GEOLOGY OF THE BENEDICT MOUNTAINS AND SURROUNDING AREAS 13J (east half) and 13I, LABRADOR

by

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INTRODUCTION

Reconnaissance geological mapping (1:100,000) during the 1979 field season covered the area shown in the accompanying map. Emphasis was given to the well-exposed coastline with most of the sparse interior outcrops visited by helicopter. Selected foot traverses were done in the more complex, better exposed areas. Mapping was done by C. Gower with contributions, especially in areas of felsic volcanics, from D. Bailey and A. Doherty.

The objectives of the work were (i) to map the eastern extension of the Central Mineral Belt (defined by Smyth *et al.*, 1978), and thus provide a basis for assessing the mineral potential of the region in terms of Central Mineral Belt metallogenesis; and (ii) to further use this geological framework as a starting point for deciphering Grenville and pre-Grenville geological histories (and associated mineral potential) in the Grenville Province immediately to the south.

REGIONAL SETTING AND GEOCHRONOLOGY

The 1:250,000 map of Stevenson (1970) is the most recent and comprehensive report available. Stevenson recognized a broad subdivision of massive granitoid rocks in the north and generally gneissic rocks to the south. These areas are separated by a major east-southeast trending shear zone (here referred to as the Benedict Fault) which he interpreted as marking the northern boundary of the Grenville Province. Present work has confirmed this two-fold division.

In addition to the massive granitoid rocks north of the Benedict Fault, several areas of felsic volcanic rocks have been mapped and an older group of foliated and gneissic rocks identified. All three units are intruded by deformed and, later, rectiplanar mafic dikes.

Stevenson reports K-Ar (biotite) ages of 1580±50 Ma and 1425±50 Ma for samples from the massive granitoid unit. Grasty *et al.* (1969) have dated some of the mafic dikes intruding the granitoid rocks, obtaining ages ranging from 972±18 Ma to 1600±20 Ma (K-Ar, whole rock).

The southern area, mapped by Stevenson as paragneiss, is reinterpreted here as metamorphosed granitoid rock with minor remnants of supercrustal rock - largely arenaceous metasediment and felsic pyroclasts. A tentative subdivision of foliated to gneissic rocks and well-banded gneiss is proposed. Much of the interior outcrop consists of a variable suite of rocks ranging from diorite to ultramafite, and collectively referred to as Michael Gabbro (Fahrig and Larochelle, 1972).

Stevenson reported a K-Ar (biotite) age of 1165±40 Ma on "paragneiss" and Grasty *et al.* (1969) obtained an age (K-Ar, muscovite) of 917±11 Ma on "gneissic" country rock intruded by mafic dikes. Reported ages for mafic intrusions within the gneissic rocks are 1340±120 Ma (K-Ar, whole rock; Stevenson, 1970) and 1457±107 Ma (Rb-Sr, whole rock; $\lambda = 1.42 \times 10^{-11}$/yr; Wanless, *in* Fahrig and Larochelle, 1972).

GENERAL GEOLOGY

Archean or Aphebian (Unit 1)

Although early workers (*e.g.* Kranck, 1953) report gneissic rocks as the bulk of the bedrock between Pottles Bay and Cape Harrison, this is very misleading and gneissic rocks are largely confined to the peninsula north of Jeanette Bay.

The rocks are strongly foliated and gneissic tonalites and granodiorites and are discordantly intruded by massive granite. As geochronological data are absent for these rocks, and because there are ambiguities attached to interpretation of the north-trending structural fabric (which could be Aphebian or Archean), the age of these rocks is uncertain. Two broad divisions are recognizable; namely, (i) fine to medium grained tonalite in the west and (ii) a variable suite of diorite to granodiorite in the east.

The dark gray weathering tonalites are heavily injected by a medium grained, buff-yellow granodiorite to form a migmatitic mixture. In places the buff-yellow granodiorite is dominant and only nebulitic remnants of tonalite remain. Field appearance suggests a close-to-*in situ*, partial melting mechanism for generating the latter. Within the tonalites, there are highly reworked and injected remnants of fine grained felsic and siliceous banded rocks which may be relicts of a volcanic and metasedimentary assemblage. Locally, this material is extensive, *e.g.* The north part of Jigger Island.

