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GEOLOGY OF THE RODDICKTON (12I/16) MAP AREA

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ABSTRACT

The Roddickton map area contains a terrane of Cambrian and Ordovician terrigenous and carbonate platformal rocks between Precambrian basement to the west and the Taconic Hare Bay Allochthon to the east. Lighthouse Cove Formation basalts and Bradore Formation fluviatile red beds of the Labrador Group infill an irregular topography on the Late Precambrian unconformity. The top of the volcanic rocks was weathered before the red beds were deposited. Above this basal sequence, marine sedimentation, which continued throughout the rest of the Early Cambrian to the Middle Ordovician, deposited (at first) a mixed terrigenous–carbonate succession, the Labrador Group. Carbonate and mudstone in the youngest rocks of this group have yielded early Middle Cambrian fossils.

The remaining platformal stratigraphy consists of carbonates similar to those occurring elsewhere in western Newfoundland. Middle Ordovician flysch overlies the carbonates. Post-Middle Ordovician diabase dikes cut the platformal sequence.

The area comprises an undeformed foreland in the west and a parautochthonous terrane in the east. The parautochthon is made up of a northwestward-directed stack of imbricate thrust slices. Metamorphism in the subgreenschist to locally greenschist facies characterizes the most highly deformed rocks in the east. Deformation of the post-Middle Ordovician dikes suggests the main deformation is Acadian in age.

The area hosts impressive deposits of marble and limestone. Minor base-metal showings occur in the platformal sequence. A gossan in a post-Middle Ordovician diabase dike contains auriferous pyrite mineralization.

INTRODUCTION

Lower Paleozoic platformal rocks form one of three geologic terranes in the Roddickton map area. The platformal rocks occupy the northern part of the map area and narrow southward adjacent to the shores of Chimney Arm and Bide Arm. Here they are wedged between the mountainous Precambrian terrane of the Long Range Inlier to the west and the hilly Hadrynian to Early Paleozoic Hare Bay Allochthon to the east. Contained within this Lower Paleozoic platformal terrane are rocks ranging from volcanic through siliciclastic to carbonate in composition, and from undeformed (in the northwest) to strongly tectonized and metamorphosed in the east. In the west and northwest, the autochthonous strata unconformably overlie Precambrian basement. However, roughly east of a line that passes north along Chimney Arm to just west of Lanes Pond, the platformal succession is parautochthonous, and Cambrian and Ordovician rocks are repeated in a number of regional thrust slices.

The area provides an opportunity to examine lateral variations of lithofacies across the platform, particularly in Cambrian rocks (see Knight and Saltman, 1980). The Ordovician succession, however, is very similar to that seen in the Hare Bay and Pistolet Bay areas (Knight, 1986).

The map area is one of physiographic contrasts, which give it a unique beauty in western Newfoundland. Barrens of granitic and volcanic rock, covered locally by low-lying vegetation, characterize the eastern and northern edge of the Long Range Mountains, which rise to 260 to 380 m above sea level. A long dip-slope underlain by volcanic rocks and sandstone of the Labrador Group leads to a wooded and marshy lowland (at less than 100 m a.s.l.) that is underlain by platformal carbonate rocks. Strata trends and faults are accentuated by ridges and linear lows. In the parautochthon, the terrane consists of well rounded hills and irregular valleys that reflect the folded and faulted structure of this area. More rugged wooded and rocky hills of resistant sandstone and volcanic rocks of the Hare Bay Allochthon rise to 160 to 200 m along a meandering fault scarp east of the platformal terrane.

Much of the area is accessible by gravel highway, and by boat along the picturesque, narrow sea arms of Bide Arm, Chimney Arm and Northwest Arm. Forest access roads and old logging trails are abundant and provide easy access to much of the platformal terrane and the Hare Bay Allochthon. The Long Range Mountains can be reached only locally by road or sea, as for example, Horse Chops and Cloud Hills

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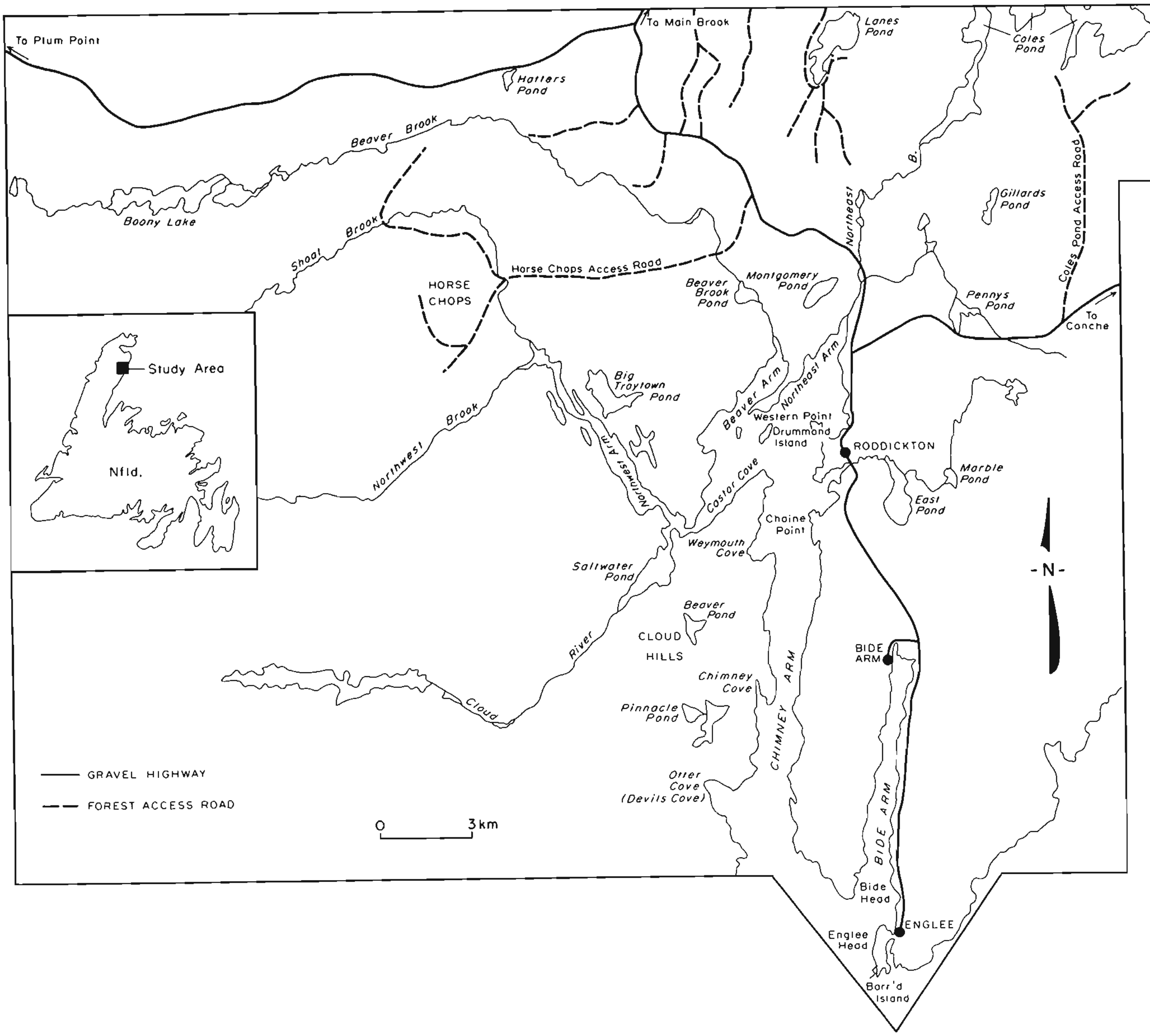


Figure 1: *Roddickton map area showing general location (inset) and place names referred to in the text.*

(Figure 1). Helicopter provides the best means of access to the rest of this terrane.

