**
Lithology:	See ROAD 1 Occurrence
Notes:	Not presently exposed. Trench filled 1987.
Occurrence:	**ROAD 1B SHOWING**
Lithology:	See ROAD 1 Occurrence.
Notes:	Not presently exposed. Trench filled 1987.
Occurrence:	**ROAD 2 SHOWING**
Lithology:	Very friable, greasy, chlorite schist (sheared Faribault Brook metabasite).
Sulphides:	Sph, aspy, cpy, gn, py, po.
Style:	Massive sulphide, 15-40 cm wide, continuous over 10 m length. Internally zoned with sph- versus aspy-rich bands. Sulphide minerals exhibit brecciation, minor remobilization.
Timing:	Emplaced during last stages of shear deformation.
Notes:	Not presently exposed. Trench filled 1987.
Occurrence:	**MOUNTAIN TOP ADITS**
Lithology:	Quartz-sericite schist (Barren Brook schist), altered metagreywacke.
Sulphides:	Aspy, cpy, py, po.
Style:	Disseminated and minor vein-style mineralization at adits below the drill road. Cpy disseminated and in stringers hosted by a thin unit of chlorite-biotite schist at adits above the drill road.
Timing:	Quartz-sericite schist-hosted mineralization is synchronous with metamorphism and deformation. The chloritic metagreywacke hosts syngenetic and/or locally remobilized sulphide.
Notes:	Four or five short adits driven c.1897-1900.

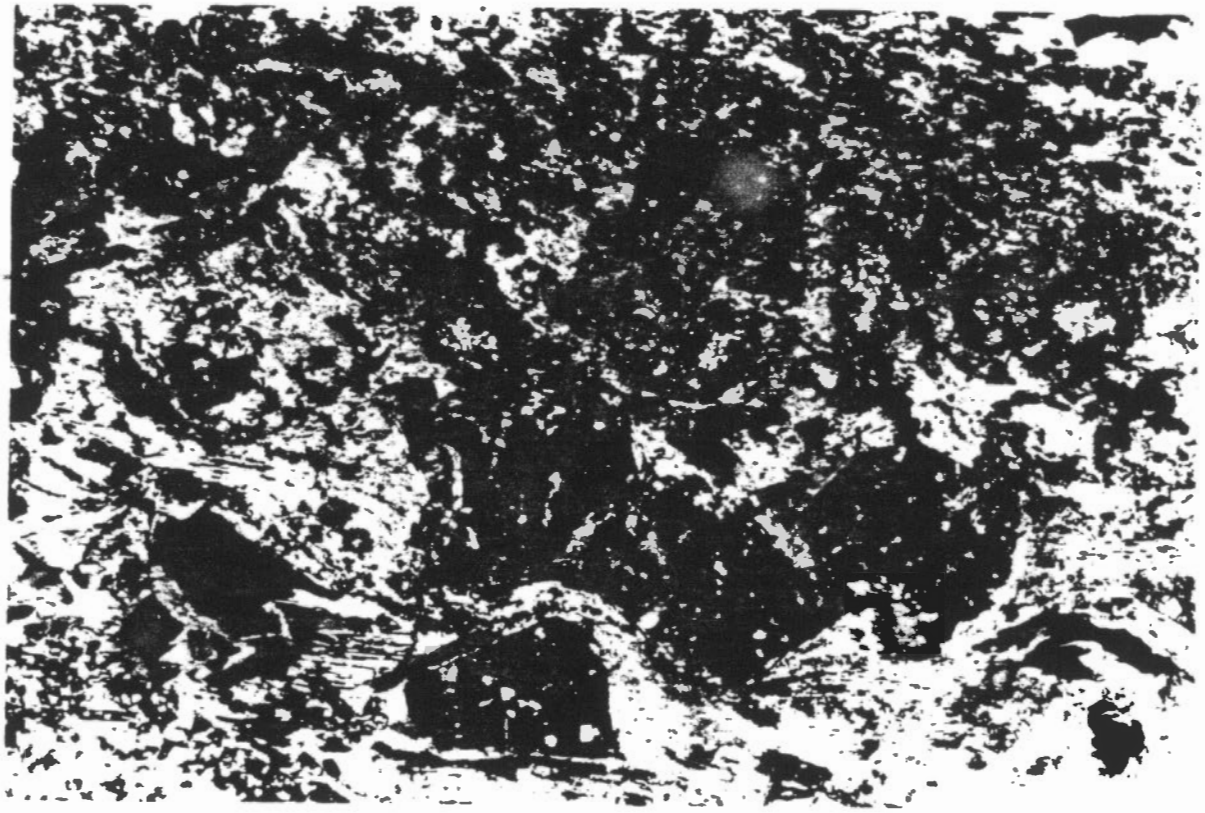
Table 2 (cont'd)

Occurrence:	**IRON CAP ADIT**
Lithology:	Biotite-metabasite (Faribault Brook metabasite).
Sulphides:	Aspy,py,po,cpy,spy,gn.
Style:	Disseminations and vein sulphides, controlled by shear zone fabric.
Timing:	Sulphides emplaced during shear zone development.
Notes:	Shear zones are 15-30 cm wide. Sulphide concentrations are minor. Late barren quartz vein tension gashes are common in the area. One adit driven approximately 80 ft., c.1900.
Occurrence:	**FISSET ROAD SHOWING**
Lithology:	Metabasite (Faribault Brook metabasite), hosts the massive mineralization. Minor quartz-sericite schist is also present.
Sulphides:	Sph, gn, aspy, py, cpy.
Style:	Massive sulphide vein, with gn versus sph banding. Aspy occurs disseminated in sulphide, also disseminated in the quartz-sericite schist.
Timing:	No direct evidence. From comparison with ROAD 2 SHOWING may be synchronous with deformation.
Notes:	Very similar to ROAD 2 SHOWING. Referred to by S. Sears, B.Sc. thesis, St. F.X., (1987), one sample.
Occurrence:	**FISSET BROOK SHOWING**
Lithology:	Quartz-sericite schists with quartz-eyes (Barren Brook Schist), altered metagreywacke, in sequence of chloritic metagreywacke.
Sulphides:	Aspy, py, cpy, po, sph.
Style:	Disseminated, eu- to subhedral aspy. Other sulphides are cleavage parallel streaky grains.
Timing:	No direct evidence indicating origin available. Inferred from other areas to be synchronous with metamorphism and deformation.
Notes:	Similar to Core Shack, Mountain Top showings but lacks the intense alteration, and the aspy veins. Studied by Sandy Sears, B.Sc. thesis, St. F.X., (1987).

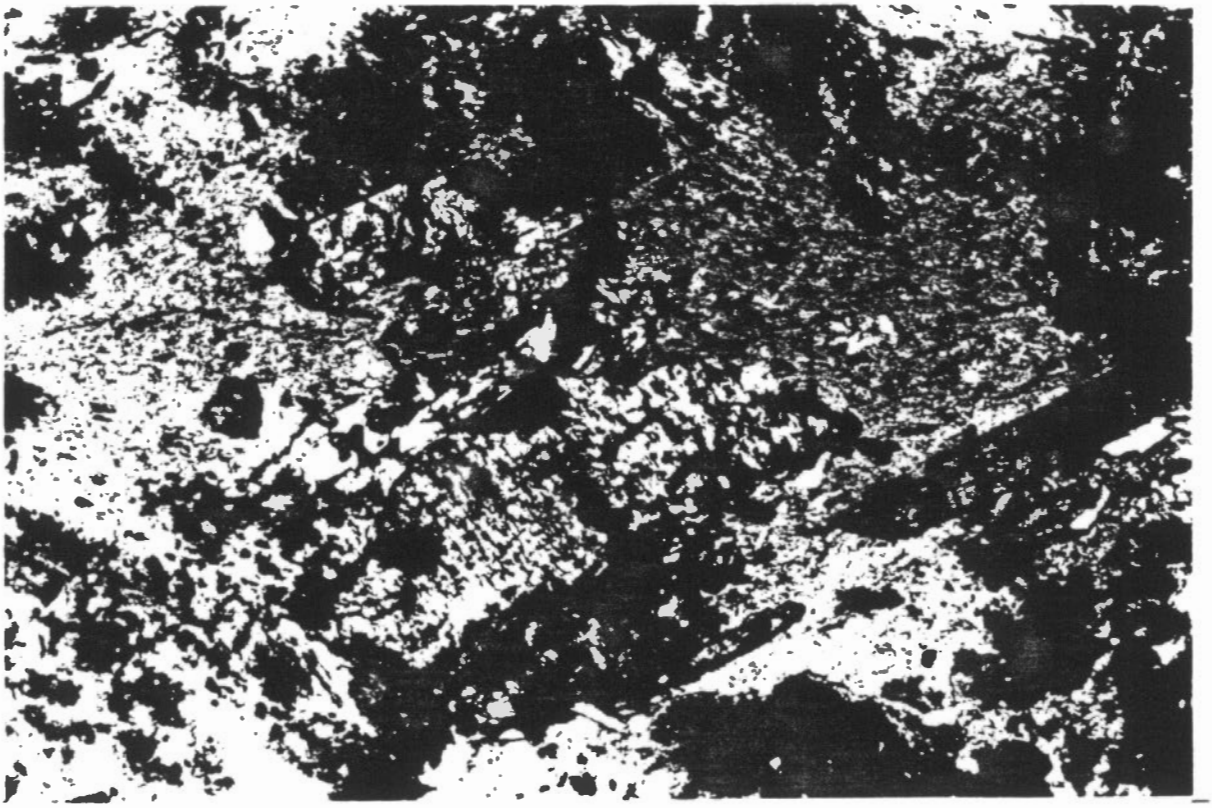
Figure 9. Tourmaline-rich shear zone overprinting chloritic shear zone in metabasite, DDH AMC-6, Faribault Brook area.

(a) Sulphides replacing garnet porphyroblasts in lower half of photo; relict garnet crystal indicated by "g". Tourmaline sprays (for example, at "t") replace plagioclase and overgrow matrix chlorite. (PPL, field of view 10 mm)

(b) Post-tectonic tourmaline (dark grey) replacing plagioclase porphyroblasts in chloritic shear zone. (PPL, field of view 2.5 mm)



9a



9b

is clear that some Cu-Pb-Zn sulphides present prior to garnet growth (e.g., at Galena Mine; Figure 10a) could represent syngenetic or pre-metamorphic epigenetic deposits (Connors, 1986). Arsenopyrite-dominated occurrences appear during the later stages of garnet growth (Figure 10b,c), and are thus syntectonic (Woods, 1986, unpublished manuscript; Tallman et al., 1988); their appearance in the syn-D_2 ductile shear zones supports this interpretation. Later deformation has deformed and remobilized these sulphides (Figure 10d), with post-F_3 late fractures containing galena and sphalerite.

AGE

As noted above, the age of the Jumping Brook metamorphic suite and its relationship to the adjacent Cheticamp Pluton is a problem with both tectonic and economic significance. On the basis of mapping and $^{40}Ar/^{39}Ar$ dating carried out in the course of this study (Plint, 1987; Jamieson et al., 1987; Reynolds et al., in preparation), and U-Pb zircon work on correlative rocks in the southern CapeBreton Highlands (Dunning, written communication, 1987; Barr et al., 1988), the Jumping Brook metamorphic suite is here regarded as Silurian, as originally suggested by Currie (1982, 1987b). The mineral occurrences can therefore be no older than Silurian, as discussed below, but may be partly as young as Middle Devonian.

