THE PETROLEUM GEOLOGY OF THE PORT AU PORT PENINSULA

Newfoundland

PART I - Text

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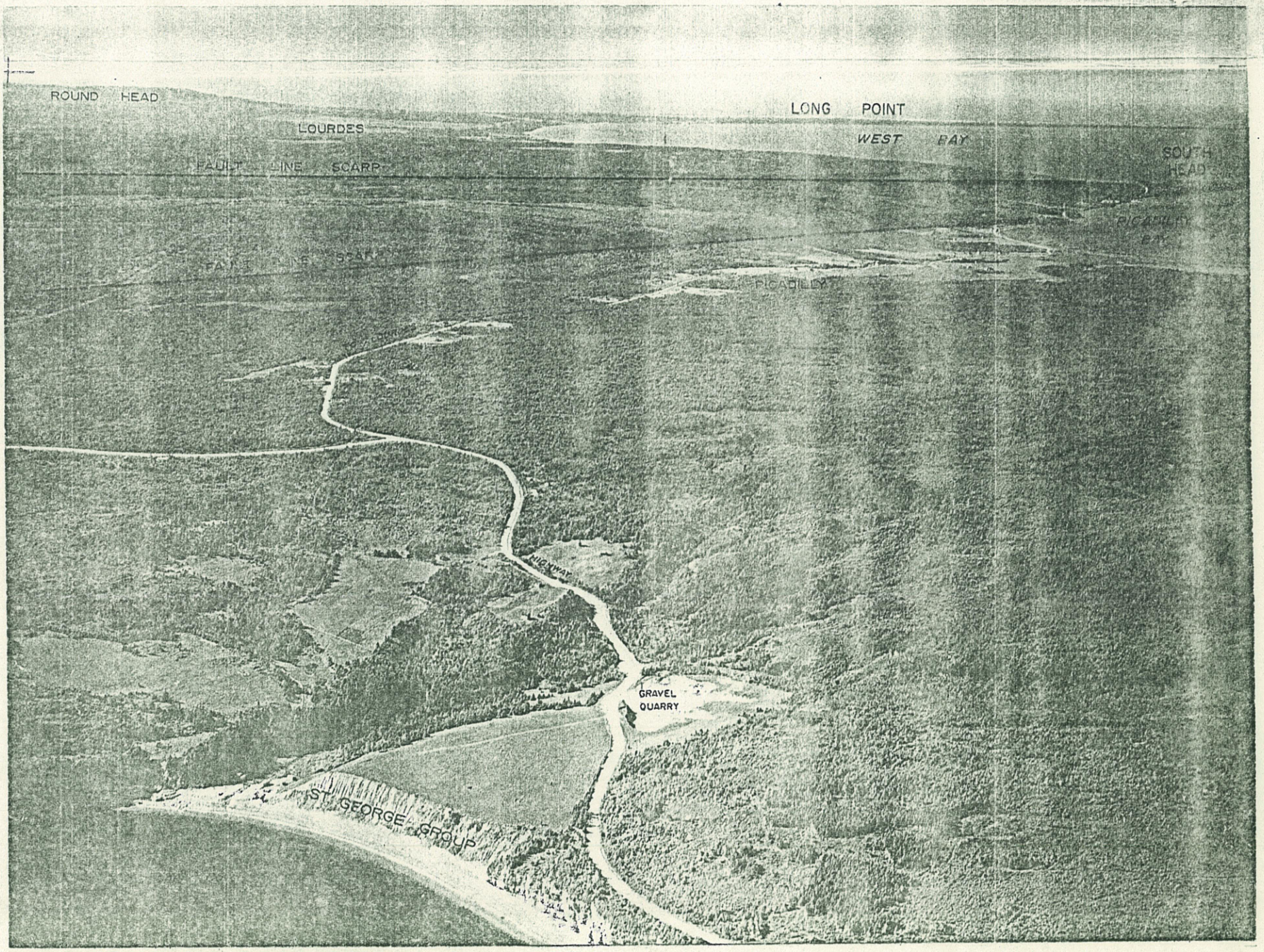

PHOTO : COURTESY NEWFOUNDLAND TOURIST DEVELOPMENT OFFICE

OBLIQUE AERIAL PHOTOGRAPH LOOKING ACROSS THE CENTRAL PORTION OF PORT AU PORT PENINSULA.
VIEW TAKEN IN A NORTHWESTERLY DIRECTION FROM ABRAHAMS COVE.

THE PETROLEUM GEOLOGY

OF THE

PORT AU PORT PENINSULA

Newfoundland

PART

I

TEXT

by

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Calgary, Alberta.

March 1965.

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Courtesy - National Air Photo Library.

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ABSTRACT

A geological study of the Port au Port Peninsula, Western Newfoundland, was undertaken in order to evaluate the oil and gas potential of the area.

The Port au Port Peninsula is underlain by rocks ranging in age from Precambrian to the Upper Mississippian. Detailed mapping indicates that miogeosynclinal limestones, dolomites, shales and sandstones of Cambrian and Ordovician age are the dominant lithological components of the Peninsula. Lower Devonian limestones, sandstones and shales occur on the northwest coast of the Port au Port Peninsula and are the only rocks of such age that are known to exist in Newfoundland.

The sediments are slightly folded with faulting and metamorphic activity being of a minor nature when compared to the rest of the West Coast of Newfoundland. Topographic eminences are underlain by resistant sandstones and carbonates, while lowland areas are associated with eroded weak shale belts and graben valleys. Glacial scouring during Wisconsin time completely removed the soil mantle. Weathering with soil formation and fluvial erosion have been dominant processes in post-glacial time.

The Palaeozoic rocks appear to hold promise provided a sufficient thickness of sediments containing suitable structures can be located. An exploratory drilling location on such a structure is recommended by the author.

INTRODUCTION

Introductory

The objective of the author's examination was to enquire into the possibilities of oil production from rocks of Cambro-Ordovician age the only ones regarded by him to have potential. This report is a

presentation of the factual data collected during the 1964 field season as regards the hydrocarbon potential of the Port au Port Peninsula, Newfoundland.

From the general geology as worked out by previous investigators, large areas of Newfoundland may be eliminated, and as the writer's own survey proceeded, it became obvious that only certain tracts of the West Coast offered any prospects at all. Consequently only such areas should be examined and treated in detail, the Port au Port Peninsula is one of these areas and is the subject of this report.

In considering the possibilities of oil production on the Port au Port Peninsula and other areas containing Cambro-Ordovician sediments only petroleum is dealt with in this report, since the investigation of possible Humber Arm oil shales in the area could not be undertaken during the season due to a limited time factor.

It should be pointed out that oil exploration efforts in Newfoundland have been based on outmoded techniques with insufficient geologic knowledge. A purposeful approach to determine the oil and gas possibilities requires more than re-reading of published literature and opinions, useful as they may be in providing basic information.

Considering the geographic advantages that would apply to the discovery of oil and gas reserves in this area, the writer has endeavoured to approach the problem from a practical point of view and has made genuine efforts to avoid becoming involved in theory and speculation. It is the writer's belief that the application of appropriate modern oil exploration techniques are both essential and justified in this area of Newfoundland.

Location of Area

The area in which this geological study was carried out is known as the Port au Port Peninsula. This peninsula is located on the southwest coast of Newfoundland extending into the Gulf of St. Lawrence beyond the northeast trending coastline of the island. The peninsula is triangular in shape, approximately 30 miles on a side and is attached at it's easterly corner to the mainland by two narrow shingle bars (tombolos) known as The Gravels, about 3/4 mile long enclosing a lagoon containing salt water. The area under study lies between latitudes 48° 27' and 48° 47' North, and between longitudes 58° 40' and 59° 15' West, and includes an area of some 250 square miles. The accompanying index map, Figure 1 shows the approximate location and the relationship of the Port au Port Peninsula with regard to the rest of Newfoundland.

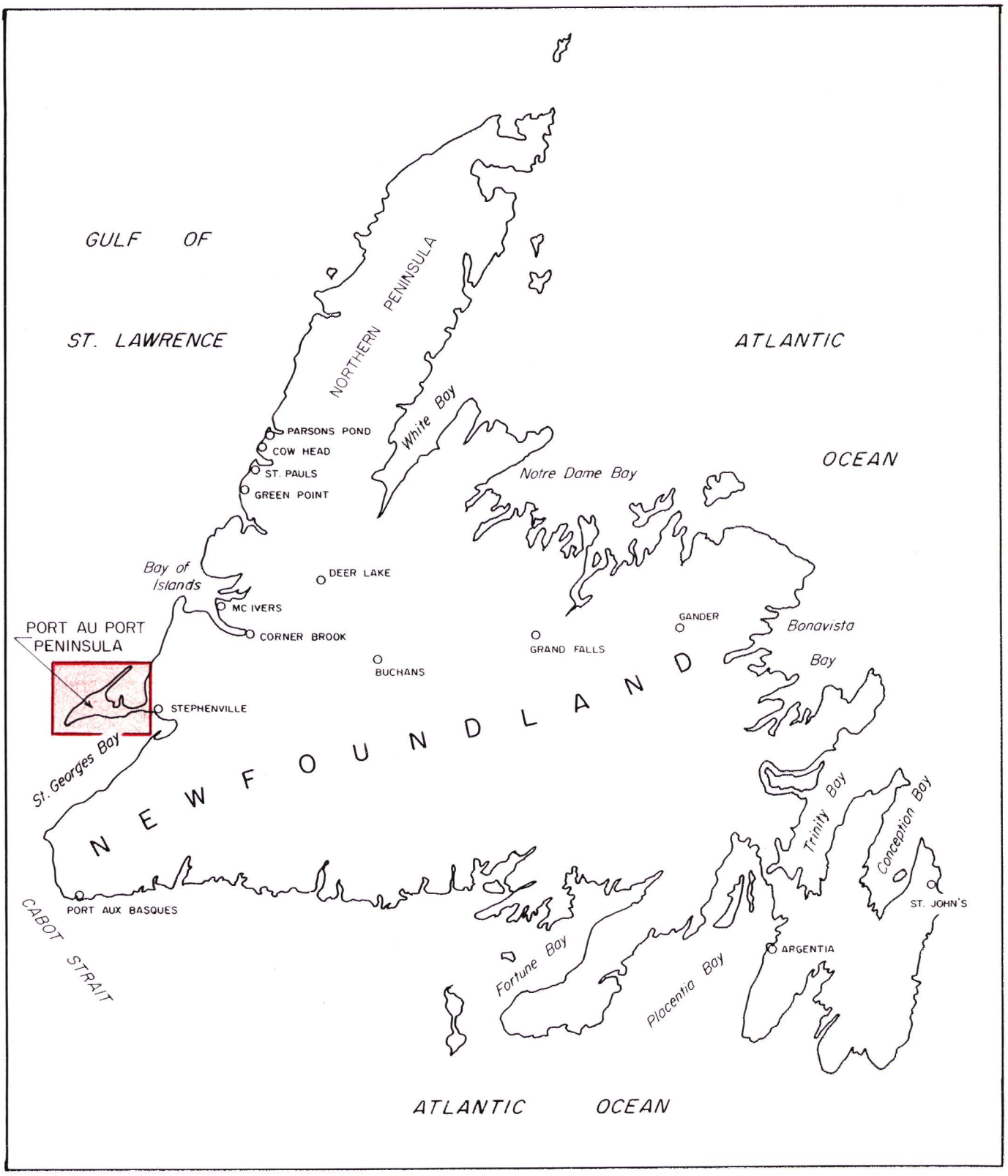


FIGURE N° 1

LOCATION MAP

AREA OF STUDY

DRAWN BY A. WERSE, MARCH 1965

GOLDEN EAGLE OIL AND GAS LIMITED

Accessibility

The main centres of population are Stephenville, which is the site of Harmon Airfield, a military and commercial base and Stephenville Crossing, the nearest town on the main railroad line. Cargo and passenger ships give access to the area via Port aux Basques or Corner Brook. Air Canada maintains a port of entry at Stephenville. The Trans-Canada Highway connects Port aux Basques and Corner Brook. Canadian National Railways operate a narrow-gauge line between Port aux Basques and St. John's.

The town of Port au Port situated on the eastern extremity of the peninsula is located a distance of 8 miles from Stephenville. This road is paved from Stephenville to Aguathuna a limestone quarry on the north coast of the peninsula. From the village of Port au Port, a road surfaced with limestone screenings in good condition follows the southern margin of the peninsula to Cape St. George. At Abraham's Cove, a similar road branches from this latter and leads to Lourdes via Piccadilly. From Lourdes the road skirts the Gulf shore in a southwesterly direction to the community of Mainland at which point it terminates. A dirt road from Lourdes extends in a northeasterly direction to the fishing village of Beach Point giving access to "The Bar" of the Long Point Peninsula. These roads are all in good condition making the automobile the most practical mode of transportation.

The interior and southwest portion of the peninsula is not as accessible as the remainder of the area due to stunted tree growth and the absence of roads but access may be obtained on foot by way of well travelled trails and streams which traverse these portions.

All coastal sectors of the Port au Port Peninsula can be reached by motor boat, weather permitting. The East Bay portion of Port au Port Bay located to the north of the peninsula contains sufficient depth of water for steamships, which are used chiefly in transporting the limestone from the quarry at Aguathuna, at which place there has been built a large pier. Smaller vessels of shallow draft may go as far as Piccadilly in West Bay where a modern concrete pier was constructed during the summer of 1963. The Bay St. George and Gulf sides of the peninsula are bold coastlines that afford little protection to ships.

The movement of present day heavy drilling equipment throughout the peninsula would not present a problem as the entire area is easily accessible. The Port au Port Peninsula was severely scoured during the Wisconsin glacial epoch removing pre-glacial soils. The soil profile that has developed since the Wisconsin epoch rests directly on consolidated bedrock with maximum depths of 10 to 12 inches which is too shallow for agricultural purposes. The soils are all strongly acidic (Ph. 4.0 to 4.5) and deficient in plant

material, making all existing tree growth, of a stunted nature. An HD4 caterpillar bulldozer would be adequate to remove any of the vegetation found on the peninsula.

Climate

The area of study lies within the humid, continental, microthermal, short-summer phase climatic belt. Because of the surrounding sea, water currents have a tempering effect, which precludes extreme and rapid temperature changes. The winters are long and cold and the summers are short and inclined to be cool, with short warm periods. The average mean temperature is 41°F, varying from about minus 5° F. in winter to 80° F. in summer. August is the warmest month, with an average temperature of 60°F. The frost-free season extends from June into September. Rainfall totals some 46 inches annually, and is well distributed throughout the year.

Snow does not disappear from the landscape during normal seasons until the end of June and it is mid-July before field parties become active on the west coast of Newfoundland. Icebergs are a common sight in the St. Lawrence Gulf throughout the month of July.

Method of Survey

The area examined on the west coast was well-wooded, weathered and peaty. The Port au Port Peninsula however, afforded some very valuable evidence, and was a fortunate starting point.

Field work for the current project was carried out during August and September 1964. Vertical aerial photographs, on a scale of 1 inch to 2640 feet, were studied stereoscopically prior to, during and following the field work. Structural features such as dip and strike of the beds, axes of anticlines and synclines and formational boundaries, were first indicated on the photographs as much as possible and later checked in the field. The aerial photographs added greatly to the accuracy of the work and to the field performance. Geological and Aeromagnetic maps were also available.

The entire belt of Palaeozoic outcrop was crossed and the field work was accomplished principally by means of pace and compass traverses along those portions of the peninsula which offered the best exposures of bedrock, such as in the streams and along the shores. Sections were measured by five-foot "Jacob's Staff," Brunton compass and tape. The bare summits of the White Hills revealed some beautiful strikelines and scour marks.

Correlations and facies changes in the area investigated are illustrated by several cross-sections and figures. Samples were collected at every major lithologic break. Comprehensive fossil collections were made, both along the traverses and at intermediate points, which were tied to a traverse either by survey of by use of the photographs.

Section names were derived from nearby topographic features or settlements and were coded with the appropriate number and letters.

The detailed lithologic logs made for each section include all pertinent data obtained during the mapping season. Further, geologic formational contacts and major structures were mapped directly on aerial photographs in the field. This information was transferred to large outcrop maps covering the total area of operation.

The interior portion of the peninsula for the most part is covered by a thick stunted vegetation of evergreens which afforded a major difficulty in deciphering the geology of this region, (See Frontispiece of this report and Plate III). Along the northern coast of the peninsula, there are several large streams with excellent exposures, such as Harry's and Victor's Brook. These streams could be followed long distances before entering the uplands, where the streams were seen to have their sources in swamp areas. Much of

this central covered area could not be examined in detail because of the absence of exposures.

An areal geological map has been compiled from the observations made in the field. The Topographic Branch of the Canadian Geological Survey issues maps at the scale of 1:40,000 of the Port au Port area. These served as a base map which was later reduced to the scale of 1:63,360 (one inch to the mile) for convenience of handling. This map is included in the pocket at the back of this report, (Enclosure No. 1). A structural map of the area, (Enclosure No. 2) and seven cross sections, (Enclosure No. 3) are included with this report. This material illustrates the interpretation of the Cambrian and Ordovician succession on the Port au Port Peninsula and elucidates correlation problems.

Photographic Plates of geological interest are included in Part II of this Report.

Previous Work

The western portion of Newfoundland including the Port au Port Peninsula is by no means virgin ground and has been examined geologically by various authorities. A good deal of this work has

either not been published or has not been obtainable by the author.

The earliest recorded work in the Port au Port area was done by Alexander Murray, the then Government Geologist of Newfoundland, he determined the thick limestone beds of the Port au Port Peninsula to be of "Lower Silurian" age. In the 1873 report, Murray described the faulted coves on the north side of the peninsula. Following the investigations undertaken by Murray, James P. Howley who succeeded him as Government Geologist, continued the work in the area. In his 1874 report, Howley gave detailed descriptions of the strata of the Port au Port Peninsula. He also mentioned the occurrence of large faults in the vicinity of Piccadilly, striking S 30° W into the peninsula, and the presence of a fault at the base of Long Point. From his work on the Port au Port Peninsula, Howley concluded that the rocks were arranged in a series of sharp anticlinal and synclinal folds, trending approximately N 22° E, and that they were further transected by a series of complicated thrust faults. In 1934, Schuchert and Dunbar established the Ordovician sequence of the Port and Port area. They also established that the strata along the west side of Long Point Peninsula were Devonian, rather than Carboniferous as had been thought by Murray and Howley. This was the first discovery of Lower Devonian strata in Newfoundland and they were designated the Clam Bank group. This work has proved to be the standard reference for all later stratigraphical investigations on the west coast of

Newfoundland. MacClintock and Twenhofel, in 1940, made the first detailed study of the glacial geology of the Port au Port and near-by St. Georges areas. J. W. Sullivan investigated the Port au Port Peninsula in 1940 for a doctoral thesis at Yale University, but his report was not published.

H. Johnson in 1943 made an economic study of strontium deposits on the Port au Port Peninsula which was not published until 1954. In 1962 the Geological Survey of Canada published Memoir 323 by G.C. Riley entitled, "Stephenville Map - Area, Newfoundland" which also included within it's scope the Port au Port Peninsula. This report included much unpublished data gathered by J.Q. Barnes, J.W. Sullivan and G.C. Riley and also incorporated a geological interpretation of magnetic anomalies resulting from an aeromagnetic survey.

The author has found the majority of the above reports to be replete with valuable and accurate information, with which the author is in general agreement. It is unfortunate, however, that the maps produced by several of the above writers were not available and appear to have been lost over the years.

Acknowledgements

The writer is indebted to many friends with whom he has

profitably discussed various aspects of this report and from whom he has received valuable suggestions and criticisms. These geologists should not only be exonerated of any liability for the view here expressed, but they should be genuinely credited for their generous efforts at giving field guidance and encouragement to the writer. Some of those consulted were: E.J. Hesketh, E. Belt, E.K. Cullingham, D.L.F. Gilbert, J.H. McKillop and J. Rodgers.

The writer wishes to express his sincere appreciation to the staff of the Department of Geology at Memorial University, St. John's, Newfoundland, and in particular to acknowledge his great indebtedness and to express his gratitude to Professor W.D. Brueckner, whose geological knowledge of the area aided immensely in solving various field problems.

The writer is also indebted to the Geological Survey of Newfoundland for the use of their library. Unstinted co-operation was received from Golden Eagle Refining Company of Canada Limited, for whom this survey was made.

Special gratitude is extended to Dr. L.M. Cumming, Geological Survey of Canada, for helpful advice in the field and for the identification of Palaeozoic faunas. Dr. S.J. Nelson also assisted in the naming of fossils.

Sincere thanks and appreciation are also to be given to the people of the Port au Port Peninsula, whose help and hospitality made the writer's stay in the area an extremely pleasurable one.

The drafting of maps, logs, etc., was done by Mr. A. Werse of Golden Eagle Oil and Gas Limited.

CONCLUSIONS AND RECOMMENDATIONS

During the 1964 field season an extensive study of the stratigraphic and structural conditions on the Port au Port Peninsula was undertaken, where faulting appears to be minimized.

The geological conclusions may be summarized briefly as follows:-

1) Favourable structural trends occur throughout the western half of the Peninsula with sufficient closure to provide excellent traps for hydrocarbon accumulations; for example the Goodyear Anticline, (Enclosure No. 2).

2) Source beds capable of generating hydrocarbons are abundant throughout the St. George group in the form of algal reefoid

beds (Plate VII) and to a lesser degree in the March Point formation. Bituminous shales are well developed in the Kippen formation and Green Point group and highly fossiliferous dark grey limestones yielding a fetid odour are present in the Green Point, St. George and basal Table Head groups.

3) A host of favourable reservoir rocks are present in the stratigraphic column. Emphasis is placed on the porosity exhibited by the oolitic dolomites of the March Point and Petit Jardin formations and the arenaceous bioclastic and fragmental limestones of the St. George group. Porous sandstones commonly occur in the March Point, and coarse conglomerates and sandstones exhibiting good porosity are present in the Cambrian and Green Point group.

4) Several intraformational coarse conglomerates and a disconformity are known to be present and a wedge belt is believed to exist where the Green Point interfingers with the St. George group. Hydrocarbon accumulations both oil and gas can be expected where porous reservoir beds are overlain unconformably by impermeable strata.

5) The Table Head group is lithographic throughout, so would form an excellent hydrocarbon seal for underlying sediments.

It is recommended that the Goodyear anticline located to the south of Round Head be tested, and that drilling be conducted to the Precambrian so that the Cambrian may be fully evaluated. A test located on this anticline could feasibly penetrate the updip edge of the petroliferous shales and limestones of the Green Point group which must pinch-out somewhere in this vicinity, (Figure 9). These are the source beds in the St. Pauls - Parsons Pond area to the north, (Figure 1).