Previous Work

The first geologists to visit the Roddickton map area were Alexander Murray in 1864 and J.P. Howley in 1902 (Betz, 1939). The first map of the area was produced by Betz (1939), who named several stratigraphic units and assigned ages to these units by comparison with rock groups defined elsewhere in western Newfoundland by Schuchert and Dunbar (1934). Trilobites recovered from the Cambrian rocks were identified by Howell (1943).

The area was ignored until Smyth (1973) investigated the Hare Bay Allochthon; he paid scant attention to the platformal carbonates, however. The volcanic rocks of the autochthon have been studied by Clifford (1965), Strong and Williams (1972) and Strong (1974, 1977). Much of the previous work was compiled in a 1:125,000 scale map and accompanying memoir by Bostock *et al.* (1983). It also included the first regional geologic mapping of the ancient rocks of the Precambrian Long Range Inlier.

In 1979, 1:50,000 scale geologic mapping of the platformal terrane, in the Roddickton map area, was partly completed (Knight *et al.*, 1979) and recent informal stratigraphic subdivisions of western Newfoundland platformal rocks were applied to the area (Knight and Saltman, 1980).

The area has received very little attention by mineral exploration companies. Investigations in the area by Sauerbrei (1964) and Siragusa (1966) for Cominco and later by Phillips Management in 1975 have located only minor showings of sphalerite. Industrial commodities such as marble, however, are abundant. They have received a lot of study, which has been summarized by DeGrace (1974). The marble deposits are currently being re-evaluated by the Newfoundland Department of Mines and Energy (Howse, 1986; *this volume).*

GENERAL GEOLOGY

Precambrian Long Range Inlier

Approximately one third of the map area is underlain by Helikian granites and gneisses of the Long Range Inlier (Figure 2). A basement gneiss complex is intruded by large quartz monzonite, granodiorite and granite intrusions of the Cloud River and Horse Chops plutons (Bostock, *in* Bostock *et al.*, 1983). The basement gneiss complex mainly comprises medium grained, leucocratic to melanocratic, schistose and banded gneiss. Biotite–quartz–microcline–plagioclase gneiss predominates; lesser amounts of quartz-rich gneiss, pelitic schist and amphibolite also occur. Metamorphic grade varies from amphibolite to granulite facies within the complex; however, retrograde greenschist metamorphism occurs along the northeastern margin of the inlier (Bostock, *in* Bostock *et al.*, 1983).

Late Precambrian Unconformity

Volcanic and siliciclastic rocks of the Labrador Group overlie the basement with profound unconformity. The ancient surface is very irregular, exhibiting significant local relief of probably tens of metres. Volcanic rocks of the Lighthouse Cove Formation are interpreted to infill depressions in the unconformity. This is indicated by local metre-scale relief and by regional relationships. At Otter Cove (locally called Devils Cove), Bradore Formation sandstone rests upon the basement. Less than 2 km to the north, a substantial thickness of basalt intervenes between sandstone and basement. Similar relationships occur between Boony Lake and the Horse Chops, and west of Northwest Arm.

A basal clastic lag underlies volcanic rocks and forms a drape upon the unconformity. It consists of a centimetre-thick, green pebbly sandstone containing quartz and some granitic pebbles up to 10 cm in diameter. West of Northwest Arm, the lag hugs the sloping surface of a basement ridge at the unconformity. Contact metamorphism of the lag, and a few centimetres of basement beneath the unconformity, has occurred below the volcanic rocks. Bostock *(in* Bostock *et al.*, 1983) illustrates a metre or so of sandstone lying beneath the volcanic rocks. Where the volcanic rocks are absent, however, Bradore Formation sandstone rests upon smooth, unweathered granite surfaces near Boony Lake, but upon a green-yellow alteration zone, possibly a regolith, near Devils Cove (see also Bostock *et al.*, 1983, page 34).

Labrador Group

One volcanic unit, the Lighthouse Cove Formation, and three sedimentary units, the Bradore, Forteau and Hawke Bay formations, compose the Labrador Group in the map area. Rocks of the Bateau Formation, which form the base of the group on Belle Isle to the northeast (Williams and Stevens, 1969), are absent in the map area although boulders of coarse, pebble-supported conglomerate occur in glacial drift on the Horse Chops.

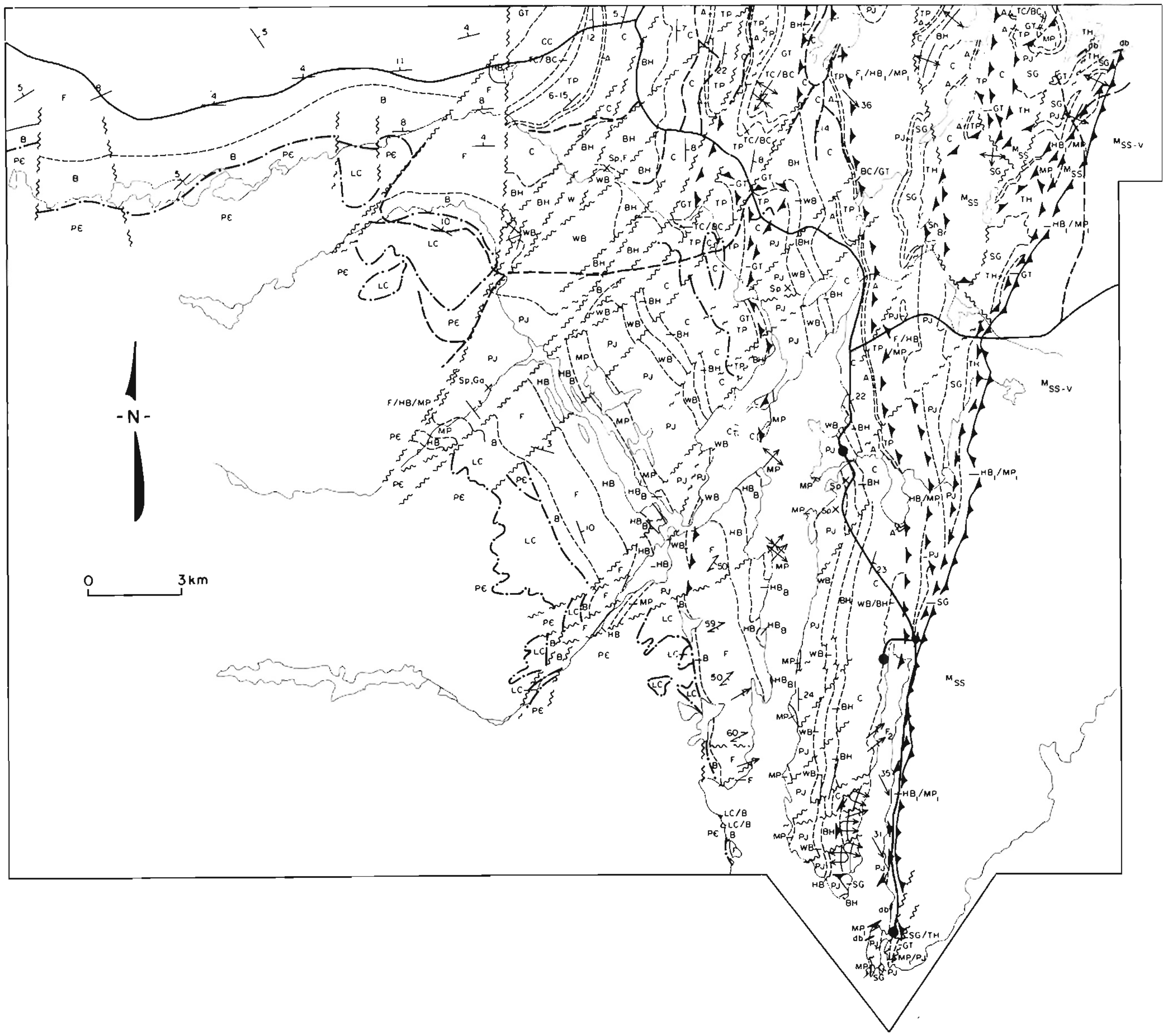
Lighthouse Cove Formation and Long Range dikes. Columnar to massive basalt of the Lighthouse Cove Formation overlies basement in an area beginning just east of Boony Lake and continuing along the northeast edge of the Long Range Inlier to Pinnacle Pond, near Devils Cove. A thickness of not less than 50 m is probable at Cloud Hills. Bostock *(in* Bostock *et al.*, 1983) estimated 75 m occurs in two or three flows separated by a thin arkosic sandstone. Columnar basalt forms the lowest flow at most localities, and is overlain by sparsely vesicular massive flows.

