Current Research (1997) Newfoundland Department of Mines and Energy,
Geological Survey, Report 97-1, pages 211-235

GEOLOGY OF CAMBRO-ORDOVICIAN CARBONATE SHELF AND COEVAL OFF-SHELF ROCKS, SOUTHWEST OF CORNER BROOK, WESTERN NEWFOUNDLAND

I. Knight
Newfoundland Mapping Section

ABSTRACT

Low-grade metamorphosed sedimentary rocks, southwest of Corner Brook, form part of a complex foreland fold-and-thrust belt that deformed lower Paleozoic rocks of the Laurentian margin. Cambro-Ordovician carbonate shelf rocks and coeval deeper water, off-shelf rocks of the Pinchgut Lake group were carried together northwestward on a major thrust, above terrigenous foreland basin rocks. Mapping outlines a major, northeast-trending and plunging antiformal stack, the Blue Pond thrust stack, which comprises multiple duplexes and horses, many of which are forward facing and display significant ramp geometry. Lithostratigraphy, facies, and a regional metamorphic grade suggest that the Blue Pond thrust stack has a common history with another thrust stack in the Goose Arm area.

The Blue Pond thrust stack lies between the Humber Arm Allochthon to the west and higher grade metasedimentary and basement/cover domains to the east. The allochthon consists mainly of inverted strata of the Irishtown formation and formed the west-dipping roof to the duplexes; it may have been finally emplaced while the duplexes were being constructed. To the east, mapping of faults and domains indicates that the metasedimentary and basement domains of this part of the area also form a thrust stack. This complex imbrication preceded formation throughout the area of east-verging folds and a penetrative cleavage.

No base-metal showings are known to occur in the area but there is a significant variety of marble of probable economic value.

The interpretation of a major regional overthrust in this part of western Newfoundland has important implications for future hydrocarbon exploration. This is because these metasedimentary terranes must have been carried far westward from their original detachment and have probably come to rest above, and adjacent to, the generally pristine foreland which is the target of present exploration.

INTRODUCTION

Geological mapping, at the scale of 1:50 000, was begun southwest of Corner Brook on mainly unknown sequences of Cambro-Ordovician carbonate shelf rocks and coeval off-shelf deep water metasediments that outcrop in the corners of four map areas. The carbonate shelf rocks mainly underlie the northeast and southeast corners of the Harry's River (NTS 12B/9) and Georges Lake (NTS 12B/16) map areas respectively. Although the shelf rocks also occur in the respective southwest and northwest corners of the Corner Brook Lake (NTS 12A/13) and Little Grand Lake (NTS 12A/12) map areas, these areas are predominantly underlain by off-shelf sedimentary rocks of the Pinchgut Lake group, their metasedimentary equivalents, and Ordovician flyschoid rocks. Carbonate shelf rocks occurring in the northwest of the Corner Brook Lake map area, east of Corner Brook, were mapped in 1994 (Knight, 1995a) and are not described further in this study. Precambrian basement rocks and their metasedimentary cover underlie the southeast of the Harry's River map area.

The area was first mapped regionally at the scale of 1:63 360 by Walthier (1949), in part at 1:250 000 by Riley (1957), and at 1:1000 by McKillop (1963). Since then, it has been included in regional 1:100 000- and 1:250 000-scale maps of Williams (1985) and Williams and Cawood (1989), respectively. Description of the area was included in a preliminary report by Williams and Cawood (1986). More recently, the eastern part of the area was mapped at the 1:50 000 scale by Cawood and van Gool (1994). The Georges Lake area was assessed for hydrocarbon potential for

Morrison Petroleum by Boyce (1981). Base-metal exploration has occurred in carbonate shelf rocks of the area north of Humber River gorge in the Corner Brook Lake map area (Wilkinson, 1983a, b; Thurlow, 1993, 1994). The area is currently the focus of marble exploration (Knight, 1995a; Meyer, 1995).

The area is characterized by a strong ridge-and-valley topography that essentially reflects the lithology and structure of the underlying rocks, particularly the carbonate shelf and off-shelf sequences. In the shelf terrane, slates and major faults form linear valleys, which contrast with ridges of resistant carbonate. The ridges and valleys tend to outline the predominant structure of the sequence, which is thrust faulted and folded about large folds. The off-shelf rocks are typically recessive weathering slates and resistant carbonates. The latter, which are narrow mappable units, form prominent ridges and hills. Elevation varies between 200 and 350 m. Areas underlain by flyschoid rocks generally exhibit a less daunting topography of rounded hills and valleys. Elevation increases to the east in the area. Southeast of Pikes Brook, elevation increases eastward from 330 to 530 m, in an area underlain by Precambrian basement and metasedimentary rocks.

Boreal forest of soft and hard woods that cover the area have a long history of exploitation and continue to be harvested today. As a result, the area is well supplied with forest access roads of various ages. The main access to the area is provided by the Pinchgut Lake, Island Pond, Lady Slipper Pond, Big Feeder Brook and Loggers School roads (Figure 1). Many branch roads and skidder trails provide more penetration into the forest. Outcrop is good along these roads and excellent outcrop occurs along the shores of Big Gull Pond, Rocky Pond and Fox Pond (Figure 1). Some large bogs in the north of the area are probably underlain by slate.

The purposes of this report are to describe the lithostratigraphy of the carbonate sequence and the Pinchgut Lake group, detail the main structural elements of the area, draw comparisons with other map areas of western Newfoundland, discuss both lithostratigraphic and structural implications, and finally to document the economic prospects in the area.

GEOLOGICAL SETTING

The map area lies in the eastern half of the outer domain of the Humber (tectonostratigraphic) Zone (Williams, 1978). The Cambrian–Ordovician sedimentary rocks were deposited on part of the western Newfoundland shelf and in the subsequent foreland basin that were located at the St. Lawrence Promontory and Newfoundland Reentrant, at the margin of the early Paleozoic Iapetus Ocean. Recent mapping of the carbonate rocks of the Corner Brook region north to Goose Arm has shown that the carbonate sequence is deformed in a complex fold-and-thrust belt (Knight and Boyce, 1991; Knight, 1992, 1994a, b, 1995b). Repeated slices of Middle Cambrian to Ordovician carbonate and flysch have been detached from basement and are assembled in a west-verging stack to form a structural culmination that arches the overlying Humber Arm Allochthon (Knight, 1994a). The stack was later deformed by east-verging folding and faulting. This style of deformation continues in the area southwest of Corner Brook.

The lithostratigraphy of the carbonate sequence and the Pinchgut Lake group compare strikingly to rocks in the Pasadena map area, north of Corner Brook. The Middle Cambrian to Middle Ordovician carbonates include facies believed to have been deposited in a more distal part of the Iapetus Ocean shelf margin and foreland basin. Lithostratigraphic sectioning of the Pinchgut Lake group indicates that it is comparable to the Weasel group of the Goose Arm area, in the Pasadena and Lomond map area (Boyce *et al.,* 1992).

Compilation of the regional geology, and combining the data from current mapping programs and existing maps (e.g., Cawood and van Gool, 1994; Williams and Cawood, 1989) indicate that there are five geological domains (Figure 2). Domain 1 occurs in the west and consists of metasedimentary rocks of the Humber Arm Supergroup, including slate and metaquartzite of the Irishtown formation, and an unnamed slate unit. These rocks appear to be mainly inverted and lie structurally against Domain 2, which comprises Ordovician flyschoid rocks that are mostly grey slate and thin green-grey metasandstone. The rocks are locally broken to form melange and include vestiges of varicoloured slate of allochthonous deep-water origin.

Domain 3 consists of three subdomains and overthrusts flysch of Domain 2. In the southwest, subdomain 3A, the Blue Pond thrust stack, is a complex repetition of Cambro-Ordovician carbonate rocks. Subdomain 3B consists of rocks of the Pinchgut Lake group that form a thin-folded thrust sheet above the flysch. However, they (subdomain 3B rocks) also structurally overlie the carbonate rocks of subdomain 3A, suggesting that they are part of a composite terrane that overthrust the flysch. Subdomain 3C consists of Cambro-Ordovician carbonate rocks like those of subdomain 3A. They have been described in a previous report (Knight, 1995a) and are not discussed further, except where germane to the present discussion.

Domain 4 consists of higher grade metasedimentary rocks and is divided into two subdomains. Subdomain 4A consists of the Breeches Pond formation of the Mount Musgrave group (Cawood and van Gool, 1994). It comprises slate and marble, structurally overlies Domain 3, and is interpreted as metamorphosed Pinchgut Lake group rocks emplaced in a separate and structurally higher thrust slice. It

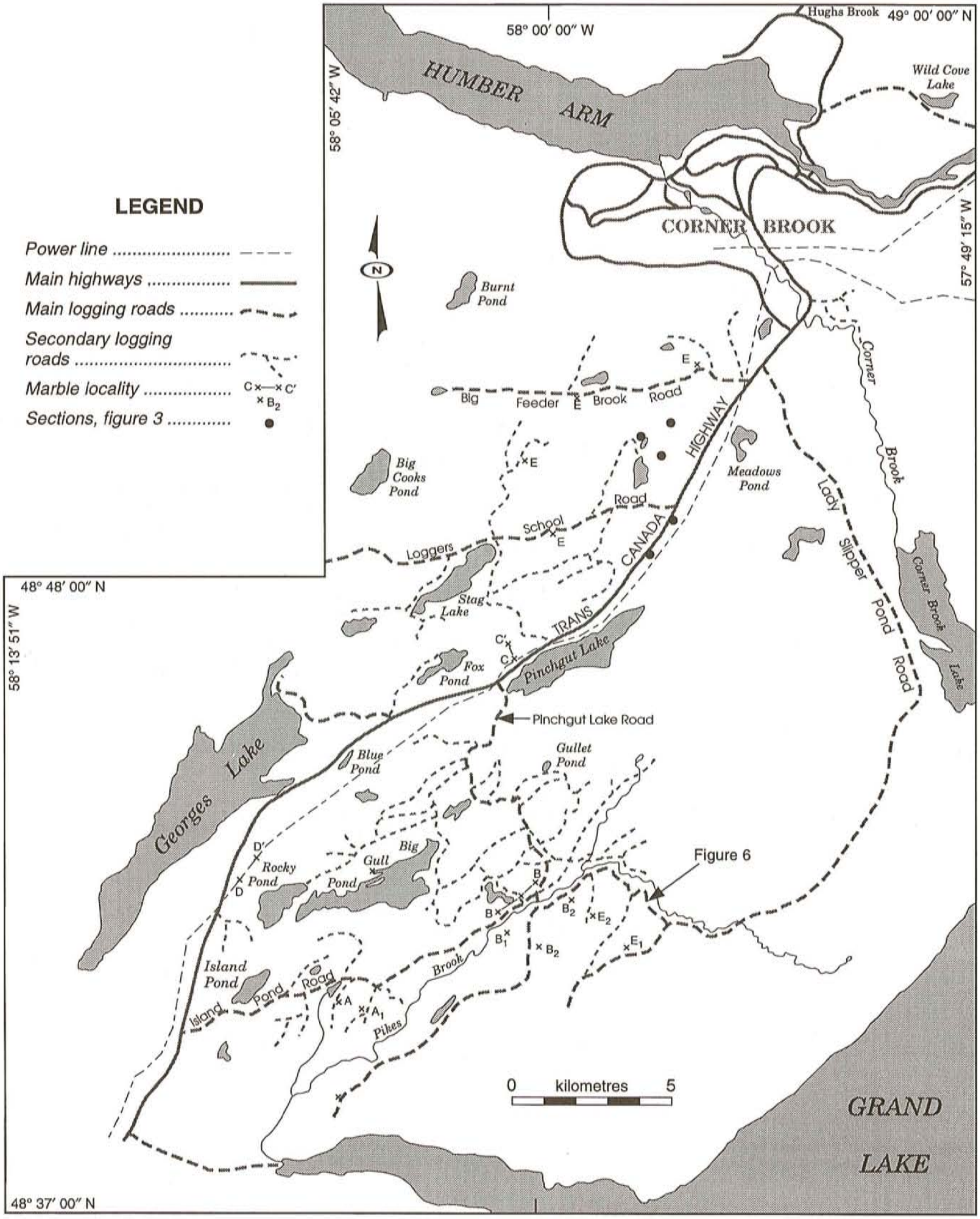

Figure 1. *Location map of the 1995 study area. Localities labelled with uppercase letters are occurrences of marble described in the text.*