A test to basement located on the above anomaly would involve a drilling depth of approximately 5,500 feet. If a basement test is not considered to be warranted at this time, a 3,500 foot hole would penetrate the top of the Cambrian and in so doing would test the St. George - Green Point sequence.

The writer is of the opinion that no additional information would be obtained in this area from further field studies, and that future knowledge can only be obtained by a subsurface stratigraphic test.

Drilling on the Port au Port Peninsula on the recommended location would encounter hard rocks of the Cambro-Ordovician sequence so penetration rate would be slow. For this reason the writer suggests that a diamond rig offers numerous advantages over conventional rotary equipment. They are lighter, more mobile, and con-

sequently less expensive in moving and setting up. The daily operating charges for a large diameter diamond rig are about one-third to one-half the charges for a rotary rig of similar depth capacity. They have operated most efficiently in Quebec and Gaspé where thick shale sections are not present which is considered by the writer to be the situation in the prospect area.

In regions, where the cost of transportation is high, targets are relatively shallow, and when a continuous core is an asset, the diamond drill makes economic sense. Once productive zones are encountered, use of conventional rigs becomes necessary and the increased logistical cost is justified.

Where core is not required, bull-nosed bits may be used to advantage if geological conditions are favourable to their use. However, it should be borne in mind that cuttings from diamond bits are very fine and do not provide as good a record as do tricone cuttings.

The standard diamond drill diameter commonly used in stratigraphic tests are NX and BX, or 3 inches and 2 3/8 inches in diameter respectively. There are available to the industry miniaturized drillstem testing tools for use in NX diameter holes. It is now possible to run Gamma-Ray and Neutron logs, Self Potential

and Resistivity logs, and Temperature logs in holes as little as 2 inches in diameter. On the other hand, logging tools of any type are not always readily available, at least not without some extra costs. Production of core in a stratigraphic test in such a case would make these logs less of a necessity.

The Maritimes are remote from the centre of petroleum activity and operators in these areas are confronted with high cost of mobilization. It is suggested, within its recognized limits, the diamond drill, with it's light weight and relatively low cost of operation, could be used to advantage in wildcat drilling for oil and natural gas in Newfoundland.

This area is analogous to the Appalachian area to the south west and like it has undergone compression. Because of this compression any gas accumulations present may have abnormally high pressures, this factor should be borne in mind in planning any drilling program.

There are no local drilling contractors or service companies, so contractors would have to be brought in from Ontario, on a day-work basis. This would mean that any drilling operation would have to be under the strict supervision of a company representative to minimize drilling costs.

On the northern limit of the settlement of St. Pauls on the west side of the highway is stacked a cable tool rig, (Plate XX) which was employed to drill the location at St. Pauls Inlet. The writer would not like to express any definite opinion about this cable tool rig due to having no previous knowledge of such equipment. The brief examination made however, gave the impression that this rig could be overhauled and placed in operating order, possibly at considerable cost. For the operating range and capabilities see Appendix B.

It is recommended that a field study of the Ordovician rocks of the entire Northern Peninsula be considered for a future field season. A study of this area could be conducted within the duration of a ten week period and would leave only Carboniferous rocks to be examined at future dates. Prior to field work it would be beneficial to have workovers done on two of the more accessible previously drilled wells in the Parsons Pond - St. Pauls area. A radioactive log run in these holes would be most useful. It is suggested that a reconnaisance of the west coast of Newfoundland be made with the view of outlining areas unfavourable to petroleum exploration. The ultrabasic rocks in the general area of the Bay of Islands have no hydrocarbon value. This complex forms a belt about 10 miles wide paralleling the coast from Fox Island River, on the east shore of Port au Port Bay, northward to Bonne Bay, a distance of 60 miles. Such an area could be checked in a cursory manner prior to relinquishing exploration interests.

GEOLOGY

The geology of the Port au Port Peninsula will be dealt with under four headings, namely:-

1) Regional Geology
2) Stratigraphy
3) Geological Structure
4) Geological History.

1) Regional Geology

The ages of the rocks in the Port au Port Peninsula range from Precambrian to Upper Mississippian, and like the rest of the west coast is part of the northern extremity of the folded Appalachian province. The Palaeozoic strata discussed in this report were accumulated in the St. Lawrence geosyncline, and are a portion of the large Palaeozoic basin which extends through New Brunswick, Nova Scotia and Western Newfoundland.

Waters of the Gulf of St. Lawrence delimit the western extention of the observable strata, while to the east, the basin is fringed by crystalline rocks of the Long Range Mountains. Structures reflect an east-northeast and west-southwest direction on the Port au Port Peninsula, a trend

which differs somewhat from the general northeasterly strike of structures which are apparent over the remainder of Newfoundland.

The present study indicates that the region contains lower Palaeozoic strata of both miogeosynclinal and eugeosynclinal origin. Sedimentation appears to have initiated in a slowly submerging geosyncline (The St. Lawrence geosyncline) which towards upper middle Ordovician time developed eugeosynclinal aspects. Collapse of the eugeosyncline resulted in intrusion of ultra basic rocks attended by extrusion of pillow lavas. The geosynclinal fill is almost entirely of sedimentary origin on the Port au Port Peninsula, with the exception of two small outcrops of pillow lavas, approximately one mile up Harrys Brook.

Middle Ordovician rocks of eugeosynclinal origin occur immediately above Lower and Middle Ordovician limestones and dolomites. These eugeosynclinal sediments include black shales, conglomerates, sub-greywackers, occasional limestones and basic flows. Eustatic crustral instability during the middle Ordovician is evidence by the presence of a diagenetic breccia, correlative with the Cow Head breccia of the Table Head group, and again by the presence of additional breccia and conglomerate in the Humber Arm group.

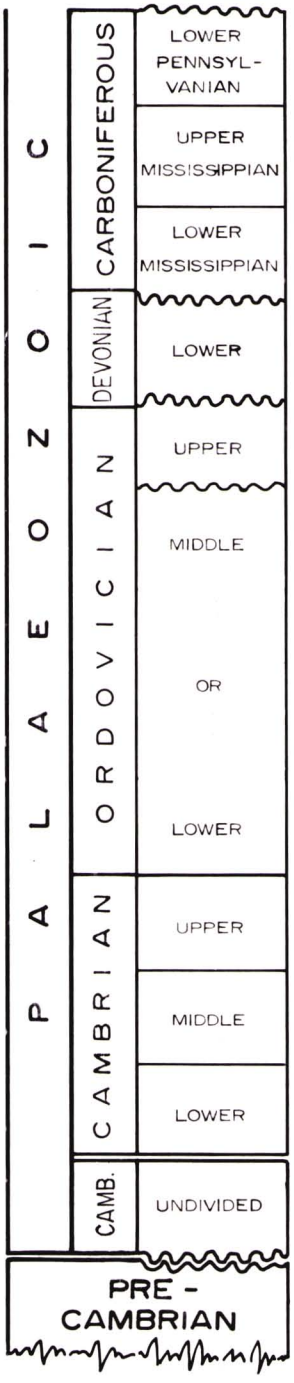
2) Stratigraphy

General Statement - With the exception of the recent drifts, alluvial deposits and a trace of pillow lava the rocks of the Peninsula belong to the Palaeozoic era and are of sedimentary origin. The exposed strata range in age from middle Cambrian to upper Mississippian, and of these, the Ordovician system is best represented on the Port au Port Peninsula. To date in Newfoundland the Ordovician rocks alone are known to be oil bearing and have been examined in detail. The Precambrian and lower Cambrian are not exposed within the confines of the study area.

There is an aggregate thickness within this area of approximately 10,500 feet of sediments, consisting of several thick units of carbonates, and several units of sandstones and shales. The areal distribution of the various geological groups and formations may be observed on Enclosure No. 1. The sequence and thickness of the various groups are indicated on the Columnar Section to the right of the above map. A correlation chart for the Port au Port area is included as Table 1 being the authors interpretation as a result of his field study and consequently is the one which is applied throughout the Report. For convenience of reference an additional copy is affixed to the inside front cover. In

TABLE I

CORRELATION CHART
FOR THE
PORT AU PORT AREA
NEWFOUNDLAND



14	BARACHOIS GP.	SANDSTONE, CONGLOMERATE, COAL, MINOR SHALE; INCLUDES SEARSTON FM.
13	CODROY GP.	SANDSTONE, SHALE, LIMESTONE, CONGLOMERATE; GYPSUM.
12	ANGUILLE GP.	LIMESTONE, CONGLOMERATE, SHALE, SANDSTONE.
11	CLAM BANK GP.	RED SANDSTONE, CONGLOMERATE, SHALE, MINOR LIMESTONE.
10	LONG POINT GP.	LIMESTONE AND SANDY SHALE
9	HUMBER ARM GP.	SHALE - RED, GREEN AND BLACK, SANDSTONE, MINOR LIMESTONE
8	TABLE HEAD GP.	LIMESTONE AND BLACK SHALE.
7	ST. GEORGE GP.	DOLOMITE AND MINOR LIMESTONE
6	GREEN POINT GP.	SHALE, LIMESTONE AND SANDSTONE
5	PETIT JARDIN FM.	SHALE, LIMESTONE AND DOLOMITE
4	MARCH POINT FM.	SANDSTONE, SHALE, LIMESTONE AND DOLOMITE
3	KIPPEN FM.	BLACK SHALE, LIMESTONE; MINOR QUARTZITE
2	UNDIVIDED	
1	UNDIVIDED	GRANITE, GNEISS AND SCHISTS

addition, as a source of reference, a comparison is drawn to comparable formations in other areas of Newfoundland and is included as Table II. A detailed discussion of the distribution and character of the several groups and formations follow in ascending order on the succeeding pages. Included, as enclosures, are lithological logs for each of the measured sections under discussion.

Cambrian System

The majority of Cambrian rocks exposed on the west coast of Newfoundland are lower Cambrian in age and are located mainly on the Northern Peninsula. A small but significant outcrop of Cambrian is exposed on the east coast of Labrador.

Sediments ranging in age from middle to upper Cambrian outcrop for seven miles along the south coast of the Port au Port Peninsula between Big Cove and Petit Jardin, (Plate III). They are exposed in cross section on the flanks and core of a broad shallow anticlinal structure the axis of which plunges gently to the north with the beds on the flanks dipping from 5^{o} to 21^{o} towards the northwest and southeast. The axis of this anticline emerges on the south coast one and a half miles west of March Point, and sections may be measured in

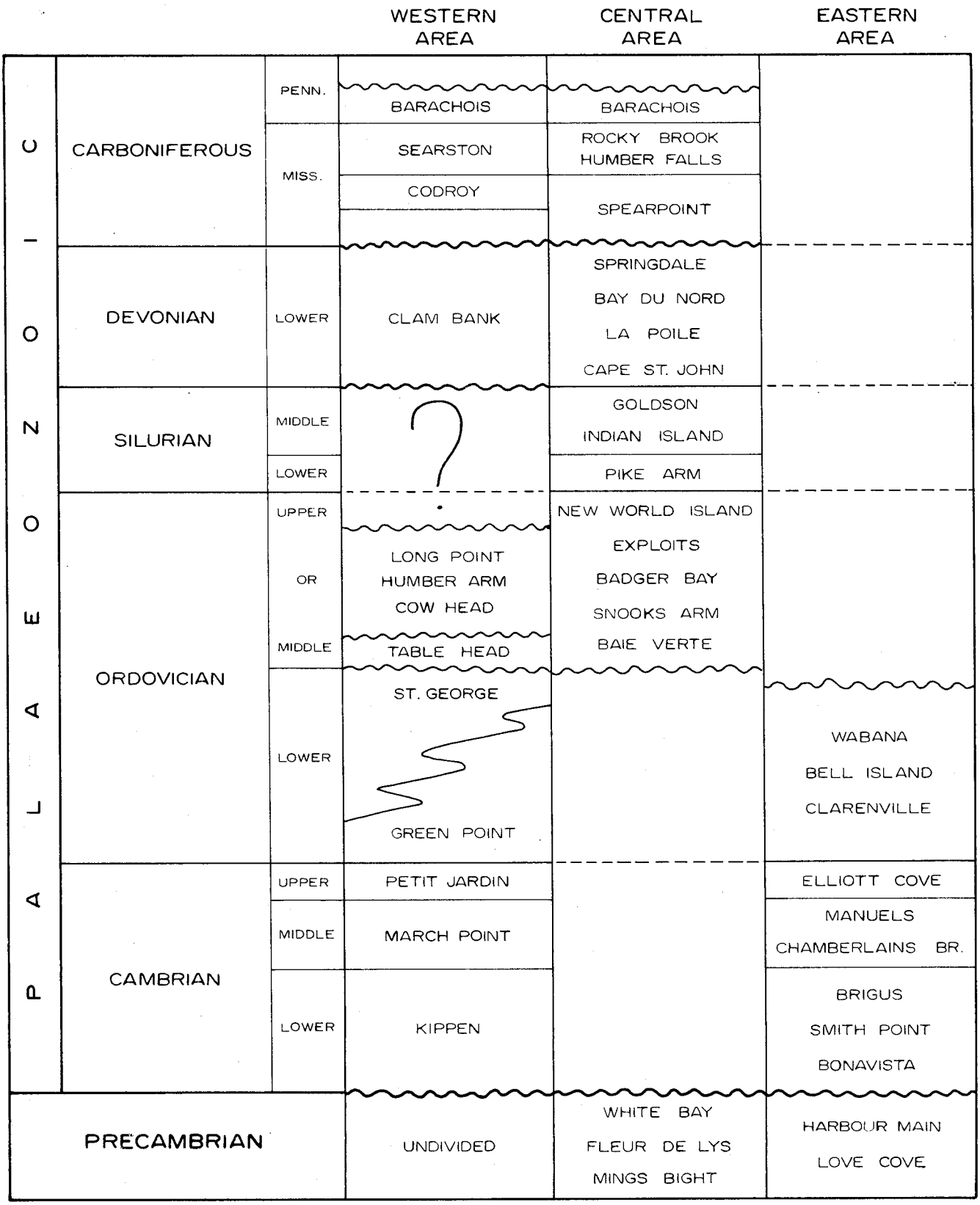


TABLE II

NEWFOUNDLAND

CORRELATION OF PRINCIPAL FORMATIONS AND GROUPS

COMPILED FROM VARIOUS SOURCES BY H. CORKIN, DEC. 1964

either direction. The predominant northerly dips result in the Cambrian being exposed in a broad strip of the south coast with the more resistant beds forming cuesta-like structures which parallel the coastline.

On the lower parts of Romaines Brook directly east of the Peninsula both lower and middle Cambrian rocks are exposed on the west limb of an open anticline that is downfaulted on it's east side.

Schuchert and Dunbar (1934, P. 34) state that the middle Cambrian was absent in western Newfoundland but Lochman (1938) recognized a middle Cambrian fauna in the Port au Port area in Schuchert and Dunbar's March Point so this strata was consequently divided into two formations based on faunal evidence.

Lithologically the Cambrian sequence on the south shore of the Port au Port Peninsula consists of quartzitic sandstones at the base grading upwards into argillaceous shales, siltstones and dolomites. The basal series attains a thickness of 846 feet and belong to the middle Cambrian March Point formation, (Plate XVII). The base of the middle Cambrian is not exposed in the axial region of this broad anticlinal structure which emerges at the settlement of De

Grau, (Enclosure No. 2). Above these beds a sequence of oolitic dolomites, siltstones and minor shale comprise the upper Cambrian Petit Jardin formation which attains a thickness or 335 feet, (Plate XVI).

The Cambrian outcrops are separated from those of the St. George group by faults on each flank, but are followed conformably by the St. Georges group over the crest of the arch. The contact between the March Point and the Petit Jardin formations is believed to be conformable and in the field is a rather difficult contact to detect. The break between the two formations is based on lithology and is taken at a point where the calcareous strata of the Petit Jardin formation are in contact with silty or arenaceous beds below.

No hiatus was recognized between the Cambrian and the St. George group so the possibility arises that the basal unit of the latter group is actually Cambrian in age. Unfortunately the bottom unit of the St. George group is unfossiliferous so there are no clues on which to base a decision. The Kippen formation of lower Cambrian age and the Precambrian upon which these Cambrian formations rest are not exposed in this area, so that the thickness figure obtained for the March Point formation must be considered as only a portion of the total footage.

The following are the authors measured sections of the Cambrian which are divided into the two formations as defined by Lochman (1938):-

March Point Formation

Section measured ascending from the anticlinal axis located one and one half miles southwest of March Point to the contact with the Petit Jardin formation two and one half miles to the northeast, (Lithology Log Enclosure No. 4).

Note the classification of bed thickness divisions used by the writer in measuring the sections is as follows:-

<	-	3"	=	Thin Bedding
3"	-	12"	=	Medium Bedding
12"	-	36"	=	Thick Bedding
36"	-	<	=	Massive Bedding.

Unit No.	Description	Thickness (Feet)
27	Dolomite - light brown, weathers same, fine grained, medium bedded, trace of pin-point porosity, friable, arenaceous, carbon-aceous, occasional thin layers of oolitic limestone.	25'

Unit No.	Description	Thickness (Feet)
26	Shale - dark grey to black, silty to arenaceous, very thin bedded, carbonaceous, slightly calcareous, micro-micaceous, brittle.	5'
25	Dolomite - dark grey to dark brown, weathers medium grey, medium grained, often oolitic, very slightly calcareous, very thin to thin bedded, often laminated, carbonaceous, fair porosity, black and brown chert pebbles very common throughout interval.	67'
24	Dolomite - medium grey, lithographic, medium bedded, very resistant to weathering, contains a concentration of algal heads, very hard, dense. Interbedded with Shale - greenish grey, thin bedded, silty to arenaceous, slightly carbonaceous, calcareous, ripple marks and mud cracks, medium hard.	8'
23	Dolomite - medium grey, weathers light brown, very fine to fine grained, thin to medium bedded, resistant to weathering, occasional vugs, very hard, dense. Occasional black and brown chert pebbles.	39'
22	Dolomite - medium to dark grey, weathers dark grey, oolitic throughout, thin bedded, carbonaceous, arenaceous in part, very hard, dense.	21'
21	Siltstone - medium grey, weathers same, thin bedded, friable, calcareous, slightly carbonaceous, very argillaceous, micaceous, glauconitic, medium hard, tight.	4'

Unit No.	Description	Thickness (Feet)
20	Dolomite - light to medium brown, weathers orange, lithographic to very fine grained, oolitic throughout unit, medium bedded, very resistant forming cliffs, carbonaceous, occasional calcite stringers, very hard, dense.	77'
19	Shale - greenish grey, platy, argillaceous, calcareous, brittle, brachiopods common.	3'
18	Shale - maroon to dark brown, silty, fissile to sub-fissile, micaceous, dolomitic, slightly carbonaceous, soft.	2'
17	Dolomite - light to medium brown, lithographic, typically oolitic throughout unit, medium to massively bedded, an occasional algal head occurs but no lattice development, very resistant, cliff forming, slightly carbonaceous, very hard, dense. A few dark grey shaly partings. Four thin interformational calcareous conglomerates are also present. Trace brown chert inclusions.	50'
16	Sandstone - light grey, weathers medium grey, fine to medium grained, thin bedded, clayey in part, calcareous, very slightly carbonaceous, medium hard, very well cemented with a calcareous clay matrix, tight.	75'
15	Conglomerate - medium to dark grey, weathers reddish-brown, very resistant to erosion, matrix a calcareous silty sand, inclusions of well rounded quartz and chert pebbles.	1.6"

Unit No.	Description	Thickness (Feet)
14	Siltstone - medium grey, weathers dark grey, very fine grained, thin bedded, calcareous, micromicaceous, medium hard, dense.	25'
13	Limestone - light grey, weathers same, fine grained, platy to thin bedded, poor pin-point porosity, gypsiferous, very hard, occasional shaly partings, tight.	6'
12	Limestone - light to medium grey, weathers medium grey, fine grained, thin bedded, bedding slightly irregular, knobbly texture, slightly carbonaceous, argillaceous in parts, trilobites throughout unit, medium hard, dense.	12'
11	Shale - medium to dark grey, papery to very thinly bedded, silty, micaceous, dolomitic, fissile, pyritic throughout unit, badly eroded, soft.	13'
10	Conglomerate - reddish brown, regular bedding plane, inclusions of chert and quartz pebbles, poorly cemented giving rise to cavities.	3'
9	Dolomite - medium grey, weathers dark grey, very fine to fine grained, thinly bedded, silty to arenaceous throughout, carbonaceous, indications of pyrite, well cemented, tight, dense, hard.	17'
8	Limestone - medium grey, weathers very light grey, crypto to micro-crystalline, thin bedded, knobbly texture, occasional algal heads, fetid odor on fresh surface, medium hard, dense.	21'

Unit No.	Description	Thickness (Feet)
7	Sandstone - greenish-grey, weathers same, very fine to fine grained, platy thin bedding, friable, very carbonaceous, calcareous, quartzite grains in a calcareous matrix, glauconitic throughout, occasional thin lenses of conglomerates which contain well rounded quartz pebbles, medium hard, tight. Occasional trilobites and gastropods occur throughout, Worm burrows are typical of unit.	32'
6	Siltstone - light to medium grey, weathers light grey, very fine grained, medium bedded, very argillaceous, calcareous, medium hard, brittle, tight.	15'
5	Sandstone - cream to light yellow, weathers light brown to orange, fine grained, medium bedded, calcareous, clean, hard, resistant and cliff forming, numerous zones where worm burrowing is common, tight.	22'
4	Sandstone - medium brown weathers reddish-brown, fine to medium grained, thick to massively bedded, very resistant to weathering, cliff forming, ferrugenous staining common throughout unit, trace of poor pin-point porosity, calcareous, hard.	28'
3	Sandstone - cream to light yellow, weathers same, medium-grained, thick bedded, bedding regular, fair to good intergranular porosity with permeability, carbonaceous, calcareous, micaceous, slightly glauconitic in parts, rare ripple marks and cross bedding, well sorted as to size, characteristic of unit are an abundance of very large worm burrows which average half an inch across and often intertwine, hard.	87'

Unit No.	Description	Thickness (Feet)
2	Sandstone - black, red and green, very fine grained, thin bedded, poorly sorted as to size, occasional rounded chert pebble, very well cemented matrix, calcareous, carbonaceous, argillaceous, hard, tight. Occasional thin argillaceous shale horizons.	115'
1	Sandstone - white to cream, often has a pinkish weathered tinge, fine to medium grained, medium bedded, cross bedded in parts, friable, clean, non-calcareous, trace of poor pin-point porosity, very resistant to weathering, very hard, tight. Rest of section covered.	73'
	Total	846.6'

Fossils from this formation were obtained in units 7, 12 and 19 but only the following could be identified among those collected by the writer because of poor preservation:-

Trilobites - Marjumia newfoundlandensis Lochman (Units 7 and 12).