The flows are fed by northeast-trending Long Range diabase dikes (Strong and Williams, 1972), a swarm dated at about 605 million years (Bostock, *in* Bostock *et al.*, 1983). At Cloud Hill, one of the dikes breaches the basal columnar flow and deformed the columns enroute to the upper flows. Bostock hints that not all the dikes of the Long Range were intruded in one event. Knight and Saltman (1980) described a dike cutting the Bradore Formation at Devils Cove.

The upper contact of the Lighthouse Cove Formation is exposed along Cloud River and Beaver Brook where the flows are extensively oxidized. Red hematitic alteration and rings of iron enrichment surrounding cores and spheroids of unaltered basalt occur. This suggests that the top of the flows were weathered before the Bradore Formation was deposited.

Bradore Formation. Knight and Saltman (1980) described approximately 62 m of red siliciclastics in the Bradore Formation at Devils Cove. There the formation consists of red to purplish-red pebbly arkose and arkose, green-gray to red quartz arenite, black to purple hematitic siltstone and sandstone, small-pebble conglomerate and yellow-weathering dolostone. The arkose is typically poorly sorted, cross-bedded with some planar stratification, ripple cross-laminated, and contains abundant heavy-mineral laminations. Mudcracked, thin siltstone and mudstone form partings between beds. Arkose forms the basal 43 m of the formation interrupted only at 35 m by 1.3 m of well sorted, green-gray to red, planar laminated and cross-bedded quartz arenite. This unit is overlain erosively by 6 to 14 cm of unsorted small-pebble conglomerate containing large, red, laminated siltstone rip-ups, and lenses of sandstone. It underlies a further 5.8 m of arkosic sandstone. Hematitic siltstone and very fine to coarse grained micaceous sandstone, 7.8 m thick, overlie the arkose. The sandstone is characterized by thin planar stratification, flaser bedding, shaly partings, thin coarse grained sandstone lenses and rare cross-bedded sandstone, and tubular bioturbation. A red crystalline dolostone rests irregularly upon the hematitic unit. It forms pebbles in a conglomerate bed, 22 to 108 cm thick, that marks the erosive base of an upper arkose unit that is 2.4 to 5 m thick. The upper arkose is pebbly and composed of narrow and wide sets of trough cross-stratification.

Elsewhere in the map area, the formation is not well exposed. West of the Hatters Pond fault, however, the formation comprises a basal unit of red pebbly sandstone and conglomerate, a middle unit of gray-pink, micaceous and glauconitic, very fine grained sandstone, and an upper unit of red, arkosic sandstone. Similar rocks with the same



SYMBOLS

Unconformity, disconformity	Folds: plunging, anticline, syncline, overturned
Formation boundary	Plunging stretching lineation
Fault	× Mineral showing
Thrust fault	sp Sphalerite
Bedding	ga Galena
Cleavage	F Fluorite

Figure 2: *Geologic map of the Roddickton map area.*

LEGEND

POST-MIDDLE ORDOVICIAN

db *Diabase dike*

HADRYNIAN TO LOWER ORDOVICIAN

ALLOCHTHON

Mss-v Maiden Point Formation: *ss–green to red sandstone, conglomerate and shale; v–basalt*

HADRYNIAN TO MIDDLE ORDOVICIAN

AUTOCHTHON

ShBr *Shale breccia*

GT Goose Tickle Formation: *green-gray sandstone and shale*

TABLE HEAD GROUP

TH Undivided Table Head Group: *marble in parautochthon*

CC Cape Cormorant Formation: *limestone breccia*

BC Black Cove Formation: *black, pyritiferous, graptolitic shale*

TC Table Cove Formation: *nodular, thin bedded limestone and shale*

TP Table Point Formation: *light-gray fenestral limestone, dark-gray, thick bedded, fossiliferous, argillaceous limestone; minor dolostone*

LOWER ORDOVICIAN

ST. GEORGE GROUP

SG Undivided St. George Group: *marble in parautochthon*

A Aguathuna Formation: *dolostone and minor white to light-gray limestone*

C Catoche Formation: *gray, fossiliferous, bioturbated, cryptalgal limestone; minor light-gray limestone at top*

BH Boat Harbour Formation: *interbedded dark- to light-gray, dolomitic limestone, cryptalgal limestone and dolostone; breccia locally at base*

WB Watts Bight Formation: *dark-gray to black, crystalline dolomite, chert, and black to light-gray, cryptalgal and bioturbated limestone*

MIDDLE TO UPPER CAMBRIAN

PORT AU PORT GROUP

PJ Petit Jardin Formation: *dolostone, argillaceous dolostone, shale*

MP March Point Formation: dolostone, parted, bioturbated, oolitic and cryptalgal limestone and minor shale; MP_1, *ribbon limestone and shale in parautochthon*

HADRYNIAN TO MIDDLE CAMBRIAN

LABRADOR GROUP

HB Hawke Bay Formation: *quartz arenite and mudstone, minor limestone;* HBB (Bridge Cove member), *oolitic and stromatolitic limestone, dolostone, mudstone, shale and quartz arenite;* HB_1, *phyllite contains thin quartz sandstone laminae in parautochthon*

F Forteau Formation: *calcareous siltstone, shale, nodular limestone, black oolitic–oncolitic limestone;* F_1, *phyllite, ribbon limestone, limestone breccia and oolitic limestone in parautochthon*

B Bradore Formation: *red arkosic sandstone, hematitic siltstone and sandstone, gray-pink micaceous sandstone and shale*

LC Lighthouse Cove Formation: *columnar and massive basalt*

HELIKIAN OR EARLIER

BASEMENT

PE *Precambrian gneiss complex and granitic plutons cut by diabase dikes* sequential order occur in the Torrent River (12I/10) map area to the southwest (Knight, *in preparation)*.

Forteau Formation. A strongly cleaved, pink, gray and cream, fossiliferous, shaly nodular limestone, termed the Devils Cove limestone (Betz, 1939), forms the basal member of the Forteau Formation. Above this, the succession to the northwest of the Hatters Pond fault consists of olive-gray to dark-gray shale and mudstone containing recessively weathering limestone nodules. Upward, the succession contains *Salterella*-bearing grainstone as lumps and beds, and extensively burrowed, cross-laminated and laminated, calcareous siltstone and very fine grained sandstone. These strata are overlain by black oolitic lime grainstone.

The equivalent succession in Canada Bay is essentially the same, although it is deformed (slaty cleavage) in the lower, muddy siliciclastic interval. This is succeeded by a succession of black shale interbedded with thin lime mudstone and skeletal, intraclastic, oncolitic and oolitic lime grainstone, which is capped by a unit of oncolitic–skeletal–oolitic grainstone, 3.25 m thick. The grainy limestone contains *Salterella* and also trilobites of the *Bonnia-Olenellus* Zone (Knight and Boyce, *this volume)*.

In parautochthonous strata, the formation is represented by gray and black phyllite interbedded with black, fine grained limestone, intraclastic lime mudstone and a unit of black oncolitic–oolitic lime grainstone in the Lanes Pond–East Pond thrust slice (Figures 3 and 4).