Age of the Cheticamp Pluton

The Cambrian age of this granodiorite to monzogranite pluton is well established. An intrusive age of 550 $\pm$ 8 Ma (U-Pb zircon; Jamieson et al., 1986) is supported by Rb-Sr isochron data (Cormier, 1972; Barr et al., 1986) and a muscovite cooling age of about 545 Ma (Reynolds et al., in preparation). It is not penetratively deformed where best studied south of the Cheticamp River (Barr et al., 1986); however, its extension north of the Cheticamp River is strongly sheared and locally mylonitized (Plint, 1987; Currie,

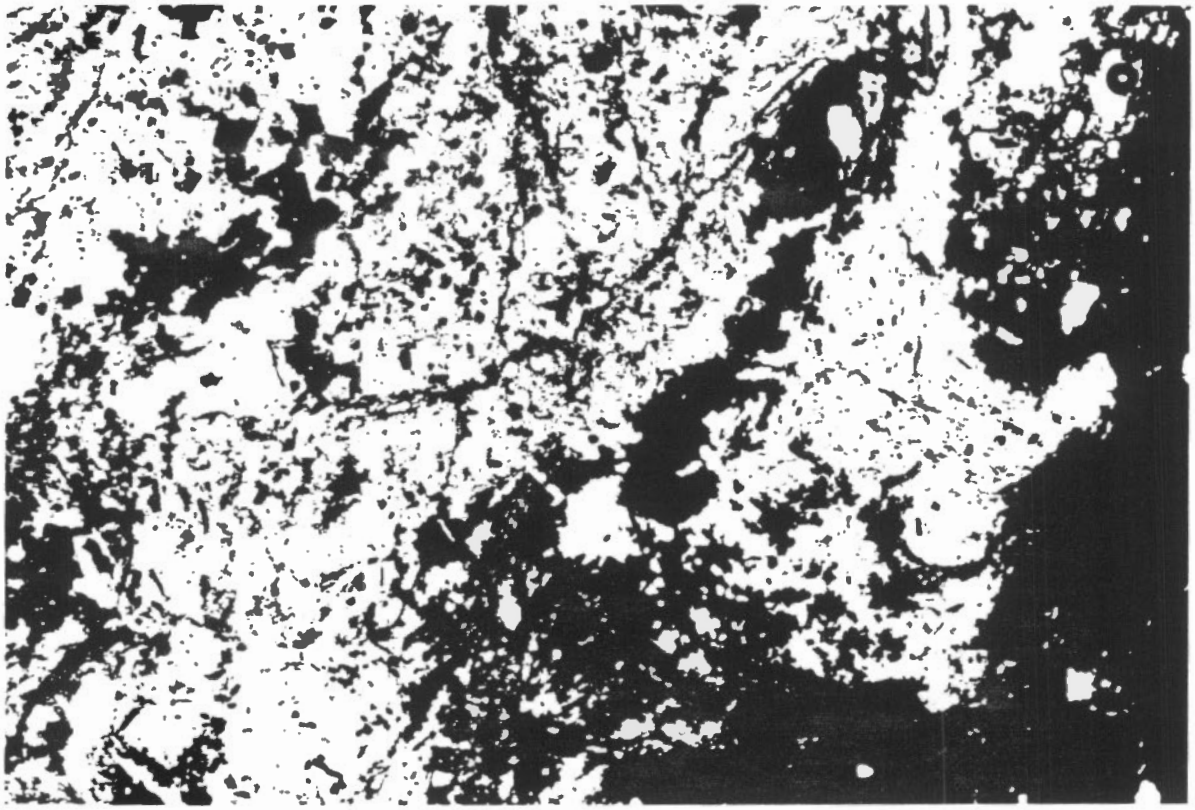
Figure 10. Photomicrographs of sulphides, Faribault Brook area.

(a) Garnet (dark grey) overgrowing and intergrown with sphalerite and galena in quartz-sericite schist, Galena Mine. Large crystal in lower centre overgrows fabric suggesting that sulphides were offset along chlorite-rich fractures prior to garnet growth. Sulphides have also grown during metamorphism and locally crosscut fabric. (PPL, field of view 10 mm)

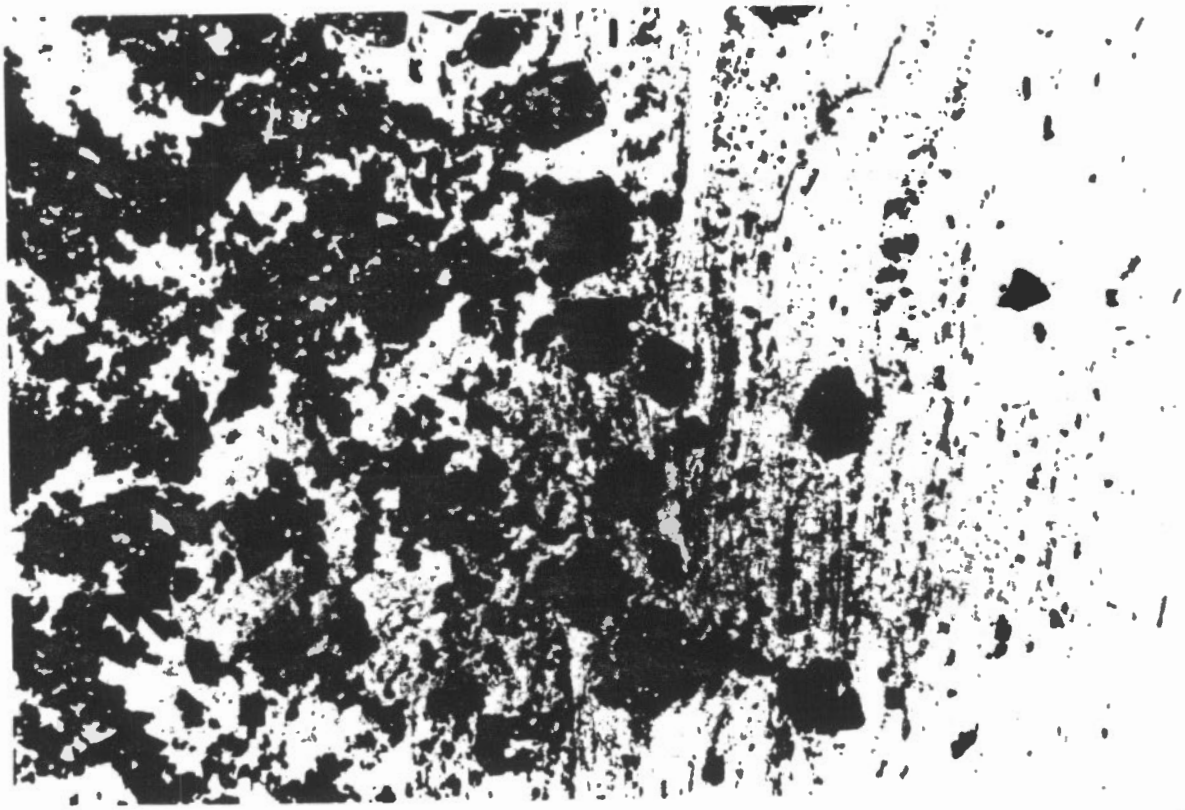
(b) Garnets and arsenopyrite-rich vein in quartz-sericite schist, DDH HM-5. Garnet (dark grey) in vein contains pyrite inclusions; arsenopyrite in vein is much coarser than inclusions in garnet, indicating growth during metamorphism. (PPL, field of view 10 mm)

(c) Garnet porphyroblast overgrowing sulphides and chlorite-muscovite matrix, DDH AMC-5. Garnet core does not contain arsenopyrite, but rim zone is intergrown with arsenopyrite; coarse arsenopyrite is present in the matrix (lower part of photo) and in a quartz vein (upper part of photo). (PPL, field of view 2.5 mm)

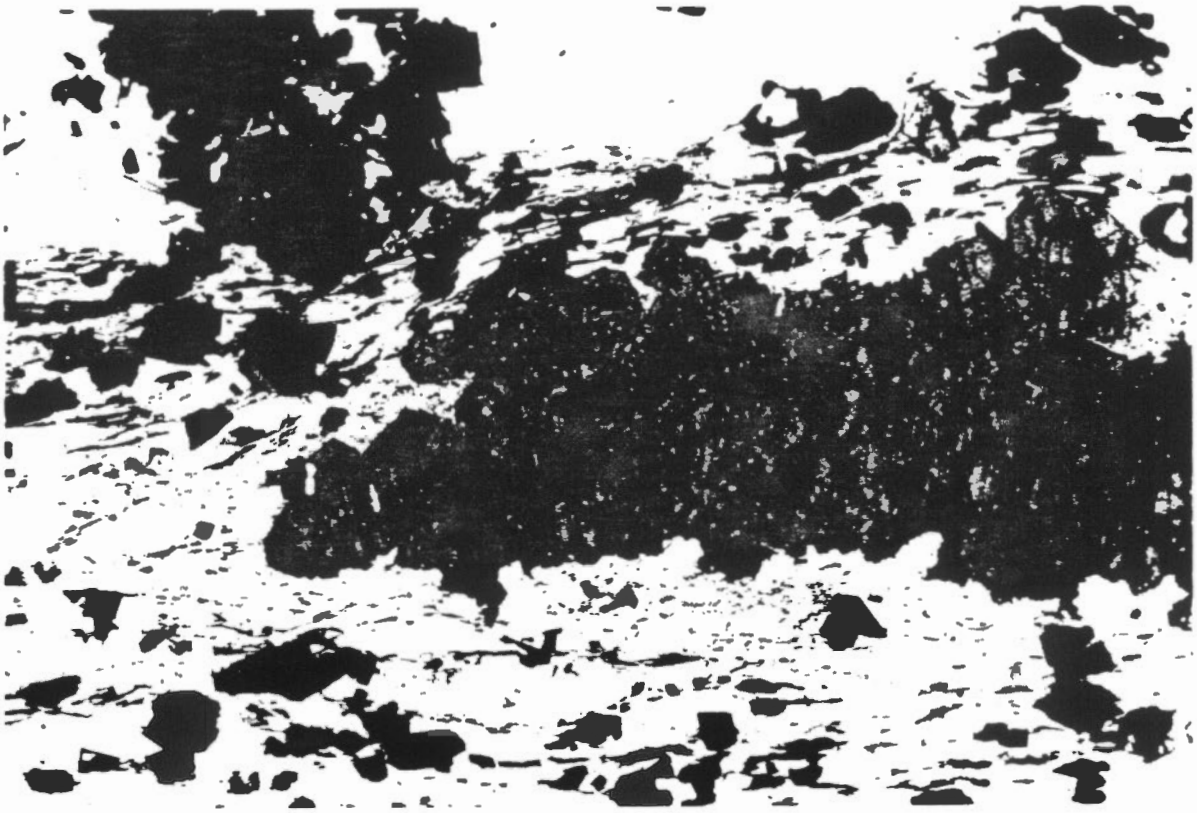
(d) Remobilization of sulphides (sphalerite and galena) into post-tectonic fracture. Early quartz-sulphide vein (left centre to upper right) cuts bedding but is folded by F_2 and cut by S_2; later fracture (left) crosscuts S_2 foliation. (PPL, field of view 10 mm)