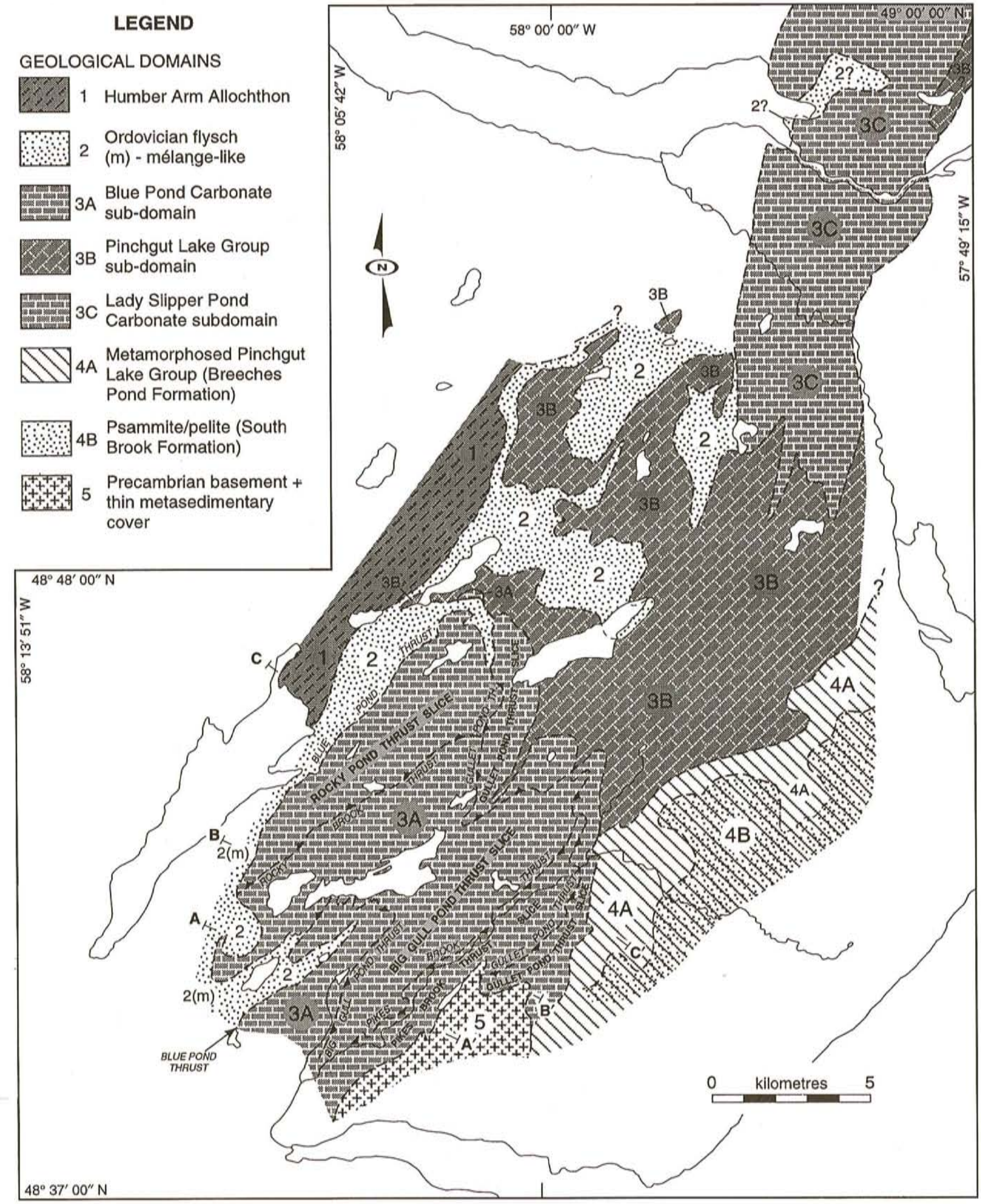

Figure 2. *Geological domains of the study area, derived from present mapping and that of Williams and Cawood (1989) and Cawood and van Gool (1994). The main thrust slices of subdomain 3A are also defined.*

is structurally overlain by subdomain 4B of psammites and pelites. These rocks have been assigned to the South Brook formation, Mount Musgrave group by Cawood and van Gool (1994), and form structural outliers capping hills formed of Breeches Pond formation rocks.

Domain 5 consists mainly of Precambrian crystalline basement rocks overlain, unconformably, by metasedimentary rocks of the Mount Musgrave group. They structurally abut against rocks of Domain 3 along a steep fault zone and against the Breeches Pond formation of Domain 4.

LITHOSTRATIGRAPHY

DOMAIN 1

Domain 1 is the eastern margin of the Humber Arm Allochthon. The two rock units of this domain that outcrop in the mapped area are metaquartzite and slate of the Early Cambrian Irishtown formation (Curling Group) and grey slate (Unit I/PG?, *see* Figure 4) of unknown affiliation.

The Irishtown formation comprises metre-thick units of white-weathering, grey metasandstone–quartzite interbedded with metre-thick units of grey slate. The poorly sorted, granular, very coarse- to fine-grained sandstones are generally massively bedded but graded, and have scoured bases with large load-casts and locally, flutes. Rounded granules of white quartz are common. The slate occurs as 10- to 15-cm-thick beds in the sandstone units, and as units several metres thick, some containing thin, laminated, crosslaminated and convoluted siltstone and sandstone beds. Thin stratification and very fine lamination are visible on cleavage faces throughout the slate beds. Slate to sandstone coarsening-upward sequences occur in the formation.

Mapped along an 8-km-strike length, the facing directions on the metaquartzites consistently indicate that the succession is inverted.

The grey slate unit is structurally overlain by the Irishtown formation and the contact is marked by a west-dipping fault zone. The unit, which is mainly recessive and badly weathered, is cut out as traced southward between the Irishtown formation and Ordovician flysch of Domain 2. Locally, outcrops display intercalated grey, blue-black and green-grey thin stratification. Other outcrops have pre-cleavage, broken bedding and convoluted fabrics and include thin, brown, rotted, calcareous thin beds and concretionary carbonate. The former varicoloured slate is comparable to some of the Arenigian shales of the Middle Arm Point formation (Botsford, 1988), but the latter resemble broken formation (transitional to melange) of the Middle Ordovician Goose Tickle group. If the unit is more correctly correlated with the Goose Tickle group, it would be better assigned to Domain 2.

DOMAIN 2

Domain 2 consists of grey slate and green-grey sandstone, in the northeast, and by its broken equivalent, which occurs mainly in the southwest, where the unit is transitional to melange. Both units are correlated with the Goose Tickle group and compare to similar rocks in the footwall of the Goose Arm thrust stack, 50 km to the north (Knight, 1994a, b). Williams and Cawood (1986) informally referred the flysch to the Whale Back formation and its broken equivalent to the Georges Lake formation. Neither name is used here.

In the northeast, the succession is dominated by dark-grey, massive to laminated phyllitic slates in decametre-thick beds, intercalated with thin siltstone, and 5 to 60 cm sandstone interbeds. The green-grey sandstones are graded, coarse to very fine grained, massive with sharp bases and tops. Locally, flame structures occur on the bases of the sandstone beds. Dark-grey, fine-grained, concretionary limestone occurs locally in the phyllites. Both sandstone and limestone beds weather chestnut brown in some outcrops.

The broken formation that outcrops to the southwest of Georges Lake is assigned to the Goose Tickle group based on two lines of evidence. First, the rock types are best compared to those of the Goose Tickle group. Second, they are similar to rocks transitional to Goose Tickle group within the footwall of a major thrust that carries the carbonate sequence west, over flysch, at Goose Arm (Knight, 1994a, b). However, it is noted that in both areas the unit contains slices of green--grey and blue-black shale derived from the deep water Ordovician shales of the Middle Arm Point formation. These slices may have been incorporated in the Taconian foreland basin sequence either by mass wastage and transportation or as thin Middle Ordovician thrust sheets, which were later broken with the Goose Tickle group.

The predominant rock in the broken formation is a poly-deformed, dark-grey to grey slate, locally showing lamination and decametre bedding. Chestnut-brown-weathering, grey limestone and calcareous siltstone are common as thin beds, locally 40-cm-thick beds, or as concretions. The thin beds occur in rootless folds that predate the cleavage, suggesting deformation as soft but competent beds. Other rock types include green-grey sandstone having very coarse- to fine-grained grading, and shale-clast pebble conglomerate consisting of small, 1 cm diameter, green and black shale clasts. Carbonate beds include ribbon limestone, dolomitic limestone, and limestone conglomerate of small, fine-grained, nodular grey limestone clasts. Large masses of waxy, black shale and mudstone are associated with the broken formation. The limestone conglomerate and the ribbon limestone are similar to rock types of the Daniel's Harbour member (Goose Tickle group) and the Table Cove Formation (Table Head

Group) (Stenzel, 1990). The shale pebble conglomerate compares to the Howe Harbour member (American Tickle formation of the Goose Tickle group, Quinn, 1992). This implies that the broken formation was created by early post-depositional processes and possibly is a massive slump or olistostrome of foreland basin sediments within the foreland basin itself.

DOMAIN 3

The following descriptions refer only to the early Paleozoic carbonate shelf sequence of subdomain 3A and the Pinchgut Lake group of subdomain 3B. Subdomain 3C has been described (previously) by Knight (1995a).

Carbonate Shelf Sequence (Subdomain 3A)

The early Paleozoic carbonate shelf sequence is exposed in a complexly folded thrust stack that overthrusts Domain 2. The succession is similar to that at Goose Arm (Knight, 1994a) and includes carbonate rocks of the Port au Port, St. George and Table Head groups. The Penguin Cove Formation (Lilly, 1963) forms the oldest unit beneath the carbonates in the Big Gull Pond and Rocky Pond thrust slices, while the Reluctant Head Formation lies at the base of the Pikes Brook and Gullet Pond thrust slices.

Penguin Cove Formation

This formation consists of grey and silver-grey phyllite–slate, green argillite, thin-bedded and nodular grey dolomitic limestone, and white-weathering, thin-bedded coarse siltstone and very fine-grained quartz sandstone. The limestone and siltstone occur in units 1 to 3 m thick, interbedded with the phyllite.

The limestone is mostly fine grained and is locally fossiliferous. On the shores of Big Gull Pond, it has yielded the trilobites *Kootenia* sp. cf. *K. cloudensis* Howell (1943) and *?Spencella* sp. cf. *S. proavita* Howell (1943), the articulate brachiopod *Nisusia* sp. undet. and the inarticulate brachiopod *Dictyonina* sp. undet. and an unidentified trilobite (D. Boyce, personal communication, 1995). The siltstone and the very fine sandstone are frequently deformed by slump folds and are dismembered into centimetre-sized fragments in slurry-like deposits. Other units display lamination, cross-lamination, small-scale load-casts, flames, and ball-and-pillow structures. Small compacted dykes occur in the interbedded phyllite as well as burrows and the trilobite trace fossil, *Cruziana* sp.

The rock types and fauna indicate correlation with the Penguin Cove Formation of the Goose Arm area (Knight and Boyce, 1991; Knight, 1994a), and also with the Bridge Cove member of the Hawke Bay Formation in Canada Bay (Knight and Boyce, 1987).

Deformed pale-green phyllite, interbedded with thin limestone and quartzitic psammite, underlie the Reluctant Head Formation in a section exposed on the roadside along Wild Cove Lake valley, north of the Humber River gorge (subdomain 3C). Similar rocks in an exposure in the carbonate sequence at Pye's Ridge, north of Deer Lake (Knight, 1993) also underlie the Reluctant Head Formation. Both phyllite occurrences are interpreted to belong to the Penguin Cove Formation or its metamorphosed equivalent.

Reluctant Head Formation

The Reluctant Head Formation (Lilly, 1963) occurs as a narrow outcrop along the sole of the Pikes Brook thrust and the Gullet Pond thrust. The formation consists of dolomitic and argillaceous, dark-grey ribbon limestone, thin-bedded grey and silver-grey phyllite, calcareous and dolomitic phyllite, minor limestone conglomerate, and bioturbated, thinly stratified limestone. Phyllite and ribbon limestone characterize most of the formation. However, the top of the formation is marked by well-stratified bioturbated limestone, and is capped by a unit of oolitic? grainstone that is mostly dolomitized. The same unit occurs at the Humber River gorge and at Old Man Pond (Knight and Boyce, 1991; Knight, 1995a). The formation is succeeded by dolostones of the Petit Jardin Formation (Port au Port group).

Port au Port Group

As elsewhere in western Newfoundland, the Middle to Late Cambrian Port au Port group is divided into the March Point, Petit Jardin and Berry Head formations. In the Big Gull Pond and Rocky Pond thrust slices, it is similar to the Port au Port group exposed at Goose Arm. However, in the Pikes Brook slice, it is dominated by dolostones of the Petit Jardin and Berry Head formations and limestone is rare except in the upper member of the Berry Head formation. In this slice, more intense recrystallization and deformation have destroyed original sedimentary fabrics so that it is impossible to determine stratigraphic position of the few limestones in the middle of the dolostone section. An incomplete succession carried above the Gullet Pond thrust is structurally truncated above a unit of dolostone and white marble within the Berry Head formation.

The March Point Formation consists mainly of bioturbated blue-grey limestone, which is intercalated with metre--thick units of stylonodular thin-bedded grainy wackestone, ribbon limestone and phyllite, and a few beds of pisolitic and oolitic grainstone. The lack of significant oolitic grainstone development contrasts with the Goose arm area, where oolite facies constitute over half of the formation. This suggests that in this area the formation may incorporate facies elements of the Reluctant Head Formation.

The conformably overlying Petit Jardin Formation in the Big Gull Pond and Rocky Pond thrust slices, like its counterpart in the Goose Arm area, comprises a tripartite stratigraphy of lower dolostone, middle limestone and upper dolostone. The dolostone of the lower and upper members are predominantly light grey, micro to finely crystalline, and massive to laminated. Quartz sand and small collapse breccia bodies occur locally in the upper member. Argillaceous dololaminite occurs in both members indicating the cyclicity of the successsion. This cyclicity is readily distinguished in the middle limestone member where oolitic grainstone and stromatolitic limestone are capped by dololaminite and argillaceous dololaminite in metre-scale sequences. Minor bioturbated limestone and intraclastic rudstone–grainstone occur in the cycles. The limestone is dark grey, grey and off-white. Sections have not been measured but a partially exposed section in the upper member is 110 m thick.

