CAMBRIAN-MIDDLE ORDOVICIAN STRATIGRAPHY OF SALMON RIVER REGION, SOUTHWEST HARE BAY, GREAT NORTHERN PENINSULA

by

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INTRODUCTION

The map area is located in the southern part of Hare Bay on the Great Northern Peninsula (Figure 1). Most of the east half of the Salmon River (12P/1) area, the northeast corner of the adjacent St. Julien's (2M/4) area, and the Brent Islands of the St. Anthony (2M/5) area were mapped on a 1:50,000 scale during the 1980 field season (Figure 1). This work is a continuation of the Daniel's Harbour Project started in 1976 (Knight, 1976, 1977a, 1978, 1980; Snow and Knight, 1979; Knight and Saltman, 1980). The rocks of the area are part of the western platform carbonate and flysch sequence deposits that overlies Grenville basement rocks of the Great Northern Peninsula inlier in, western Newfoundland (see Stevens, 1970; Williams, 1975). The platformal rocks are divided into two broad groups: (a) Cambro-Ordovician sediments of platformal to basinal aspect; this sequence includes both clastic and carbonate rocks and a flysch unit at the top; (b) allochthonous sedimentary, volcanic and plutonic rocks of the Hare Bay Allochthon (Gillis, 1966; Smyth, 1971, 1973) that is thrust over the Middle Ordovician flysch unit of the Goose Tickle Formation.

Access to the area west and southeast of Salmon River is provided by woods roads which branch off the gravel highways leading to Main Brook and Croque. The coastal exposures were completed by boat.

A veneer of locally derived glacial till or the products of *in situ* weathering, highly variable in thickness, covers most of the inland area. The topographically high areas are extensively covered by spruce forest and plateaus are covered by bog. Bedrock exposure is generally poor.

Karstification has greatly modified the topography. Many dry canyons, underground waterfalls and caves are present so the drainage system in the area is unpredictable; *e.g.* rivers flow into but not out of many ponds. During early spring, the water level of the ponds is high because the underground holes are frozen, but during the summer ponds become dry as subterranean runoff is permitted. Subterranean flows resurface in many shoreline springs.

PREVIOUS WORK

The Cambro-Ordovician geology of the area was relatively unknown, with previous investigations concentrating mainly on the stratigraphy of the transported rocks north and east of the present map area (Murray, 1881; Cooper, 1937; Gillis, 1966; Tuke, 1968; Smyth, 1971; 1973; Williams, 1975; and Bostock *et al.*, 1976). The only reconnaissance account of the lower Paleozoic rocks of Hare Bay (Cooper, 1937 and Bostock *et al.*, 1976), was based on mapping in southern Hare Bay and northeast of the map area. Stevens and James (1976) presented a detailed study of the Ordovician sponge mounds of the Brent Islands. Conodont (Fahraeus, 1970; Stouge, 1980b) and graptolite age data (Erdtmann, 1971a, b) are available for the map area and surrounding areas.

STRATIGRAPHY

Present mapping revealed a sequence of carbonate rocks ranging in age from

LEGEND

AUTOCHTHON

MIDDLE ORDOVICIAN

5a **Melange:** Black and bright green shales with blocks of green chert, hemipelagic limestone, pelagic dolostone, pillow lava and massive and coarse sandstone. Siltstones at the top.

5 **Goose Tickle Formation:** Gray-green siltstone and shale; minor brown weathering sandstone and conglomerates at the top; black shales with limestone nodules/beds.

4 **Table Head Formation:** Massive bedded, micrite, biomicrite; nodular bedded, micrite-biosparite and hemipelagic limestone. Shaly at the top.

LOWER-MIDDLE ORDOVICIAN

WEST	EAST
3d **Unnamed unit:** Dolostone, finely laminated, dolomitic micrite and minor bioturbated micrite and massive bedded fenestral micrite. Stromatolites and chert at base.	3 **St. George Group:** Stromatolite and sponge mounds predominate: chert abundant. Bioturbated micrite, medium - bedded; minor dolostone units. Undivided equivalents of 3a-d.
3c **Catoche Formation:** Medium bedded micrite-biosparites, bioturbated, dolomitic burrows. Minor mounds and minor finely laminated dolostone.	
3b **Boat Harbour Formation:** Dolostone interbedded with finely laminated dolomitic micrite and bioturbated micrite. Chert mounds; minor massive bedded micrite.	
3a **Watts Bight Formation:** Vuggy, dolostone, brown. Mounds and bioturbated dolostone. Chert.	

