GEOLOGY EAST OF THE BAIE VERTE LINEAMENT

by James Hibbard

INTRODUCTION

Comprehensive geological mapping of the Baie Verte Peninsula resumed in 1977 with coverage of the terrane east of, and including northerly exposures of the Baie Verte Lineament (Kidd, 1974) (Figure 1). This area has been the subject of many intensive geologic studies since the most recent systematic geologic mapping of the area by Neale (1958, 1959). These studies have focussed largely upon either economic aspects of local zones or regional tectonic overviews. The purpose of the present project is to remap, compile,and integrate the results of these studies in this area of proven economic and academic importance.

The emphasis of the present mapping project was directed at areas where previous surveys were brief or outdated; field checks were undertaken in areas that have been the subject of recent research. The expanse of intrusive rock that underlies the south central portion of the area was only briefly examined. As many earlier studies have described the rock units in the area, the following discussion presents a brief outline of the regional geologic framework and focusses upon (1) the tectonic situation of the Mings Bight Group, (2) nomenclature and particular geologic aspects of the Baie Verte supergroup (new), (3) the structural and metamorphic history of the area, and (4) economic aspects of the area.

GEOLOGIC FRAMEWORK

The following four major geological elements are recognized in the area (figure 1): (1) a metasedimentary terrane, (2) sequences of dominantly mafic-ultramafic rocks, (3) granitic intrusive rocks, and (4) sedimentary rocks derived largely from a granodioritic source.To the northeast is a distinct sequence of layered psammites and semipelites, the Mings Bight Group (Baird, 1951), that is believed to contain the oldest rocks in the area. They are bounded to the south and west by an extensive area of mafic and ultramafic rock assemblages that are informally termed, here, the Baie Verte supergroup. The Baie Verte supergroup exhibits subtle lithologic, metamorphic, and structural variations that allow for its subdivision into dominantly ophiolitic terranes of the Point Rousse and Advocate complexes (Williams *et al.*, 1977), presumed volcanic arc lithologies of the Pacquet Harbour group (Church, 1969), and mainly mafic rocks of the Flatwater group (Williams *et al.*, 1977).

Three unrelated granitic plutons intrude the Pacquet Harbour group. One, the Dunamagon granite (Baird, 1951), intrudes both the Mings Bight and Pacquet Harbour groups and obliterates the contact between them. The Burlington granodiorite (Neale and Kennedy, 1967) occupies the central one-third of the map area and is intruded by the Cape Brûlé porphyry. The granodiorite is nonconformably overlain by conglomerate, sandstone and mafic lava of the Mic Mac Lake Group (Kidd, 1974) at Flatwater Pond. West of the nonconformity, the Mic Mac Lake Group is faulted against the Flatwater group. South of the area, Mic Mac Lake lithologies have yielded Rb/Sr whole rock ages of 395±5 Ma and 393±23 Ma (Kidd, 1974) indicating that they straddle the Silurian-Devonian boundary.

RELATIONSHIP OF THE MINGS BIGHT GROUP WITH SURROUNDING ROCKS

The Mings Bight Group is faulted against the Point Rousse complex, whereas its contact with the Pacquet

Harbour group is not exposed. Atypical lithologies occur within the Mings Bight Group near these contacts. Locally, graphitic schist containing large pods (up to 2 m) of coarse actinolite schist occurs near the contact with the large ultramafic body south of Mings Bight. Where this contact occurs along the coast, greenschist containing discrete pods of actinolite schist (Williams, personal communication, 1977) is interlayered with typical Mings Bight Group psammites. Greenschist is also interlayered with Mings Bight Group psammites along the northern edge of the small serpentinite body on the eastern shore of Mings Bight and near the unexposed inland contact between the Mings Bight Group and Pacquet Harbour group.As the Pacquet Harbour group is composed largely of greenschist, interpretation of the relationship at the latter locality is equivocal; interlayered psammites and greenschists may represent either a conformable interfingering of the Mings Bight and Pacquet Harbour groups or a sequence of interbedded Mings Bight strata similar to that exposed at the coast.