The Berry Head formation consists of two members, a lower dolostone member and an upper limestone–dolostone member, both of which are cyclic. The lower member is characterized by light-grey, grey, grey and purple mottled, pink and cream, micro to finely crystalline, thick-bedded, massive to laminated dolostone. Decametre-scale intraformational collapse breccia occurs locally and consists of argillaceous and massive dolostone in a red dolostone matrix. Chert is present in some intervals and the base of the member is marked by a dark-grey mottled thrombolitic and stromatolitic dolostone (locally limestone) and chert. Argillaceous dololaminites indicate that the member is cyclic. Quartz veins are common in the dolostones. The member is 82 m thick at one section east of Island Pond, compared with a thickness of 122 m in the section at Goose Arm.

The upper member, like its counterpart in the Pasadena map area (Knight and Boyce, 1991; Knight, 1994a), consists of metre-scale cycles of limestone and dolostone. Each cycle consists of bioturbated and stromatolitic, dark-grey and grey limestone capped by grey, pink and cream dololaminite and argillaceous dololaminite. The unit is 52 m thick in the section east of Island Pond, and 83 m thick along the southeast shore of Big Gull Pond. An 18-m-thick unit of white and pink limestone occurs in the middle of the unit.

St. George Group

The Early Ordovician St. George Group comprises the Watts Bight, Boat Harbour, Catoche and Aguathuna formations, all of which have been mapped elsewhere in western Newfoundland (Knight and James, 1987; Knight, 1994a).

The Watts Bight Formation consists of thick-bedded, locally cherty limestone, intercalated with 15- to 20-cm-thick dolostone beds. Two members form a section 93 m thick east of Island Pond. The lower member, which is 52 m thick, is dominated by dark-blue-grey thrombolitic and bioturbated dolomitic limestone. The upper member contains 41 m of grey, pure limestone having only a few discernable structures due to recrystallization. At a faulted section along the southeast shore of Big Gull Pond, the formation is 142 m thick and is dominated by dark-grey thrombolitic limestone beds in a lower 56-m-thick member. Similar mound-dominated intervals occur in the upper part of the formation, where they are intercalated with some pure grey limestone and a number of decimetre-thick units of bioturbated limestone and dolostone.

The Boat Harbour Formation is a 137-m-thick sequence of intercalated limestone and dolostone. The limestone beds, which range from 1 to 4 m in thickness, vary from grey, dark grey and light blue-grey to off-white. They display burrowed, thrombolitic, stromatolitic, parted, undulose, thinly stratified, laminated and fenestral laminated fabrics. The dolostones, ranging from 0.5 to 8 m thick, are commonly laminated, and locally display mudcracks and tepees. These rocks are arranged in repetitive shallowing-upward metre-scale cycles through much of the formation, and are similar to those found in the formation elsewhere in western Newfoundland. A dolostone bed, 14 m thick, marks the base of the formation.

The Catoche Formation is more than 100 m thick and consists of dark-grey dolomitic limestone, capped by white limestone of the Costa Bay member (Knight and James, 1987). The dark-grey limestone has a lower member, 20 to 25 m thick, of bedded bioturbated, thrombolitic and grainy limestone and rare dolostone caps. Sharp planar truncation surfaces mark the bases of the 1 to 5 m cycles. These commence with either bioturbated limestone or grainstone, and are capped by thrombolitic mounds or, in one or two cycles, by thinly stratified and laminated limestone and dolomitic limestone.

The middle of the formation consists of very thick beds of massive thrombolitic limestone marked by cerebral, digitate and clotted structures. Large gastropods and straight and coiled cephalopods are present in the mound beds. Most of the upper part of the grey limestone is bioturbated, although rare beds of thrombolitic mound limestone occur locally.

The Costa Bay member outcrops sporadically and consists of white, off white to pink, stylo-bedded limestone locally interbedded with dolostone. North of Pinchgut Lake, and along the western boundary line of Stag Lake park, the member reaches 10 m or more in thickness. A similar thickness occurs on the southeast shore of Big Gull Pond, east of Island Pond and north of the bridge over Pike's Brook along the Pinchgut Lake access road.

However, the Costa Bay member is absent in the well exposed woods road section just south of the west end of Big

Gull Pond. Here, thrombolitic and bioturbated grey limestone of the Catoche Formation is directly overlain by dolostone belonging to the Aguathuna Formation.

The Aguathuna Formation, which is up to 56 m thick, is characterized by yellow-weathering, light-grey micro-crystalline dolostones and minor interbedded thin, grey and/or white limestones in some sections. The formation is generally less than 10 m thick even in sections only a few kilometres away from the 56 m section. This marked thickness variation is attributed to erosion beneath the St. George Unconformity that marks the boundary between the St. George and Table Head groups (Knight *et al.*, 1991).

Table Head Group

The Table Point Formation is the only part of the Table Head Group present in the map area. The exact thickness of the unit is not known because the top of the formation is usually truncated by a thrust. One measured section, northeast of Island Pond, is 66 m thick, but based on the across strike outcrop width of the formation, this thickness is probably a minimum.

The formation is divisible into two parts. The lower Spring's Inlet member (Ross and James, 1987) of interbedded limestone and dolostone is 10.8 to 33 m thick. It comprises dark-grey, bioturbated limestone interbedded with thinly stratified grey and off-white limestone, and laminated and mudcracked dolomitic limestone and dolostone. The bioturbated limestone is rich in dolomitic argillaceous seams and, locally, large molluscs, sponges and chert. Most beds are thinner than a metre but some limestone beds are up to 2.5 m thick.

The upper unnamed part of the formation, which is at least 33 m thick, is dominated by bioturbated, fossiliferous and stylo-nodular to stylo-thin-bedded argillaceous limestone and dolomitic limestone. The limestones are intercalated with laminated lenses of fine-grained limestone and locally with crosslaminated and planar-crossbedded, very fine-grained grainstone beds that are 10 cm thick. Large gastropods and 2 to 3 cm lumps, which are possibly sponges (*cf.*, Stenzel, 1991), dominate some limestone beds. Ostracods and rare gastropods occur in the stylo-bedded argillaceous limestone on the southwest shore of Big Gull Pond.

A 5-m-thick unit of planar thin-bedded ribbon limestone occurs 4.5 m from the base of the upper member. The very fine-grained limestones are separated by millimetre-thick laminated dolomite partings. The facies resembles that of the upper part of the Table Cove Formation in northwestern Newfoundland (Stenzel *et al.*, 1990) and was previously reported in the Corner Brook area (Knight, 1995a) as possibly part of the Table Cove Formation.

Goose Tickle Group

Three small areas of subdomain 3A, two east of Big Gull Pond and one along the Trans-Canada Highway west of the Pinchgut Lake access road, are assigned to the Goose Tickle group. East of Big Gull Pond, the group occurs as a narrow band, several kilometres long in the footwall to the Big Gull Pond thrust, and a second small area in the same general vicinity is defined overlying Table Point Formation in the Big Gull Pond thrust slice. The Trans-Canada Highway outcrop overlies recumbently folded Table Point Formation.

Rock types in these outcrops consist predominantly of dark-grey to black slates. Black slates in the Trans-Canada Highway outcrop are intercalcated with a few thin beds of massive to laminated dark-grey fine-grained limestone and thin concretionary laminated limestone; pyrite lamination occurs in the slate. The rock types suggest that the outcrops belong to the Table Cove and Black Cove formations.

In the Big Gull Pond area, dark-grey slate is interbedded with a bed of limestone conglomerate, 1 to 2 m thick, and thin beds and broken fragments of green-grey sandstone. Fragments of green and black shale are incorporated in the grey slate suggesting that locally it may be a pebbly mudstone or "melange". The limestone conglomerate comprises centimetre-sized Table Point limestone clasts in a dolomitic matrix and is assigned to the Daniel's Harbour member of the American Tickle formation (Stenzel *et al.*, 1990).

Pinchgut Lake Group (Subdomain 3B)

Pinchgut Lake group is the name given by Williams and Cawood (1986) to an undivided succession of phyllitic slate, thin-bedded limestone, and limestone conglomerate. Williams and Cawood (1989) mapped the group over a wide area southwest of Corner Brook, and separated it from rocks assigned to the Goose Tickle Group. Later mapping (Cawood and van Gool, 1994) includes the Goose Tickle rocks in the Pinchgut Lake group but assigns metamorphosed rocks in the southeast (subdomain 4A, this report) to the Breeches Pond formation of the Mount Musgrave group.

The current mapping separates the Pinchgut Lake group from rocks of the Goose Tickle group (Domain 2). It places metacarbonates and phyllites assigned by Cawood and van Gool (1994) to the Breeches Pond formation in subdomain 4A, but retains these rocks in the Pinchgut Lake group.

The Pinchgut Lake group is interpreted to form a thin thrust slice structurally above carbonate shelf rocks. The thrust slice, which overthrusts the Goose Tickle group of Domain 2 was folded about east- and then northeast-trending folds. The succession consists of dark-grey to silver-grey phyllites and phyllitic slates, intercalated with calcareous and dolomitic phyllites, thin-bedded, ribbon and nodular ribbon grey limestone, dolomitic limestone and argillaceous limestone, grey limestone conglomerate, oolitic limestone, and, locally, dolostone replacing grainstone and conglomerate. A number of incomplete sections measured along the Trans-Canada Highway, at Southwest Pond, and along Loggers School road and branch woods road (Figure 3) provide the basis for the stratigraphy outlined below.

Stratigraphy

Based on the mapping and the sections measured, the following lithostratigraphy is proposed for the Pinchgut Lake group beginning at the base.

1. A thick lower grey phyllite having thin intercalations of ribbon limestone and some thin conglomerate beds;
2. a clast-supported limestone conglomerate dominated by platy clasts having sparse dolomitic matrix and rare quartz sand;
3. a thick interval of phyllite and some ribbon limestone and minor conglomerate;
4. a clast-supported to graded limestone conglomerate having an oolitic matrix, oolitic grainstone and oolitic dolostone intercalated with ribbon limestone and phyllite. Oolitic grainstone clasts occur in the conglomerate and quartz sand is rare;
5. a clast-supported to graded limestone conglomerate having a quartz sand matrix, quartz sandstone and sandy limestone;
6. a clast-supported limestone conglomerate having a dolomitic carbonate matrix, ribbon limestone and dolomitic limestone;
7. a thick interval of phyllite and ribbon limestone and minor limestone conglomerate; and
8. thick shale–phyllite containing metre-thick limestone conglomerate beds composed of platy limestone clasts, rare grainstone clasts and minor ribbon limestone.

Correlation

The Pinchgut Lake group is correlated with the Weasel group of the Goose Arm area (Williams and Cawood, 1986; Boyce *et al.*, 1992). Although the Pinchgut Lake group, unlike the Weasel group, has not yielded fossils, both share similar lithofacies and occupy the same structural position above shelf rocks and below the Humber Arm Allochthon.

Comparison of these two units and, in more general terms, comparison of the Pinchgut Lake group with that of the allochthonous slope rocks of the Cow Head Group and the carbonates of the shelf sequence, allows the definition of a chronostratigraphy within the group. Units 1 to 4 are interpreted as Cambrian, Units 6 and 7 are believed to be Ordovician, and Unit 5 could belong to either period.

Oolites in grainstone clasts, as matrix and as discrete beds suggest a Middle to early Late Cambrian age for Unit 4. Oolitic limestone is most common in the March Point and Petit Jardin formations of the Port au Port Group. Rare rounded quartz sand occurs in the upper part of Petit Jardin Formation. This suggests some of the conglomerates from Units 2 and 3 may be Dresbachian in age; this is supported by the similar occurrence of oolitic clasts and grains, which are common in conglomerates and grainstones of bed 4 of the Downes Point member (Cow Head Group), dated as upper Dresbachian in age (James and Stevens, 1986).

The well-dated Cambrian section of the Weasel group (Boyce *et al.*, 1992) contains a few beds of oolitic limestone in phyllite that are succeeded by a thick succession of dolomitized conglomerate and sandstone, rich in rounded quartz sand. Trilobites in the Weasel group indicate an age younger than the middle Late Cambrian Elvinia zone for this succession, but older than Ordovician conglomerates, which contain orthoconic cephalopods; this would correspond to the late Franconian stage (Boyce *et al.*, 1992). Abundant quartz sand also occurs in late Franconian conglomerates and grainstone of bed 6 of the Tuckers Cove member of the Cow Head Group (James and Stevens, 1986).

Platy clast-rich conglomerates that have sparse dolomitic mud matrices typify conglomerates of both the Pinchgut Lake Unit 1 and the lowest Cambrian part of the Weasel group. Similar conglomerates occur in Units 7 and 8 of the Pinchgut Lake group and in the upper part of the upper conglomerate of the Weasel group. The presence of sponges and cephalopods in clasts in the Weasel conglomerates supports an Ordovician age for the latter two units.

Thickness

The thickness of the Pinchgut Lake group is impossible to estimate because argillaceous and fine limestone intervals are mostly covered, and the succession is deformed by at least two generations of folds. The thickest measured section of strata, believed to be Cambrian, is 140 m, and a section believed to be Ordovician ranges up to 85 m. The group may be at least double the aggregated 225 m thickness of these two sections.