CAMBRIAN

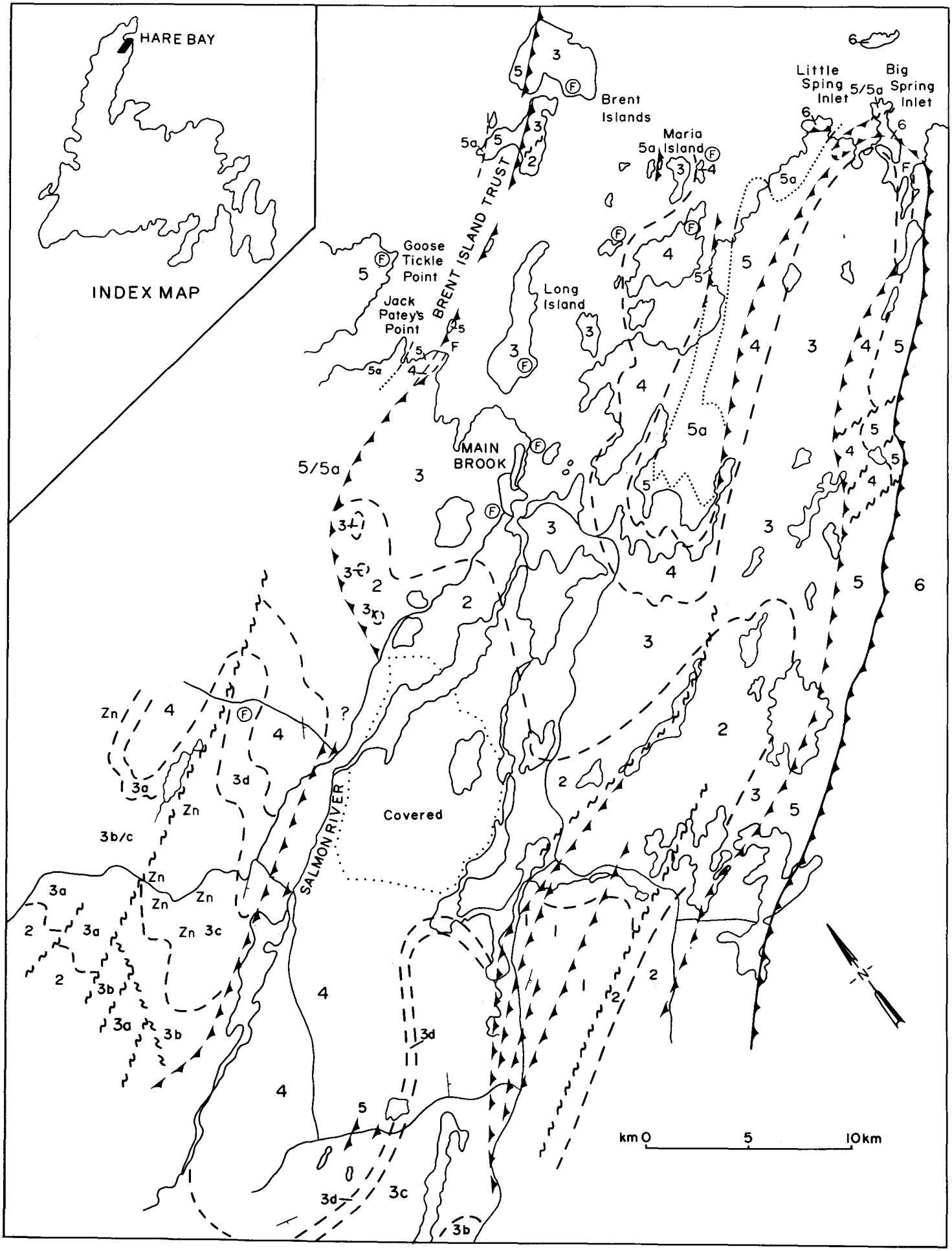
2 Massive bedded dolostone, gray, homogeneous, yellow weathering. Dark gray, brown dolostone, chert, stromatolitic mounds. Minor shale, finely laminated dolostone and vuggy dolostone.

1 Gray, rusty brown weathering shale; ribbon limestone; oolitic/ oncolitic limestone; minor stromatolite mounds.

LOWER? CAMBRIAN (or older)

HARE BAY ALLOCHTHON

6 **Maiden Point Group:** Coarse and massive bedded gray sandstones, minor shale and siltstone. Minor volcanoclastic rocks.


HARE BAY
INDEX MAP
Brent Islands
Maria Island
Little Sping Inlet
Big Spring Inlet
Goose Tickle Point
Jack Patey's Point
BRENT ISLAND TRUST
Long Island
MAIN BROOK
SALMON RIVER
Covered
km 0 5 10km

Early Cambrian(?) to at least Middle Ordovician. The sequence breaks down into two distinct divisions, (1) shelf carbonates in the southwestern area and (2) shelf-edge carbonates, including oolitic shoals and stromatolitic mounds that pass into shelf-slope, basin shales, ribbon limestones and turbidites in the northeast.

Besides the northeast-southwest facies change, there is an northeast-southwest change in dolomitization and in the presence of the associated mineralization in the Ordovician rocks. The Ordovician shelf carbonates to the northwest are almost identical in facies, degree of dolomitization and style of mineralization to those described by Knight (1978; 1980) for the St. Barbe area. However, the Ordovician shelf edge sediments of northeastern Hare Bay are different from those in the west in that secondary dolomitization is mainly restricted to minor beds or burrows in bedded limestone and mound structures. Mineralization is absent in the northeastern part of the map area. A similar change is noted in the Canada Bay area (Knight and Saltman, 1980).

Six rock units were identified in the map area (Table 1), none of which are formalized. The Cambrian sediments comprise Units 1 and 2. The Ordovician strata are included in Units 3 (St. George Group), 4 (Table Head Formation), 5 (Goose Tickle Formation) and 5a (melange) (Figure 1). West of the Salmon River thrust, the St. George Group sediments were subdivided into Units 3a to 3d. Northeast of Salmon River, the subdivision of Unit 3 cannot be applied at present because of differences in facies and dolomitization. A new unit (3d) divisible into two subunits or members, has been recognized in the Hare Bay area. It forms the top formation of the St. George Group.