The dioritic and granodioritic rocks are extremely variable, both in composition and fabric. Diorite and monzodiorite are abundant on the north side of Jeanette Bay. Though strongly foliated, these rocks are nowhere well-banded gneisses. Further north, heterogeneous granodiorite, with a fabric ranging from massive to well banded gneiss, is present. Some contains K-feldspar megacrysts and accessory garnet. Quartzofeldspathic lenses and mafic enclaves are ubiquitous. At False Cape there are adistinct group of garnet-bearing, mafic-rich monzodiorites. Garnet locally exceeds 5% in these rocks.

Aphebian ? (Unit 2)

The age of this group of felsic volcanic and metasedimentary rocks is uncertain. One choice is to correlate the rocks west of Mount Benedict with similar rocks forming the Upper Aillik Group north of Witch Doctor Lake (Bailey, 1978). These have been dated at 1776±2 Ma (Kontak, 1979) and 1673±8 Ma* (Watson-White, 1976) ($\lambda = 1.42 \times 10^{-11}$/yr) and are thus Paleohelikian using the 1800 Ma Aphebian-Helikian boundary of Stockwell (1972). A second choice is to correlate them with more deformed rocks south and east of Deus Cape. The latter have a definite north-trending structural fabric, presumably no younger than Hudsonian, which means that the rocks are Aphebian, assuming deformation prior to 1800 Ma. The rocks occur in five main areas.

West of Mount Benedict

Agglomerates and coarse tuffs are abundant on the west side of the belt with clasts commonly exceeding 20 cm diameter. The fragments are generally rhyolitic and both quartz and feldspar porphyries are present. In the central and eastern parts, very fine grained rhyolite is common, with both flows and fine grained tuffs being present. Crossbedded arkose/quartzite, in association with conglomerate/agglomerate, is exposed on the coast at the eastern margin of the belt. Quartz-feldspar porphyry, probably

*The sample locations of Watson-White suggest that a heterogeneous suite of rocks was dated. The pooled isochron may therefore have reduced validity (Bailey, personal communication)

LEGEND

VARIOUS AGES - MOSTLY PRE-HADRYNIAN

Dikes, sills and irregular bodies of diorite, gabbro and ultramafite; metamorphosed in part.

NEOHELIKIAN (Reworked Paleohelikian and Earlier)

4a Quartz-rich continuously banded gneiss; protolith probably arenaceous metasediments.

4b Fine grained metafelsic volcanic and pyroclastic rocks.

4c Highly garnetiferous "lensy"-banded gneiss; protolith possibly intermediate pyroclastic rocks.

4d Garnet-bearing foliated to gneissic biotite granodiorite; metaplutonic rocks.

4e Garnet-bearing foliated to gneissic biotite granodiorite with megacrysts/augen of K-feldspar; metaplutonic rock.

4f Garnet-bearing discontinuous to well-banded diorite, tonalite and granodiorite gneiss; protolith probably igneous.

Paleohelikian

3a Coarse grained equigranular biotite granite.

3b Coarse grained hornblende-biotite granodiorite/granite.

3c Coarse grained biotite granodiorite with K-spar megacrysts.

3d Coarse grained biotite-hornblende granodiorite/quartz monzonite with very large K-spar megacrysts.

3e Coarse grained alkali granite.

3f Medium to coarse grained syenite, locally quartz syenite or monzonite.

3g Variable group of syenite, monzonite and granodiorite rocks; may include remnants of Unit 1.

3h Coarse grained hornblende alkali syenite.

3i Medium to coarse grained diorite, monzo-diorite.

3j Mafic-rich coarse grained syenite to monzonite (strongly foliated due to proximity to major fault).