Lithofacies

Limestone conglomerate is the most prominent lithofacies of the Pinchgut Lake group. The conglomerate dominates sections that are more than 50 m thick, and also forms beds 1 to 2 m thick within sections of phyllite and ribbon limestone. By tracing beds/units along strike, it can be

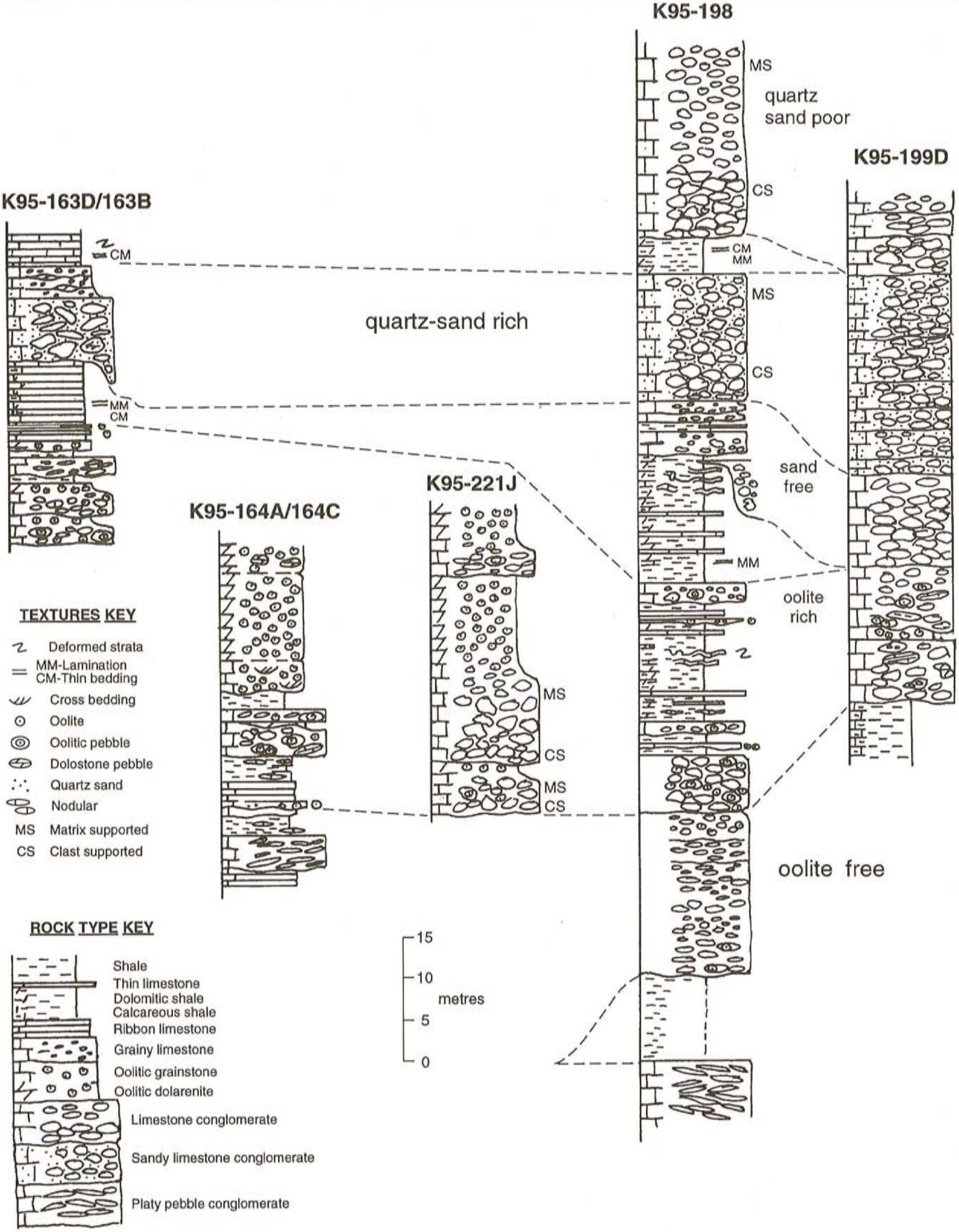

Figure 3. *Measured sections in the Cambrian part of the Pinchgut Lake group; section localities are shown on Figure 1.*

demonstrated that many of the dekametre-thick sections are formed by amalgamation of metre-thick beds; thin interbeds of ribbon limestone, and dolostone and phyllite drapes and lenses are present in one section but not the next. In addition, mapping and sectioning indicate that the conglomerates vary greatly in thickness along strike, and pinchout locally.

The conglomerates have sharp to locally downcutting erosive bases. They are commonly clast-, to slightly to prominently matrix-supported. Some conglomerates show normal grading in clast size and matrix. The coarser conglomerates generally comprise 5- to 20-cm-size clasts of platy ribbon and fine-grained laminated limestone, intermixed with varying amounts of rounded to blocky grainstone, oolitic limestone, sandy limestone and massive limestone clasts; dolostone and shale clasts occur locally. Some conglomerates comprise almost 100 percent platy clasts. Smaller clasts of 1 to 3 cm dominate some conglomerates and the upper parts of graded ones. The matrix of the conglomerates is generally fine-grained dolomite and limestone mud, but in the Cambrian part of the section, the matrix of important marker conglomerates consists of oolitic and quartz sand; the sand grains are well rounded and varies from fine to coarse.

Thick oolitic grainstone and calcareous sandstone or sandy limestone gradationally overlie the matrix-supported conglomerate. Laminated calcareous quartz sandstone and sandy limestone form beds 60 cm to 3.5 m thick. Oolitic grainstone beds, or their dolomitized equivalents, attain thicknesses of up to 12 m. There are also individual grainstone beds within phyllite sequences that range up to 2 m in thickness. Although most of the thicker grainstone units appear massive, some crossbeds occur locally.

Fine-grained, pure argillaceous and dolomitic ribbon limestone intercalated with partings to thin beds of grey phyllite form units up to 10 m thick. They appear to grade into phyllite units containing sparse interbeds of ribbon limestone. Locally, the phyllite contains thin beds of nodular limestone. Generally planar in aspect, the ribbon limestone is locally deformed by overturned slump folds particularly beneath channel-scoured conglomerate. In some sections, ribbon limestone is intercalated with 30 cm to 1.4 m oolitic grainstone beds.

Phyllite is probably the most common rock type within the group and it dominates section intervals up to 50 m thick. It is grey to silvery grey, non-calcareous to calcareous and dolomitic, and has ubiquitous disseminated pyrite. Although most sedimentary structures have been destroyed by polydeformation, thin bedding of interleaved massive and laminated divisions can be observed locally.

DOMAIN 4

The Pinchgut Lake Group of Subdomain 4A

Subdomain 4A contains rocks believed to be metamorphosed equivalents of the Pinchgut Lake group of subdomain 3B. Rock types include sericitic phyllite to schistose micaceous phyllite, banded calcareous marble and limestone conglomerate marble. The polydeformed domain is metamorphosed to greenschist grade.

Rocks lithologically similar to the metamorphosed Pinchgut Lake group of subdomain 4A occur at the eastern end of Wild Cove Lake valley, north of the Humber River gorge. They structurally underlie Penguin Cove, Reluctant Head and Petit Jardin formations (subdomain 3C) that underlie the mountains and the rest of the valley to the west and are mapped as Reluctant Head Formation on earlier maps (Williams and Cawood, 1989; Cawood and van Gool, 1992, 1994).

White-, light-grey to rusty-weathering, dark-grey and grey pyritic phyllite, which comprises the bulk of the formation, varies systematically from west to east. In the west, the phyllite is sericitic and locally retains original bedding depicted by colour banding and lamination on cleavage planes. The phyllite is, however, schistose and micaceous in the east and has no evidence of bedding. Locally in the east, grey schistose quartz–mica phyllite is associated with pyritic, black and green-grey, micaceous, schistose phyllite intercalated with thin, fine-grained psammitic layers. Veins of white quartz and calcite, Fe-dolomite and quartz are common in the phyllite.

The banded marble is dominantly dark grey to grey but includes some white and off-white bands derived, in part, from deformed calcite veins. The marble ranges from thin bands and lenses in phyllite, through being interbanded with phyllite over a few metres, to thick carbonate-dominated units up to 5 m thick. The marble is fine grained in the west, becoming medium grained 1 km east of the western subdomain boundary. The crystallinity increases to very coarse grained over the next kilometre and locally, at the eastern edge of the subdomain, granular crystals of calcite overprint the schistose carbonate. Although the original limestone protolith was probably thin-bedded, ribbon limestone, as in the Pinchgut Lake group, the banding of the carbonate can rarely be proved to represent original bedding. Instead, it is a composite structural fabric of transposed bands of schistose limestone and phyllite.

The limestone conglomerate, 0.25 to 2 m thick, mainly consists of grey and white, elongate limestone clasts up to 15 cm in length and a few centimetres thick. Rare dolostone, round black limestone, possibly after grainstone, and chert clasts occur in some of the conglomerate outcrops. The conglomerate is not common or widespread and occurs as a few layers that are structurally high in the domain, and are therefore also elevated topographically.

DOMAIN 5

Precambrian basement rocks, overlain unconformably by a thin cover of metasedimentary rocks, occur in highlands above the west end of Grand Lake. Cover rocks of the domain form a narrow west-dipping tract adjacent to Domain 3.

The basement rocks range through micaceous quartzo-feldspathic gneiss, garnet–biotite schist, amphibolite and micaceous quartzitic psammite, and micaceous pelite. Centimetre- to decimetre-wide granite veins intrude the amphibolite. Zones of epidote-veined cataclasite cut the gneiss locally. Mafic minerals are chloritized and epidotized, especially close to the unconformity.

The unconformity is exposed at one locality on a woods road 1 km north of Grand Lake. Gneissosity in the basement strikes 224° and dips 71° west. The unconformity, which is a subtle surface, strikes 210° and dips at 73° west. It truncates an early cleavage that affects the gneissic banding. Bedding in overlying fine- to medium-grained quartzitic psammite strikes 215° and dips at 47° .

A few elongate granite pebbles occur in the quartzitic psammite immediately above the unconformity and blocks and sheared outcrops of quartz and granite pebble conglomerate, containing pebbles up to 10 cm diameter, also occur above the unconformity. Traced northward 50 m, the conglomerate has a quartz-mica schistose matrix. However, the cover rocks consist mostly of medium-bedded, massive quartzitic psammite separated by thin grey phyllite and green-grey psammitic phyllite. Crossbeds displayed by subtle grain-size variations occur in some psammite beds.

Ten metres above the unconformity, the psammite is interbedded with a 5.8-m-thick pink to green-grey chloritic marble. The marble has a strong chloritic foliation and centimetre-thick pink calcite and white quartz veins and sweats. The marble is then overlain by 10.5 m of psammite and the section is completed by 6 m of sheared conglomerate and dark-grey quartz mica schist. This strongly recrystallized and schistose lithology occurs adjacent to the fault that juxtaposes the cover/basement complex with the carbonate terrane of subdomain 3A.

The metamorphic grade and lithology of the supracrustal rocks, suggest that they are part of the Mount Musgrave terrane, which outcrops east of the Corner Brook Lake thrust (Cawood and van Gool, 1994). The supracrustal rocks may correlate with the Labrador Group of the outer domain of the Humber Zone. In particular, the psammite is probably equivalent to the Bradore Formation, which unconformably overlies Precambrian basement. If this is correct, then the chloritic marble correlates with the Devils Cove limestone of the Forteau Formation. The Bradore Formation in Gros Morne National Park is a quartz arenite up to 10 m thick (James *et al.,* 1988), whereas the Devils Cove limestone in the same area is a 11-m-thick, nodular fossiliferous limestone containing abundant argillaceous partings (James *et al.,* 1988).

STRUCTURE

The following discussion concentrates on the poly-deformed rocks of Domains 2 and 3. Detailed mapping (Figure 4) indicates that the rocks of these domains were assembled when imbricated, early Paleozoic, dominantly carbonate rocks of Domain 3 overthrust Ordovician flysch of Domain 2. Within Domain 3, off-shelf rocks of the Pinchgut Lake group structurally overlie the coeval carbonate shelf rocks. The rocks of subdomain 3A comprise a thrust stack, which is herein called the Blue Pond (thrust) stack, the stack itself is deformed about northeast-trending folds.

EVIDENCE FOR THE OVERTHRUST

Carbonate Shelf above Flysch

The critical exposures, which indicate that the carbonate shelf of subdomain 3A overthrust the flysch of Domain 2, occur in the southwest of the area, west of Rocky Pond and near Island Pond. Just west of Rocky Pond, slate and flyschoid sandstone occupy a circular pond-strewn valley surrounded by scarps of brecciated dolostone and limestone of the Port au Port and St. George groups. The contact is essentially horizontal. This semicircular geological map pattern accompanied by strong topographic contrast across the carbonate–slate contact is interpreted to reflect erosion through the basal thrust of the Blue Pond stack.

Traced south and east, this same relationship of slate overlain structurally by St. George and Table Head carbonate is exposed in the hillsides above Island Pond. Here, a lineated foliation in the hanging-wall carbonate dips 32 to 58° northwest with the stretching lineation plunging down the foliation between 300 to 308°. Dolostone boudins in the foliation trend 025° and plunge 30° northeast.