The Middle Ordovician Table Head Formation of shelf and slope deposits is divided into two members. The Middle Ordovician clastic deposits of the Goose Tickle Formation may be divisible into three members and a melange unit of Middle Ordovician age consists of two members.

A general stratigraphic scheme for the map area and approximate correlations with the Roddickton map area to the south (Knight and Saltman, 1980) and with the west coast of the Great Northern Peninsula (Knight, 1978; Knight and Snow, 1979; Schuchert and Dunbar, 1934) is presented in Table 1. Names used by Cooper (1937) are also included for reference.

CAMBRIAN

Cambrian strata in the area include the lower and middle Cambrian Unit 1 and a middle(?) to upper Cambrian carbonate sequence (Unit 2). The typical Western Platform Cambrian stratigraphy is not fully preserved here because the Labrador Group has not been recognized in the area and the lower part of the overlying Micrite Unit of Knight (1978) is apparently missing. This may be due to thrusting of lower and middle Cambrian sediments (Unit 1) over the middle(?) to upper Cambrian (Unit 2).

LOWER AND MIDDLE CAMBRIAN

Cambrian Shale-Limestone Unit (Unit 1)

In Hare Bay, lower and middle Cambrian sediments (Unit 1) are preserved in thrust slices that are exposed along the Main Brook road (Figure 1). The sediments are composed of clastic and carbonate rocks. Three stratigraphic successions (A, B and C) are preserved in separate thrust sheets from west to east. Faults and isoclinal folds have produced repetitions of the strata as well as complicating the internal stratigraphy. The three successions in combination are, however, considered to form a diverse section, which is included in a common stratigraphic interval and generally coarsens upwards.

