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AND LABRADOR

DEPARTMENT OF MINES AND ENERGY

MINERAL DEVELOPMENT DIVISION

REPORT 74-2

LIMESTONE RESOURCES OF NEWFOUNDLAND AND LABRADOR

by JOHN R. DeGRACE

ST. JOHN'S, NEWFOUNDLAND

1974

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Accompanying maps Map 1, Map 2 and Map 3 can be viewed by clicking on each map number

PUBLISHER'S NOTE

Report 74-2, *Limestone Resources of Newfoundland and Labrador* by John R. DeGrace, being the only comprehensive study of the limestone resources of the province to date, is being reissued to provide the necessary background information to facilitate limestone exploration activities in the province. However, the *format* of the reissue has been changed from the original to conform to the format presently used by the Geological Survey. The report is being reprinted in its entirety without any updating or corrections whatsoever; and is being made available only digitally, including on the web.

Readers should be aware that later reviews of the geology of the areas covered in Report 74-2 are those by Hibbard (1983), King (1988), Knight and James (1988), Smyth and Schillereff (1982), Stouge (1983a,b), and Knight (1983). Details concerning the economic potential of the limestone resources themselves, also have been updated in the interim. The Newfoundland Department of Mines and Energy began a reassessment of Newfoundland marble resources in 1985, the objective of which was to determine their industrial potential as filler and dimension stone. Significant reassessments of some of the old deposits were made and new deposits of high-purity, white marble were delineated by diamond drilling. The results of this ongoing reassessment are contained in Howse (1986, 1987, 1988, 1989), Delaney and Howse (1988), Howse and Delaney (1987), and Howse (2004).

Interested persons should initially refer to Current Research Reports 86-1 through 90-1, for the most currently available data. In addition, the Department has issued, over the years, open-file reports on the limestone resources of the province, and these can be obtained from the Geoscience Publications and Information Section of the Geological Survey.

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FOREWORD

Commercial production of limestone in Newfoundland dates back to the early part of this century. The earliest extraction was for the production of quicklime, and since that time large tonnages have been produced for metallurgical use, cement and paper manufacture and, to a lesser extent, for road metal, aggregate and agstone.

As a result of earlier assessment work a considerable volume of data had accumulated in the Department's files up to the inception of the Program of the Canada-Newfoundland Agreement on Mineral Exploration and Evaluation in 1971. The author of this report was placed in charge of a project, under the Program, to further assess the Province's limestone potential and to publish the results of that assessment, together with a summary of all the other information which had been compiled over the years. Funding was provided under the Agreement by the Department of Regional Economic Expansion, and Energy Mines and Resources.

The results of the current assessment are quite encouraging in that very large reserves of high grade limestone, close to tidewater, have been outlined and, at time of writing, two large companies are conducting a feasibility study with the intention of establishing a large portland cement producing operation based on these reserves.

The information contained in this report constitutes a valuable guide for those interested in the Province's endowment of this particular commodity. New, and expanding, industrial developments will require increasing tonnages of limestone and limestone products. The Province's reserves are capable of meeting the growing demand.

J.H. McKillop
Deputy Minister

February, 1974

PREFACE

This report is intended to thoroughly summarize the existing data on limestones in Newfoundland and Labrador so far as they pertain to possible industrial uses for the material. Most of the information presented was available in one form or another, from various sources, before the survey was begun, but significant contributions were made to the store of data available in the course of making the survey.

Although there is a wealth of information available, it is by no means of uniform reliability, the quality of the data being dependent on the investigators concerned and the amounts of time they spent examining the various deposits. The writer has tried to remain objective in considering the various sources of data used in this report, and has stated his estimate of the reliability of various pieces of information where his own knowledge might be of some value. Some of the geological descriptions given and analytical data presented could not, however, be checked. It must also be borne in mind that the amount of information available on the various deposits is roughly proportional to the amount of work done on them, and not to their potential worth as sources of raw materials. This is because the limestone resources of this province are huge, and are still in such an early stage of investigation that many areas underlain by high-purity limestones have scarcely been examined.

This report should not, therefore, be considered as a definitive work on the limestone resources of Newfoundland, but rather as a handy compilation of the data available-a useful starting point for organizations considering the commercial exploitation of limestone in the province. To this end emphasis has been placed on stating estimates of grades and tonnages where available, no matter how approximate these may be. Pertinent information on geologic setting, access, topography and potential quarrying problems has been included as far as possible with these considerations in mind. Information regarding the various past and present quarrying ventures in Newfoundland is included in Chapter III.

ACKNOWLEDGEMENTS

A great many people have contributed directly or indirectly to the production of this report, and not all of them can be acknowledged here. A cursory examination of the selected bibliography will indicate the extent of this writer's indebtedness to previous investigators.

J.H. McKillop, Deputy Minister of the Department of Mines and Energy, is gratefully acknowledged for his constructive support of the project, and for kindly making available the considerable amount of his and his associates' unpublished work on limestone deposits in Newfoundland. Glynn Bartlett conducted extensive research into the economic aspects of limestone production in Newfoundland, and his efforts played a major role in defining the course the project was to take. David Besaw, assisted by Michael Bungay and John Besaw, was responsible for well-executed mapping and sampling projects in the Port au Port and Canada Bay areas, which were completed as part of this study. His continuing interest in the project after the term of his employment was particularly appreciated. Miss Sheila Pafford cheerfully and meticulously completed a Keysort data retrieval system for information on limestones in Newfoundland, which was used in the preparation of this report. Dr. A.S. Lee and her associates at the Mines Branch Laboratory; and Dr. D.F. Strong, Mr. Jaan Vahtra and Mrs. G.A. Andrews of Memorial University cooperated fully with the writer, often under difficult circumstances, to provide accurate analytical data with a minimum of delay. The writer gratefully acknowledges many helpful discussions with geologists of the Mineral Development Division, especially Messrs. J.M. Fleming (now director), E. Hsu, C.C.K. Fong, B.A. Greene and J. Butler. The figures accompanying this report were drafted by Mr. Kenneth Byrne of the Mineral Development Division; Miss Jane Gillam was the principal typist.

J.R. DeGrace

St. John's, Newfoundland
February, 1974

ABSTRACT

Limestone is exposed at many localities in eastern and central Newfoundland and in Labrador. It is in the western part of the island including the Great Northern Peninsula, however, that the largest and most commercially attractive deposits occur. These deposits are confined, for the most part, to the St. George Group and Table Head Formation of Ordovician age, and large tonnages of high-calcium limestone have been outlined in the latter unit at Coney Arm, White Bay; Cooks Harbour, Pistolet Bay; and St. John Island, St. John Bay. On the Port au Port Peninsula up to 2 billion tons of extremely pure St. George Group limestone are exposed.

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CHAPTER I

CHEMICAL AND PHYSICAL PROPERTIES AND DEFINITIONS OF LIMESTONES

From the point of view of a potential consumer, limestone deposits are of interest not so much for their geological significance as for their structure, composition, size (tonnage) and accessibility; these are the factors which concern this report.

Structure includes the present attitude of a deposit and the extent to which it has been folded and faulted. The attitudes of joint sets in the rock are also important as these affect the behaviour of the stone when blasted. Composition refers to the nature and proportions of the various physical and chemical constituents of the stone, and to such physical variables as bedding and porosity. The size of a deposit is, of course, not only governed by geological factors, but also by practical considerations such as reasonable maximum depths of quarrying. Accessibility includes-in addition to the major consideration of distances to potential markets-such local factors as the presence or absence of natural harbours, or potential problems in road-building.

The chemical constraints on the definitions of carbonate rocks for industrial purposes are arbitrary. Pure high-calcium limestone is composed entirely of calcium carbonate ($CaCO_3$), but natural limestones are never that pure. For practical purposes, a rock of 97 to 99 per cent $CaCO_3$ by weight with 1 to 3 per cent impurities is considered high calcium stone. Similarly, pure dolomite (54.3 per cent $CaCO_3$ and 45.7 per cent $MgCO_3$) is practically non-existent, and 40 to 44 per cent $MgCO_3$ is considered to be a high-purity stone.

More often than not the chemical compositions of carbonate rocks, like all rocks, are stated in terms of weight per cent of oxide constituents. Carbonates may be recalculated as oxides or vice versa as follows:

1% CaO is equivalent to 1.78% $CaCO_3$
1% MgO is equivalent to 2.09% $MgCO_3$
1% $CaCO_3$ is equivalent to 0.560% Ca0
1% $MgCO_3$ is equivalent to 0.478% MgO

The most common impurities in limestones are silica (SiO_2) as quartz or silicate minerals, aluminum (usually in silicate minerals) and iron (as oxides, sulphides, carbonates and silicates). Sulphur and phosphorus, while generally present only in minute quantities, are nevertheless important negative considerations for some limestone uses. Impurities are frequently summarized as SiO_2 and R_2O_3. The latter abbreviation represents all impurities not directly accounted for in the analysis, and is usually aluminum oxide with some iron oxides and very low percentages of other impurities. Loss on ignition (L.O.I.) is often included with those analyses done by wet-chemical means and refers to the total weight per cent of carbon dioxide (CO_2) and water (H_2O) evolved when the sample is calcined before analysis.

For the purposes of this report, all analytical results stated are given in terms of weight percent. Analyses were done at various laboratories, at different times and by a number of different techniques. Most of the results could not be checked, and the analyses are therefore presented without comment as to analytical methods or accuracy. Where sampling procedure and the extent of investigation of a deposit have been such that the analytical techniques used are of real concern, these are stated to the extent that they are known.

Terms used in this report which require definition are listed as follows (after Boynton, 1966, except where otherwise stated):

Argillaceous limestone is an impure type of limestone, containing considerable clay or shale, and as a result, has a relatively high silica and alumina content.

Cementstone is an impure limestone, usually argillaceous, possessing the ideal balance of silica, alumina, and calcium carbonate needed for portland cement manufacture. When calcined it produces a hydraulic cementing material.

Dolomitic limestone contains considerable magnesium carbonate. Pure dolomite stone contains a ratio of 40 to 44 per cent $MgCO_3$ to 54 percent $CaCO_3$. The term is more loosely used, however, so that any carbonate rock containing 20 per cent or more $MgCO_3$ is regarded as "dolomite". It varies in purity, hardness and colour.

Fossiliferous limestone is a very general term denoting any carbonate stone in which fossil content is visually evident.

High-calcium limestone is a general term for stone comprised largely of calcium carbonate with not much magnesium carbonate (only 2 to 5 percent, depending on the point of view). It occurs in varying degrees of purity.

Hydrated lime is a dry powder obtained by hydrating quicklime with enough water to satisfy its chemical affinity, forming a hydroxide due to its chemically combined water. It may be high-calcium, magnesian, dolomitic, or hydraulic (impure).

Lime is a general term which connotes a burned form of lime, usually quicklime, but which may also refer to hydrated lime. It may be calcitic, magnesian, or dolomitic.

Limestone (after Chillingar, Bissel, and Fairbridge, eds., 1967, p. 159) is a carbonate rock composed of more than 50 percent by weight of the mineral calcite.

Magnesia is the chemical compound, magnesium oxide (MgO), that is an important constituent in dolomitic and magnesian limes and limestones.

Magnesian limestone contains more magnesian carbonate than high-calcium stone but less than dolomite. Authorities are not in full agreement as to its range of magnesium carbonate, but the consensus favours 5 to 20 percent. It occurs in varying degrees of purity.

Marble is a metamorphic, highly crystalline carbonate rock which may be high-calcium or dolomitic. It may be extremely pure or rather impure. It occurs in virtually every colour in varying mottled effects and is the most beautiful form of limestone. Its unique texture permits it to be cut more precisely and polished to a smoother surface than any other stone. Varieties with more poorly interlocking crystals are often called crystalline limestone.

Quicklime is a lime oxide formed by calcining limestone so that carbon dioxide is liberated. It may be high-calcium, magnesian, or dolomitic and of varying degrees of chemical purity.

Slaked lime is a hydrated form of lime, in the form of a dry powder, putty, or aqueous suspension.

For far more complete discussions of the chemical and physical properties of carbonate rocks the reader is referred to Boynton (1966); Chilingar, Bissell, and Fairbridge, eds. (1967); and Ham, ed. (1962).

CHAPTER II

GEOLOGICAL SETTING OF LIMESTONES IN NEWFOUNDLAND

The island of Newfoundland is part of the Appalachian-Caledonian orogen, a mountain belt extending from the southeastern United States along the Atlantic seaboard, and through Canada's Atlantic Provinces. To the northeast of Newfoundland the orogen is fragmented as the result of continental drift and is represented in Ireland, Scotland and Norway among other areas. In Newfoundland, the belt is frequently considered in terms of three major tectonic/stratigraphic divisions (Williams, 1964) (see Fig. 1). These are designated the Avalon Platform, Central Mobile Belt and Western Platform. In the past, geological environments have favoured limestone deposition on the two platform areas, and on the Western Platform in particular.

AVALON PLATFORM

Most of the limestone deposited on the Avalon Platform belongs to the Smith Point Formation of Cambrian age. This rock unit reaches a maximum thickness of about 50 feet and is, for the most part, deformed into tight folds with steeply-dipping limbs. Generally low tonnages are available where the unit is exposed (see Fig. 2). Exposure of the limestone is particularly good on the headlands of Trinity Bay as the result of its relatively high resistance to erosion. The Smith Point limestones are high in silica, alumina and iron content, and approach cementstone in composition. A comparative stratigraphic column including the Smith Point Formation is presented in Table No. 1.

Small, impure deposits are found elsewhere on the Avalon Platform in the Precambrian and Cambrian sections, and those of any conceivable commercial interest are discussed in chapter III.

CENTRAL MOBILE BELT

Among the oldest rocks of the Central Mobile Belt are those of the Eocambrian (?) Fleur de Lys Supergroup on the Baie Verte Peninsula. Small, intensely deformed deposits of crystalline limestone and marble in the group are associated with semi-pelites. The best exposed of these are on the east side of White Bay at Clay Cove, Purbeck's Cove and Bear Cove (see Fig. 3).

Middle Ordovician rocks at Cobb's Arm on New World Island contain high-purity, high-calcium limestones, which were evidently deposited on a small platform of volcanic rocks during a pause in volcanism (Harris, 1966, p. 26). Extensive folding and faulting have made much of this deposit unexploitable. Small limestone deposits have been reported from the Notre Dame Bay region and from central Newfoundland associated with Ordovician and Silurian volcanic rocks, and from the Bay D'Espoir region associated with Ordovician sedimentary rocks.

WESTERN PLATFORM

Limestones comprise an important part of the Paleozoic section on the Western Platform (see Fig. 4). Overlying the basement gneisses and intrusive rocks of Grenville age are sedimentary (and some intrusive) rocks, which are readily separated regionally into three major divisions. Structurally lowest of these are Cambrian to Ordovician sedimentary rocks which are "in place" and are termed autochthonous. Rocks of the same age and older which were transported from the east during mountain building to rest structurally atop the autochthonous rocks, are termed allochthonous, and comprise the klippe terrain of the Western Platform. Sediments which were deposited on both the former divisions during and after transport of klippen are termed neoautochthonous. Limestones are common to all three divisions. The youngest rocks on the Western Platform are practically undeformed clastic, evaporitic and impure carbonate sediments of Carboniferous age. These cover rocks are extensive in southwest Newfoundland and in the Deer Lake area. A comparative table of formations for the Western Platform is presented in Table No. 2.

Autochthonous Rocks

The structurally lowest Paleozoic rocks on the Western Platform are a section of Cambrian and Ordovician sandstones, carbonates and shales. Within this section, the St. George Group and Table Head Formation of Lower and Middle Ordovician age comprise a very extensive carbonate bank, which today outcrops along much of the west coast from the Port au Port Peninsula to Pistolet Bay on the Great Northern Peninsula, and probably includes deposits around Canada Bay and western White Bay. The two rock units are separated by a widespread disconformity.

The less known Lower Ordovician St. George Group in the Port au Port area is about 2,000 feet thick as reported by Schuchert and Dunbar (1934, p. 50), and over 2,450 feet as measured by Sullivan (Riley, 1962, p. 18). Where the section is relatively well known on the Port au Port Peninsula and in the Corner Brook area, it has proved to be readily divisible into a number of lithostratigraphic units which are very persistent along strike (Besaw, 1972; McKillop, 1963). Limestones of the St. George Group have been quarried at Aguathuna and are still being quarried at Corner Brook by North Star Cement Company.

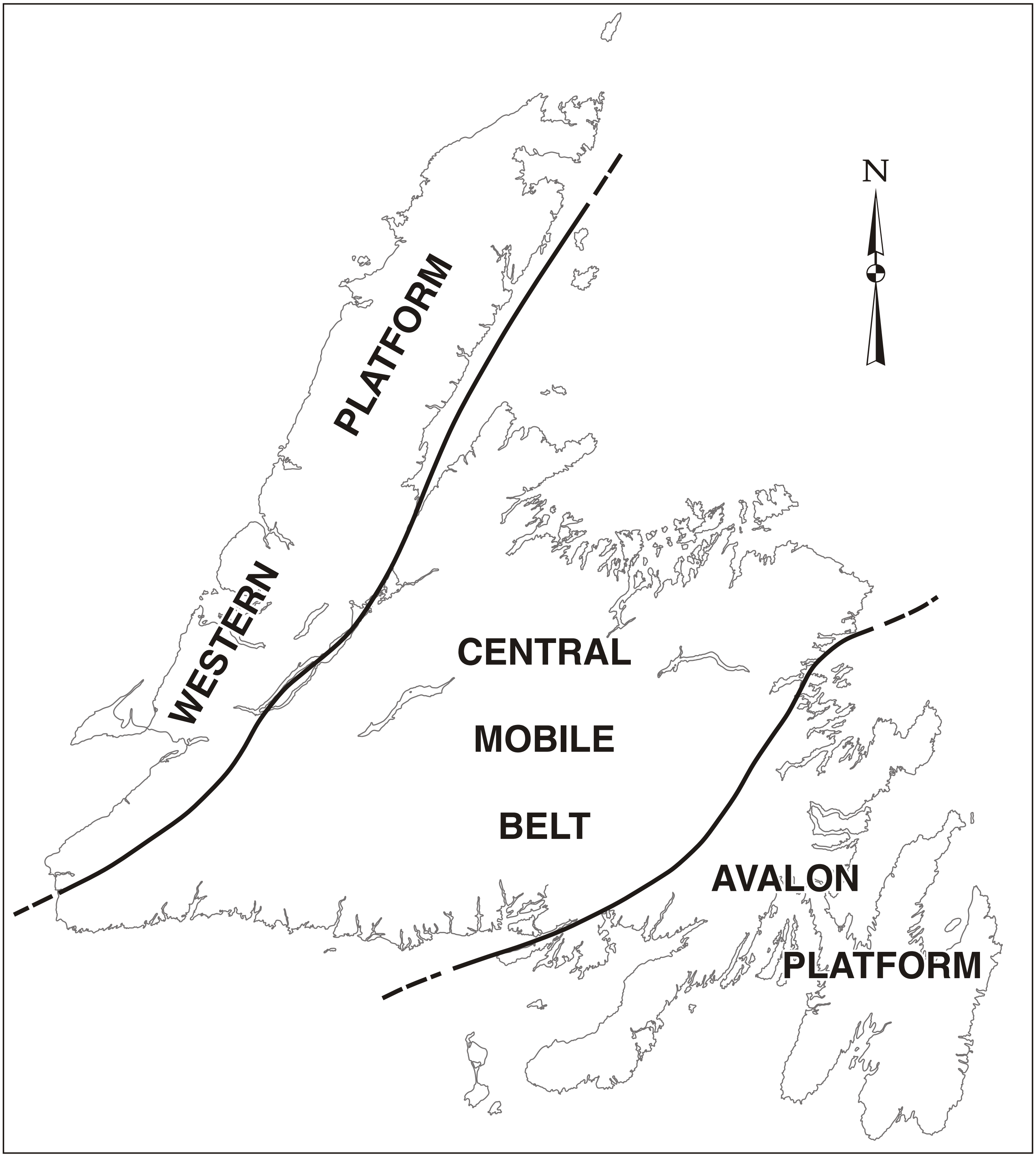

Figure 1. *Principal geologic subdivisions of Newfoundland.*

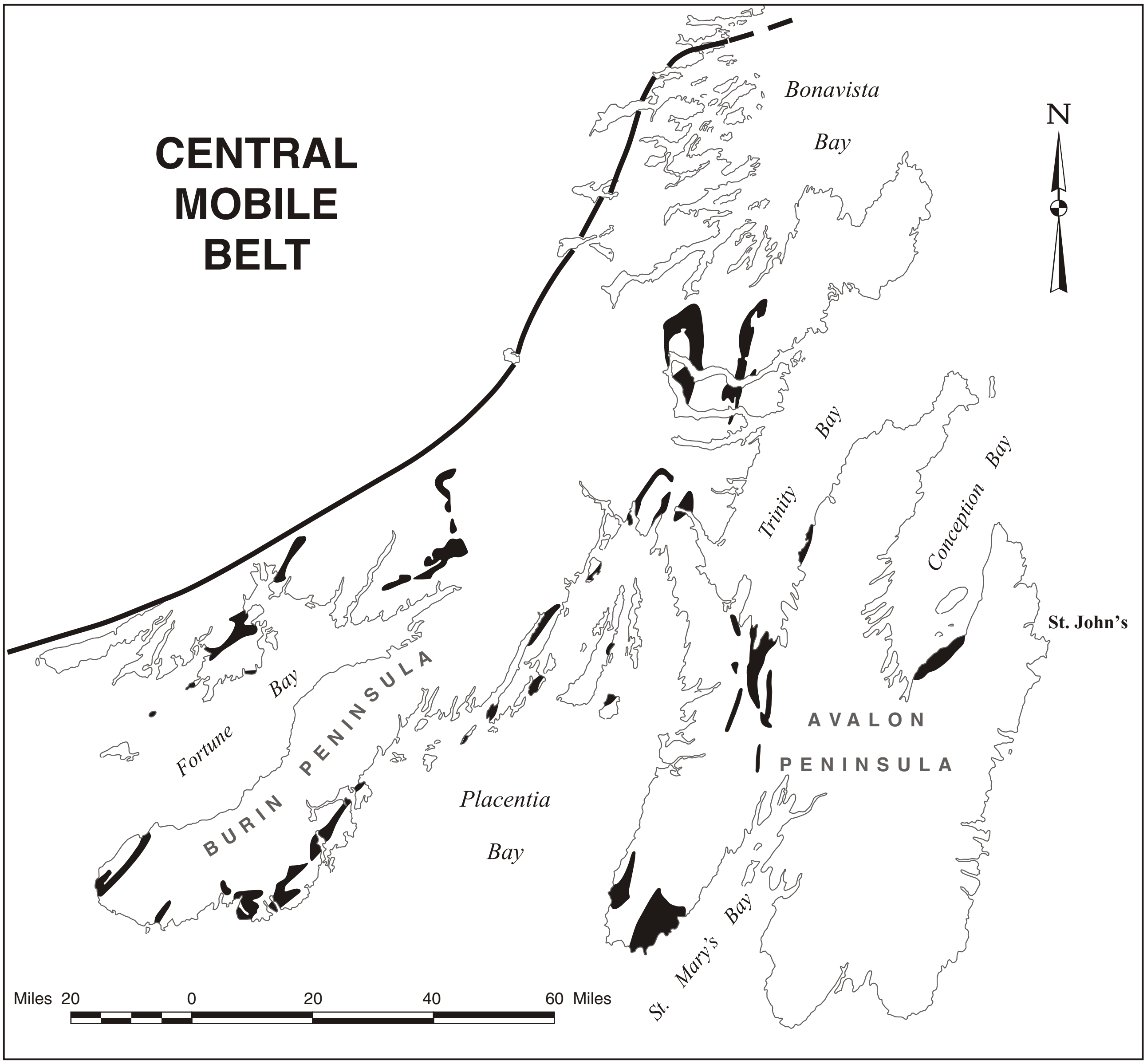

Figure 2. *Distribution of Cambrian rocks on the Avalon Platform. Source: Williams, 1967.*

TABLE 1: GENERALIZED TABLE OF FORMATIONS FOR AVALON PLATFORM EMPHAZING THE CAMBRIAN ROCKS

AGE	Northwest Trinity Bay (Jenness, 1963)	Southwest Trinity Bay (McCartney, 1957)	Southeast Trinity Bay (McCartney, 1957)	Holyrood Bay (McCartney, 1954)	East of Conception Bay (Rose, 1952)
LOWER ORDOVICIAN	Grey, black shale, siltstone.	(if deposited, not preserved)		Shale, sandstone, oolitic hematite.	(if deposited, not preserved)
UPPER CAMBRIAN (All units not preserved in each locality.)	Elliott Cove Group: grey, green, to black silty, micaceous shale or slate and siltstone; rare grey or black cone-in-cone limestone concretions.				
MIDDLE CAMBRIAN	Manuels River Formation: grey to black shale or slate, with numerous thin beds and lenses of grey or black limestone, locally includes Chapel Arm volcanic rock member.				
	Chamberlain's Brook Formation: green shale or slate, with minor limestone, locally includes red members near base and basal black manganiferous bed.				
LOWER CAMBRIAN	Brigus Formation: red, purple or green shale or slate; minor red or pink limestone as thin beds or nodules.				
	Smith Point Formation: pink, red or green, wavy bedded, locally algal, limestone.				
	Bonavista Formation: red, green or purple shale or slate; minor pink or green l imestone; locally with basal conglomerate.				
CAMBRIAN (?)	White quartzite and sandstone interbeds, Random Formation; 18-500 ft.			(probably not deposited)	
PRECAMBRIAN	Musgravetown Group: Arkoses, slates, and conglomerates; 5,000-10,000 ft. Volcanic rocks of Bull Arm Formation; up to 8,000 ft.		Arkose, siltstone, and slates of Hodgewater Group; up to 16,000 ft	(not deposited, or eroded from Precambrian Holyrood horst)	Arkose, siltstone, slate, and conglomerate of Cabot Group; + 14,000 ft.
	Greywacke, siltstone and slate of Connecting Point Group; 9,000-17,000 ft.		Greywacke, slate and siltstone of Conception Group; 7,000 ft.	(probably eroded)	Greywacke, slate and siltstone of Conception Group.
	Volcanics of Love Cove Group	Not exposed		Holyrood Granite 574±11 m.y. Volcanics and sediments of Harbour Main Group; + 6000 ft.	