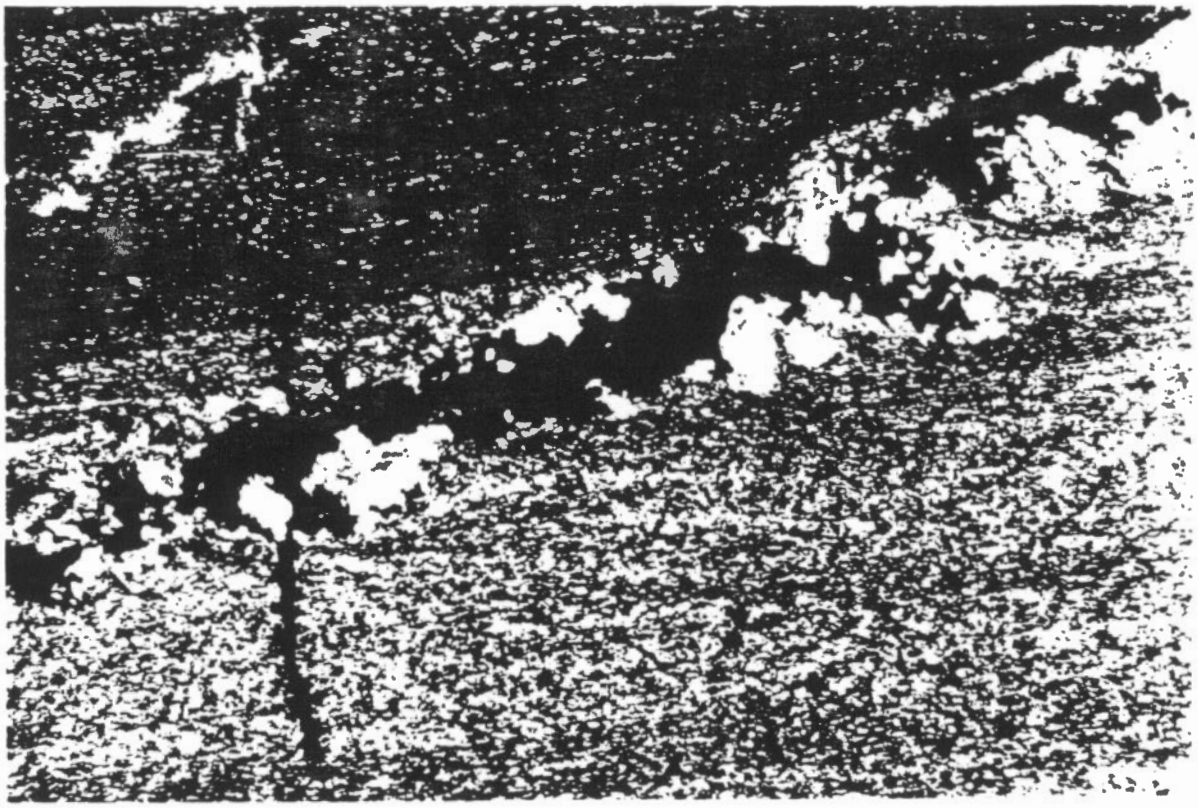
10a



10b



10c



10d

1987b). The relative lack of deformation of the Cheticamp Pluton and polyphase deformation of the Jumping Brook metamorphic suite led Jamieson and Craw (1983) and Plint et al. (1986) to infer a late Precambrian age for the latter. A genetic relationship between pluton emplacement and mineralization in the Faribault Brook area was suggested by Woods (1986, unpublished manuscript) based on the proximity of the pluton to the deposits and on geochemical anomalies in the contact zone. Currie (1982, 1987b) suggested that the pluton intruded the Pleasant Bay complex but was overlain by the Jumping Brook rocks. Jamieson et al. (1987), noting its faulted margins and the presence of probable Cheticamp Pluton detritus in the Jumping Brook metamorphic suite, also concluded that it is older than the adjacent metamorphic rocks (cf. Jamieson and Craw, 1983; Plint et al., 1986), but could not confirm an intrusive relationship between the Cheticamp Pluton and the Pleasant Bay complex (cf. Currie, 1987).

Age of deposition of the Jumping Brook metamorphic suite

Currie (1982, 1987b) suggested an Ordovician-Silurian age for the Jumping Brook metamorphic suite, based on a presumed unconformity between these rocks and the gneisses of the Pleasant Bay complex and a U-Pb zircon date on a rhyolite dyke inferred to feed the felsic volcanic rocks (Currie et al., 1982). Several studies in well exposed areas of the Jumping Brook - Pleasant Bay transition have failed to confirm the supposed unconformable relationship (e.g., Craw, 1984; Conrod, 1984; Plint, 1987). However, since no intrusive contact has been found, and boulders of Cheticamp Pluton-like granite occur near the base of the Barren Brook schist, Jamieson et al. (1987) agreed with the Ordovician-Silurian age for deposition of the Jumping Brook metamorphic suite protoliths, in agreement with Currie (1982, 1987b). Although these rocks have yet to yield a stratigraphic age, geochronological data from elsewhere in the Highlands support this interpretation. A U-Pb zircon date on rhyolitic tuff from the Sarach Brook area

in the southern Highlands, generally regarded as correlative with the Jumping Brook metamorphic suite (Jamieson and Craw, 1983; Jamieson and Doucet, 1983), indicates a primary age of about 433 Ma (Dunning, written communication, 1987; Barr et al., 1988). Cooling ages from the Jumping Brook metamorphic suite north of the Cheticamp River fall consistently in the range 390-380 Ma (Figure 11), with no evidence for resetting of older ages (Plint, 1987; Plint and Jamieson, in press; Reynolds et al., in preparation).

Age of deformation and metamorphism

A number of lines of evidence suggest that the deformation and metamorphism of the Jumping Brook metamorphic suite occurred in a fairly short time period during the Late Silurian and Early Devonian (Plint and Jamieson, in press). Clearly, deformation and metamorphism can be no older than the age of the rocks, about 433 Ma. A further constraint on the timing of tectonism is provided by the zircon date of 433 $\pm$ 20 Ma on the syntectonic Belle Cote Road orthogneiss (Jamieson et al., 1986). Thermal modeling of the metamorphic history and geochronology suggests that peak metamorphic conditions were achieved at about 410-400 Ma (Plint and Jamieson, in press). Hornblende and biotite from the area between the Cheticamp River and Pleasant Bay have yielded Early Devonian $^{40}Ar/^{39}Ar$ cooling ages between 390 and 380 Ma (Figure 11), indicating rapid cooling, probably related to tectonic exhumation (Plint, 1987; Plint and Jamieson, in press; Reynolds et al., in preparation). By the time of intrusion of the Salmon Pool pluton at 365 M (Jamieson et al., 1986), the Jumping Brook metamorphic suite was within 10 km of the surface (Plint and Jamieson, in press). This is very similar to the timing and pattern of tectonism in southwestern Newfoundland (Chorlton and Dallmeyer, 1986).

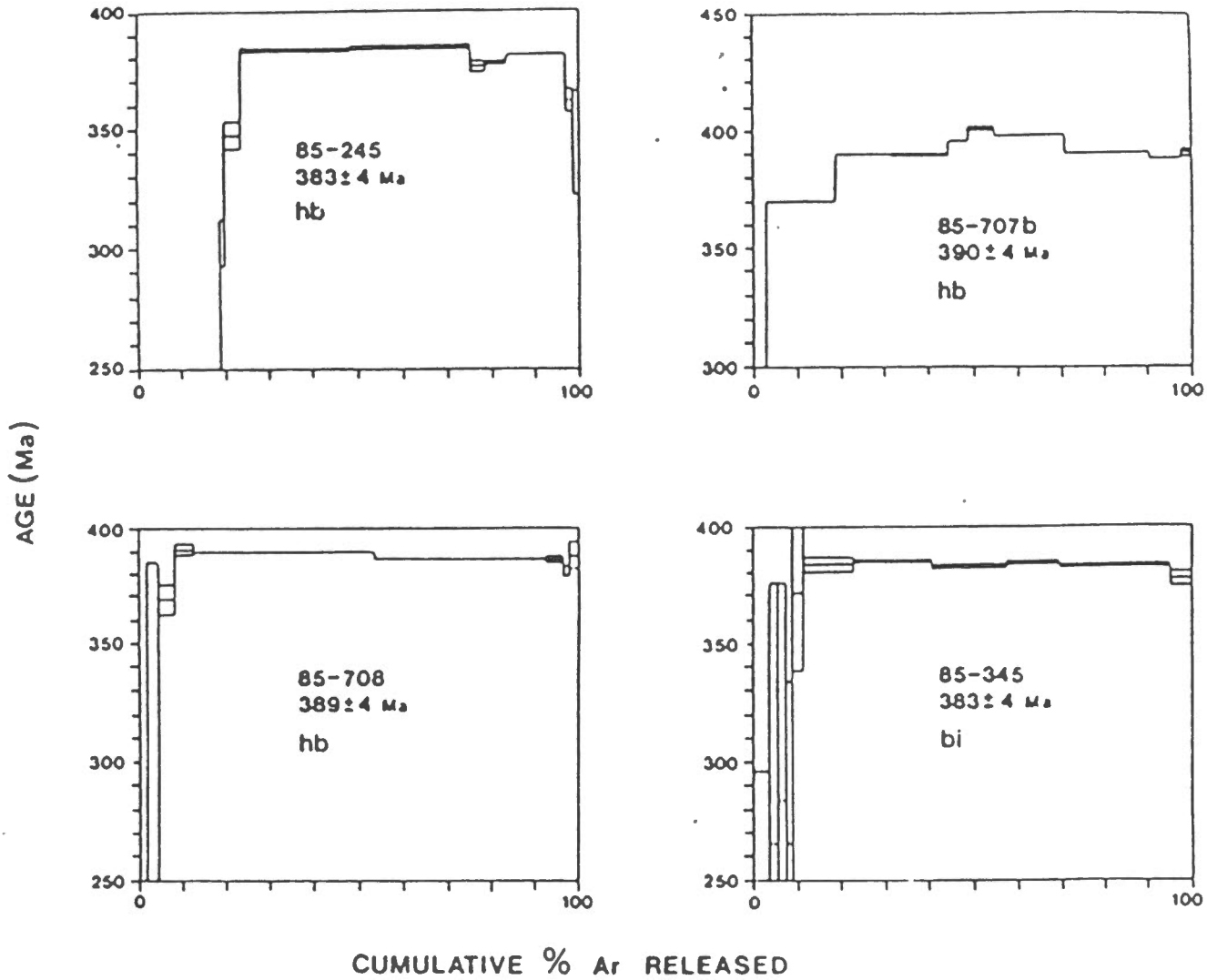


Figure 11. $^{40}Ar/^{39}Ar$ spectra from the Jumping Brook metamorphic suite (Fishing Cove River schist) north of the Cheticamp River (Plint, 1987). Note the well developed plateaux, and close correspondence between hornblende and biotite ages, indicating rapid cooling.

Age of mineral deposits

The pre-tectonic Cu-Pb-Zn sulphide deposits associated with the Barren Brook schist presumably formed during or soon after deposition of their Silurian host rocks. However, the timing of remobilization of these deposits in shear zones, and the formation of the shear-related arsenopyrite deposits, is not well constrained. The inferred late syn-tectonic emplacement of the arsenopyrite-dominated association is presumably synchronous with peak metamorphism (latest Silurian to earliest Devonian), but later quartz veins associated with significant retrogression and alteration may be as young as middle Devonian.

REGIONAL CORRELATIONS

Cape Breton

The Jumping Brook metamorphic suite is part of a belt of metavolcanic and metasedimentary rocks that extends through the west-central Cape Breton Highlands from Cape North to Middle River and southwest into the Mabou Highlands (Figure 1; Barr et al., 1985; Barr and Raeside, 1986; Raeside and Barr, 1987). These rocks and associated plutons and gneisses are characteristic of the Aspy Zone, one of several pre-Carboniferous tectonostratigraphic zones recognized in Cape Breton Island (Barr and Raeside, 1986, Raeside and Barr, 1987; Reynolds et al., in preparation). The Aspy Zone is bounded on the east by dioritic Late Precambrian to Cambrian dioritic and granitic rocks of the Bras d'Or Zone (Raeside and Barr, 1987), on the northwest by Grenvillian metaplutonic rocks and gneisses (Barr et al., 1986), and on the southwest by Cambrian and older granite, diorite, and gneiss referred to as the Cheticamp Zone (Reynolds et al., in preparation), which may be related to the Bras d'Or Zone.