Hawke Bay Formation. A lower siliciclastic member (approximately 85 m thick) and an upper member of limestone, mudstone and sandstone, approximately 90 m thick (the Bridge Cove member) constitute the Hawke Bay Formation in a narrow belt along Northwest Arm and Chimney Arm. This two-part stratigraphy contrasts with the 150 m of dominantly quartz arenite in the formation at Hawkes Bay (Knight, 1977) and the St. Barbe coast (Cumming, *in* Bostock *et al.*, 1983, Yankee Point core log).

Limestone is virtually absent from the formation in a gently folded section along Northwest Brook, only 6 km west of Northwest Arm, although mudstone is still interbedded with quartz arenite. A conglomerate composed of discoid quartz arenite clasts occurs in this section. This lithofacies pinch-out suggests a rapid transition from the Chimney Arm mixed terrigenous–carbonate belt to the inner, exclusively terrigenous belt to the west.

The lower siliciclastic member comprises thinly bedded, very fine grained quartz arenite interbedded with mudstone and shale. Gray *Salterella*-bearing calcareous lumps, nodules and beds, and beds of dark gray, oncolitic, skeletal and intraclastic lime rudstone occur toward the top. These limestones have yielded trilobites of the *Olenellus-Bonnia* Zone of late Early Cambrian age.

The rock types of the Bridge Cove member are arranged in terrigenous-carbonate cycles (see Knight and Boyce, *this volume)*. The member contains units of black, cross-bedded, oolitic and oncolitic limestone, containing lenses and beds of dolostone. Other carbonate rock types, some of which are marker beds, include stromatolitic limestone, oncolitic rudstone, parted limestone, fenestral limestone and dolostone, karst breccia and phosphatic, intraclastic sandstone and dolostone. The limestone units are interbedded with units of purple-brown-weathering, dark-gray mudstone that are intercalated with yellow- to rusty-weathering, light-gray to white, thin to thick bedded quartz arenite. The thicker arenite beds display planar lamination, cross-beds, possible hummocky cross-beds, ripple cross-lamination and convolute bedding. Locally, soft-sediment deformation resulted in sandstone ball-and-pillow structure within mudstone. Thin sandstone beds in the mudstone are commonly laminated and cross-laminated, and exhibit flaser bedding, some ripple marks, and mudcracked bases. Deformed sandstone- and dolostone-filled fissures, and narrow, channel-bound sandstone bodies also characterize the terrigenous units. Inarticulate brachiopods and beautifully preserved trilobites occur in some mudstone beds.

The trilobite fauna from both limestone and terrigenous units indicates that the Bridge Cove member is essentially early Middle Cambrian in age. Trilobites of the *Glossopleura* Zone, including *Glossopleura* sp., occur in the middle of the member, and are underlain by rocks containing some forms of the *Albertella* Zone though not *Albertella* itself. The top of the member contains trilobites of the *Ehmaniella* Zone. These faunas and those of the lower member suggest the formation accumulated in the late Early Cambrian and early Middle Cambrian. This stratigraphic interval spans the period assigned to a continent-wide regressive event, called the Hawke Bay Event by Palmer and James (1980). There is so far no hint from either the fossils or lithostratigraphy of a major hiatus in this area.

Correlatives of the formation are generally poorly exposed and not easy to identify in the parautochthon. In a quarry on the Conche Road and in thrust slices along Bide Arm, equivalent strata lie beneath ribbon limestone and shale of the March Point Formation. These strata consist of dark-olive-gray to gray, pyritic phyllite containing laminae and thin beds of rusty-weathering, light-gray sandstone and a few beds of ribbon limestone (Figure 3).

Port au Port Group

The Port au Port group consists of Middle to Upper Cambrian carbonate of the March Point and Petit Jardin formations, which constitute a succession at least 500 m thick in the map area.

March Point Formation. The March Point Formation rests conformably upon the Hawke Bay Formation. The formation consists of approximately 100 to 130 m of burrowed, thinly bedded limestone and dolostone, oolitic lime grainstone with associated stromatolite mounds, shaly and dolomitic parted limestone, and shale and mudstone containing nodular limestone. Some of these argillaceous rock types contain slump folds. This succession persists from the autochthon to the Drummond Island thrust slice of the parautochthon. The formation in the more easterly slices consists of thinly bedded, blue-gray ribbon limestone,

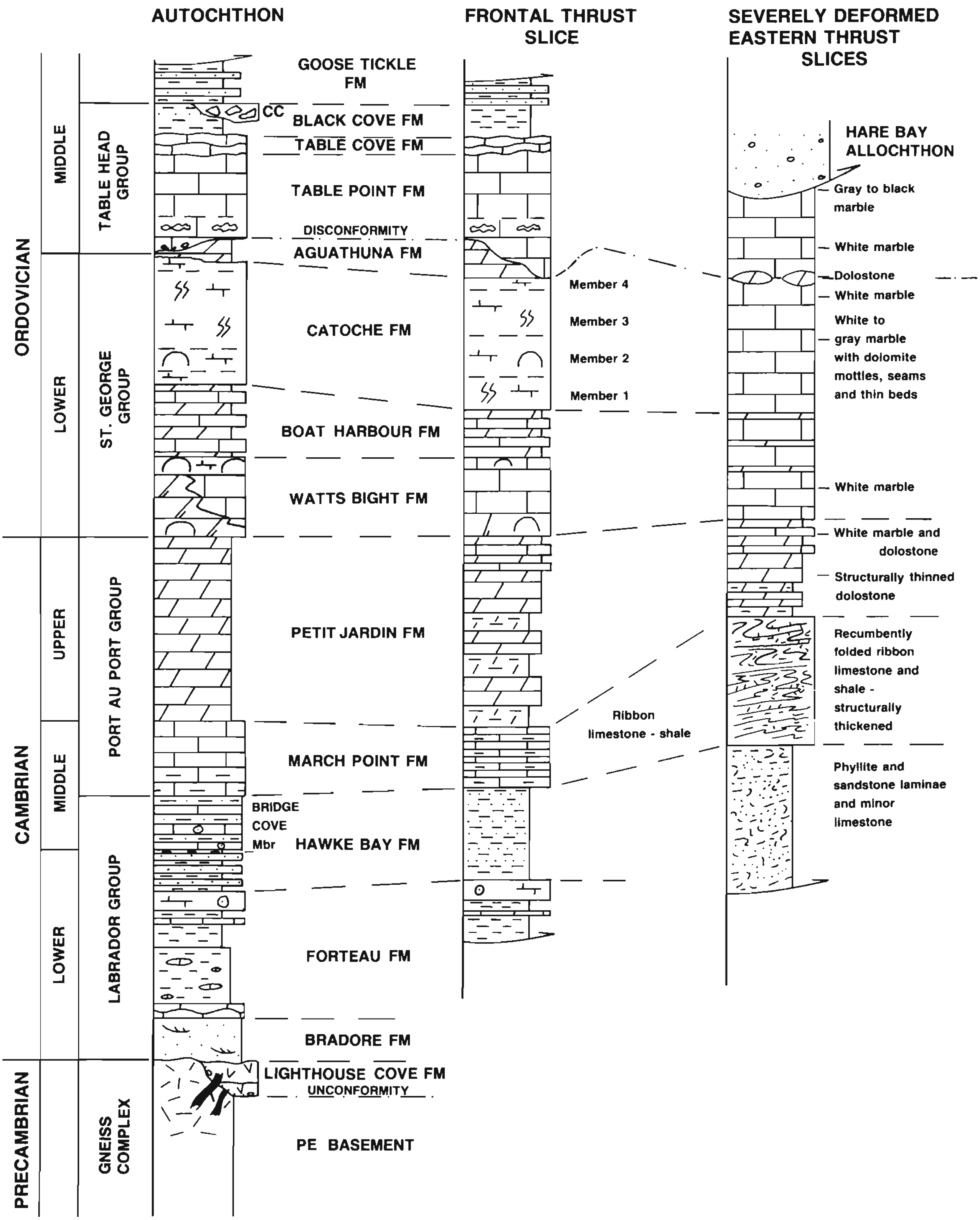


Figure 3: *Schematic diagram of stratigraphic subdivisions of autochthonous and parautochthonous strata in the Roddickton map area; vertical scale imprecise.*

dolomitic limestone and shale, and dark-gray phyllite interbedded with rare slump breccia composed of platy limestone clasts. These strata sit stratigraphically beneath Upper Cambrian dolostone of the Petit Jardin Formation.