These relationships closely resemble those between the Fleur de Lys Supergroup, Birchy complex, and Advocate complex along the Baie Verte lineament on the west coast of Baie Verte (Williams, 1977). This similarity lends further support to the traditional lithological and structural correlation of the Mings Bight Group and the Eocambrian (?) Fleur de Lys Supergroup (Baird, 1951), and indicates that the trend of the lineament may swing eastward through Mings Bight.

SUBDIVISION AND NATURE OF THE BAIE VERTE SUPERGROUP

In recent years, the Baie Verte Group (Baird, 1951) has been subdivided (Church, 1969; Kidd, 1974; Kennedy, 1975) such that nomenclature of the group has become confused and has lost significance. In an attempt to retain the useful name "Baie Verte" for the dominantly mafic and ultramafic rocks of the area, this study informally relegates the Advocate and Point Rousse complexes, the Pacquet Harbour group, and the Flatwater group to the Baie Verte supergroup. It is hoped that a formal terminology will be established by the end of the present mapping project.

The Point Rousse and Advocate complexes form the bulk of the Baie Verte Lineament to the north and have been described by Willliams *et al.* (1977). In addition to being structurally and geographically distinct, nonophiolitic components of these complexes differ.

The relatively intact ophiolite assemblage of the Point Rousse complex is conformably overlain by approximately 1500 m of mafic volcanic and associated sedimentary rocks. This sequence includes green pillow basalt with associated limestone, lapillistone, reworked tuff, mafic graywacke and volcanic conglomerate. At one locality on the west side of Mings Bight, a volcanic conglomerate contains abundant large (up to 1 cm) euhedral pyroxene crystals.

The Advocate complex is composed of an intensely dismembered but complete ophiolite stratigraphy (Kennedy, 1975). Along the south coast of Baie Verte, the complex is composed of a monotonous, northwest dipping sequence of gray-green intermediate volcanics, tuff, and volcanic conglomerate that was probably deposited on top of ophiolitic rocks. Reconnaissance work in the Baie Verte and Advocate mine areas indicates that, in contrast to the Point Rousse complex, the Advocate complex contains abundant gray and black slate along lithologic contacts. Locally the slate is pebbly and in places it contains blocks of surrounding rock types.

The Point Rousse and Advocate complexes are inferred to be correlative with the Betts Cove ophiolite and related to a single cycle of ocean floor generation (Williams *et al.*, 1977). The Betts Cove ophiolite is overlain by volcanic and sedimentary rocks bearing Arenig graptolites, thus inferring a lower Ordovician or older age for all the ophiolites.

The Pacquet Harbour group is a moderately to steeply north dipping sequence of variably deformed and metamorphosed submarine mafic volcanic, pyroclastic, and sedimentary rocks and felsic volcanic and pyroclastic rocks that are all intruded by numerous gabbro dikes and sills. Reliable stratigraphic facing evidence for the unit is sparse, though in the area of Consolidated Rambler Mines and the La Scie Highway, strata are consistently north facing.

The Pacquet Harbour group has previously been considered as part of the Fleur de Lys Supergroup (Church, 1969) and to predate local ophiolite complexes (Church, 1969; Kennedy, 1975). Ophiolitic blocks within the Pacquet Harbour group indicate that it postdates formation of the ophiolites that form the Baie Verte Lineament. Mafic tuffs east of Scrape Pond contain large (1x3 m) slabs of coarse metadiorite and metagabbro.They have been altered to actinolite-feldspar assemblages, though actinolite growth predates the main regional foliation and metamorphism. As these slabs have no chill margins and are texturally identical and lithologically similar to layered diorite, gabbro and pyroxenite of the nearby Point Rousse complex, they are interpreted as being ophiolite derived blocks that were deposited in Pacquet Harbour mafic tuffs. Early growth of greenschist facies minerals may be related to ocean floor metamorphism. To the north, the Pacquet Harbour group is in fault contact with the Point Rousse complex; in the area of Scrape Pond, small tectonically emplaced pods of altered ultramafic rock delineate this fault. Its