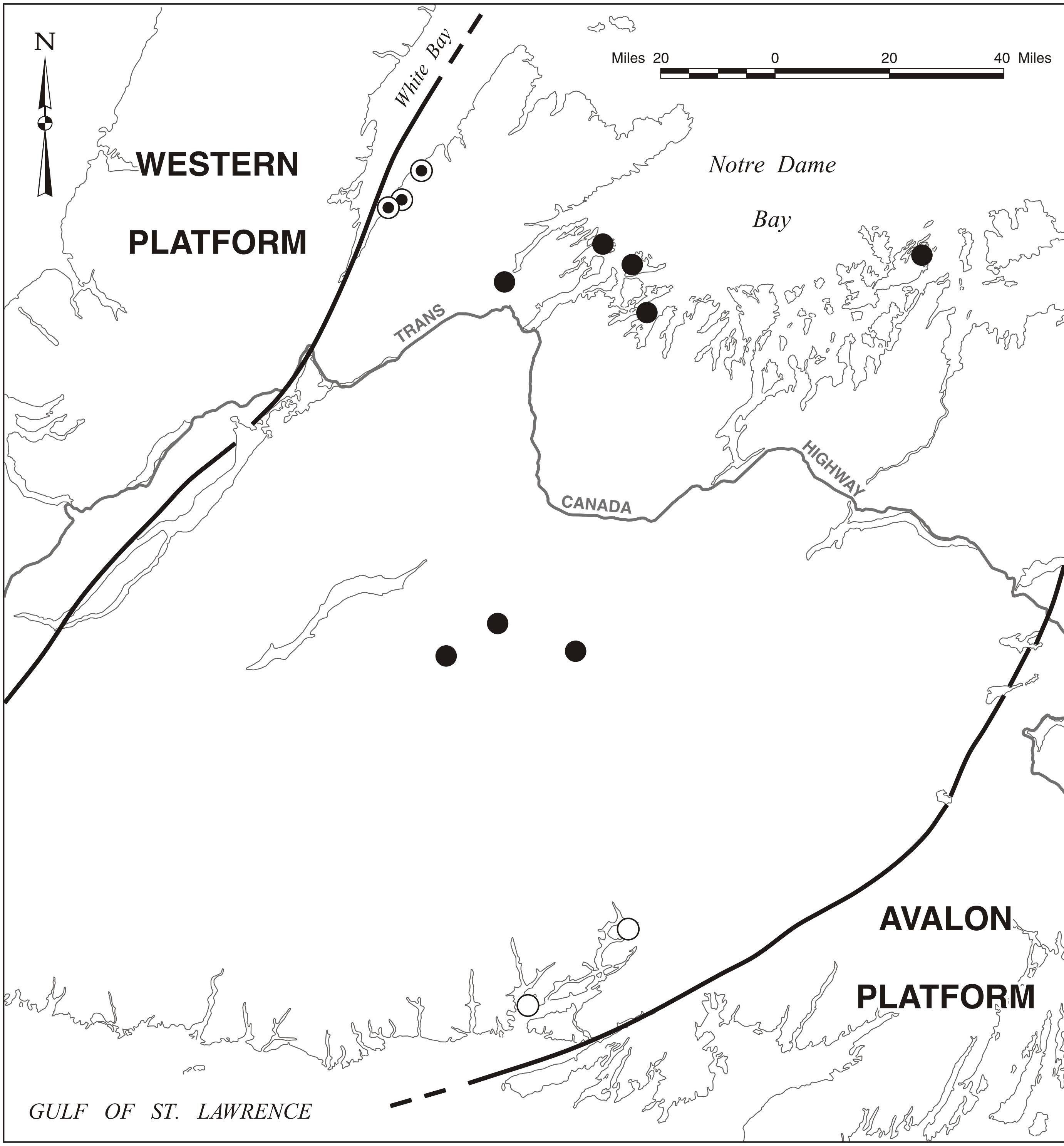

Figure 3. *Locations of limestone deposits in the Central Mobile Belt: Open circles - deposits in Ordovician (?) metasediments; solid circles - deposits associated with Ordovician and Silurian volcanic rocks; circled dots - deposits in Eocambrian (?) Fleur de Lys Supergroup.*

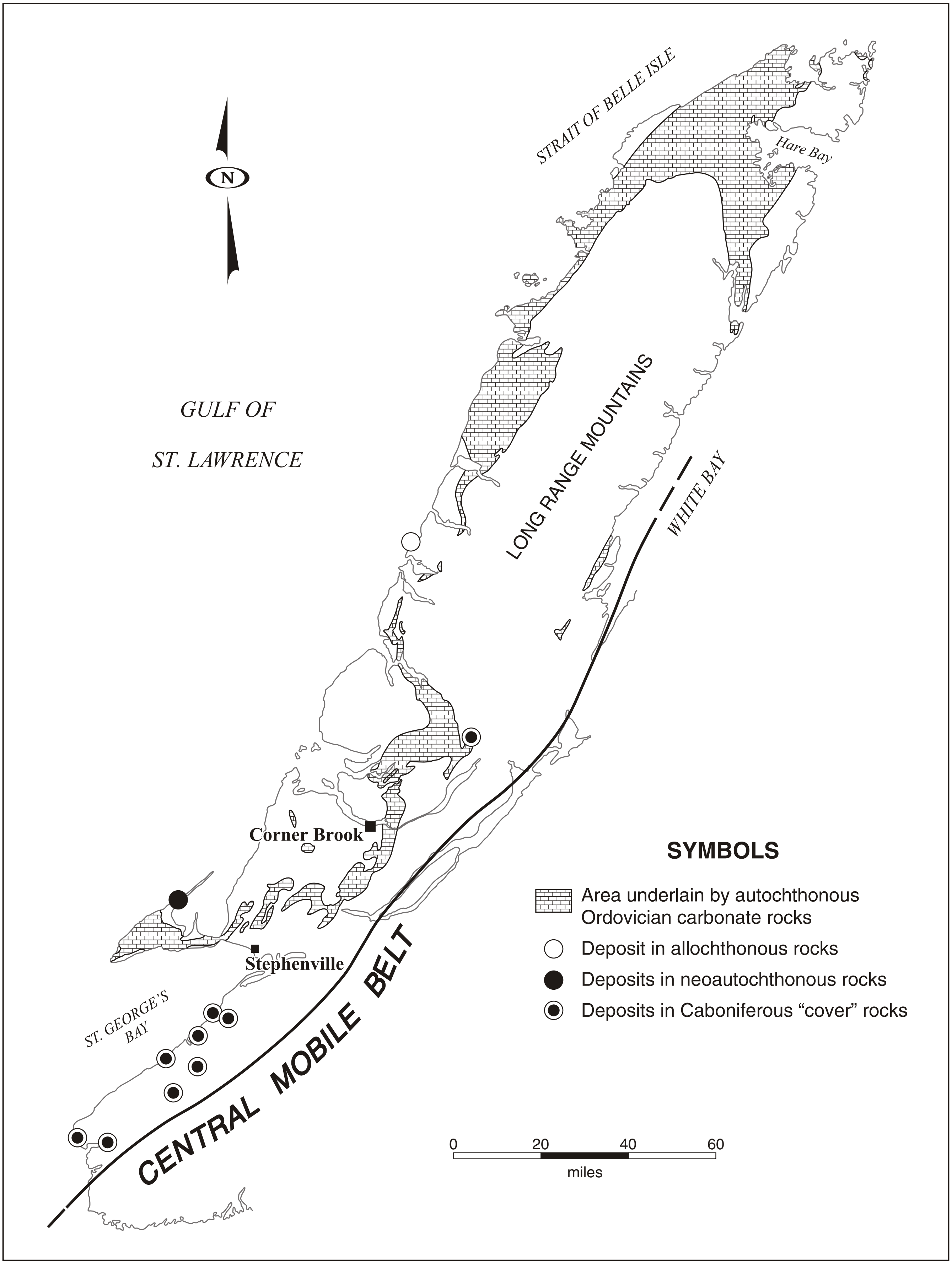

Figure 4. *Distribution of carbonate rocks on the Western Platform.*

TABLE 2: GENERALIZED TABLE OF FORMATIONS FOR THE WESTERN PLATFORM, EMPHASIZING THE AUTOCHTHONOUS CARBONATE SUCCESSION

PERIOD		Port au Port Peninsula (Riley, 1963; Stevens,1970)	Port au Port to Corner Brook (Walthier, 1949).	Corner Brook area (McKillop, 1963; Lilly, 1963).	Corner Brook north of Humber (Merrill, 1957).	Daniel's Hbr. to Pistolet Bay (Schuchert & Dunbar, 1934; Tuke, 1968).	Hare Bay to Canada Bay (Betz, 1939; Whittington & Kindle, 1967).	Western White Bay (Bird & Dewey, 1970; after Lock, 1969).	Allochthonous rocks.
DEVONIAN	U, M								
DEVONIAN	L	Clam Bank Group: sandstone, shale, argillaceous limestone.							
SILURIAN	U, M, L	?						Clastic sediment and acidic to basic volcanics (mostly pyroclastic).	
ORDOVICIAN	UPPER	Long Point Group: limestone, sandstone, shale.							
ORDOVICIAN	MIDDLE	Unnamed easterly derived flysch	Unnamed easterly derived flysch	(flysch unit not identified)	(flysch unit not identified)	Unnamed sandstones and shales.	Goose Tickle Formation coarse easterly-derived flysch.	Murrays Cove Fm.: mostlyshales.	
ORDOVICIAN	MIDDLE	Table Head Formation: Mostly thick-bedded limestone, becoming shaly towards top of section.	Table Head Formation: Mostly thick-bedded limestone, becoming shaly towards top of section.	Table Head Formation: calcitic to dolomitic marble and cryltalline limestone.	Table Head Formation: not identified.	Table Head Formation: mostly thick-bedded limestone becoming shaly towards top of section.	Table Head Formation: mostly limestone and white marble; blue grey dolomite in upper part of formation.	Taylors pond formatin: shale.	Limestone breccia at Cow Head
ORDOVICIAN	LOWER	St. George Group: thick-bedded limestone, and dolomite units.	St. George Group: thick-bedded limestone, and dolomite.	St. George Group: Corner Brook Formation: mostly crystalline limestone. Hughes Brook Formation: crystalline cherty dolomite.	Marblehead Formation: mostly massive crystalline limestone. St. George Formation: crystalline dolomite, cherty in places.	St. George Group: thick bedded limestone and dolomite.	St. George Group: mostly thick bedded limestone and dolomite.	Doucers Formation: marble and crystalline limestone.	Humber Arm and Hare Bay allochthons: mostly clastic sediments, with slices of basic and ultrabasic rock having ophiolotic affinities, some metamorphic rocks. Includes limestone breccias at Cow Head.
CAMBRIAN	U, M, L	Kippens, March Point, and Petit Jardin Formation: sandstone, shale, impure carbonates; basal quartzite.	Shale, limestone, dolomite and sandstone.	Mount Musgrave Formation and Grand Lake Brook Group: semi-petites and impure marbles.	Mount Musgrave Formation and Grand Lake Brook Group: semi-petites and impure marbles.	Labrador Group: sandstone, shale, impure carbonates, basal quartzite intruded by basalt dikes and sills.	Labrador Group and overlying Treytown Pond Formation of limestones and dolsmites.	Beaver Brook Formation: shale, phyllite, basal quartzite.	
PRECAMBRIAN		Grenville "basement"	Grenville "basement"	Grenville "basement" (assumed)	Grenville "basement" (assumed)	Grenville "basement"	Grenville "basement"	Grenville "basement"	

The Middle Ordovician Table Head Formation is better known. Where the type section is located at Table Point near Bellburns, the sedimentary pile is about 1,381 feet thick (Schuchert and Dunbar, 1934, p. 64) and in the Port au Port area it measures 841 feet (Schuchert and Dunbar, 1934, p. 66; Riley, 1962, p. 20). The formation consists of a section of massive, high-calcium limestones about 700 feet thick grading upwards into shales as the result of interbedding. The lower limestone unit has been quarried at various places in Newfoundland, notably at Aguathuna (DOSCO quarries) and Corner Brook (Dormston quarry); marbles of the Table Head Formation at Canada Bay were quarried early in this century. A large deposit of high-purity, high-calcium limestone at Coney Arm, White Bay, may be Table Head Formation equivalent.

Allochthonous Rocks

Rocks of the transported sections contain, in places, limestone beds, lenses and nodules; none are of any possible commercial significance so far as is known, except the "Cow Head Breccia" limestone, best exposed at Cow Head north of Bonne Bay. This unit is considered to be a reef-front stratigraphic equivalent of the St. George Group and Table Head Formation, and to have been deposited on the east side of the autochthonous Cambro-Ordovician carbonate bank before transport to its present position (Rodgers and Neale, 1963; Stevens, 1970).

Neoautochthonous Rocks

Neoautochthonous rocks of the Long Point Formation are composed in part of limestones on Long Point, Port au Port Peninsula (Riley, 1963). The composition is adequate for some commercial uses, but there has, as yet, been no serious effort to exploit them.

Carboniferous Sediments

Siliceous limestones in the nearly undeformed Carboniferous cover rocks in southwest Newfoundland have been quarried for local agricultural purposes, but contain no limestone deposits of much commercial interest.

CHAPTER III

LIMESTONE RESOURCES OF NEWFOUNDLAND AND LABRADOR

The divisions in this chapter have no particular political or geological significance, but are convenient in that they refer to the various bays and coastal areas which are familiar to anyone acquainted with the geography of the province. All of the individual deposits discussed in this report are indicated on the accompanying Limestone Resources Map of Newfoundland (map jacket). Where a particular deposit merits more detailed graphic presentation, the appropriate figures accompany the text.

CONCEPTION BAY

A number of small, impure limestone deposits occur in the Cambrian sedimentary section around the shores of Conception Bay, with the limestone units tending to thicken westward. In particular, limestone beds which are not in general over three feet thick occur at Topsail Head and Manuels River (Nautiyal, 1966); Dale (1915) described a ten-foot thick bed at Chapel Cove; and still further west, at the entrance to Brigus Harbour, the limestone unit in the Smith Point Formation is 27 feet thick.

None of these deposits has recently been considered a possible source of limestone for industrial uses, because they are all impure and small, and the Brigus deposit is practically inaccessible. Quarrying on a limited scale was, however, carried out at Topsail Head at one time, and the stone was used to supply a kiln in St. John's. The deposits were investigated as part of a manganese resource study by Dale (1915) and were described in Geological Survey of Canada reports by Rose (1952), Hutchinson (1953, 1962), and McCartney (1967). Reference to them has been made in a number of university sponsored studies and theses, notably those of Nautiyal (1966) and Douglas (in press).

The only deposit in Conception Bay of the slightest commercial interest is that at the entrance to Brigus Harbour. The section of the Smith Point Formation as exposed at Brigus South Point consists of 27 feet of pink, massive, wavy-bedded limestone (Hutchinson, 1962, p. 128). There are a number of limestone beds under ten feet thick in the overlying Brigus formation. The sedimentary section at Brigus South Point dips to the east at 45°. Douglas (in press) states that the chemical composition of the Smith Point Formation limestone deposit at Brigus is as follows:

CaO	44.32
MgO	3.62
SiO_2	8.46
Fe_2O_3	1.03
Al_2O_3	2.80
MnO	0.61
S	0.23

No tonnage estimate has been made. The deposit is about 1.5 miles overland from the community of Brigus; there is no road for most of the way and the topography is extremely rugged, as is the coastline at Brigus South Point.

TRINITY BAY

All of the limestone deposits around Trinity Bay belong to the Smith Point Formation of Lower Cambrian age. In general, they are impure and of fairly low tonnage. In the past, a few of the deposits underwent minor quarrying for local agricultural purposes, but no commercial operations are known to have used them as a resource.

Dale (1915) refers to the deposits at Smith Sound in his paper on the Cambrian manganese deposits of Conception and Trinity Bays. Most of the deposits were described in some detail by Bogert (1939) and discussions of some or all of the deposits were included in reports of the Geological Survey of Canada by Hutchinson (1953, 1962), Jenness (1963), and McCartney (1967).

The Smith Point limestone is represented everywhere in the Cambrian section of the Avalon Peninsula except on the east side of Conception Bay around Manuels. It is generally between 20 and 50 feet thick in the Trinity Bay area, and is thickest in the vicinity of Heart's Delight (Hutchinson, 1962, p. 14). The type section is at Smith Point, Smith Sound east of Clarenville (Jenness, 1963, p. 65), where the formation consists of 24 feet of dull, pinkish red, thin to fairly thick-bedded limestone-its typical lithology. While the overlying and underlying formations contain some limestone beds, only the Smith Point limestone has possible economic significance and this is the only one discussed in this report.

The outcrop distribution of the Smith Point Formation in the Trinity Bay area is presented in geological maps by

Jenness (1963) and McCartney (1967) and is reproduced in Figure 5 of this report. The beds containing the limestone are deformed, for the most part, into tight synclines with axial plane traces trending north-northeast: the Smith Point limestone outcrops along some of the headlands of eastern Trinity Bay, where it constitutes part of the eastern limb of a syncline. Both limbs are exposed between Heart's Desire and Heart's Delight, and at Chapel Arm, where the axial plane trace strikes inland to the south. The limestone unit is exposed on the south shore of Trinity Bay at Long Cove and Spread Eagle. At Smith Sound the limestone unit, again folded into tight synclines, is exposed at tidewater at Smith Point and at Petley, Random Island.

East Shore of Trinity Bay

McCartney (1967, p. 69) considered the Smith Point Formation on the east shore of Trinity Bay to contain the best grade of limestone available in eastern Newfoundland. Sections elsewhere contain a higher proportion of shaly interbeds and are therefore of lower purity. The stone in the eastern Trinity Bay area approaches a cementstone in composition more closely than that to the south or west, where a larger amount of pure limestone would have to be added to make an acceptable raw material for cement manufacture. In addition, the Smith Point Formation is thickest on the east shore of Trinity Bay, being 52 feet thick at Heart's Delight (Hutchinson, 1962, p. 14 and p. 130) and thinning to the east, west and south.

According to Bogart (1939, p. 38) the major occurrences of limestone in the area, in order of importance, are "in the hill between Heart's Desire and Heart's Delight, in the hill south of Cavendish, and in the hill south of Islington". A comparison of these three locations as quarry sites is presented in Table No. 3. Less extensive deposits are found at the south head of Heart's Desire, between Heart's Delight and Islington, at the northern point of Whiteway Harbour, across the longest point just south of Whiteway, at Hopeall Head and on Hopeall Island.

Hill between Heart's Desire and Heart's Delight

The deposit occurs east of the road connecting the two communities, and is best exposed midway between them and about 1,000 feet south of the road, where the limestone forms the crest of a short ridge. The Smith Point Formation there strikes between N10° and N20°E and dips between 35° and 65° to the west. Bogart (1939, p. 40) reported that the unit had been investigated along a 2,000-foot strike-length by five trenches. The thickness of the Smith Point Formation was found to vary between 32 and 39 feet, averaging 35 feet from the stratigraphically lowest limestone bed to the topmost shale-rich bed. Picked specimens assayed as follows:

	Limestone	Shale Interbeds
$CaCO_3$	65.0 to 78.0	2.0 to 25.0
SiO_2	14.0 to 22.0	50.0 to 70.0
Al_2O_3	3.5 to 6.0	13.0 to 23.0
FeO	2.0 to 2.5	6.0 to 10.0

The shale interbeds comprise from 5 to 10 per cent of the section and may reduce the available thickness of the limestone to about 30 feet.

Hill South of Cavendish

The deposit is located in the hill south of the community on the south side of the harbour. The Smith Point Formation outcrops at the top of the hill and at two places in the hillside. Over the estimated 1,5OO-foot strike-length of quarryable material, only the upper 29 feet of the unit are exposed, with an estimated 10 feet of the section not visible. The limestone unit strikes about N15°E and dips about 40° to the west. Bogert (1939, p. 53) recorded a weighted analysis of the stone there, which was derived from a number of channel samples taken from weathered outcrop:

$CaCO_3$	66.40
$MgCO_3$	2.12
SiO_2	27.42
Al_2O_3	2.07
FeO	1.07
Fe_2O_3	1.13

Bogert considered that leaching of $CaCO_3$ had probably reduced the carbonate content of the weathered samples, and, in fact, picked samples from a depth of six inches in the outcrop contained between 71 and 74.6 per cent $CaCO_3$.

Hill South of Islington

The Smith Point limestone is exposed in a hill just south and east of the abandoned railway station at Islington, and at tidewater just south of the harbour embayment. There the unit strikes about N15°E and dips about 40°W, but local folding has complicated the rock structure in the area. In an outcrop in a meadow on the hillside the limestone unit strikes due north and dips 75° to the west. At the top of the hill, the unit strikes N10°E and dips between 10° to 20° to the west, and to the south of the hill the attitude is N5°W, dipping between 10° and 20° to the west. Bogert (1939, p. 45) stated that the limestone unit was approximately 38 feet thick over the estimated 1,000-foot quarryable strike-length

Other Deposits

The other exposures of the Smith Point limestone in this area (see Fig. 5) are not so well known, but possibly also merit consideration for local agricultural use.

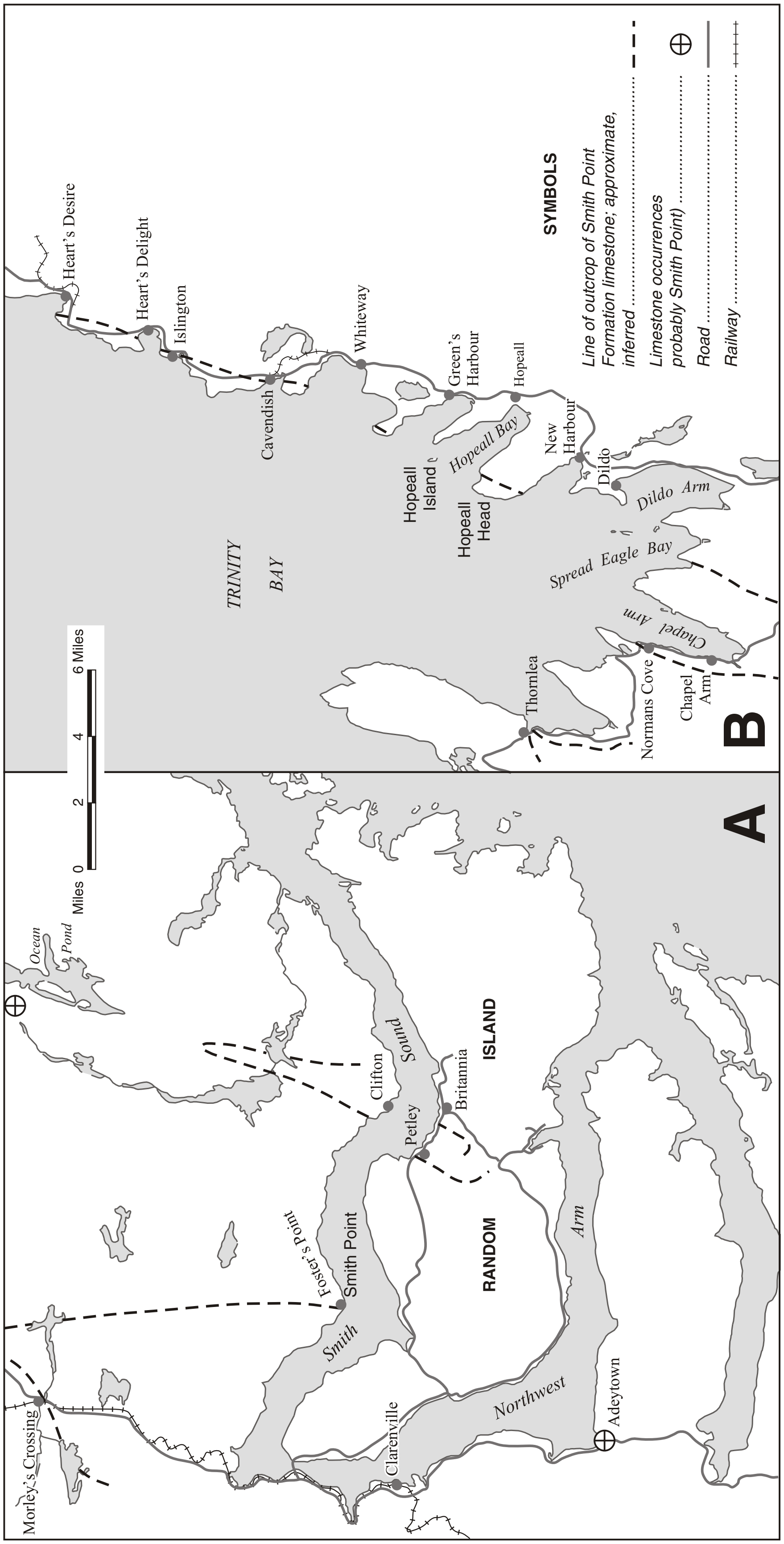

Figure 5. *Distribution of Smith Point Formation outcrop in the Trinity Bay area. A - Random Island area; B - south and east Trinity Bay. Sources: Jenness, 1963; McCartney, 1967.*

Table 3. Comparison of limestone deposits in Eastern Trinity Bay as possible quarry sites. SOURCE: Bogert, 1939, p. 47

	Heart's Delight	Islington	Cavendish
Elevation	250 ft.	150 ft.	150 ft.
Drainage	Should be no problem. A swamp whose level is less than 50 ft. below the hill top may coincide with water table approximately at that level	Drainage level 100 ft. below the hill top	Drainage level 100 ft. below the hill top
Width of available limestone	35 ft.	35 ft.	35 ft.
Estimated quarryable length	2,000 ft.	1,000 ft.	1,500 ft.
Average strike	N15°E	N10°W	N15°E
Maximum and Minimum dip	35° to 65°W	10° to 75°W	40°W
Average dip	50°W	25°W	40°W
Computed available volume of rock in cubin ft.	2,482,000	1,591,000	1,861,500
Tons available at 11.9 cubic ft. per ton	208,500	133,900	156,400

West Shore of Trinity Bay

Deposits of the Smith Point limestone in the western Trinity Bay area are, in general, thinner and of lower grade than those on the east shore. The best deposits, in the vicinity of Random Island, are only about 24 feet thick (Hutchinson, 1962, p. 14). Elsewhere the unit is thinner and the rock so high in silica content that in places it cannot properly be called limestone at all. Some of the occurrences might be of use for local agricultural purposes, however, and their locations are indicated in Figure 5 (for the Random Island area) and Map 1.

The limestone in the area was investigated from an economic standpoint by Harris (1962) who visited most of the Smith Point Formation exposures. Except where otherwise stated the data presented in this section were collected by him.

Come by Chance Bay

The Smith Point Formation is exposed on both sides of Come by Chance Bay, but the available deposits are very small as the result of extensive faulting, and do not in general exceed 500 tons. Nowhere did Harris (1962) consider conditions to be favourable for quarrying.

Two miles from the head of the bay along the east shore is an outcrop of Smith Point Formation which was visually estimated to be composed of equal amounts of limestone and shale. The section assayed 60.7 per cent silica over a 25-foot sample length. Directly across the bay a 19-foot section of steeply-dipping limestone is exposed, which assayed 41.7 per cent silica.