Similar suites of volcanic and metamorphic rocks occur in the Aspy Zone of the northern and southern Cape Breton Highlands (Money Point Group, Macdonald and Smith, 1980; Sarach Brook volcanic rocks, Jamieson and Doucet, 1983) and

the Mabou Highlands (Mabou Highlands complex, Barr and Macdonald, in press). These rocks are characterized by a similar stratigraphic sequence - lower metabasites, followed by silicic schists derived from pyroclastic and rhyolitic rocks, followed by metasedimentary rocks. Felsic volcanic rocks, including ash flow and crystal-lithic tuffs and minor flow-banded rhyolite, dominate the upper part of the sequence in the Sarach Brook region; the relative proportion of silicic volcanic rocks dies out northwards, with metatuffs, volcanogenic metasedimentary rocks, and clastic metasedimentary rocks dominant elsewhere. Despite the intense deformation, the overall character of the rocks suggests that they originally represented a felsic volcanic pile constructed on a mafic volcanic base, centred on the Sarach Brook region, and interfingering with sedimentary rocks on its margins. The volcanism appears to have been submarine, judging by the character of the associated sedimentary rocks throughout the belt, and the presence of possible pillow lavas in the Faribault Brook area (Connors, 1986). However, the possibility that the volcanic centre in the Sarach Brook region was subaerial cannot be ruled out. Crystal tuffs from the upper part of the Sarach Brook volcanic rocks have yielded a U-Pb zircon date of about 433 Ma (Dunning, written communication, 1987; Barr et al., 1988). The volcanic-sedimentary sequence is thus Silurian, although the lower parts may be as old as Ordovician.

The metasedimentary and metavolcanic rocks are associated with high grade metamorphic rocks (Cape North Group, Pleasant Bay complex, Middle River metamorphic suite, Mabou Highlands complex); metamorphic grade increases towards the core of the Highlands in each region. The relationships between the lower and higher grade rocks are complex, owing to tectonized transition zones (Craw, 1984; Marcotte, 1987) and to a significant orthogneissic component in the high grade rocks which results in locally crosscutting contacts (Jamieson et al., 1987). However, Plint (1987) demonstrated a continuous

progression from low to high grade rocks in the area between the Cheticamp River and Pleasant Bay; a similar conclusion was reached by Doucet (1983) for the Middle River area. Plint (1987) compared the metamorphic histories of the Sarach Brook - Middle River and Money Point - Cape North areas with the Jumping Brook - Pleasant Bay region, and found very similar metamorphic and structural patterns, although different mineral assemblages occur locally. Our conclusion is that the low grade and high grade rocks form part of a single metamorphic complex, with the significant component of syntectonic tonalitic to granodioritic orthogneiss in the Pleasant Bay complex contributing directly to the high grade conditions. Although the presence of older enclaves within the gneisses cannot be ruled out entirely, no evidence of stratigraphic, metamorphic, or tectonic unconformity has been documented in the course of this investigation (cf. Currie, 1987 a,b).

Northern Nova Scotia

In northern mainland Nova Scotia, Silurian bimodal volcanic rocks at Arisaig (e.g., Keppie et al., 1978) and in the Cobequid Highlands (e.g., Donohoe and Wallace, 1982; Murphy et al., 1988) may have formed at the same time as the Aspy Zone volcanic rocks. They escaped the complex Silurian to Devonian deformation and metamorphism that affected the western Cape Breton Highlands, and their original tectonic setting and position relative to the Aspy Zone volcanic rocks is not clear at present.

Newfoundland

Silurian volcanic rocks are common in central Newfoundland, notably in the Springdale and LaPoile regions (e.g., Chandler and Dunning, 1983; Chandler et al., 1987; Coyle and Strong, 1987). Although the LaPoile area has a complex Lower Paleozoic volcanic history, subaerial Silurian rhyolites and related rocks are probably correlative with the

volcanic rocks of the Aspy Zone (Chorlton, 1983; Dunning, personal communication, 1987; Yule, in preparation). The Springdale Group and its equivalents comprise a calc-alkaline suite ranging from basalts to high silica rhyolites (Coyle and Strong, 1987). The geochemistry of the Springdale Group is similar in many respects to that of the Aspy Zone volcanic rocks, although intermediate volcanic rocks are poorly represented in the latter and may form mainly pyroclastic deposits (e.g., Macdonald and Smith, 1980). In Newfoundland, the Silurian volcanic complexes are regarded as post-orogenic overlap assemblages (Coyle and Strong, 1987; Chandler et al., 1987). Despite their broadly similar compositions and ages, the equivalent rocks in Cape Breton are clearly synorogenic, having undergone intense deformation and high grade metamorphism shortly after their formation.

Regional tectonic models

Stockmal et al. (1987) proposed a tectonic model for the Ordovician to Devonian development of the Canadian Appalachians in which collision of an island arc with the irregular continental margin of North America during the Taconian orogeny resulted in incomplete closure of the Iapetus Ocean. In Newfoundland, lithospheric delamination after oceanic closure resulted in Silurian post-orogenic volcanism and plutonism. South of Newfoundland, subduction of oceanic crust continued through the Silurian until collision was completed during the Acadian orogeny. This model is consistent with the available data from the Jumping Brook metamorphic suite and adjacent rocks, and explains contrasts between the Silurian geology of Newfoundland and Cape Breton.

In this tectonic context, the Jumping Brook metamorphic suite represents a volcanic-sedimentary pile formed close to a Late Ordovician to Silurian subduction zone, that underwent deformation and high grade metamorphism in response to late Silurian to Devonian collision with North America. Rapid exhumation (Plint and Jamieson, in press) resulted from

thrusting of the Jumping Brook metamorphic suite over the North American margin. The convergent orogenic setting explains the relatively short time span between deposition, metamorphism, and uplift of these rocks.

The tectonic contacts and contrasting age and tectonothermal histories of the Cheticamp Pluton and the Jumping Brook metamorphic suite strongly suggest that they were juxtaposed during accretion of the latter to the Appalachians. However, the Cheticamp Pluton or similar granite was shedding detritus into the Barren Brook schist during the Silurian. The change to felsic volcanism may thus have coincided with the approach of the Jumping Brook protoliths to a continental margin. The Cheticamp Pluton or its equivalent may have acted as a rigid buttress against which Jumping Brook metamorphic suite was deformed (e.g. Jamieson and Beaumont, in press). If the Cheticamp Pluton and its host rocks are equivalent to the Bras d'Or Zone, the Jumping Brook metamorphic suite may represent a thin allochthonous slice underlain by older, unrelated, Bras d'Or Zone rocks (Reynolds et al., in preparation).

MINERAL DEPOSITS

Faribault Brook area

The various mineral occurrences in the Faribault Brook area are summarized in Table 2. It has proven virtually impossible to generalize about the origin of the deposits because of the complexity of structural reworking and because more than one episode and style of sulphide deposition have been recognized. However, the deposits can be discussed in terms of two different associations - a pre-metamorphic Cu-Fe-Zn association, and a later, synmetamorphic, arsenopyrite-dominated association.

The pre-metamorphic Cu-Fe-Zn association includes the Galena Mine, Highland Mercury, Core Shack, Silver Cliff, and Grandin Cliff showings, although in all of these cases there is evidence of sulphide remobilization and later arsenopyrite

is common. These occurrences are localized near the transition from metabasites to metasedimentary rocks; the host rock is commonly quartz-sericite schist. The pre-metamorphic character of the base metal sulphides is evident from their presence as inclusions in garnet porphyroblasts (Figure 10a), and their occurrence as foliation-parallel smears (e.g., Connors, 1986). It is not clear whether these sulphides formed at time of host rock deposition (syngenetic), or whether they formed in pre-metamorphic hydrothermal veins (early epigenetic). At Galena Mine early quartz veinlets containing minor galena are overgrown by garnet, suggesting some pre-metamorphic but post-depositional introduction or remobilization of sulphides. However, owing to intense deformation of the metasediment-metabasite transition, and the ease of recrystallization of the sulphide minerals, any structures bearing on the primary nature of this type of occurrence have been obliterated.

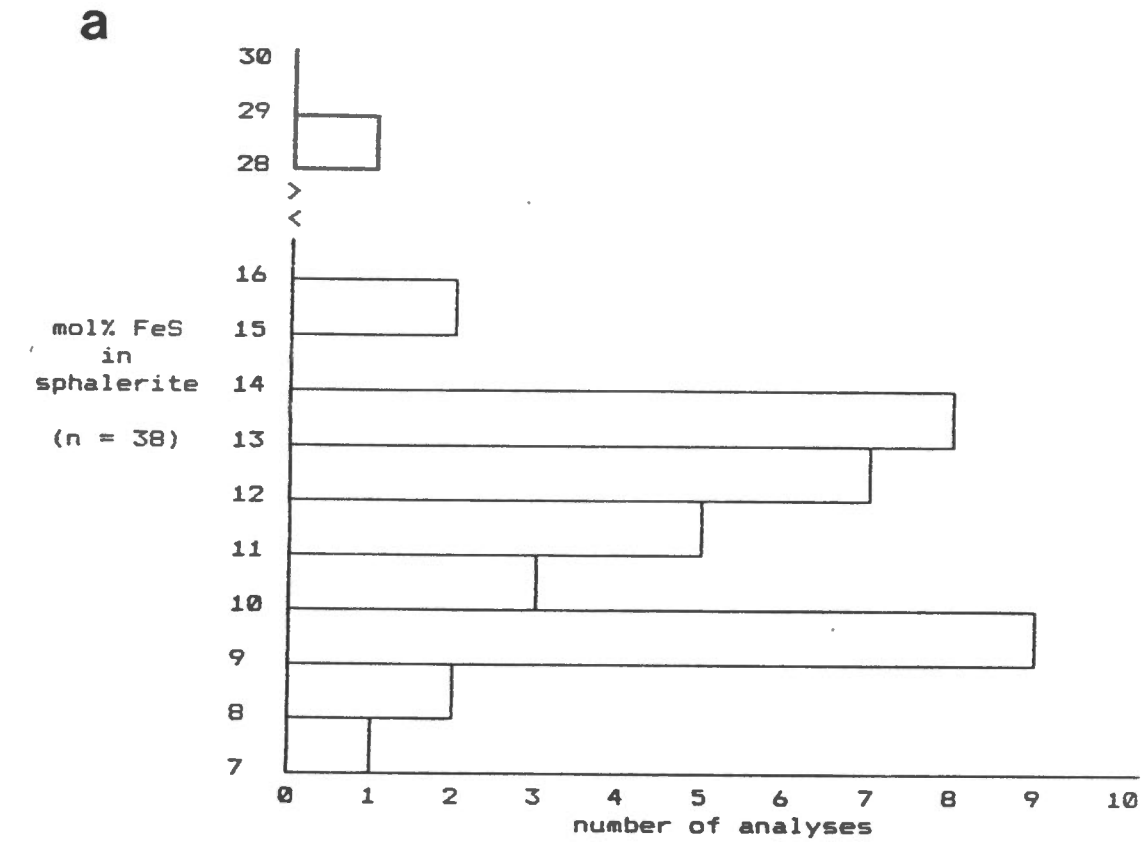
Virtually all of the sulphide occurrences in the Faribault Brook area contain significant arsenopyrite; the association of arsenopyrite with high Au values (Chatterjee, 1980; Woods, 1986, unpublished manuscript) makes this style of mineralization of particular interest. Arsenopyrite-dominated mineralization can be divided into three sub-classes on the basis of host lithology and style of occur-rence - disseminations in felsic intrusions, disseminations in metasedimentary rocks, and massive veins in metabasites.