Brachiopods - Obolus sp. (Unit 19).

Lochman (1938) has assigned the formation to the middle Cambrian and has tentatively correlated them palaeontologically with the Neolenus - Marjumia beds of middle Cambrian

in the Cordilleran region.

Petit Jardin Formation

Ascending type section from the contact of the March Point formation located three quarters of a mile southwest of Big Cove to a conspicuous fault on the west side of the same cove, (Lithology Log Enclosure No. 5).

Unit No.	Description	Thickness (Feet)
13	Dolomite - light brown, weathers orange brown to pink, very finely crystalline, well cemented with a non-calcareous cement, very slightly carbonaceous, medium to thick bedded, bedding regular, very resistant cliff forming, very hard, dense.	13'
12	Dolomite - light brown, weathers same, finely crystalline to cryptocrystalline, thin bedded, well cemented matrix, carbonaceous, argillaceous, medium hard, dense. Interbedded regularly with Shale - light to medium grey, arenaceous for the most part, very thin bedded, carbonaceous, very micaceous, clayey in part, medium hard, brittle.	40'
11	Dolomite - light to medium grey, weathers an orange brown colour, medium to thick bedded, regular bedding, resistant forming cliffs,	160'

Unit No.	Description	Thickness (Feet)
	medium grained, very carbonaceous in part, some horizons exhibit good to excellent porosity, other horizons are cemented with calcareous clay. The upper and lower portions of this interval contain small vugs in which permeability appears to be absent, medium hard.	
10	Shale - medium to dark grey, silty, very thin to papery bedded, fissile to sub-fissile, calcareous, argillaceous, medium soft. A few unidentifiable brachiopods collected in this unit.	15'
9	Dolomite - medium grey, weathers light to medium brown, microcrystalline, very thin bedded, laminated, clayey, carbonaceous, brittle, tight, dense.	3'
8	Dolomite - light to medium brown, weathers dark grey, characteristically oolitic, very thinly bedded, clayey to silty in texture, often laminated, trace of pin-point porosity, very slightly carbonaceous, medium hard.	15'
7	Siltstone - medium grey to light brown, weathers orange-brown, very fine grained, thin regular bedding, calcareous, very slightly argillaceous, well cemented matrix, hard, tight.	5'
6	Shale - light brown, weathers medium grey, platy bedding, non-calcareous, argillaceous, micro-micaceous, brittle, medium soft, recessive weathering.	5'

Unit No.	Description	Thickness (Feet)
5	Siltstone - light to medium grey, weathers same, medium bedded, arenaceous in part, calcareous, friable, some current bedding and ripple marks, very slightly carbonaceous, medium hard, tight.	15'
4	Dolomite - medium grey to medium brown, oolitic to very fine grained, thin bedded, trace of pin-point porosity, very slightly calcareous, carbonaceous throughout. This unit is crowded with trilobites and occasional shell fragments, very hard, resistant to weathering.	8'
3	Shale - dark greenish grey, thin bedded, silty, pyritic in part, very slightly calcareous, clayey, carbonaceous, laminated in part, micaceous, medium hard, brittle, trilobites common.	10'
2	Siltstone - medium grey, weathers same, medium bedded, arenaceous in parts, calcareous, slightly carbonaceous, micaceous, well cemented by a calcareous matrix, resistant to weathering forming cliffs, fetid odor when struck, hard, dense, tight. An interformational conglomerate occurs in this interval being 3 inches in thickness, a few trilobites.	40'
1	Shale - medium to dark grey, weathers same, papery to very thinly bedded, fissile to sub-fissile, often clayey, micaceous, calcareous, carbonaceous, soft, trilobites abundant.	6'
	Total.	335'

The identifiable fauna collected from the Petit Jardin formation consisted only of trilobites from units 1 to 4 of which the following have been named:-

Trilobites

Arapahoia raymondi Lochman
Coosella helena Lochman
Kingstonia walcotti Resser
Maryvillia arion Walcott
Millardia avitas Walcott
Talbotina solitaris Lochman
Welleraspis newfoundlandensis Lochman.

The faunas collected from these units are characterized by the abundance of Arapahoia raymondi Lochman, enabling Lochman (1938) to correlate these beds of the Petit Jardin formation with the oldest faunal zone assigned to the upper Cambrian series.

Ordovician System

General

Although the Ordovician rocks of the Port au Port Peninsula are gently folded and somewhat disturbed they have suffered comparatively little alteration and are less distorted than elsewhere on the Island. All known oil shows in Newfoundland have occurred in this System and on the Port au Port Peninsula hydrocarbon shows occur at several horizons. Consequently particular attention was devoted to the sediments of this sequence and area in the hope of finding oil field conditions.

A generalized, two-fold sedimentary sequence for the Ordovician is in evidence on the Port au Port Peninsula. During the early Ordovician a thick accumulation of miogeosynclinal carbonates were deposited which were eventually succeeded by the eugeosynclinal clastics of the Humber Arm group, during the middle Ordovician.

The oldest Ordovician rocks on the Port au Port Peninsula occur in a faulted wedge at the geographical base of Long Point. Elsewhere on the Peninsula beds of Cambrian age are followed, possibly without a break, (nc contact is

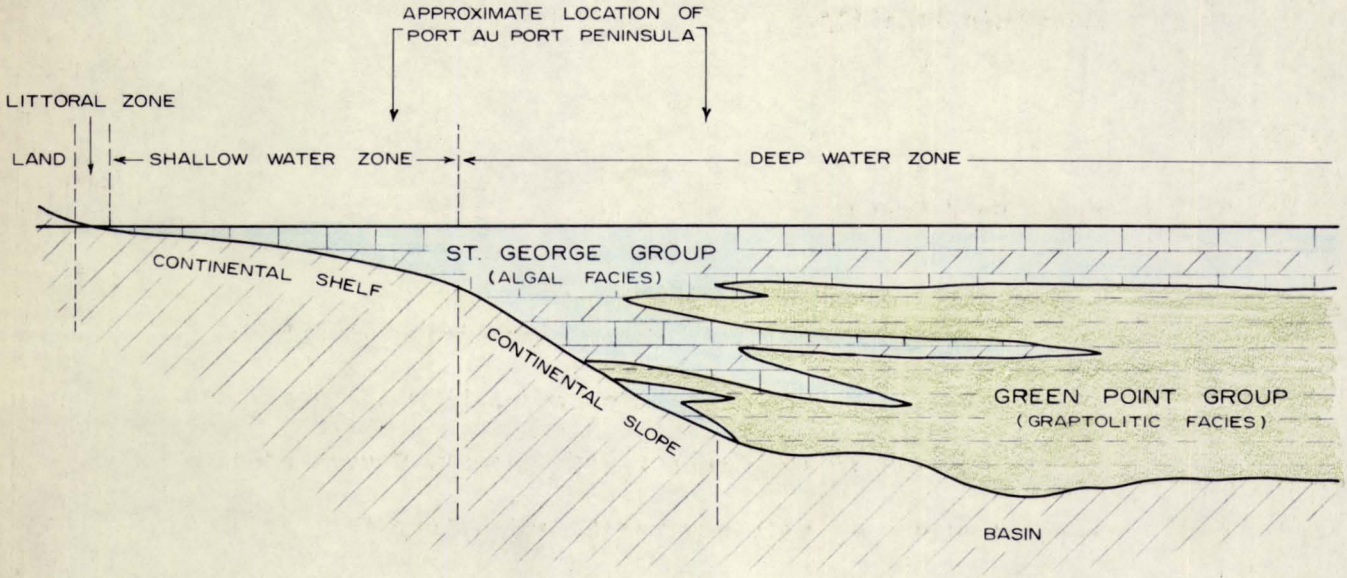


FIGURE N° 2

SCHEMATIC DIAGRAM OF THE FACIES RELATIONSHIP BETWEEN THE ST. GEORGE AND GREEN POINT GROUPS.

COMPILED BY H. CORKIN, DEC. 1964

exposed) by a succession of carbonates and interbedded shales, known as the St. George group. A disconformity separates this group from the stratigraphically younger sequence of limestones and shales of the Table Head group.

The massive dolomites of the St. George group are believed by the writer to have been deposited in shallow Ordovician seas while synchronous with this deposition in deeper basin areas, the Green Point group, a series of graptolitic shales were deposited. Although relationships between the St. George and Green Point beds are obscure, it is felt, that the former represents shelf deposition which obtains support from the presence of prolific algal reefoid structures which are intertidal in habitat and are definitely littoral in aspect, (Figure 10), while the latter represents deposition in a deeper part of the basin, (Figure 2).

The Green Point group on faunal evidence is placed as early Ordovician. It has been established by the graptolite, Staurograptus dichotomus found near the base of this group that the lowest portion of the Green Point is geologically older than any of the beds included within the St. George group. In the St. Pauls - Parsons Pond area the Green Point group overlies beds of Cambrian age and underlies St. George sediments which are greatly reduced in thickness.

The juxtaposition of these two dissimilar facies types on the Port au Port Peninsula in the vicinity of Rocky Point possibly occurred as a result of normal faulting resulting in the raising of the interfingering Green Point group to the surface. This also indicates that the break in slope between basin and shelf depositional environments occurs in the vicinity of the Port au Port Peninsula within the confines of Port au Port Bay, with the shaly basin facies possibly pinching out updip in the neighbourhood of the Goodyear anticline, Enclosure No. 1 and No. 2. The interbedded shales and limestones of the Green Point group being characteristic of a graptolitic basin facies to the north with the carbonate shelf facies of the St. George group occurring in the Port au Port area, (Figure 2).

Uplift resulted in erosion and the removal of approximately 200 feet of the uppermost St. George dolomite beds, (a calculated figure obtained by a comparison of lithologies from the same group occurring to the north). This gives rise to an extremely variable horizontal unconformity ranging in places on the Peninsula from a slight disconformity to an erosional surface having a relief of several feet between this group and the overlying limestones and calcareous shales of the Table Head group. However, bedding in general is concordant between these groups

indicating that no radical movements occurred at the close of the St. George period of accumulation.

A significant field discovery this summer was the presence of an unconformity between the Humber Arm and Long Point groups which is exposed on the coast immediately north of the Green Point faulted wedge. Previous to this finding, workers in the area had suggested that the Long Point group was probably an off-shore platform facies of the Humber Arm group.

The present writer is satisfied that the presently accepted view that Long Point rock fragments are incorporated in portions of the breccia composing Round Head is without foundation. Many hours were spent on this structure with only Table Head group fragments being found. None of the rock fragments in the breccia at Round Head are even vaguely similar to the Long Point limestones. Consequently the writer feels strongly that the formation of the breccia at Round Head was completed during Table Head times.

The shaly Green Point group and the limestone - clastic facies of the St. George group are considered in this report to be time equivalents, varying only in lithology and speed

of accumulation. The Green Point group will be described first in the usual ascending order from the oldest to the youngest.

Green Point Group (Lower Ordovician)

The Green Point group occurs on Port au Port Peninsula near the base of Long Point a mile east of the village of Lourdes, where it occupies a faulted wedge between the Humber Arm and Long Point groups, (Enclosure No. 1). The fault with the Long Point group is vertical and strikes at N 75° E forming a prominent escarpment trending southwest and paralleling the resistant basal beds of the Long Point group. The fault contact between the Humber Arm and Green Point groups is not as well expressed topographically but a strike of N 94° E with a southerly dip was easy to obtain. On field evidence it appears as if this latter dislocation is a normal fault which has dislodged the Green Point strata in such a way that close to the fault the beds are dipping steeply to the north-northwest.

As a result of the above mentioned faults only an incomplete section of the group is exposed as the top and bottom portions have been faulted out. In addition this

faulted relationship makes it impossible to obtain a clear understanding as to the normal stratigraphic position of these beds with respect to other groups in this area. The facies relationship of these beds with those of the St. George group as interpreted by the writer has been adequately discussed previously (Page 36) within the general remarks on the Ordovician System. It should be emphasized that the stratigraphic and geographic extent of the Green Point and St. George groups seem to be of paramount importance in the evaluating of petroleum potential of the Ordovician in western Newfoundland. All the oil seeps observed by the writer at Parsons Pond and St. Pauls came from the bituminous, argillaceous beds of the Green point group.

In summary, this group consists of interbedded black to brown bituminous shales (or argillites), light grey, fine grained sandstones, thin bedded limestones and intraformational limestone conglomerates. The following is the authors detailed description of the Green Point group located east of Lourdes which is an incomplete section due to the Upper and Lower contacts being obscured by faulting.

Green Point Group

Section measured from a fault contact with the Humber

Arm group, 1¼ miles northeast of the village of West Bay to a similar fault contact with the Long Point group a third of a mile further to the north, (Lithology Log Enclosure No. 6).

Unit No.	Description	Thickness (Feet)
11	Shale - black to dark grey, clayey, bituminous, fissile to sub-fissile, carbonaceous, micro-micaceous, very brittle, soft. Interbedded occasionally with Limestone - medium grey, weathers same, fine grained, thin bedded, bedding very irregular due to being associated with the fault contact with the Humber Arm group, very arenaceous in nature, carbonaceous, microcrystalline porosity, permeability absent due to cement, slightly friable, medium hard.	126'
10	Limestone - dark grey, weathers light medium grey, medium bedded, lithographic, argillaceous, slightly carbonaceous, gypsiferous in part, occasional pyrite cubes are found as inclusions. Two juvenile gastropods were found in this unit.	37'
9	Shale - black to very dark brown, clayey, recessive weathering, very thin to thin bedding, bituminous throughout, argillaceous, fissile to sub-fissile, carbonaceous, micro-micaceous, pyritic, trace of limonitic staining in parts, soft. Occasional thin graptolitic beds occur from which a poorly preserved meagre collection was gathered.	373'

Unit No.	Description	Thickness (Feet)
8	Limestone - medium grey, weathers same, lithographic, thin to medium bedded, argillaceous, slightly carbonaceous, nodular texture in outcrop, brittle, fetid odor on fresh surface, hard, dense, unfossiliferous. Occasional non-calcareous, dark greyish-brown stringers of bituminous shale are found and two six inch intraformational limestone conglomerate beds.	60'
7	Shale - medium to dark grey, chocolate brown in places, weathers medium grey to light brown, thin regular bedding, arenaceous, grades to a fine grained, Siltstone - light to medium grey, very micaceous, brittle, medium hard, tight. Occasional very thin stringers of medium grey, Limestone - occur throughout this unit.	107'
6	Limestone - medium grey, weathers same, lithographic, thin bedded, fetid odor on fresh surface, very argillaceous, dense, medium hard, unfossiliferous. Interbedded rhythmicly with Shale - dark grey to black, weathers medium grey, very thin bedded, argillaceous, carbon-aceous, sub-fissile, bituminous, slightly gypsiferous, pyrite nodules common, soft. Graptolites - are in abundance.	107'
5	Limestone - dark grey to dark brown, weathers medium grey, lithographic, thin bedded, occasional small calcite filled vugs, calcite stringers common, slightly gypsiferous, strong fetid odor on the fresh surface, unfossiliferous, hard, dense.	25'

Unit No.	Description	Thickness (Feet)
4	Shale - black to dark green, clayey to silty texture, mainly argillaceous, beds up to 4 inches thick, very carbonaceous, bituminous, very pyritic in content, fissile to sub-fissile, evidence of minor faulting, graptolites common throughout unit. Occasional Chert pebbles - black and dark brown, highly polished, rounded, approximately the size of a large pin head, very hard. An eight inch intraformational limestone conglomerate is located 75 feet from the top of this unit.	238'
3	Sandstone - light grey to very light brown, weathers yellow to orange, ferrugenous staining common, very fine to fine grained, thin to medium bedded, irregular bedding, slightly carbonaceous, sideritic in part, non-calcareous, mainly siliceous throughout, well cemented, tight, hard, resistant to weathering. Interbedded with occasional Limestone - medium to dark grey, weathers chocolate brown, crypto-crystalline to micro-crystalline, thin irregular bedding, calcite stringers common, argillaceous, very hard, dense.	134'
2	Shale - dark brown to black, some bottle green in colour, thin wavy bedding, distortion only mild, fissile and papery, very bituminous, carbonaceous, argillaceous, pyritic nodules, non-calcareous, soft and brittle, occasional Graptolites - occur towards the base.	54'
1	Limestone - dark grey, weathers medium grey, lithographic to crypto-crystalline, thin bedded, argillaceous, micro-micaceous, slightly carbonaceous, fractured, brittle, dense. This unit is highly contorted and mashed at the contact with the Long Point group. Trace Sandstone - light grey to very light brown, weathers dark grey,	20'

Unit No.	Description	Thickness (Feet)
	very fine to fine grained, thin bedded, well cemented, calcareous, resistant to weathering, hard, tight.	
	Total.	1301'

The fauna is unmistakably of earliest Ordovician time. Of the graptolites which occur in great profusion in unit 6 and sporadically in units 2 and 9 the following have been identified:

Dictyonema flabelliforme (Eichwald)

Staurograptus dichotomus Emmons.

St. George Group (Lower Ordovician)

This group, has its type section located on the Port au Port Peninsula where it is well exposed along the south coast, westward from The Gravels to a point between March Point and Sheaves Cove where it forms the resistant White Hills. The St. George group strikes from the Peninsula into

the mainland to form Table Mountain and continues in a northerly direction, resting on the Cambrian. It appears on the coast again in the Portland Creek area, and is fully exposed at Table Point. It is a thick group of dolomites and dolomitic limestones with but minor calcitic limestones and interbedded shales.

These strata aggregate more than 2,500 feet in thickness and they appear to rest conformably on upper Cambrian beds (Petit Jardin formation) without an observable break. As was stated previously, where the basal contact would normally be expected, it is heavily covered with vegetation, with no good exposures. It should be recalled however, that a considerable thickness of unfossiliferous sediments intervene between known horizons in both systems. For that reason a definite line of demarcation cannot be made and the beds in question must be considered as a transitional series of Cambro-Ordovician age until there is sufficient evidence to draw a more precise contact. The lateral relationship of the Green Point group and the St. George group has already been discussed on Page 37. The group is overlain disconformably by the Table Head group and this relationship holds true for all localities where there are exposures. This contact with the overlying Table Head group is seen

both northeast and northwest (Plate VIII) of The Gravels, in the various coves to the south of East Bay, in the Aguathuna Quarry, where the Table Head limestones lie upon an irregular surface with a relief of approximately one foot (Plate IX), as well as in the fault-line cliffs at Piccadilly located at the bottom of Piccadilly Bay. There is an even more conspicuous disconformity in the sea cliffs one mile north of Cape St. George where an erosional surface of 8 to 10 feet relief has been developed on the surface of the St. George beds, and the Table Head group has filled the hollows on this surface. There is, however, no angular discordance between them at any exposure.

Lithologically, the St. George group consists of light brown to pink oolitic dolomites, grey and black massively bedded limestones which split up laterally towards the west into thinner beds, minor bituminous shale horizons and a few bands of chert. The group in general weathers a bright yellowish-orange colour due to ferruginous staining (Plate XVIIIa), that gives to the cliffs along the south coast of the peninsula a striking appearance. Some of the beds have a peculiar brecciated appearance and these, when occurring near the top of the group, often emit a strong odor of petroleum when struck with the hammer. About the

middle of the group are some very well developed oolitic and pisolitic dolomites, the size of the grains passing from one to the other; corals and sponges occur in some of the beds and chert is disseminated throughout the group but to a lesser degree than in the Cambrian.

It contains a great number of Algal beds, some of the most conspicuous of which are found on the shore northeast of The Gravels, (Plate VII). A large part of the group is unfossiliferous, but there are zones which contain many varieties of organisms the most important of which include: Maclurea, Trimerella, Pleurotomaria, Orthoceratites, Trilobites, Obella, Lingula, Orthis, and Crinoid stems.

The following is the measured section of the St. George group from the "Type Locality" which starts at the contect with the Table Head limestones, 200 yards northwest of The Gravels, and continues as far as Big Cove on the Bay St. George shore. Within this section one proceeds downward in the group, toward the axis of the anticline which was mentioned in connection with Cambrian formations. It is not a simple descending section, as the St. George group undulates which must be considered when measuring, but the correlating of marker beds is simple. This section

is broken by occasional small faults, and in the vicinity of Ship Cove and Lower Cove is dislocated by faults of greater magnitude, but key beds enable the throw to be determined in most cases.

St. George Group (Type Section)

Section of the St. George group, descending from the contact with the Table Head Group, 200 years northwest of The Gravels and proceeding westward along the Bay St. George coast to Big Cove, a distance of 16 miles, (Lithology Log Enclosure No. 7).