Ehmaniella Zone trilobites collected from the autochthon and the Drummond Island thrust slice indicate that the formation is late Middle Cambrian in age (Knight and Boyce, *this volume)*.

Petit Jardin Formation. This formation, which is at least 400 m thick, gradationally but abruptly succeeds the March Point Formation. It consists of pale-gray to dark-gray microcrystalline dolostone, gray to white fine grained dolostone, dark-gray to black cherty dolostone, argillaceous dolostone, green-gray dolomitic shale and minor black shale. A transitional zone of interbedded dolostone and limestone occurs locally at the top of the formation below the St. George Group near Bide Head. The formation is well described by Knight and Saltman (1980).

In the most easterly thrust slices of the parautochthon, the Petit Jardin Formation is usually structurally reduced to a few metres of yellow-weathering massive dolostone. In areas of low strain, such as on Englee Head and Barr'd Island, a thick succession of interbedded sequences of dolostone with argillaceous dolostone and dolostone show that the formation has changed little in lithofacies or probable thickness from the complete succession that is exposed in the Drummond Island thrust slice to the west.

St. George Group

Watts Bight, Boat Harbour, Catoche and Aquathuna formations constitute the St. George Group in both the autochthon and parautochthon in the map area. In most aspects, including lithological, faunal and stratigraphic, the formations and members compare closely with those defined in the Pistolet Bay and Hare Bay areas by Knight (1986). In severely deformed parautochthon, the St. George Group is metamorphosed to gray to white lime marble and gray dolomite marble in which the individual formations are distinguished only locally.

Watts Bight Formation. The Watts Bight Formation comprises approximately 90 m of dark-gray to black crystalline dolostone and black limestone. The formation is almost entirely dolomitized in the northwestern part of the area, as it is elsewhere on the Great Northern Peninsula (Knight, 1977, 1978). Southeastward, however, only the basal 6 to 17 m of the formation is dolomitized. The limestone displays large, cherty, thrombolitic mounds and dolomite-burrow-mottled lime mudstone–wackestone.

A pale-gray to pinkish-gray limestone unit forms the top of the formation. The unit is composed of a mound complex of thrombolites and stromatolites associated with skeletal–intraclastic grainstones (see Figure 3 of Knight and Saltman, 1980). Previously, the unit was thought to occur toward the top of the Boat Harbour Formation, immediately beneath the Boat Harbour disconformity (Knight and Saltman, 1980).

Boat Harbour Formation. The Boat Harbour Formation is a recessively weathering, poorly exposed unit of fine grained limestone and dolostone, believed to be no more than 70 m thick. The limestone consists essentially of 1) dolomite-burrow-mottled wackestone rich in gastropods, 2) smooth, wavy, thinly bedded, dolomitic lime mudstone rich in the trace fossil *Chondrites* and lenses of skeletal and intraclastic grainstone and rudstone, and 3) thrombolitic and stromatolitic boundstone. The limestone is interbedded with laminated, commonly mudcracked, dolostone. Pockets of dolomite–chert breccia occur locally at the base of the formation, which is conformable upon the Watts Bight Formation.

Catoche Formation. The Catoche Formation comprises bioturbated fossiliferous limestone and cryptalgal limestone that are arranged in four members similar to the formation in Pistolet Bay and Hare Bay (Knight, 1986). The thickness is unknown in the map area. The lower burrowed limestone member consists of unevenly thin bedded, burrowed lime mudstone and wackestone containing lenses and thin beds of intraclastic and skeletal grainstone and rudstone; some thrombolitic mounds also occur. The middle mound member is a spectacular complex of dolomitic, thrombolite–sponge mounds surrounded by grainstone; large molluscs and trilobites, and locally fibrous calcite cements, are associated with the mounds. The upper burrowed limestone member is not well exposed. It consists of black to dark-gray, grainy to dolomitic, burrow-mottled limestone locally indistinguishable from younger Table Head Group limestone. The overlying white limestone member is 2 to 18 m thick. It consists of stylolitic, bioturbated, peloidal and fenestral limestone, and contains thrombolite mounds near Lanes Pond.

Aguathuna Formation. The Aguathuna Formation comprises buff- to yellow-weathering, light-gray, microcrystalline dolostone and chert, and minor light-gray to white, peloidal, fenestral and cryptalgal limestone. It is 20 to 30 m thick except in the centre of the map area, north of Beaver and Northeast arms, where it thins abruptly to 1 to 2 m. It is absent at the bridge crossing Beaver Brook along the Horse Chops access road; there Table Point Formation limestone rests disconformably upon Catoche Formation limestone.

Dolostone interbedded with light-gray peloidal limestone occurs at the base of some sections overlain by 15 m of burrow-mottled, locally patterned dolostone and laminated and thinly stratified, locally mudcracked dolostone. A 85-cm-thick bed of pale-gray to white, fenestral, peloidal and cryptalgal limestone occurs beneath an upper dolostone. The dolostone is 7 m thick and consists mostly of chert and mudcracked laminated dolostone. In the parautochthon near Coles Pond, massive and laminated limestone beds, 30 to 60 cm thick, are intercalated with 80- to 180-cm-thick beds of dolostone in the last 8 m below the Table Point Formation. In sections near Lanes Pond and East Pond, the 20- to 30-m-thick section appears to be exclusively dolostone. Near Lanes Pond, a basal breccia of limestone intraclasts set in a dolomite matrix occurs above the dolostone-cemented broken top of the white limestone member of the Catoche Formation.

Table Head Group

Klappa *et al.* (1980) defined four formations in the Table Head Group, the Table Point, Table Cove, Black Cove and Cape Cormorant formations; all four outcrop in the map area.

Table Point Formation. The lithostratigraphy of the Table Point Formation is similar to that described in the Pistolet Bay and Hare Bay areas by Knight (1986). A lower association, 1 to 9 m thick, comprises nodular, bioturbated, fossiliferous and oncolitic, dark-gray limestone interbedded with calcic dolostone and dolomitic limestone. A basal pebbly and sandy dolostone composed of chert and dolostone detritus occurs locally. The overlying association comprises 18 m of light-gray, mottled and fossiliferous lime wackestone, lime grainstone and fenestral limestone. It is succeeded by rubbly weathering, thickly bedded, fossiliferous, dark-gray muddy limestone characterized by argillaceous seams and partings. Black nodular chert, molluscs, crinoids and solitary sponges are common. In stratigraphic sections along the shore of Coles Pond, the fenestral limestone association is absent. Instead, the lower Table Point Formation consists of several tens of metres of 30- to 50-cm-thick beds of thinly bedded and mudcracked laminated lime mudstone and calcic dolostone, interbedded with thick units of bioturbated black limestone.

Table Cove Formation. Nodular, thinly stratified, shaly, highly fossiliferous lime wackestone and shale form the Table Cove Formation in the map area. It rests conformably upon the Table Point Formation and attains a thickness of approximately 13 m (S. Stenzel, personal communication, 1986).

The formation contains the trilobites *Ampyxoides semicostatus* (Billings), *Cybelurus* sp., undet., *Lonchedamas clavulus* Whittington, *Peraspis lineolata* (Raymond) and *Robergia schlotheimi* (Billings) (D. Boyce, personal communication, 1986), and the graptolites *Cryptograptus tricornis schaeferi* Lapworth, *Glyptograptus* cf. *G. teretiusculus* cf. *G. teretiusculus* Hisinger, and *Glyptograptus* sp. undet. (D. Skevington, personal communication, 1979). Pelmatozoa, orthid and inarticulate brachiopods, ostracods and branching stick and tabular sponges also occur.