contact with the Mings Bight Group is not exposed in the inland area, though to the east at Pacquet Harbour, it has been interpreted that the Pacquet Harbour group conformably overlies the Mings Bight Group (most recently by DeGrace *et al.*, 1976). The contact between the Pacquet Habrour group and the Dunamagon granite is also not exposed in the area; DeGrace *et al.* (1976) report the granite as intrusive into Pacquet Harbour group to the east of the area. To the east and south, the Burlington granodiorite intrudes and hornfelses the Pacquet Harbour group. Locally, near this contact, zones of pink aplite and hybrid mafic-granodioritic rocks occur within the granodiorite. South of the Rambler area, a dike of Cape Brûlé porphyry intrudes both of these units. Locally, at the margins of the main porphyry body, the country rocks display extensive quartz "sweat" zones.

Southerly exposures of the group, east and immediately north of Gull Pond, are predominantly massive mafic pillow basalt, agglomerate, and lapillistone that are pervasively intruded by diabase and gabbro dikes and sills. The mafic intrusive rocks constitute approximately 40 percent of the exposed terrane. In places, felsic volcanic and pyroclastic rocks are interlayered with mafic rocks and at one locality, quartz porphyry forms the matrix to brecciated mafic volcanic rock. Felsic volcanic and mafic sedimentary rocks dominate the terrane to the north.

Lithological and chemical affinities (Gale, 1971) infer that Pacquet Harbour lithologies may represent primitive island arc rocks that may have been deposited on ophiolitic basement.

The Flatwater group is composed of dominantly megaconglomerate, mafic volcaniclastic rock and felsic tuff that form the eastern margin of the Baie Verte Lineament. The sequence is moderately to steeply west dipping and faces east on the north shore of Flatwater Pond. Excluding the possibility of structural repetition, the unit is approximately 2000 m thick at this locality. Along its eastern margin, the group is fault bounded to the east by the Mic Mac Lake Group in the Flatwater Pond area and by the Burlington granodiorite north of Flatwater Pond. Kidd (1974) has outlined a detailed stratigraphy for this sequence to the south of and including the Flatwater Pond area.

Megaconglomerate containing large blocks of dominantly ophiolitic rock types in a green, buff, and black slaty matrix forms the base of the Flatwater group. Locally, as at the north end of the Baie Verte Highway, this unit is difficult to distinguish from the ophiolitic Advocate complex. The remainder of the unit is largely buff weathering green mafic volcaniclastic and pyroclastic rocks, though a megaconglomerate horizon similar to the basal deposit occurs in the upper portions of the sequence. Pink silicic tuffs and dark brown rhyolite porphyry interlayers are also found in the upper part of the group.

STRUCTURE AND METAMORPHISM

The complex stratigraphy of the Baie Verte Lineament and rocks to the east has been further compounded by inhomogeneous deformation and metamorphism. In the area, portions of the Pacquet Harbour group and the Mings Bight Group are polydeformed and locally attain amphibolite grade metamorphism whereas the Advocate complex, Point Rousse complex, Flatwater group and Mic Mac Lake Group have been subject to one regional penetrative deformation and lower greenschist grade metamorphism.