Unit No.	Description	Thickness (Feet)
53	Limestone - light brown, lithographic, platy to very thinly bedded, carbonaceous, limonitic, slightly fetid odor, smooth texture.	3'
52	Limestone - medium grey to olive-grey, lithographic, marly, biostromal development of algae, which appear to play out laterally, few crinoids, dense, very hard.	2'

Unit No.	Description	Thickness (Feet)
51	Limestone - light brownish-red to olive-grey, lithographic to very fine grained, thin to thick bedding, hackly fracture, very argillaceous in parts, quartz geodes common in lower part with some being filled with calcite, irregularly bedded, forms escarpment, coquinal in part, fetid odor, very hard, dense.	17'
50	Algal Bed - limestone light grey, lithographic, irregularly bedded, top surface mounded and irregular, very hard, resistant, dense.	2'
49	Limestone - light red to olive green, mottled in part, lithographic to very fine grained, thin to thick bedding, regular bedding, smooth texture, hackly fracture, fetid odor, commonly ripple marked. Minor Shale - greenish grey, thinly bedded, gypsiferous, calcareous, fissile, with lenses of limestone.	18.4'
48	Limestone - light to medium grey, lithographic, thin bedded, regular bedding, cherty throughout, slightly argillaceous, slightly carbonaceous, fetid odor, smooth texture, medium hard, dense, resistant. Contains a brachiopod and gastropod fauna.	3'
47	Limestone - brownish-red to olive green, lithographic to very fine grained, thinly bedded, regular bedding, very argillaceous and developing almost into a shale, medium soft, dense, commonly ripple-marked.	3'

Unit No.	Description	Thickness (Feet)
46	Limestone - light brown to grey, lithographic to very fine grained, medium to massively bedded, regular bedding, resistant, hackly fracture, argillaceous, dense, vugular in part with some being filled with calcite crystals, limonitic, slightly fetid odor.	31'
45	Algal Bed - limestone light grey, lithographic, massive irregular bedding few crinoids, very hard, dense.	2'
44	Limestone - light brown to reddish weathering, fresh surface medium to dark grey, lithographic, thin to thick bedded, irregular bedding, fetid odor, hackly fracture, medium hard, dense, Algal layers throughout unit, slightly carbonaceous, very resistant.	10'
43	Conglomerate - Limestone - light to medium grey, lithographic, very thin to thinly bedded, irregular bedding, contains a wavy conglomeratic lense which disappears and reappears laterally, numerous black and brown chert nodules, Algae and brachiopods common.	3'
42	Limestone - light brown to light grey, lithographic, thick bedded, regular bedding, hackly fracture, fetid odor when struck, slightly argillaceous, few vugs with calcite crystals, resistant, very hard, dense.	12'
41	Limestone - light to medium grey, lithographic, medium bedded, irregular bedding, slightly fetid odor, dense, contains numerous	6'

Unit No.	Description	Thickness (Feet)
	algal developments. Trace Shale - red and green, argillaceous, platy bedding, laminated, calcareous, marly, gypsiferous, very slightly fissile.	
40	Limestone - white to cream, weathers light brown, lithographic, thick bedded, regular bedding, hackly, very argillaceous in part, slightly carbonaceous, top surface mounded and irregular, slightly phosphatic, limonitic, medium hard, dense.	9'
39	Dolomite - very light brown, weathers light brown, lithographic to very fine grained, thick bedded, regular bedding, very hard, dense. Occasional interbeds of red and green calcareous shale. Few beds of grey, massive, argillaceous, limestone.	37'
38	Covered Interval - located between the two bars of The Gravels. The occasional outcrop that does exist appears to dominantly consist of Dolomite and Limestone as in the unit above. A light grey limestone within this unit yielded a large brachiopod fauna.	650'
37	Dolomite - light grey, lithographic to very fine grained, thin irregular wavy bedding, very slightly calcareous, slightly argillaceous, marly, limonitic staining, hard, dense.	50'
36	Limestone - medium grey, lithographic, platy bedding, laminated in parts, current bedding is characteristic of unit, occasional small calcite filled vug, very argillaceous, brachiopods common.	6'

Unit No.	Description	Thickness (Feet)
35	Dolomite - cream to very light brown weathering, medium brown on fresh surface, fine to medium grained, medium bedded, regular bedding, extremely arenaceous, contains very finely disseminated hematite, very well cemented with calcite, hackly fracture, medium resistant, medium hard, dense. Trace Limestone - medium grey, medium grained, thin irregular bedding, medium hard.	30'
34	Limestone - light to medium grey, medium grained, medium bedded, regular bedding, well cemented, occasional very small vug containing quartz crystals, resistant, medium hard, dense, Algae occur throughout this unit.	50'
33	Dolomite - light brown, weathers same, lithographic, platy, thin regular bedding, often laminated, very slightly calcareous, hackly fracture, brittle.	5'
32	Limestone - medium to light grey, lithographic, thin to medium bedded, regular bedding, very argillaceous, well cemented, contains disseminated hematite, few crinoids, marly in part, smooth texture, hard, dense.	5'
31	Conglomerate - light to medium grey, matrix arenaceous, irregularly bedded, pebbles of brown chert and dark grey limestone, inclusions are pea grade in size, very poor pin-point porosity, mainly dense, very resistant, top surface is mounded and irregular similar to a slight disconformity.	3'

Unit No.	Description	Thickness (Feet)
30	Limestone - medium grey, weathers same, very fine grained, platy irregular bedding, laminated slightly, medium hard, dense, Algal throughout.	6'
29	Limestone - light to medium grey, very fine to fine grained, thick to massively bedded, regular to wavy bedding, poor pin-point porosity, some laminated beds, slightly to very arenaceous, black chert nodules common, numerous calcite filled vugs, fetid odor when struck, resistant cliffs.	52'
28	Dolomite - medium brown, weathers same, lithographic, platy to thin bedded, regular bedding, hackly fracture, limonitic staining, slightly fetid odor, hard, dense.	104'
27	Limestone - light to medium grey, lithographic, thin regular bedding, very argillaceous, commonly ripple-marked, numerous grastropods, and possibly other small fossils of muddy-bottom dwellers, poorly preserved.	10'
26	Limestone - medium grey, lithographic to very fine grained, thin irregular bedding, rubbly and hackly appearance, marly, slight limonitic staining, very well cemented matrix, medium hard, dense.	36'
25	Algal Bed - light grey, very calcareous limestone, lithographic, very irregular to wavy bedding, very hard, dense, slightly fetid odor, top surface mounded and very irregular.	20'

(At this point, 1/2 mile southwest of The Gravels, several normal faults break the section. The exact amount of throw cannot be accurately determined but is believed to be of a minor nature. An arbitrary figure of plus or minus 40 feet is suggested for the interval that has been faulted out).

Unit No.	Description	Thickness (Feet)
24	Dolomite - medium grey, weathers medium brown, lithographic, thin bedded, regular bedding, marly, slightly argillaceous, very slightly calcareous, resistant, hackly fracture, very hard, dense.	40'+ -
23	Dolomite - light brown to light grey, weathers same, lithographic, thick bedded, regular bedding, smooth to hackly fracture, strong fetid odor when struck, chert beds common, resistant, very hard, dense.	100'
22	Limestone - medium grey, weathers same, very fine grained, thin to medium bedded, regular bedding, numerous black chert inclusions, well cemented with calcite, marly in part, medium hard, dense. Algal throughout unit.	30'
21	Dolomite - medium grey to light brown, weathers light brown, fine grained, thin to medium bedded, regular bedding, very well	30'

Unit No.	Description	Thickness (Feet)
	cemented with calcite, very slightly calcareous, argillaceous in part, marly, hackly fracture, strong fetid odor. Black Chert pebbles common, very hard, resistant, dense. Algal throughout unit.	
20	Dolomite - light grey, weathers cream to light brown, lithographic, thin bedded, regular bedding, platy and laminated in part, very slightly calcareous in part, hard, resistant, dense. Trace of interbedded light grey Limestone - coarse grained, thin to platy bedded, regular bedding, poor pin-point porosity, medium hard, very argillaceous, contains an abundant gastropod fauna and other muddy-bottom dwellers.	45'
19	Limestone - light grey, weathers medium grey, lithographic, thick to massively bedded, regular bedding, well cemented, slight limonitic staining, very hard, dense, forms cliff face, Algal throughout unit.	25'
18	Limestone - light grey, weathers same, lithographic, thin to thick bedded, very irregular to wavy bedding, top surface mounded and irregular, very slightly argillaceous, black chert inclusions throughout, few ripple marks and mud cracks, extremely fossiliferous with various species of brachiopods and gastropods. (This unit occurs at Green Head approximately 3/4 mile southwest of The Gravels. From this point the coast swings in a true westerly direction and coincides closely to the true strike of the St. George group. Due to this factor the section descends very slowly over a great distance).	15'

Unit No.	Description	Thickness (Feet)
17	Limestone - light grey to brownish-grey, weathers medium brown, fine to coarse grained, massive regular bedding, trace of slight irregular bedding due to algae, very poor porosity, black chert nodules throughout, medium hard, mainly dense, resistant, cliff forming. Algal in part.	48'
16	Limestone - as above but regularly bedded.	10'
15	Dolomite - light brown to cream, weathers light brown, very fine grained, platy to thin bedded, regular bedding, hackly fracture, marly, very slightly calcareous in part, limonitic staining, fetid odor when struck, hackly fracture, well cemented, medium hard, dense.	28'
14	Limestone - very light to light grey, weathers very light brown, very fine grained, thin bedded, regular bedding, nodular texture, slightly fetid odor, very hard, dense, Algae very common throughout unit.	10'
13	Chert - black, lithographic, massive bedded, regular bedding, conchoidal fracture, resistant weathering, very hard.	3'
12	Dolomite - very light to light brown to pale green, weathers cream to light brown, medium grained, thin bedded, regular bedding, limonitic staining in part, trace of pyrite, poor pin-point porosity, medium hard. Trace occasional Chert - black to reddish brown, very hard, dense. A few interbeds of light grey, thin bedded limestone.	177'

Unit No.	Description	Thickness (Feet)
11	Limestone - light to medium grey, lithographic to very fine grained, very thin to thinly bedded, regular bedding, strong fetid odor when struck, very slightly argillaceous, hackly fracture, nodular texture, very hard, dense, Algal throughout unit. An intraformational 12 inch conglomerate occurs 20 feet below the top of this unit, the matrix is arenaceous in content and friable, inclusions are light grey limestone.	40'
10	Limestone - light to medium grey, very fine to fine grained, thin bedded, very slight irregular bedding, laminated in part, ripple marks common, mud cracks numerous, very slight pin-point porosity, Algal throughout unit, very hard. Trace of interbedded shale and dolomitic beds which are less resistant in general. Three thin beds (maximum 4 inches) of conglomerate occur within this unit. These conglomeratic beds are well exposed on either side of Man O'War Cove.	55'
9	Dolomite - medium grey, weathers cream to light brown, lithographic to very fine grained, thin to thick bedded, regular bedding, shaly and argillaceous in part, numerous calcite filled vugs, limonitic staining, trace of pyrite, medium hard, dense. At 50' from top of this unit is a 14 inch pink resistant quartzitic bed. At 63' from top is a 2 foot Algal bed having irregular bedding. At 70' is a small to medium grained conglomerate which appears to form a slight erosional disconformity, but lenses out laterally.	87'

Unit No.	Description	Thickness (Feet)
8	Dolomite, Limestone and Shale. Dolomite - medium brown, weathers same, lithographic, platy to thin bedded, regular bedding, slightly laminated, very slightly calcareous, medium hard, dense. Limestone - medium to dark grey, weathers medium brown, lithographic, massively bedded, regular bedding, medium hard, dense, slight fetid odor. Shale - medium grey to dark green, papery bedding, very argillaceous, fissile, very slightly calcareous, limonitic, gypsiferous, recessive weathering, medium soft.	110'
7	Limestone - light to medium grey, weathers medium to dark grey, very fine grained, thin to thick bedded, irregularly bedded and even wavy in nature, well cemented with calcite, Algal throughout entire unit, very hard, resistant, cliff forming, dense.	50'
6	Dolomite - medium brown to pale yellow, weathers pale yellow, lithographic, medium bedded, in part slightly laminated, trace of quartzite in a 4 inch layer which is pink in colour and well silicified. Unit very hard, resistant to weathering, dense.	30'
5	Limestone - medium grey, weathers same, very fine grained, very thin to thinly bedded, regular bedding, arenaceous, very slightly carbonaceous, poor pin-point porosity, nodular to hackly texture is characteristic, resistant to weathering, mainly dense.	45'

Unit No.	Description	Thickness (Feet)
4	Dolomite - light grey, weathers same, lithographic, massive regular bedding, very slightly calcareous, resistant weathering, very hard, dense, a few small calcite filled vugs.	70'
3	Limestone - medium grey, weathers same, lithographic to very fine grained, medium bedded, regular bedding, argillaceous, slightly carboneceous, marly, smooth texture, limonitic, gypsiferous in part, Coquinal limestone, yield ag abundant small fossils of muddy bottom dwellers which include both brachiopods and gastropods, brittle, recessive weathering. Many of the shells have been highly phosphatized, well exposed on east side of Ship Cove. (This unit is exposed on both salients of Campbell's Cove. This same interval is exposed in a westerly direction for the next 9 miles due to the cliffs following the strike from Campbell's Cove to Jerry's Nose. In addition three major normal faults located in Ship Cove and Lower Cove, have kept this unit in constant view along the coastline. These three normal faults have their upthrown side to the west thus keeping this unit visible until the horizontal beds come into contact with a fault at Big Cove).	15'
2	Dolomite - light grey, weathers same, lithographic, massive regular bedding, very slightly calcareous, slightly argillaceous, hackly fractured surface, cliff forming, very hard, dense. (On the west side of Pigeon Head there is a distinctive argillaceous horizon within this unit which contains both brachiopods and gastropods. From the structural aspect of Pigeon Head, it is seen that it is a faulted block, the beds to the east being up-thrown with respect to the block. Correlation of beds does	215'

Unit No.	Description	Thickness (Feet)
	not present a difficulty as the fossil horizon can be identified to the west of the fault block).	
1	Dolomite - medium grey, lithographic to very fine grained, medium bedded, regular bedding, occasional calcite filled vugs, limonitic staining, hackly fracture, slightly fetid odor when struck, some black chert inclusions, very hard, dense. (Basal beds below this unit are covered so the contact with the Cambrian cannot be seen. At Big Cove, it is believed that the actual Cambrian contact is not far below the exposed St. George group).	45' +
	Total.	2508.4

This gives a thickness for the St. George group in excess of 2508 feet. The basal beds would add somewhat more footage, but just how much cannot be estimated.

The following fauna was collected by the writer from the St. George group which indicates equivalence to the Beekmantown formation of Canadian age:-

Arthropods

Euchasma blumenbachi (Billings)

Cephalopods

Diphragmoceras sp.
Orthoceras explorator (Billings)
Protocycloceras lamarcki (Billings)
Tarphyceras prematurum Hyatt

Gastropods

Euconia etna (Billings)
Helicotoma tritonia Billings
Maclurites affinis (Billings)
Maclurites oceanus (Billings)
Maclurites rotundatus (Billings)
Murchisonia cf. M. obelisca Whitefield
Ophileta nerine Billings
Pleurotomaria normani Billings
Turritoma acrea (Billings)

Brachiopods

Archeorthis hippolyte (Billings)
Billingsella sp.

Porifera

Calathium sunstedi Billings

Algae

Cryptozoon proliferum cf. C. fieldii Fenton and Fenton.

Kindle, C.H. and Whittington, H.B. have recently recognized Talbotina solitaris Lochman and Kingstonia wallcotti Resser from algal beds at Campbells Cove and east of Felix Cove. These Cambrian fossils of the Petit Jardin formation are found in strata that have been previously considered typically Ordovician in age. This will result in the Cambro-Ordovician contact being placed within the St. George group.

Table Head Group (Middle Ordovician)

The type section for this group is displayed in the cliffs on the shore at and adjacent to Table Point which is located on the Northern Peninsula (Figure 1), approximately 50 miles north of Cow Head. Unfortunately the writer was unable to visit this locality due to the limited time at his disposal.

This group overlies the St. George group, and is separated from it by an erosional disconformity, (Plate IX). The Table Head group is well exposed throughout the peninsula, but the most complete exposure of this group is to be found on the shores of the mainland. The Table Head group is well exposed throughout the peninsula. In the

eastern section of the study area the basal beds are exposed in the salients of the coves and in the quarry at Aguathuna, where approximately 220 feet of the basal beds of this group are exposed. Other exposures of the group occur in the bluffs on the west side of Piccadilly Bay and from that point west to Cape Cormorant and Big Cove on the St. Lawrence Gulf coast. In the central portion of the peninsula, the continuity of the outcrop is displaced by several normal faults, which offset the group on the western side of the dislocations toward the north.

In several areas of the peninsula and especially along the Gulf shore between Cape Cormorant and Big Cove the eroded beds of the Table Head group are overlain with distinct angular unconformity by horizontal beds of Mississippian Codroy age. This is similarly true of the St. George group especially in the White Hills area, within the depressions of which are to be found Mississippian deposits.

The massively bedded limestones of the Table Head in conjunction with the dolomites of the St. George group have been bowed and thrown into a broad arch, whose axis trends towards the northeast to parallel the normal direction

of folding east of the peninsula. On the coast of the mainland, northeast of The Gravels, the Table Head and St. George strata outcrop in regular series, dipping northwest between 20^{o} to 40^{o}, and strike oblique to the shoreline. The ensuing measured section was obtained from this locality.

Table Head Group

Section of the Table Head group descending from the contact with the Humber Arm group, 1½ miles northeast of The Gravels to the contact with the St. George group approximately one mile southwest, (Lithology Log Enclosure No. 8).

Unit No.	Description	Thickness (Feet)
6	Conglomerate - light to medium brown, arenaceous, irregularly and wavy bedded, often lenses out completely, iron stained throughout, all inclusions are limestone derived from reworked Table Head sediments. This hiatus is much more definite than the one occurring at the base of the group.	9" (maximum)

Unit No.	Description	Thickness (Feet)
5	Shale - black, papery to very thinly bedded, laminated in part, fissile to sub-fissile, carbonaceous, calcareous, argillaceous, very gypsiferous, a few thin lenses of limestone which lense out laterally.	20'
4	Limestone - medium to dark grey, weathers light grey, fine grained, thin to medium bedded, regular bedding, argillaceous, very slightly carbonaceous, coquinal in part, marly, occasional small calcite filled vugs, medium hard, dense. Interbedded in a 70-30 ratio with Shale - medium to dark grey, weathers same, papery bedding, very slightly gypsiferous, micro-micaceous, slightly carbonaceous, very calcareous, fissile to sub-fissile. Some of the shale is platy and laminated. The shale is very fossiliferous carrying a varied graptolitic fauna.	40'
3	Limestone and Shale - Interbedded as above. Limestone - dark grey to black, weathers black, very fine grained, thin to medium bedded, regular bedding, smooth texture, very well silicified, slightly argillaceous, ripple marks common in some beds, indication of limonitic staining, fetid odor when struck, contains numerous brachiopods and a few trilobites. Shale - Interbedded with the Limestone, medium grey, weathers light grey to light brown, clayey, very thin to thinly bedded, laminated in part, fissile, brittle, non-calcareous, unfossiliferous.	38'
2	Limestone - medium grey, weathers same, very fine to fine grained, well cemented with calcite,	741'

Unit No.	Description	Thickness (Feet)
	thick to massively bedded, regular bedding, resistant, cliff forming, argillaceous, slightly carbonaceous, occasional ripple marks. Fossils occur throughout this unit and include the following - brachiopods, gastropods and pelecypods plus other muddy-bottom dwellers. A thick concentration of gastropods occurs within the lower 100 feet of this interval where the Limestone becomes very argillaceous.	
1	Conglomerate - A very slight disconformity occurs at the contact with the St. George group. Conglomerate is a medium rusty brown, arenaceous matrix, friable, calcareous, recessive weathering, dense. Pebble inclusions consist of Chert, Quartz and Limestone. This conglomerate is well exposed in the Quarry at Aguathuna and again at the contact 200 yards northwest of The Gravels, (Plates IX and VIII).	0.25'
	Total.	840'

The Table Head group of the Port au Port Peninsula and neighbouring area yields a prolific fauna which is poorly preserved for the most part and difficult to collect. The majority of previous workers concerned with the Table Head group have found it convenient to divide the faunas into two types, those collected from the interbedded shales and limestone, and those obtained from the more massive

limestone below. The present writer believes a more practical and accurate threefold division, corresponding to upper, middle and lower units of the Table Head group can be easily proven on faunal grounds and to a lesser degree on lithology types. The upper Table Head group is characterized by a prolific graptolitic fauna with other fossils being completely absent, the middle Table Head is typified by trilobites as the most common fossil, accompanied by a few brachiopods and ostracods. The lower Table Head may be identified by the great number of varied and unrelated species that occur within this unit. Arthropods, cephalopods and gastropods are common but trilobites are rare. Other faunal types within this lower unit include ostracods, straight and coiled nautiloids and sponge spicules.

The following is a list of the fauna collected by the writer from the Table Head group northeast of The Gravels and on the Port au Port Peninsula from Belman's and Lead Coves, the anticline to the south of Round Head and from the cliffs between Big Cove and Cape Cormorant on the Gulf shore. The fauna is divided for convenience into the threefold classification outlined above which is based on distinct faunal and lithology types:-

1) Upper Table Head - Dark carbonaceous shales and limestones.

Arthropoda

Megalaspis huttoni (Billings)

Brachiopoda

Leptobolus cf. L. walcotti Hoedemaeker

Graptolites

Climacograptus parvus Hall
Climacograptus sp.
Didymograptus sagittiformis Ouriey
Diplograptus sp.
Glossograptus whitfieldi (Hall)
Trilograptus plumosus Hall
Trilograptus sp.
Tetragraptus quadribrachiatus (Hall)

2) Middle Table Head - Thin bedded, rubbly, dark grey limestones and light grey arenaceous limestones.

Cephalopoda

Dawsonoceras primus (Billings)

Gastropoda

Maclurites sp.

Trilobites

Anisonotus glacialis (Billings)
Ampyxlaeviusculus (Billings)
Bronteopsis gregaria Raymond
Carolinites sp.
Cersurinus polydorus (Billings)
Cybele mira (Billings)
Endymionia schucherti (Clarke)
Harpides concentricus Billings
Megalaspis huttoni (Billings)
Nileus scrutator Billings
Niobe lineolata (Billings)
Niobe merrisi (Billings)
Niobe quadraticaudata (Billings)
Robergia schlotheimi (Billings)
Scheerenochus deserius (Billings)
Telephus americanus Billings.

3) Lower Table Head - massively bedded, rubbly limestones.

Arthropods

Ectenonotus westoni (Billings)
Illaenus sp.
Leperditia concinnula Billings.

Brachiopods

Aporthophyla aurora Billings
Obolus sp.

Cephalopods

Dawsonoceras priamus (Billings)

Orthoceras sp.
Tarphyceras extensum Hyatt
Vaginoceras placator (Billings)

Gastropods

Eccyliomphalus cf. E. distans (Billings)
Hormotoma augustina (Billings)
Maclurites acuminatus (Billings)
Maclurites sp.

Porifera

Archaeoscyphia minganensis (Billings)
Calathium fittoni Billings

The Table Head group had prior to 1956 been considered to be of the same age as the Chazy group of New York. In 1956 G.A. Cooper's correlations led him to consider this group to be, at least in part, older than the Chazy group but post Canadian in age. The writer accepts Cooper's age determination so therefore the Table Head group in this report is regarded as being Middle Ordovician in age.

Cow Head Breccia

Of all the formations and groups that occur on the Port au Port Peninsula, none are so complicated and poorly understood as the Cow Head Breccia. The Breccia derives it's name from the excellent exposure on Cow Head Peninsula about 100 miles north of the study area which the writer was able to visit.

In the area of study the Cow Head Breccia occurs at or near the base of the Humber Arm group and is characterized by it's discontinuous distribution and variable thickness. In places a series of lesser breccias and conglomerates succeed the main mass and are interbedded in the basal part of the Humber Arm group or the graptolitic shales of the upper Table Head group.

In general, there appears to the writer to be two distinct classes of breccias in western Newfoundland, those intercalated in the Humber Arm sequence, (Plate IV) that Neale and Rodgers (1963), consider a klippe, and those intercalated in the strictly autochthonous sequence of limestones and graptolitic shales overlying the Table Head. It should be pointed out that the writer found no supporting

evidence for Neale and Rodgers hypothesis for the existence of a klippe in the Port au Port area and therefore does not accept it. All the breccias or series of conglomerates in the Cow Head region (except possibly Daniels Harbour, etc.) belong to the first class, as also the breccias and related finer grained clastic limestones in the type Humber Arm (e.g. the limestone at McIvers). At several places the breccias may be seen to be enclosed above and below by fine grained, dense limestones with interbedded dark shales. The limestone and shales, represent the sediments that are characteristic of the environment, with the breccias being washed in from outside.