Goobies

Close by the highway and near a lake three miles west of Goobies, some 120,000 tons of poor quality Smith Point limestone are exposed: 15 feet of the section assayed 45.8 per cent silica. Harris (1962) considered this to be a poor quarrying prospect.

Petley

Some 40,000 tons of Smith Point limestone are exposed near the village of Petley on Random Island. The unit is located in a sidehill southwest of the community, several hundred yards from the road, where the limestone follows the slope under thin overburden. The stone is available along a 600-foot strike-length following the hillside, with an average of 50 feet of surface exposure across the hill. A 10-foot section assayed as follows:

Ca0	35.3
Mg0	1.4
$Si0_2$	33.8

Smith Point

Smith Point, just east of Broad Cove, Smith Sound, is the type locality for the Smith Point Formation (Hutchinson, 1962, p. 12): the limestone underlies much of the village of Foster's Point, and an estimated 300,000 tons are available in the immediate vicinity of the community. The 24-foot section of limestone sampled there assayed as follows:

Ca0	36.0
Mg0	1.1
Impurities	31.6

Clifton

The Smith Point Formation is exposed along the road through the community, where a 10-to 20-foot ridge of limestone north of the road can be followed for 1 **3** miles (Harris, 1962, p. 58). At least 100,000 tons of stone are available in the immediate vicinity of the community. A 25-foot section there assayed 37.9 per cent silica.

Morley's Crossing

The Smith Point limestone is exposed in Southwest Brook just southwest of Morley's Crossing where a considerable (but undetermined) tonnage is available. A l4-foot exposed section of limestone there assayed as follows:

Ca0	38.0
Mg0	1.8
Impurities	26.9

CAPE ST. MARY'S PENINSULA

On the Cape St. Mary's Peninsula limestone occurs as two rock units (Fig. 6). The Lower Cambrian Smith Point Formation of dull, pinkish red, thin to fairly thick-bedded limestone is exposed on the shore in places, and varies in thickness between 14 and 29 feet (Hutchinson, 1962, p. 14). The unit is present in all the synclinally preserved Lower Cambrian outcrops on the peninsula (Fletcher, 1972, p. 105). In addition, an extremely calcareous volcanic unit in the Middle Cambrian Harcourt Group (Jenness, 1963, p. 58) is exposed just south of Branch Cove. In general, the deposits are impure and of low tonnage. No commercial enterprises using them as a resource are known to have been undertaken.

The Cambrian stratigraphy of the Cape St. Mary's peninsula was investigated by Hutchinson (1962), and the northern part of St. Mary's Bay was included in McCartney's (1967) Whitbourne map area. Fletcher (1972) produced an unpublished geological map of the peninsula and described the Cambrian rocks there in detail. The Branch/Point Lance area was investigated by Greene (1962).

Smith Point Limestone Deposits

Cuslett-St. Bride's

A 29-foot section of Smith Point limestone dipping south at 30° to 40° is exposed along the east shore of Placentia Bay about **2** mile south of the community of Cuslett. Samples collected by Harris (1962, p. 52) representative of 27 feet of the section assayed 57.7 per cent silica; 200,000 tons of stone were estimated to be available there.

Harris (1962, p. 50) noted that near the village of St. Bride's the Smith Point limestone was gently-dipping and in places flat-lying, with up to 4,300,000 tons of stone available under thin overburden. Unfortunately the stone was very impure. Harris took several chip samples, only one of which assayed less than 50 per cent silica, at 34.2 per cent.

Lance Cove

The Smith Point Formation is extensively exposed northwest of Lance Cove (Fig. 6). Samples collected from the limestone unit by Harris (1962, p. 49) assayed between 50 and 70 per cent silica and R_2O_3, and generally less than 1 per cent magnesia.

Branch Cove

The Smith Point limestone outcrops in several places north of the community of Branch, St. Mary's Bay. Samples taken by Harris (1962, p. 48) about halfway up Branch

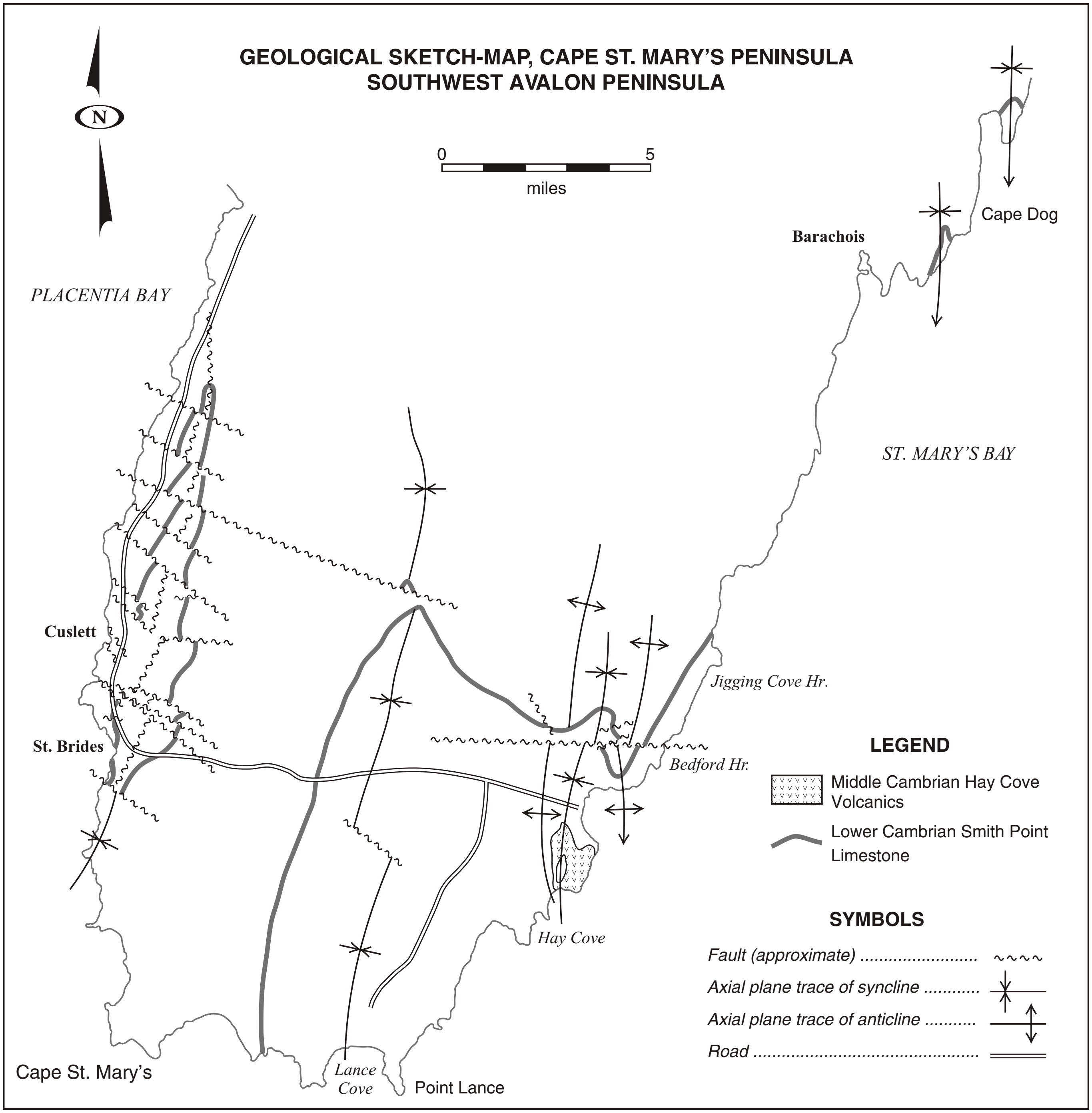

Figure 6. *Geologic sketch map of the Cape St. Mary's Peninsula showing distribution of the Smith Point Formation. Source: Fletcher, 1972.*

River, and some 7 2 miles from the Branch-St. Bride's road assayed as follows:

CaO	27.9
MgO	1.0
SiO_2	39.9
R_2O_3	7.0

Other Deposits

The Smith Point Formation is exposed on the west side of St. Mary's Bay north of Jigging Cove Head (14 feet), at Barachois (14.5 feet) and at Cape Dog (18 feet). No chemical data are available on these deposits. Measured sections were recorded by Hutchinson (1962, pp. 138, 139).

Hay Cove Volcanics

A section of extremely calcareous aquagene tuffs of Middle Cambrian age is locally present south of the community of Branch (Fig. 6). The deposit was first mapped by Greene (1962) and later by Fletcher (1972). The latter termed them the "Hay Cove Volcanics' (1972, p. 162), and gave a full description:

> ....a fluviovolcanic episode centred around the Hay Cove-Branch Head region resulted in the deposition of highly calcareous hyaloclastites-tuffs, breccias and thin basic pillow lavas. From a thickness in excess of 200 feet at Hay Cove, the waterlain volcanics rapidly thin so that at Beckford Head the wavy-bedded aquagene tuffs measure 2 ft. 4 in., on the western side of Deer Cove, 11 inches and on the eastern side, 9 inches. These eruptive rocks ... gave rise to a lens-shaped rock body within the latest member of the Manuels River Formation. The volcanics are ... typical hyaloclastites developed with calcite as the main interstitial cement and this is so dominant that they may now almost be classed as bedded limestones. Each bed is variously coloured and the prominent pinks and pale greens obviously reflect some iron content.

Three samples of the rock unit, from unspecified parts of the section, were collected. The analyses of these were as follows:

	Sample 1	Sample 2	Sample 3
CaO	37.24	27.96	30.66
MgO	7.50	10.26	9.61
SiO_2	10.81	14.96	15.96
Fe_2O_3	6.66	6.39	6.23
Al_2O_3	2.80	8.87	5.78
S	0.18	0.17	0.18

BURIN PENINSULA

The Smith Point Formation limestone is absent from many of the Cambrian sections exposed on the Burin Peninsula (Hutchinson, 1962, p. 14). Where present, the unit is in most places too thin to be of consequence from the standpoint of commercial exploitation. Van Alstine (1948) and Harris (1962), however, investigated the quarrying possibilities of Cambrian limestones at Salmonier and at North Harbour. Rocks of the Burin series of probable Precambrian age (Williamson, 1956a) contain limestone beds south of the community of Burin. Van Alstine (1948) and Williamson (1956b) examined those deposits from an economic standpoint.

Smith Point Limestone Deposits

The Smith Point limestone is exposed on the west shore of North Harbour, south of North Harbour Village. Hutchinson (1962, p. 14) recorded that the formation was 20 feet thick, and Harris (1962, p. 55) estimated that the steeply-dipping, north-south trending, complexly faulted unit could provide about 30,000 tons of stone. Chip samples taken from the deposit assayed 70.2, 41.6 and 40.3 per cent silica.

Van Alstine (1948, p. 44) investigated a section of Cambrian limestone (possibly Smith Point) about ten feet thick, exposed on the shore about 500 feet north of Salmonier. A chip sample from the outcrop analyzed as follows:

$CaCO_3$	81.78
$MgCO_3$	3.80
SiO_2	11.15
Al_2O_3	3.21
Fe_2O_3	1.19

The bed strikes N70°W, dips 35° to the north and is somewhat disrupted as the result of faulting.

Burin Series Limestone Deposits

The community of Burin is underlain by rocks of the Burin series, which in that area is composed mostly of basalt, conglomerate and shale, with minor amounts of limestone (Williamson, 1956b). Van Alstine (1948) considered the section to be of probable Ordovician age, but Williamson (1956a, p. 29) revised that interpretation on regional considerations, and stated with some assurance that the rocks were Precambrian. Williams (1967) interpreted the Burin Series as being equivalent to the Musgravetown Group on the Avalon Peninsula.

Magnesian limestone beds in the series outcrop south of Burin between Whale Cove and Mosquito Cove (Fig. 7). The beds strike between N25°E and 35° and dip between

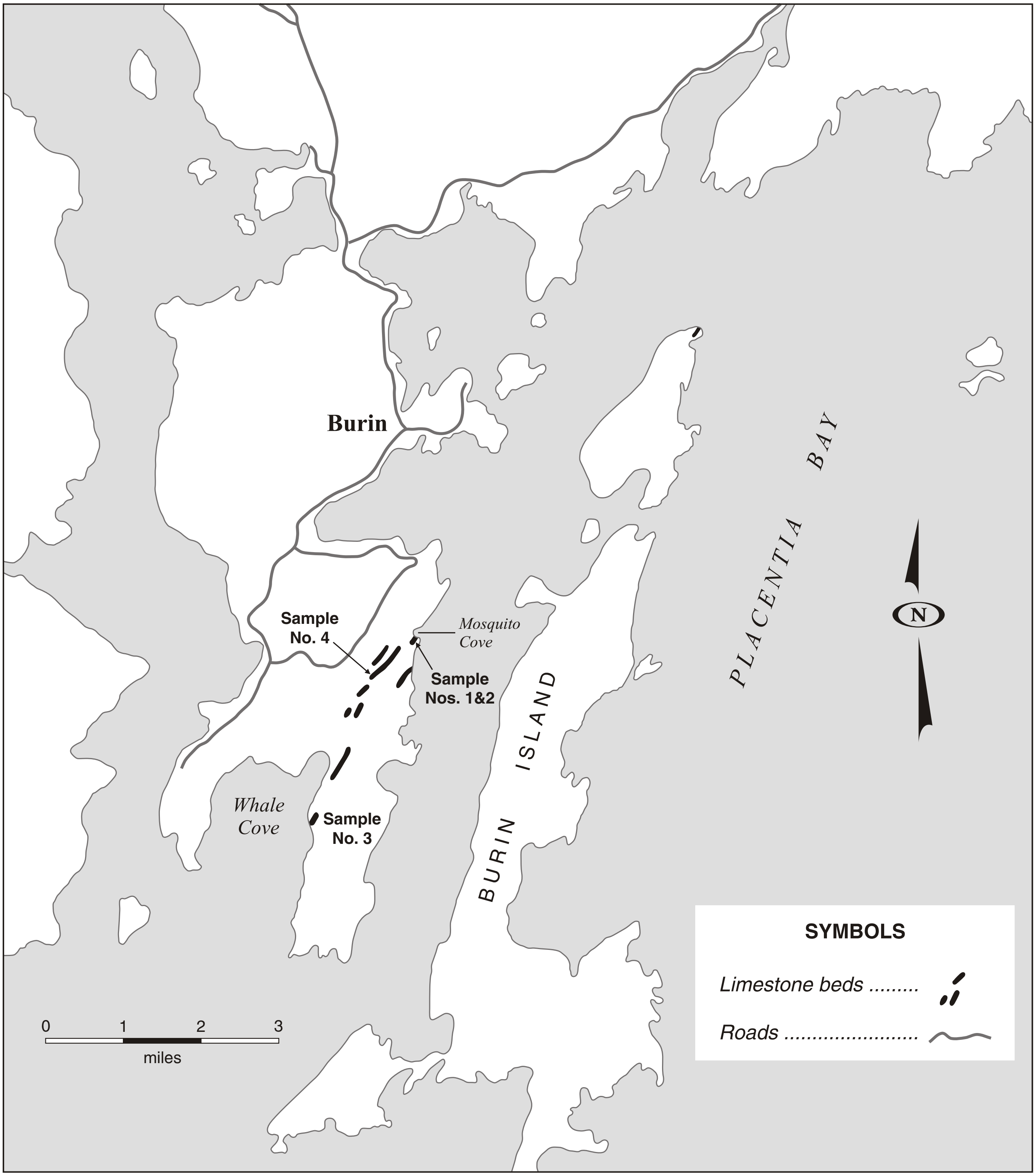

Figure 7. *Locations of limestone exposures in the Burin Series near Burin, Placentia Bay. Source: Williamson, 1956b.*

60° and 75° to the northwest. Williamson (1956b, p. 2) stated that there were two parallel beds of limestone which have been structurally deformed to produce offsetting and therefore discontinuous outcrops. The more easterly bed is only about five feet thick and discontinuous, while the thicker westerly bed can be traced almost continuously from Mosquito Cove to Whale Cove; this is the bed of commercial interest.

At Mosquito Cove, the stone is massive and weathers light grey. To the southwest the unit becomes nodular, the matrix consisting of shale, volcanic ash or conglomerate. On the south side of Mosquito Cove and for a distance of perhaps 1,000 feet to the southwest, the unit is thinner and slaty in places, and on the east side of Whale Cove the limestone unit, interbedded with greenish coloured basaltic flow breccia, is only six to eight feet thick. No tonnage estimates have been made, but probably less than 200,000 tons of stone are quarryable. The limestone deposits have been chip sampled and analyzed a number of times and the results are presented below (for sample locations see Fig. 7):

	Mosquito Cove (Van Alstine, 1948, p. 43)		Whale Cove (McKillop, ms., 1962)	Midway between coves (McKillop, ms., 1962)
	Sample 1	Sample 2	Sample 3	Sample 4
CaO	29.10	34.66	39.8	36.3
MgO	19.07	16.85	9.5	10.4
SiO_2	5.24	2.10	5.9	8.9
Al_2O_3	2.30	1.07	-	-
Fe_2O_3	1.14	0.39	-	-
R_2O_3	-	-	2.8	3.2

FORTUNE BAY TO BAY D'ESPOIR

Parts of the Fortune Bay-Bay D'Espoir region have been included in Geological Survey of Canada map areas by Anderson (1965) and Williams (1971a, b). The area has also been the subject of thesis projects by Widmer (1950) and Calcutt (in press), among others. Private reports referring to the limestone deposits have been produced by Widmer (1946), Harrison (1953) and Dunlop (1953). Three small, impure deposits of limestone have been described in the Great Bay de l'Eau area (Widmer, 1946, 1950), and two very small, very impure deposits are known from the Bay D'Espoir area (Dunlop, 1953). The locations of these are indicated on the Limestone Resources Map of Newfoundland (see map jacket).

Dunlop (1953, p. 25) recorded descriptions of two deposits in the Bay D'Espoir Group of Ordovician and possibly earlier age (Williams, 1971a). A small deposit of limestone cut by calcite stringers was observed along the south shore of Conne Basin and a larger deposit of crystalline limestone is present on the west end of Goblin Head. The latter is approximately seven feet thick and is fairly steeply-dipping. Where exposed, the limestone is banded with fine graphitic material and contains small specks of chalcopyrite and pyrrhotite. No grade or tonnage estimates have been made for either deposit.

Three deposits have been described from the Cinq Isles Formation on the shores of Great Bay de l'Eau. This formation consists of micaceous sandstone, quartz-pebble conglomerate, shale, and grey to pink micritic limestone which Williams (1971b, p. 22) considered to be Devonian in age and possibly earlier.

Widmer (1946, p. 22; and 1950, p. 425) stated that a ridge of grey Cinq Isles Formation limestone outcrops on the east side of the bay, north of Wreck Cove and on the north end of the road from Belleoram to Wreck Cove. The stone comprises a single bed, over 40 feet thick and dipping to the south at 50° to 70°, which is exposed in two ridges, each several hundred yards long. The deposit is readily accessible from the road and from the harbour. No estimates of grade or tonnage have been made; a single sample from the unit analyzed as follows (Widmer, 1950, p. 426):

$CaCO_3$	84.29
MgO	0.65
$Fe_2O_3 + Al_2O_3$	1.30
Insol. residue	12.20

A thick bed of Cinq Isles limestone dipping to the northwest at about 35° is located on the shore at White Cove, between Harbour Breton Bay and Little Bay West, on the west side of Great Bay de l'Eau (Widmer, 1950); the deposit is some three miles distant from the nearest road to the north over rough terrain. In addition, a limestone bed dipping to the north at 30° outcrops on the eastern head of Little Bay. Neither of these has been assayed or subjected to grade or tonnage estimates.

CENTRAL NEWFOUNDLAND

These occurrences of limestone of possible commercial interest are located in central Newfoundland, east of Red Indian Lake (see Fig. 8). All are located in a section of sedimentary and volcanic rocks of Silurian age. The regional setting of the deposits is adequately set forth in Geological Survey of Canada Map Sheets by Anderson and Williams (1970) and Williams (1970). The deposits themselves have been the subject of interest at one time or another to individuals in industry, government and academic circles, and reports by Brown (1958), Mullins (1961) and McKillop (1961a) are of particular interest in this regard.

Tally Pond

The Tally Pond occurrence is located about **2** mile south of the private road to the pond. It is exposed in places

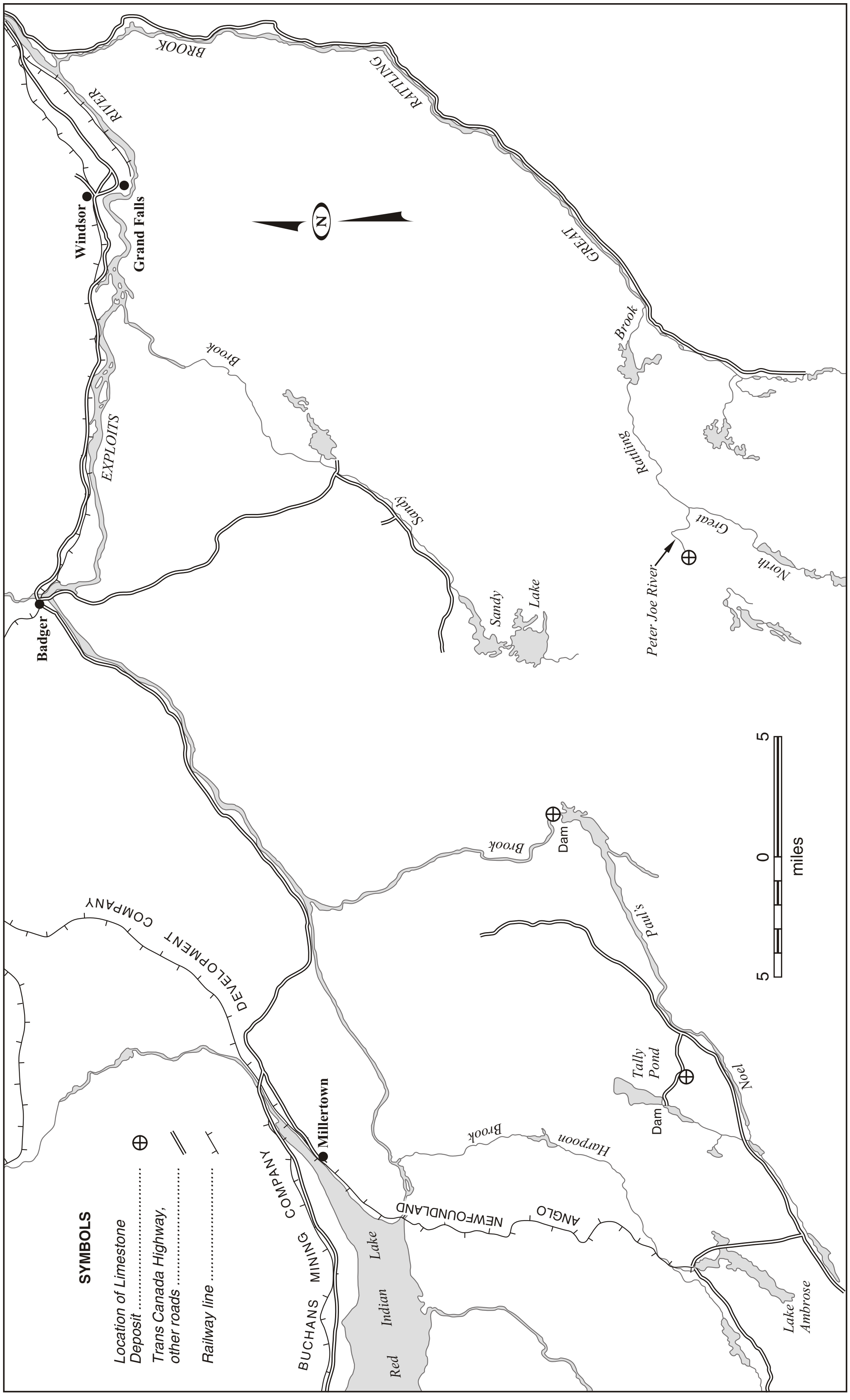

Figure 8. *Locations of limestone deposits in central Newfoundland.*

on a low hill about 200 feet across, which stands about ten feet above the surrounding marshes. The beds strike N45°E and dip at about 50° to the southeast. A line of apparent sink holes extends southwest for several hundred feet and presumably indicates an extension of the deposits in that direction. McKillop (1961a) stated that the deposit consists of a stratigraphic thickness of 175 feet of thin-bedded recrystallized grey limestone with a well-developed shaly parting. Seven chip samples of the stone were taken at intervals on a line across strike, with an average analysis as follows:

CaO	49.82
MgO	2.63
SiO_2	5.64
R_2O_3	2.20
L.O.I.	39.71

McKillop estimated that at least 30,000 tons of limestone could be readily obtained by removing the low hill underlain by the rock unit.

Noel Paul's Brook

An occurrence of high-calcium limestone is located at the bend of Noel Paul's Brook just below the dam and rapids at the north end of Noel Paul's Steady. It was first mapped by Mullins (1961) and later investigated in some detail by McKillop (1961a).

The deposit is part of a section of magnesian limestone associated with intermediate volcanic rocks. The beds strike N80°W and dip to the north at about 70° (McKillop, 1961a), and the surface width across strike in the high-calcium zone is between 30 and 50 feet. The strike-length of the unit is not known: it is exposed intermittently on the shore of the south side of the Brook, and is indicated inland to the west for several hundred feet by a line of small sink holes and limestone boulders.

Two chip samples from the high-calcium zone analyzed as follows:

	Sample 1	Sample 2
CaO	53.43	54.80
Mg0	1.80	1.18
SiO_2	1.52	1.17
R_2O_3	0.78	0.71
L.O.I.	41.85	41.28

The average analysis of seven chip samples taken from the enclosing magnesian limestones is as follows:

CaO	36.65
MgO	12.72
SiO_2	2.25
R_2O_3	1.49
L.O.I.	42.22

No tonnage estimates have been made. The deposit is under thick overburden for the most part, and is about five miles from the nearest road. Noel Paul's Brook is not navigable.

Peter Joe River

A small deposit of limestone occurs about 4 miles from the mouth of Peter Joe River, a tributary of the North Branch of Great Rattling Brook. The nearest road is some eight miles to the east. The deposit has been described by Brown (1958) and McKillop (1961a).

Two outcrops of fairly homogeneous limestone representing at least 30 feet of carbonate section in a succession of slate and mudstone are present on the north side of the river. The deposit is low-lying under extensive overburden, and its proximity to the stream and surrounding bogs led Brown (1958) to estimate that only about 10,000 tons could be quarried without encountering drainage problems. No data regarding the composition of the deposit are available.