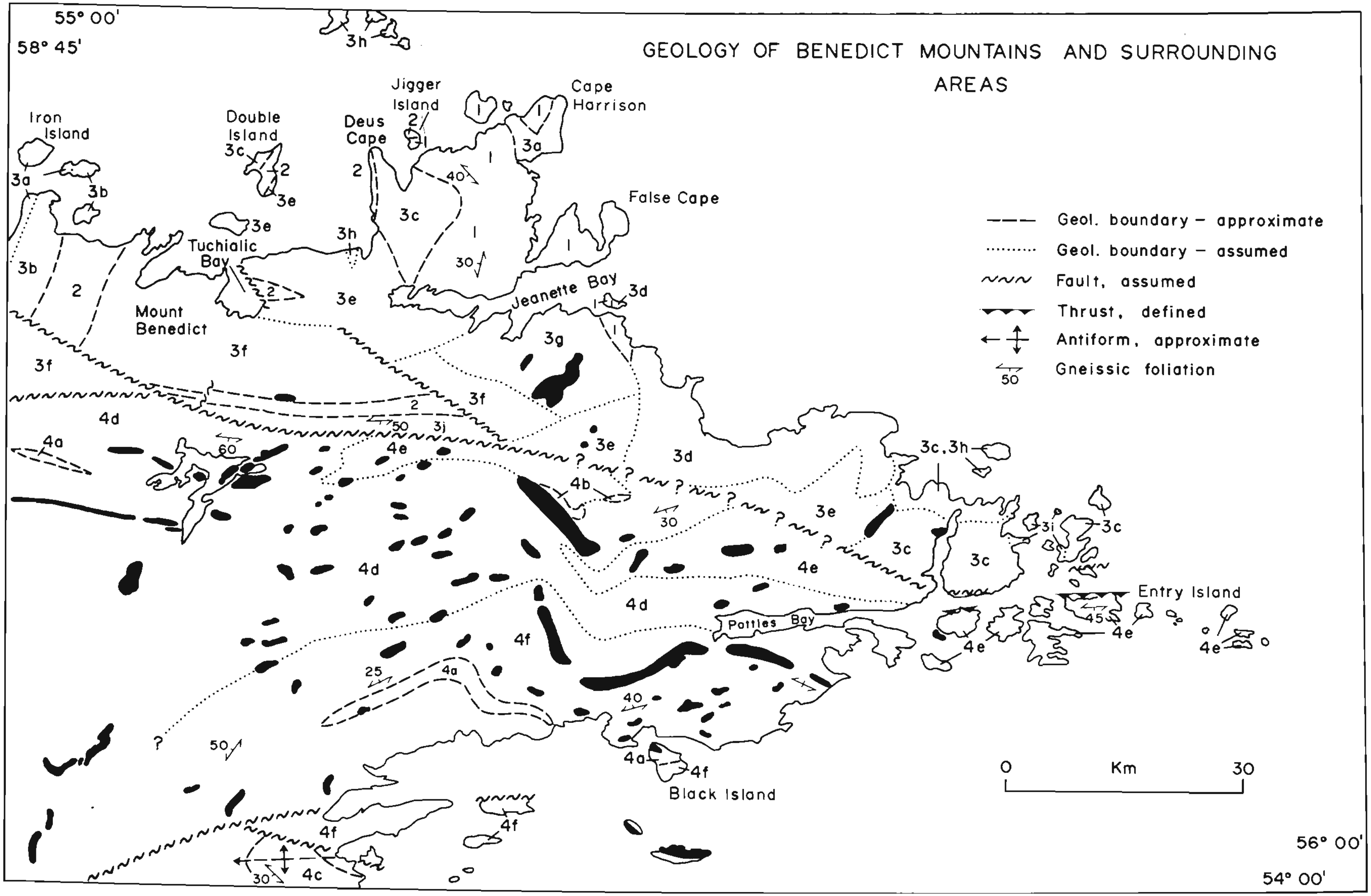
APHEBIAN?

2 Metarhyolitic flows and fragmental volcanic rocks, subsidiary meta-arkose and quartzite, minor fine grained amphibolite.

APHEBIAN OR ARCHEAN?

1 Strongly foliated and gneissic garnet-bearing tonalite and granodiorite, locally migamatitic and megacrystic.

Note: Granitoid terminology follows IUGS recommendations.
Granitoid rocks massive unless stated otherwise.



GEOLOGY OF BENEDICT MOUNTAINS AND SURROUNDING AREAS hypabyssal, is also common on the eastern side of the belt.

The sequence has been injected by closely spaced, southeast-trending diabase dikes which exceed 50% of the total outcrop in places. It is certainly these dikes that led Stevenson (1970) to map a large intrusion of mafic rock in this area.

Double Island

Both the grade of metamorphism and the proportion of sediments are higher in the supercrustal rocks on Double Island than west of Mount Benedict. The volcanic rocks are probably rhyolite lavas but strong shearing and associated microgranite injection has destroyed most of the primary fabric. More obvious, especially on the northeast part of the island, are well banded, locally strongly folded quartzites. Some lensy, siliceous rocks, interpreted as pyroclastics, are associated with structureless, fine grained feldspar porphyries, probably intrusive in origin. A wide band of uniform fine grained amphibolite, most obvious on the west coast, lacks primary fabric and could be either intrusive or extrusive.