Black Cove Formation. Black, calcareous, graptolitic and pyritic shale of the Black Cove Formation conformably overlies the Table Cove Formation. Approximately 13 m thick, it contains some layers of limestone nodules and olive-brown-weathering, laminated silty shale and calcareous siltstone beds, some up to 10 cm thick.

Cape Cormorant Formation. Limestone breccia belonging to the Cape Cormorant Formation occur in one area of the Roddickton map area, just east of Hatters Pond. The unbedded, poorly sorted deposit is at least 5 m thick. It consists of abundant, irregularly shaped, angular lumps of lime wackestone, some up to 25 cm square,and fewer flat slabs of laminated lime mudstone. The clasts are set in a brown weathering, calcareous mudstone matrix. Rare clasts of white, laminar and tubular fenestral limestone, some up to 35 cm across, also occur. No contacts with adjoining lithostratigraphic units are exposed, but the formation probably rests upon Black Cove Formation shale and is overlain by Goose Tickle Formation flysch.

Middle Ordovician Flysch

Goose Tickle Formation. Folded, poorly exposed, interbedded green-gray sandstone and gray shale of the Goose Tickle Formation complete the autochthonous succession in the map area. The sandstone beds are mostly fine grained, rarely thicker than 30 cm, and exhibit fluted bases, cross- and planar lamination (including climbing ripple drift) and convoluted structures. Cross-laminated siltstone and minor fine grained limestone beds are also intercalated.

Allochthonous Rocks

Maiden Point Formation. Sandstone, conglomerate, siltstone, shale and minor interlayered basalt compose the Maiden Point Formation of the Hare Bay Allochthon in the map area. The succession within the main allochthon is dominated by massive, thick bedded, green to gray, pebbly and gritty, very coarse to fine grained sandstone interbedded with thinly stratified, laminated and locally cross-laminated siltstone and shale. Scours are common at the base of the sandstone. The sandstone is compositionally lithic subarkose composed of gray to blue quartz, plagioclase, rock fragments, muscovite and clays (Williams and Smyth, *in* Bostock *et al.*, 1983).

In an outlier of the Hare Bay Allochthon, west of Gillards Pond (Figure 2), the formation contains a significant thickness of red to reddish-gray pebbly sandstone, sandstone and conglomerate. The conglomerate contains pebbles, cobbles and rarely boulders of white and red quartz, pink K-feldspar, green phyllite, green epidote, fine grained granite, and pink medium grained arkosic sandstone set in a matrix of very coarse grained sandstone. The sandstone is a pebbly, very coarse to fine grained arkose interbedded with gray to brown siltstone. Detrital pink K-feldspar is common. Basal scours, structureless beds, beds of planar stratification and lamination, containing shale interbeds, and some small-scale trough cross-beds characterize the sandstone.

The red beds and coarse conglomerate have the characteristics of subaerial braided-stream deposits. Their association with more typical green sandstone of the Maiden Point Formation rules out the possibility that they are a thrust slice of Bradore or Bateau formation sandstone. Similar rocks, mapped in a narrow thrust slice at Canada Harbour, are defined as Bateau and Bradore formations by Bostock *et al.* (1983). If the red beds are terrestrial clastics, it would suggest the Maiden Point Formation is, in part, a non-marine and deltaic sequence that accumulated along the rifted continental margin of the Iapetus Ocean.

Diabase Dikes of Unknown Age

A suite of thin diabase dikes intrude Cambrian to Ordovician carbonate rocks of the parautochthon. The dikes are pristine in low-strain zones, but sheared and boudinaged where deformed in mylonite zones (Plates 1 and 2). Pristine dikes intrude Petit Jardin Formation dolostone on the western

Plate 1: *Diabase dike of unknown age cutting Petit Jardin Formation dolostone, Englee Head.*

Plate 2: *Boudinaged diabase dike within mylonitized March Point Formation, Barr'd Island, Englee.*

shore of Englee Head (originally described by Betz, 1939) and marbles of the St. George and Table Head groups on the shores of, and inland from, Coles Pond.

The diabase dikes are brown to rusty weathering, dark green-gray to gray, and aphanitic to plagioclase porphyritic. They are mostly 35 to 70 cm wide, but at Coles Pond they are up to 3 m wide along a strike length of 15 m. The dikes trend between 040 to 046° and 062 to 090°, and dip between 55 to 90° southeast. They are pyritiferous, and have vesicular margins at Englee Head.

STRUCTURE

The Roddickton map area provides an unique opportunity to study a structural transect across the deformed margin of the St. Lawrence Platform in Newfoundland (Figures 2 and 4). The area includes a foreland of relatively undeformed autochthon in the west and a north-trending stack of imbricate thrusts in the east (parautochthon), which are structurally overlain by the Hare Bay Allochthon. Metamorphism and deformation increases eastward in the parautochthon. At least two phases of deformation affect the parautochthon. Metamorphism is in the subgreenschist to greenschist facies. Both foreland and parautochthon are cut by numerous northeast-trending high-angle cross faults.

In the foreland, west of the Hatters Pond fault, undeformed Cambrian strata dip gently northward off Precambrian basement. The only significant structures are a number of north- and northeast-trending faults, which generally show minor vertical offset. East of the Hatters Pond fault, the Cambro-Ordovician sedimentary rocks trend north to northwest and dip gently to moderately eastward. They are affected by cleavage or folding only locally, close to cross faults. Southward along the west side of Chimney Arm, fine grained lower Cambrian strata are metamorphosed to slate. They are openly folded about northeast-plunging fold axes, and are cut by a moderate to steeply southeastward-dipping, northeast-trending penetrative cleavage. At present, it is unclear if this area is underlain by a thrust and is actually part of the thrust stack. The style of deformation certainly is comparable to that in the frontal thrusts of the parautochthon on the east side of Chimney Arm.

The parautochthon is deformed by a series of high- to low-angle thrust faults named in west to east succession: Salmon Pond, Drummond Island, Bide Head (Plate 3), Lanes Pond—East Pond, Englee Head and Bide Arm thrusts (Figure 4). A number of smaller thrusts occur in the Coles Pond area. The roof thrust is represented by the sole thrust of the Hare Bay Allochthon, which is a moderately to steeply eastward-dipping structure. An outlier of the allochthon occurs west of Gillards Pond resting upon the Lanes Pond—East Pond thrust slice and a tectonic breccia of shale. Similar tectonic breccia occurs just southeast of Coles Pond beneath the main allochthon, but in general a sharp thrust contact is developed without mélange or breccia. Locally, very narrow slivers of the allochthonous Maiden Point Formation sandstone occur between the Gillards Pond outlier and the main allochthon. Williams and Smyth (*in* Bostock *et al.*, 1983) concluded that early recumbent folds and a low-angle penetrative cleavage associated with emplacement of the allochthon deformed the Maiden Point Formation. Steep northeast-trending structures later deformed the allochthon and the basal thrust.

In the western part of the parautochthon, the lowest thrust slice is relatively undeformed except at the bottom and top of the slice. North-trending, west-verging folds associated with a north-trending cleavage occur at the base of the thrust slice on Western Point. North-trending west-facing recumbent folds occur at the top near Bide Head. At the top of the slice from East Pond north to Lanes Pond, bedding is intensely flattened to a phyllitic limestone mylonite, and contains a southeast-trending and southeast-plunging stretching lineation. The recumbent structures near Bide Head are folded about later northeast-plunging and northeast-trending upright folds that are accompanied by a penetrative axial planar cleavage. Northeast-trending cross faults cut the thrust slice.