NOTRE DAME BAY

Small limestone deposits are associated with Ordovician volcanic rocks in places around Notre Dame Bay. Only one of these, the deposit at Cobb's Arm, New World Island, has been extensively quarried. Most of the other deposits are so small and/or inaccessible that for the purposes of this report, they merit only passing mention as to location and geological features.

The regional setting of the Notre Dame Bay deposits has been well described in Geological Survey of Canada reports by Patrick (1956), Williams (1963a,b), and Neale and Nash (1963); and in papers by Horne and Helwig (1969) and Kay (1969). A number of other reports describe specific deposits, and reference is made to these in the following sections.

Cobb's Arm

The local geology of the Cobb's Arm area of New World Island was investigated in detail by Williams (1958) and later by Harris (1966). Most of the information which follows relates to the latter report, which was issued as Bulletin No. 37 of the Mineral Development Division.

High-calcium limestones of Middle Ordovician age overlie intermediate and basic volcanic rocks and underlie a unit of black argillite in the Cobb's Arm area. The limestone is for the most part a light grey, massive, medium to coarse calcarenite which is partly recrystallized. Some darker grey interbeds are present towards the base of the unit, but it is the light coloured stone which is of commercial interest. The carbonate section is at least 150 feet thick, but the relationships are somewhat obscured by extensive folding and faulting in the area. Limestone of the unit outcrops at several localities on New World Island and on the islands to the southwest, but the occurrence at Cobb's Arm is by far the most extensive (Harris, 1966, p. 8). Harris considered that the limestone was deposited "on a platform of volcanic rocks that possibly extended little beyond the present limit of limestone occurrences in the eastern Notre Dame Bay region" (Harris, 1966, p. 26).

The Cobb's Arm limestone unit has been structurally dissected into isolated blocks (see map 2), only a few of which are of any commercial interest. Harris (1966, p. 20) interpreted the earliest major structure to be a major south-east to northwest thrust of Ordovician and Silurian rocks (including the limestone section) over later Silurian rocks. The record of this structural event is obscured by subsequent normal and strike-slip fault sets of several ages. While the detailed nature of the structures is (in my opinion) still somewhat conjectural, Harris nevertheless succeeded in defining the most important limestone occurrences on the basis of their enclosing structures, and by diamond drilling he determined the approximate vertical thicknesses of stone available in most of them.

Between 1912 and 1966, high-calcium stone from Cobb's Arm was quarried by Newfoundland Lime Manufacturing Company Limited and shipped to Grand Falls about 70 miles to the southwest. The stone was used in the manufacture of sulphite pulp at the Price (Newfoundland) Pulp and Paper Company mill there. Table No. 4 is a summary of the major remaining deposits in the Cobb's Arm area, with reference to their suitability as quarry sites in addition to estimates of grade and tonnage.

Western Notre Dame Bay

Small limestone deposits have been reported in the following areas: Lush's Bight, Long Island; Duck Island, Badger Bay; Limestone Island (west of Little Bay Island); and south of King's Point, Southwest Arm. The locations of these occurrences are indicated in Figure 9.

In the community of Lush's Bight, Long Island, a limestone unit in the Cutwell Group (Espenshade, 1937) strikes approximately east-west and underlies the Salvation Army church. The section is of about 100 feet of steeply-dipping limestone breccia interbedded with minor greywacke. The inland extent of the occurrence is not known but is probably not much over 1,000 feet. A sample taken from the breccia near the church entrance analyzed as follows:

CaO	48.41
MgO	2.03
SiO_2	4.88
Fe_2O_3	0.29
Al_2O_3	2.02
S	0.09

Limestone occurs in the Exploits Group of Ordovician age (Williams, 1963b) on the west shore of Duck Island, Badger Bay. It has, reportedly, been quarried in the past and calcined at Tilley's Cove (Espenshade, 1937, p. 44). The quarry is in a l5-foot thick bed of recrystallized limestone; no information is available regarding grade or tonnage.

An apparently small occurrence of recrystallized limestone of the Cutwell Group outcrops on Limestone Island, off the west shore of Little Bay Island. No information on the grade of the deposit is available.

A minor occurrence of limestone is located in the Catcher's Pond Group (Neale and Nash, 1963) about five miles south of the head of Southwest Arm. The steeply-dipping beds are not over a few feet thick and are practically inaccessible, being exposed as low-lying outcrops on a lake shore some distance from the nearest road. No grade or tonnage data are available.

WHITE BAY

On the east side of White Bay a number of small crystalline limestone and marble occurrences have been reported from the Eocambrian (?) polydeformed Fleur de Lys Supergroup (as defined by Church, 1969). The carbonates, which are most commonly associated with semi-pelites, comprise small isolated pods in the enclosing rock. The best known deposits are on the coast at Clay Cove, Purbeck's Cove, Bear Cove, and Fleur de Lys (Fig. 10).

In western White Bay, Cambrian to Silurian clastic and carbonate rocks unconformably overlie the crystalline "Grenville" basement rocks of the Western Platform. The Late Cambrian and Ordovician Doucers Formation (Lock, 1972) of limestone and marble is probably lithofacies equivalent to the Ordovician carbonates to the west of the Long Range Mountains, and to carbonates of about the same age at Canada Bay to the north. The carbonates are commonly partly dolomitized and silicified; they contain breccia units in places, especially around Coney Arm (Lock, 1972, p. 314). Although somewhat disrupted by faults, the formation extends almost continuously from Coney Arm to the north, south past Taylor Pond (Fig. 11). Lock (1969a,b, 1972) interpreted the area underlain by the Doucers Formation to be continuous along strike from Coney Arm to Taylor Pond; Figures 10 and 11 present the interpretations of Heyl (1937a) and Neale and Nash (1963) south of Main River. The section is over 300 feet thick near Sop's Arm and may be as much as three times that at Coney Arm. The unit dips steeply to the east at about 70°. The carbonates tend to be increasingly recrystallized and deformed from north to south, and in the vicinity of Sop's Arm they have been considered possible sources of ornamental building stone because of their attractiveness when polished (Bain, 1937).

Table 4. Principal limestone deposits of the Cobb's Arm area. SOURCE: Harris, 1966, p. 32

Location by sub-area*	Estimated reserves (tons)	$CaCO_3$ content (approx. average)	Accessibilty	Topography	Remarks**
A	250,000 +	97.6 (to depth of 50 ft.)	500 yrds. over fairly level ground to nearest road.	Occupies fairly low ground between hills to the east and west.	Fair quarry site, possible problems in confined working space and drainage.
B	50,000	97.8 (to depth of 45 ft.)	150 yrds. over uneven ground to nearest road.	Occupies part of a small hill.	Fair to poor quarry site, could be approached from the south, confined working space.
C	150,000	97.0	100 ft. over level ground to nearest road.	Occupies a small plateau between two hills. Forms a north -facing scarp that rises from a flat-base to a relatively flat top.	Excellent quarry site with wide approach. A horizontal fault separates the limestone from argillite at a depth of 45 ft.
D	60,000 (?)	95.4 (to depth of 40 ft.)	Beside road from Cobbs Arm to Rogers Cove.	Extends back from road into a gently sloping hill.	Poor quarry site. A quarry was started here a few years ago, then abandoned because quarry face small and confined.
E	150,000	97.7 (to depth of 80 ft.)	100 ft. to road leading from operating quarries to loading pier.	Occurs in a 300 foot long fault block that forms part of a 60 - to 80 - foot high north - facing scarp.	Good quarry site in most respects. Several thousand tons of fill required to establish flat quarry floor prior to production.
F	60,000 +	96.3 (to depth of 35 ft.)	300 yds. over uneven ground to nearest road.	Underlies a low hill surrounded by humocky terrain and a poorly drained area to the west.	Fair to poor quarry site. Initial development costs probably would be high.
G	(probably large)	?	Relatively inaccessible, 350 yards over uneven ground to nearest road.	Underlies low ground, in part poorly drained.	Outcrop is sparse, thus surface extent may be much less than shown on Map No. 2. Suitable for further exploration.
H (excluding main quarry)	150,000	95.0	A rough road behind the main quarry extends to the east side of sub-area "H".	Occupies high ground and extends back from a 20 - to 30 - foot high northwest - facing scarp.	Fair quarry site requiring little initial development costs. However the limestone here is highly fractured and faulted.
I	30,000	variable	Readily accessible.	Underlies a steep incline.	Existing quarry face.
J	80,000	94.5	Readily accessible	Projects from a side-hill and rises from a flat base to a flat top.	Existing quarry face.

* Lettered circles on Map No. 2 denote sub-areas. Each sub-area contains a deposit of potentially commercial limestone.
** Overburden on limestone deposits negligible in all sub-areas except "e"

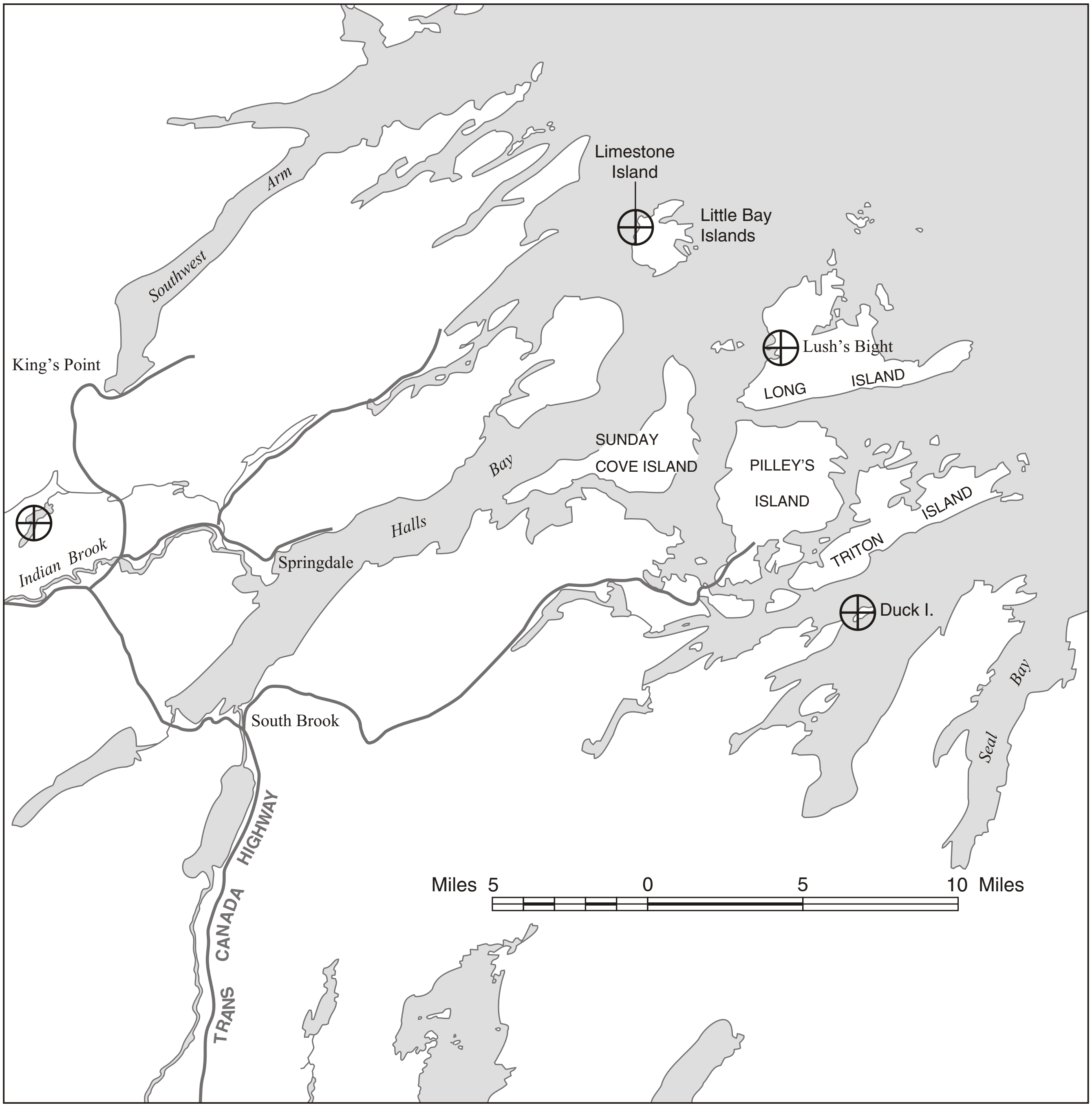

Figure 9. *Locations of limestone deposits in western Notre Dame Bay.*

Figure 10. *Locations of limestone deposits in the White Bay area.*

Limestone and marble deposits in the White Bay area have been discussed in Geological Survey of Newfoundland bulletins by Bain (1937), Heyl (1937a) and Betz (1948). A Geological Survey of Canada paper by Neale and Nash (1963) adequately indicates the regional setting. Detailed studies by Lock (l969a,b; 1972) relate in part to the Doucers Formation limestone, and unpublished reports by Lee (1956) and Bedford (1957) are concerned with the economic prospects of the deposits at Coney Arm.

Eastern White Bay

Clay Cove

Edgar (1928) reported that at Clay Cove, some two miles south of Purbeck's Cove on the east side of White Bay, a large deposit of marble was exposed (Fig. 10). The steeply-dipping carbonate unit strikes east-west from the shoreline into a hill about 1,000 feet high. The section is only 40 feet thick at the base of the hill, but Edgar stated that at an elevation of 800 feet the unit is 300 feet thick. Although coarse-grained for the most part, near the base of the hill a "vein of fine statuary marble" is exposed, and according to Edgar, there "must be millions of tons' of commercial marble available, but this estimate is almost certainly over-optimistic. No data regarding the chemical composition of the deposit are available.

Purbeck's Cove

Small deposits of marble are located on the north and south shores of Purbeck's Cove, Eastern White Bay (Fig. 10). Bain (1937) described the deposits in some detail from the standpoint of their usefulness as an ornamental or building stone, The deposit on the south side is small, not over a few tons, and will not be considered here. On the north side of the cove, the white stone is visible in an old quarry face about halfway up the steep hillside and about halfway into the harbour. According to Bain (1937, p. 21), small amounts of material were quarried in the past for lime and for local uses, presumably agricultural.

The marble apparently comprises the core of a tight synform, the axis of which strikes about N55°E and dips to the north at about 85° (Bain, 1937, p. 22). The unit reaches a maximum apparent width of 200 feet at the top of the slope but is generally much thinner. Both coarse and fine-grained marble is present in the deposit, but Bain considered them both to be unsuitable for any ornamental or building use because intense jointing makes the stone unsound in most places. In addition, "the stone does not take a high finish and has a dull brownish-grey tone which is not at all attractive" (Bain, 1937, p. 22).

Available analyses of chip samples from the quarry are as follows:

	McKillop (1962, ms.)	Min. Dev. Div. (1972)
CaO	54.60	50.71
MgO	0.79	1.00
SiO_2	1.20	2.35
Fe_2O_3	0.90	0.32
Al_2O_3		0.83
S	-	0.04

No tonnage estimates have been made of the deposit, but probably not over a few thousand tons are present.

Bear Cove

At Bear Cove, the site of a now-resettled community north of Western Arm, crystalline limestone and marble are exposed at several places on the west shore of the harbour (Fig. 10). The deposits are associated with and, in places, intimately interbanded with muscovite schist. They are all very small, and the writer suspects that each is part of the same carbonate unit, exposed repeatedly at the shoreline as the result of minor faulting and folding. The best exposures are at White Point at the south end of the Cove, and at a location about halfway into the cove. Analyses of representative chip samples collected by the writer in 1972 are as follows:

	White Point	Halfway in Cove
CaO	43.50	48.71
Mg0	8.22	4.64
SiO_2	0.70	0.44
Fe_2O_3	2.56	1.12
Al_2O_3	0.21	0.12
S	0.03	0.03

Fleur de Lys

In the vicinity of Fleur de Lys at the north end of the Baie Verte Peninsula the "Starboard Gneiss" is reported to contain marble beds up to 40 feet thick (Fuller, 1941, p. 13). No information is available regarding their commercial possibilities.

Western White Bay

Coney Arm

Doucers Formation limestones and marbles outcrop along the west shore of Great Coney Arm from the bottom of the bay to Cobbler Head (Fig. 11). Bedding in the unit generally strikes at about N35°E and dips 75° to 80° to the east, though according to Lock (1972, p. 314) "structural interpretations are ambiguous-a large isoclinal fold may be causing strata to be repeated".

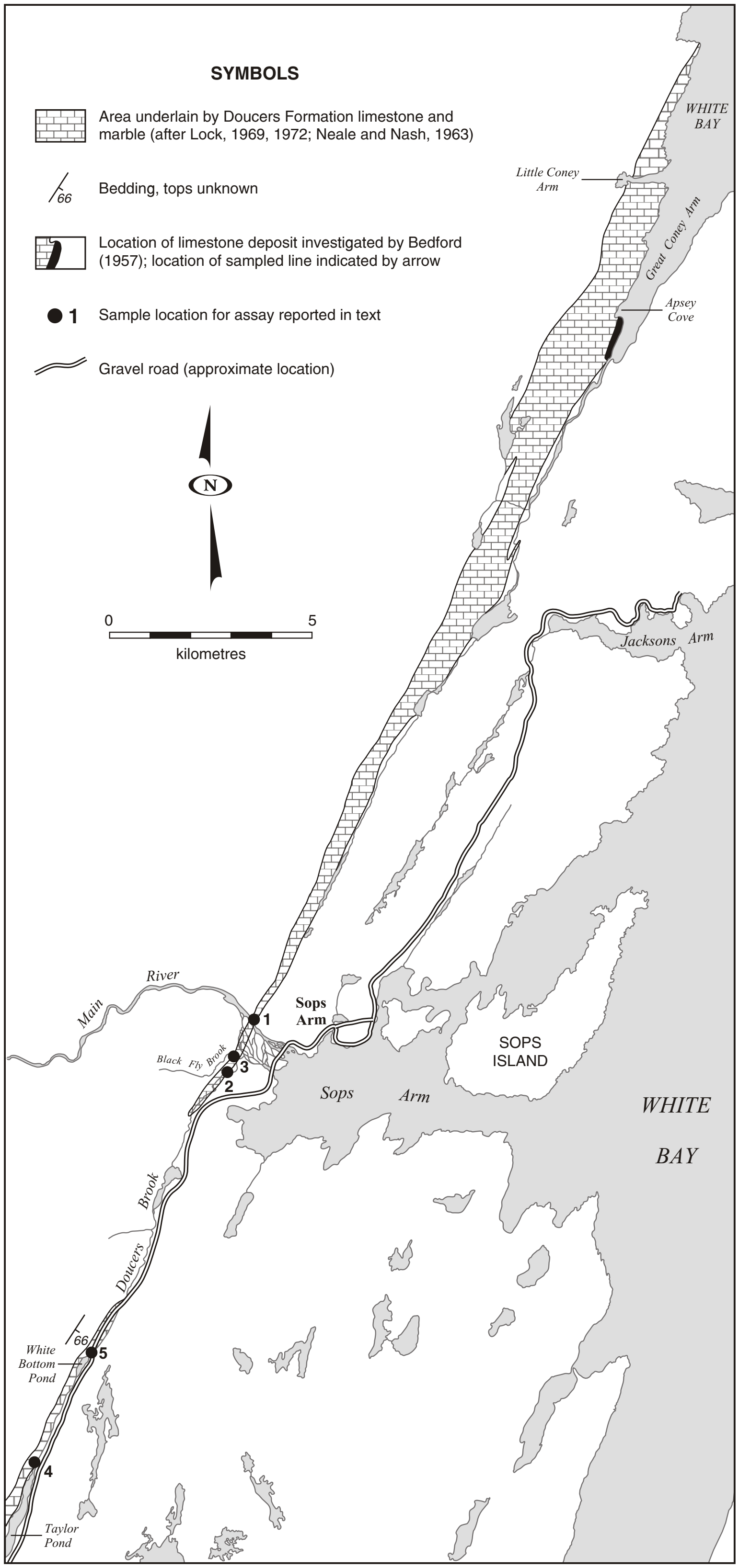

Figure 11. *Area underlain by doucers formation limestone and marble (after Lock, 1969, 1972; Neale and Nash, 1963) showing locations referred to in text.*

Lee (1956) obtained chip samples for analysis from scattered locations throughout the coastal section. He reported disappointing results from the samples taken at Little Coney Arm, with assays ranging from 38.48 to 94.73 per cent $CaCO_3$. At Apsey Cove Bottom, two chip samples of apparently highly silicified stone assayed only about 50 per cent $CaCO_3$. The best stone was exposed on a linear ridge which runs parallel to the shore line from Apsey Cove Point to Great Coney Arm Bottom; all but five of twenty-three samples taken assayed between 96.58 and 99.66 per cent $CaCO_3$. Three samples from an old quarry (history unknown to the writer) halfway between Apsey Cove Point and Great Coney Arm Bottom assayed slightly over 97 percent $CaCO_3$. Here the water deepens abruptly offshore and the depth at the end of an existing dock and was measured to be over 30 feet. Lee estimated that some 200,000,000 tons of crystalline limestone were quarryable, with an average grade of 97.02 percent $CaCO_3$.

Bedford (1957) undertook a more detailed survey of the deposit between Apsey Cove and Great Coney Arm Bottom, and estimated that about 32,000,000 tons of stone averaging 97.0 per cent $CaCO_3$ and 1.20 percent $MgCO_3$ could be recovered by quarrying inland for about 500 feet from the coast. The location of the deposit is indicated in Figure 11, together with the location of the continuously sampled line to which Table No. 5 relates (assay data are available for this line only, though Bedford sampled three):

Coney Arm as the result of nearby shearing, and possibly granite intrusion (Bain, 1937; Lee, 1956). The occurrences are difficult of access, being in general more than a mile from the road to the community of Sop's Arm. In addition, Sop's Arm at the mouth of Main River is very shallow, making ready access by sea impossible.

Pale grey to pinkish marble is exposed on the north shore of Main River, approximately 1?2 mile from its mouth. According to Bain (1937) the marble is exposed along 170 to 200 feet of the river bank and is lithologically inhomogeneous, with a cherty dolomite zone near the middle of the exposure. The stone is attractive in places, with a light red veining and a faint reddish tint, but is practically useless as an ornamental stone because it is very badly fractured. The largest sound block which could be obtained would be not over three feet across. A chip sample, representative of the visually purest parts of the showing was collected by the writer (Fig. 11, sample 1) and analyzed as follows:

Ca0	55.02
MgO	0.58
SiO_2	0.50
Fe_2O_3	0.05
Al_2O_3	0.12
S	0.04

Table 5. Chemical results of continuous sampling on a line south of Apsey Cove, Coney Arm (after Bedford, 1957). From a blasted trench, chip samples averaging about three pounds per lineal foot were collected. Sample footage was measured westwards from the shoreline.

Composite sample	Ft.	CaO	MgO	CO_2	SiO_2	Al_2O_3	Fe_2O_3	SO_3	P_2O_5
0-42.5	42.5	54.48	0.48	43.20	0.70	0.25	0.16	0.03	0.009
42.5-56.0	13.5	53.00	1.26	42.90	1.47	0.56	0.26	0.07	0.013
56.0-118.5	62.5	54.69	0.47	43.43	0.57	0.12	0.18	0.05	0.009
Weighted averages:		54.42	0.57	43.29	0.72	0.22	0.19	0.045	0.010

Jackson's Arm

The same crystalline limestone unit that crops out at Apsey Cove Point is present along the western shore of Jackson's Arm Pond, about a mile west of Jackson's Arm Bottom (Lee, 1956). The stone comprises a cliff, the face of which trends N 30°E. No information is available regarding grade or tonnage of the deposit.

Sop's Arm

A number of marble occurrences in the Doucers Formation are located in the vicinity of Sop's Arm. In general, they are more highly metamorphosed than the limestone at

Doucers Formation marble is exposed in a number of places along Doucers Brook, which flows into Main River from the south. In particular, a prominent 15O-foot long cliff exposes the marble unit west of Doucers Brook, about **2** mile west of the bottom of Giles Cove. Nothing is known of the chemical composition of the stone there. Bain (1937, p. 18) considered "the southwestern corner of the hill ... to be the only sufficiently sound and attractive part to constitute a possible marble deposit. The section for 100 to 150 feet north from the south end of the ledge appears relatively free from unsoundness, has a very attractive colour and appears to be the most, if not the only, promising marble deposit on Sop's Arm”. The marble is white to dove-coloured with reddish veins and is almost massive. The writer collected a single chip sample from a marble outcrop along strike on the west shore of Doucers Brook south of the cliff (Fig. 11, sample 2) which analyzed as follows:

CaO	46.54
MgO	2.29
SiO_2	8.00
Fe_2O_3	0.17
Al_2O_3	1.78
S	0.03

Black Fly Brook, which flows into Doucers Brook from the west near its confluence with Main Brook, cuts a deep, very narrow, sinuous gorge for about 175 feet through an almost complete section north of the above-mentioned cliff-face. The limestone is grey with irregular mottlings and numerous siliceous dolomite nodules (Bain, 1937, p. 18), and is unattractive compared to the above-mentioned deposit. The westernmost 20 feet of the section is a limestone breccia with a deeply hematite-stained siliceous carbonate matrix. The writer collected chip samples of both units in the gorge (Fig. 11, sample 3), which analyzed as follows:

	Sample from marginal breccia	Composite of 3 samples representative of marble section
CaO	47.32	55.43
MgO	2.51	0.42
SiO_2	6.13	0.66
Fe_2O_3	0.43	0.14
Al_2O_3	1.80	0.25
S	0.04	0.04

Taylor Pond Area

On the west side of Taylor Pond and for some distance to the north, Doucers Formation marble is exposed on a steep hillside which is in places a cliff. The deposits are some miles from tidewater but are readily accessible by the gravel road to Sop's Arm, which follows the strike-line of the rock unit for some miles.

The marble unit is exposed along nearly all the west side of Taylor Pond (the road follows the east side). On a cliff at the north end of the pond, the stone is grey to blue-grey and massive to thin-bedded. There are no obvious impurities; a chip sample (Fig. 11, sample 4) considered by the writer to be representative of the exposure analyzed as follows:

CaO	51.66
Mg0	1.24
SiO_2	2.68
Fe_2O_3	0.23
Al_2O_3	0.64
S	0.04

About two miles north of this occurrence (just north of White Bottom Pond) the road to Sop's Arm crosses Doucers Brook. Here, the Doucers Formation is exposed in a road-cut as a dark grey marble with irregular calcite patches. The stone is badly fractured, partly as the result of blasting. A single representative chip sample (Fig. 11, sample 5) collected by the writer analyzed as follows:

CaO	55.82
MgO	0.01
SiO_2	0.32
Fe_2O_3	0.05
Al_2O_3	0.11
S	0.04

CANADA BAY

Limestone and marble of the Canada Bay area were among the first on the Island of Newfoundland to be investigated for their possible commercial value-in that case as ornamental building stone. Some quarrying was done at Canada Harbour on the south side of Canada Bay early in this century, but no stone was shipped.