Tuchialic Bay

Two rock types can be recognized; namely, (i) gray and pink, structureless, very fine grained rock with large, scattered saussauritized feldspar phenocrysts (this is interpreted as a hypabyssal intrusion) and (ii) well banded ash-flow rhyolite showing eutaxitic structures. These rocks are intruded by cogenetic rhyolite dikes.

South of the Benedict Mountains

This easterly trending belt consists of felsic tuffs with subsidiary lavas. Alternation of well banded, cream, pink and green weathering crystal tuffs and ashes are particularly common at the western end. The lavas are mostly white weathering, very fine grained rhyolites. Associated with both rock types are hypabyssal feldspar porphyries, locally containing plagioclase phenocrysts up to 2 cm long.

South of Deus Cape

The rocks in this area compare closely with those on the west side of Double Island, but are more strongly deformed. Very fine grained, buff weathering felsic rock with a streaky, lensy fabric dominates and is ubiquitously injected by anastomosing granitic material. Associated with these rocks are gray weathering, flaggy, very siliceous rocks, most likely quartzite or graywacke. Primary fabric has been almost obliterated, except for one area of probable lapilli tuff.

Paleohelikian (Unit 3)

The subdivision of the massive granitoid rocks has been made with the assistance of numerous stained slabs. Granitoid terminology follows IUGS recommendations (Streckeisen, 1973). No age relationships are implied by the order of the units in the legend.

Coarse grained equigranular biotite granite (3a)

The rock on Iron Island, and the mainland immediately south, is very coarse grained (greater than 2 cm); it is pink weathering, massive with rare mafic enclaves and very few minor granitic intrusions. Fluorite is a very common accessory mineral.

The granite at Cape Harrison is very leucocratic; color index is less than 4. Extensively chloritized biotite, sericitized plagioclase, and a granulated matrix, together with a well defined photolineament, confirm the southerly trending fault postulated by Stevenson (1970) in this area.

Coarse grained hornblende-biotite granodiorite/granite (3b)

In contact with felsic volcanics west of Mount Benedict, Unit 3b is a granodiorite with K-feldspar megacrysts. Progressing north, the plagioclase proportion decreases and both quartz and plagioclase grain sizes increase to give a coarse grained, crudely equigranular rock gradational into Unit 3a. Thus, Unit 3b may be simply a border facies of Unit 3a. In contrast to Unit 3a, hornblende (altered to biotite + epidote) is the dominant mafic phase in Unit 3b. Mafic enclaves and minor granitic intrusions are uncommon. Fluorite occurs in some shears.

Coarse grained biotite granodiorite with K-feldspar megacrysts (3c)

The granodiorite southeast of Deus Cape has a seriate to megacrystic texture with K-feldspar up to 4 cm. The massive interior grades into a recrystallized, strongly foliated border, showing greater compositional variability. Though biotite is dominant, hornblende occurs rarely.

The megacrystic granodiorite northeast of Pottles Bay differs from the granodiorite southeast of Deus Cape in having a higher mafic content, less conspicuous seriate texture, and lower quartz content.

Coarse grained biotite-hornblende granodiorite/quartz monzonite with very large K-feldspar megacrysts (3d)

In typical samples, almost all the K-feldspar is concentrated into megacrysts which may exceed 7 x 4 cm. The megacrysts are generally euhedral, zoned and contain inclusions of quartz and plagioclase. Hornblende is the dominant mafic mineral but is partially pseudomorphed by biotite. Allanite, up to 1 cm, and sphene are unusually common accessory phases. The rock contains enclaves of gneiss and amphibolite and is intruded by microgranite dikes.

Coarse grained alkali granite (3e)

In the alkali granite east of Tuchialic Bay, K-feldspar exceeds 60%, plagiclase is less than 10%, and chloritized biotite less than 5%, except in the border areas where plagioclase content is slightly greater. Fluorite is a common accessory phase and is also found in fractures associated with epidote. Mafic enclaves and minor granitic intrusions are rare.