A few kilometres north of the valley, the contact is exposed along the transmission line just east of the Trans-Canada Highway. Here, oolitic and stromatolitic limestone and dolostone of the Petit Jardin Formation are overturned and folded about northeast- and east-trending fold axes in the hanging wall of the Blue Pond thrust fault. The latter, from the power line to the northeast end of Georges Lake, forms a straight scarp and truncates both stratigraphy and fold axes. It is interpreted to be a thrust plane steepened by later northeast-trending folding.

Pinchgut Lake Group above Flysch

Like the carbonate shelf sequence, the rocks of the Pinchgut Lake group (subdomain 3B) occupy topographic high ground compared to the structurally underlying slate and flyschoid sandstone. The contact is exposed at a number of localities along an extensive system of woods roads off Loggers School and Big Feeder Brook roads. It is folded by two generations of folds, as shown by the outcrop pattern at the northeast end of Pinchgut Lake and in the area just west of the Trans-Canada Highway, and north of Loggers School road (*see* Figures 1 and 4). Early folds are east-trending and deformed by later northeast-trending structures.

Carbonate Shelf Sequence/Pinchgut Lake Group Contact

A well exposed outcrop shows phyllite and ribbon limestone of the Pinchgut Lake group juxtaposed against limestone of the Table Point Formation; it is located just west of the gas station on the Trans-Canada Highway at Pinchgut Lake. Both units dip steeply eastward and the contact has been previously mapped as a high angle fault (Williams, 1985; Williams and Cawood, 1989). However, the trace of the fault curves as it is traced to the north and south suggesting that it is folded. The carbonate shelf stratigraphy obliquely terminates against the contact as it is traced to the south. These relationships suggest a thrust fault now steepened by folding about the main northeast-trending fold structures. Similarly, the contact of subdomain 3C carbonate shelf sequence with the Pinchgut Lake group is also folded about large scale northeast-trending folds near Lady Slipper and Meadows ponds (Knight, 1995a).

Implications

The evidence suggests that the carbonate shelf sequence and the Pinchgut Lake group were thrust over Ordovician flysch together, and that all domains were subsequently folded about the northeast-trending fold structures.

BLUE POND THRUST STACK

General Description

The Blue Pond thrust stack consists of several large and small thrust slices that are folded about a large northeast-plunging antiform and associated folds, similar to an antiformal stack (Boyer and Elliot, 1982). The map pattern (Figure 4), cross sections (Figure 5) and respective displacements across thrusts indicate that the stack comprises more than three large thrust panels, each panel itself being internally shortened by a number of smaller duplexes. Structural truncation of the shelf stratigraphy by the thrusts suggests that there is significant ramp geometry preserved in the stack. A pop-up structure marks the southern part of the stack core (Figure 5C).

The Blue Pond thrust is the sole thrust to the complex. Northwest of the stack, the main thrusts from northwest to southeast are the Rocky Pond and Big Gull Pond thrusts. They branch up from the sole thrust and each thrust and panel dips to the northwest. A number of lesser thrusts, such as Gull Pond Steady thrust, link the main thrusts and indicate that each thrust panel is a duplex. In addition, in the vicinity of Island Pond, three small northwest-dipping horses occupy the footwall of the Big Gull Pond thrust above the Blue Pond thrust and form a foreland dipping duplex.

The most southeasterly thrust slices in the complex are the Pikes Brook and Gullet Pond thrust slices. The former, a steeply southeast-dipping thrust panel, truncates the eastern end of some of the core duplex thrusts. The thrust itself is folded locally within this steep zone. To the southwest, the Pikes Brook thrust slice is juxtaposed against Precambrian basement and metaclastic rocks and marble of Domain 5 along a steep shear zone. The metaclastic cover strikes 215°, and steepens from 41 to 84° as it approaches the shear zone. West of the shear zone are grey phyllites that probably belong to the Reluctant Head Formation, but could be rocks of Domain 2 emerging as faulted footwall windows to the stack.

The steep shear zone at the edge of Domain 5 appears to bifurcate when it is traced to the northeast. A southern branch forms the basal detachment to Precambrian basement of Domain 5. It flattens and swings southward around prominent mountain sides to project toward the west end of Grand Lake. The northerly branch becomes the folded trace of the Gullet Pond thrust that is mapped around the eastern culmination of the stack to where it connects with the Pikes Brook thrust. This suggests that the steep shear zone is a steepened thrust.

It should be noted that the succession carried in the Pikes Brook and Gullet Pond thrust slices is not like that in the more westerly slices. For instance, the Port au Port Group lacks a definitive middle limestone member in the Petit Jardin Formation and the succession begins with rocks of the Reluctant Head Formation rather than the Penguin Cove Formation. In addition, the carbonates are higher grade, deformed marbles and the associated phyllites are more micaceous in aspect.

Thrusts Description

The thrusts are characterized by narrow (< 1 m) to wide (up to 200 m) zones of intense flattening and foliation,

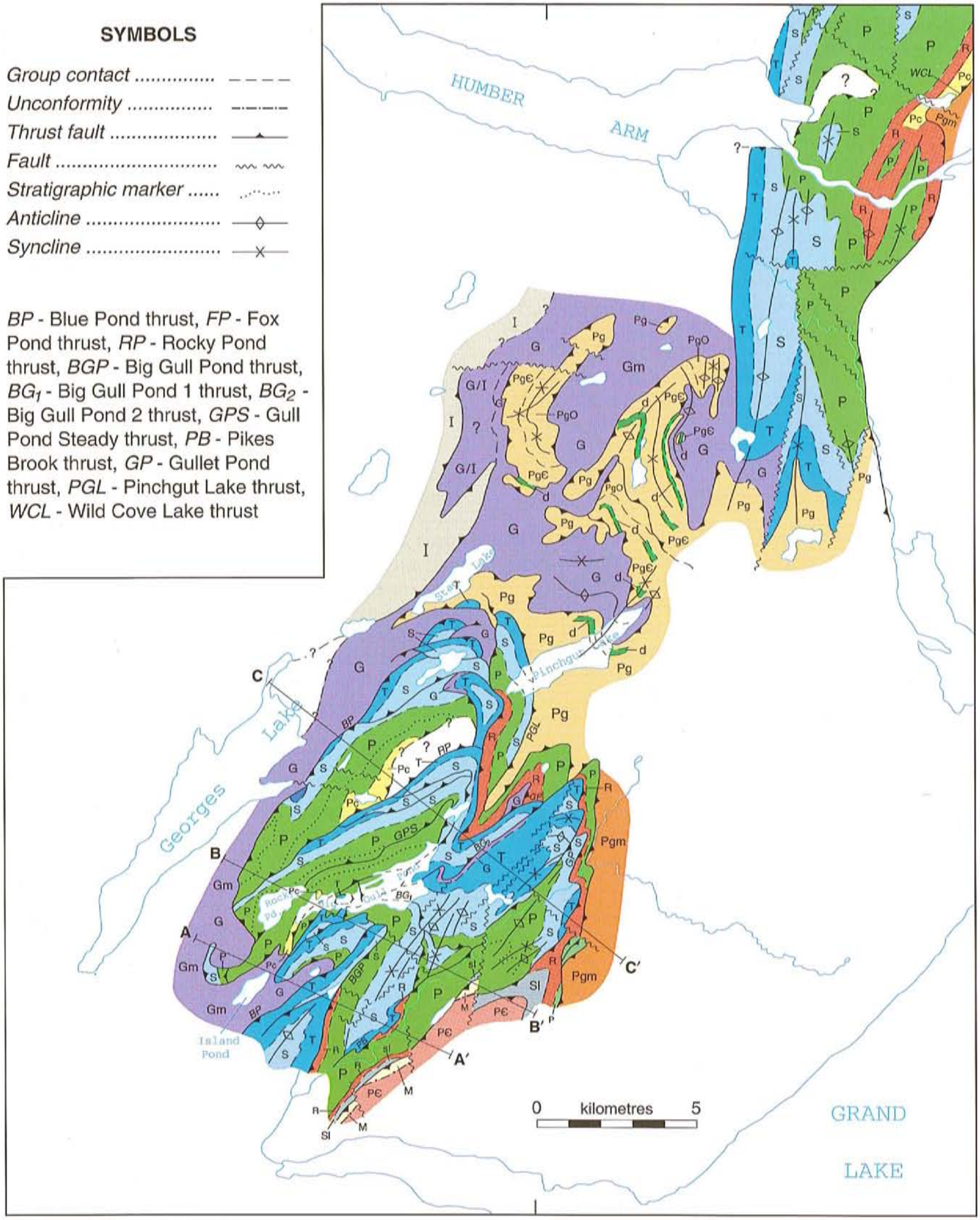

Figure 4. *Geological map of the study area.*

LEGEND (Figure 4)

DOMAIN 1

HUMBER ARM ALLOCHTHON

Cambrian

I *Irishtown Formation (Curling Group): quartzitic metasandstone;* **G/I**, *grey slate and phyllite*

DOMAIN 2

Ordovician

G Goose Tickle Group: *green-grey metasandstone, grey phyllite, dolomitic siltstone, minor ribbon limestone and dolostone;* **Gm,** *disrupted formation to melange-like*

DOMAIN 3A, 3C

Ordovician

G GooseTickle Group: *grey slate, green-grey sandstone, siltstone, minor thin-bedded and conglomeratic limestone*

T Table Head Group: *grey, bioturbated and stylonodular to stylo-thin-bedded limestone, argillaceous limestone, dolostone and dolomitic limestone in lower part*

S St. George Group: *grey limestone and interbedded dolostone and limestone*

P Port au Port Group: *pale-grey dolostone, argillaceous dolostone; dotted marker - oolitic and stromatolitic limestone interbedded with dolostone*

R Reluctant Head Formation: *ribbon limestone, grey phyllite, minor limestone conglomerate, grainstone at top, locally dolomitized*

Pc Penguin Cove: *thin-bedded quartzose sandstone and siltstone, nodular and thin-bedded limestone, grey and green-grey phyllite and slate*

Sl Unnamed unit: *grey slate and phyllite*

DOMAIN 3B, DOMAIN 4

Cambrian – Ordovician

Pg Pinchgut Lake Group: *grey and silver-grey phyllite, slate, calcareous and dolomitic phyllite, ribbon limestone, oolitic and quartzitic limestone, limestone conglomerate;*

Pg ∈-Cambrian; Pg O -Ordovician;

d - marker of oolitic and quartzitic limestone, limestone conglomerate in Pg ∈;

Pg m, micaceous phyllite, conglomeratic and crystalline grey marble (Breeches Pond Formation of Cawood and van Gool, 1994)

DOMAIN 5

Cambrian – Precambrian?

M Mount Musgrave Group: *quarztitic psammite, green-grey to pink chloritic marble, pelite*

Precambrian

P∈ Grenvillian gneiss: *granitic gneiss, amphibolitic gneiss, micaceous schist*

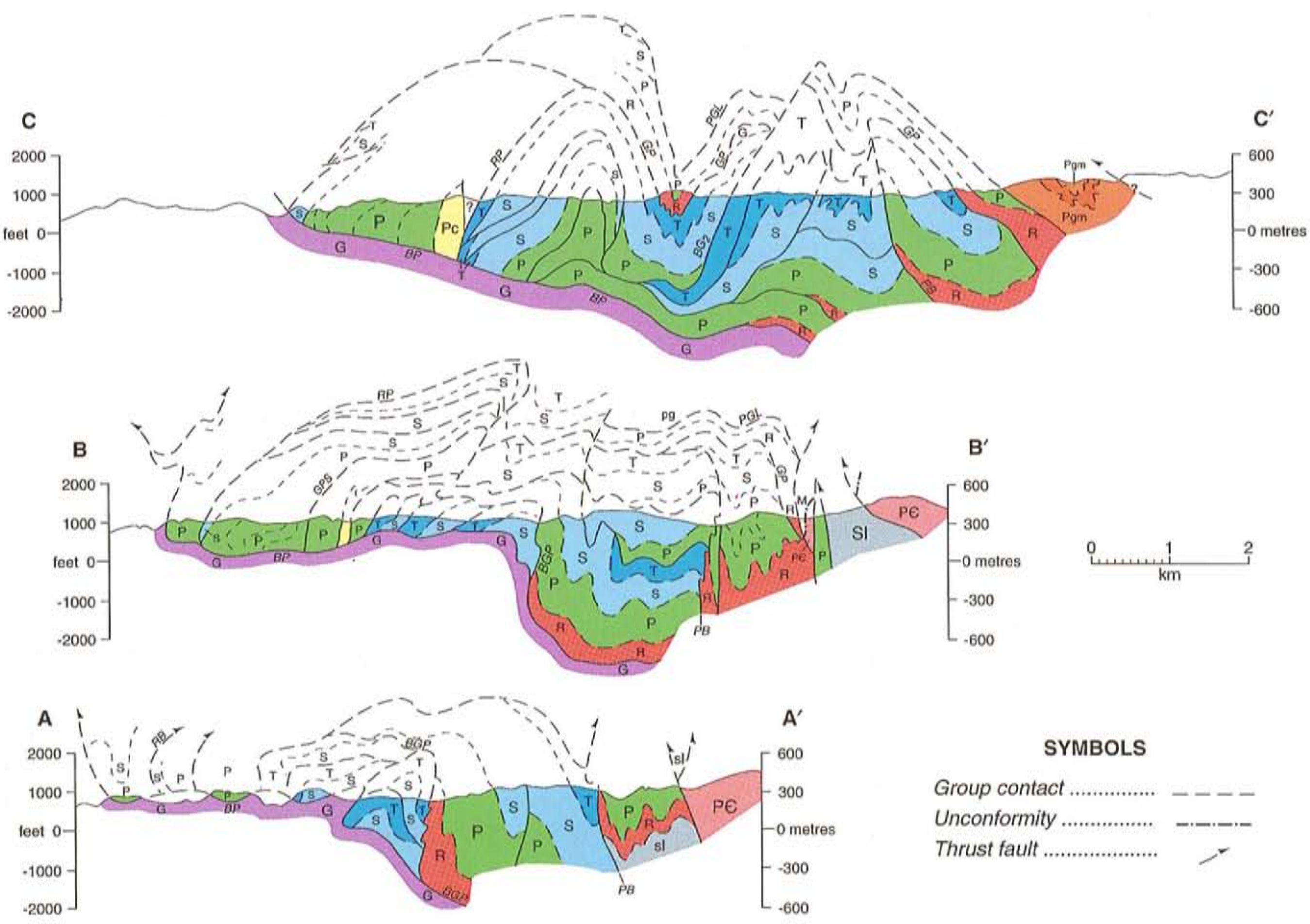

Figure 5. *Preliminary interpretative cross sections through the Blue Pond thrust stack; vertical exaggeration x 2.*