Marble was first reported from the area by Murray and Howley (1881), and most of the early work on the deposit was done by Edgar (1928). The deposits were the subject of serious investigation in the late 193O's as the result of earlier reports submitted by Muir (1935) and Howse (1936). Bain (1937) investigated the Canada Bay Deposits in some detail from an economic standpoint, and Betz (1939) reported on the entire area. After that time, interest in the limestone and marble deposits was sporadic and was concerned mostly with their potential usefulness for their chemical composition. McKillop (1955) sampled coastal exposures extensively and reported the results of his analyses, and Besaw (1973a) revised Betz's map somewhat and added to the store of chemical data on the deposits. Meanwhile, fresh insights into the regional geology of that part of the Great Northern Peninsula were provided by, among others, Cooper (1937), Rodgers and Neale (1963), Williams (1967), Tuke (1968) and Smyth (1971).

The rock units of the autochthonous succession in the Canada Bay area are gross lithostratigraphic equivalents to those in western Newfoundland (see Table No. 2), although the base of the section is probably somewhat older. In particular, concerning the carbonate rocks, the Chimney Arm Formation described by Betz (1939) is identifiable with the St. George Group, and the Bide Arm Formation with the Table Head Formation, and current usage adopts the regionally applicable nomenclature. The rocks strike more or less north-south and dip steeply to the east, but this structural picture is complicated by faults and by fold sets which have been related to three phases of deformation (Betz, 1939, p. 2O; Besaw, 1973a). In a few places, notably Englee Island, deformation of interbedded limestones and dolomites resulted in the disruption of the more competent dolomite layers and their emplacement as tectonic inclusions in a marble matrix.

The St. George Group at Canada Bay consists of interbedded dolomite and limestone, and is not, in general, of any commercial interest. The beds, which are up to two feet thick, are generally black, grey or blue on fresh surfaces, and weather brown, yellow, white or light grey (Betz, 1939, p. 18). A black, shaly-appearing limestone exposed on headlands on the east side of Chimney Arm might be of marble quality (Betz, 1939, p. 37), but this possibility has never been seriously investigated.

The Table Head Formation consists of bluish grey marble and dolomite, and white marble. The unit is in apparent conformity with the underlying St. George Group and is overlain by black phyllites of the Englee Formation (Betz, 1939, p. 11) which are probably equivalent to the middle and upper units of the Table Head Formation of western Newfoundland. Both the bluish grey marbles and the white marble have been considered possible building stone material; the white marbles are chemically pure, and so have potential for other uses as well.

The stratigraphic section of the Table Head Formation at Canada Bay has never been mapped in detail. Besaw (l973a) after Betz (1939) subdivided the formation at Canada Harbour into the following units in descending stratigraphic order:

Unit	Thickness, ft
Blue marble and grey dolomite (dolomite predominating towards base of unit)	100
White marble, with scattered thin dolomite beds	120
Grey dolomite (base not exposed)	?

The same formation as exposed on the shores of Bide Arm to the north has been interpreted as being some 1,500 feet thick (Betz, 1939, p. 20). Betz divided that section in descending stratigraphic order into the following units:

upper part	Blue-grey dolomite, more massive than in lower part; shaly in places.
white marble unit	Exposed at Canada Harbour and at Englee Island. "Not uniformly developed but... present in zones where the deformation of the beds has been intensive enough to effect fairly complete recrystallization."
lower part	Dark limestone beds averaging two feet in thickness, weathering brown or grey. Associated with white, cream or pink marble in places.

Besaw (l973a) substantially agreed with this interpretation, but indicated that the middle "white marble" unit is continuous northwards from Canada Harbour to Marble Pond east of Roddickton though very poorly exposed.

The communities of Roddickton and Englee are accessible overland by a gravel road departing from the west side of the Great Northern Peninsula at Plum Point. Both Englee and Canada Harbour are good deep water ports.

Canada Harbour

An extensive deposit of white marble is located at Canada Harbour on the south side of Canada Bay (Fig. 12). Two small quarries were opened in the deposit early in this century for the purpose of removing high quality building stone, but none was ever shipped.

The marble unit strikes slightly east of north and comprises the core of a tight to isoclinal upright anticline, plunging gently to the north. The thickness of the stratigraphic section is somewhat uncertain as the result of structural complications, but Besaw (1973a) after Bain (1937) estimated it to be about 120 feet. Bain (1937, p. 31) described two marble units within the white marble section. The "lower" or western unit has "a general ivory tone and varies from near pink at one extreme to pure white at the other". It is extremely fine-grained and fractures conchoidally. The "upper" eastern deposit has "a harsher white colour and a porcellaneous texture" and fractures irregularly. In both deposits "conspicuous green bands of chlorite, sericite and minor quartz in a calcite matrix" are present on bedding planes. Betz (1939, p. 40) summarized Bain's opinion of the quality of the marble as building stone:

1. The limited thickness and width in a marble lacking any outstanding qualities makes it improbable that this deposit could compete with other similar types in a world market.

2. The colour markings (especially the green chlorite) prevent the quarrying of large uniform blocks required for building purposes, except to a limited extent.

3. The abundance of cross-joints indicates an almost complete unsoundness of the marble.

4. Quarried blocks in Canada Harbour show open seams sub-parallel to the bedding. These also point to a weakness in the rock, which may possibly disappear at depth.

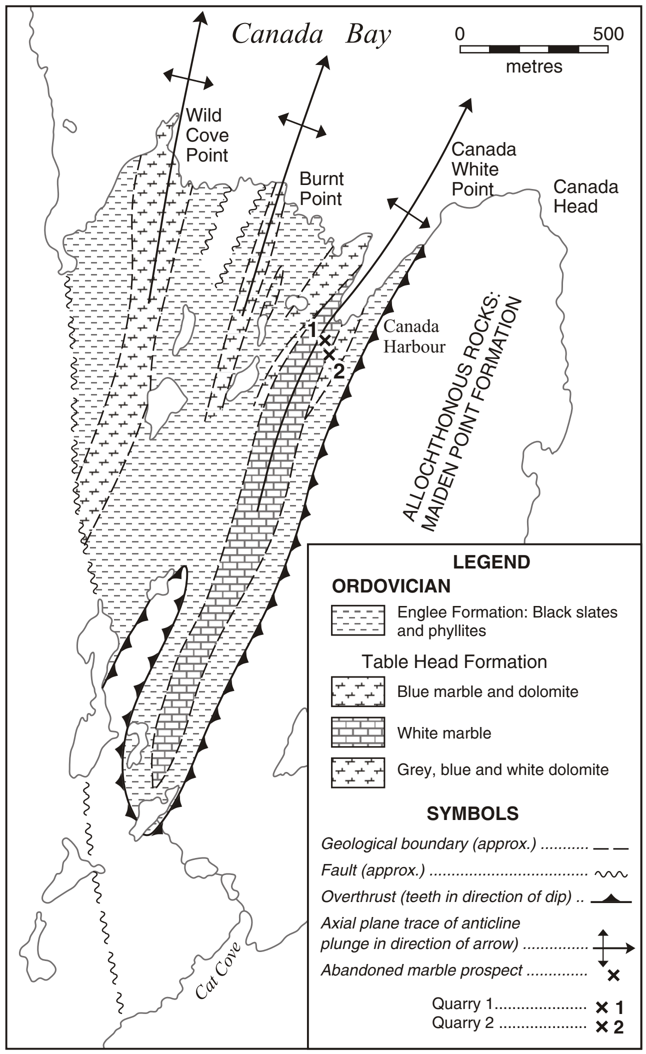

Figure 12. *Geologic sketch map of the Canada Harbour area, showing distribution of marble deposits. Source: Besaw, 1973a.*

The chemical composition of the deposit is known in a general way. Besaw (l973a) stated that "locally folded and boudinized" dolomite beds are scattered throughout the entire marble section, though the latter lithology is strongly dominant. Besaw collected 18 chip samples from scattered locations within the section up to **2** mile south of Canada Harbour Bottom. Of these, the samples collected from white marble beds were consistently pure, the average analysis of 13 samples being as follows:

CaO	52.47
MgO	1.80
SiO_2	1.53
Fe_2O_3	0.14
Al_2O_3	0.54
S	0.04

The average analysis of the five dolomite samples collected is as follows:

CaO	27.80
MgO	20.16
SiO_2	7.29
Fe_2O_3	0.51
Al_2O_3	0.92
S	0.02

Analyses of a number of marble samples taken from the unit south of Canada Harbour on a bush trail to Cat Cove (Besaw, 1973a) indicate that the stone is of about the same purity throughout its strike-length.

Besaw (l973a) also collected a number of samples of the upper blue marble and dolomite unit of the Table Head Formation. The unit is exposed on the flanks of the Canada Harbour anticline and also at Burnt Point from which it strikes south (Fig. 12). Besaw's results indicated that the marble beds in the unit contain about 4 percent MgO and up to 2 percent of other impurities; and the dolomite samples collected contain up to 20 percent MgO and proportionally higher percentages of other impurities. The relative proportions of marble and dolomite in the section are unknown, but there is probably no great predominance of one lithology over the other.

McKillop (1955) collected continuous samples of the carbonate section around Canada White Point. Assays of his samples were made for CaO and MgO and indicated that the stone is mostly dolomitic. McKillop sampled the section around Wild Cove Point to the west in the same way. His assay results, confined by analyses of a number of samples collected along strike by Besaw (1973a) indicated that the grey dolomitic stone there contains between 10 and 20 per cent MgO and up to 10 per cent SiO_2.

Englee Island

The white marble unit of the Table Head Formation is exposed at the south end of Englee Island (Fig. 13). It is overlain in turn by blue marble and grey dolomite of the same formation, and by black shales and phyllites of the Englee Formation which is also exposed on the island. Extensive faulting and inhomogeneous deformation of the rock has rendered the geologic structure of the island somewhat obscure. Bain (1937, pp. 25, 30) considered the structures to be best described as a series of large north-south trending drag folds subsidiary to the anticline exposed at Marble Ridge to the south, and the structural picture to have been complicated by nearby major faulting. Betz (1939, p. 19) stated that "on Englee Island, the beds of the Bide Arm Formation are exposed on the western limb of an overturned fold". Besaw (l973a) concluded that the island is underlain by chaotically oriented dolomite "wedges" or "plates" in a matrix of Englee Formation phyllites and Bide Arm Formation marbles which are deformed "into several upright isoclinal folds".

The Englee Island white marble deposit is quite small compared to the one at Canada Harbour, and the intense and complex deformation of the rock probably severely limits the amount of quarryable material underlying the exposed section. The marble is almost pure white; chlorite-rich veins like those present on bedding planes at the Canada Harbour deposit are much less prominent. At Englee Island, however, the small size of the deposit, and the irregular and unpredictable fracturing characteristics of the marble, make it unlikely to be a source of building or monumental stone. No chemical data are available concerning the deposit.

Other Deposits

White marble of the Table Head Formation is exposed at Marble Brook west of Roddickton (Fig. 13). The stone is finely crystalline and has a slightly greyish cast. Betz (1937, p. 39) stated that the stone tends to break in thin slabs, often not more than an inch thick; and this characteristic combined with its relatively unattractive colour and in-accessible location make it an unlikely source of commercial marble. Besaw (1973) recorded an analysis of a chip sample collected just upstream from the mouth of the brook at Marble Pond:

CaO	54.88
MgO	nil
SiO_2	0.50
Fe_2O_3	0.10
Al_2O_3	0.19
S	0.05

McKillop (1955) collected continuous samples of the coastal section of the Table Head Formation at Bide Head. His assay results indicated that the dolomite and interbedded marbles there contain 15 to 20 per cent magnesia. Besaw's (1973a) analyses of chip samples from the same section confirmed McKillop's results and further showed that the rocks contain up to about 5 percent silica and minor amounts of other impurities.

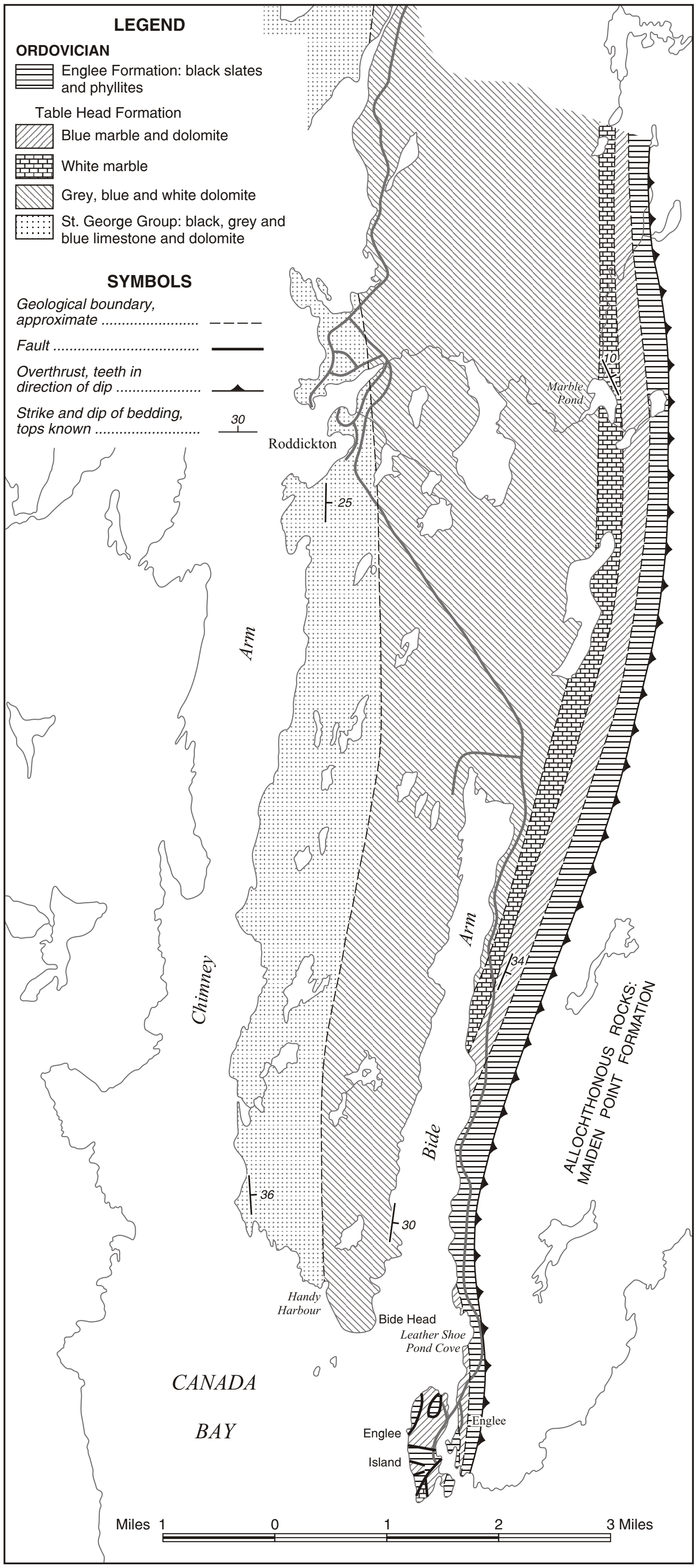

Figure 13. *Geologic sketch map of the Bide Arm area, showing distribution of marble deposits. Source: Besaw, 1973a.*

Finally Bain (1937) and Betz (1939) discussed blue marble deposits (including recrystallized dolomite) in the area from the point of view of their potential as building and ornamental stone. They considered most of the stone to be too badly fractured and physically inhomogeneous to be worth consideration. Sections exposed at Burnt Point (90 feet measured horizontally), Seal Cove (150 feet) and on the shoreline around the community of Englee were, however, thought to be of adequate quality and of exploitable tonnages, though no tonnage estimates were made. The stone is dark bluish-grey in colour and very fine grained. It takes a good polish but tends to be quite brittle, so that extensive blasting of the deposits might not be feasible.

HARE BAY-PISTOLET BAY

Limestones of the Table Head Formation are extensively exposed north of Canada Bay to Pistolet Bay (Fig. 14). West of Hare Bay the autochthonous succession is practically flat-lying (Harris, 1962; Tuke, 1968). The intensity of deformation increases eastwards; the dominant structures are north-northeast trending open upright folds, disrupted by high-angle normal and reverse faults which strike in the same direction. The limestones are crystalline in places around Hare Bay, and metamorphosed to marble in places around Canada Bay. The limestones are overlain by an easterly-derived flysch deposit (Stevens, 1970) which is in turn structurally overlain by a tectonically emplaced klippe of sedimentary, volcanic and ultrabasic rocks (Rodgers and Neale, 1963; Tuke, 1968; Smyth, 1971).

Limestone deposits to the north of Canada Bay were first investigated by Cooper who stated that "there is plenty of limestone in the Hare Bay Area for use as building stone, crushed stone and agricultural lime" (Cooper, 1937, p. 32). Subsequent work, notably by Harris (1962), has borne out this conclusion and if the area were not so remote from larger centres of population it might have merited still more intensive investigation. Harris concluded that there are three commercially promising limestone deposits in the Hare Bay/Pistolet Bay area: Cook's Harbour vicinity, Burnt Island and Hare Island. A number of other deposits, while not so outstanding as the above, were also reported by Harris as being of some commercial interest.

Cook's Harbour

A deposit of Table Head Formation limestone which is particularly well-suited for quarrying is located just north of the community of Cook's Harbour (Harris, 1962, p. 71), though the rock unit is exposed throughout the area to the west of Pistolet Bay. Harris described the limestone to the north of Cook's Harbour as being medium to dark grey in colour with a brownish cast, and weathering to a medium grey colour. The stone is micro- to fine-crystalline, dense, hard and somewhat deformed and contorted. White calcite veins are abundant. Like much of the Table Head limestone, the rock has been intensely fractured by chemical and physical weathering processes to leave a rubbly zone of pebble- and cobble-size fragments which mantle the fresh stone beneath.

A 2O-foot section of the deposit north of Cook's Harbour was sampled by Harris (1962) and analyzed as follows:

CaO	53.1
MgO	1.1
SiO_2	2.1
R_2O_3	0.3

A chip sample collected about 2,000 feet to the west of the community analyzed as follows:

CaO	54.6
MgO	0.8
SiO_2	1.2
R_2O_3	0.3

Harris estimated that about six million tons of limestone were quarryable at the best site on the north side of Cook's Harbour, and further considered that perhaps two billion tons were quarryable between Cook's Harbour and the junction of the Cook's Harbour road with the road to St. Anthony. The whole area is accessible by sea, and Cook's Harbour is a particularly well-sheltered port.

Burnt Island

Burnt Island is situated west of the village of Raleigh on the east side of Pistolet Bay. The island is entirely underlain by Ordovician carbonate rocks. Tuke and Baird (1967, p. 5) indicated that the west half of the island is underlain by St. George Group beds, and the east half by Table Head limestone (Fig. 14). Harris (1962, p. 72) stated that the island is composed entirely of limestone, presumably of the Table Head Formation. The stone is similar to that of Cook's Harbour to the west, but is somewhat more highly metamorphosed and is folded in an open undulating style. Harris (1962) concluded that the upper 50 feet of the exposed section has "good commercial possibilities", and he described the composition of that unit as "53 per cent or more of CaO, about 1.0 per cent or less of MgO, and 2.0 per cent or less of impurities." He estimated that about 70 million tons could be quarried from the upper, higher-purity beds, while a total of about 400 million tons of quarryable stone are available on the island. Burnt Island is accessible by sea via a good harbour at Raleigh.

Hare Island

At Hare Island in western Hare Bay some 150 feet of limestone overlie 30 feet of interbedded dolomite and limestone (Harris, 1962, p. 73). The section is exposed on the eastern half of the island and is in fault contact with shales on the western half (Fig. 14). A chip sample collected by Harris from the south end of the island analyzed as follows:

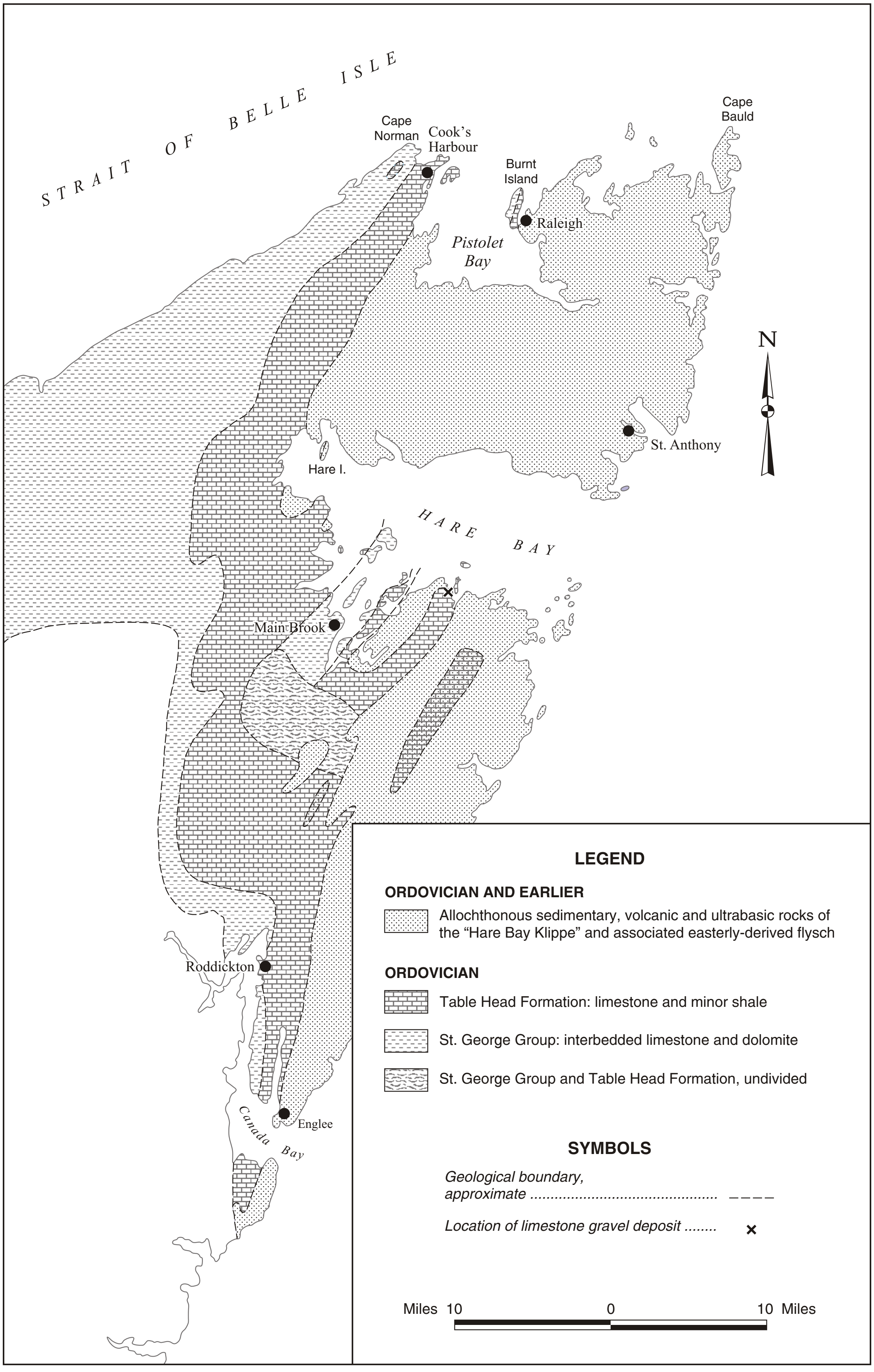

Figure 14. *Distribution of autochthonous carbonate rocks in the Hare Bay-Pistolet Bay area, Great Northern Peninsula. Geological Data derived from many sources, published and unpublished.*

CaO	54.1
MgO	0.6
SiO_2	1.1
R_2O_3	0.4

Harris estimated that about nine million tons of high-calcium stone could be quarried on the island.

Other Deposits

Limestone and dolomite are exposed around much of the shore of Hare Bay (Fig. 14). These deposits are generally low-lying and less pure than the prospects described above. Metamorphism and structural disruption of the deposits increase in intensity eastwards, and Harris (1962, pp. 73, 74) concluded that none of the deposits would be as good a prospect for commercial development (for the foreseeable future) as those described above. Practically any of the stone exposed around the bay might be suitable for local use as agricultural limestone.

At the most easterly coastal exposure of the Table Head limestone on the south shore of Hare Bay (Fig. 14), the rubbly weathered surface typical of that formation is developed to an extreme extent. Harris (1962, p. 75) described the deposit as follows:

> Wave action, apparently over an extended period of time, has created a gravel beach that rises at a steep angle to a height of 10 or 15 feet above sea level. The gravel then extends back several hundred feet where it disappears under a cover of moss and evergreen. The gravel is composed entirely of limestone pebbles with occasional mollusc shells. Sorting from layer to layer in the gravel modifies a general uniformity in pebble size. The gravel is in fact the rounded equivalent of the rubble produced by weathering of Table Head limestone.

Harris collected a representative grab sample of the deposit which analyzed as follows:

CaO	53.4
MgO	1.2
SiO_2	1.8
R_2O_3	0.3

He estimated that about 400,000 tons of the gravel could be removed from the site, which is close to a sheltered harbour. An additional 500,000 tons of consolidated limestone could be readily quarried. Harris reported that in the past, gravel from the deposit had been used as road-fill at St. Anthony.

ST. JOHN BAY TO COW HEAD

The autochthonous succession west of the Long Range Mountains underlies a broad plain extending inland for up to fifteen miles. Carbonate rocks of the Lower and Middle Ordovician St. George Group and Table Head Formation are widely exposed on the coast (Fig. 15). The rocks are flat-lying to gently southwest dipping, and are somewhat disrupted by normal faults related for the most part to the uplift of the Grenville "basement" which comprises the Long Range Mountains to the east (Cunming, 1967).

The St. George Group is composed mostly of dolomite and is not a good prospect for commercial limestone compared to the lower, massive limestone unit of the overlying Table Head Formation. A deposit of Table Head limestone on St. John Island is by far the best prospect in the area, but the unit is also favourably exposed at Table Point (location of the type section) near Bellburns, on the Point Riche Peninsula and at numerous other coastal localities. Wherever the massive limestone unit of the Table Head Formation is exposed on the coast, the weathered surface is overlain by a rubbly carpet of angular limestone pebbles and cobbles. In places, this zone has proved thick enough for use as a road metal.