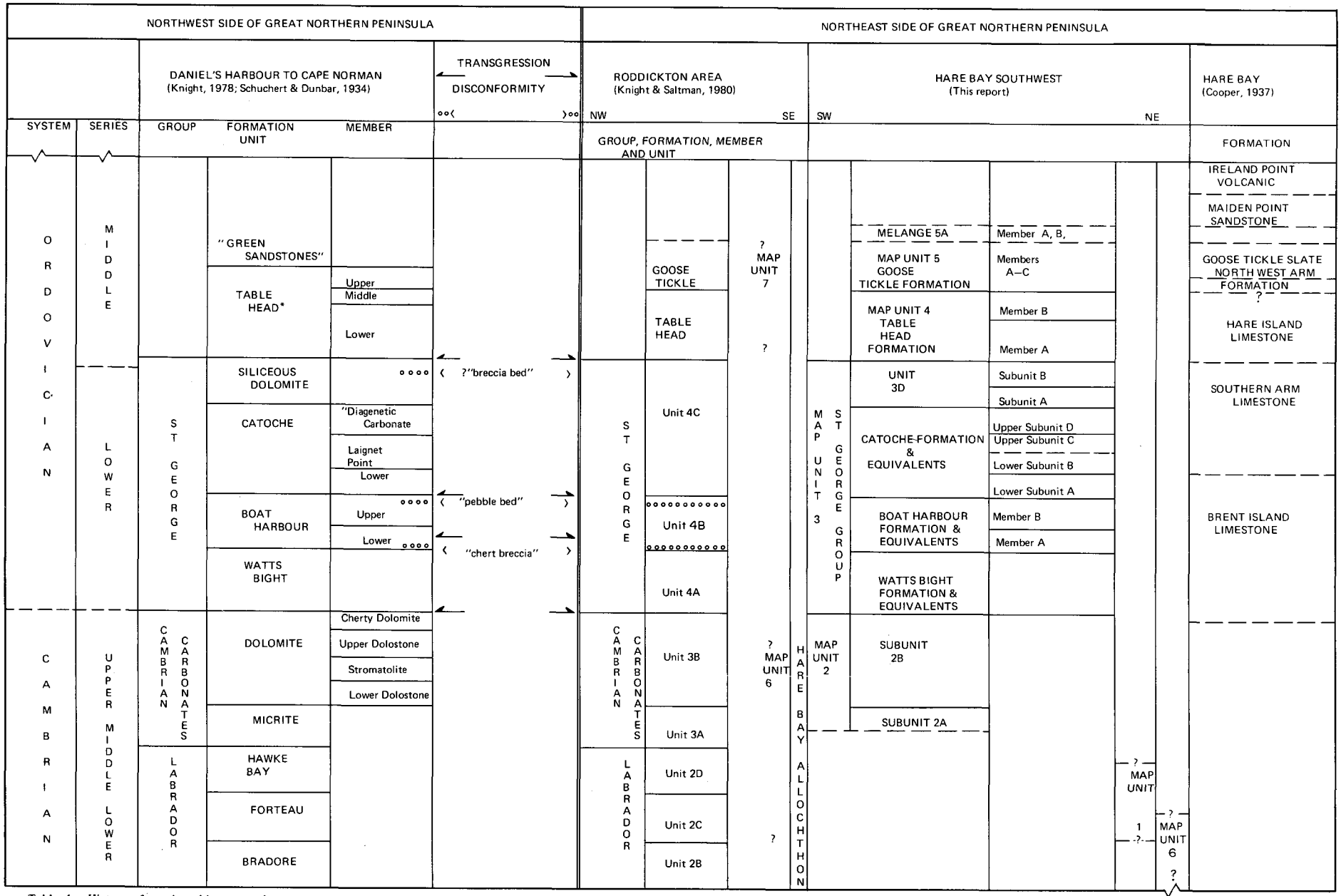


Table 1. History of stratigraphic nomenclature

A) Shale-Ribbon Limestone-Oolitic Limestone: The lower part in the westernmost thrust sheet consists of gray to green, rusty brown weathering calcareous shale with beds of siltstone, and rarely fine grained sandstone. This lithology cannot be distinguished easily from part of the Goose Tickle Formation (Unit 5, member B) of early Middle Ordovician age (see Bostock *et al.*, 1976).

The middle part consists of dark, bluish gray micrite, interbedded with rusty brown weathering gray shales. The overlying upper sediments consist of a number of limestone lithologies. These include red weathering, bedded, bluish gray micrite with yellow argillaceous stringers, and oolitic limestone with minor oncolitic limestone. The top of the upper part consists of large algal mounds associated with oolitic and oncolitic limestone. The thickness of this upper division exceeds 20 m.

(B) Oolitic Limestone - Thinly bedded Limestone Silty Limestone: The thrust slice contains a dark gray to bluish gray, massive oolitic micrite at its base which is succeeded by sandy, intraclastic, light gray and mottled limestone. Silty, finely laminated, dolomitic limestone is a minor component. Crossbeds in the oolitic micrite and ripples with oolite-filled troughs are common in the siltstone.

(C) Shale Silty Limestone Oolitic Limestone: This slice contains rusty brown weathering shale overlain by silty, homogeneous, locally sparry, micrite and uniform, massively bedded, dark gray, oolitic limestone. White quartz and black chert occur with the oolitic limestone.

MIDDLE(?) TO UPPER CAMBRIAN

Unit 2

Yellow weathering and brown weathering, massive to medium bedded, dark gray dolostones (Unit 2) form the oldest shelf sediments of the area. The sediments are well exposed in the westernmost extremity of the map area and are in continuity with units mapped further west (Knight, 1980). The unit also occupies an east-west trending belt in the center of the map area. The unit is divisible into two lithological subunits.

Subunit 2A: Massively bedded, dark gray to light gray, mottled dolostones, bioturbated dolostones with vugs partly filled by white quartz, and dull brown weathering dolostones with white stringers characterize subunit 2A. It is at least 30 m thick. This subunit correlates with the lower part of Knights Unit 3 in Canada Bay (Knight, *personal communication*, 1980; Knight and Saltman, 1980).

Subunit 2B: This subunit consists of an alternation of brown weathering, massively bedded and finely laminated, dark gray dolostone; pale yellow weathering, massive bedded, light gray, homogeneous dolostone; and medium bedded, gray rusty brown weathering, platy, commonly mudcracked dolostone. Gray dolomitic shales are minor associates. The subunit is over 300 m thick.

The succession consists of a lower part of dolostone and dolomitic shales, with stromatolitic algal mounds and dolostones. These are overlain by an upper part consisting of homogeneous dolostone which is followed by repetitive strata of dolostone. Lamellar and columnar stromatolites and cherty algal mounds are common in this upper part. This description suggests a comparison with Unit 3B (Knight, 1980) of the Canada Bay area.

ORDOVICIAN

Ordovician strata consist of the Lower-Middle Ordovician St. George Group and the Middle Ordovician Table Head and Goose Tickle Formations. The sequence is

structurally dissected by normal and thrust faults, but the partial sections overlap, and a complete stratigraphic section can be established.

Lower-Middle Ordovician

St. George Group (Unit 3)

The base of the St. George Group is marked by the top Cambrian carbonate dolostone sequence. The boundary is conformable in the area as it is elsewhere on the Great Northern Peninsula (Knight, 1980).

Cooper (1937) divided the Ordovician carbonates of Hare Bay into three formations in ascending order, the Brent Island Limestone, Southern Arm Limestone and Hare Bay Limestone. Although this division appears useful for the east to northeastern part of the map area it cannot be applied southwestwards until the type sections are defined. Thus, the stratigraphy and redefinition of the formations must await completion of mapping in the Hare Bay area.

Knight (1978) subdivided the St. George Group carbonates from the western part of the Great Northern Peninsula into four formations or units, namely, the Watts Bight Formation, the Boat Harbour Formation, the Catoche Formation (Kluyver, 1975), and the "Siliceous Dolomite" unit. Broadly, the Watts Bight Formation, the Boat Harbour Formation and the lower part of the Catoche Formation (Table 1) are equivalent to the Brent Island Limestone (Cooper, 1937). The upper part of the Catoche Formation correlates with the Southern Arm Limestone. The "Siliceous Dolomite" unit is contained in the Hare Island Limestone (Cooper, 1937; Table 1).