Disseminated arsenopyrite-chalcopyrite-pyrrhotite-pyrite mineralization is associated with pink quartz-sericite schists of probable intrusive origin at the Marleau showing. Disseminated and minor vein arsenopyrite mineralization is associated with altered, sericitzed metasedimentary rocks at the Core Shack and Mountain Top showings. Veins and local associated arsenopyrite disseminations occur with chalcopyrite-pyrrhotite-pyrite mineralization in biotite- and chlorite-rich shear zones in metabasites (e.g., Road 1, Road 1A, Road 1B showings). Disseminated arsenopyite does not occur as inclusions in garnet cores in either the metasedimentary

rocks or the chloritic shear zones. However, it is intergrown with garnet rims (Figure 10b,c), and is interpreted here to represent a later, syn-metamorphic stage of mineralization. Large arsenopyrite crystals in the biotite-chlorite shear zones appear to post-date at least one phase of movement on the shears (i.e., they are porphyroblasts), but fracturing suggests that they may have acted as rigid porphyroclasts during later stages of deformation; these crystals are thus syntectonic. Arsenopyrite veins at the Core Shack showing are continuous for several meters, and clearly post-date the early stages of cleavage development in the host metasedimentary rocks, although they have been affected by late-stage, open folding (probably F_3).

Although the source of arsenopyrite remains a problem, the various styles of arsenopyrite-dominated mineralization are interpreted to be genetically related on the basis of their very similar sulphide mineralogy. The presence of syngenetic arsenopyrite in a felsic intrusive rock cutting metabasites at the Marleau showing suggests that some arsenopyite may have been introduced with syntectonic intrusions. These felsic intrusions are more abundant in drill core than their outcrop distribution suggests (Figure 5; Tallman et al., 1988). Arsenopyite mineralization in the metasedimentary rocks and metabasites appears to be syntectonic and may have been introduced at about the same time. Alternatively, two or more broadly synchronous separate mineralizing episodes may have introduced arsenopyrite; this possibility is considered unlikely.

Microprobe analyses of sphalerite and arsenopyrite from a number of localities show a very broad compositional range (Figure 12). No consistency was noted in terms of textural association, style of deposit, other sulphide phases present, or host rock. The range of compositions implies disequilibrium on all scales, probably owing to variable re-equilibration during polystage deformation and recrystallization, and unfortunately renders useless any geothermometer or



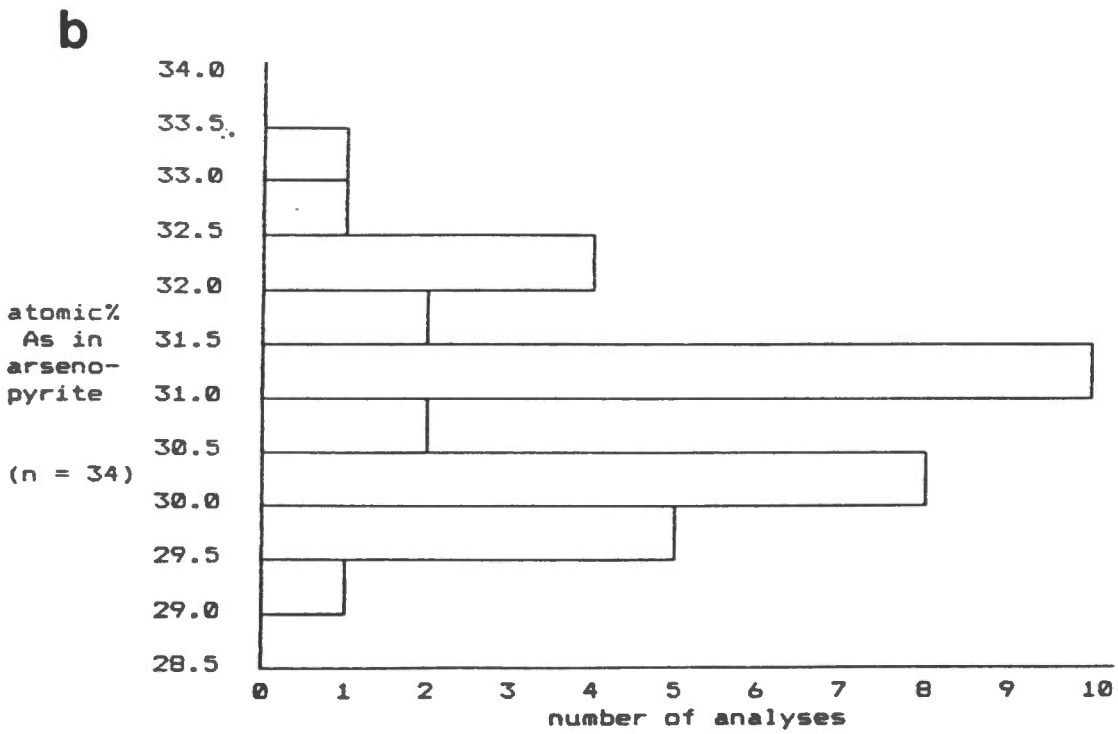


Figure 12. Sphalerite (a) and arsenopyrite (b) compositions from the Faribault Brook area. The wide compositional range indicates disequilibrium; no correlation was found between composition and textural type, host rock, style of occurrence, or associated sulphide minerals.

geobarometer based on arsenopyrite or sphalerite (e.g., Scott, 1983; Jamieson and Craw, 1986).

Alteration, particularly sericitization, has accompanied arsenopyrite-dominated mineralization in some places (e.g., Core Shack). Some descriptions of the quartz-sericite schists imply that "silicification" has also accompanied sulphide deposition. However, since high silica content is a primary feature of the quartz-sericite schists, which are derived from silicic volcanic rocks, not all silica-rich rocks associated with the sulphide occurrences are "silicified". Although we could not find evidence for wholesale replacement of silicates by sulphides as suggested by Chatterjee (1980), one example of post-tectonic sulphides replacing earlier garnet has been documented in this study (Figure 9a,b). In this case, the sulphides are associated with post-tectonic tourmaline, which overgrows chlorite and plagioclase in what was probably originally a chloritic shear zone. It should be noted that, in general, the chlorite in the chlorite-rich shear zones is not an "alteration" product, but part of the peak metamorphic assemblage along with biotite and garnet or hornblende. Its stability in these lower amphibolite facies rocks reflects the relatively high Mg/Fe ratios of the metabasites.

Intense deformation and remobilization of sulphides is evident throughout the region on all scales (Figure 10). Sulphides can be found as foliation-parallel smears (Connors, 1986), as late crosscutting veins (Figure 10d), and as everything in between (Figure 9d, 10). Except for the scarcity of arsenopyrite prior to deformation and metamorphism, all the sulphide phases have been affected and it does not appear possible at this stage to predict how any particular deposit has responded.

The concentration of deposits in the Faribault Brook area appears to be related to two factors - a regional stratigraphic control related to the interfingering of mafic metavolcanic rocks and metasedimentary rocks with the distal part of a felsic volcanic pile, and the structural and

hydrothermal reworking of these deposits in a short-lived but intense metamorphic episode. The stratigraphic situation is unique in the Aspy Zone; other areas have either higher proportions of felsic volcanic rocks, which in general have very low metal concentrations, or lack significant thicknesses of turbiditic metasedimentary rocks. In addition, the Faribault Brook area is so far the only region in which syntectonic felsic dykes, which appear to be related to the arsenopyrite-dominated sulphide association, have been recognized.

The intense deformation affecting the Faribault Brook area has probably served to disperse rather than to concentrate the metals. Geochemical anomalies associated with the tectonic contact between the Cheticamp Pluton and the Jumping Brook metamorphic suite probably result from fault and shear zone related fluid circulation, rather than to a genetic relationship between the pluton and the sulphides, as inferred by Woods (1986, unpublished manuscript).

Aspy Zone

Despite the occurrence of correlative units elsewhere in the Aspy Zone, the Faribault Brook area is by far the most important from a metallogenic point of view. As noted above, this probably reflects the particular stratigraphic setting of this area. However, significant lead and tungsten occurrences have been described from the Sarach Brook region, where they are associated with shear zones cutting gneissic and granitoid rocks. Gold in the Second Gold Brook locality is associated with quartz-carbonate veins near the termination of a major shear zone of probable mid-Devonian age. The veins are hosted by metasedimentary rocks, very similar to the Dauphinee Brook schist, which are interlayered with conglomerate containing abundant felsic volcanic fragments (Doucet, 1983). Tourmalinite of probable replacement origin has been found in the area (Jamieson, unpublished data). A few kilometers east of the Faribault Brook area, the shear zone that forms the

boundary between the Aspy Zone and the Bras d'Or Zone is now the site of a major gold exploration effort.

CONCLUSIONS

The most important conclusions of this study include the following:

1. The Jumping Brook metamorphic suite is a Silurian volcanic complex, as originally suggested by Currie (1982, 1987b). It is faulted against the Cambrian Cheticamp Pluton on the west, and grades into gneisses of the Pleasant Bay complex on the east. Five mappable units have been identified on a regional scale, of which the most important in the study area are the Faribault Brook metavolcanic rocks, the Barren Brook schist, and the Dauphinee Brook schist.

2. The volcanic rocks originated in an oceanic island arc setting, and were deformed and metamorphosed to upper amphibolite facies conditions during late Silurian to Early Devonian collision with North America.

3. The mineral deposits of the Faribault Brook area include some pre-metamorphic, syngenetic or early epigenetic, Cu-Pb-Zn sulphide occurrences associated with the distal part of a felsic volcanic pile where it interfingers with mafic metabasalts and turbiditic metasedimentary rocks. Arsenopyrite-dominated occurrences appear to be somewhat later, and may be related to the intrusion of syntectonic felsic dykes. The geometry and the distribution of the sulphide bodies have been extensively modified by polyphase deformation.

REFERENCES

Barr, S.M., Jamieson, R.A., and Raeside, R.P.
1985: Igneous and metamorphic geology of the Cape Breton Highlands; GAC/MAC 1985 Field Guide, Excursion 10, 48 p.

Barr, S.M., Macdonald, A.S., and Blenkinsop, J.
1986: The Cheticamp Pluton: a Cambrian granodioritic intrusion in the western Cape Breton Highlands, Nova Scotia; Canadian Journal of Earth Sciences, v. 23, 1686-1699.

Barr, S.M. and Raeside, R.P.
1986: Pre-Carboniferous tectonostratigraphic subdivisions of Cape Breton Island, Nova Scotia; Maritime Sediments and Atlantic Geology, v. 22, 252-263.

Barr, S.M., Raeside, R.P., Dunning, G.R., and Jamieson, R.A.
1988: New U-Pb ages from the Cape Breton Highlands and correlations with southern Newfoundland. GAC/MAC Abstracts with Programs, St. John's, 1988.

Barr, S.M., Raeside, R.P., and Jamieson, R.A.
1987: Geological map of the igneous and metamorphic rocks of northern Cape Breton Island, Nova Scotia. Geological Survey of Canada, Open File 1:50000 Maps.

Barr, S.M., Raeside, R.P., and Jamieson, R.A.
in press: Geological map of the igneous and metamorphic rocks of northern Cape Breton Island, Nova Scotia. Geological Survey of Canada, Open File 1:100000 Maps, in press.