The allochthonous succession, which is exposed in the south part of the area, consists mostly of clastic sediments, but includes coastal exposures of "Cow Head" type breccia. This rock unit contains thick sections of breccia consisting of chaotically oriented limestone boulders-which are very large in places-in a limestone matrix. Within a stratigraphic thickness of only about 1,000 feet (Kindle and Whittington, 1958), a time span from Middle Cambrian to Middle Ordovician is represented by an orderly faunal succession through successively younger conglomerate beds. The section is considered a reef-front stratigraphic equivalent of the autochthonous succession, deposited on the east side of the autochthonous Cambro-Ordovician carbonate bank before tectonic transport to its present position (Rodgers and Neale, 1963; Stevens, 1970). Commercially interesting deposits of Cow Head limestone breccias are located at Cow Head and at Broom Point a few miles to the south (Fig. 15).

Geological maps of parts of the area were prepared by Woodard (1957), Nelson (1955) and Oxley (1953) of the provincial Mines Branch. The most important academic study of the autochthonous succession in the area was undertaken by Schuchert and Dunbar (1934). The Cow Head breccias have been thoroughly described in papers by Kindle and Whittington (1958) and Baird (1960). Harris (1962) undertook an evaluation of the commercial possibilities of the limestone deposits of the area.

Table Head Limestone Deposits

St. John Island

The limestone deposits on St. John Island were investigated in considerable detail by Harris (1962, pp. 62-66). In this discussion, Harris's report is extensively quoted, although his presentation has been changed in places to conform to the style of this report.

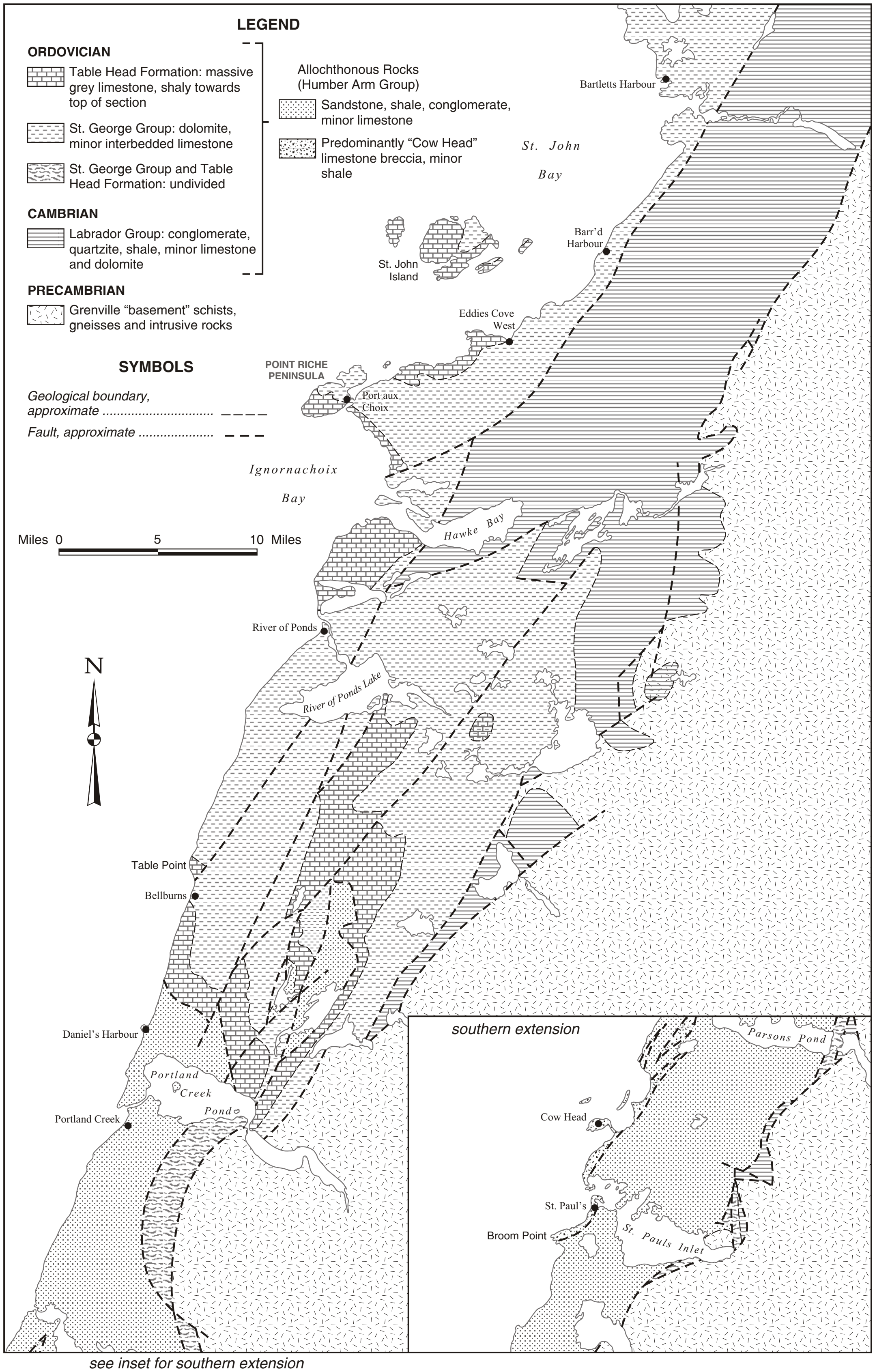

Figure 15. *Geologic sketch map of the Cow Head-St. John Bay area, emphasizing the autochthonous carbonate rocks. NOTE: Geological data derived from many sources, published and unpublished.*

St. John Island lies in St. John Bay, eight miles to the north of Port aux Choix. The island is low-lying, with a maximum elevation of 200 feet above sea level . Most of the island is underlain by Table Head limestone with a little St. George dolomite exposed on the northeastern shore. The best exposures of limestone occur at or near the coast. Inland, a large portion of the island is without vegetation and is commonly mantled with limestone rubble. There is an excellent 75-foot deep harbour on the south side of the island.

The Table Head limestone is in general brownish grey, weathering medium grey; medium-to thick-bedded; fossiliferous; medium hard to hard; fine- to medium-crystalline; and with an irregular fracture pattern which results in the stone physically weathering to a rubble. A black pyrobituminous or tarry material occurs along fractures in many places, sometimes in company with minor argillaceous material. The attitude of the beds varies from flat-lying to gently-dipping. The limestone on the island is, with minor exceptions, uniform in lithology throughout the section, with slight variations in colour, hardness, amounts of pyrobituminous matter present, and degree of fracturing.

The limestone readily breaks along existing fracture planes into discrete fragments ranging in size from **3** inch to 1 **2** inches across. The fracture planes are commonly lightly cemented with calcite which disintegrates on weathering, forming a limestone rubble. This fracture pattern enhances the commercial value of the rock for two reasons: firstly, the rock tends to break into fragments of roughly uniform size, a desirable attribute for commercial purposes, and the crushed material is relatively free of undesirable fines; secondly, the rock is ideally suited for use as road metal due to the tendency to fracture and weather into desirable particle sizes. The limestone rubble that mats the island in areas barren of vegetation provides a source of material that could be collected without the expense of blasting and crushing.

The western half of St. John Island is entirely underlain by limestone. Structurally, the limestone beds describe a gentle dome, such that no more than 100 feet of section occur near the surface over this half of the island. Continuous outcrop enabled a lateral tracing of beds so that nearly all of the limestone section was sampled. It is likely that a high-quality limestone could be quarried over most of this half of the island to a depth of about 100 feet, and reserves are accordingly estimated at 650 million tons. The results of laboratory tests indicate that the bulk of this is high-calcium limestone consistently low in impurities. An average analysis for the stone in this part of the island is as follows:

CaO	50.8
MgO	1.6
SiO_2	3.8
R_2O_3	0.6

To the southeast of St. John Harbour lies a neck of land on which occurs about a 1OO-foot thickness of limestone similar to that on the western portion of the island. Here again, conditions are highly favourable for quarrying, and about 60 million tons of stone can be recovered. The average of five analyses of the stone to the southeast of the harbour, representative of the entire section exposed there, is as follows:

CaO	49.0
MgO	2.1
SiO_2	3.0
R_2O_3	2.4

The northeastern portion of the island is less suitable for, quarrying. The St. George Group is exposed along the northern shore and contains about 30.3 per cent CaO, 19.4 per cent MgO and 2.4 per cent impurities. An estimated 1,300,000 tons of this rock could be quarried, along with at least one million tons of less magnesian limestone near the base of the Table Head section. This latter 2O-foot thick unit contains about 35.9 percent CaO, 15.8 percent MgO, and 2.3 percent impurities.

St. John Island is a comparatively good commercial prospect with reserves of high-calcium limestone in the order of 760 million tons, and over 2,300,000 tons of magnesian limestone. The cost of quarrying and handling the limestone would be low due to a light or absent soil and vegetation cover, the general lack of deformation of the beds, lateral and vertical uniformity of composition, and the conveniently developed fracture pattern. The isolated location and problems with sea-ice during the winter months could, however, hamper any large scale development of the resource.

Other Deposits

Table Head limestone is exposed extensively from Eddie's Cove West to around Bellburns (Fig. 15). While analytical data is scanty, the composition is probably much the same as that on St. John Island. At virtually all inland exposures the stone is covered by a rubble mat which has, in the past, been removed for road metal.

Harris (1962) estimated that at least 68 million tons of stone were quarryable in the immediate Port aux Choix area: 50 million tons were estimated to be available on the Pointe Riche Peninsula, and the balance close to the shore to the north and south of Port aux Choix.

No estimate of the amount of stone available from the Table Head Formation west of Eddie's Cove West is available, but analytical results on the few samples collected (Harris, 1962) indicated that the stone contains about 46 per cent CaO, 5 percent MgO, and 6 percent impurities. Table Head Limestone is also extensively exposed between Hawke Bay and River of Ponds, but there the ground is low-lying; and, compared to the good exposures of stone elsewhere on the coast, the quarrying possibilities are poor.

Finally, the Table Head Formation is exposed along the coast south of Bellburns. The composition is variable and the Table Head is magnesian limestone in places. Analyses of four samples considered by Harris (1962) to be representative of the stone are as follows:

	Sample 1	Sample 2	Sample 3	Sample 4
CaO	54.4	53.6	49.7	44.7
MgO	0.3	1.3	4.9	7.9
SiO_2	1.6	2.4	1.8	3.5
R_2O_3	0.6	0.2	0.3	0.6
L.O.I.	42.5	42.6	43.4	43.3

"Cow Head Breccia" Limestone Deposits

Limestone breccias of the allochthonous Cow Head Group were examined by Harris (1962) for their commercial possibilities. Bedded chaotic breccias are exposed primarily on the south shore of Cow Head. Harris collected six samples which are probably representative of the stone there. The average of these, along with the maximum and minimum values for each oxide determined, is as follows:

	Average	Minimum	Maximum
CaO	47.48	42.9	51.6
MgO	3.48	2.0	5.2
SiO_2	7.08	3.2	11.7
R_2O_3	0.67	0.4	1.3
L.O.I.	41.22	40.2	42.9

Harris (1962) estimated that about 35 million tons of stone at about the above average grade could be quarried on Cow Head. Cow Cove, to the south of the Head, is fairly deep and is sheltered from all but southwest winds.

A large tonnage of limestone from the same rock unit underlies Parson's Pond Hill some 22 miles south of the community of Parson's Pond. A representative sample collected by Harris at the roadside was analyzed:

CaO	47.3
MgO	2.0
SiO_2	10.6
R_2O_3	0.7
L.O.I.	39.1

Cow Head limestone breccia is exposed at a few other places on the coast (Fig. 15).

BONNE BAY (GROS MORNE NATIONAL PARK AREA)

A narrow belt of carbonate rocks is exposed between the Grenville "basement" gneisses which underlie the eastern part of the area, and allochthonous sediments and rocks of the ophiolite suite (mostly basic and ultrabasic rocks) which underlie the western part (Fig. 16). These St. George and Table Head carbonates are, for the most part, left unseparated on existing geological maps, and are exposed on the coast only at East Arm, Bonne Bay. In the allochthonous terrain, "Cow Head" limestone deposits are exposed on the coast at Broom Point. The area is included in maps by Troelson (1945), Johnson (1948), Baird (1959) and Cumming (in press). The St. George Group and Table Head Formation were mapped separately south of East Arm, Bonne Bay by Troelson (1945). Harris (1962) investigated carbonate deposits at Neddy Harbour and at Broom Point for their commercial possibilities.

Immediately northeast of Neddy Harbour, steeply-dipping carbonates of the Ordovician autochthonous succession are exposed. Most of the rock appears to be magnesian limestone with about 5 per cent impurities (Harris, 1962). A considerable tonnage of stone is quarryable there.

Broom Point, on the coast some three miles south of the community of St. Paul's, is underlain by steeply-dipping high-calcium and magnesian limestone of the allochthonous Cow Head Group. Some 600,000 tons of stone could be quarried (Harris, 1962). A high proportion of impurities in some parts of the section is accounted for by chert and shale interbeds.

BAY OF ISLANDS TO ST. GEORGE'S BAY

The area between Bay of Islands and St. George's Bay is extensively underlain by carbonate rocks of the St. George Group and Table Head Formation (Fig. 17). It is in this area and on the Port au Port Peninsula that limestone comprises a commercially interesting part of the St. George section: of the five limestone quarries operating or known to have been operating in the Corner Brook area, (Fig. 18), four are located in the St. George Group.

Parts of the area have been included in Geological Survey of Canada maps by Riley (1957, 1962) and Baird (1959). Walthier (1949) mapped the area between Corner Brook and Stephenville for the Geological Survey of Newfoundland. The carbonate deposits around Corner Brook have been discussed in some detail in unpublished reports by Merrill (1557), McKillop (1963) and Lilly (1963).

The St. George Group in the Corner Brook area has been informally divided into two formations: a lower dolomitic unit and an upper unit in which limestone predominates (Table No. 6). Merrill (1957) assigned the name St. George (formation) to the lower, dolomitic section and referred to the upper calcitic unit as the Marble Head (formation). McKillop (1963) measured the St. George Group section south of the Humber River. By mutual agreement, he

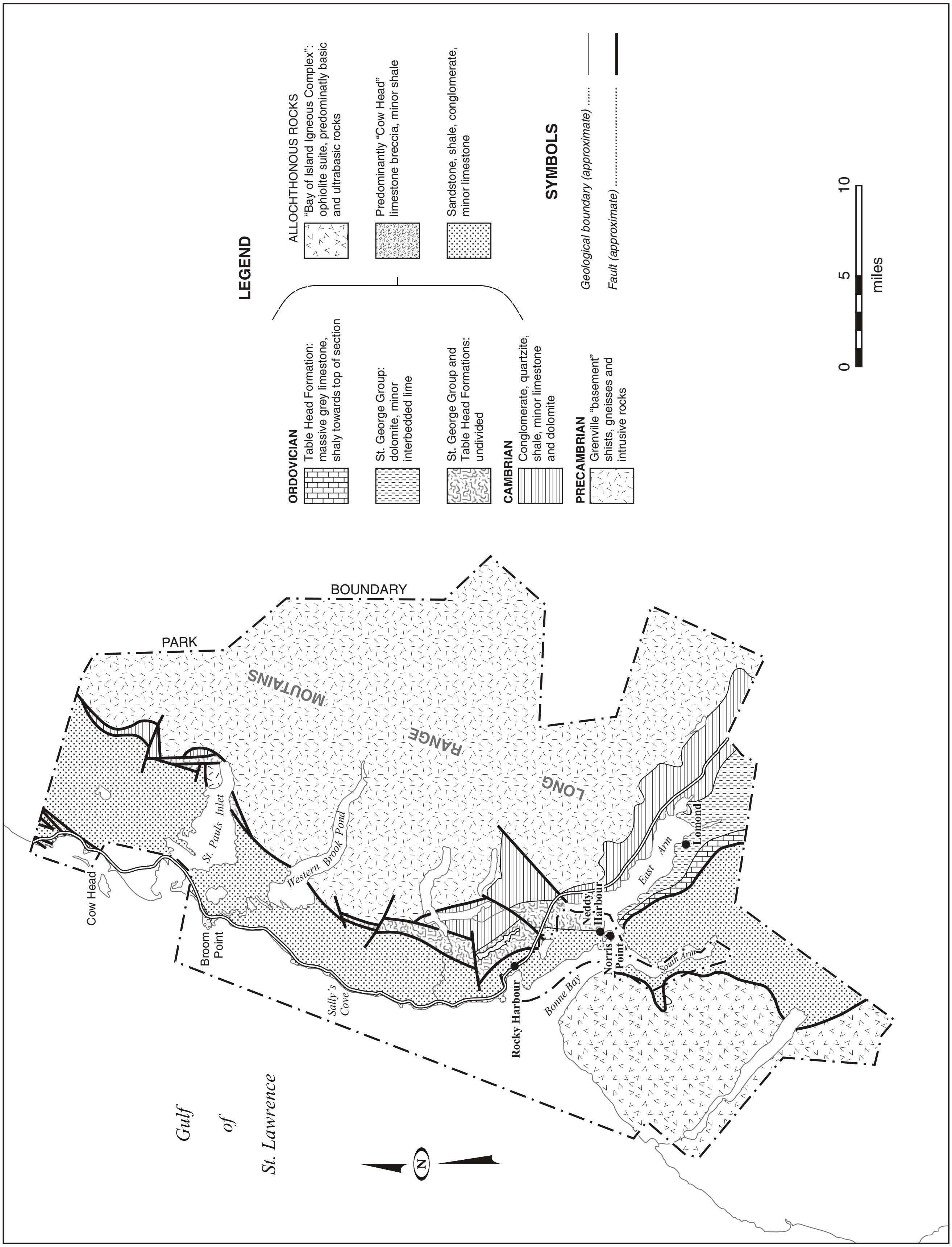

Figure 16. *Geology of the Gros Morne National Park area, emphasizing the autochthonous carbonate rocks. Sources: Baird, 1959; Troelson, 1945.*

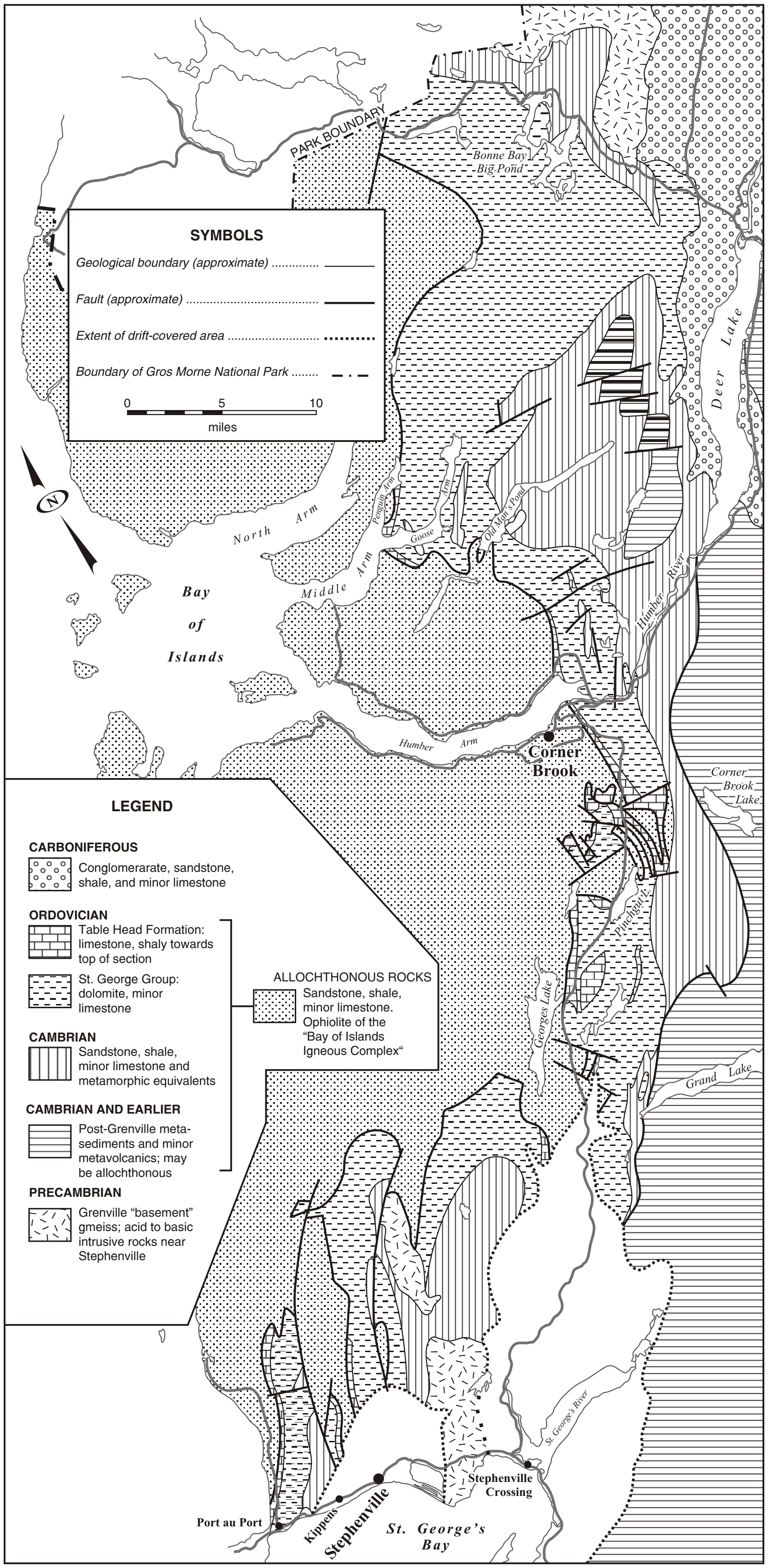

Figure 17. *Geology of the Bay of Islands - St. George's Bay area, emphasizing the autochthonous carbonate rocks. Sources: Walthier, 1949; Baird, 1959; Riley, 1962.*

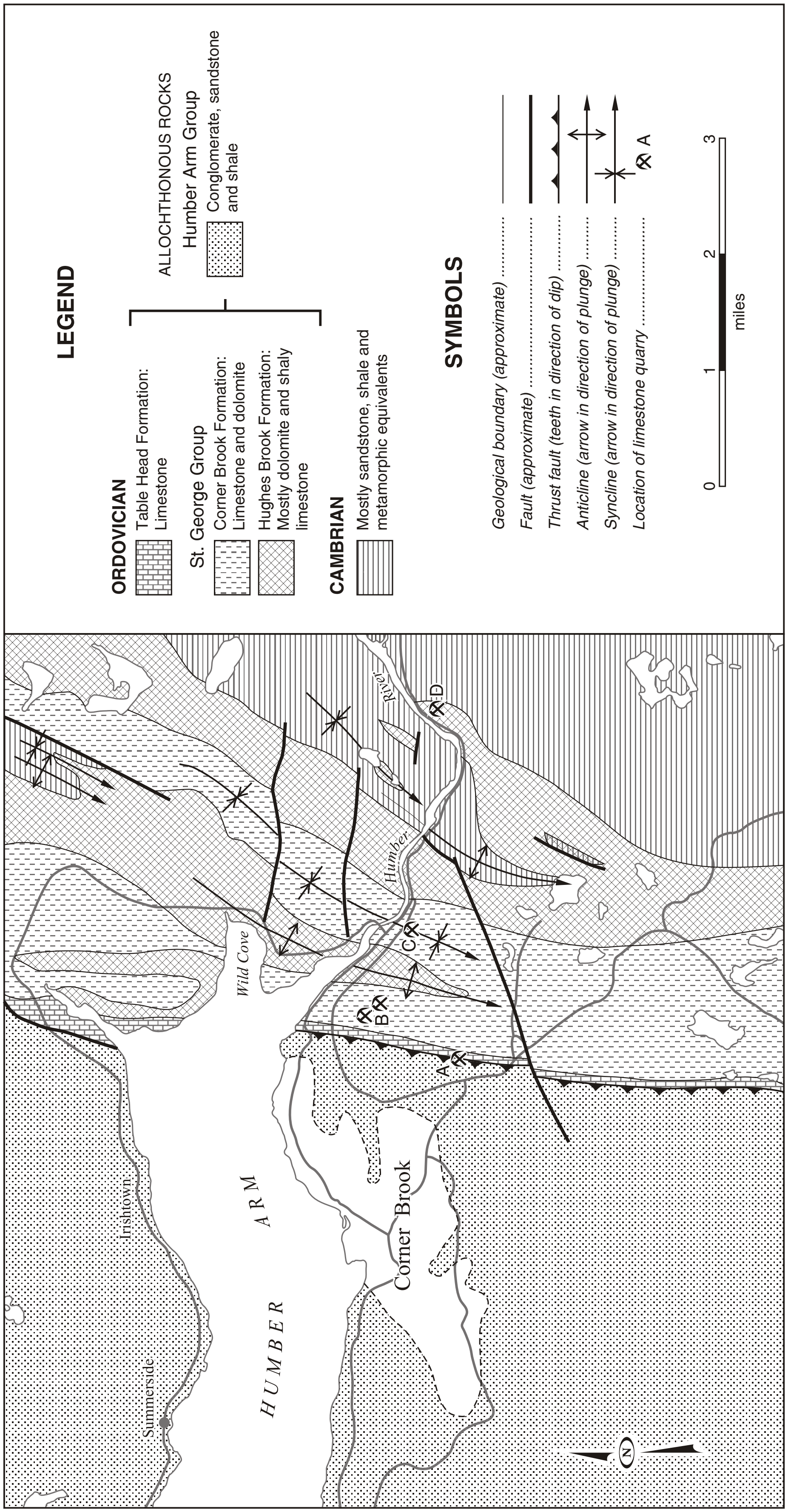

Figure 18. *Geology of the Corner Brook area, emphasizing the autochthonous carbonate rocks and showing the locations of limestone quarries. A - Dormston Quarry; B - North Star Cement Quarries; C - Leonard House Quarry; D - Limestone Junction Quarry. Sources: McKillop, 1963; Lilly, 1963.*

TABLE 6: AUTOCHTHONOUS CARBONATE SUCCESSION IN THE CORNER BROOK AREA AS MEASURED BY MERRILL (1957) AND MCKILLOP (1963), EMPHASIZING THE ST. GEORGE GROUP

Period	Group	Formation	Merrill (1957) North of Humber River	T, ft.	McKillop (1963) South of Humber River	T, ft.
ORDOVICIAN			Table Head Group: Marble, dark grey; siliceous and magnesian towards bottom of section	600	Table Head Group: Marble, dark grey; siliceous and magnesian towards bottom of section	600
	ST. GEORGE GROUP		Section not measured		Dolostone and calcitic marble	270
		Marble Head Lst.	Dark grey to black, massive medium-crystalline limestone interbedded with thin, very finely crystalline dolomitic limestone and dolomite	1,250	Marble and dolostone	175
					High-calcium marble	140
					Dominantly grey marble; local beds strongly dolomitic	675
					High-calcium marble	75
					Marble and dolostone interbedded	388
		George dolomite	Dolomite, limy, dark-grey to pink, mottled red, many laminated beds, medium-bedded; brecciated beds; chert in lower part	326	Finely crystalline to aphanitic, well-stratified dolostone with varying amounts of silica which is mainly in the form of chert	2,550
			Dolomite, grey, very finely crystalline, medium-bedded, inter-bedded with sericitic to sandy dolomite; brecciated	973		
			Dolomite, white to grey, mottled red, medium-bedded, very finely crystalline; brecciated beds; sandy and cherty in lower part	234		
			Dolomite, grey to pink, mottled red, medium- to thick-bedded, very finely crystalline, brecciated beds; sandy with scattered oolites and pyrite crystals in lower part	987		
			Total St. George Group	3,770+		4,223

and Lilly (1963) referred to the lower part as the "Hughes Brook Formation", and to the upper part as the "Corner Brook Formation". McKillop pointed out that Merrill's type section north of the Humber River is incomplete, the upper part of the Marble Head limestone being absent; and that in any case his nomenclature was potentially confusing. Although it is an informal division, McKillop's (1963) separation of the St. George Group into the Hughes Brook and Corner Brook Formations is handy and widely used in the Humber Arm area, and this writer will use it as well.