Breccias of the first class do occur on the Port au Port Peninsula although the only obvious one observed by the writer are those in the "Green Point" beds on the east side of Long Point at it's base (just to the north of the boat slip). Typical of the second class of breccia are those on the <u>east</u> coast of East Bay about one and a half miles north of Port au Port (under the large fuel tanks of the U.S. Base), the breccias at Cape Cormorant, at South Head, at the mouth of Smelt Brook which flows into Piccadilly Harbour and within the brook itself, on the flanks of the anticline to the south of Round Head, and

at both salients of Big Cove on the Gulf shore. The writer is convinced on faunal evidence that the Round Head Breccia can essentially be correlated-as to stratigraphic position, composition and origin - with breccias of uppermost Table Head group age (mid-Ordovician) and is analogous to those breccias belonging to the second class. We are not considering any of the Mississippian breccias at this point. These Ordovician breccias of the second class, are in the main, composed of limestone boulders and smaller fragments of unquestionable Table Head origin (knobbly-nodular-looking limestone beds underlying the shaly upper members of the group).

A typical exposure of a breccia classified in the second class occurs on the east coast of East Bay about 1½ miles north of the village of Port au Port (under the fuel tanks of the U.S. Base). In this vicinity the breccia is a medium grey colour, made up for the most part of limestone pebbles 1 to 2 inches in diameter although boulders and slabs up to 4 feet do occur. The breccia is irregularly bedded, striking almost parallel to the coast and dipping to the northwest at angles up to 48°. The breccia here overlies a 5 foot sandstone layer, which in turn overlies a series of black shales and thin bedded

light grey limestones. The coarse breccia grades upward into a shaly conglomeratic mass, and then into the dark greenish shales and sandstones of the Humber Arm group. The thickness of the breccia at this location varies from 50 to 260 feet and in attitude is conformable with the Table Head group beneath and the Humber Arm above. At this same location a few dolomitic and chert fragments were observed which could have been derived either from Table Head strata or the upper part of the underlying St. George group.

At this locality as well as other areas on the Peninsula belonging to this second class of breccia the coarseness of the inclusions appear to have no real significance as far as it's origin is concerned. One can trace a breccia along the strike and, where in one area blocks and boulders may be fairly large and rewarding in the number which yield fossils, further along the strike the fragments dwindle in size and the possibility of finding fossils seems to vanish. It may also be added that these breccias are widespread in distribution but vary greatly in thickness at different localities.

Another example of a breccia belonging to the second class was studied at Cape Cormorant. At this locality, angular, coarse blocks up to 5 feet in diameter similar to those in the Cow Head Breccia, in beds up to 10 feet thick are encounted and attempts have been made by various workers to associate these with the nose of a thrust fault. Even here the breccia and interbedded limestones and shales are conformable with underlying massive limestones, dipping at the same angle. At all other locations mentioned above the conglomeratic breccias are not confined to tectonic trends. The outcrop of breccia and it's contact with the carbonate rock at Cape Cormorant is not as clear cut as one might desire and in addition the carbonates are greatly disturbed. The beds are not only contorted but are displaced by numerous minor faults near the contact with the breccia. As the cliffs are followed in a southwesterly direction the carbonate rocks gently descend, with the dip decreasing as one proceeds. Two and a half miles along the shore the rocks are overlain by a group of conglomeratic breccias dipping at the same angle. These are the same breccias as those that occur at Cape Cormorant. The intervening area between these two brecciated exposures can only be interpreted as an

asymmetrical anticline which has been complicated by faulting on the northwest side. Faulting which did occur obviously accompanied the folding which occurred at some time after the deposition of the breccias. This breccia reappears at the northern salient of Big Cove on the Gulf of St. Lawrence side of the peninsula. Due to folding, Big Cove has a synclinal structure which is pitching steeply towards the west. Erosion has resulted in each salient of the cove exhibiting huge masses of these conglomeratic breccias, and in this locality there is no evidence of any faulting except for a displacement immediately north of Big Cove. Round Head consists of an 800 foot exposure of a homogeneous mass of limestone blocks, which are large in size, angular, and of Table Head origin. A vague but definite attempt at bedding may be observed in the northwest cliff-face of this structure.

The ages of the fragments in the breccias of the first class or Cow Head type range from middle Cambrian to middle Ordovician, as proven by Kindle and Whittington, (1958). The occurrence of this breccia type at several stratigraphic horizons is obvious. The writer is in complete agreement with the above authors age determination, Figure 3.

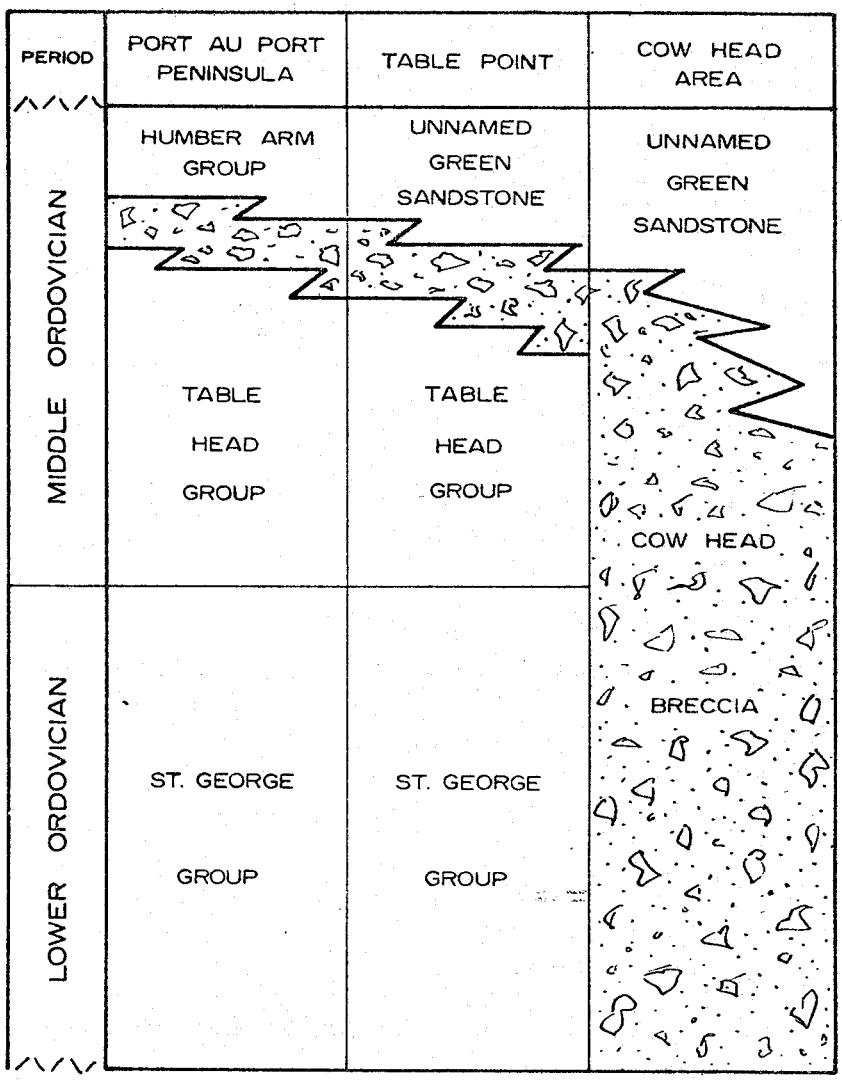


FIGURE N° 3

CORRELATION AND AGE OF THE COW HEAD BRECCIA

COMPILED BY H. CORKIN, DEC. 1964

The breccias of the second class are younger than Table Head, but need only be very slightly younger, since in the writer's opinion they must be older than the Long Point, which is located about the middle of the middle Ordovician.

Now whether Round Head is of the first or second class, is a difficult problem and one which has been avoided by geologists working in the area. The writer studied Round Head in some detail and believes, it belongs to the second class. Breccia was found all around the anticlinal area to the south of Round Head, suggesting a breccia near the base of the autochthonous shales above the Table Head, and it seems logical to the writer that Round Head is just a bigger mass of the same. This is not the conclusion of other workers in the area and it is hard to determine exactly what they thought; in any case they definitely tie the Round Head Breccia to the thrust fault postulated between the Humber Arm etc. and the Long Point, but whether as a simple fault breccia or a fault-line sedimentary deposit is never quite clear. The writer is of the opinion that the simple fault breccia idea can be eliminated, for the breccia certainly is sedimentary in origin, and the fault line idea can also

be removed as an unconformity was discovered this season at the basal contact of the Long Point group. Any thrusting along it must be contemporaneous with the upturning and overturning of the Long Point and Clam Bank, and hence is part - Lower Devonian.

The fragments in the Cow Head Breccia (or series of conglomerates) as previously stated range in age from middle Cambrian to middle Ordovician with the youngest inclusions containing trilobites of Table Head age. The trilobite, Nileus scrutator Billings (found in the matrix of the Cow Head Breccia) was obtained from a block within the Round Head Breccia so this complex appears to be younger than part of the Cow Head Breccia. Round Head is Ordovician, being older than Long Point, and so can not be tied to the thrust faults, if any, which would be younger. The author is of the opinion therefore that Round Head is simply an especially massive body of the same lime-breccia that appears above the Table Head at Cape Cormorant and on the east shore of Port au Port Bay beneath the tanks.

At the Cow Head Peninsula the uppermost strata of the "Cow Head Breccia" (exposed along the southeast shore

of the peninsula) are similar to the breccias just mentioned although coarser and of a more complex composition. On the faunal evidence mentioned above, only the upper part of the Cow Head Breccia could be equivalent. The lower part of the "Cow Head Breccia" sequence, however, exposed on the northern side of the Cow Head peninsula, is different in composition as well as in age, and has been proven by Kindle and Whittington (1958) to include fragments ranging in age from middle Cambrian to middle Ordovician. The only part of the Cow Head that could possibly be equivalent to the Cape Cormorant Breccia, and hence to Round Head, is the very highest part, best shown at Lower Head (immediately north of Cow Head), but also present on the southeast side of Cow Head peninsula. At Lower Head there are immense blocks of brecciated Table Head limestone which are identical to that which is found at Round Head.

As for the origin of all the rather coarse limestone breccias of western Newfoundland which contain recognizable fragments of nearby carbonate formations the writer is convinced that tectonic brecciation can be dismissed as a primary cause. It is necessary to imagine environmental circumstances which allowed "violent" erosion of carbonate

rocks of the Cambro-Ordovician sequence and approximately simultaneous "violent" transportation to an area of deposition. The breccias of the first class, such as the Cow Head Breccia , the writer believes were emplaced by gravity some type of submarine mechanism. For example slipping or slumping. The lime rubble under such circumstances would be deposited along and away from the foot of a great carbonate bank in deeper water just to the east, by slump off the scarped and probably faulted edge of the bank and partly as turbidity current deposits triggered from such slumping. A present day analogy of this above mechanism can be compared to the deposits forming now in deep water beside the Bahama Banks. At Broom Point, Martins Point, and Green Point, which were probably farther away from the source bank than Cow Head or Lower Head, the graded bedding in the breccias and fine grained deposits is obvious. The platy nature and angular shape of some of the breccia fragments is very similar to beach shingle accumulating today at Daniels Harbour and it is easy to visulize such angular fragments being dragged seaward and swept over the edge of an abrupt submarine slope.

The writer is harder put to understand the breccias of the second class, which are intercalated in the shale

above the Table Head. It is suggested that somewhere still farther west, faulting lifted the western part of the bank and depressed the eastern; black mud was deposited on the lower eastern part, but at times slumps of coarse debris descended from the higher western area. Some such reasoning as the above must be applied to Round Head, Cape Cormorant, and the east side of Port au Port Bay. The eastern edge of the original limestone bank, according to the writer, would have to be somewhere around Grand Lake or White Bay; the Cow Head and Humber Arm rocks were brought in from east of there, but the Cape Cormorant and the east shore of Port au Port Bay localities are clearly autochthonous, and the writer is inclined to place Round Head with them.

As for the relationship of the Round Head breccia to the "Possible Klippen" postulated by Rodgers and Neale (1963), the writer is of the opinion that it belongs to the area which is to be considered as autochthonous in any case. The patches on the Port au Port Peninsula mapped as Humber Arm group consist of rocks of so distorted a structure that they may represent the basal horizons of a far-travelled allochthonous mass

but more probably are merely incompetent beds. The Klippe theory of Rodgers and Neale is adequately outlined in the section of the report entitled, "Structure."

Humber Arm Group (Middle Ordovician)

This group obtains it's name from the type section which is located in the Humber Arm of the Bay of Islands. The Humber Arm group has a wide areal distribution on the Port au Port Peninsula and vicinities. The group outcrops continually along the northern shore of the peninsula from Shoal Point which is underlain by these sediments, (Plate XIVa) to Rocky Point which is located on the east coast of Long Point at the base; on the west shore from Three Rock Point to Cape Cormorant, in the cliffs of Big Cove, (Plate XIXa) and on the mainland 2 miles northeast of the village of Port au Port, (Plates V and VI).

The Humber Arm group is found exposed only in cliff faces or deeply entrenched rivers as the sediments are soft and recessive to weathering. Characteristically,

the group forms an undulating, relatively flat lowland topography which is easily recognized. As a result of the impervious nature of the eroded shale these areas are often covered with peat, to form bogs.

On the Port au Port Peninsula the entire group is sedimentary in origin consisting of a thick sequence of clastic sediments. The component beds of the group are so similar at different horizons, generally twisted and contorted, faulted and repeated, (Plate XIVa) and are subject to much lateral variation in all directions that the detail mapping of the group presents numerous problems. The group consists mainly of thick dark-grey, black, red and green fissile shales, with irregularly developed limestones and thin limestone bands and sandstones; it becomes sandy towards the top and finally passes into varicoloured, sandstones. A few bands of limestone conglomerate are also found. At the base there occurs a breccia containing limy Table Head inclusions, (Plate IV) which are discussed in the preceeding section entitled, "Cow Head Breccia."

The oldest beds of the group can be observed resting on the graptolitic shales of the Table Head group, one and a half miles west of South Head. At this location there

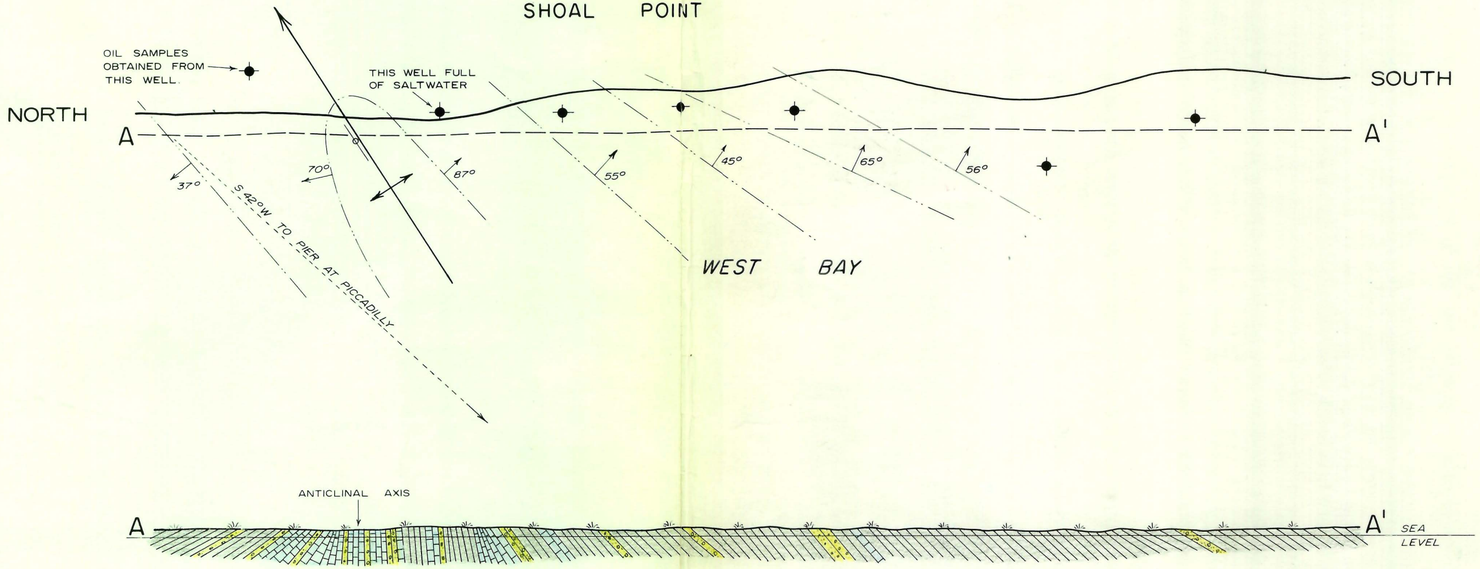
is a thick sequence of dark grey to black fissile shales with a few thin limestone beds. Limestone bands and stringers are also irregularly developed in the form of concretions, but occur in definite horizons. These are also seen in the upper portions of Harrys and Victors Brooks. These platy limestones and shales contain a sparse graptolitic fauna. The limestones are frequently bituminous and give a fetid odor when struck with a hammer. Concretions were found which when cracked open contained a central mass of "tarry" residue. The same horizon is found in the vicinity of Mainland on the Gulf shore but is much more sandy with sandstones replacing most of the limestones indicating the group to be more arenaceous towards the west.

The same group of beds also occur towards the base of Shoal Point and along the west shore of Piccadilly Harbour where they contain limestone concretions and an abundance of iron pyrite. The great concentration of limestone concretions at these two above locations, especially within the more calcareous portions of the shales indicates an abnormal depositional cycle.

A younger series of this same group, consisting of similar shales and limestones occur in the West Bay area between Harrys and Victors Brooks and at the top of Shoal

Point. This series is similarly bituminous and contain numberous beds of concentrated concretionary iron pyrites. Approximately two miles south of the tip of Shoal Point the thin limestones and shales form a sharp folded anticline the axis of which can be seen at low tide. This has led to the drilling of seven wells on the west shore of Shoal Point, the positions of which are indicated on Figure 4. The stratigraphic youngest beds of the Humber Arm in the area are those exposed in Harrys Brook where they are composed of dark green, arenaceous shales and brown to greenish sandstones which grade up into thinly laminated, friable, greenish sandstones.

On the east shore of East Bay the Humber Arm is very well exposed in perpendicular cliffs a mile and a half north of the village of Port au Port. From this point the group occurs continuously along the coast for a distance of fifteen miles, but actual outcrops within this distance are seldom seen. The lithology at this location consists essentially of steeply dipping dark coloured shales, thick bands of limestone breccias, conglomerates, and in general is richly veined in all directions with calcite, in the lower portion, while the younger beds are of the arenaceous type. The oldest part of the section consists mainly of



PROFILE AS IN 1938

LEGEND

- LIMESTONE
- SANDSTONE
- SHALE
- PEAT
- ABANDONED OIL WELL
- 45° DIP AND STRIKE
- ANTICLINE
- 1964 COASTLINE
- 1938 COASTLINE

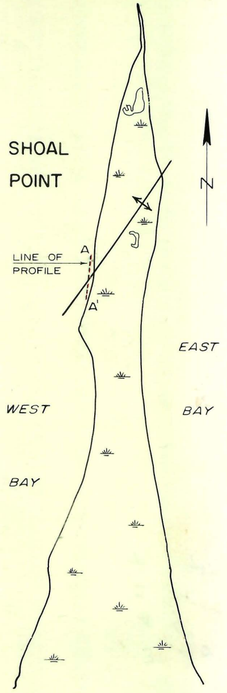


FIGURE Nº 4

PETROLEUM LOCALITY ON SHOAL POINT

PORT AU PORT PENINSULA

SCALE : 1 INCH = 100 FEET

NOTE : OBTAINED THROUGH THE COURTESY OF THE G.S.C.
ORIGINALLY DRAWN BY J.W. SULLIVAN (1940).
MODIFIED AND UPDATED BY H. CORKIN IN 1964

incompetent strata which are often repeated several times by folding and faulting, and some beautiful contortion is exhibited as shown in Plates V and VI, especially in the limestones. The strata commonly dip steeply at from 30° to 90° to the northwest and are often overturned or reversed and occasionally isoclinal folds are exposed.

It would appear from the lithology that a change in area level occurred within the region with somewhat shallower conditions prevailing during the deposition of the Humber Arm sediments, than existed throughout the preceeding stage.

This group is disconformable where ever it is in visible contact with the Table Head group which is evidenced by a hiatus, during which time the limy conglomerates were formed and incorporated into the basal portion of the Humber Arm group, (Plate IV). No angular unconformity between these groups was observed within the area of study. The contact with the overlying Long Point group is seen three quarters of a mile north of Rocky Point, (Figure 5) which is located on the east shore at the base of Long Point where a distinct unconformity occurs. Elsewhere on the peninsula younger beds of

Mississippian age (Codroy group) are in angular unconformity with the underlying Ordovician beds.

Due to the complexity of folding, the measuring of outcrops was difficult, so the purpose of the ensuing sections are to indicate the lithological character and components of the group rather than a detail measurement as to actual thickness. The following are three Humber Arm sections measured by the writer.

Humber Arm Group

Descending section from the southwest salient of Three Rocks Cove in a southwesterly direction to the contact with the Table Head group at Cape Cormorant, (Lithology Log Enclosure No. 9).