The two southerly areas contain a texturally variable group of K-felspar-rich granites and it is unlikely that the mapped areas represent individual intrusions. Both areas are characterized by less than 3-4% mafic minerals, mainly chloritized biotite.

Medium to coarse grained syenite, locally quartz syenite or monzonite (3f)

Characteristically, these rocks contain ragged white plagioclase in a K-feldspar-mafics groundmass though the contrast in grain size is insufficient to describe the rock as megacrystic. Pyroxene, hornblende and biotite are all present, showing alteration to low-temperature phyllosilicates. Near the borders of the intrusion, the rock is medium grained, more variable, and more commonly monzonite. An area of fine to medium grained rock on and south of Mount Benedict may indicate proximity to the roof of the intrusion.

Variable group of syenite, monzonite and granodiorite (3g)

These rocks are grouped primarily by default from other defined units. The syenites and monzonites are medium and coarse grained with hornblende and biotite as mafic phases. They may represent an eastern border phase of Unit 3f. The granodiorites are variable, locally megacrystic and moderately foliated and perhaps should be assigned to Unit 1.

Coarse grained alkali syenite (3h)

Dark gray to chocolate-weathering syenites were reported by Christie *et al.* (1953) and described by Stevenson (1970). However, both authors include some of the texturally and compositionally distinct rocks of Unit 3f. Microcline perthite comprises up to 65% of the rock with subsidiary plagioclase, quartz, hornblende and biotite.

The rocks were emplaced after Units 3c and 3e, truncating shear zones in the former. Stevenson suggested that the syenites may be younger than the mafic dikes. Although the syenite may postdate the deformed net-veined dikes, they are certainly intruded by later, rectiplanar mafic dikes.

Medium to coarse grained diorite, monzodiorite (3i)

These brownish gray rocks consist dominantly of plagioclase (greater than 60%) with quartz and K-feldspar as accessory felsic minerals, and hornblende, pyroxene and biotite as mafic phases. Ultramafic rocks are associated on the eastern side. In view of the contrast to the generally alkali granitoid rocks, it is possible that these rocks represent an unusually feldspar-rich phase of the gabbros. The unit may be reassigned after thin section and chemical data are available.

Mafic-rich, coarse grained syenite to monzonite (3j)

This very distinctive rock type extends over a strike length of 35 km parallel to the Benedict Fault. K-feldspar and some plagioclase augen are contained within a protomylonitic matrix of quartz and mafic minerals, the latter mainly chlorite.

Helikian (Unit 4)

All the rocks south of the Benedict Fault were deformed during the Grenville Orogeny and are grouped as Helikian, although reworked Aphebian, and possibly Archean rocks may be present.

Large segments of the area are underlain by strongly foliated and gneissic biotite granodiorite (Unit 4d), grading into tonalite, diorite or granite locally. These rocks are totally recrystallized, generally medium grained and have a color index less than 10. Discontinuous quartzofeldspathic layers and elongate mafic enclaves define a crude banding in places. Garnet and hornblende porphyroblasts occur, especially in the quartzofeldspathic layers.

Two areas of foliated to gneissic biotite granodiorite with megacrysts/-augen of K-feldspar (Unit 4e) have been mapped. Smaller areas, not shown on the map, occur elsewhere close to the Benedict Fault. These rocks are mostly deformed megacrystic granodiorites. The unit north of Pottles Bay may be, in part, a deformed equivalent of Unit 3c further east.

On the islands east of Pottles Bay, zones of well banded gneiss alternate with more uniform rock containing K-feldspar augen. The gradational boundaries between the two indicate a common granitoid pluton protolith.

Fabric is the main contrast between the rocks west and south of Pottles Bay (Unit 4f) and those further north. Unit 4f consists mostly of well-banded biotite granodiorite to tonalite gneiss with layers defined by subtle mineralogical and grain size heterogeneities and more obvious quartzofeldspathic zones. The latter contain abundant garnet and hornblende porphyroblasts. Immediately south of Pottles Bay, the gneisses are mostly dioritic with some areas of almost uniform metadiorite. Monzonite is a common rock type in the southwest part of Unit 4f.

Contrasting to Units 4d, 4e and 4f are creamy, white or rusty weathering, continuously banded rocks (Unit 4a) interpreted as derived from a metasedimentary protolith. These rocks are very siliceous with biotite, muscovite or, less commonly, feldspar as other essential phases. Interleaved tonalitic gneiss and quartzofeldspathic metasediments are well exposed on Black Island. Some finer grained metasediments are also present.