It is emphasized, however, that the division is probably not valid in the St. George Group elsewhere.

Deposits in the St. George Group

The St. George Group is widely exposed in the Bay of Islands-St. George's Bay area. High-calcium units in the Corner Brook area are extensive along strike and prospecting the St. George for limestone, should the need arise, would be more advisable than in areas farther north.

Limestone Junction Quarry, Corner Brook

Between 1925 and 1943, Bowaters (Nfld.) Pulp and Paper Company obtained most of the limestone needed for their operation from the Limestone Junction Quarry, which is located at the base of a 300-foot cliff some four miles east of Corner Brook on the south side of the Trans-Canada Highway (Fig. 18). The stone is white, pink and cream, crystalline magnesian limestone of the Hughes Brook Formation. A grab sample collected by the writer analyzed as follows:

CaO	42.41
MgO	10.75
SiO_2	2.07
Fe_2O_3	0.03
Al_2O_3	0.11
S	0.03

The average annual production from the quarry was 6,500 tons. The extreme proximity of the operation to the railroad and highway, along with the difficulty in quarrying into the high and badly fractured rock face, led Bowaters to abandon Limestone Junction in favour of the Dormston Quarry nearby.

North Star Cement Quarries 1 & 2, Corner Brook

North Star Cement Company Limited operates two limestone quarries south of Humber Arm in the Corner Brook Formation (Fig. 18). Quarry No. 1 is in the upper, and quarry No. 2 in the lower high-calcium marble unit (McKillop, 1963, and Table No. 6). The St. George Group in that area dips at about 60° to the west, and this has made quarrying somewhat difficult. Limestone was first removed from the quarries in 1952 and since then about 100,000 tons per year have been extracted. The approximate average chemical composition of the stone from each quarry is as follows (McKillop, 1963):

	Quarry No. 1 (West)	Quarry No. 2 (East)
CaO	52.5	54.5
MgO	1.9	1.0
SiO_2	1.8	2.0
R_2O_3	0.5	0.1

At the time of writing these quarries are within a very few years of being abandoned, as most of the easily recoverable stone has been removed. North Star Cement Company Limited is planning to open a new quarry to the east of the existing two and west of the Leonard House Quarry.

Leonard House Quarry, Corner Brook

The Leonard House Quarry is located at the south side of the Trans Canada Highway about a mile east of the North Star Cement Quarries (Fig. 18). It was opened in about 1964 by Mr. Leonard House of Stephenville Crossing and produced some 70 tons of crushed stone per day, which was used as a raw material by the Bowaters Pulp and Paper mill in Corner Brook. The chemical composition of the stone is not known except to say that it is a high-calcium limestone similar to that in the Corner Brook Formation elsewhere in the area. The stone was obtained from the upper part of the Corner Brook Formation close to the axial plane of a north-south trending syncline. The stone at the Leonard House quarry may in fact be stratigraphically equivalent to one of the high-calcium marble units described by McKillop (1963).

Area North of Humber River

Merrill (1957) undertook a fairly detailed evaluation of St. George Group deposits extending up to 1 1?4 miles north of Humber River (Fig. 18). His results were consistent with those of McKillop (1962) in that the Hughes Brook Formation north of the river is a magnesian limestone for the most part, while the Corner Brook Formation is relatively high-calcium. The average chemical compositions of the units are as follows (after Merrill, 1957, p. 78):

	Corner Brook Formation (270 samples)	Hughes Brook Formation (335 samples)
CaO	48.66	33.52
MgO	4.62	16.80
SiO_2	3.87	5.02
R_2O_3	0.82	1.25
L.O.I.	42.27	43.59

The rocks are steeply-dipping (except close to the axes of folds in the area) and the local topography is very rugged. Both factors would conspire to make quarrying difficult, though very, large tonnages of stone are available.

Deposits in the Table Head Formation

Like the St. George Group, the Table Head Formation is widely exposed in the Bay of Islands-St. George's Bay area: in particular, at or near the shore of Penguin Arm, Bay of Islands; at Corner Brook and at Port au Port. Table Head limestone is also exposed at a number of places close to the Trans-Canada Highway in the George's Lake-Pinchgut Lake area (Fig. 17). For the most part, the beds are steeply dipping.

Dormston Quarry, Corner Brook

The Dormston Quarry is situated close to the Trans-Canada Highway about a mile southwest of the North Star Cement Quarries (Fig. 18). The quarry was operated by Bowaters (Nfld.) Pulp and Paper Limited from 1943 to 1956, the stone (15,000-20,000 tons annually) being used for the manufacture of sulphite pulp. Some 10,000 additional tons of stone were used annually, mostly for road metal and concrete aggregate. Since 1956, stone has been removed at various times for use as fill at the waterfront in Corner Brook and for municipal construction purposes.

The beds of the Table Head Formation at the Dormston Quarry strike north-south and dip 60° to the west. The stone is exposed in a steep hillside which parallels the strike of the beds, and this has made quarrying somewhat difficult. The quarry face (more or less a single bedding plane) is over 300 feet high. The Table Head limestone at the quarry is dark grey to black, fine- to medium-grained and crystalline. Most of the beds, which are generally two to three feet thick, have anastomosing dark grey shaly or dolomitic laminae. Walthier (1949, p. 44) considered the stone to be "highly commendable as a building and ornamental stone ... the marble takes a good polish giving the rock an attractive bluish cast". Joint sets which transect the bedding (the joints being generally one to two feet apart, and in places cemented by calcite) would restrict the size of the blocks which could be quarried. Chemically, the stone is similar to Table Head limestone elsewhere in western Newfoundland, but is relatively high in MgO and other impurities (McKillop, unpublished ms., 1962).

North of Port au Port

Table Head limestone is exposed on the face of a hillside extending from the shore just north of Port au Port in a north-northeasterly direction inland to a point east of Fox Island River, where it has been removed by faulting (Fig. 17 and Map 3 in map jacket). Lee (1956) and Besaw (1972) have investigated this deposit from an economic standpoint.

The Table Head Formation north of Port au Port dips to the west at close to 30` and is exposed on a bare hillside which itself slopes seaward at almost 30° in places. Besaw (1972) collected for analysis seven samples of limestone representative of the section on the shore, and an additional five samples from up to a mile inland along strike. A summary of the analytical results is as follows:

	SS Max.	SS Min.	SS Aver.	SI Aver. (12 samples)
CaO ± 5%	53.0	41.0	50.0	50.0
MgO ± 5%	5.0	-	1.0	1.0
SiO_2	9.97	0.51	2.56	2.02
Fe_2O_3	1.01	0.04	0.23	0.17
Al_2O_3	0.91	0.09	0.40	0.38
S	0.14	0.04	0.06	0.06

SS - Shoreline Samples
SI - Shoreline + Inland Samples

Sampling by Lee (1956) indicated that the stone may be somewhat less pure to the north. Sets of chip samples collected on the south and north walls of a stream-cut gorge west of Black Point assayed 89.42 and 72.26 per cent $CaCO_3$ respectively. As much as 200,000,000 tons of stone may be quarryable north of Port au Port.

PORT AU PORT PENINSULA

The Port au Port Peninsula is extensively underlain by carbonate rocks and is the most commercially attractive area in the province so far as limestone resources are concerned. In addition to the Table Head limestone much of the St. George Group section on the peninsula is limestone, and neoautochthonous limestones of the Long Point Group are exposed as well (Map 3). In particular, the St. George Group north of Lower Cove contains vast reserves of extremely pure and extremely high-calcium stone.

The carbonate succession on the Port au Port Peninsula was first described by Schuchert and Dunbar (1934) and subsequently redescribed by Sullivan (1940), Riley (1962) and Besaw (1972, 1973b). Geologic maps of the Port au Port Peninsula have been prepared by Sullivan (1940), Riley (1962) and Besaw (1973b). Besaw divided the St. George Group on the Port au Port Peninsula into five informal lithostratigraphic units as outlined in Table No. 7 and on Map 3. Limestone deposits on the Port au Port Peninsula have been the subject of reports by Lee (l956), Carr (1958), Gillis (1961), Besaw (1972, 1973b) and DeGrace (1972, 1973).

Three limestone quarries have been operated in the Aguathuna (Map 3). The Dominion Limestone Division of Dominion Steel and Coal Corporation (DOSCO) operated two limestone quarries in the Table Head Formation and one in the White Hills unit of the St. George Group. The stone was shipped to Sydney, Nova Scotia, where most of it was used as flux in the steel-making process. Quarrying was begun in 1913 and carried on, with the exception of the years 1915, 1925, 1932 and 1933, until 1965, when DOSCO opted to obtain its limestone input from Cape Breton Island and closed the quarries. In all, more than 10 million tons of stone were shipped from the DOSCO quarries, an average of over 250,000 tons per year.

TABLE 7: TABLE OF FORMATIONS FOR AUTOCHTHONOUS CARBONATE SUCCESSION ON THE PORT AU PORT PENINSULA

NOTE: THICKNESSES ASSIGNED TO THE INFORMAL UNITS OF THE ST. GEORGE GROUP APPLY TO THE AGUATHUNA AREA, AND ARE DIFFERENT ELSEWHERE

SOURCE: Besaw, 1972

AGE	NAME		LITHOLOGY	THICKNESS (feet)
MIDDLE ORDOVICIAN	TABLE HEAD FORMATION		720 feet of uniformly massive, thick-bedded, grey limestone, weathering to rubble; overlain by alternating limestone and black shale, becoming thinner-bedded and shalier towards top section	813
			UNCONFORMITY	
		Port au Port unit	Interbedded red, green and grey dolomite, grey limestone, minor shale	166
LOWER ORDOVICIAN	ST. GEORGE GROUP	White Hills unit	Very pale buff, nearly massive calcilutite	50+ (150,N. of Lower Cove)
LOWER ORDOVICIAN	ST. GEORGE GROUP	Pine Tree unit	Massive dark- to light-grey weathering, buff to brown coarse dolarenite; well developed burrow anastomosis in places; minor chert	250±
LOWER ORDOVICIAN	ST. GEORGE GROUP	Pigeon Head unit	Grey-weathering limestone, thin- to thick-bedded; minor limestone breccia beds	137
LOWER ORDOVICIAN	ST. GEORGE GROUP	Lower Cove unit	Interbedded dolomite, shaly dolomite, limestone, shaly limestone; weathers buff, light grey and brown; minor sandstone	900+
		BASAL BEDS UNEXPOSED		

The East Quarry in the Table Head Formation was opened in 1913 and was closed in 1956 because the east-west oriented quarry face proved unstable. The Table Head beds dip north at about 20° at the quarry, and there had been a history of frequent rock falls resulting from slippage along bedding planes. Subsequently, most of the stone quarried was removed from a new north-south quarry face developed on the west side of the West Quarry. The quarrying procedure was described in some detail by Gillis (1961). Gillis stated that a typical analysis of the stone from the Table Head quarries was as follows:

CaO	51.82
MgO	1.95
SiO_2	1.76
R_2O_3	1.10
L.O.I.	43.22

Since the unconformity separating the St. George and Table Head is exposed in the face of the West Quarry, it is probable that some St. George limestone and dolomite (Port au Port unit) was quarried as well as Table Head limestone; and that the analysis is not, therefore, an altogether accurate reflection of the purest stone available there.

The Brook Quarry is located in the White Hills unit of the St. George Group south of the West Quarry (Map 3). It was opened by DOSCO towards the end of their operation, to supplement the stone being removed from the West Quarry. Lundrigan's Ltd. of Corner Brook reopened the quarry during part of 1969 and removed some 175,000 tons of stone which was crushed and stockpiled for use in Sea Mining Corporation's seawater magnesia manufacturing plant nearby. No product was shipped from the plant, which was never entirely completed, and which closed the same year because of corporate difficulties. Much of the stockpiled limestone was used in 1973 as a raw material for linerboard manufacture by Labrador Linerboard Limited of Stephenville, about ten miles to the east. The average chemical composition of the stone which was removed from the Brook Quarry and stockpiled is as follows (James Cochrane, 1973, pers. comm.):

CaO	50.33
MgO	3.9
SiO_2 + insol.	1.18
R_2O_3	4.84
L.O.I.	43.26

This is somewhat less pure than the White Hills unit immediately along strike to the west because some of the overlying and underlying dolomitic rock units were quarried as well.

From the point of view of quarrying limestone for export markets, the Port au Port Peninsula is well-situated. St. George's Bay is deep enough to accommodate large ships and is virtually ice-free. Port au Port Bay, on the other hand, is not over 30 feet deep and is much shallower than that in many places. In addition, the bay acts as a "catch-basin" for ice drifting southwards during cold winters and is not, therefore, a potential year-round port. The road system on the peninsula is well-developed.

As positive factors in considering limestone on the Peninsula for portland cement manufacture, shale and sandstone are available in abundance from the Humber Arm Group, exposed in the West Bay-Lourdes (Map 3); and gypsum, in addition to being exposed west of Boswarlos and at the mouth of Romaines Brook, is available from existing quarries at Flat Bay.

Deposits in the St. George Group

Pigeon Head Unit

The Pigeon Head unit (Table No. 7 and Map 3) is exposed between Aguathuna and Cape St. George. It strikes roughly east-west and dips to the north at between 10` in the west, and 20` in the east at Aguathuna. The unit is 137 feet thick in the eastern part of the Peninsula (Besaw, 1972) and seems to be about the same thickness to the west. Besaw (1972, 1973b) collected 23 grab samples of Pigeon Head limestone from various localities on the Peninsula. A summary of his analytical results is as follows:

	Maximum	Minimum	Average
CaO	53.0	44.0	49.14
MgO	6.0	tr	3.20
SiO_2	3.99	1.41	2.43
Fe_2O_3	0.39	tr.	0.15
Al_2O_3	1.91	0.15	0.46
S	0.10	0.01	0.03

Besaw (1972) considered two areas underlain by the Pigeon Head unit to be particularly suitable for quarrying. North of Campbell's Creek, the Pigeon Head unit is in part exposed in a vertical east-west trending, south facing cliff (Map 3, area 1). The area is about a mile from the existing road. No chemical data are available for rocks from the immediate vicinity, but the composition is probably about the same as for the Pigeon Head unit elsewhere.

The Pigeon Head unit is exposed between Lower Cove and Sheaves Cove (Map 3, area 2); the stone dips to the north at about 10° and is a 50- to 100-foot cliff-face in places (Map 3). Overburden is practically absent, and the area is accessible by road and by sea, Lower Cove being a deep-water (if not very well-sheltered) harbour. The analytical data presented above is representative of the chemistry of the rock unit in the area. Besaw (1973, pers. conm.) estimated that over 700,000,000 tons of Pigeon Head limestone could be quarried in the Lower Cove-Sheaves Cove area.

White Hills Unit

Limestone of the White Hills unit is, in places, extraordinarily pure and chemically homogeneous, on the basis of analytical data available to date (DeGrace, 1972; Besaw, 1972, 1973b). The stone is nearly massive, pale buff calcilutite, the unit being about 40 feet thick north of Port au Port, 50 feet thick near Aguathuna, and up to 150 feet thick northwest of Sheaves Cove.

In the Aguathuna area (Map 3, area 3), the White Hills unit has been explored by diamond drilling, by DOSCO and by Canadian Refractories Limited as well as by the Mineral Development Division (DeGrace, 1972, 1973). DeGrace (1972) investigated the White Hills unit there in detail. Twenty-three boreholes were drilled at l00-foot intervals along strike on a 4,000-foot east-west base line west of the Brook Quarry. Alternating two-foot intervals of the core obtained were analyzed by X-ray fluorescence. In all, slightly over 500,000 tons of the unit, which dips to the north at about 18° were outlined for the eastern 2,000 feet of the base line (as far west as Gillam's Brook). The average chemical composition of the stone is as follows:

CaO	52.48
MgO	2.19
SiO_2	0.66
Fe_2O_3	0.07
Al_2O_3	0.22
S	0.03

Beneficiation testing done at the Atlantic Industrial Research Institute (DeGrace, 1972) indicated that with little loss of input material, a calcined product could be obtained which, when recalculated to the original limestone, contained almost 30 per cent less silica. The procedure involves calcining the stone, slaking the product and wet-sieving it, and discarding the plus 325 mesh fraction.

By means of macroscopic observation combined with statistical analysis DeGrace (1973) showed that about 0.2 of the 0.7 percent average SiO_2 content of the stone is free quartz, the balance being assigned to mineral glauconite and to minor mud. Similarly, about 0.03 of the 0.07 per cent Fe_2O_3 appears to be the mineral hematite, the balance being "tied up" in glauconite and mud. Fong (1973, pers. comm.) also observed carbonaceous material on some styolites in thin section and DeGrace (1972) recorded the presence of very minor possible sphalerite.

The quarryable tonnage can be increased to over 2.5 million tons with not much loss in grade, by diluting the White Hills unit limestone with stone quarried from the overlying and underlying units, and with Table Head limestone exposed to the north. The Brook Quarry provides an existing quarry face in the White Hills unit at Aguathuna. Overburden on the deposit is scanty, never exceeding two feet in thickness.

Besaw (1972, 1973b) investigated the White Hills unit north and west of Sheaves Cove (Map 3, area 4). In this area, the stone is extremely pure on the basis of analytical results available to date. Besaw collected eight grab samples from the unit in 1972, and the analytical results (by X-ray fluorescence) are summarized as follows:

	Maximum	Minimum	Average
Ca0 ± 5%	52.0	49.0	51.0
Mg0 ± 5%	2.0	n.d.	0.5
SiO_2	0.45	0.30	0.38
Fe_2O_3	0.07	0.03	0.04
Al_2O_3	0.16	0.09	0.11
S	0.04	0.03	0.03

In 1973, Besaw collected 88 samples from the White Hills unit in the area, along several traverse lines across strike to ensure representative sampling of the limestone section. Sample freshness was ensured by collecting only unweathered specimens, obtained by blasting with dynamite placed in open fractures in the rock. The analytical results presented below were obtained by the X-ray fluorescence method, with the exception of MgO values which were determined by atomic absorption because of the low concentrations involved:

	Maximum	Minimum	Average
CaO	55.96	53.59	55.13
MgO	0.28	0.10	0.18
SiO_2	0.64	n.d.	0.07
Fe_2O_3	0.27	n.d.	0.03
Al_2O_3	0.30	n.d.	0.04
S	0.08	n.d.	0.01

Eleven specimens representative of the same unit (Map 3, area 4) were re-analyzed by wet-chemical techniques, and the results are summarized as follows:

	Maximum	Minimum	Average
CaO	55.8	55.4	55.55
MgO	0.30	0.16	0.20
SiO_2	0.33	0.13	0.21
Fe_2O_3	0.04	0.01	0.02
Al_2O_3	0.13	0.03	0.07
S	0.05	nil	0.01

The writer has more confidence that these results are representative of the White Hills unit north of Sheaves Cove than he has in the results obtained by X-ray fluorescence, which evidently were incorrect for SiO_2, Fe_2O_3 and Al_2O_3. In any case, the amount of impurities in the rock is in fact, very small.

North of Sheaves Cove, the White Hills unit dips to the north at about 10°. Overburden is practically non-existent. The area can be approached by a rough track from Lower Cove, but is not otherwise readily accessible. The writer estimates that over 300,000,000 tons of high-purity, high-calcium limestone can be quarried in the area from the

White Hills unit above (allowing for an average quarrying depth of 75 feet).

Other Deposits

West of Marches Point the St. George Group undergoes a lithofacies change (Map 3). The section, though not yet described in detail, appears to be predominantly limestone with dolomite beds scattered throughout (Besaw, 1973b). Besaw collected twenty-three samples representative of the undivided St. George Group on two traverse lines across strike, in a stratigraphic position equivalent to that of the White Hills unit (Map 3, area 5). The sampling procedure was as outlined above for the White Hills unit. The samples were analyzed by X-ray fluorescence, the MgO determinations being made by atomic absorption (as indicated above). Three of the samples were magnesian limestone containing about 16 per cent MgO. These would seem to represent rare dolomitic beds in the section. The remaining twenty samples were of fairly uniform composition, and the analytical results on them are summarized as follows:

	Maximum	Minimum	Average
CaO	55.50	46.49	52.80
MgO	2.9	0.17	0.58
SiO_2	6.24	n.d.	1.95
Fe_2O_3	0.47	0.01	0.13
Al_2O_3	1.56	n.d.	0.27
S	0.03	0.01	0.02

While the stone does not seem to be as chemically pure as that in the White Hills unit to the east, it is nevertheless a fairly high-purity, high-calcium limestone. From a quarrying standpoint, the area is attractive despite its inaccessibility compared to other parts of the peninsula. Overburden is virtually absent, and the stone dips at between zero and 23` north. The writer estimates that the area sampled is representative of over 200,000,000 tons of stone, allowing for an average quarrying depth of 100 feet. Bearing in mind that limestone seems to predominate in this undivided part of the St. George Group, it may be that further investigation will reveal much larger tonnages of high-purity limestone which could be quarried.

Deposits in the Table Head Formation

Aguathuna-Boswarlos Area

In the immediate vicinity of the East and West Quarries (Map 3, area 6), the amount of Table Head limestone still quarryable probably does not exceed a few hundred thousand tons. The chemistry of the Table Head south of the West Quarry is fairly well known as the result of exploration by DOSCO. Besaw (1973, pers. comm.) supplied the writer with an average Table Head limestone analysis south of the quarry based on the results from several diamond drill holes:

CaO	51.88
MgO	2.20
SiO_2	1.64
R_2O_3	1.05
L.O.I.	42.39

This would seem to be a reasonable approximation of the composition of the stone throughout the area of the quarries, though in some areas, particularly to the west of the West Quarry, analysis of diamond-drill core has shown the purity to be somewhat higher with at least a million tons of stone quarryable.

Lee (1956) sampled the Table Head limestone where it is exposed in fault controlled steep-walled valleys between Aguathuna and Boswarlos. Four of these north-south trending "canyons" were investigated west of the West Quarry. No systematic change in the composition of the Table Head limestone was discovered along strike; the analyses ranged between 91.98 and 98.16 per cent $CaCO_3$ with the eleven samples averaging 95.38 per cent $CaCO_3$.

Piccadilly Area

West of the community of Piccadilly, Table Head limestone is exposed in a number of high-angle fault blocks (Map 3, area 7). The beds dip to the north at about 10°, and the stone is exposed in several places along fault line scarps, forming cliffs up to 100 feet high.

Little chemical data is available on the stone at Piccadilly but it is probably chemically similar to the Table Head limestone elsewhere in the area. Lee (1956) reported an analysis of Table Head limestone from an unspecified location at Piccadilly:

$CaCO_3$	93.60
$MgCO_3$	3.29
Fe + Al	3.00
acid insoluble	0.53
L.O.I.	42.45

Besaw (1973b) collected six unweathered samples from the Table Head limestone in the community, the analytical results being summarized as follows:

	Maximum	Minimum	Average
CaO	54.82	52.81	53.75
MgO	1.36	0.38	0.82
SiO_2	0.85	0.40	0.70
Fe_2O_3	0.28	0.05	0.12
Al_2O_3	0.38	0.06	0.28
S	0.06	0.03	0.05

As is the case with some analyses reported above for the White Hills unit, the results obtained for SiO_2, Fe_2O_3, and

Table 8. Results of chemical analysis of samples collected from the Long Point Group, Port au Port Peninsula. SOURCE: Besaw, 1972.

Bed No. (Riley, 1962) and lithology	No. of samples	CaO ±5%	MgO ±5%	SiO_2	Fe_2O_3	Al_2O_3	S
3. (170 ft.)							
Shaly, sandy	4	32	9	15.59	1.46	3.33	0.21
limestone and		33	9	13.85	1.34	2.87	0.19
interbedded		47	3	3.11	0.50	1.84	0.16
shale		41	5	8.22	1.01	2.40	0.24
2: (240 ft.) Thin-bedded, knobbly, coarse grained, light grey and brownish limestones	1	51	1	0.79	0.22	0.19	0.9
3: (180 ft.) Thick-bedded, massive, grey limestone; A few greenish grey shaly	2	51	1	0.78	0.13	0.31	0.11
layers		52	1	1.54	0.24	0.73	0.04

Al_2O_3 were suspect at the time of writing and may be higher than stated here.

Besaw (1973b) stated that as much as 400,000,000 tons of Table Head limestone could be removed from the area, allowing for an average quarrying depth of 150 feet. Structural complications in the area may, however, make much of this stone practically inaccessible.

Other Deposits

The Table Head Formation is widely exposed south of the community of Lourdes and west as far as Mainland. No chemical data are available on the stone; tonnages available are huge. In the vicinity of Mainland (Map 3) the Table Head Formation thickens considerably and is overlain successively by limestone conglomerate and by easterly derived flysch deposits related to the westerly transport of the allochthonous Humber Arm Group (Stevens, 1970).

Deposits in the Long Point Group

Neoautochthonous limestones of the Middle Ordovician Long Point Group are exposed on the east side of Long Point and between the communities of Lourdes and Three Rock Cove (Map 3). On Long Point the beds dip to the northwest at between 30° and 45° and to the southwest they are steeply-dipping to overturned. The stratigraphic section has been described by Riley (1962).

Besaw (1972) collected a number of samples representative of the bottom three beds of the Long Point Group (Riley, 1962) between Lourdes and Black Duck Brook. The analytical results on his samples are shown in Table No. 8. No tonnage estimates have been made.