Unit No.	Description	Thickness (Feet)
13	Sandstone - (Quartzose), light to medium grey, weathers green, very fine grained, thin to medium bedded, cross-bedding typical, friable, non-calcareous, occasional thin conglomeratic beds a few inches thick containing inclusions of quartz and brown chert of approximate pea	150' +

Unit No.	Description	Thickness (Feet)
	size. (This unit is greatly disturbed by folding and thrust faulting. Several of the folds are overturned in a northwesterly direction and are broken. It is most difficult to ascertain a correct thickness, but recognizable marker beds do occur and the footage figure obtained by the writer corresponds closely to the equivalent unit at Victor's Brook).	
12	Shale - medium grey to dark green, papery to platy bedding, fissile, non-calcareous, slightly micaceous, brittle. Occasional thin stringers of dolomitic limestone and sandstone.	20'
11	Sandstone - (Quartzose) light brown to green, weathers dark green, fine to coarse grained, medium bedded, cross-bedded, clean, occasional ripple marks. A few thinly laminated, fissile shale beds.	347'
10	Sandstone - (Quartzose) light green, weathers dark green, fine to coarse grained, thin to medium bedded, regular bedding, minor cross-bedding, trace of glauconite, non-calcareous, friable, poorly cemented, trace of poor pin-point porosity. Occasional very thin beds of medium grey fissile shale.	190'
9	Sandstone - (Quartzose), medium brown to medium green, weathers dark green, coarse grained, thin to medium bedded, very arenaceous, friable, fair porosity throughout unit, very slightly carbonaceous, non-calcareous, brittle.	33'

Unit No.	Description	Thickness (Feet)
8	Sandstone - (Quartzose), light brown, weathers medium green, coarse grained, thick bedded, regular bedding, cross-bedding common, non-calcareous, argillaceous, well cemented with clay, very hard, tight, resistant weathering. Minor thin beds of soft, green, fissile shale.	46'
7	Sandstone - (Quartzose), medium brown to medium green, weathers dark greyish-green, medium grained, thin bedded, regular bedding, well sorted as to size, friable, poorly cemented, fair porosity, non-calcareous, very arenaceous, brittle, slight recessive weathering, conglomeratic near base. (Descending the section from this unit it is obvious that as a result of much folding and faulting much of the section is repeated. Subsequently much of the ensuing outcrop was not measured as correlation via marker beds was impossible. An estimation as to thickness was made and any error in footage if present should be of a minimal nature).	100'
6	Limestone - light grey, weathers same, very fine to fine grained, thin bedded slightly irregular bedding, very argillaceous in content, limonitic staining in part, very well cemented, occasional small calcite filled vugs, medium hard, tight. Trace of light greyish-green, fissile shale.	60'
5	Sandstone - (Quartzose), medium grey to medium brown, weathers dark brown, very fine grained, thin bedded, regular bedding, slightly argillaceous, carbonaceous in part, non-calcareous, micro-micaceous, well cemented with clay, cross-bedding common and even typical, tight.	48'

Unit No.	Description	Thickness (Feet)
4	Shale - very dark grey to black, weathers medium grey, very slightly argillaceous, very gypsiferous in parts of unit, papery to very thin bedding, slightly disturbed bedding but not faulted, slight limonitic staining, calcareous, recessive weathering. Obtained a small collection of brachiopods and two graptolite fossils.	205'
3	Conglomerate - light grey to light brown, coarse with boulders up to 4 feet in diameter, massive bedding when present, arenaceous, quartzose matrix, poorly cemented, friable, fair to medium porosity, boulders and pebbles are composed of limestone. Minor shaly partings near base of unit.	40'
2	Breccia - cream to light brown, weathers same, very poorly sorted, massively bedded to bedding completely absent, limestone inclusions are both coarse and angular with sizes ranging from 2 inches up to 4 feet across. Matrix is mainly an arenaceous limestone which finally does grade into a true sandstone within the bottom 100 feet. Interval is well cemented with calcite and porosity is absent, resistant weathering. (This is the talus breccia occurring at Cap Cormorant).	220'
1	Conglomerate - medium grey, weathers same, composed of limestone pebbles having an average size range of ½ inch up to two inches in diameter. Pebbles are very well cemented into a very fine grained arenaceous limy matrix, very hard, resistant weathering, tight. Top surface mounded and irregular.	186' +
	Total.	1645'

Humber Arm Group

Descending section on Victor's Brook. Measuring started approximately one mile from the mouth and proceeded up stream in a southwesterly direction for a distance of two miles, (Lithology Log Enclosure No. 10).

Unit No.	Description	Thickness (Feet)
19	Conglomerate - grey, limestone pebbles, chert and shale inclusions, silty matrix, semi-friable, calcareous, dense. Pebbles range in size from ¼ inch to 1 inch in diameter.	23'
18	Shale - variegated, mainly black and light green in colour, papery to very thin bedded, fissile to sub-fissile, argillaceous, carbonaceous, slightly micro-micaceous, very recessive weathering, gypsiferous, non-calcareous, brittle.	20'
17	Shale - variegated, maroon and light green, papery bedded, irregular bedding, fissile, argillaceous, micro-micaceous, non-calcareous.	15'
16	Shale - light to medium grey, very thin to platy bedded, regular bedding, very slightly calcareous, laminated towards base of unit, slightly argillaceous, sub-fissile, brittle.	115'

Unit No.	Description	Thickness (Feet)
15	Sandstone - (Quartzose), light to medium brown, fine grained, thin to medium bedded, micro-micaceous, well sorted, non-calcareous, well cemented with clay, tight, occasional limestone pebbles interbedded in light green fissile shale.	10'
14	Shale - medium grey to pale green, very irregular bedding, fissile, gypsiferous, non-calcareous, slightly argillaceous, micro-micaceous, brittle.	56'
13	Sandstone - (Mainly Quartzose), light grey to light green, fine to medium grained, thin bedded, irregular bedding, indications of cross-bedding, friable, a few conglomeratic pebbles one inch in diameter occur halfway down this unit.	40'
12	Sandstone - (Quartzose), medium grey to medium green, fine grained, carbonaceous throughout, very friable, poorly cemented, non-calcareous, micro-micaceous, trace of poor pin-point porosity. (A thrust fault breaks this unit but appears to be of small magnitude, distinguishable beds on either side of the fault are absent).	30'+
11	Shale - light grey to light green, thin to platy bedded, irregular bedding, non-calcareous, clayey, limonitic, some laminations in part, very slightly carbonaceous, brittle.	10'
10	Sandstone - (Quartzose), light to medium brown, weathers same, very fine to fine grained, cross-bedding characteristic, laminated throughout, friable in part, mainly well cemented, dense and tight, non-calcareous,	170'

Unit No.	Description	Thickness (Feet)
	a few thin conglomeratic beds a few inches thick occur which contain pea sized pebbles of quartz and chert.	
9	Shale - light green, papery to platy bedded, slightly irregular bedding, non-calcareous, gypsiferous, slightly micaceous, sub-fissile, brittle. Trace of sandstone as above but is more friable and weathered.	20'
8	Sandstone - (Quartzose), light to medium brown, some green, weathers dark brown due to iron staining, fine grained, medium bedded, trace of cross-bedding, carbonaceous throughout, non-calcareous, very friable due to arenaceous nature of the sediments, poorly cemented, trace poor pin-point porosity. Trace of conglomeratic stringers containing chert and quartz pebbles in shaly partings.	700'
7	Limestone - light grey, weathers same, fine grained, thin bedded, regular bedding, a few calcite filled vugs, well cemented, argillaceous, medium hard, dense.	50'
6	Sandstone - (Quartzose), light to medium brown, weathers medium brown, very fine to fine grained, thin bedded, poor porosity, slightly argillaceous, micaceous, mainly cemented with clay, some cross-bedding, tight.	50'
5	Shale - very dark green to black, tissue thin bedding, very fissile, limonitic, very slightly calcareous, certain units are carbonaceous, gypsiferous, recessive weathering.	180'

Unit No.	Description	Thickness (Feet)
4	Conglomerate - light brown, weathers dark brown, very fine to fine grained, arenaceous quartzose matrix, well cemented with clay, inclusions are pebbles of green sandstone and grey limestone, resistant and hard.	20'
3	Shale - dark grey to black, weathers dark green, argillaceous, very fissile, slightly calcareous, micro-micaceous in part. Trace of brown and green pea sized chert pebbles, recessive weathering.	67'
2	Sandstone - (Quartzose), light grey to light green, weathers medium grey, thin bedded, regular bedding, very fine grained, clayey, non-calcareous matrix, micaceous, dense, medium hard, resistant. Contains a few green limestone inclusions approximately ½ inch in diameter.	21'
1	Conglomerate - medium grey, weathers light to medium brown, irregularly bedded, calcareous, sandy matrix, very slightly carbonaceous, very poorly sorted, very hard, dense. A maximum of 30 feet of this unit is exposed, the rest of the section is covered.	30' +
	Total.	1627' +

Humber Arm Group

Descending section approximately three miles south

of the tip and proceeding southward along the west side of Shoal Point to the base, (Lithology Log Enclosure No. 11).

Unit No.	Description	Thickness (Feet)
16	Shale - maroon, medium green and dark grey, papery to thin bedded, strata almost vertically dipping, clayey, fissile to sub-fissile, argillaceous in part, non-calcareous, soft, brittle.	52'
15	Limestone - medium to dark grey, weathers medium grey, lithographic to micro-crystalline, thin irregular bedding, laminated in part, slightly argillaceous, dense, tight.	125'
14	Shale - dark black, clayey, tissue thin bedding, disturbed bedding, gypsiferous throughout, non-calcareous, bituminous, very fissile, very soft, carbonaceous in part, brittle.	198'
13	Limestone - medium grey, weathers very light to light grey, micro-crystalline, thin to thick bedded, regular dipping beds at 20° to the northwest, very slightly argillaceous, occasional calcite filled vugs, well cemented, medium hard, hackly fracture, slightly fetid odor, dense, tight.	60'
12	Shale - medium green, weathers same, very thin to thin bedded, slightly irregular bedding, calcareous, very slightly argillaceous in parts, micro-micaceous, fissile, very soft to soft. Trace of alternating thin beds of limestone as above (Unit 13).	60'

Unit No.	Description	Thickness (Feet)
11	Sandstone - light green, weathers medium green, coarse grained, thin to medium bedded, pin-point porosity, slightly carbonaceous, poorly cemented, friable, occasional interbeds of Shale - medium grey to pale green, micaceous, argillaceous, fissile to sub-fissile, non-calcareous, soft.	320'
10	Limestone - medium grey, weathers same, lithographic, argillaceous, gypsiferous, limonitic staining, Hackly fracture, resistant weathering, hard, dense, tight.	17'
9	Shale - dark green to black, very thin to thin bedded, fissile, non-calcareous, laminated and arenaceous towards base of unit, micro-micaceous, brittle, recessive weathering. Occasional very thin stringer of light brown, lithographic limestone.	56'
8	Shale - varicoloured in reds, maroons and greens, papery to very thin bedding, very irregularly dipping beds, fissile and rotten, slight folding indicated, non-calcareous, silty in parts, carbonaceous in part, micaceous, soft. Occasional thin beds of angular brown to black chert.	648'
7	Conglomerate - medium brown to green, massively bedded, arenaceous matrix, well sorted as to size, in many respects similar to a coarse grained grit, with pebbles composed of chert and quartz grains which are well rounded, very hard, resistant.	10'

Unit No.	Description	Thickness (Feet)
6	Sandstone - medium green, weathers same, medium to coarse grained, medium bedded, slightly to very glauconitic, clean, fair porosity, friable, slight iron staining in parts towards base of unit, resistant weathering, medium hard.	87'
5	Covered Interval - Indications are that this unit consists of variegated very fissile shales. No outcrop exists but talus of the above composition is in evidence.	79'
4	Shale - reddish-brown, very thin to thin bedding, beds regularly dipping at 29° to the northwest, ferruginous, non-calcareous, small scale ripple marks common, micro-micaceous, resistant, very similar to ironstone. Green coloured chloritic shales are also present, bentonitic beds occur and form excellent guide markers for correlating.	37'
3	Shale - medium grey to dark brown, papery bedding, very fissile, recessive weathering, much decayed, dolomitic, argillaceous, micro-micaceous, very slightly gypsiferous, brittle.	200'
2	Limestone - medium grey, weathers very light brown, fine grained, well cemented, hackly fracture, fetid odor, resistant, very hard, dense, brachiopods common, brachiopods in some beds are so concentrated that they form a shell bank or coquinal limestone. Occasional stringer of sandstone - light to medium grey, some light green, quartzose, calcareous matrix, glauconitic throughout, dense, tight.	50'

Unit No.	Description	Thickness (Feet)
1	Shale - varicoloured, thin bedded, argillaceous, non-calcareous, micaceous in part, slightly fissile, fragmentary, brittle, recessive weathering. Small sandstone concretions are also found up to 6 inches across. (The rest of the Section is covered by sand and gravel).	60'
	Total.	2059' +

The Humber Arm group is sparsely fossiliferous and those that do occur are restricted to the shale beds near the base. A meagre collection of fossils were obtained in these basal shales at Cape Cormorant, and on the east coast of East Bay, 1½ miles north of the village of Port au Port. The fossils obtained from this group included the following:-

Brachiopods

Neotreme sp.
Paterula amii Schuchert
Sowerbyella sp.

Graptolites

Climacograptus caudatus Lapworth
Climacograptus scharenbergi Lapworth
Phyllograptus sp.

Cooper (1956, p. 171) assigned Paterula amii Schuchert to his Porterfield stage which places the lower part of the

Humber Arm group in the middle to uppermost middle Ordovician. It appears as if the basal portion of the Humber Arm group is slightly younger than the uppermost Table Head shales and that there was no major interruption of deposition following Table Head time.

Long Point Group (Upper Middle Ordovician)

The Long Point group receives it's name from the dagger-like projection referred to as "The Bar" on the Port au Port Peninsula at which location these sediments occur. Long Point is the only area in Newfoundland where sediments of this age occur. Long Point strata occur along the south eastern shoreline of The Bar and are in contact with sediments of Devonian age which outcrop along the northwestern coast.

The Long Point group consists of an excess of 1,438 feet of very fossiliferous limestone, sandstone and shale which dips at approximately 40^{o} to the northwest. The basal portion of the Long Point group is very resistant to erosion and is exposed along the eastern margin of The Bar as an escarpment. This entire area therefore takes on the form of a cuesta and the distinct break in slope on the dip

slope of this feature is regarded by the writer as demarcating the contact of the Long Point group with beds of the Clam Bank group which are of Devonian age. An unconformity between the Humber Arm and Long Point groups was discovered for the first time this summer and is exposed at Rocky Point which is located at the Base of Long Point on the east coast, (Figure 5).

A composite section of the Long Point group follows which was compiled from measurements of outcrops on both shores of Long Point. The resulting thickness is a minimum figure as the top of the group is not exposed.

Descending section measured from a 25 foot covered interval occurring between the Clam Bank and Long Point groups at Misty Point, the western salient of Black Duck Cove. The outcrop extends along the west shore of Long Point in a northeasterly direction to within half a mile of the light house. At this point the section is continued on the eastern shore of Long Point and is well exposed continuously to within one and a half miles of the village of West Bay, (Lithology Log Enclosure No. 12).

59°05'

59°00'

58°55'

48°40'

LEGEND

GEOLOGICAL CONTACT

FAULTING AND MOVEMENT

STRIKE AND DIP 20

VERTICAL , OVERTURNED 65

ANTICLINE

CLIFFS , ESCARPMENT

CLAM BANK GP.

LONG POINT GP. (POORLY EXPOSED)

LONG POINT GP. (WELL EXPOSED BASAL UNIT)

HUMBER ARM GP.

TABLE HEAD GP.

COW HEAD BRECCIA (ROUND HEAD)

GREEN POINT GP.

GULF OF ST. LAWRENCE

Black Duck Cove

MISTY PT.

BLACK DUCK BROOK

BLACK DUCK BR.

WINTERHOUSE

UNCONFORMITY BETWEEN HUMBER ARM AND LONG POINT GROUPS

PORT AU PORT BAY

Clam Bank Cove

RED PT.

LOURDES

TEA COVE

ROCKY PT.

Salmon Cove

ROUND HEAD BRECCIA

WEST BAY

THREE ROCK PT.

Three Rock Cove

THREE ROCK COVE

GOODYEAR ANTICLINE

VICTORS BROOK

U.S.A.F. COMMUNICATION BASE

WEST BAY

FIELD GEOLOGY BY H. CORKIN DURING AUG. AND SEPT. 1964

DRAWN BY A. WERSE , FEB. 1965

GOLDEN EAGLE OIL AND GAS LIMITED

GEOLOGICAL MAP OF THE NORTHWESTERN AREA

PORT AU PORT PENINSULA

FIGURE N° 5

SCALE : 1.25 INCHES = 1 MILE OR 1 : 50 000

1 0 5 0 1 2 MILES

Unit No.	Description	Thickness (Feet)
12	Limestone - light grey to greyish-green, lithographic to micro-crystalline, thin bedded, regular bedding, micaceous, medium hard, dense, tight, recessive weathering. Very fossiliferous, containing mainly brachiopods and occasional coquina beds.	289'
11	Limestone - very light grey to medium grey, pale greenish in part, fine grained throughout, very thin to thin bedded, regular bedding, very arenaceous, friable, slightly carbonaceous near top of unit, numerous calcite stringers, matrix cemented with calcite, brittle, fractures into a platy talus, tight, occasionally fossiliferous - mainly brachiopods. (This unit is exposed in the central portion of Black Duck Cove).	97'
10	Limestone and Shale. Limestone - very light to light grey, very fine grained, thin regular bedding, very well cemented matrix, occasional calcite filled vugs. Interbedded on a 50% ratio with Shale - pale green to light grey, clayey, thin bedded, calcareous, laminated in parts, micro-micaceous, brittle. Minor thin beds of light brown, fine grained, calcareous, sandstone also exist towards base. Large portions of this unit are poorly exposed so that the actual thickness should be considered as an approximation. (This zone is exposed sporadically along the west coast of Long Point from Black Duck Cove to within half a mile of the Light House).	450'
9	Conglomerate - medium grey, sorting completely absent, bedding absent, limestone inclusions which range from pebble to boulder size, 2 feet maximum diameter, very well cemented sandy matrix, siliceous non-calcareous cement, very hard, tight,	4'

Unit No.	Description	Thickness (Feet)
	resistant weathering. (Exposed half a mile south of the Light House on the west coast of Long Point).	
8	Limestone - light to medium grey, lithographic to fine grained, thin to medium bedded, arenaceous, clean, pin-point porosity, slightly fetid odor, hackly fracture, medium hard. Occasionally fossiliferous with brachiopods. (This unit and the remainder of the Section is exposed along the east coast of Long Point).	125'
7	Limestone and Shale. Interbedded on a 50% ratio. Limestone - as above but unfossiliferous. Shale - olive green to dark green, clayey, platy, regular bedding, silty, carbonaceous, non-calcareous, very well laminated, ripple marks on thicker beds, brittle. Trace of thin bedded sandstone which forms a typical "Calcarenite".	53'
6	Limestone - light grey, weathers light brown, very fine to coarse grained, thin bedded, irregular bedding, very calcareous, shell fragments common, very well cemented, hackly fracture. Brachiopods and bryozoans common.	161'
5	Limestone - very light grey, weathers light grey, fine grained, thin to irregular bedding, fetid odor, very calcareous, carbonaceous, shell fragments common, coquinal beds exist in parts, hard, dense, tight. Occasional recognizable fossils include:- brachiopods, gastropods, pelecypods, and bryozoa. Worm burrows are also in evidence, Resistant and cliff forming.	73'

Unit No.	Description	Thickness (Feet)
4	Limestone and Shale - Interbedded, Limestone - light to medium grey, weathers light brown, micro to crypto-crystalline, very thin to thin bedded, bedding irregular, has a rubbly algal appearance, very calcareous, calcite stringers very common, argillaceous, medium hard, dense, tight, ripple marks common, fossils include brachiopods and gastropods, occasional trilobites, worm tubules common, and tabulate corals. Shale - bluish-grey, papery to very thin bedded, irregular bedding, very calcareous, laminated, slightly gypsiferous, clayey, brittle, unfossiliferous. Dip is to the west at 36°.	38'
3	Limestone - very light grey, weathers light grey, medium to thick bedding, occasional irregular bedding, unit forms a characteristic resistant platform along the entire east coastline of Long Point. Very calcareous, very fine to fine grained, shell fragments common often being concentrated into pockets. Numerous algal lumps and coral heads ranging in size from 3 inches to 3 feet across. Several places exist where lattice development has occurred, other fossils include:- brachiopods, orthocerids and bryozoans. The rocks are very porous where any algae occur.	80'
2	Limestone and Shale - Limestone - light grey, weathers very light grey, cryptocrystalline, medium bedded, nodular texture, argillaceous, unfossiliferous, fetid odor, medium hard, dense, tight. Interbedded with Shale - light brown to light green, clayey, very thin bedded, carbonaceous, non-calcareous, laminated, micro-micaceous, brittle.	10'

Unit No.	Description	Thickness (Feet)
1	Calcarenite - Quartzose limy-sandstone, light brown to light grey, very fine to fine grained, thin to medium bedded, arenaceous, friable, very calcareous matrix, poor to fair porosity, resistant weathering, cross-bedding common. (This section concludes one and half miles northeast of the village, of West Bay at a large fault which throws the Green Point group into contact with the Long Point group. At low tide near the boat slip at Rocky Point the unconformable contact with the Humber Arm is exposed).	58'
	Total..	1438' +

The limy basal unit of the Long Point group contains an abundant fauna but the group becomes more sparsely populated as the section is ascended. The fauna includes mainly brachiopods, but corals, bryozoans, gastropods, cephalopods, ostracods, crinoids, and trilobites also occur. Large mound shaped colonies of the Labyrinthites sp. a tabulate coral (incorrectly referred to as the bryozoa Monotrypa in Schuchert and Dunbar, 1934 p. 70) may be observed in the basal limestone member of the Long Point group, (Plate X). The heads of these corals are in a growing position along the base of Long Point, and stand out on the

weathered surfaces. Dr. T. Bolton, (personal communication) states that Labyrinthites is a good middle Ordovician index fossil that may be recognized all the way to Ellesmere Island.

The following were collected by the writer from the above measured section.

Arthropods

Leperditia fabulites Conrad

Brachiopods

Dalmanella rogata (Sardeson)
Dinorthis sp.
Glyptorthis sp.
Hesperorthis tricenaria (Conrad)
Opikina sp.
Rafinesquina alternata (Emmons)
Rafinesquina minnesatensis Winchell
Sowerbyella sericea (Sowerby)
Valcourea sp.
Strophomena incurvata (Shepard)

Bryozoa

Bioclastic limestone common with non-identifiable bryozoan fragments.

Corals (Tabulate)

Favistella sp. cf. F. halli (Nicholson)
Halysites labyrinthicus Goldfuss
Labyrinthites sp.

Gastropods

Maclurites bigsbyi (Hall)

Cephalopod

Gonioceras anceps (Hall)

Trilobites

Ceraurus pleurexanthemus (Green)
Cryptolithus sp.
Encrinurus cybeleformis (Raymond)

The above fauna appears to correlate with the Black River and earliest Trenton which are of middle Ordovician age, thus making the Long Point group younger than the Table Head group. G.A. Cooper (1956) on the basis of the brachiopods assigned the formation to the upper Wilderness stage (= lowest Trenton of Kay). Fossils occur from top to bottom of the group but no marked difference in age is apparent. The discovery of an unconformity between the Long Point group and older Humber Arm group eliminates a previously held concept that the Humber Arm sediments were synchronous with those of the basinal Long Point group.