The rocks exposed west to southwest of the Salmon River thrust correlate with the stratigraphy of the western part of the Great Northern Peninsula (Knight, 1978, in press) and will be briefly discussed here. East to northeast of the Salmon River thrust, sediments with similar stratigraphic and structural positions to those in the west differ in dolomitization and predominance of bioturbated limy mudstone and large stromatolite mounds, but are similar to the succession described for Canada Bay (Knight and Saltman, 1980) on strike to the south. Both the west and east successions are conformably overlain by the Table Head Formation (Middle Ordovician).

Watts Bight Formation (and equivalents) (Unit 3a).

The Watts Bight Formation (Lower Ordovician) was defined by Knight (1978), who measured and described sections from the Watts Bight area. The formation is about 100 m thick in the type area and conformably overlies the Cambrian carbonate sediments. In Hare Bay, the Watts Bight Formation conformably overlies the Cambrian Carbonates. West of Salmon River, the formation comprises a succession of buff to gray, vuggy dolostone. The dolostones are characterized by bioturbation and spherical, domal and columnar algal structures. Pale blue and white cherts are common associates.

To the east of the Salmon River, the stratigraphically similar strata consist of large stromatolitic, chert-bearing mounds. The mounds have diameters up to 5 m across and chert is multicolored orange and black. This part of the St. George Group is well exposed from the northern tip of Long Island towards the south. On the southern island of the Burnt Islands the lower boundary is obscured due to folding and faulting.

Some of the mounds are similar to the sponge mounds of the Catoche Formation, and distinction between the two formations is difficult without fossil control.

Boat Harbour Formation (and equivalents) (Unit 3b)

The Boat Harbour Formation (Knight, 1978) consists of limestone and stromatolitic dolostones that overlie dolostones of the Watts Bight Formation. The Boat Harbour Formation is approximately 100 m thick at the type section.

In Hare Bay, the Boat Harbour Formation apparently overlies the Watts Bight Formation with a disconformity. The base is a sandy pebble bed with clasts of dolostones and black and pale blue chert which is well exposed on the north coast of the southern island of the Brent Islands. Sparry dolomite partly fills vugs in the bed.

A similar breccia bed was described at a similar stratigraphic position from west of Vee Pond (Knight, 1977), Boat Head, and in the Roddickton area (Knight, 1977, 1980; Knight and Saltman, 1980). Knight (1980) suggested that the bed could be a disconformity or, alternatively, a stratabound collapse breccia. The widespread distribution of this horizon favors the former interpretation. Current fossil research will focus on this problem.

The Boat Harbour Formation in the Hare Bay region consists of dark and light gray, bioturbated limestones interbedded with laminated dolostones and homogeneous dolostones. Stromatolitic domal structures associated with black chert and mudcracked, finely laminated, silty dolostones are characteristic. Two members are present in this formation.

Lower Member A: The lower member lies above the basal sand and pebble bed, and consists of a cyclic series of light gray, massively bedded micrite, domal algal mounds capped by black chert, finely laminated dolostones and minor chert bands. Massively bedded, pale gray to white and pale yellow dolostone with cherty algal structures are common in the lower part of the member.

Upper Member B: This member consists of interbeds of medium bedded, bioturbated micrite with dolomitic burrows, dolostones with argillaceous stringers, and finely laminated dolostones. Chert mounds capped by finely laminated silty dolostones, which are mudcracked, are present in minor amounts. The limestones are characterized by burrows along bedding planes. Gastropods are the main faunal component.

Catoche Formation (and equivalents) (Unit 3c)

The Catoche Formation (Kluyver, 1975; Knight, in press) consists of bioturbated, bedded limestone and mounds. On the west side of the Great Northern Peninsula, the top of the limestone is extensively dolomitized (Knight, 1978; in press). The Catoche Formation is about 300 m thick in the type area.

In Hare Bay, east of the Salmon River thrust, the Catoche Formation is not secondarily replaced by dolomite and the formation can be divided into four alternating dark-light-dark-light subunits. The Catoche Formation is approximately 185 m thick in Hare Bay.

Lower Dark Limestone subunit A (75 m): This subunit conformably overlies the Boat Harbour Formation. The limestones are gray to dark gray, medium bedded, bioturbated micrites separated by thin silty layers. Some stromatolite mounds occur. Fossils are present, but not abundant. Trilobites, brachiopods, cephalopods and gastropods are the most common taxa. Conodonts from much of the section include the species *Oepikodus communis* (Ethington and Clark) and imply a correlation with lower Catoche beds of the Catoche Formation on the west side of the Great Northern Peninsula (Stouge, in press).

Lower Light Mottled Mound subunit B (55 m): This subunit includes large mounds surrounded by micritic limestones locally rich in sparite beds and minor dolostone beds. The texture of the

mounds is the result of replacement by dolomite, giving a bioturbated limy mud. Partial dolomitization of the mound structure gives white to light gray, mottled appearances in a dark gray matrix. The mounds, which are up to 3-4 m across and 2 m high, were possibly built by sponges (Stevens and James, 1976). Commonly, the mound beds are interbedded with white, massively bedded, brittle and hard dolostones and associated with trilobites, brachiopods and straight cephalopods.

Upper Dark Gray Limestone subunit C (25 m): Upper subunit C comprises 25 m of dark gray, medium bedded and bioturbated micrites and minor black chert. Silt and shale drapes are common in micrites. Small chert mounds and chert beds are also associated.