One area of deformed felsic volcanics was mapped (Unit 4b). Feldspar porphyritic rhyolite is interbedded with very fine grained tuffaceous sediment and lapilli tuff. Much of the rhyolite is structureless and could be hypabyssal. Some of the volcaniclastic sediments are deformed to muscovite-biotite schist.

Unit 4c may also have been derived from a volcanic protolith. The rocks have a distinct "lensy" banding suggesting a deformed agglomerate or breccia. The mineralogy is very variable over small areas and the rock commonly highly garnetiferous (greater than 35%). Dispite a dark weathering appearance, much of the rock is silica-rich.

Various ages - dikes, sills and irregular mafic bodies

In the northern part of the area, two clearly distinct groups of mafic intrusions can be identified. An older group of dikes commonly has a net-vein appearance and shows external deformation. The net-veining has been described by Elders and Rucklidge (1969). The younger group of dikes are rectiplanar and undeformed.

In the southern area, four groups of mafic rock can be distinguished; namely, (i) fine to medium grained massive, equigranular diabase, (ii) medium grained, massive, equiganular diabase with a distinctive purplish weathering tinge, (iii) an assortment of coarse grained ultramafites, and (iv) gabbro-leucogabbro.

STRUCTURE AND METAMORPHISM

North of the Benedict Fault

The strongly foliated and gneissic rocks of Unit 1 show complex isoclinal folding in detail but regionally form a north-trending terrain which has suffered later open folding about east-trending, upright axial surfaces. This later folding may have resulted from deformation during the Grenville Orogeny. Isoclinal folding is also apparent in the metasediments of Unit 2 but a lack of marker horizons prevents delineation of major structures. The rocks have been metamorphosed to lower-middle amphibolite facies with retrograde greenschist effects.

The granitoid rocks of Unit 3 are generally massive and structureless. Locally, east-southeast trending shears or fracture cleavage is present and interpreted as the result of Grenville deformation. Apart from minor deuteric alteration, the rocks are unmetamorphosed.

Two southeasterly trending splay faults are present north of the Benedict Fault. The western fault is obvious from aeromagnetic and ground lineaments as well as lithology distribution. The eastern fault is suggested by a poorly defined photolineament. The orientation of these faults, coupled with the geometry of minor folds observed on the coast, suggests a dextral component to the predominantly reverse movement (south-side-up) on the Benedict Fault.

South of the Benedict Fault

Three main folding events can be recognized. The earliest folds are isoclinal and have north-trending axes. These folds were refolded along major east-trending structures. An antiform in the southern part of the area can be extrapolated eastwards through the islands of Groswater Bay. An poorly defined synform can be interpreted north of this with its axial trace passing south of Pottles Bay.

These major folds are refolded by northeasterly trending folds which seem to be confined to the eastern part of the region. They are tentatively interpreted as the product of the same stress field that was responsible for the dextral movement on the Benedict Fault.

The grade of metamorphism is middle to upper amphibolite facies. Garnet and hornblende porphyroblasts are abundant in the tonalitic gneiss and tend to be concentrated in quartzofeldspathic layers. No alumina silicates were observed in hand specimens but Stevenson (1970) has reported sillimanite and cordierite and the Metamorphic Map of the Canadian Shield shows a kyanite locality on the islands in the extreme eastern part of the region (Geological Survey of Canada, Map 1475A).

MINERALIZATION

Malachite staining, associated with shears in pink medium grained granite, was observed on an island 7 km south of Cape Harrison. Copper mineralization has also been reported on Black Island. It is associated with arenaceous metasediments also showing a pink staining, possibly erythrite, in epidote-rich pods.

Molybdenite has been reported from the area and a prospect drilled at the south end of Jay Lake. A new molybdenite locality, in veins associated with pyrite, was found on Entry Island.

Pyrite, in irregular veins, was located in felsic volcanics west of Mount Benedict. No mineralization was found associated with any of the other felsic volcanic areas. Many of the metasedimentary horizons in the southern area are pyritic.

Fluorite is a ubiquitous accessory phase in some of the granites, especially 3a, 3b and 3e, and also occurs in shears associated with epidote in the same rocks.

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