ST. GEORGE'S BAY AND DEER LAKE AREA- DEPOSITS IN ROCKS OF CARBONIFEROUS AGE

The youngest rocks in Newfoundland are marine and subaerial sedimentary cover rocks of Carboniferous age. These are exposed in widely scattered localities on the island, but are the predominant rock type on the west side of St. George's Bay and north of Grand Lake (Fig. 19). The rocks are, for the most part, unmetamorphosed, and are deformed into open, upright folds in places. At White Bay, the beds are steeply-dipping to vertical.

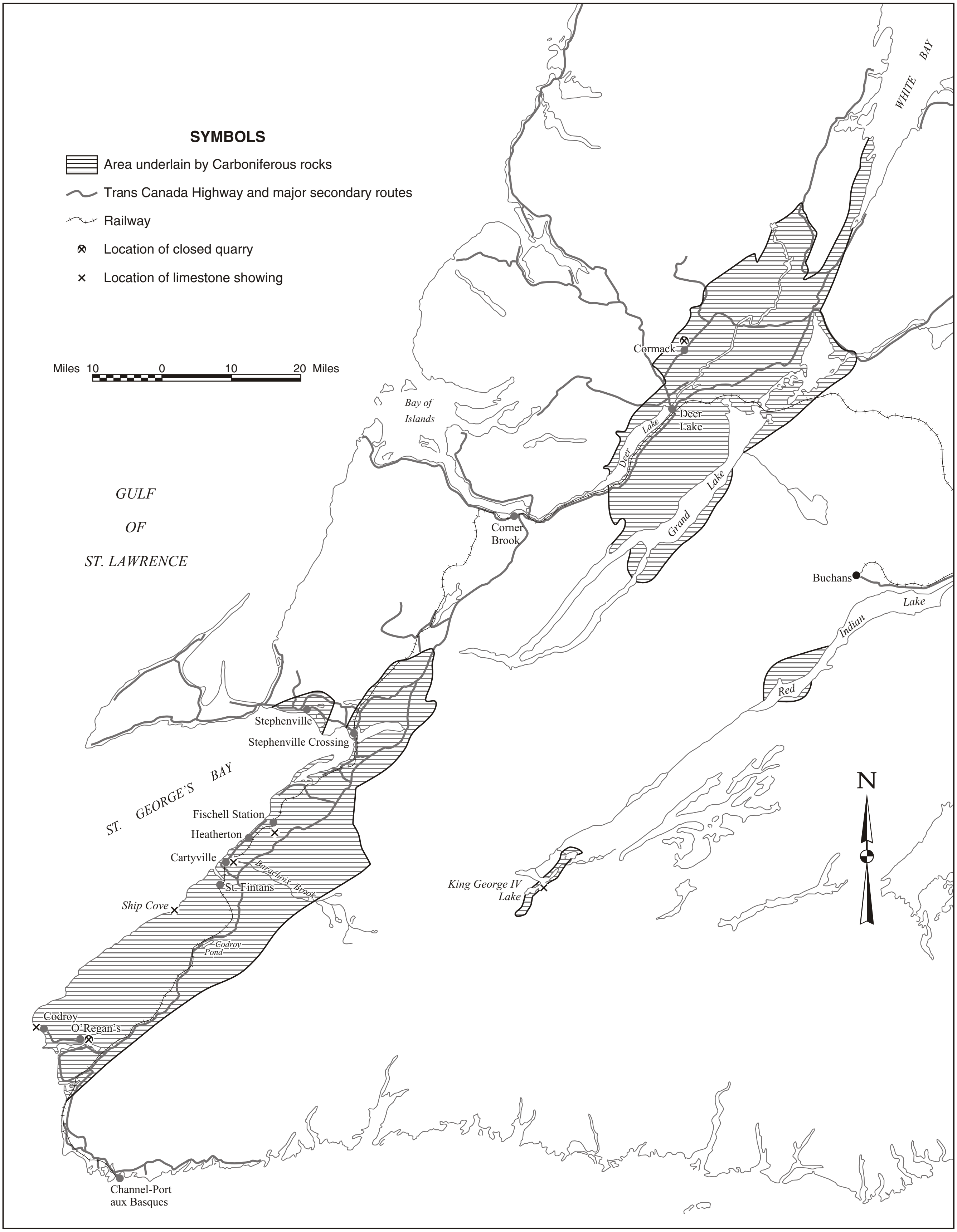

Figure 19. *Distribution of Carboniferous rocks in southwest Newfoundland, showing locations of limestone quarries and principal limestone exposures.*

The Carboniferous strata in western Newfoundland have been included in Geological Survey of Canada maps by Baird (1959), Riley (1962), and Gillis (1972). Bell (1948) described in detail the various stratigraphic sections exposed along the southern shore of St. George's Bay. Limestone deposits east of St. George's Bay have been described by Snelgrove (1940) and Harris (1962).

The Carboniferous section east of St. George's Bay is divided roughly into three rock groups. The basal, Anguille Group, consists of at least 2,000 feet of predominantly non-marine sandstone and shale. The overlying Codroy Group consists of alternating marine and non-marine deposits. Shale, sandstone, limestone and gypsum are the predominant rock types, and limestone seems to be confined, for the most part, to the lower parts of the section, though beds are scattered throughout. The basal unit of the Codroy Group is the Ship Cove limestone. The unit is about 60 feet thick, and many layers of the limestone, which is ribbon-banded, have abundant, small, concretion-like pellets. The middle part of the member includes grey and purplish-grey, shaly, micaceous and slightly arkosic sandstone, of which some surfaces are rippled (Bell, 1948, p. 18). Impure limestones of the Codroy Group are also exposed in narrow, north-south trending fault-bounded valleys in the eastern part of the Port au Port Peninsula (Map 3). The uppermost part of the Carboniferous section is the Barachois Group of predominantly non-marine conglomerate, sandstone, and shale. Flat-lying limestone conglomerate (derived from the underlying St. George Group and Table Head Formation) is exposed on the upper part of Blanche Brook north of Stephenville (Riley, 1962, p. 35).

In the Deer Lake area, thin beds of freshwater limestone are exposed in the Rocky Brook Formation and in the immediately underlying predominantly conglomeratic unit (Baird, 1959).

Impure limestone have been quarried from the Carboniferous rocks in small amounts and used for local agricultural purposes (see below). No quarries are operating at present.

Ryan's Brook Quarry

Ryan's Brook Quarry is located in the community of O'Regan's about a mile east of the Grand Codroy Bridge (Fig. 19). Siliceous limestone of the Codroy Group (Ship Cove Member) was removed from the quarry on a cooperative basis between 1943 and 1951, for local agricultural use. A little less than 1,000 tons per year were removed, and McKillop (1962, unpub. ms.) estimated that only about 6,000 tons of recoverable stone remain. In fact, the quarry must now be considered forever abandoned since a home has been built on the quarry floor, and the quarry face landscaped and planted with flowers. The limestone unit, which strikes N53°E and dips 32°SE is exposed along strike for some distance in either direction. The thickness is not known exactly, but is probably close to the 60 feet indicated by Bell (1948, p. 18). Snelgrove (1940) and DeGrace in 1972 collected grab samples of the stone at Ryan's Brook:

	Snelgrove (1940)	DeGrace (1972, unpub.)
CaO	42.36	34.69
MgO	2.85	5.17
SiO_2	12.55	13.35
Fe_2O_3	5.68	1.67
Al_2O_3	3.97	
S	-	0.09

Cormack Quarry

Impure limestone has been quarried for agricultural use at Cormack, about six miles north of the town of Deer Lake (Fig. 19). The quarry, in the Rocky Brook Formation (Baird, 1959), was opened in 1947 by the Agricultural Division of the Newfoundland Department of Mines and Resources. About 1,000 tons per year were removed until the quarry closed in 1950 or 1951. The beds are subhorizontal (McKillop, 1974, pers. comm.), and the rock has been described as a "fine-grained, buff-coloured dolomite" (McKillop, 1962, unpub. ms.).

Other Deposits

Impure deposits of Ship Cove limestone and other Codroy Group limestones are exposed at a number of localities close to roads in the St. George's Bay area. Harris (1962, p. 61) reported that a 70-foot thick section of limestone is exposed in a road-cut on the Trans-Canada Highway, 1 2 miles north of the bridge over North Branch River and 2 2 miles south of Codroy Pond. Harris estimated that about 500,000 tons of stone are readily quarryable there. Other occurrences, of little if any economic interest, have been reported from Black Point near the village of Codroy, along the railway tracks six miles south of St. Fintan's, in a sea cliff at Ship Cove, along the shore of St. George's Bay near Heatherton, in Barachois Brook upstream from Cartyville, and at several localities south of Fischell Station (McKillop, 1962, unpub. ms.). Finally, limestone beds have been reported from Carboniferous rocks at King George IV Lake in southwest Central Newfoundland (DeGrace, 1974).

LABRADOR

There are no known limestone deposits in Labrador which are likely to be of commercial interest in the foreseeable future.

Impure limestone of the Lower Cambrian Forteau Group occurs as Archaeocyathid reefs on the south coast of Labrador between Blanc Sablon and West St. Modeste (Christie, 1951; Fong, 1967). In the Labrador Trough, generally thin beds of siliceous magnesian limestone and dolomite are widespread (Wynne-Edwards, 1960, 1961;

dolomite are widespread (Wynne-Edwards, 1960, 1961; Frarey, 1961 ; Fahrig, 1967). Johnston (1958) summarized the scanty available data on these deposits and on other small, impure deposits at Moran Lake, Winokapau Lake, Croteau Lake, Aillik Bay, and Port Hope Simpson in south-east Labrador; and at the headwaters of Nakvak Brook in northern Labrador.

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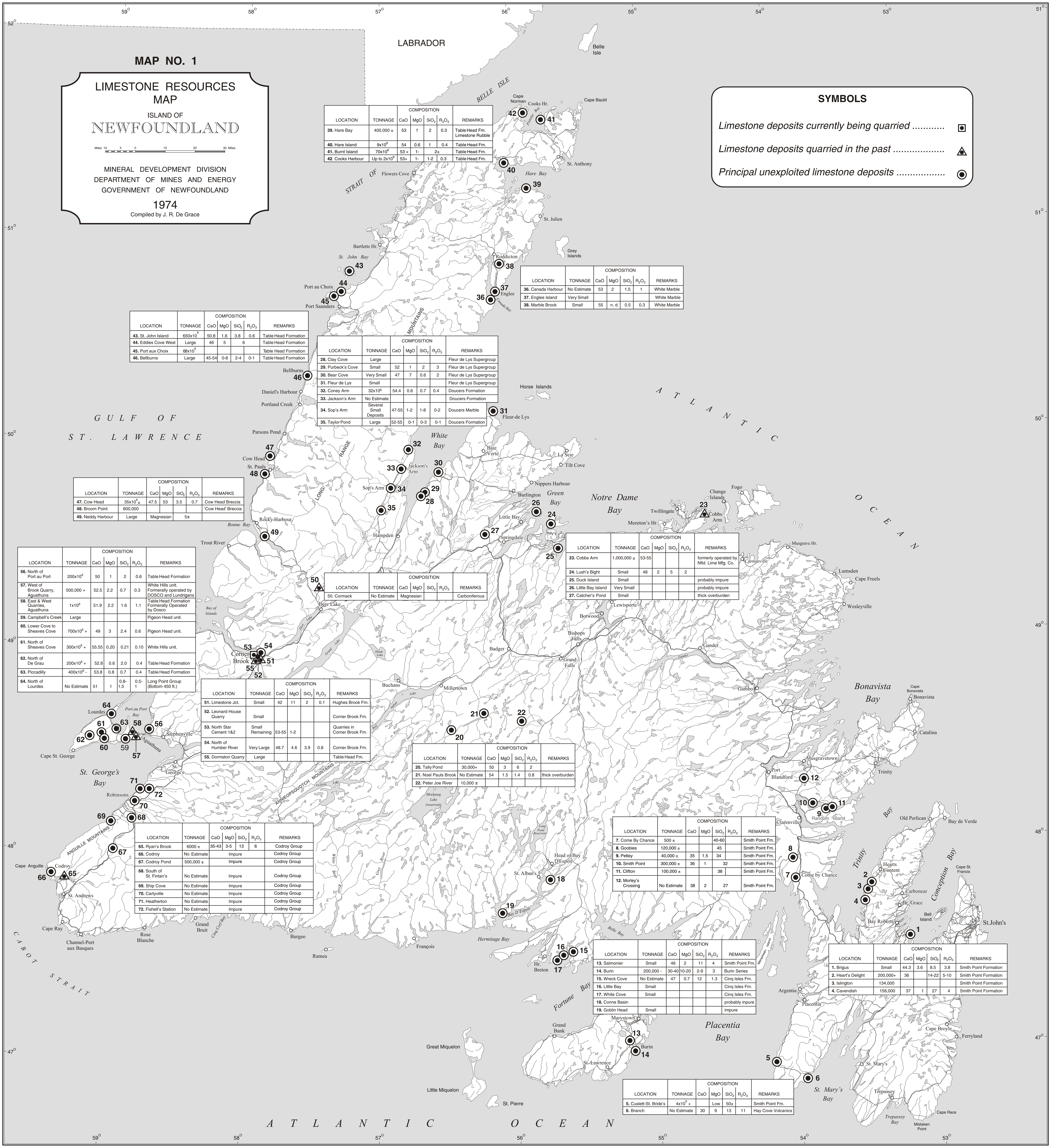


LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
39. Hare Bay	400,000 ±	53	1	2	0.3	Table Head Fm. Limestone Rubble
40. Hare Island	$9x10^6$	54	0.6	1	0.4	Table Head Fm.
41. Burnt Island	$70x10^6$	53 +	1-	2±		Table Head Fm.
42. Cooks Harbour	Up to $2x10^9$	53+	1-	1-2	0.3	Table Head Fm.

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
36. Canada Harbour	No Estimate	53	2	1.5	1	White Marble
37. Englee Island	Very Small					White Marble
38. Marble Brook	Small	55	n. d.	0.5	0.3	White Marble

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
43. St. John Island	$650x10^6$	50.8	1.6	3.8	0.6	Table Head Formation
44. Eddies Cove West	Large	46	5	6		Table Head Formation
45. Port aux Choix	$68x10^6$					Table Head Formation
46. Bellburns	Large	45-54	0-8	2-4	0-1	Table Head Formation

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
28. Clay Cove	Large					Fleur de Lys Supergroup
29. Purbeck's Cove	Small	52	1	2	3	Fleur de Lys Supergroup
30. Bear Cove	Very Small	47	7	0.6	2	Fleur de Lys Supergroup
31. Fleur de Lys	Small					Fleur de Lys Supergroup
32. Coney Arm	$32x10^6$	54.4	0.6	0.7	0.4	Doucers Formation
33. Jackson's Arm	No Estimate					Doucers Formation
34. Sop's Arm	Several Small Deposits	47-55	1-2	1-8	0-2	Doucers Marble
35. Taylor Pond	Large	52-55	0-1	0-3	0-1	Doucers Formation

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
47. Cow Head	$35x10^6$±	47.5	53	3.5	0.7	Cow Head Breccia
48. Broom Point	600,000					'Cow Head' Breccia
49. Neddy Harbour	Large	Magnesian		5±		

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
56. North of Port au Port	$200x10^6$	50	1	2	0.6	Table Head Formation
57. West of Brook Quarry, Aguathuna	500,000 +	52.5	2.2	0.7	0.3	White Hills unit. Formerely operated by DOSCO and Lundrigans
58. East & West Quarries, Aguathuna	$1x10^6$	51.9	2.2	1.6	1.1	Table Head Formation Formerly Operated by Dosco
59. Campbell's Creek	Large					Pigeon Head unit.
60. Lower Cove to Sheaves Cove	$700x10^6$ +	49	3	2.4	0.6	Pigeon Head unit.
61. North of Sheaves Cove	$300x10^6$ +	55.55	0.20	0.21	0.10	White Hills unit.
62. North of De Grau	$200x10^6$ +	52.8	0.6	2.0	0.4	Table Head Formation
63. Piccadilly	$400x10^6$ -	53.8	0.8	0.7	0.4	Table Head Formation
64. North of Lourdes	No Estimate	51	1	0.8-1.5	0.5-1	Long Point Group (Bottom 450 ft.)

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
50. Cormack	No Estimate	Magnesian				Carboniferous

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
23. Cobbs Arm	1,000,000 ±	53-55				formerly operated by Nfld. Lime Mfg. Co.
24. Lush's Bight	Small	48	2	5	2	
25. Duck Island	Small					probably impure
26. Little Bay Island	Very Small					probably impure
27. Catcher's Pond	Small					thick overburden

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
51. Limestone Jct.	Small	42	11	2	0.1	Hughes Brook Fm.
52. Leonard House Quarry	Small					Corner Brook Fm.
53. North Star Cement 1&2	Small Remaining	53-55	1-2			Quarries in Corner Brook Fm.
54. North of Humber River	Very Large	48.7	4.6	3.9	0.8	Corner Brook Fm.
55. Dormston Quarry	Large					Table Head Fm.

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
20. Tally Pond	30,000+	50	3	6	2	
21. Noel Pauls Brook	No Estimate	54	1.5	1.4	0.8	thick overburden
22. Peter Joe River	10,000 ±					

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
65. Ryan's Brook	6000 ±	35-43	3-5	13	6	Codroy Group
66. Codroy	No Estimate	Impure				Codroy Group
67. Codroy Pond	500,000 ±	Impure				Codroy Group
68. South of St. Fintan's	No Estimate	Impure				Codroy Group
69. Ship Cove	No Estimate	Impure				Codroy Group
70. Cartyville	No Estimate	Impure				Codroy Group
71. Heatherton	No Estimate	Impure				Codroy Group
72. Fishell's Station	No Estimate	Impure				Codroy Group

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
7. Come By Chance	500 ±			40-60		Smith Point Fm.
8. Goobies	120,000 ±			45		Smith Point Fm.
9. Petley	40,000 ±	35	1.5	34		Smith Point Fm.
10. Smith Point	300,000 ±	36	1	32		Smith Point Fm.
11. Clifton	100,000 ±			38		Smith Point Fm.
12. Morley's Crossing	No Estimate	38	2	27		Smith Point Fm.

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
13. Salmonier	Small	46	2	11	4	Smith Point Fm.
14. Burin	200,000 -	30-40	10-20	2-9	3	Burin Series
15. Wreck Cove	No Estimate	47	0.7	12	1.3	Cinq Isles Fm.
16. Little Bay	Small					Cinq Isles Fm.
17. White Cove	Small					Cinq Isles Fm.
18. Conne Basin						probably inpure
19. Goblin Head	Small					impure

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
1. Brigus	Small	44.3	3.6	8.5	3.8	Smith Point Formation
2. Heart's Delight	200,000+	36		14-22	5-10	Smith Point Formation
3. Islington	134,000					Smith Point Formation
4. Cavendish	156,000	37	1	27	4	Smith Point Formation

LOCATION	TONNAGE	COMPOSITION CaO	MgO	SiO_2	R_2O_3	REMARKS
5. Cuslett-St. Bride's	$4x10^6$ +		Low	50±		Smith Point Fm.
6. Branch	No Estimate	30	9	13	11	Hay Cove Volcanics

MAP NO. 2

LEGEND

SILURIAN

6	Conglomerate, quartzitic sandstone, arkosic sandstone, greywacke, siltstone and argillite
5	Greywacke, sandstone, siltstone, argillite, pebble conglomerate and minor coarse conglomerate
4	Argillite; green to grey, silty, fossiliferous. Minor sandstone and siltstone
2,3,4,5	Map units 2, 3, 4 and 5 undifferentiated

ORDOVICIAN

3	Argillite; black, graphitic, graptolitic, pyritic. Thin siliceous interbeds common
2	Limestone; light- to dark-grey, crystalline. Lower beds are argillaceous and siliceous
1	Andesite and basalt with minor agglomerate and tuff
5,6	Map unit 5 or 6

GEOLOGY
COBBS ARM AREA, NEW WORLD ISLAND, NEWFOUNDLAND

(AFTER HARRIS, 1966)

FEET 400 0 400 800 1200 FEET

SCALE 1 INCH TO 400 FEET

SYMBOLS

Fault (position defined)

Fault (position approximate)

Fault (occurrence and position inferred)

Fault (dipping vertical, inclined)

Stratigraphic contact

Geological boundary (fault or stratigraphic contact)

Geological boundary (inferred fault or stratigraphic contact)

Quarry (solid line indicates top of quarry wall)

Quarry face

Diamond drill hole

Bedding (inclined, tops known)

Bedding (overturned)

Bedding (upper side of bed unknown)

Bedding (vertical, upper side of bed unknown)

Bedding (vertical, tops indicated by arrow)

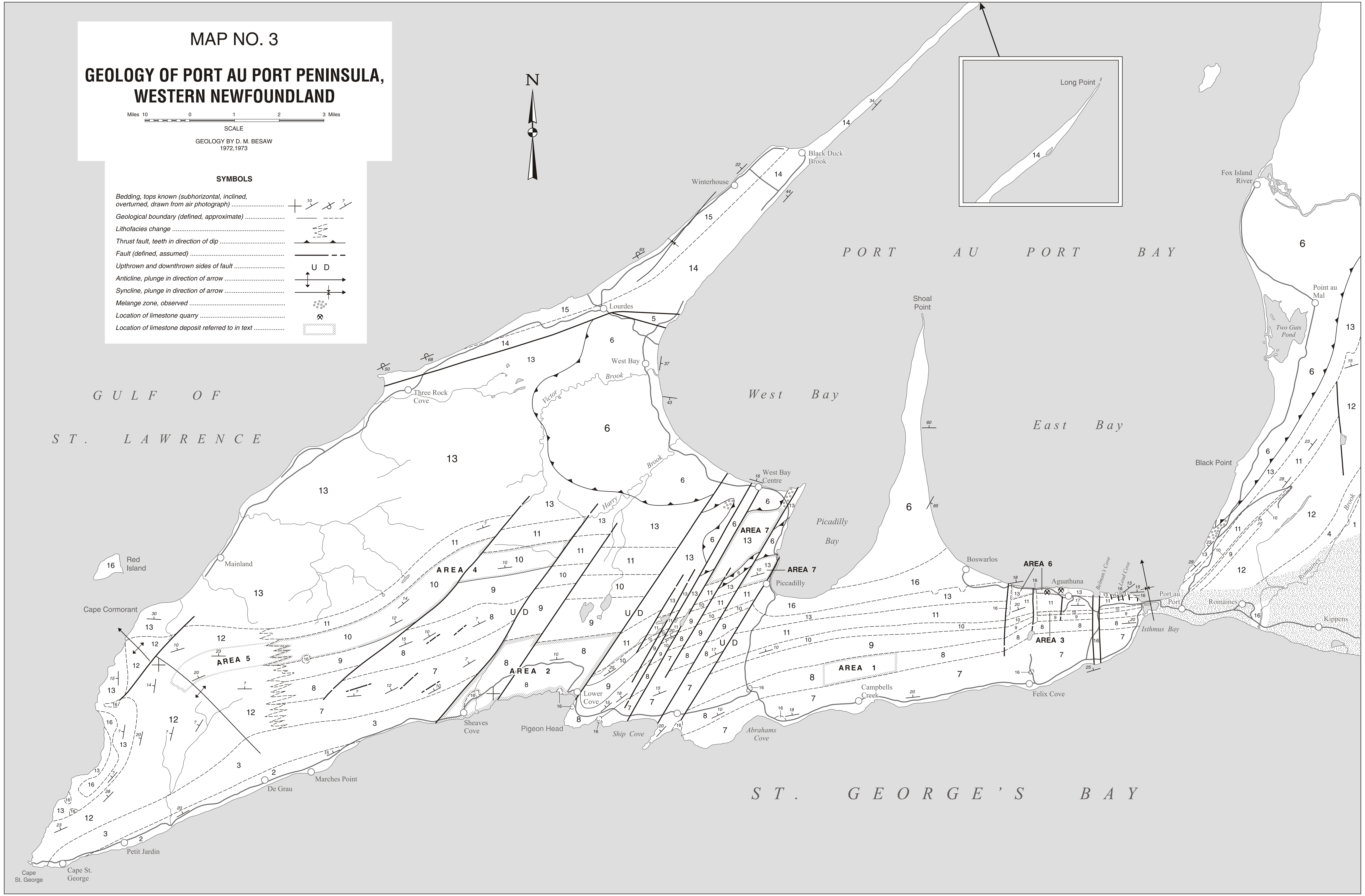
Bedding (horizontal)

Cleavage, foliage

Anticline

Syncline

Fossil location



LEGEND

PLEISTOCENE

Glacial cover

CARBONIFEROUS

LOWER MISSISSIPIAN

Codroy Group

16 — Grey, green and red sandstone and siltstone; limestone; gypsum; barite-celestite deposits in fault-bounded valleys containing Codroy Group rocks around Aguathuna

DEVONIAN

LOWER DEVONIAN

Clam Bank Group

15 — Red sandstone, shale, conglomerate and minor limestone

ORDOVICIAN

MIDDLE TO UPPER ORDOVICIAN

Long Point Group (neoautochthonous)

14 — Grey limestone, sandstone, fossiliferous limestone, greenish-grey shaly layers

Table Head Group (autochthonous)

13 — Dark-brown and grey, thick-bedded limestone throughout peninsula; black carbonaceous shales on the east side of East Bay; carbonate conglomerate between Lourdes and Big Cove; quartzo-feldspathic flysch between Mainland and Three Rock Cove

LOWER TO MIDDLE ORDOVICIAN

St. George Group (autochthonous)

Port au Port unit

11 — Interbedded grey limestone; red, green and buff dolomite; stromatolitic limestone; minor red and green shale

White Hills unit

10 — Fine-grained, thick-bedded, white- to light-grey, high purity limestone

Pine Tree unit

9 — Massive, course-grained, buff and grey dolomite; anastomosing burrow casts

Pigeon Head unit

8 — Fine-grained, thin and thick-bedded grey limestone, burrows common; intraformational breccia in places

Lower Cove unit

7 — Buff and grey limestone and dolomite; minor red shale, stromatolitic limestone, sandstone

St. George Group, undivided

12 — Grey fine-grained limestone and dolomite

Green Point Group

5 — Shale, limestone, sandstone

Humber Arm Group (allochthonous)

6 — Red, green and black, highly fissile shales, scattered pyrite and malcast concretions; sandstone; tuff; agglomerate; minor limestone

CAMBRIAN

UPPER CAMBRIAN

Petit Jardin Formation

3 — Grey Shales, limestone, dolomite

MIDDLE CAMBRIAN

March Point Formation

2 — Sandstone, shale, limestone, dolomite

4 — Shale, limestone, dolomite, sandstone

LOWER CAMBRIAN

Kippens Formation

1 — Black shale, limestone, minor quartzite