The micrites contain a sparce fauna of cephalopods and trilobites. The latter group is represented by *Petigurus nero* Billings and *Uromystrum* cf. *affine* (Poulsen) (D. Boyce, personal communication, 1980), which indicates a late Canadian age for the strata (Boyce, 1978, 1979; Fortey, 1979). Large cephalopods cover whole bedding planes in the upper part of the subunit.

Upper Light Gray Mound subunit D (40 m): The top subunit consists of dolostone, bioturbated micrite, dolomitic stromatolitic mounds and sponge mounds. The sponges may be up to 7 m across and 3-5 m high. Chert forms a minor but characteristic constituent in this unit. In the upper part of the subunit, dolostones become increasingly common. The very top of the subunit is formed of white to pale yellow, sandy, coquina beds and domal algal mounds. Stevens and James (1976) described the sponge mounds from this unit.

Dolomitic sandy dikelike bodies were described by Cooper (1937) as cross-cutting the unit on Maria Island. He interpreted them as fissure fillings formed beneath the Table Head disconformity which had been recorded from the west side of the Great Northern Peninsula by Schuchert and Dunbar (1934). The dolomitic sandy "dikes", which are 20 cm across, resemble similar structures described from the Catoche Formation type section in mound beds by Knight (1977b). Here they are interpreted to have formed either by infilling between the mounds or by selective dolomitization of the mound structure.

Unit 3d

This lithostratigraphical unit of formational rank is 75 m thick at the type section in Little Spring Inlet and Big Spring Inlet. It consists of dolostones and interbedded dolostones and dolomitic limestones and minor bioturbated micrite. The unit conformably overlies the top member of the Catoche Formation and is gradually succeeded by the lower Table Head limestone. The unit, at present unnamed, is included in the top of the St. George Group. The unit is well exposed on Burnt Island in Pistolet Bay and on Hare Island outside the map area, where it was previously included in the Hare Island limestone (Cooper, 1937). Cooper (1937) correlated the Hare Island limestone with the Table Head Formation from the west side of the Great Northern Peninsula (Schuchert and Dunbar, 1934). Elsewhere on the Great Northern Peninsula, strata that occupy a similar stratigraphic position were referred to as the Siliceous Dolomite formation by Knight (1978) or upper dolomite formation (Klappa *et al.*, 1980).

Conodonts (Stouge, unpublished) recorded from the upper part of the unit indicate an early Whiterockian age.

This unit is divisible into two subunits.

Lower subunit A (25 m): The basal subunit is a light gray to pale yellow or white, massive dolostone which is faintly laminated. Stylolites and vertical fracturing are characteristic

but there is no macrofauna. Minor cream colored micrite with yellow argillaceous stringers occurs in thin platy beds and, locally, chert may be abundant.

The lower subunit A is only preserved within shear zones and secondary crystallization has seriously affected the sediments. Locally, the subunit has the appearance of massive "marble" (e.g. Big Spring Inlet and Maria Island east).

Upper subunit B (50 m): The lower part of this subunit consists of cyclic, repetitive, massive dolostone, finely laminated and stromatolitic dolostone, and dolomitic micrite with argillaceous stringers. Above lies a medium bedded, light to medium gray, bioturbated micrite, finely laminated dolomitic micrite and burrowed dolomitic micrite in a dolomitic and argillaceous matrix. Mudcracks are common within the finely laminated sediments and chert may be abundant locally. Fauna is not abundant and is dominated by highspired gastropods (*Hormotoma* sp.) and fragments of conodonts of Whiterockian affinity (Stouge, unpublished). This suggests that, although the unit is included in the lower Ordovician St. George Group on lithological grounds, much of it is of Middle Ordovician age.

In the western half of the map area, a light gray, massively bedded, bird's eye micrite (dismicrite) with stylolites occupies a similar stratigraphic position to subunit B.

Middle Ordovician

Table Head Formation (Map Unit 4)

The name, Table Head Formation, was given by Schuchert and Dunbar (1934) and Whittington and Kindle (1963) to the limestones, limestones and shales, and black shales that overlie dolostones of the St. George Group at Bellburns, Port au Choix and in the Port au Port area on the west side of the Great Northern Peninsula. The Table Head Formation is approximately 350 m thick at the type section (now Table Point) (Whittington and Kindle, 1963; Klappa *et al.*, 1980; Stouge, 1980b). In Hare Bay, strata of this age (Middle Ordovician) were originally referred to as the Hare Bay Limestone (Cooper, 1937). Recently, Klappa *et al.* (1980) redefined the formation to include carbonate breccias of the Table Point and Port au Port areas and included it in the Table Head Group. Their subdivisions are not recognized in the Hare Bay area or are, in general, too detailed to be used in 1:50,000 scale mapping. Consequently, the name Table Head Formation is retained for the limestones.

The Table Head Formation in the Hare Bay region is 115 to 140 m thick, and comprises gray to bluish gray micrites, biomicrites, massive to nodular bedded micrites, hemipelagic limestones and allodapic limestones with shale interbeds. The Table Head Formation is herein divided into two members that broadly correlate with the lower and middle Table Head from Table Point (Stouge, 1980b).