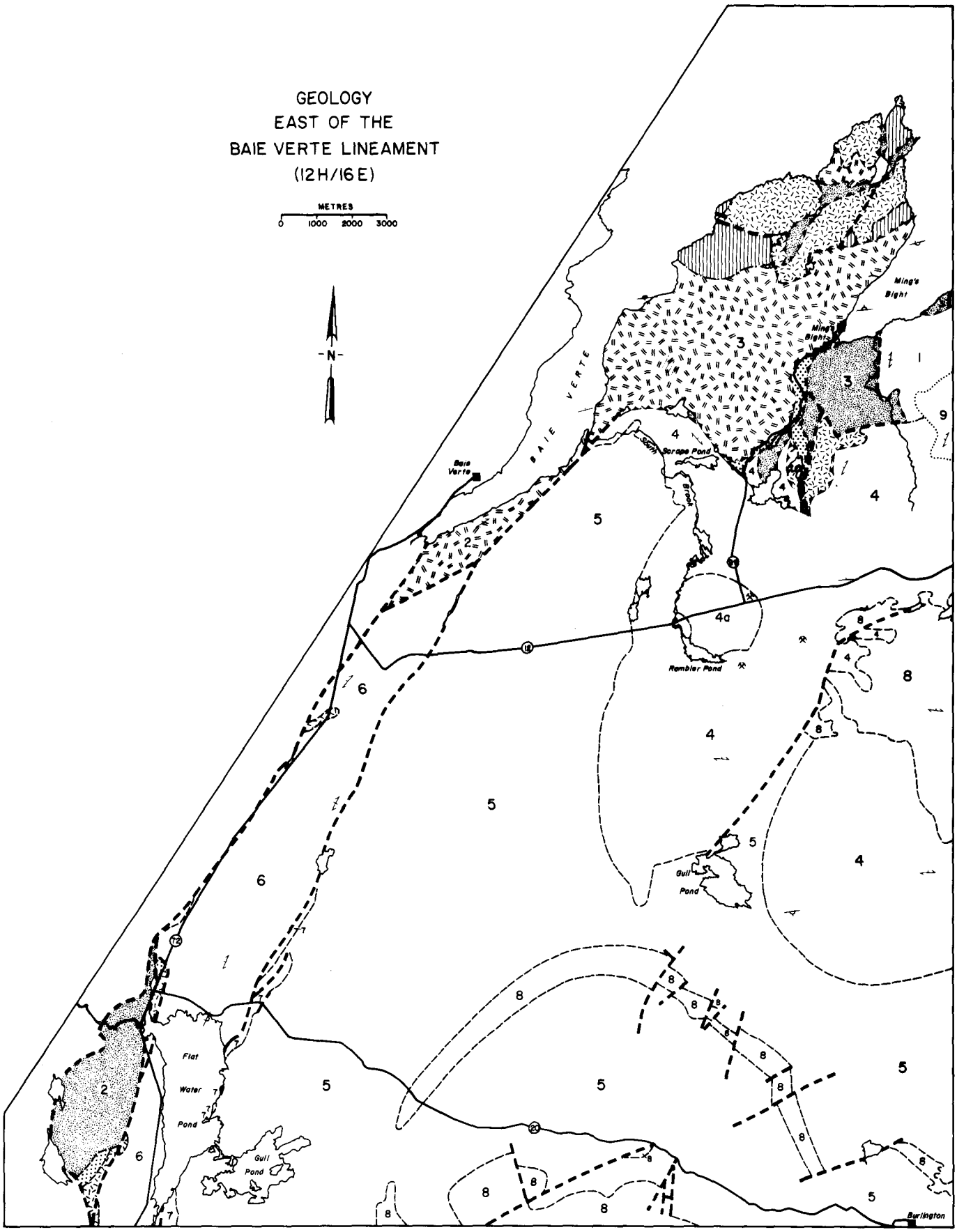
The main regional penetrative fabric (S_m) within the Pacquet Harbour group is coplanar with the primary layering and has been reported to be a composite fabric (Tuach, 1976). An earlier foliation (S_{m-1}) has been macroscopically observed at only one locality, along the Mings Bight Road, where it has been transposed by S_m. North of the La Scie Highway S_m is characterized and locally defined by a strong mineral and fragment lineation that generally plunges to the northeast. The intensity of S_m appears to weaken substantially in central and southeastern exposures of the Pacquet Harbour group; this may reflect rock competency rather than stress intensity during deformation, as massive pillow basalt and gabbro underlie these areas. Only locally have F_m minor folds been observed, usually in thin quartz veins, and no major F_m structures have been recognized in the area. Upper greenschist to lower amphibolite grade metamorphism of the northerly portion of the Pacquet Harbour group probably accompanied the formation of S_m.