particularly where the footwall rocks are Ordovician marble. The widest zones occur in the footwall to the Pikes Brook and Gullet Pond thrusts. They are characterized by very tight isoclinal folds, eye folds and many deformed white calcite veins. A prominent stretching lineation on the foliation of most of the thrusts has a general trend between 300 and 340°. Dolostone beds and fabrics are boudinaged and rotated to form small to large tailed augen, which together with C–S fabrics and drag folds indicate northwest vergence on the thrusts. Thrusts in the northwest of the stack dip to the northwest and have therefore been tilted. Black fibrous, presumably syntaxial, calcite (?beef calcite) is commonly associated with the thrusts. It occurs as 0.5- to 1.0-cm-thick bedding-parallel bands where the thrusts propagate through dark blue-grey crystalline limestone marble of the Watts Bight Formation and, locally, the Boat Harbour Formation.

Deformation of the hanging-wall rocks varies depending on the overriding stratigraphic unit. At least two phases of folding affect the mixed fine clastic and carbonate rocks of the Penguin Cove Formation in the hanging wall to the Big Gull Pond thrust at the core of the antiformal stack. The later folds consistently trend around 200 to 220°, plunging both northeast and southwest, however, transposition of bedding is absent.

Phyllitic ribbon limestone of the Reluctant Head Formation in the more easterly slices generally becomes more deformed near the thrusts. Bedding breaks down into a composite transposed banding or even into a phyllitic limestone mylonite, implying progressive or poly deformation. The composite banding contains augen of the thin bedded and laminated limestone protolith and small rootless folds lie parallel to the banding. The phyllitic carbonates are locally folded by small, tight recumbent folds, eye folds and sheath folds close to the thrust plane. Augen of bedded limestone in the mylonitic banding and folded *en echelon* quartz and calcite veins indicate a northwestward sense of overthrusting.

Port au Port Group dolostones are commonly intensely fractured and brecciated in the hanging wall to the Pikes

LEGEND (Figure 5)

DOMAIN 1

HUMBER ARM ALLOCHTHON

Cambrian

I *Irishtown Formation (Curling Group): quartzitic metasandstone;* **G/I**, *grey slate and phyllite*

DOMAIN 2

Ordovician

G Goose Tickle Group: *green-grey metasandstone, grey phyllite, dolomitic siltstone, minor ribbon limestone and dolostone;* **Gm,** *disrupted formation to melange-like*

DOMAIN 3A, 3C

Ordovician

G GooseTickle Group: *grey slate, green-grey sandstone, siltstone, minor thin-bedded and conglomeratic limestone*

T Table Head Group: *grey, bioturbated and stylonodular to stylo-thin-bedded limestone, argillaceous limestone, dolostone and dolomitic limestone in lower part*

S St. George Group: *grey limestone and interbedded dolostone and limestone*

P Port au Port Group: *pale-grey dolostone, argillaceous dolostone; dotted marker - oolitic and stromatolitic limestone interbedded with dolostone*

R Reluctant Head Formation: *ribbon limestone, grey phyllite, minor limestone conglomerate, grainstone at top, locally dolomitized*

Pc Penguin Cove: *thin-bedded quartzose sandstone and siltstone, nodular and thin-bedded limestone, grey and green-grey phyllite and slate*

Sl Unnamed unit: *grey slate and phyllite*

DOMAIN 3B, DOMAIN 4

Cambrian – Ordovician

Pg Pinchgut Lake Group: *grey and silver-grey phyllite, slate, calcareous and dolomitic phyllite, ribbon limestone, oolitic and quartzitic limestone, limestone conglomerate;*

Pg ∈-Cambrian; Pg O -Ordovician;

d - marker of oolitic and quartzitic limestone, limestone conglomerate in Pg ∈;

Pg m, micaceous phyllite, conglomeratic and crystalline grey marble (Breeches Pond Formation of Cawood and van Gool, 1994)

DOMAIN 5

Cambrian – Precambrian?

M Mount Musgrave Group: *quarztitic psammite, green-grey to pink chloritic marble, pelite*

Precambrian

P∈ Grenvillian gneiss: *granitic gneiss, amphibolitic gneiss, micaceous schist*

KEY

BP - Blue Pond thrust, FP - Fox Pond thrust, RP - Rocky Pond thrust, BGP - Big Gull Pond thrust, BG1 -Big Gull Pond 1 thrust, BG2 - Big Gull Pond 2 thrust, GPS - Gull Pond Steady thrust, PB - Pikes Brook thrust, GP - Gullet Pond thrust, PGL - Pinchgut Lake thrust, WCL - Wild Cove Lake thrust

Brook thrust. Several generations of *en echelon* quartz and dolomite veins are common and the early ones are folded. Argillaceous dolostones commonly have multiple cleavage development. The early cleavage, which is coplanar with the bedding, is folded about later cleavages.

Other Structural Features of the Antiformal Stack

Within the stack, most of the structural fabric is associated with west-dipping, northeast-trending cleavage related to the late folding of the stack. Early structures are confined to a local bedding parallel foliation and a shallow east-dipping cleavage in argillaceous beds. Burrow dolomite and other fine dolomite fabrics are commonly stretched, broken and rotated in the plane of the foliation. These structures are commonly crenulated by the main cleavage. Rare kink bands that trend 325° and dip 80° east, occur in the eastern part of the Big Gull Pond thrust slice.

High-Angle Faults. A number of west to north-northwest-trending high-angle faults offset stratigraphic boundaries within the thrust slices of the stack. The faults trend 250 to 305°, dipping between 70 and 80°N. Subhorizontal slickensides and offset, usually of only few metres, suggest right lateral movement in many of the faults. Some faults are marked by gouge and locally by small amounts of red cave breccia and fibrous speleothem cement, possibly of Carboniferous age. Some cave breccias may also be offset, suggesting post-Carboniferous movement.

Some north-trending faults, which have significant vertical displacements, crosscut the main thrusts of the stack and also offset the southern contact of the stack with Domains 4 and 5. Although the fault planes themselves have not been observed, there are wide zones of fracturing and brecciation where the faults cut the Cambrian dolostones.

STRUCTURE OF THE PINCHGUT LAKE GROUP

Beds and stratigraphic markers, which are truncated by the basal thrust, define a west to northwest trend that has been deformed by northeast-trending folds. Younging directions, particularly in oolitic and quartzitic limestone, dolostone, and limestone conglomerate markers indicate that the group was folded by a series of early northwest-trending folds and possibly repeated by at least one thrust. The northwest fold trend is also present in the flyschoid rocks of the footwall to the thrust slice. Bedding is inverted, locally, in both the hanging wall and footwall.

The main structural grain in the Pinchgut Lake group of the hanging wall and in the flysch of the footwall is north to northeast. It is associated with D2 folds, and a penetrative cleavage that dips predominantly to the southwest at moderate angles of 20 to 45°. A later crenulation cleavage, trending northwest to northeast and dipping west to north at angles of less than 30°, openly warps the D2 cleavage.

STRUCTURE OF SUBDOMAIN 4A

The marbles and phyllites of subdomain 4A are polydeformed (Figure 6). In carbonate units, a composite foliation, which is axial planar to tight isoclinal folds, locally deforms earlier isoclinal folds and is parallel to the banding and boundaries of marble units; the isoclinal folds are west--verging. The foliated marbles and phyllites are folded about later east-verging, northeast-plunging folds (D3 or D4) that have an axial-planar cleavage striking 210 to 230° and dipping 60° west; the folds plunge between 15 and 25°. Detailed tracing of marble units suggests that they are lenticular in shape possibly reflecting west-verging fold closures that postdated the isoclinal folds but predated the east-verging structures (Figure 6). This suggests that at least four deformations affected the subdomain. The east-verging folds are believed to be co-generational with those of Domains 2 and 3.

Locally, a crenulation cleavage, trending 275° and dipping 40° north, deforms the northeast-trending cleavage; crenulation folds plunge almost due north at 40°.

Although isolated from subdomain 4A proper, it is appropriate here to discuss the rocks of metamorphosed Pinchgut Lake group at Wild Cove Lake valley, northeast of Corner Brook. The polydeformed, intercalated phyllite, marble and limestone conglomerate dip westward at about 55°. Most significant in the marble beds is the presence at the top of the map unit of a large dekametre-scale C–S fabric associated with dolostone augen. The vergence on the fabric indicates that the subdomain has been overthrust by the west-dipping rocks outcropping farther west along the valley. These rocks compare to the Penguin Cove Formation and are in turn overlain by the carbonate sequence of the Humber River mountains.

DISCUSSION OF THE STRUCTURE OF THE HUMBER ZONE SOUTHWEST OF CORNER BROOK

The eastern edge of the outer section of the Humber Zone, southwest of Corner Brook, preserves diverse elements of the ancient Laurentian margin, within a foreland fold-and-thrust belt. The accretion of several domains includes a middle ground of Cambro-Ordovician carbonate shelf rocks, its deeper water equivalents of the Pinchgut Lake group derived farther east, and Ordovician flyschoid rocks. Transported Cambrian terrigenous rocks of the Humber Arm Allochthon lie along the western edge of the flyschoid domain. To the southeast, Precambrian basement rocks with a thin cover of metaclastic and marble rocks, which are metamorphically and lithologically distinct from the shelf rocks and the Pinchgut

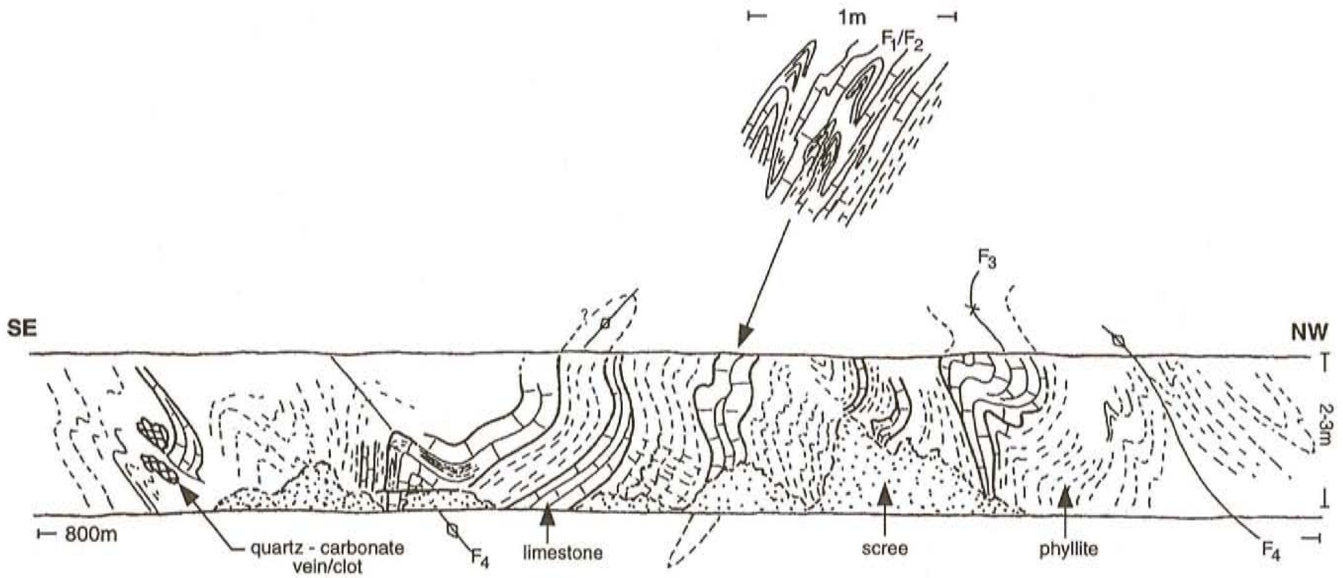

Figure 6. *Notebook sketch of polydeformed phyllite and marble of subdomain 4A. The sketch is of a roadcut along a gravel road that follows the steep southern slope of Pikes Brook valley (Figure 1).*

Lake group, are probably part of the inner section of the Humber Zone.