Barr, S.M., Raeside, R.P., and van Breemen, O.
1987: Grenvillian basement in the northern Cape Breton Highlands, Nova Scotia. Canadian Journal of Earth Sciences, v. 24, 992-997.

Bell, T.H.
1981: Foliation development: the contribution, geometry, and significance of progressive bulk inhomogeneous shortening; Tectonophysics, v. 75, 273-296.

Bell, T.H.
1985: Deformation partitioning and porphyroblast rotation in metamorphic rocks: a radical reinterpretation; Journal of Metamorphic Geology, v. 3, 109-118.

Blanchard, M.C., Jamieson, R.A., and More, E.B.
1984: Late Devonian - Early Carboniferous volcanism in western Cape Breton Island, Nova Scotia; Canadian Journal of Earth Sciences, v. 21, 762-774.

Chandler, F.W., and Dunning, G.R.
1983: Fourfold significance of an Early Silurian U-Pb zircon age from rhyolite in redbeds, southwest Newfoundland, NTS 12 A/4; in Current Research, Part B, Geological Survey of Canada, Paper 83-1B, 419-421.

Chandler, F.W., Sullivan, R.W., and Currie, K.L.
1987: The age of the Springdale Group, western Newfoundland, and correlative rocks - evidence for a Llandovery overlap assemblage in the Canadian Appalachians; Transactions of the Royal Society of Edinburgh: Earth Sciences, v. 78, 41-49.

Chatterjee, A.K.
1980: Mineralization and associated wall rock alteration in the George River Group, Cape Breton Island, Nova Scotia; Unpublished Ph.D. thesis, Dalhousie University, 197 p.

Chorlton, L.B.
1983: Geological development of the southern Long Range mountains, southwest Newfoundland: a regional synthesis; Unpublished Ph.D. thesis, Memorial University of Newfoundland, 581 p.

Chorlton, L.B. and Dallmeyer, R.D.
1986: Geochronology of early to middle Paleozoic tectonic development in the southwest Newfoundland Gander Zone; Journal of Geology, v. 94, p. 67-89.

Connors, K.A.
1986: Relationships between the sulphide minerals, metamorphism, and deformation in the Faribault Brook area of the Cape Breton Highlands, Nova Scotia; Unpublished B.Sc. thesis, Dalhousie University, 105 p.

Conrod, D.M.
1984: The relationship between low and high grade metamorphic rocks in the French Mountain area, Cape Breton Highlands, Nova Scotia; Unpublished B.Sc. thesis, Dalhousie University, 214 p.

Cormier, R.F.
1972: Radiometric ages of granitic rocks, Cape Breton Island, Nova Scotia; Canadian Journal of Earth Sciences, v. 9, p. 1074-1085.

Covey, G.
1979: Report on the Cheticamp Project, Amax Minerals Exploration Limited; Nova Scotia Department of Mines and Energy Assessment File 11K/10B, 7-J-09 (48).

Coyle, M. and Strong, D.F.
1987: Geology of the Springdale Group: a newly recognized Silurian epicontinental-type caldera in Newfoundland; Canadian Journal of Earth Sciences, v. 24, 1135-1148.

Craw, D.
1984: Tectonic stacking of metamorphic zones in the Cheticamp River area, Cape Breton Highlands, Nova Scotia; Canadian Journal of Earth Sciences, v. 21, p. 1229-1244.

Currie, K.L.
1975: Studies of granitoid rocks in the Canadian Appalachians; in Report of Activities, Part A, Geological Survey of Canada Paper 75-1A, p. 265-270.

Currie, K.L.
1982: Paleozoic supracrustal rocks near Cheticamp, Nova Scotia; Maritime Sediments and Atlantic Geology, v. 18, p. 94-103.

Currie, K.L.
1987a: Contrasting metamorphic terranes near Cheticamp, Cape Breton Highlands, Nova Scotia; Canadian Journal of Earth Sciences, v. 24, 2422-2435.

Currie, K.L.
1987b: Relations between metamorphism and magmatism near Cheticamp, Cape Breton Island, Nova Scotia; Geological Survey of Canada Paper 85-23, 66 p.

Currie, K.L., Loveridge, W.D., and Sullivan, R.W.
1982: A U-Pb age on zircon from dykes feeding the Jumping Brook complex, northwestern Cape Breton Island, Nova Scotia; in Current Research, Part C, Geological Survey of Canada, Paper 82-1C, 125-128.

Donohoe, H.V., and Wallace, P.I.
1982: Geological map of the Cobequid Highlands, Colchester, Cumberland, and Pictou Counties, Nova Scotia; Nova Scotia Department of Mines and Energy, Maps 82-6, 82-7, 82-8, and 82-9, scale 1:50000.

Doucet, P.
1983: The petrology and geochemistry of the Middle River area, Cape Breton Island, Nova Scotia; Unpublished M.Sc. thesis, Dalhousie University, 339 p.

Fletcher, H.
1885: Report on the geology of northern Cape Breton; Geological Survey of Canada, Report of Progress for 1882-84, part H.

Gaudette, H.E., Olszewski, W.J., and Jamieson, R.A.
1985: Rb-Sr ages of some basement rocks, Cape Breton Highlands, Nova Scotia; GAC-MAC Program with Abstracts, v. 10, p. A20.

Jamieson, R.A. and Beaumont, C.
in press: Orogeny and metamorphism: a model for P-T-t paths in convergent orogens with applications to the central and southern Appalachians. Tectonics, in press.

Jamieson, R.A. and Craw, D.
1983: Reconnaissance mapping of the southern Cape Breton Highlands - a preliminary report; in Current Research, Part A, Geological Survey of Canada Paper 83-1A, p. 263-268.

Jamieson, R.A., and Craw, D.
1986: Sphalerite geobarometry in metamorphic terranes: an appraisal with implications for metamorphic pressure in the Otago Schist; Journal of Metamorphic Geology, v. 5, 87-99.

Jamieson, R.A. and Doucet, P.
1983: The Middle River - Crowdis Mountain area, southern Cape Breton Highlands; in Current Research, Part A, Geological Survey of Canada Paper 83-1A, p. 269-275.

Jamieson, R.A., Tallman, P., Marcotte, J.A., Plint, H.E., and Connors, K.A.
1987: Geology of the west-central Cape Breton Highlands; Geological Survey of Canada, Paper 87-13, 11 p.

Jamieson, R.A., van Breemen, O, Sullivan, R.W. and Currie, K.L.
1986: The age of igneous and metamorphic events in the western Cape Breton Highlands, Nova Scotia; Canadian Journal of Earth Sciences, v. 23, 1891-1901.

Keppie, J.D., Dostal, J., and Zentilli, M.
1978: Petrology of the early Silurian Dunn Point and MacGillivray Brook Formations, Arisaig, Nova Scotia; Nova Scotia Department of Mines and Energy, Paper 78-5.

Macdonald, A.S. and Smith, P.K.
1980: Geology of the Cape North area, northern Cape Breton Island, Nova Scotia; Nova Scotia Department of Mines and Energy, Paper 80-1, 60 p.

MacLaren, A.S.
1955: Cheticamp River, Inverness and Victoria Counties, Cape Breton Island, Nova Scotia; Geological Survey of Canada, Preliminary Map 55-36.

Marcotte, J.A.
1987: Regional mapping and petrographic study of a Silurian gneissic complex, Belle Cote Road, Cape Breton, Nova Scotia; Unpublished B.Sc. thesis, Dalhousie University, 93 p.

Milligan, G.C.
1970: Geology of the George River Series, Cape Breton; Nova Scotia Department of Mines, Memoir 7, 111 p.

Murphy, J.B., Pe-Piper, G., Nance, R.D., and Turner, D.
1988: A preliminary report on the geology of the eastern Cobequid Highlands, Nova Scotia; in Current Research, Part B, Geological Survey of Canada, Paper 88-1B, 99-107.

Neale, E.R.W.
1963: Pleasant Bay map area, Nova Scotia; Geological Survey of Canada, Map 1119A.

Neale, E.R.W., and Kennedy, M.J.
1975: Basement and cover rocks at Cape North, Cape Breton Island, Nova Scotia; Maritime Sediments, v. 11, p. 1-4.

O'Beirne-Ryan, A.M., Barr, S.M., and Jamieson, R.A.
1986: Contrasting petrology and age of two megacrystic granitoid plutons, Cape Breton Island, Nova Scotia; in Current Research, Part B, Geological Survey of Canada, Paper 86-1B, 179-190.

Pearce, J.A., and Cann, J.R.
1973: Tectonic setting of basic volcanic rocks determined using trace element analysis; Earth and Planetary Science Letters, v. 19, 290-300.

Plint, H.E.
1987: Metamorphism of the Jumping Brook metamorphic suite, western Cape Breton Highlands, Nova Scotia: Microstructure, P-T-t paths, and tectonic implications. Unpublished M.Sc. thesis, Dalhousie University, 368 p.

Plint, H.E., Connors, K.A., and Jamieson, R.A.
1986: Geology and mineral occurrences of the Jumping Brook Complex, Cheticamp - Pleasant Bay area, Cape Breton Island, Nova Scotia; in Current Research, Part B, Geological Survey of Canada, Paper 86-1B, p. 557-566.

Plint, H.E., and Jamieson R.A.,
in press: Syntectonic progressive metamorphism, western Cape Breton Highlands, Nova Scotia - microstructure, P-T history, and tectonic implications; Journal of Metamorphic Geology, in press.

Ponsford, M. and Lyttle, N.A.
1984: Metallic mineral occurrences map and data compilation, eastern Nova Scotia; Nova Scotia Department of Mines and Energy, Open File Report 600.

Raeside, R.P., and Barr, S.M.
1987: Geology of the northern and northeastern Cape Breton Highlands, Cape Breton Island, Nova Scotia; Geological Survey of Canada, Open File Report.

Scott, S.D.
1983: Chemical behaviour of sphalerite and arsenopyrite in hydrothermal and metamorphic environments; Mineralogical Magazine, v. 47, 427-435.

Stockmal, G.S., Colman-Sadd, S.P., Keen, C.E., O'Brien, S.J., and Quinlan, G.
1987: Collision along an irregular margin: a regional plate tectonic interpretation of the Canadian Appalachians; Canadian Journal of Earth Sciences, v. 24, 1098-1107.

Tallman, P., Sangster, A., and Jamieson, R.A.
1988: Geology and mineralization of the Jumping Brook metamorphic suite, Faribault Brook area, western Cape Breton Island, Nova Scotia; in Current Research, Part B, Geological Survey of Canada, Paper 88-1B, p. 109-117.

Winchester, J.A. and Floyd, P.A.
1977: Geochemical discrimination of different magma series and their differentiation products using immobile elements; Chemical Geology, v. 20, 325-343.

APPENDIX 1. GEOCHEMICAL ANALYSES

Table A1. Geochemical analyses from the Faribault Brook metavolcanic rocks and equivalent units.

Table A2. Geochemical analyses from the Barren Brook schist, Dauphinee Brook schist, and equivalent units.

Table A3. Geochemical analyses from the Sarach Brook area, southern Cape Breton Highlands.

Table A4. Geochemical analyses of Silurian metaplutonic rocks, western and central Cape Breton Highlands.

TABLE A1. Geochemical data from the Faribault Brook metavolcanic rocks and other metabasites in the western Cape Breton Highlands.