In the eastern part of the parautochthon, the succession is strongly deformed and metamorphosed in the subgreenschist to greenschist facies. Shale is transformed to slate and chloritic phyllite, and limestone to marble (Plate 4). Thrust

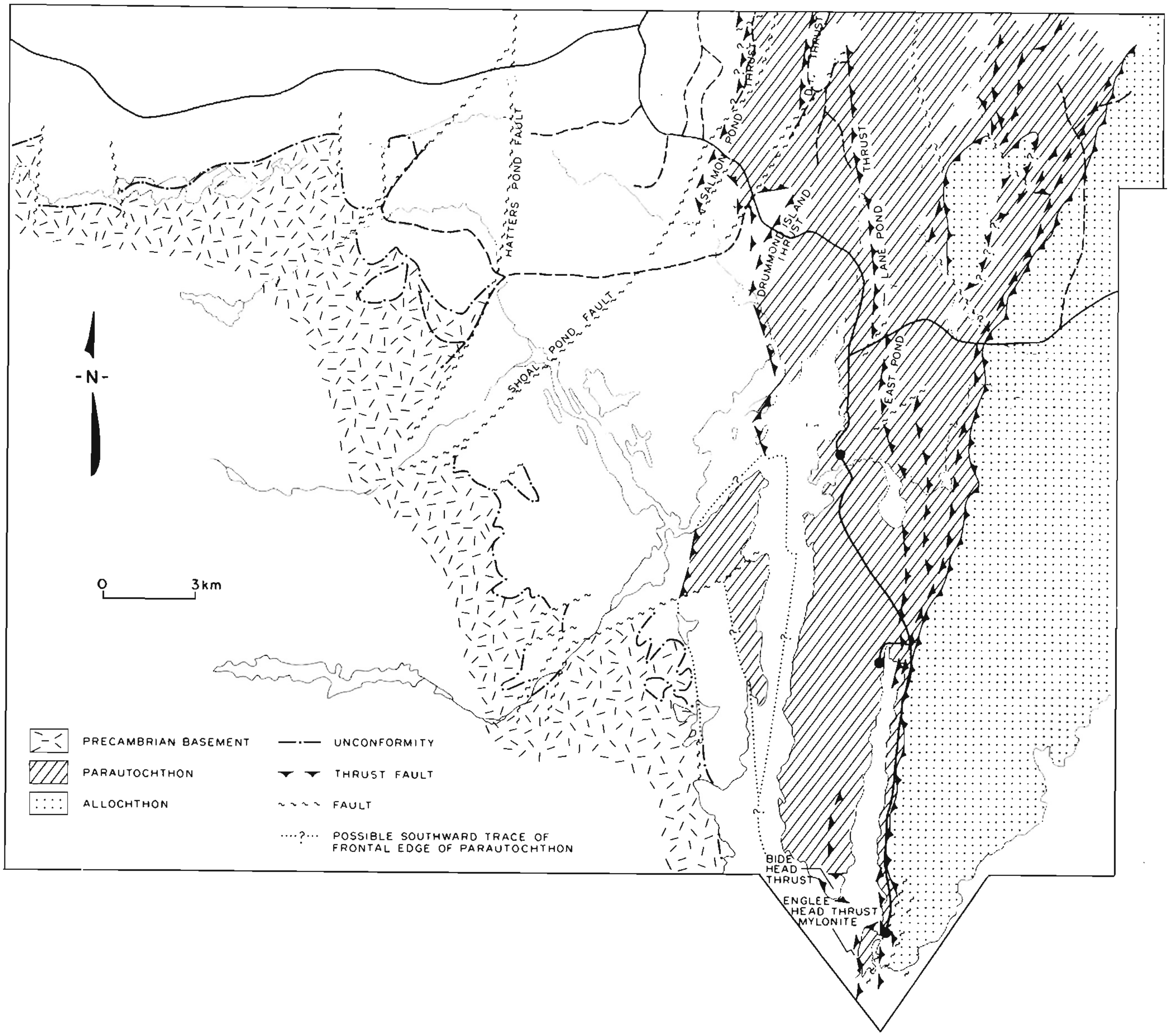


Figure 4: *Structural elements of the Roddickton map area.*

faults, limestone–shale mylonite zones (Plate 5), intense flattening and associated southeast-trending stretching lineations (Plate 6), *C–S* fabrics, boudinage of dolostone units and diabase dikes (Plate 2), as well as west-verging, small- and large-scale recumbent folds (Plate 7), all occur in the zone. Type 3 interference fold patterns, sheath folds, rotation of small recumbent folds, folding and rotation of the stretching lineations about recumbent folds (Plate 8), and boudinaged and rotated calcite veins (Plate 9) occur in mylonite zones and the easternmost part of the parautochthon. These structures are gently folded about northeast-plunging open folds, and are offset by the northeast-trending cross faults and minor structures such as kink bands (Plate 5). Unlike areas in Hare Bay and Pistolet Bay, no mélange is present in the map area, and all thrusts are hard rock.

The discovery of diabase dikes of likely post-Middle Ordovician age that are deformed by thrusts in the Englee area suggests the main structures of the platform, i.e., thrust faults and recumbent folds, may be Acadian rather than Taconic in age. Lamprophyric and diabase dikes cut platform, mélange and allochthon in the Hare Bay area (Williams and Smyth, *in* Bostock *et al.*, 1983). Williams and Smyth *(op. cit.)* indicate that the dikes postdate the latest steep cleavage in bordering rocks. A whole-rock K–Ar age of 408 ± 17 Ma is given for the lamprophyres (Wanless *et al.*, 1968). Dikes near Coles Pond that superficially appear to lack a structural fabric are cut by shear planes and *en échelon* quartz and epidote veins. Diabase dikes cut the Cambro-Ordovician Coney Arm Group and Precambrian basement in southern White Bay. These dikes are truncated by thrust faults and deformed by structures interpreted as post-Taconic by Tuach and French (1986).

If the diabase dikes in the map area form a common suite, they are probably at least post-Taconic in age. Since they are

Plate 3: *The Bide Head thrust: Petit Jardin Formation dolostones structurally overlying flattened and recumbently folded limestone of the St. George Group.*

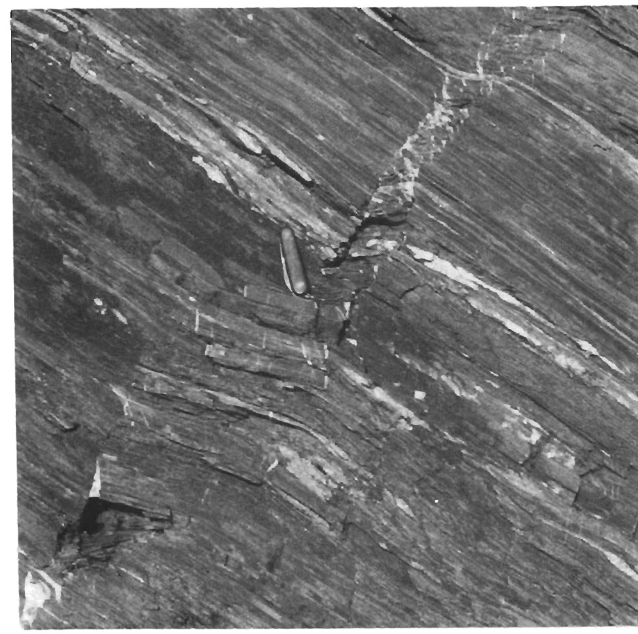


Plate 5: *Limestone mylonite crosscut by late kink band, Englee Head.*

Plate 4: *Folded white marble, metamorphosed St. George Group, Englee Head.*

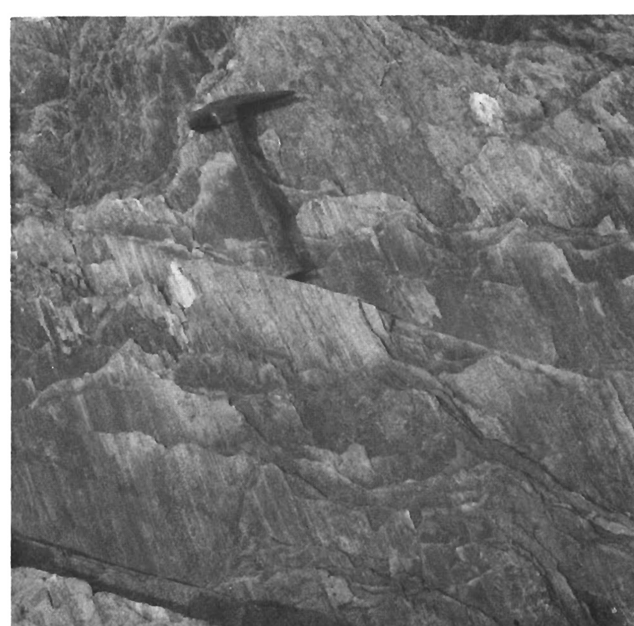


Plate 6: *Stretching lineation, Ordovician marble, Englee.*

Plate 7: *Recumbent folds, Middle Cambrian March Point Formation, Barr'd Island.*