The middle domain is dominated by an antiformal stack that carries repeated sections of the carbonate shelf sequence over Ordovician flyschoid rocks. The stack traveled at least 6 km over the flysch, and is internally shortened by several kilometres more. The west-verging stack is built of a number of forward-facing thrust slices in the west and the core of the complex. A prominent pop-up structure that verges eastward accommodates shortening within the stack in the southeast (*see* cross section C - C', Figure 5). The thrust slices along the southeastern side of the complex dip steeply southeastward. Stratigraphic cutoffs within the thrust slices at their leading and trailing edges suggest that a significant part of the complex includes ramp geometries. The stratigraphy of western thrust slices begins with Penguin Cove Formation that is overlain by typical Port au Port Group and Ordovician shelf stratigraphy. In contrast, the Cambrian stratigraphy of the eastern slices consists of the Reluctant Head Formation overlain by a reduced Port au Port Group succession. This west to east change of the Cambrian succession mirrors that in the thrust stack of Goose Arm that also overthrusts Ordovician flysch (Knight, 1994a).

The Pinchgut Lake thrust slice carried deepwater sediments of its namesake group westward over the Ordovician flysch. However, it was first accreted structurally to the carbonate shelf sequence and together, they overthrust the flysch. Early west- to northwest-trending folds, and at least one thrust, affected/deformed the Pinchgut Lake thrust slice before it was folded by later east-verging, northeast-trending folds. The latter deformation also deformed the shelf rocks in the Blue Pond (antiformal) stack, including the basal thrust. In addition, the generation of east-verging folds affected the more highly deformed and metamorphosed Pinchgut Lake group of subdomain 4A, where the early thrust structures and folds also verge westward to northwestward.

IMPLICATIONS OF STRUCTURAL COMPARISON OF THE HUMBER ZONE SOUTHWEST OF CORNER BROOK AND THAT OF THE GOOSE ARM – HUGHES BROOK AREAS

The thrust stack of low-grade metamorphosed carbonate shelf rocks, overlying flysch, in the Georges Lake–Pinchgut Lake area is comparable to that mapped in the Goose Arm area 50 km to the north (Knight, 1994a, b). Therefore, it can be speculated that the carbonate rocks of the two areas were once a contiguous thrust slice that also carried the intermediary carbonate domain (subdomain 3C) of the Corner Brook area.

Knight (1994a, b) described footwall rocks of flysch and broken formation, including elements of allochthonous deepwater shale below the folded Penguin Head thrust slice. These rocks, which are exposed at the leading edge of the Goose Arm thrust stack, occupy topographically low areas of the Pasadena map area including the shore of Penguin Arm. West-verging recumbent anticlinal folds occur in the hanging wall to the thrust, and the thrust and folds are deformed by east-verging folds like those that deform the Blue Pond stack.

Knight (1994a) also described west-verging folded thrusts and downward-facing recumbent folds near Hughes Brook in the Pasadena map area. These structures, which are associated with a west-dipping but reoriented cleavage, may have been tilted by the later east-verging deformation. Since forward-facing duplexes occur in the Blue Pond stack (compare with Boyer and Elliot, 1982, Figure 24A), it is suggested that the recumbent folds of the Hughes Brook area may be downward- and forward-facing folds within a foreland-facing duplex that includes all the topographically high carbonate rocks of the Corner Brook area.

No exposures of flyschoid rocks that would be part of the footwall to the overthrust are exposed in the Hughes Brook area. However, the shoreline of the eastern end of Humber Arm abruptly terminates the steeply west-dipping, highly resistant, and topographically pronounced Cambrian and Ordovician carbonates with no offset of boundaries across the fiord. This topographic contrast also continues into the marshy, sack-shaped valley occupied by the Wild Cove refuse dump. Here, the valley has an elevation barely above sea level but is surrounded by spectacular carbonate scarps. This sea-level-hugging topographic discontinuity might reflect the erosion of the fiord through the sole of the thrust stack (Figure 4).

THE WILD COVE LAKE VALLEY THRUST

Metamorphosed rocks of the Pinchgut Lake group, at the east end of Wild Cove Lake valley structurally underlie carbonates in the mountains bordering the Humber River gorge, and these carbonates could be part of a major overthrust. Although this relationship has yet to be mapped in detail, the large west-verging C–S fabric in the Wild Cove Lake valley rocks support this suggestion. Thus, the carbonates of the Humber River gorge region may overlie a major thrust that carried the shelf rocks westward above the deeper water, outer shelf Pinchgut Lake group.

A corresponding relationship may have been overlooked (by the author) where similar rocks occur north of Hughes Brook as it turns east to Ball Pond in the Pasadena map area (Knight, 1994b, *see* conglomerate unit, Reluctant Head Formation). The rocks, which are assigned to the Reluctant Head Formation (Knight, 1994b), form a steeply dipping zone sandwiched between the structurally overlying Old Man Pond allochthon to the northeast and the carbonate shelf sequence to the west. The relationship in this area may have been obscured by the east-verging folds that deform the Goose Arm thrust stack and its contact with the Old Man Pond allochthon.

THE ROOF TO THE ANTIFORMAL STACK

Defining the roof to the Blue Pond–Pinchgut Lake thrust stack is difficult. This is because of the recessive weathering of the fine-grained slaty and phyllitic rocks that occur widely along the western edge of the stack. This has helped to obscure the relationship between the stack and the allochthonous rocks of Domain 1 and the roof may lie within the phyllitic rocks or at the base of the allochthon.

Cawood and van Gool (1994), and earlier Williams and Cawood (1986, 1989), indicated that the rocks of Domain 1 immediately adjacent to Domains 2 and 3 are deformed by east-verging structures including a fan of thrusts. However, although all maps show structures dipping to the west, none indicate that the quartzite and phyllite of the Irishtown Formation are inverted over a substantial distance adjacent to the domain boundary. As the carbonate sequences are principally deformed by west-verging imbrication with substantial elevation of the thrust stack, it is reasonable to assume that where the Humber Arm allochthon lay structurally above the stack, it was arched and tilted to the west. This is the relationship mapped at Goose Arm (Knight, 1994a, b) and is the relationship that best applies to the present disposition of domains north and south of Corner Brook (Knight, 1994a, b). It also marks the western edge of the Blue Pond thrust stack near Georges Lake.

The inversion of the Irishtown Formation rocks must predate the elevation of the stack and any later east-verging shortening. In addition, the broken flysch formation is best interpreted as an early foreland basin feature, indicating that the relationship of the Irishtown Formation to the flysch is a late structural development.

The roof thrust may therefore coincide with the base of the allochthon, which may or may not include the so-called melange. Brittle fault relationships occur extensively at the allochthon–carbonate shelf contact in the Goose Arm area. This suggests that the deepwater rift sequences of the Humber Arm Allochthon formed the roof to the shelf duplexes, and that the allochthon moved into its present position during the structural episode that created the duplexes. Additional mapping will be necessary to define the western relationship of the stack and the Pinchgut Lake slice to the adjacent Humber Arm Allochthon.

FURTHER IMPLICATIONS OF THE BLUE POND AND GOOSE ARM THRUST STACKS

The structural elevation of the carbonate sequence and the conclusion that it has been detached from its basement suggests that it has been transported a significant distance. It also implies that the Blue Pond and Goose Arm thrust stacks form part of a major regional thrust sheet that carried already metamorphosed sedimentary rocks to their present positions. This thrust sheet may also include the various imbricates of more metamorphosed Pinchgut Lake group (subdomain 4A) rocks and rocks of the Precambrian basement and supracrustal cover (Domain 5). The presence of all these rocks in a single thrust sheet is supported by the apparent common deformation of each domain by the late east-verging folding and penetrative cleavage. This structural event may be linked to the westerly imbrication of the fold-and-thrust belt during the Acadian Orogeny at the time when the Port au Port triangle zone formed (Stockmal and Waldron, 1993; Waldron and Stockmal, 1994). If the east-verging structures are Acadian, it is probable that the earlier westward overthrusting of the metasedimentary domains is of Silurian age, part of the Salinic deformation that has been recently documented in the Newfoundland Appalachians (Dunning *et al.,* 1990; Knight and Cawood, 1991; Knight and Hawkins, 1993, 1994; Cawood and van Gool, 1994; Knight, 1995b).

Ordovician flysch forms the footwall to the overthrust throughout the region, therefore, it is likely that the carbonate shelf sequence is repeated at depth, where it may have been involved in thrust imbrication as the west-verging system propagated toward the foreland. This suggests that imbricated shelf carbonate, flysch and probably basal rocks of the allochthon occur in the subsurface below the exposed sedimentary and ophiolitic rocks of the Humber Arm Allochthon. In this situation, the facies of the shelf sequence and the thermal maturity of the carbonate will more likely resemble those of the essentially pristine sequence of the Port au Port area and Cow Head Allochthon. Therefore, these rocks may present an attractive target for hydrocarbon exploration, unlike the rocks exposed at surface.

ECONOMIC COMMODITIES

BASE METALS

No base metal showings are present in the Georges Lake area. A single showing of disseminated pyrite occurs in subdomain 3A on the northeast shore of Big Gull Pond. The disseminated pyrite is brecciated in epigenetic dolostone that replaces the uppermost limestone of the March Point Formation. The dolostones consist of centimetre-sized, rounded, dark-grey, finely crystalline, breccia clasts that are encased in a narrow fringe of white sparry dolomite. Pyrite occurs in pores between clasts. The dolostone occurs immediately below the upper contact of the formation with the overlying pale-grey, microcrystalline dolostones of the Petit Jardin Formation.

Sphalerite, galena and pyrite occur close to the upper contact of the Reluctant Head Formation with dolostones of the Petit Jardin Formation, north of Humber River gorge. These showings were discovered by Westfield Minerals (Wilkinson, 1983a, b) in the early 1980s and have recently been examined by VMS Consultants (Thurlow, 1993, 1994).

DIMENSION STONE

The area has significant potential for marble deposits. White, pink, peach, red, purple, grey, dark-grey and varicoloured calcareous and dolomitic marble possess a broad spectrum of sedimentary and structural fabrics including veined, stylolitic, nodular, banded, brecciated and conglomeratic textures. The marble varies from finely crystalline in much of Domain 3 to medium to coarse grained in the Pinchgut Lake group of subdomain 3B and Domain 4.

MARBLES OF SUBDOMAIN 3A

White and pink marbles occur in the upper part of the Reluctant Head Formation, the upper member of the Berry Head Formation, the Costa Bay member of the Catoche Formation, and the middle member of the Petit Jardin Formation.

A variety of white, pink, purple and red dolomitic and calcareous marbles occur on the southwest-trending ridge southwest of the Island Pond access road (localities A and A1, Figure 1). At locality A, the Reluctant Head Formation contains white to off-white calcareous marbles that display conglomeratic textures and red stylolitic veining. They are associated with two unique marbles, the first of which is a red marble of conglomeratic origin showing grey and off-white translucent mottles and fragments enclosed by a red matrix. The contrast between the grey and white areas and the red matrix gives the non-red areas a glassy look. The second marble is calcareous and consists of white and peach clots surrounded by a wandering, light-brown matrix.

Dolomitic and lesser calcareous marbles of the overlying Petit Jardin and Berry Head formations occupy the ridge above the Reluctant Head marbles. The hard, microcrystalline, often brittle, dolomitic marbles are very abundant as homogeneous, pink- to peach-coloured types, which locally have some interesting pink varieties. The latter include a salmon pink breccia having white to light pink clasts and white crystalline cement patches. The breccia is associated with a white marble enclosing pink burrow mottles. Dolomitic marbles in the same area also include creamy-white and salmon-pink to red streaked varieties.

Pink, grey with purple mottles and streaks, and cream dolomitic marbles are common at localities A1 and B (Figure 1). The marbles, which are abundant, are hosted by the Berry Head Formation and the upper part of the Petit Jardin Formation. At locality B1, the dolomites are carried in the hanging wall to the Pikes Brook thrust. Here the dolomites are locally yellow and have brecciated textures.

In the footwall to the Pikes Brook thrust (locality B), there are a number of white and pink marbles associated with the Costa Bay member and the Berry Head Formation. White marbles of both units, as the Pikes Brook thrust is approached, become intensely flattened and develop a foliation. One banded variety consists of white and dark-grey to black linear bands that are commonly folded. Cut parallel to the foliation, the fabric is similar to *arabescato*. Another foliated white marble, which lacks the dark-grey bands, provides a more vitreous look. Small augen of pale yellow dolomite and pale grey and locally reddish streaking occur within white marble. This gives a texture like that of the commercial marbles, *Agia Marina* and *Rosewind*. Cut parallel to the banding, white marble dominates large areas that surround diffuse patches of reddish grey colour and dolomite augen. Both these marbles have fine to medium crystallinity and take a good polish.

A blush-pink to peach to cream microcrystalline dolostone marble, is found in the same area (locality B) in the footwall to the Pikes Brook thrust. It contains straight to folded, white dolomite and quartz veins and pale green, pale yellow and reddish argillaceous seams. The veins, seams, and variable colour produce a marble with a vibrant, active appearance. The unit probably occurs in the upper part of the Berry Head Formation, but similar dolostones also occur in the Boat Harbour and Aguathuna formations. Examples of this marble are displayed at Marble Mountain Ski Resort, Corner Brook.