It appears strange to the writer that the Long Point group should have ever been considered to be a basin facies with it's existing profusion of shallow water corals, bryozoans

and algae, (Plate X).

Due to the structural complexity of this group and it's close relationship with the Clam Bank group and Round Head a special section of this report has been devoted to outlining the author's interpretation which is a new concept to those that have previcusly been held and are non-acceptable to the writer.

Clam Bank Group (Siluro-Devonian?)

The Clam Bank group outcrops along the west shore of Port au Port Peninsula as a thin veneer which extends from Black Duck Brook to the northern end of Salmon Cove. The marine sediments in the upper part of the Clam Bank group on faunal evidence are considered to be lower Devonian in age, being the only occurrence of such sediments in western Newfoundland. No fossils have been obtained from the basal coarse brick-red weathering glauconitic sandstones so the writer believes that these sediments could possibly be Silurian in age. These sandstones above the Long Point appear to have been deposited continuously into the Clam Bank and suggests to the writer that approximately 800 feet

of redbeds and finer clastic sediments, represent most of the upper Ordovician and Silurian record. A disconformity could also be postulated between these two groups and thereby assign the Clam Bank entirely to the upper Silurian and lower Devonian. This interpretation would allow the fossiliferous limestone near the middle to demarcate the group boundary. In any case no angular unconformity occure between the Long Point and Clam Bank groups.

The Clam Bank strata are similarly disturbed to those of the Long Point group and are standing at high angles for the most part. A mile and half northeast of Clam Bank Cove the beds are standing up-right but flatten out in a north-easterly direction with dips to the northwest at between 47° and 40°, (Figure 5). In a southwesterly direction from the vertical strata the Clam Bank sediments are overturned as far as Salmon Cove, dipping in a southeasterly direction at between 45° to 70°, with the strike running obliquely to the coast. A special section in this report is devoted to the Long Point and Clam Bank groups and should be consulted for the structural relationship of these groups.

Lithologically the group consists of brick-red, coarse-grained, cross-bedded, friable, glauconitic sandstones,

bottle green siltstones, grey arenaceous shales, intra-formational conglomerates and light green fossiliferous chloritic limestones. The following section is that of the Clam Bank group as measured by the writer which gave a total thickness of 1,510 feet.

Clam Bank Group

The section commences at a point one and a quarter miles southwest of Clam Bank Cove. The section descends in both directions from this point. The following measured section descends in a northeasterly direction from this point along the coast to the contact with the Long Point group at Misty Point located on a salient to the west of Black Duck Brook, (Lithology Log Enclosure No. 13).

Unit No.	Description	Thickness (Feet)
11	Sandstone (Quartzose) - Typical redbeds, brick red, weathers reddish-brown to chocolate brown, medium to coarse grained, medium bedded, thinly laminated, iron stained, friable,	340'

Unit No.	Description	Thickness (Feet)
	glauconitic, non-calcareous, poorly cemented, trace of fair to good porosity, micaceous, cross-bedding, ripple marks and mud cracks common. Occasional Conglomerate - brownish-red, weathers same, arenaceous matrix, bed 18 inches thick, chert and quartz pebbles range in sizes up to ½ inch in diameter, very well cemented, resistant, very hard, tight.	
10	Shale and Siltstone - Shale - very similar to a mudstone, reddish-brown, weathers same, platy, non-calcareous, argillaceous, glauconitic, ferruginous, marly in part, micro-micaceous, medium soft. Interbedded with Siltstone - dark red, weathers reddish-brown, very fine grained, thin bedded, well cemented with clay, micaceous, carbonaceous, medium hard, tight.	178'
9	Sandstone - (Quartzose) - Typical redbeds, brick red, weathers same, fine to medium grained, thin to medium bedded, thinly laminated towards base of unit, cross-bedding common, occasional ripple marks, non-calcareous, slightly-carbonaceous, glauconitic, very micaceous, fair porosity, friable, medium hard but brittle, occasional worm casts. Minor reddish-brown, thin bedded, argillaceous shale.	280'
8	Limestone and Shale - Limestone - medium grey to light green, weathers light grey, lithographic to micro-crystalline, thin to medium bedded, slight irregular bedding in part, occasional calcite filled vugs, arenaceous, very hard, tight, very fossiliferous with brachiopods and a few corals. Interbedded with Shale - medium grey, thin bedded, clayey, micro-micaceous, sub-fissile, very slightly calcareous, brittle, ripple marks and mud cracks common.	90'

Unit No.	Description	Thickness (Feet)
7	Limestone - medium to dark grey, weathers light grey, cryptocrystalline, thin regular beds, arenaceous, slightly carbonaceous, micro-micaceous, ripple-marks, hackly fracture, fetid odor, calcite stringers, very hard, occasional brachiopod and shell fragments.	33'
6	Limestone - medium grey to light green, weathers light grey, very fine grained, medium bedded, poor to fair porosity, very arenaceous, carbonaceous, mud cracks common, brittle, mainly tight, occasional pelecypod casts.	85'
5	Sandstone - (Quartzose) - Typical redbed appearance, brick red, weathers dark red to chocolate -brown, very fine to fine grained, thin to medium bedded, cross-bedding common, arenaceous, friable, brittle, poor to fair porosity, slightly carbonaceous, high concentration of iron staining, resistant weathering.	83'
4	Sandstone and Shale - Sandstone - as above. Interbedded with Shale - a calcareous mudstone, medium green to medium brown, weathers same, micro-micaceous, slightly argillaceous, fissile to sub-fissile, platy, pyritic, soft.	10'
3	Limestone - light grey, weathers medium grey, lithographic, medium regular bedding, argillaceous, micaceous, slightly fetid odor, ripple marks, medium hard, tight, occasional brachiopod and gastropod.	103'

Unit No.	Description	Thickness (Feet)
2	Limestone and Shale - Limestone - light to medium grey, weathers medium grey, very fine to fine grained, thin bedded, regular bedding, very arenaceous, micro-micaceous, poor pin-point porosity, slightly friable, brittle, calcite stringers, medium hard. Interbedded with Shale - similar to a red mudstone, brick red, weathers reddish-brown, platy, very silty in parts, very thin bedded, laminated towards base of unit, slightly arenaceous, carbonaceous, calcareous, micro-micaceous, brittle.	207'
1	Sandstone - (Quartzose) - Typical redbed characteristics, brick red, weathers reddish-brown, fine to medium grained, medium bedded, cross-bedding common, thinly laminated in parts, glauconitic, trace of poor pin-point porosity, occasional ripple marks, poorly cemented, friable, carbonaceous, brittle, mainly tight.	101'
	Total..	1510'

The Clam Bank group is not as fossiliferous as the Long Point group but even so has furnished a respectable fauna. Fossils are concentrated in and mainly restricted to the two limestones outcroping to the southwest of Clam Bank Cove - one at the southwest salient of the Cove and the other 2½ miles farther southwest. The fauna includes corals, brachiopods,

bryozoa, gastropods and crinoids. The following specimens were collected:-

Brachiopods

Dalmanella cf. D. concinna (Hall)	Unit 3
Leptaena rhomboidalis (Wilckens)	Unit 3,6 and 7
Meristina sp.	Unit 3
Spirifer modestus? Maynard	Unit 3 and 7
Strophonella sp.	Unit 3 and 6.

Corals

Favosites sp.	Unit 3 and 8
Zaphrentis sp.	Unit 3.

Crinoids

Camarocrinus sp.	Unit 3, 6 and 8.

Gastropods

Platyceras sp.	Unit 3.

Molluscs

Sanguinolites sp.	Unit 3 and 7.

Numerous unidentifiable Trilobite (Unit 7) and Bryozoan (Units 3, 7 and 8) fragments were also collected.

In general the above faunas which were collected only from the limestones suggest an age close to the Silurian-Devonian transition. Cooper (1942, P. 1753) suggested correlation with the Keyser limestone of the central Appalachians, then considered uppermost Silurian but now commonly classed as basal Devonian, (Helderbergian). As mentioned previously the non-fossiliferous redbeds included in the lower part of the Clam Bank group may represent part of the upper Ordovician and Silurian.

Mississippian System

Carboniferous strata, late Mississippian-Codroy in age, occur here and there on the Port au Port Peninsula, resting indiscriminately in angular unconformity on many of the older units, but nowhere in contact with the Long Point or Clam Bank groups.

The Codroy group is best exposed on Red Island which is located approximately one mile to the northwest of Cape Cormorant, (see Frontispiece of Part II of this report). Here the group consists of a brick-red conglomeratic mass

and a similarly coloured course grained sandstone containing fragments derived from the Laurentian Mountains and local rocks and rests on the steep dip slopes of the Ordovician, (Plate XIXb). The bed beds owe their colour to iron oxide (hematitic cement) which binds the clastic components.

Another large area of this group consisting of red and green sandstones which have been faulted against the Cambrian occurs on the north coast of St. George's Bay immediately east of The Gravels. Stratigraphically higher in this group, occurs a mass of gypsum which is exceptionally well exposed near the mouth of Romaine's Brook east of Table Mountain, (Plate XVIa) and again southeast of Piccadilly Harbour. In Romaine's Brook the gypsum overlies sandstones pointing to the probability that the two were laid down in sequence as lacustrine or lagoonal deposits during the increasing dessication of these lagoons. In the Piccadilly area the gypsum appears in irregular mounds and hollows but the ground is so obscured that nothing is seen of the associated sandstones. No higher beds of the Codroy group are known in this area.

Large lenses of Codroy sediments are well exposed in Big Cove on the Gulf of St. Lawrence side of the Peninsula and also occurs as lenses in the depressed saddles of the

White Hills, (Plate XIII). An interesting and unusual feature of the Codroy group is it's association with the various coves situated along the southern shoreline of East Bay. Fossiliferous limestones are overlaid by sandstones and shales of Codroy age occurring as small isolated exposures in the bottom of the coves. These coves are but 200-300 feet in width and the sides meet the general coast at right angles. At the bottom occurs the Carboniferous limestone disturbed at the edges and highly veined and mineralized, galena, sphalerite, and copper sulphides being the chief minerals. At Lead Cove (in 1963) an unsuccessful attempt was made to mine the galena. The side walls of the coves are of Table Head limestone. The junction is faulted but the fault is not an ordinary one. Sections studied on the south side of the Peninsula show the phenomenon from it's beginning. The St. George limestone in which the dips are gentle has been eroded and undercut by the sea. The mass then began to slip between the major planes in the limestone, this operation keeping pace with the undercutting. Eventually the central mass has been let down several tens of feet, and in it's descent the edges have become upturned. Calcite crystallized along the joint-planes, and slickensided surfaces are in evidence. Where the limestone was overlaid by Carboniferous beds these were gradually let down on the decending

limestone till they reached the position in which they are seen, the rest of the Carboniferous having been removed by erosion. The beds are actually let down by faults, but these faults are in no way tectonic in origin, the phenomenon therefore is unusual.

Due to the intermittent nature of outcrops of Codroy age, combined with the horizontallity of the beds and small thickness of existing deposits it was considered that no meaningful information would be obtained from any measured sections. From observations made at the above named localities the Codroy group is composed lithologically of a heterogeneous assortment of maroon and green arkose, reddish-green cross-bedded micaceous sandstones, reddish limy basal conglomerates, gypsum, light brown fossiliferous limestones and dark coloured siltstones and shales.

It would appear that these lithological types found on the Port au Port Peninsula are characteristic of the strata belonging to the marine second stage of the group found at the type locality at Codroy. These sediments may be interpreted as the reworkings of eroded material which was incorporated into a basal conglomerate indicative of an encroachment of the Codroy seas over the Port au Port Peninsula. Throughout

most of the Codroy time the peninsula remained above sea level, forming the northwest margin of the Codroy subsiding depositional basin. Conclusive evidence that the Port au Port Peninsula approximated the strandline of the middle Codroy seas can be seen to advantage in "The Narrows" of Aguathuna Quarry, (Plates XVIIa and XVIIb). At this locality a cave or cavern composed of Table Head limestone is filled with fossiliferous Codroy sediments.

The following fauna was collected from Codroy limestone deposits at Lead Cove and Big Cove on the Gulf of St. Lawrence shore of the Peninsula:-

Arthropods

Paraparchites sp.

Brachiopods

Camarotoechia acadiensis (Davidson)
Martinia galataea Bell
Pugnax dawsonianus (Davidson)
Schuchertella sp.

Cephalopods

Orthoceras sp.

The Codroy group has been correlated, on palaeontological evidence, with the Windsor group of Nova Scotia. The Codroy group deposited on the Port au Port Peninsula therefore is upper Mississippian in age, and are the youngest Palaeozoic deposits represented in this area.

3) Geological Structure

The geological structure of Newfoundland as a whole is very complicated, having resulted from the action of continued pressure throughout the Palaeozoic combined with igneous activity. On the west coast, however, the rocks have not been so highly disturbed and altered, and comparatively gently folding predominates. Thus, it is on the west coast that the possibility of finding suitable structures for the accumulation of oil is greatest.

The major geologic structures of the Port au Port Peninsula strike in an east-northeast and west-southwest direction which is divergent to the major structures of Newfoundland which trend in a general northeast, southwest direction, (see Figure 6).

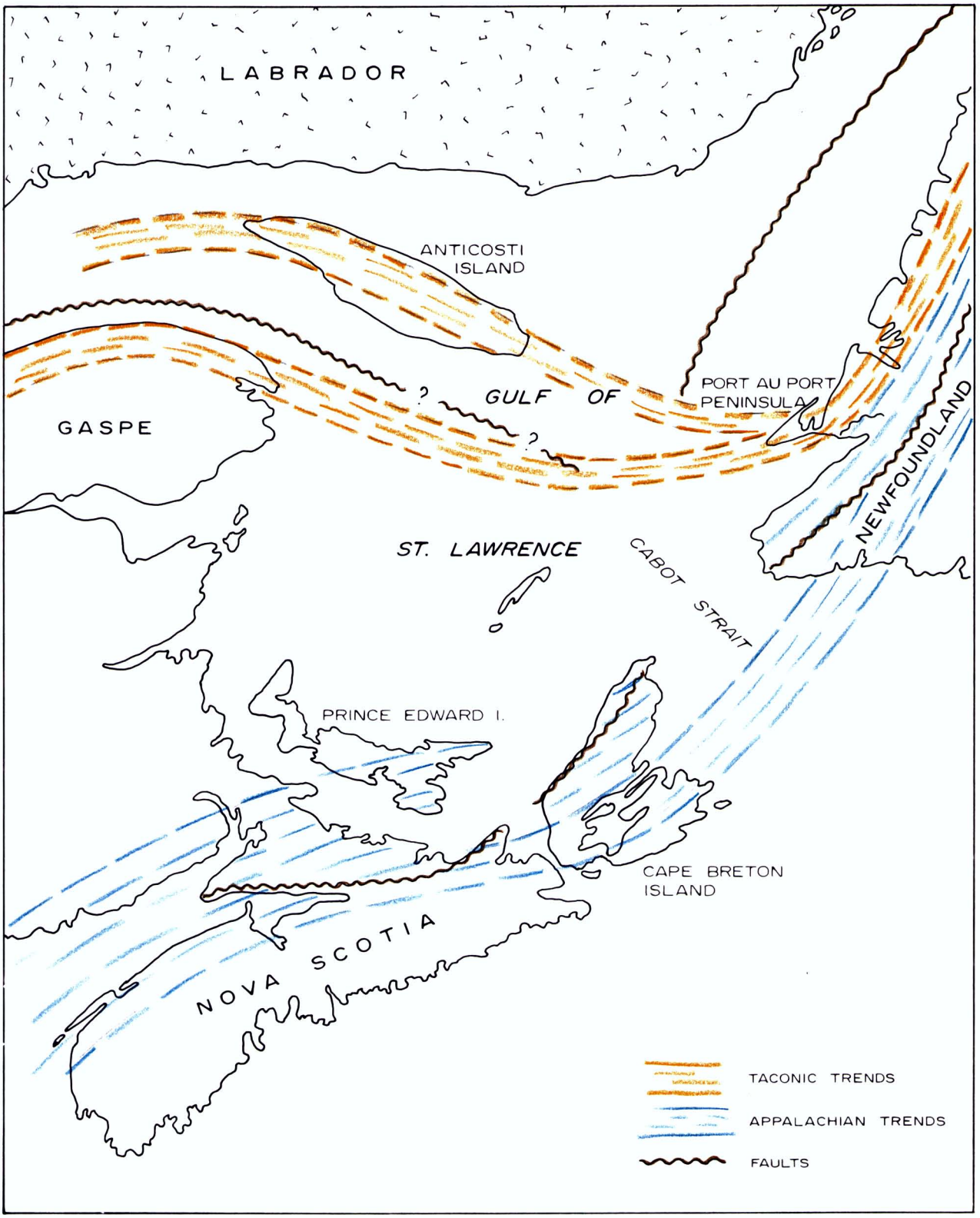


FIGURE N°6

DIAGRAM SHOWING

GENERALIZED STRUCTURAL TRENDS AND CRUSTAL DISPLACEMENT

IN THE GULF OF ST. LAWRENCE REGION

The structure is much clearer on the Peninsula owing to the absence of intrusives and the active participation of the competent carbonates of the St. George and Table Head groups which have been thrown into a series of asymmetrical folds. The lower Palaeozoic strata of the Peninsula, and likewise, the rest of western Newfoundland can be divided into two different terranes. One contains a shallow-water, carbonate sequence; the other a clastic terrane of deep-water shale, sandstone, conglomerate, and lime-breccia. On the Port au Port Peninsula the northeasterly trending hills of resistant limestone and dolomite rise from a gentle rolling lowland, which is underlain by less resistant sandstones and incompetent shales of Mississippian and Ordovician age.

The Peninsula is broken in the central portion by four northeasterly striking, steeply dipping, normal faults, which are downthrown on their eastern sides, (see Frontispiece Part I). These faults form prominent steep linear escarpments which trend from Piccadilly Bay in the north to the vicinity of Pigeon Head on the south shore of the Peninsula, (Enclosure No. 2). The entire area is bowed into a broad shallow arch whose axis runs in a general north-south direction and probably was the cause of the parallel normal faulting found in the

central part of the Peninsula, and the numerous tensional faults that occur around the coastline. The drainage pattern reflects the bedrock structure, and many streams are controlled by fault traces.

An examination of the structures on the Port au Port Peninsula indicate three structural trends to be present:-

1) Major vertical normal faults, trending N 45° E, downthrown to the east.

2) Major folds plunging predominantly to the east and normal faults, trending N 70° E to N 80° E, downthrown to the west.

3) Minor tensional faults, parallel to anticlinal axes.

The structural features can be adequately and conveniently discussed by dividing the Port au Port Peninsula into four structural areas, (see Enclosure No. 2). The divisions include the following:-

A. Eastern Area
B. Central Faulted Area
C. Northwestern Area
D. Southwestern Area.

A. Eastern Area (See Figure 7)

This structural area extends from the mainland to the central faulted section of the Peninsula.

The east coast of East Bay (the mainland) is occupied by the northwest limb of the Table Mountain fold, the beds of which dip at about 22° N 30° S, but the strike swings round through The Gravels to follow the crest of the Pierways Hill with the axial trend finally being deflected to the southwest and out to sea in the vicinity of Jerrys Nose.

The fold which is observed passing through to the south of Piccadilly pier located in Piccadilly Bay is of small amplitude and is largely obscured by the amount of faulting in it's vicinity. On either side of this anticline is a series of parallel step faults which are down thrown on their eastern side and have left clear evidence of their existence in the topography, (see Frontispiece, of Text).

A rather ill-defined syncline passes across the base of Shoal Point but has been obscured to a great extent by the deposition of Carboniferous Codroy sediments.

LEGEND

GEOLOGICAL CONTACT

FAULTING AND MOVEMENT

SYNCLINE

ANTICLINE

STRIKE AND DIP 20

CLIFFS AND ESCARPMENT

UP THROWN U

DOWN THROWN D

CODROY GP.

HUMBER ARM GP

SHINGLE

TABLE HEAD GP

ST. GEORGE GP.

58°55'

58°50'

58°45'

48°35'

EAST BAY

PICCADILLY BAY

PICCADILLY

BOSWARLOS

AGUATHUNA

Bellman's Cove

Lead Cove

Gravels Pond

PORT AU PORT

ISTHMUS BAY

PIERWAYS HILL

△ 786'

FELIX COVE

Man O' War Cove

CAMPBELLS CREEK

Campbells Cove

Abraham's Cove

ST. GEORGES BAY

FIELD GEOLOGY BY H. CORKIN
DURING AUG. AND SEPT. 1964

DRAWN BY A. WERSE, FEB. 1965
GOLDEN EAGLE OIL AND GAS LIMITED

GEOLOGICAL MAP OF THE EASTERN AREA

PORT AU PORT PENINSULA

FIGURE N° 7

SCALE : 1.25 INCHES = 1 MILE OR 1 : 50 000

1 0.5 0 1 2 MILES

On the mainland, northeast of The Gravels a conformable sequence of strata occurs which dips in a northwesterly direction and strikes obliquely to the coast. An ascending series of formational groups may be followed in a northeasterly direction from The Gravels commencing with the uppermost algal beds of the St. George group. These beds are followed after a slight disconformity by the limestones of the Table Head group and in turn by the limestones and graptolitic shales of the same group. Above is found a limestone conglomerate which is followed disconformably by the incompetent, variegated shales of the Humber Arm group which extend for a distance in excess of 15 miles in a northeasterly direction, (see Enclosure No. 1). This same sequence of beds are also encounted in the same order if one descends from the top of Table Mountain in a northwesterly direction towards the coast.

The sequence in this area is broken by several minor normal faults which are vertical in nature and strike at N 65^{o} W. The coves along the south shore of East Bay have been formed by northerly-striking collapse faults coupled with the downward displacement of fault blocks (Figure 7), which has been fully described in the section on stratigraphy entitled, "Mississippian System",

(pp 116 to 117). Most of the coves have not been named, but the more prominent ones are Lead Cove and Bellman's Cove.

The structure of the eastern portion of the peninsula is very similar to that which exists on the mainland with the exception of the structural trend which is divergent to a more westerly direction. This region of the Peninsula is underlain by the bevelled strata of the St. George and Table Head groups of the Ordovician which dip at low angles to the north. These beds are gently folded, so that the dips may be slightly east or west of north. Along the northern shore of this eastern portion of the Peninsula the disconformable contact between the St. George and Table Head groups is often seen, (Plates VIII and IX) but very little thickness of the latter group remains as most has been removed by erosion. From a mile west of the Aguathuna pier, across the base of Shoal Point to the faulted central portion of the Peninsula the Table Head group is overlapped in angular unconformity by the Codroy group of Mississippian age.