North of Rambler Mines, S_m has been folded about gently northeast plunging axes of F_{m+1}; locally, a crenulation cleavage (S_{m+1}) defines the axial planes of these recumbent folds. The largest F_{m+1} structures observed in the area have an amplitude of approximately one metre. S_{m+1} dies out towards the south and is not recognized south of the Rambler area.

Near the margins of the Burlington granodiorite, Pacquet Harbour rocks display a strong penetrative foliation that parallels the perimeter of the batholith, and locally, also exhibits a crenulation cleavage. The main penetrative fabric parallels a foliation that is developed in portions of the Burlington granodiorite. The relationship of these foliations with S_m is unknown.

Rocks of the Mings Bight Group also display S_m and S_{m+1}, though D_{m+1} structures are more intensely developed than those in the Pacquet Harbour group.

The Cape Brûlé porphyry and Dunamagon granite display a strong foliation that is generally parallel to S_m



LEGEND

Silurian - Devonian

Mic Mac Lake Group
- [7] Sandstone, conglomerate, mafic volcanic rock

Silurian and Older

Baie Verte Supergroup (2,3,4,6)

Flatwater Group
- [6] Megaconglomerate, mafic volcanic and volcaniclastic rocks, minor silicic tuffs

Pacquet Harbour Group
- [4] Mafic volcanic and pyroclastic rocks with associated sediments and abundant gabbro dikes
  - 4a - Silicic volcanic and pyroclastic-rocks

Lower Ordovician

Point Rousse Complex
- [3] Ophiolite and mafic volcanic and pyroclastic rocks

Advocate Complex
- [2] Ophiolite and mafic volcanic rocks

Eocambrian (?)

Mings Bight Group
- [1] Psammitic and semipelitic schists

- [9] Dunamagon Granite
- [8] Cape Brûlé Porphyry
- [5] Burlington Granodiorite

- Mafic volcanic rocks
- Sheeted dikes
- Gabbro
- Cumulate ultramafic rocks and gabbro
- Ultramafic rocks

SYMBOLS

Geological boundary (defined, approximate, assumed) .....

Geological boundary (transitional) .....

Bedding, tops known (inclined, overturned) .....

Strike and dip of pillows, tops known (inclined, overturned) .

Foliation (inclined, vertical) .....

Fault (defined, approximate) .....

Thrust fault (defined, approximate) .....

in the Pacquet Harbour group. These foliations are all tentatively considered as correlative.

Major faults separate these rocks from the Point Rousse complex, Advocate complex, and Flatwater group, all of which display a single regional penetrative fabric and lower greenschist facies metamorphism. These faults generally dip to the west and northwest and on a small scale repeat lithologies; thus they may be thrust faults. Correlation of fabrics across the faults is not possible at this time.

The age of the deformation is uncertain and probably is not consistent throughout the area, but all fabrics postdate formation of the ophiolites that constitute the lineament. As these are tentatively correlated with the Lower Ordovician or older Betts Cove ophiolite, all deformation in the area is considered Taconic or younger.

ECONOMIC GEOLOGY

The mineral potential of the Baie Verte Lineament and rocks immediately to the east has been well established; they are host to base metal deposits of the abandoned Goldenville (Pointe Rousse complex) and Terra Nova Mines (Advocate complex) as well as the presently operating Consolidated Rambler Mine (Pacquet Harbour group) and the Advocate asbestos mine (Advocate complex). Numerous showings have been reported from the area, though the most significant of these occur in the Point Rousse complex and the Pacquet Harbour group.

In the Point Rousse complex the most important showings appear to be in the lower portions of the largely volcaniclastic sequence overlying the ophiolite. These include chalcopyrite-pyrite showings at the Barry Cunningham adit, Mud Pond, Green Cove Pond, and Gillard's Pond. Many small pods of pyrite- chalcopyrite occur in the sheeted dike complex of the ophiolite.