Lower Member A (115 m): The base of this member consists of 25 m of massively bedded and bioturbated, bluish gray micrite interbedded with minor finely laminated, dolomitic micrite and micrite with argillaceous stringers. The lower part becomes increasingly dolomitic at some localities and grades down into the top unit of the St. George Group. The bioturbated micrite often has gastropods (*Maclurites* sp.) and straight cephalopods.

The succeeding upper 90 m consists of micrite and black chert with biosparite lenses. The chert occurs as irregularly shaped stratabound bodies (?sponges) or as competent beds. The top sequence is massively bedded.

This unit has yielded trilobites and conodonts (Stouge, 1980b) of Whiterockian age (Middle Ordovician).

Upper Member B (15-40 m): The upper part of the lower member is shaly and nodular bedded in places and grades into a sequence of shaly limestone and shale of Member B. Member B is up to 40 m thick. This upper member is commonly omitted by thrusting, but it is exposed at low tide at Little Spring Inlet, and in the beach zone 3 km northwest of Main Brook.

This upper member is rich in brachiopods, cephalopods and trilobites, the latter commonly silicified. The following trilobite species have been observed (Fortey, 1979,):

Ampyx sp
Carolinites sibiricus Chuguva
Carrickia sp. nov.
Celmus sp.
Ceratophala sp.
Nileus sp.
Oenonella sp. nov.
Raymondaspis cf. *vesperhinus* Ross
Robergiella? sp.
Shumardia cf. *exophtalmus* Ross

Conodonts (Fahraeus, 1970; Stouge, 1980b) are abundantly represented and include the following species:

Acodus combsi Bradshaw
Belodella jemtlandica Lofgren
Cordylodus? horridus Barnes & Poplawski
Histiodella sp. A
Oistodus aff. *lanceolatus* Barnes & Poplawski
Peridon cf. *aculeatus* Hadding
Polonodus? clivosus (Viira)
Polonodus sp. A sp. nov.
Walliserodus ethingtoni (Fahraeus)

The fosssils suggest a Whiterockian age (Lower Middle Ordovician).

Goose Tickle Formation (Unit 5)

The Table Head Formation is conformably overlain by clastic sediments of shale and sandstone with some lime beds named the Goose tickle Formation (Cooper, 1937; Tuke, 1968). The sandstone beds are more prominent towards the top of the sequence.

The formation was interpreted to be 1860 feet (620 m) thick (Murray, 1961) or more (Cooper, 1937), but internal structural disturbance results in repetitions by isoclinal folding and thrusting, and prohibits an accurate determination of the thickness.

Erdtmann (1971a, b) recorded graptolites from the Goose Tickle Formation at Goose Tickle Point in the northwesternmost extremity of the map area which indicate the Middle Ordovician Zone 9 of the North American graptolite succession (Berry, 1960).

Member A (15 - 20 m): The basal member consists of black shale with commonly associated irregular or regular, lenticular lime nodules, or silty, finely laminated, limestone beds. The limestone nodules are typical of the member in the eastern part of the area (*e.g.* Little Spring Inlet), whereas the sediments grade into shales above the lower hemipelagic limestones of the Table Head Formation elsewhere.

The member correlates with upper Table Head black shales at Table Point (Schuchert and Dunbar, 1934; Whittington and Kindle, 1963).

Member B: Most of the member consists of thinly interbedded, gray-green shale and siltstone. The beds are generally 2 to 4 cm thick, but some siltstone beds are up to 12 cm thick. Typical Bouma (1962) turbidite cycles are recognizable, but most of them contain the upper Bouma divisions only. The siltstone beds are cross laminated and pass upwards through a parallel-laminated siltstone and pelite division into structureless, dark gray pelite. The unit coarsens upwards and grades into member C.

Member C: Gray-green shales, siltstones and brown weathering, fine grained, gray sandstones characterize the member. Flattened pebbles of sandstones 1.5 - 4 cm in size occur in the siltstones. Turbidite cycles are recognizable and

the lower Bouma (1962) divisions are preserved. These consist of graded sandstone and parallel and cross laminated siltstone.

The Goose Tickle Formation is a distal flysch which coarsens upsection, indicating the approach towards the source rocks.

Melange (Unit 5a)

A heterogeneous and chaotic unit (Member A) and siltstones (Member B) overlies the Goose Tickle Formation.

Member A: Member A consists of thinly bedded (2 cm) black and bright green shale with abundant pyrite nodules 2 - 10 cm in size. Bedding in the shales is mostly deformed or chaotic with a heterogeneous assemblage of isolated blocks resting in the shale matrix. Ghost bedding is preserved to the east within the larger blocks, which can be boulder to house size. The blocks include massively, bedded, brown weathering sandstone and shale and, an assemblage of volcanic rocks including pillow lava and porphyritic andesite associated with hemipelagic, dolomitic limestone and chert. Blocks of pelagic, finely laminated crossbedded dolostone are also common. The latter show evidence of soft-sediment deformation. The volcanic rock assemblage occurs only in the east whereas the sedimentary blocks are ubiquitous. The source of the massive sandstone and volcanic blocks is the Maiden Point Group of the Hare Bay Allochthon (Smyth, 1973), but no source is known for the hemipelagic carbonates.