White marble of the Costa Bay member is accessible and has good topographic relief at the ridge immediately west of the gas station on the TCH at Pinchgut Lake (locality C, Figure 1). The marble here is at least 10 m thick and is a stylolitic pure calcareous marble. The same unit is also found in the Pikes Brook thrust at locality B2, where it is more deformed and recrystallized and includes grey stylolitic veining.

Lastly, white marbles having a pale yellow-green stylolitic veining, and mottling and fabrics derived from deformation of stromatolite mounds, burrows and oolitic grainstones occur in the lower part of the middle member of the Petit Jardin Formation at localities D and D1 (Figure 1).

GREY MARBLE IN DOMAIN 3

Dark-grey to grey marble are common in the Watts Bight, Catoche and Table Point formations. The fine to coarsely crystalline marbles are commonly massive, thick bedded and display deformed fabrics and structures, particularly burrow and microbial mound structures. The latter are especially important in distinctive marbles of the Watts Bight Formation at locality A1 (Figure 1). The grey is triple toned with dark-grey dapples enclosed by light and medium grey mottles. Light grey to whitish stylolitic seams, locally reddened, wander across the marble at centimetre spacing.

Where the dark-grey marbles of the Watts Bight, Catoche and Table Point formations approach the major thrust faults, they are strongly flattened with a well developed planar foliation. This produces a marble that is similar to *Bardiglio cappella* (Istituto commercio Estero, 1982).

Another grey marble with distinctive appearance is formed by the conglomerates of the Pinchgut Lake group. It is best seen along the Big Feeder Brook and Loggers School forest access roads (localities E, Figure 1). This marble occurs in a massive, well-cemented, thick-bedded outcrop. Slabbed samples of essentially undeformed conglomerate reveal a range of pebble colours, including charcoal grey, slate grey and a medium dappled grey. The matrix between clasts is slightly lighter than the clasts. Fine white veins define the outlines of many pebbles and short white calcite veins cut the conglomerate. Where the conglomerate is deformed in inverted fold limbs or close to shear zones, pebbles are flattened and elongated.

MARBLE OF DOMAIN 4

Grey marble occurs in this domain as thick layers within the predominantly phyllitic units. Only the conglomeratic marbles have visual appeal because they are generally strongly deformed with the pebbles flattened and elongated (localities E1 and E2, Figure 1). The pebbles are mostly light grey and have dark-grey stylolitic outlines, so that the marble resembles *Bardiglio carrarra scuro* (Istituto commercio Estero, 1982). Some boulders of grey conglomerate have a white and dark-grey contrast between pebble and matrix suggesting that there are more conglomeratic varieties in this domain, which have not yet been discovered in outcrop.

MARBLE OF DOMAIN 5

A 6-m-thick unit of chloritic marble in the supracrustal cover sequence at locality F (Figure 1) provides a strongly foliated, gneissic, marble of grey-green to pink colour. Very hard and massive in outcrop, the marble has a striking appearance due to its strong banding and the presence of pink calcite augen and veins. Cut at right angles to the foliation, but parallel to the axis of elongation, the marble has the appearance of a gneiss. It contains diffuse millimetre-thick pink and grey-green calcite foliae and dark-green chlorite foliae, as well as veins and augen of pink, coarsely crystalline calcite having translucent white quartz augen. The unit has been traced intermittently over a distance of 2 km.

OTHER BUILDING-STONE USES

Many of the carbonate rocks of the area can be easily split into flags and tablets of various dimensions suggesting that they could be used to build walls and paths. The flaggy nature of the thinly stratified limestones and dolostones of the St. George and Table Head groups, especially the Boat Harbour and lower Catoche formations, yields stone having good textured to smooth surfaces. The dark-grey limestone weathers with time to a light grey, and the lighter grey dolostone with time should acquire a buff to yellow colouration. The wide zones of strongly planar, foliated to mylonitic marbles close to the major thrusts also contain flagstone with a smooth, planar appearance. The closely spaced phyllitic folia in these marbles allow easy defoliation by splitting techniques. They could provide excellent paving stones and slabs of different dimensions and various colours.

HYDROCARBON EXPLORATION

Although no traces of hydrocarbons are known in the area, the present mapping has significance for the overall direction and extent of future exploration. The definition of a major regional Paleozoic thrust carrying metamorphosed carbonate westward suggests that pristine foreland basin and shelf sequences occur at depth below the overthrust and below the Humber Arm Allochthon. There is, therefore, good reason to suppose that buried thrust imbricates of suitably mature rocks may occur between Corner Brook and the triangle zone of the Port au Port Peninsula, up to 50 km east of the Appalachian front.

ACKNOWLEDGMENTS

George Ellsworth provided excellent assistance during field work. Steve Colman-Sadd reviewed the article and Tony Paltanavage drafted the figures. Geoff Thurlow granted access to the confidential maps of the Humber gorge area.

REFERENCES

Botsford, J.W.
1988: Depositional history of Middle Cambrian to Lower Ordovician deep-water sediments, Bay of Islands, western Newfoundland. Unpublished Ph.D. thesis, Memorial University of Newfoundland, St. John's, 509 pages.

Boyce, W.D.
1981: Assessment report on geology and hydrocarbon potential for Reid lots 24-29 in the Georges Lake and Serpentine Lake areas, western Newfoundland. A. and V. Harris Exploration Services, Report for Morrison Petroleum, 26 pages, Open file NFLD 1250.

Boyce, W.D., Knight, I. and Ash, J.S.
1992: The Weasel Group, Goose Arm Area, western Newfoundland. Lithostratigraphy, biostratigraphy, correlation and implications. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 92-1, pages 69-84.

Boyer, S.E. and Elliott, D.
1982: Thrust systems. American Association of Petroleum Geologists, Bulletin, Volume 66, Number 9, pages 1196-1230.

Cawood P.A. and van Gool, J.A.M.
1992: Stratigraphic, structural, and metamorphic relations along the eastern margin of the Humber zone, Corner Brook Lake map area, western Newfoundland. *In* Current Research, Part E. Geological Survey of Canada, Paper 92-1E, pages 239-247.

1994: Geology of the Corner Brook Lake region, Corner Brook, Newfoundland. Geological Survey of Canada, 1:50 000 scale map, Open File 2830.

Dunning, G.R., O'Brien, S.J., Colman-Sadd, S.P., Dickson, W.L., O'Neill, P.P. and Krogh, T.E.
1990: Silurian orogeny in the Newfoundland Appalachians. Journal of Geology, Volume 98, pages 895-913.

Istituto commercio Estero
1982: Italian Marble: Technical Guide. *Edited by* Vallardi, F. Lli., Italian Institute for Foreign Trade, Rome, Volume 2, 146 pages.

James N.P. and Stevens, R.K.
1986: Stratigraphy and correlation of the Cambro-Ordovician Cow Head Group, western Newfoundland. Geological Survey of Canada, Bulletin 366, 143 pages.

James, N.P., Knight, I., Barnes, C.R. and Stevens, R.K.
1988: Sedimentology and paleontology of an early Paleozoic continental margin, western Newfoundland. Geological Association of Canada Field Trip Guide B1, St. John's, Newfoundland, 121 pages.

Knight, I.
1983: Geology of Cambro-Ordovician rocks in parts of the Castor River, St. John Island and Port Saunders map sheets. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 1-10.

1992: Geology of marmorized lower Paleozoic platformal carbonate rocks, "Pye's Ridge", Deer Lake. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 92-1, pages 141-158.

1994a: Geology of Cambrian – Ordovician platformal rocks of the Pasadena map area (NTS 12H/4). *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey, Report 94-1, pages 175-186.

1994b: Pasadena map area (12H/4). Geological Survey of Newfoundland, Newfoundland Department of Mines and Energy, Map 93-163.

1995a: Preliminary 1:50 000 mapping of lower Paleozoic parautochthonous sedimentary rocks of the Corner Brook area. *In* Current Research. Newfoundland Department of Natural Resources, Geologicial Survey, Report 95-1, pages 257-265.

1995b: Western Newfoundland, Canada: a lower Paleozoic basin with hydrocarbon potential. Abstract, Canadian Society of Petroleum Geologists, luncheon talk, Calgary, March, 1995.

Knight, I. and Boyce, W.D.
1987: Lower to Middle Cambrian terrigenous - carbonate rocks of Chimney Arm, Canada Bay: Lithostratigraphy, preliminary biostratigraphy and regional significance. *In* Current Research. Newfoundland Department of Mines, Mineral Development Division, Report 87-1, pages 359-365.

1991: Deformed lower Paleozoic platformal carbonates, Goose Arm – Old Man's Pond. *In* Current Research. Newfoundland Department of Mines and Energy, Report 91-1, pages 141-154.

Knight, I. and Cawood, P.A.
1991: Paleozoic geology of western Newfoundland: an exploration of a deformed Cambro-Ordovician passive margin and foreland basin, and Carboniferous successor basin. Centre for Earth Resources Research. Memorial University of Newfoundland, Short course and field guide, 403 pages.

Knight, I. and Hawkins, D.
1993: Western Newfoundland, a lower Paleozoic basin with hydrocarbon potential. Abstract with Program. Annual Meeting of Eastern Chapter of American Association of Petroleum Geologists, Williamsburg, Virginia.

1994: Western Newfoundland, a lower Paleozoic basin with hydrocarbon potential. Abstract with Program. Annual Meeting, Canadian Society of Petroleum Geologists, Calgary.

Knight, I. and James, N.P.
1987: Stratigraphy of the St. George Group, (Lower Ordovician) western Newfoundland; the interaction between eustasy and tectonics. Canadian Journal of Earth Sciences, Volume 24, pages 1927-1952.

1988: Stratigraphy of the Lower to Lower Middle Ordovician St. George Group, western Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 88-4, 48 pages.

Knight, I. James, N.P. and Lane T.E.
1991: The Ordovician St. George Unconformity, Northern Appalachians: The relationship of plate convergence at the St. Lawrence Promontory to the Sauk-Tippecanoe sequence boundary. Geological Society of America Bulletin, Volume 103, pages 1200-1225.

Lilly, H.D.
1963: Geology of Hughes Brook – Goose Arm area. Memorial University of Newfoundland, Department of Geology, Report 2, 123 pages.

McKillop, J.H.
1963: Geology of the Corner Brook Lake area, Newfoundland, with emphasis on the carbonate deposits. Memorial University of Newfoundland, Department of Geology, Report 1, 102 pages.

Meyer, J.
1995: Resurgence of interest boosts Atlantic Canada's stone industry. Stone World, Volume 12, Number 3, pages 88-94.

Quinn, L.A.
1992: Foreland and trench slope basin sandstones of the Goose Tickle and Lower Head Formation. Unpublished Ph.D. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 573 pages.

Riley, G.C.
1957: Stephenville map-area, Newfoundland. Geological Survey of Canada, Memoir 323, 72 pages.

Ross, R.J. Jr. and James, N.P.
1987: Brachiopod biostratigraphy of the Middle Ordovician Cow Head and Table Head groups, western Newfoundland. Canadian Journal of Earth Sciences, Volume 24, pages 70-95.

Stenzel, S.R.
1991: Carbonate sedimentation in an evolving Middle Ordovician foreland basin, western Newfoundland. Unpublished Ph.D. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 575 pages.

Stenzel, S.R., Knight, I. and James, N.P.
1990: Carbonate platform to foreland basin; revised stratigraphy of the Table Head Group (Middle Ordovician), western Newfoundland. Canadian Journal of Earth Sciences, Volume 27, pages 14-26.

Stockmal, G.S. and Waldron, J.W.F.
1993: Structural and tectonic evolution of the Humber Zone, western Newfoundland: 1. Implications of balanced cross sections through the Appalachian structural front. Tectonics, Volume 12, pages 1056-1075.

Thurlow, J.G.
1993: Report on 1993 mineral exploration on fee simple mineral holdings belonging to Corner Brook Pulp and Paper Ltd., western Newfoundland. Unpublished confidential report, Open file NFLD 2404.

1994: Report on 1994 mineral exploration on fee simple mineral holdings belonging to Corner Brook Pulp and Paper Ltd., western Newfoundland. Unpublished confidential report, Open file NFLD 2514.

Waldron J.W.F. and Stockmal, G.S.
1994: Structural and tectonic evolution of the Humber Zone, western Newfoundland: 2. A regional model for Acadian thrust tectonics. Tectonics, Volume 13, pages 1498-1513.

Walthier, T.N.
1949: Geology and mineral deposits of the area between Corner Brook and Stephenville, western Newfoundland. Geological Survey of Newfoundland Bulletin 35, 87 pages.

Wilkinson, R.
1983a: Report on 1982 exploration, Bowater fee simple mining grant, Corner Brook, Newfoundland. Westfield Minerals Ltd. Unpublished report, 26 pages. Open file NFLD 1319.

1983b: Report on 1983 exploration, Bowater fee simple mining grant, Corner Brook, Newfoundland. Westfield Minerals Ltd. Unpublished report, 16 pages. Open file NFLD1356.

Williams, H.
1978: Tectonic lithofacies map of the Appalachian orogen. Memorial University of Newfoundland. Map 1.

Williams, H. and Cawood, P.A.
1986: Relationships along the eastern margin of the Humber Arm Allochthon between Georges Lake and Corner Brook, western Newfoundland. *In* Current Research, Part A. Geological Survey of Canada, Paper 86-1A, pages 759-765.

1989: Geology, Humber Arm Allochthon, Newfoundland. Geological Survey of Canada, Map 1678A (1:250 000).