(A) FARIBAULT BROOK METAVOLCANIC ROCKS (CONNORS)

SAMPLE	KC-40a	KC-40b	KC-49c	KC-51b	KC-40d	KC-48b	KC-48d
SiO_2	46.38	48.09	45.90	45.71	48.25	46.05	48.40
TiO_2	0.78	.72	0.85	1.03	0.80	0.99	0.91
Al_2O_3	14.89	15.01	15.41	15.95	14.80	14.76	14.56
Fe_2O_3							
FeO	10.52	9.58	9.76	10.81	9.34	10.17	10.99
MnO	0.18	0.17	0.14	0.20	0.17	0.20	0.22
MgO	10.59	9.85	9.16	9.73	9.56	8.73	8.74
CaO	10.29	9.60	10.82	10.75	10.32	11.43	8.37
Na_2O	2.03	2.95	2.76	2.29	2.53	2.12	0.59
K_2O	0.13	0.12	0.13	0.18	0.16	0.13	0.05
P_2O_5	0.06	0.06	0.08	0.08	0.06	0.09	0.07
LOI	3.37	2.97	5.99	3.40	2.94	5.43	8.07
TOTAL	99.22	99.12	101.00	100.00	98.93	100.10	100.97
Ba		8					
Rb							
Sr	91	90	102	107	93	95	114
Y	24	22	26	29	23	28	26
Zr	45	41	29	57	47	59	50
Nb	3	3	4	3	3	4	3
Th							
Pb	8	5	10	10	5	10	13
Ga	13	11	13	15	11	14	13
Zn	162	161	101	105	85	88	172
Cu	23	22	120	61	88	64	52
Ni	162	142	147	163	164	115	151
V	281	256	210	293	275	248	236
Cr	641	622	415	507	589	257	458

TABLE A1 (A) (cont'd) FARIBAULT BROOK METAVOLANICS (CONNORS)

SAMPLE	KC-49d	KC-50d	KC-40	KC-49b	KC-50a	KC-50b	KC-50b3
SiO_2	49.58	46.47	48.5	49.33	45.90	46.77	47.50
TiO_2	0.89	0.88	0.8	1.00	0.83	0.81	0.87
Al_2O_3	15.33	15.28	15.3	15.12	14.57	13.47	13.80
Fe_2O_3							
FeO	9.22	10.46	9.0	10.04	9.63	9.00	9.25
MnO	0.13	0.18	0.1	0.19	0.18	0.18	0.18
MgO	8.13	10.41	9.0	8.76	10.45	8.76	9.16
CaO	9.56	9.31	10.3	9.24	10.23	12.41	11.56
Na_2O	3.13	2.66	2.6	3.02	2.67	2.69	2.96
K_2O	0.22	0.18	0.1	0.16	0.22	0.25	0.25
P_2O_5	0.07	0.07	0.0	0.07	0.07	0.07	0.07
LOI	3.03	4.17	2.7	2.72	5.17	5.50	4.23
TOTAL	99.29	100.07	99.02	99.65	99.92	99.91	99.83
Ba					8	13	7
Rb					5	4	5
Sr	103	93	105	101	96	86	90
Y	28	25	26	27	24	24	24
Zr	51	49	47	55	48	47	49
Nb	3	4	4	3	2	3	3
Th							
Pb	15	10	7	8	16	12	18
Ga	12	11	15	18	11	15	14
Zn	127	113	113	117	107	85	85
Cu	15	98	93	98	66	110	101
Ni	140	183	165	158	177	129	141
V	261	285	281	284	251	247	258
Cr	419	591	624	466	588	443	482

TABLE A1 (A) (cont'd) FARIBAULT BROOK METAVOLCANICS (CONNORS)

SAMPLE	KC-52a	KC-49a	KC-51a	KC-48c	KC-50c	KC-40c
SiO_2	46.40	50.11	48.67	51.56	46.59	43.84
TiO_2	1.09	0.72	0.89	0.73	0.93	0.88
Al_2O_3	15.91	14.25	15.94	14.38	16.70	15.88
Fe_2O_3						
FeO	10.54	7.36	9.35	8.59	10.05	11.39
MnO	0.19	0.15	0.18	0.18	0.18	0.18
MgO	11.23	6.32	7.57	7.87	9.10	10.55
CaO	8.60	12.81	10.02	9.40	10.06	11.02
Na_2O	2.20	3.40	3.28	3.12	2.66	1.58
K_2O	0.14	0.18	0.19	0.16	0.17	0.11
P_2O_5	0.08	0.06	0.07	0.06	0.06	0.05
LOI	3.77	4.92	3.44	3.16	3.72	4.17
TOTAL	100.15	100.28	99.60	99.21	100.22	99.65
Ba	7		4	6	7	
Rb			3		4	
Sr	160	128	127	99	166	141
Y	25	22	25	22	26	25
Zr	59	45	51	45	52	49
Nb	3	3	3	3	4	3
Th						
Pb	9	15	9	5	8	9
Ga	14	10	13	11	16	17
Zn	146	59	94	133	137	180
Cu	30	159	87	105	35	16
Ni	172	115	99	120	114	196
V	244	213	271	219	305	315
Cr	539	353	427	339	418	744

TABLE A1 (cont'd)

(B) FARIBAULT BROOK METAVOLCANICS (TALLMAN)

SAMPLE	MB86-1	MB86-2	MB86-3	MB86-4	MB86-5	MB86-6	MB86-7
SiO_2	45.30	47.40	45.18	48.25	49.31	44.78	45.83
TiO_2	1.40	0.90	0.71	0.39	1.02	0.85	2.89
Al_2O_3	16.27	16.95	15.52	13.85	12.83	13.60	13.38
Fe_2O_3							
FeO	12.71	10.72	9.84	7.93	9.73	11.29	13.40
MnO	0.19	0.21	0.19	0.18	0.42	0.54	0.57
MgO	6.99	7.50	10.48	9.90	9.33	10.20	5.94
CaO	9.54	11.49	10.26	14.38	8.20	10.03	10.88
Na_2O	1.42	2.43	1.92	2.22	1.27	0.56	2.58
K_2O	0.09	0.19	0.29	0.09	3.11	2.69	0.20
P_2O_5	0.11	0.08	0.06	0.04	0.10	0.08	0.33
LOI	5.03	2.00	4.01	3.39	2.99	4.17	2.41
TOTAL	99.05	99.87	98.46	100.62	98.31	98.79	98.41
Ba	13	81	90		630	612	11
Rb	1		10	1	156	128	
Sr	222	73	107	88	163	142	272
Y	38	26	22	18	30	22	50
Zr	81	56	42	28	72	64	229
Nb	2	4	2	3	3	4	9
Th							
Pb	2	2	12	24	5	12	
Ga	22	24	23	18	22	20	34
Zn	106	148	102	64	171	349	150
Cu	87	32	62	136	138	14	121
Ni	65	59	74	102	103	141	30
V	269	207	250	202	280	254	499
Cr	238	74	396	709	409	604	37

TABLE A1 (B) (CONT'D)

FARIBAULT BROOK METAVOLCANICS (TALLMAN)

SAMPLE	MB86-12	MB86-13	MB86-14	MB86-16	K86-40a	K86-50d
SiO_2	51.89	46.22	47.08	47.01	46.61	46.56
TiO_2	0.73	1.18	1.12	1.13	0.77	0.87
Al_2O_3	13.48	14.56	15.06	15.00	14.80	15.18
Fe_2O_3						
FeO	9.72	11.71	10.04	10.00	10.43	10.25
MnO	0.39	0.53	0.23	0.23	0.18	0.17
MgO	8.08	8.70	8.85	9.16	10.14	10.16
CaO	9.18	9.87	10.03	10.03	10.43	9.37
Na_2O	2.73	1.38	2.32	2.04	1.92	2.71
K_2O	1.97	1.28	0.18	0.18	0.14	0.18
P_2O_5	0.05	0.09	10.15	0.15	0.06	0.07
LOI	2.59	3.11	4.23	4.22	3.47	4.25
TOTAL	100.81	98.63	99.29	99.15	98.95	99.77
Ba	501	1059	54	49		
Rb	82	69				1
Sr	140	161	156	154	94	96
Y	23	33	35	35	22	21
Zr	45	72	100	102	45	51
Nb	2	1	2	3	2	1
Th						
Pb	8	16				3
Ga	24	25	24	25	28	20
Zn	761	212	96	93	173	115
Cu	21	99	57	50	26	113
Ni	68	101	65	63	84	97
V	227	251	289	286	279	287
Cr	251	521	391	393	617	578

TABLE A1 (cont'd)

C) BELLE COTE ROAD AMPHIBOLITES (MARCOTTE)

SAMPLE	JM86-038	JM86-058
SiO_2	47.76	49.87
TiO_2	2.18	2.93
Al_2O_3	14.98	12.75
Fe_2O_3		
FeO	10.61	13.40
MnO	0.20	0.29
MgO	8.04	4.37
CaO	9.52	9.32
Na_2O	3.13	2.33
K_2O	0.50	0.57
P_2O_5	0.21	0.98
LOI	1.69	1.81
TOTAL	98.82	98.62
Ba	99	338
Rb	14	10
Sr	283	293
Y	34	80
Zr	165	416
Nb	8	13
Th		
Pb	19	5
Ga	23	25
Zn	114	187
Cu	20	58
Ni	38	38
V	338	221
Cr	234	63

TABLE A1 (cont'd)

D) GEORGE BROOK AMPHIBOLITE (PLINT)

SAMPLE	HP-706b	HP-708b	HP-245	HP-345	HP-621d	HP-631g
SiO_2	46.96	48.11	53.91	50.51	45.85	47.71
TiO_2	1.89	3.16	0.52	0.52	0.74	0.75
Al_2O_3	18.35	14.53	15.51	16.15	12.35	12.62
Fe_2O_3						
FeO	11.61	14.62	12.11	10.42	11.81	9.27
MnO	0.26	0.36	0.33	0.20	0.15	0.17
MgO	6.61	5.38	4.80	7.67	17.31	14.87
CaO	9.33	7.94	7.68	10.91	5.82	7.02
Na_2O	3.24	2.85	2.06	1.47	0.84	1.94
K_2O	0.30	0.91	1.50	0.97	0.56	0.17
P_2O5	0.20	0.32	0.03	0.03	0.13	0.15
LOI	0.54	0.89	1.07	0.87	5.20	4.00
TOTAL	99.29	99.07	99.52	99.72	100.74	98.67
Ba	50	260	385	216	200	41
Rb	3	29	61	42	20	4
Sr	490	231	108	90	38	93
Y	35	32	36	10	17	21
Zr	169	151	37	14	85	89
Nb	8	7	3	2	6	5
Th					3	8
Pb	16	5	36	3	8	14
Ga	27	27	17	18	12	11
Zn	176	124	239	91	100	103
Cu	27	43	24	5	15	
Ni	47	19	16	26	369	260
V	340	602	462	363	170	158
Cr	188	7	15	130	1634	1154

TABLE A2 Geochemical data from the Barren Brook and Dauphinee Brook schists and equivalent higher grade units.