Williams (1975) included Unit 5a in the Northwest Arm Formation (see Cooper, 1937), and separated the unit as a structural slice. More mapping is required to verify this interpretation. At present, the strata within the map area differ from the Northwest Arm Formation by their chaotic appearance (melange) and heterogeneous assemblage of blocks. This is in contrast to the stratabound and monomict lime breccias of the Northwest Arm Formation at its type section. Member A is interpreted as a melange formed during the thrusting of the Hare Bay Allochthon.

Member B: This member apparently conformably overlies member A at Fack Patey's Point. It is composed of gray siltstone interbedded with 1 to 3 cm thick sandstone beds. These beds may be conglomeratic with sedimentary siltstone and sandstone clasts (1 x 3 cm).

LOWER? CAMBRIAN

Hare Bay Allochthon (Unit 6)

Allochthonous rocks for the eastern boundary of the map area and form part of the Maiden Point Formation. It consists of massively bedded (0.5 to 1.5 m beds), brown weathering graywackes, interbedded with green siltstones. The strata are coarse to medium grained. Complete Bouma (1962) turbidite cycles are preserved and sole marks are prominent. The formation is presumed to be of Lower? (or older) Cambrian age (Smyth, 1973; Williams, 1975).

South of Big Spring Inlet and inland, lithologies of white weathering, brown shale and siltstone are prominent. Their stratigraphic affinity is unknown.

DIKES

In the eastern extremity of the map area, a swarm of young diabase (?) dikes averaging 1 m in thickness cut the Ordovician strata. The dikes trend northeastwards and are only affected by small scale faults. The dikes, therefore, are younger than the major deformation of the strata in Hare Bay.

PLEISTOCENE

Pleistocene marine sediments are exposed in many places up to 20 m above present sea level in the lower parts of valleys in the map area. They consist of bluish gray to pale red silts and

claystones with rounded pebbles 1 - 5 cm in size. The sediments are very fossiliferous and contain a diverse fauna which includes:

Arthropods: *Balanus hameri* (Ascanius) (a barnacle)
Pelecypods: *Astarte mortagni striata* (Leach)
Mya truncata Linne
Gastropods: *Buccinum tenue* Gray
Buccinum cyaneum Bruguiere
Natica sp.
Brachiopods: *Hemithiris psittacea* (Emelin)
Bryozoans: (fragments)
Microfossils: Ostracods and, in particular, foraminifera.

STRUCTURE

The rocks of the area were affected by at least two deformations (Smyth, 1973). The first deformation (D_1) folded the strata into a series of anticlines and synclines which commonly are either overturned or recumbent; the folds trend northeastwards and plunge at moderate angles in northeasterly or southwesterly directions. Associated with the folding is a penetrative cleavage which, except in the fold hinges, is subparallel to bedding. Structural pinching out of incompetent units is common, and isoclinal folding is developed in shale units (*e.g.* Units 1 and 5).

Two, perhaps three, thrust faults associated with the first deformation (D_1) are recognized within the autochthonous sequence. These are: (1) the Salmon River thrust, which juxtaposes St. George Group strata against Table Head/Goose Tickle Formations; (2) the Burnt Island thrust, which juxtaposes the southern Cambrian carbonates over ?Goose Tickle Formation or Table Head Formation, whereas in the north on Brent Islands, St. George Group strata override the Goose Tickle Formation; and (3) the Main Brook Road thrust, which juxtaposes Cambrian carbonates and the St. George Group against the shales and oolitic limestones of Unit 1. The thrusts were probably formed during recumbent folding synchronous with emplacement of the Hare Bay Allochthon over the carbonate sequence.

The uncertain age affinity of the shale unit exposed west of Main Brook (Figure 1) means that the southern extension of the Brent Island thrust could either join with the Salmon River thrust or extend across the map area to connect with the Main Brook road thrust fault.

A second deformation (D_2) is developed in the rocks of Units 1 to 5. This deformation folded the penetrative cleavage of D_1 into open synclines and anticlines.

Minor northeast and northwest trending faults cut the strata. In the carbonate terrain, these are commonly associated with "pseudobreccias" in the limestones or with prominent breccias within dolostone units.

ECONOMIC GEOLOGY

Zinc mineralization is located to the southwest and to the west of the area (Cant, 1976; Cant and van Ingen, 1976; Knight, 1980) and east of the Salmon River thrust. The mineralization is associated with white sparry dolomite which has replaced limestone ("pseudobreccia") of the Catoche Formation. The zinc occurrences are exposed mainly near northeast trending faults and are located sporadically for distances of 14 km near the faults. Minor zinc occurrences have also been observed in limestones unaffected by secondary dolomitization. No new significant zinc mineralization was found.

The potential for hydrocarbons within the area lies in the shales of the Goose Tickle Formation and Unit 5a. These pyritiferous and bituminous black

shales are tentatively suggested as source rocks. Vuggy carbonate rocks within the Watts Bight Formation and "Diagenetic Carbonates" are potential reservoirs. The northeast trending faults and the recumbent folds are potential traps.

The Pleistocene marine sequence is, in places, completely free of coarser particles and is a clean clay. This may be of potential use in the ceramic industry.

Commercial limestone deposits in Hare Bay have been described by Cooper (1937), Harris (1962) and DeGrace (1974).

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