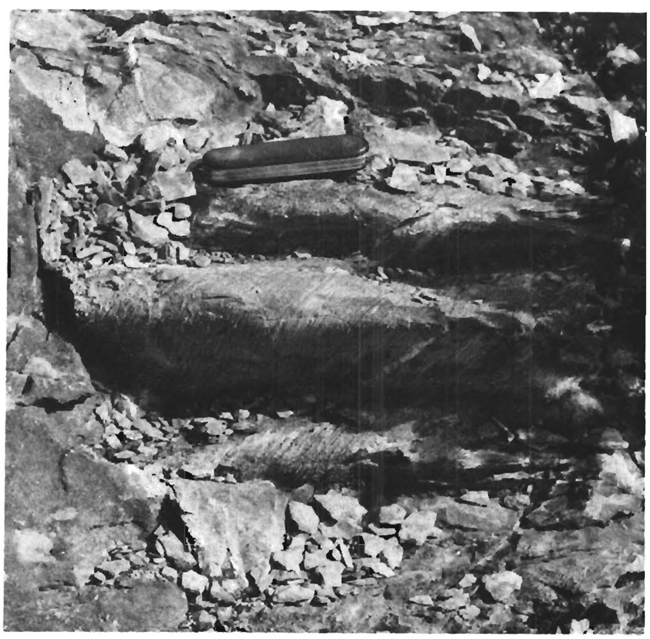


Plate 8: *Stretching lineation folded around small recumbent folds, March Point Formation, Englee Head.*

deformed in the map area by the thrust faults, it is perhaps reasonable to conclude that the main deformation in the area is Acadian in age. This would also include the imbricate thrust stack of the Canada Harbour area to the south, where not only the allochthon, but Precambrian basement rocks are interpreted to be involved in Taconic thrusting (Williams and Smyth, *in* Bostock *et al.*, 1983). Furthermore, since it can be shown in the Hare Bay area that the allochthon was emplaced during Taconic orogenesis (Williams and Smyth, *in* Bostock *et al.*, 1983), it appears that evidence of this event is obliterated in the map area. Based upon the interpretation for the Canada Bay area, brittle thrusts that affected the autochthon, mélange and allochthon in the Hare Bay area (Williams and Smyth, *in* Bostock *et al.*, 1983; Knight, 1986) may be entirely Acadian in age.

Plate 9: *Rotated calcite veins within limestone mylonite, Englee Head. Dextral shear indicated, suggesting westward overthrusting.*

Horizontal shortening involved northwestward overthrusting. Sheath folds, rotation of recumbent fold axes, folding and rotation of stretching lineation, and generation of type 3 interference folds in the sole and the higher levels of mylonite zones close to the Hare Bay Allochthon suggest that the main deformation was either a multiphase or continuous process. Toward the foreland, deformation within thrust slices is associated with local zones of high strain close to the thrust faults. Later shortening was accommodated by northeast-trending and northeast-plunging folds, and cogenetic high-angle cross faults.

ECONOMIC GEOLOGY

Base Metals

Galena and sphalerite occur together in dolostone of the Petit Jardin Formation along Northwest Brook. Other showings reported by Sauerbrei (1964) and Siragusa (1966) occur in the same formation just south of Roddickton. Sphalerite noted near Montgomery Pond by Phillips Management (1975) also occurs in Petit Jardin Formation dolostone. Minor sphalerite is developed at the base of the Watts Bight Formation at Roddickton, and is associated with fluorite at the top of the formation along Beaver Brook.

The Northwest Brook showing consists dominantly of galena (approximately 2 percent) and minor honey-green sphalerite. The minerals occur in the upper 20 cm of a 75-cm-thick bed of vuggy, stromatolitic, massive dolostone and the overlying 30-cm-thick dolostone bed. The mineralization occupies fracture and vug porosity over a strike length of 13 m.

Brown-red to yellow sphalerite occurs in cherty, dark-gray, cryptalgal dolostone mound beds of the basal Watts Bight

Formation at Roddickton. The showing exposed in a drainage ditch at Canning Sales and Service contains a small pod of disseminated sphalerite associated with a zone of chert in the mounds. Although the mound horizon was traced laterally in the Roddickton area, no further mineralization was found.

Honey-colored, vuggy, diagenetic(?) dolostone, and dolomite breccia rich in sparry dolomite contain sparsely disseminated, brown-red sphalerite and green translucent fluorite near the 'underground hole' on Beaver Brook. The host dolostone forms vertical pillars up to 20 m wide and 50 m long that replace large cryptalgal mounds and associated grainstones in light-gray limestone at the top of the Watts Bight Formation.

Other showings reported by Cominco (Sauerbrei, 1964; Siragusa, 1966) and by Phillips Management (1975) have not been located. They are all reportedly small (<2 percent Zn) and composed of disseminated yellow-green sphalerite and pyrite in Petit Jardin Formation dolostone.

One of the post-Middle Ordovician diabase dikes that cut Petit Jardin Formation dolostone at Englee Head hosts a rusty-orange gossan. The dike, which is 40 cm wide, is extensively altered to a siliceous, carbonitized light-gray rock containing visible pyrite. The alteration affects the width of the dike over its exposed strike length. A chip sample along the length of the dike assayed 1080 ppb Au.

Industrial Stone

Metamorphism of limestone in the St. George and Table Head groups has produced marbles of various grades in eastern thrust slices of the parautochthon. The marbles vary from gray through dappled (gray and white), to off-white to brilliant white. Boudinaged remnants of dolostone beds occur in some marbles, others retain bedding as color banding (Plate 4), dolomite laminae and phyllitic and chloritic partings. However, the marbles are locally massive, fine grained and white. Several deposits occur: 1) Penny's Pond, 2) along Marble Brook to Marble Pond, 3) the ridges northeast of Penny's Pond, 4) the ridges west and east of the outflow of Coles Pond, and 5) two ridges south of inner Coles Pond. Other well known marble deposits occur at the southern tip of Englee Head.

The deposits at Penny's Pond, Marble Pond, west and south of the outflow at Coles Pond, the eastern deposit south of Coles Pond and the deposits at Englee Head are all believed to lie stratigraphically within the basal part of the St. George Group. Other high-grade marbles replace limestone from the top of the St. George Group and the basal part of the Table Point Formation. Such deposits occur on the ridge east of the Coles Pond outflow, the ridge northeast of Penny's Pond and the western deposit south of Coles Pond. Further discussion of the marble deposits of the area is given by Howse *(this volume)*.

High-quality pure limestone suitable for cement and building stone occupy an area of more than 15 km² in the map area. The deposits all lie to the north and within a few kilometers of Beaver Arm and Northeast Arm, which have deep water and are open to shipping for at least 9 months of the year. The deposits occur on ridges underlain by light-gray, fenestral limestone and dark-gray limestone of the Table Point Formation. Whereas some nodular chert horizons and argillaceous seams occur in the more than 50-m-thick section of dark-gray limestone, the fenestral limestone, which is 18 m thick, appears visually and petrographically to lack impurities, especially dolomite. It is composed of original calcium-carbonate components and calcite cements, and is hard, massive and non-porous. Since it is thick bedded and contains fossils and interesting depositional fabrics, it may be also suitable as a building stone.

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