A) ROCKY BROOK AREA METASEDIMENTS (TALLMAN)

SAMPLE	MB86-8	MB86-9	MB86-10	MB86-11	MB86-15
SiO_2	61.55	64.58	62.09	64.33	64.47
TiO_2	0.95	0.79	0.91	0.86	0.87
Al_2O_3	17.23	16.68	18.20	15.75	15.65
Fe_2O_3					
FeO	7.07	5.50	5.61	6.47	6.47
MnO	0.19	0.15	0.26	0.11	0.11
MgO	2.78	2.38	2.63	2.71	2.94
CaO	1.41	1.15	1.73	1.58	1.57
Na_2O	2.77	2.13	3.70	2.11	2.63
K_2O	2.96	3.69	2.09	2.72	2.74
P_2O_5	0.14	0.15	0.12	0.14	0.16
LOI	3.09	2.82	2.73	3.23	3.03
TOTAL	100.14	100.02	100.07	100.01	100.64
Ba	476	516	268	308	309
Rb	118	166	85	123	123
Sr	107	138	121	101	104
Y	34	30	30	31	32
Zr	202	202	204	207	206
Nb	15	15	15	14	16
Th	10	12	18	5	3
Pb	10	12	12	1	2
Ga	33	26	28	27	23
Zn	111	76	151	54	57
Cu	33	15	29	18	22
Ni	30	30	20	30	28
V	148	121	141	128	129
Cr	75	54	68	67	70

TABLE A2. (cont'd)

B) BARREN BROOK SCHIST

SAMPLE	86-264C	86-311	86-344	86-385	86-078
SiO_2	74.10	71.85	75.25	76.78	73.03
TiO_2	0.27	0.33	0.23	0.17	0.36
Al_2O_3	14.12	14.26	13.60	12.64	14.16
Fe_2O_3	0.75	2.70	11.17	0.16	0.39
FeO	1.02	0.49	0.40	0.99	1.52
MnO	0.07	0.03	0.01	0.01	0.08
MgO	0.48	0.43	0.14	0.13	0.48
CaO	1.40	0.35	0.16	0.14	0.14
Na_2O	3.79	2.82	3.50	4.14	4.44
K_2O	4.26	5.45	5.89	3.05	3.86
P_2O_5	0.08	0.03	0.02	0.04	0.04
LOI	0.69	1.35	0.42	0.88	0.92
TOTAL	101.03	100.09	100.79	99.13	99.42
Ba	645	529	442	610	795
Rb	123	195	118	60	99
Sr	210	22	133	63	61
Y	19	89	44	57	48
Zr	129	549	205	254	427
Nb	10	22	18	17	19
Th	18	28	25	14	14
Pb	9	19	10	11	13
Ga	14	24	17	16	19
Zn	48	46	7	19	38
Cu					
Ni	4	21	10	12	14
V	15		7	4	4
Cr	6	5	3	5	15

TABLE A3. Geochemical data from the Sarach Brook volcanics and related units in the Cape Breton Highlands.

A) SARACH BROOK RHYOLITES

SAMPLE	SBR-1	SBR-2	SBR-3Q	SBR-3A	SBR-4	SBR-5
SiO_2	81.67	75.90	72.69	71.89	74.23	80.16
TiO_2	0.15	0.18	10.22	0.21	0.25	0.14
Al_2O_3	9.87	12.55	15.38	15.48	14.30	11.95
Fe_2O_3	0.23	0.28	0.40	0.90	0.35	0.55
FeO	0.23	0.14	0.22	0.35	0.42	0.57
MnO	0.01	0.01		0.01	0.02	0.02
MgO	0.12	0.04	0.04	0.26	0.84	0.14
CaO	0.02	0.01	0.06	0.03	1.64	0.70
Na_2O	0.15	0.22	2.90	2.02	6.78	5.66
K_2O	7.54	10.20	8.22	8.96	0.43	0.30
P_2O_5	0.01	0.01	0.02	0.01	0.01	
LOI	0.44	90.34	0.56	0.79	0.20	0.42
TOTAL	100.44	99.88	100.71	100.91	99.47	100.61
Ba	850	1082	1073	958	6	9
Rb	143	217	174	149		1
Sr	23	146	51	58	78	72
Y	41	29	40	35	112	57
Zr	143	185	249	216	805	345
Nb	10	12	17	16	33	26
Th	21	27	38	30	16	27
Pb	11	7	9	11	5	9
Ga	7	9	16	13	23	17
Zn	11	6	8	7	17	11
Cu			7	7		
Ni	10	11	8	10	20	5
V	3	3	8	2	3	2
Cr	5	10	8		2	2

TABLE A3. (cont'd)

B) MONEY POINT AND MABOU HIGHLANDS RHYOLITES

SAMPLE	MP-1	MP-2	MHR-1	MHR-2	MHR-3
SiO_2	77.02	74.85	77.50	76.51	75.68
TiO_2	0.21	0.32	0.10	0.15	0.18
Al_2O_3	13.60	14.44	13.22	13.05	12.94
Fe_2O_3			0.24		0.30
FeO	0.28	0.22	0.70	0.79	0.72
MnO	0.01	0.04	0.02	0.02	0.40
MgO	0.06	0.28	0.16	0.16	0.21
CaO	0.32	0.35	0.29	0.37	0.50
Na_2O	4.30	5.07	1.50	4.37	3.98
K_2O	4.52	3.27	5.60	3.63	3.73
P_2O_5	0.02	0.04	0.01	0.01	0.03
LOI	0.42	0.61	0.95	0.37	0.68
TOTAL	100.76	99.49	100.29	99.43	98.99
Ba	522	489	327		833
Rb	104	91	144		84
Sr	77	90	84		79
Y	17	39	18		21
Zr	170	335	79		114
Nb	10	12	11		11
Th	21	19	17		11
Pb	12	11	22		25
Ga	11	15	12		13
Zn	11	34	24		23
Cu					
Ni	5	4	5		3
V	6	4	3		7
Cr	26	4	33		8

TABLE A3. (cont'd)

C) SARACH BROOK SHEAR ZONE

SAMPLE	MR-044	MR-349	MR-374	MR-435
SiO_2	75.89	66.40	70.19	76.78
TiO_2	0.35	0.80	0.65	0.18
Al_2O_3	14.39	18.69	15.33	14.31
Fe_2O_3	0.16	0.49	3.18	0.32
FeO	1.00	1.44	0.69	0.64
MnO	0.01	0.01	0.05	0.01
MgO	0.67	1.10	0.35	0.25
CaO	0.31	1.65	2.28	0.38
Na_2O	6.83	6.01	5.16	6.16
K_2O	0.40	2.30	1.83	1.67
P_2O_5	0.04	0.07	0.16	0.02
LOI	0.56	1.04	0.87	0.36
TOTAL	100.61	100.00	100.74	101.08
Ba	9	340	459	268
Rb	33	51	65	14
Sr	31	169	179	49
Y	676	35	47	76
Zr	660	274	309	526
Nb	20	20	15	26
Th	27	18	13	19
Pb	6	30	16	8
Ga	19	21	16	21
Zn	12	27	26	8
Cu				
Ni	23	21	6	13
V	23	96	53	1
Cr	26	69	2	6

TABLE A3 (cont'd)

c) SARACH BROOK SHEAR ZONE (CONTINUED)

SAMPLE	MR-041	MR-045	MR-379	MR-383	MR-389	MR-431
SiO_2	64.66	55.49	50.99	69.80	81.71	50.84
TiO_2	0.89	1.43	1.30	0.55	0.26	2.16
Al_2O_3	15.85	15.08	15.82	15.02	9.17	14.37
Fe_2O_3	1.22	0.67	1.43	0.78	0.29	0.50
FeO	4.06	9.42	6.50	2.68	2.07	9.85
MnO	0.07	0.18	0.17	0.19	0.06	0.25
MgO	2.12	5.48	7.62	1.18	1.49	5.31
CaO	1.48	4.22	8.93	0.65	0.30	9.38
Na_2O	2.93	4.54	3.47	5.10	3.64	3.64
K_2O	4.93	1.54	0.58	2.81	0.55	0.68
P_2O_5	0.17	0.19	0.19	0.09	0.03	0.40
LOI	1.62	1.85	2.74	1.42	1.03	1.07
TOTAL	100.00	100.09	99.74	100.27	100.60	98.45
Ba	794	279	46	518	58	95
Rb	140	52	16	68	10	19
Sr	147	48	341	49	44	256
Y	61	32	34	64	40	56
Zr	394	164	191	444	398	254
Nb	18	7	8	21	13	11
Th	14	4	4	17	8	
Pb	10	7	5	13	6	5
Ga	23	19	18	24	13	22
Zn	42	45	90	44	21	84
Cu	12	1	125	1		32
Ni	44	58	123	19	9	48
V	92	255	206	39	9	438
Cr	72	131	268	25	14	45

TABLE A4. Geochemical data from granitic rocks, western and central Cape Breton Highlands.

A) BELLE COTE ROAD ORTHOGNEISS (MARCOTTE)

SAMPLE	JM-069	JM-016	JM-024	JM-022	JM-005	JM-084	JM-GC3
SiO_2	67.94	72.51	70.79	57.29	70.45	66.43	78.57
TiO_2	0.88	0.34	0.17	0.52	0.35	0.81	0.59
Al_2O_3	15.77	15.02	16.50	20.50	14.03	15.77	10.39
Fe_2O_3							
FeO	5.13	1.94	0.97	3.20	4.22	5.08	2.89
MnO	0.11	0.05	0.03	0.08	0.14	0.14	0.09
MgO	1.54	1.03	0.77	3.59	1.33	2.25	1.31
CaO	0.45	2.17	2.34	2.52	2.78	2.15	1.19
Na_2O	1.38	4.30	5.68	6.30	4.20	3.94	2.67
K_2O	3.93	2.55	1.21	2.76	1.15	1.93	1.22
P_2O_5	0.12	0.08	0.07	0.10	0.07	0.08	0.07
LOI	2.78	0.42	0.41	1.26	1.47	0.97	1.33
TOTAL	100.03	100.41	98.94	98.12	100.19	99.55	100.32
Ba	414	647	278	172	256	280	213
Rb	198	72	21	99	41	71	56
Sr	74	305	1117	225	176	221	159
Y	28	12	8	17	36	26	22
Zr	178	112	100	180	92	172	174
Nb	20	9	5	13	5	12	11
Th	16	4		2		7	2
Pb	31	28		18	9	12	26
Ga	23	23	20	29	18	18	18
Zn	70	50	40	51	67	59	74
Cu	2	15	44	2	7	29	7
Ni	33			9	13	22	13
V	128	39	25	88	49	107	95
Cr	91	4	9	4	9	81	55

TABLE A4. (cont'd)

B) TAYLORS BARREN PLUTON

SAMPLE	TBG-1	TBG-2	TBG-3	TBG-4	TBG-5	TBG-6	TBG-7
SiO_2	68.06	77.95	73.18	76.55	74.40	76.85	76.99
TiO_2	0.50	0.16	0.22	0.16	0.29	0.17	0.20
Al_2O_3	16.22	12.20	14.17	12.80	12.98	12.60	12.45
Fe_2O_3	1.39	0.71	0.64	1.22	1.51	1.12	1.27
FeO	1.64	0.59	1.00	0.49	0.87	0.52	0.48
MnO	0.04	0.01	0.02	0.01	0.02	0.01	0.01
MgO	0.41	0.13	0.19	0.12	0.16	0.08	0.11
CaO	0.11		0.08	0.01	0.04		0.01
Na_2O	3.90	3.59	3.49	3.37	3.72	3.14	3.24
K_2O	6.78	4.40	5.56	4.87	4.59	5.49	5.32
P_2O_5	0.11		0.08	0.01	0.04		0.01
LOI	0.37	0.34	0.63	0.44	0.41	0.36	0.40
TOTAL	99.53	100.08	99.26	100.05	99.03	100.33	100.49
Ba	831	65	256	149	265	98	257
Rb	152	144	205	187	130	150	128
Sr	103	6	63	30	40	23	39
Y	56	53	42	78	91	50	39
Zr	615	386	194	188	343	195	202
Nb	32	37	24	22	27	22	17
Th	21	26	17	27	25	32	17
Pb	45	16	31	44	32	38	25
Ga	25	22	19	21	22	22	20
Zn	52	21	30	23	28	20	13
Cu							
Ni	12	13	13	22	18	18	9
V	12		5			2	3
Cr	17	22	19	29	21	23	22