Disseminated pyrite occurs in carbonatized schists south of the fault between the Point Rousse complex and the Pacquet Harbour group along the Mings Bight road. Also in the Pacquet Harbour group, disseminated pyrite and pyrite-chalcopyrite occurs in pillow basalts and agglomerate southeast of Gull Pond. The discovery of thin bands of felsic volcanics in this area should definitely encourage interest in its economic potential. A single boulder of granodiorite containing pyrite and chalcopyrite was found approximaetly 2 km south of Rambler Pond.

Alteration of ultramafic rock in the Advocate complex at Flatwater Pond and in the Point Rousse complex at Deer Cove has produced a quartz-magnesite-fuchsite rock (virginite). This rock is suitable for building or ornamental stone. Large quartz veins within the virginite may have potential for gold; this will be investigated next season.

In addition to sulfide deposits, lake sediment geochemistry studies (Davenport and Butler, 1976) indicate high uranium anomalies in the Dunamagon granite just east of the area (greater than 100 ppm) and in the Burlington granodiorite northeast of Gull Pond (100 ppm).

Acknowledgements: *The author thanks Jane Saltman and Willy for able field assistance.*

REFERENCES

Baird, D.M.

1951: The geology of the Burlington Peninsula, Newfoundland; Geological Survey of Canada Paper 51-21, 70 pages.

Church, W.R.

1969: Metamorphic rocks of Burlington Peninsula and adjoining areas of Newfoundland and their bearing on continental drift in the North Atlantic; *in* North Atlantic Geology and Continental Drift (Kay, M., editor); American Association of Petroleum Geologists, Memoir 12, pages 212-233.

Davenport, P. and Butler, J.

1976: Uranium and lake sediments, Burlington Peninsula, Newfoundland; Department of Mines and Energy, Mineral Development Division, Open File Map 7680.

DeGrace, J.R., Kean, B.F., Hsu, E., and Green, T.

1976: Geology of the Nippers Harbour map area (2E/13), Newfoundland; Department of Mines and Energy, Mineral Development Division, Report 76-3, 73 pages.

Gale, G.H.

1973: Paleozoic basaltic komatite and ocean floor type basalts from northeast Newfoundland; Earth and Planetary Science Letters, Volume 18, pages 22-28.

Kennedy, M.J.

1975: Repetitive orogeny in the northeastern Appalachians - New plate models based upon Appalachian examples; Tectonophysics, Volume 18, pages 39-87.

Kidd, W.S.P.

1974: The evolution of the Baie Verte Lineament, Burlington Peninsula, Newfoundland; Ph.D. thesis, Cambridge University, Cambridge, England, 294 pages.

Neale, E.R.W.

1958: Baie Verte, Newfoundland; Geological Survey of Canada Map 10-1958.

1959: Fleur de Lys, Newfoundland; Geological Survey of Canada Map 16-1959.

Neale, E.R.W., and Kennedy, M.J.

1967: Relationship of the Fleur de Lys Group to younger groups of the Burlington Peninsula, Newfoundland; *in* Geology of the Atlantic Region (Neale, E.R.W. and Williams, H., editors); Geological Association of Canada Special Paper 4, pages 139-169.

Tuach, J.

1976: Structural and stratigraphic setting of the Ming and other sulfide deposits in the Rambler area, Newfoundland, M.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 128 pages.

Williams, H.

1977: Ophiolitic mélange and its significance in the Fleur de Lys Supergroup, northern Appalachians, Canadian Journal of Earth Sciences Volume 14, pages 987-1003.

Williams, H., Hibbard, J.P., and Bursnall, J.T.

1977: Geologic setting of asbestos bearing ultramafic rocks along the Baie Verte Lineament, Newfoundland; Geological Survey of Canada, Paper 77-1, Part A, pages 351-360.