Along the St. Georges Bay coastline of this eastern section of the Peninsula, the St. George group outcrops continuously in the sea cliffs dipping at approximately 20°

towards the north. The strike is parallel to the shoreline with the attitude of the beds being such that a continuous descending section of the St. George group is exposed. This strata is broken occasionally by minor north-south normal faults which are downthrown on their western side.

Shoal Point over it's greatest area has an overburden of peat below which the Humber Arm group outcrops along the coast. The least distorted strata occur on the west side of Shoal Point being due mainly to the presence of a higher percentage of competent limestones in the section. Located a mile and one half south of the tip of Shoal Point is an anticline the axis of which is pitching steeply towards the east, (see Enclosure No. 2). At this locality and within the distance of a quarter mile to the south of the axis, the attitude of the strata changes from a strike of N 63° E and a dip of 37° N, through the vertical to a strike of N 50° E, and dip of 45° S. Seven oil wells were drilled across this anticlinal axis, (Figure 4 and Plate XVIIIb) at the turn of the century, but these wells have long since been abandoned. The coast in this vicinity is being rapidly eroded by wave action and at the present time only two wells remain on dry land from one of which a sample of oil was obtained. The laboratory analysis of this

sample appears in the Appendix of this report.

The axis of the anticline which passes through Shoal Point can be traced in a southwesterly direction across West Bay and onto the Peninsula at a point, one and a half miles west of South Head, (Enclosure No. 2). A synclinal axis bisects South Head but was not located on Shoal Point due to the contorted nature of the shales.

From this locality southward for a distance of three miles the Humber Arm group is covered by peat bog. From this covered area the group is exposed almost continuously to it's contact with the Codroy bed at the base of Shoal Point. These beds are composed of soft, fissile, variegated shales which are considerably distorted, mashed and broken by numerous small faults. The beds strike, in general, ENE - WSW and dip at high angles to the north.

B. <u>Central Faulted Area</u> (See Enclosure No. 2)

This structural area is bound on the east by a fault which runs diagonally from the south shore of Piccadilly

Bay to the east side of Ship Cove located on the south coast of the Peninsula. The western boundary is demarcated by a fault located immediately east of South Head which trends in a southwesterly direction to emerge at Lower Cove.

The intervening area is characterized by a number of large, parallel, vertical faults which strike approximately N 45° E and are all downthrown on the eastern side. These faults are all well expressed in the topography by steep walled escarpments often exceeding 100 feet in elevation, (see Frontispiece of Text). A consequent drainage pattern also occurs within the boundary of this structural area.

On the west side of Ship Cove, a normal fault is exposed which dips at 80° to the southeast and trends in a northeasterly direction as a conspicuous escarpment which emerges in Piccadilly Bay half a mile south of Smelt Brook, (Plate II). Within the scarp face of this fault the contact of the St. George and Table Head groups is found on both the up and down thrown sides of the fault, about one mile southwest of Piccadilly Bay. The St. George - Table Head contact on the east side of this fault is offset by approximately half a mile from the same contact on the opposing west side of the fault. There is no way of determining the individual displacement of the beds.

At the mouth of Smelt Brook where it enters Piccadilly Bay, the basal Humber Arm conglomerate is exposed as are the underlying graptolitic shales and limestones of the upper Table Head group. This disconformable contact occurs 850 feet stratigraphically above the contact of the St. George group which is in agreement with the measured Table Head section, (Enclosure No. 8).

A prominent vertical scarp face also occurs on the west side of Lower Cove, striking at N 46° E to emerge on the east side of South Head. This fault at it's northeast limit, has on it's southeast side the variegated shales of the Humber Arm group, and on the northwest side the Table Head limestones. A small section of Humber Arm shale does occur on South Head immediately north of the Table Head limestone but is greatly displaced from the Humber Arm on the opposite side of the fault. This fault is the most conspicuous in this area and surface evidence indicates it to have the greatest magnitude of throw. In the cliffs immediately west of South Head there is evidence of another steep dipping fault but due to the recessive weathering of shales, it was not possible to detect the magnitude of the displacement.

These above described faults are all parallel to each other, striking approximately N 45° E, the movement along the fault planes has been vertical, and all are downthrown to the southeast. This movement in combination with the dip of the limestone layers would be sufficient to cause the offsetting of the strata as is seen in the field at the present time. Drag folding is rare along this faulted zone, although the Humber Arm shales are overturned along the east shore of South Head. The dragging of the upper Table Head shales near South Head, coupled with the flattening out of the St. George beds at Lower Cove is sufficient evidence, the writer believes, for the vertical movement of these faults.

The strike of these faults are parallel to the general structural trends of Newfoundland and in particular to the faults that occur immediately northeast of Table Mountain. The writer does not consider the southeast shore of Long Point to be a fault line scarp, but a close similarity of strike does exist between the central faulted area and this coastline.

The axis of a minor fold cuts the coastline of Piccadilly Bay south of Smelt Brook and trends in a southwesterly direction. This fold of small amplitude is largely

obscured inland by the amount of faulting in it's vicinity.

Along the St. Georges Bay shore in the various coves at points where these faults emerge the depressed Ordovician beds are overlain in angular unconformity with Mississippian-Codroy conglomeratic deposits.

C. Northwestern Area (See Figure 5)

This structural area includes all the land which occurs north of a line drawn in an east northeast direction from Cape Cormorant to South Head.

West of South Head two subsidiary fold axes have been developed, one an anticlinal axis passing a mile and a half west of South Head and the other, a synclinal axis located between Harry's and Victor's Brooks, which also has a branching limb to the south, (see Enclosure No. 2). These folds are comparatively gentle but slight contortion is prevalent and small faults occur.

Humber Arm sediments outcrop continuously along the shores of West Bay between South Head and Rocky Point, and also along the Gulf shore from Three Rock Point to Cape Cormorant. The Humber Arm beds are well exposed in the streams of these areas, so it would appear that the Humber Arm strata underlies the whole of the broad lowland areas. The soft shales and thinly laminated sandstones of the Humber Arm in this area, as elsewhere, have been contorted, folded and further complicated by numerous faults of small dimensions. The detailed mapping of structure and measurement of sections is almost impossible, therefore recorded dip and strike values plotted within the boundaries of this group should be applied with caution. In the less distorted Humber Arm sections, which include the three measured and described by the writer, (see Enclosures Nos. 9, 10 and 11), it was observed that the variegated shales and sandstones of the Humber Arm group descended into limy conglomeratic horizons, up to three in number before the disconformable contact with the graptolitic shales of the Table Head group are reached. Characteristically, these more resistant, competent basal conglomerates retain a high degree of conformity in contrast to the overlying shales.

Situated between the two lowland areas of Humber Arm strata mentioned above, Table Head sediments outcrop at surface. Directly to the south of Round Head occurs a low broad anticline, known locally as, "Goodyear Hill," as this was the location of the Goodyear Lead Prospect. This anticline is exposed as a glaciated limestone ridge, which is four miles long and one mile in width, with it's axis striking at N 70° E, (see Enclosures Nos. 1 and 2). This anticline reaches a maximum elevation of 556 feet above sea level with it's axial crest pitching off in either direction to disappear beneath the younger Humber Arm strata. Above the 500 foot contour there is very little overburden and the bedrock is frequently exposed or thinly covered with vegetation. The bedding in the limestone is almost horizontal, the maximum variation noted being 15 degrees. It would appear that the area is but slightly disturbed except for a rather clean-cut fracture cutting the bedding. The walls of the various veins have not been affected by mineralization to any great extent. No slickensiding indicative of strong movement was found. In the occasional massive galena observed, iron stained vugs or geodes were characteristic. These cavities were probably originally plugged with iron and zinc sulphides so a prediction could be made that the galena vein at depth

would be of a low grade resulting from an increase of zinc.

Round Head located to the northwest of the "Goodyear anticline", is a conspicuous topographic feature attaining a maximum elevation of 831 feet. The structure is three miles long, a mile wide with the longitudinal axis striking at N 70° E. Round Head is composed entirely of a breccia, containing inclusions of Table Head limestones and is of a sedimentary origin and not tectonic in nature. The origin and structural relationships of Round Head and Long Point is covered in detail in the following section of this report.

The Long Point projection is disturbed near it's base, but towards the northeast, the Long Point limestones and shales form a monoclinal structure, dipping on an average at 40° to the northwest. The greater portion of this point is underlain by these beds, the only exception being a thin veneer of Clam Bank sediments of Siluro-Devonian age along the southern half of the northwest shoreline. The southeast coastline of Long Point is exposed as a wall of resistant, precipitous cliffs.

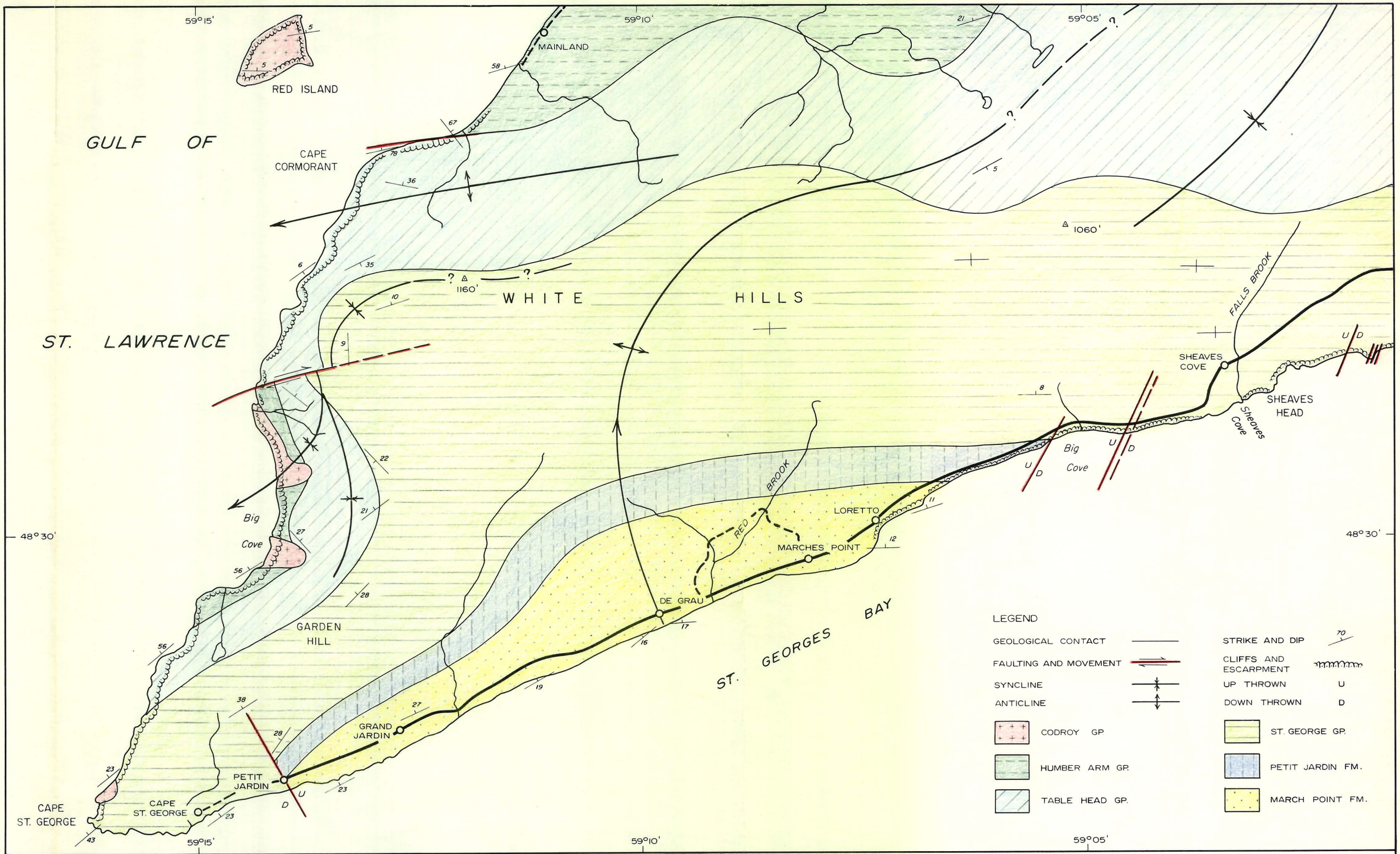
Two east-northeasterly striking faults separate the Green Point strata from the Humber Arm and Long Point

groups on the west side of Port au Port Bay in the vicinity of Rocky Point. The Green Point group is exposed as a faulted wedge-shaped block which has its apex located straight west from the coast, a mile and a quarter inland. The Green Point strata against the most southerly of the two faults has been dragged upwards which gives a predominating dip towards the north. The northern fault forming this wedge is marked by a scarp face formed by the basal limestone member of the Long Point group and strikes at N 72° E. Immediately north of this fault a distinct unconformity divides the Humber Arm group from the overlying, younger Long Point group.

D. Southwestern Area (See Figure 8)

This structural region of the Peninsula is bounded on the east by the northeasterly trending faults line scarps of "Area B", and is bounded on the north by a line drawn from Cape Cormorant to South Head. It is surrounded on the other sides by the Gulf of St. Lawrence and St. Georges Bay.

Topographically this is the highest elevated area of the Peninsula, attaining a maximum elevation of 1,160 feet



FIELD GEOLOGY BY H CORKIN
DURING AUG. AND SEPT. 1964

DRAWN BY A.WERSE, FEB. 1965
GOLDEN EAGLE OIL AND GAS LIMITED

GEOLOGICAL MAP OF THE SOUTHWESTERN AREA

PORT AU PORT PENINSULA

FIGURE N° 8

SCALE : 1.25 INCHES = 1 MILE OR 1 : 50 000

1 0.5 0 1 2 MILES

in the White Hills near Cape Cormorant. The greater relief is attributed to the area being underlain by the resistant carbonate and sandstones of the Cambrian, and the Ordovician, St. George and Table Head groups. The hills of this region have a monoclinal structure and strike diagonally across the Peninsula from South Head at about S 65° N, for a distance of 5 miles, at which point they swing westward, emerging on the Gulf shore between Cape Cormorant and Cape St. George. Along the west coast an axis of a syncline branches with the northerly most branch entering the Gulf of St. Lawrence at Big Cove and the southerly limb paralleling the coast, half a mile inland. Immediately north of the syncline is an anticline, which emerges onto the Gulf shore, midway between Big Cove and Cape Cormorant. Both the syncline and anticline are plunging steeply to the west, (see Enclosure No. 2 and Figure 8). West of Big Cove, located on the St. Georges Bay coast, to approximately Cape St. George, the Cambrian sandstones and dolomites have been arched upwards into a broad, shallow anticline. The axis of this structure has a north-south trend, emerging at De Grau where middle Cambrian beds are exposed in the core.

To the west of Lower Cove on the south coast, (Enclosure No. 2) the St. George group is well exposed with

the strata lying almost horizontal, being affected only by minor faults. Minor breaks occur in the strata 3/4 mile west of Lower Cove and a much larger one is seen one mile west. These normal faults have very little displacement and are downthrown to the east. Big Cove on the south shore is faulted at either side and it is in the western most wall of this cove that the Cambrian, Petit Jardin formation outcrops. At the village of Petit Jardin, seven miles southwest, there is another disturbed and faulted zone against which the Cambrian beds end. From this point to the Cape, the St. George strata are continuous, but the dip increases to the west.

A quarter of a mile north of Cape St. George, is a pocket containing a lense of conglomeratic Codroy group which rests in angular unconformity on the tilted beds of the St. George group, (Plate XIII). Similar Codroy beds of Mississippian age are found in depressions along the cliffs of Big Cove facing the St. Lawrence Gulf, and form the entire exposed surface of Red Island, (Plate XIXb).

Within the boundary of Big Cove on the Gulf shore, the dips may be seen to fluctuate in direction. Before the cliffs of Big Cove are reached the Table Head group gives

way to the Humber Arm, so that the lowermost Humber Arm conglomerates, (of the type previously described in connection with the Humber Arm group) form the resistant cliff-like salients at either end of the cove. At the northern salient of this cove, the axis of the syncline is broken by a high angle thrust fault. The coarse, angular breccia of very localized extent present in this area is probably not of tectonic origin (p 71-73). This thrust appears also to be of very limited extent, as it cannot be traced for any great distance inland. A conformable series descends from the southern salient of Big Cove to Cape St. George. The basal conglomerates of the Humber Arm group pass down into the graptolitic shales of the upper Table Head and finally into the St. George group a mile from the Cape, (see Frontispiece of Part II).

In the cliffs between Cape St. George and Cape Cormorant the Table Head group has a sigmoidal appearance, being composed of a syncline and an anticline which both plunge steeply towards the west. Along the coast in the region of the anticline, the Table Head limestones outcrop in the upper parts of the cliffs, dipping down to sea level to the north and south, while the St. George group dolomites are exposed in the lower part of the sea cliffs.

The strata on the northern flank of the anticline which plunges out into the Gulf a mile south of Cape Cormorant, is overturned towards the Cape, where it has become the nose of a thrust fault. This fracture extends in an east northeasterly direction inland, coinciding with the contact between the Humber Arm and Table Head groups. The magnitude of the thrust is not considered to have been of major proportions as it's surface indications disappear completely a mile and a quarter inland. Clear evidence that thrusting did occur at Cape Cormorant is well preserved in the Table Head limestones which are seen to curve down along the nose of the thrust, (Plate XI). Also associated with this thrusting is the presence of a coarse, angular limestone, tectonic breccia which also has mashed within it's matrix the softer shales and sandstones of the Humber Arm group.

Regional Structural Relationship

There are two major orogenic axes within the Maritime Provinces of Canada, (see Figure No. 6). One of the axes passes through Nova Scotia and Cape Breton Island and on into Newfoundland with a general northeast - southwest

direction, (Woodward, 1964 pp 339). To the north a second orogenic trend passes through Gaspé to swing in a broad arc to the east so as to include Anticosti Island and the Port au Port Peninsula under it's influence. On the mainland of Newfoundland this trend swings to the north-east again to link up with the orogenic trend which enters onto the Island from Cape Breton. The Port au Port Peninsula is only influenced by the northern orogenic axis of the Taconic Trend (Figure 6).

The St. Lawrence Geosyncline was the depositional area where the sediments of the Port au Port area were deposited. It was in the quiet, relatively stable environment of this seaway that the miogeosynclinal carbonates, shales and sandstones of the Cambrian, St. George and most of the Table Head groups were deposited. Towards the close of the deposition of the Table Head, crustal movements began to exert their influence throwing the area into broad low-lying folds and resulted in some thrusting. This movement was accompanied by shoaling conditions giving rise to talus breccias and conglomerates, especially in the basal zone of the Humber Arm group. During the deposition of the latter group the neighbouring lands were standing high and it was from these elevated areas that great thicknesses of

clastic sediments were derived. The basal Long Point member which is of bioclastic origin was obviously deposited in shallow agitated waters. A break in slope caused by a monclinal ridge or flexure at the right elevation would be required to initiate a reefal lattice development of the type found in this member. This could be regarded as evidence for a fault-line scarp along the southeast shore of Long Point although the writer himself, does not support that theory. Subsequent oscillating movements of the basin floor resulted in the cyclic deposition of the overlying interbedded shales and limestones of the group.

The incompetent shales and sandstones between the basal Humber Arm conglomerates and the base of the Long Point group were sandwiched between the folds giving rise to the contorted and complex structures of that group. A thin veneer of Devonian and possibly Silurian sediments were deposited along the south western half of Long Point under what appears to have been shallow eustatic conditions. Carboniferous beds of Mississippian, Codroy age were deposited in low lying areas of the Port au Port Peninsula, being in angular unconformity with the older Palaeozoic sequence, (Plate XIII).

The sequence comprising the Long Point and Clam Bank

groups are distinct from the older more deformed rocks (Humber Arm sediments) on which they rest unconformably, and from the younger Carboniferous strata which are in angular unconformity. It is this sequence that records the geological history between the orogenic climaxes of the Taconian and Acadian disturbances. The former deformed middle Ordovician strata and the latter affected the Carboniferous beds.

Rodgers and Neale, (1963) have published a hypothesis in which they suggest a possible "Taconic" klippen in western Newfoundland. The writer does not wish to pass judgement on this theory at the present due to his limited knowledge of the geology of the west coast other than the Port au Port Peninsula. A comment, however, can be made that no evidence of a klippe was noted in this area and the geology of the Peninsula can be explained satisfactorily without postulating the presence of one.

From the evidence available the writer is of the opinion that the west coast of Newfoundland was strongly influenced by the Appalachian tectonic orogeny, (Figure 6). No evidence was found in the Port au Port area that would disprove the Woodward (1964, pp 338) hypothesis of the

"no basement" concept of deformation which infers that existing sedimentary structures are independent of those on the basement. Woodward also stated that the configuration on the basement cannot be calculated from the assumed thickness of overlying sediments. The writer accepts the Woodward hypothesis for the Port au Port Peninsula and considers the gentle folding to be the result of lateral compression within the sedimentary column and to be independent of movement of the basement. In contrast to the above structures is the Long Range fault which parallels the west coast of Newfoundland and affects beds ranging in age from Precambrian to Carboniferous.

A series of geological profiles dissecting the Port au Port Peninsula at strategic points where adequate information was available for their construction are included as, Enclosure No. 3. The Busk method of constructing a geologic cross section was employed as it appears applicable to the structural problems of the study area. The limitations of these cross sections should be realized due to the scattered dip control available and it is not known at the present time how variable the isopach thickness of the various formations and groups may be.

4) Geological History of the Port au Port Peninsula

a) Deposition of Cambrian strata with great unconformity over the Pre-Cambrian crystalline complex.

b) Deposition of an extensive lower Ordovician algal, carbonate sequence (St. George Group) on shalf areas, synchronous with a graptolitic shale facies (Green Point Group) in the deeper parts of the basin. Only a very slight hiatus, or none at all, exists between the Cambrian and Ordovician.

c) A short erosion interval with the removal of the uppermost portion of the St. George beds.

d) Deposition of the Table Head group.

e) Minor orogenic disturbances causing folding of the St. George and Table Head groups, and the establishment of zones of weakness along which later movements occurred. This mid-Ordovician orogenic activity initiated the accumulation of a thick sequence of clastics and minor carbonates. Shoaling and re-advancing of the sea with development of sedimentary breccias, of the Table Head and slide talus breccias, and basal conglomeratic breccias of the Humber Arm. A period of eustatic movement.

f) Further collapse of the eugeosyncline.

g) Deposition of the thick incompetent Humber Arm group.

h) At the close of the Ordovician, Taconic disturbances accentuated the original folds and developed minor thrust and associated tension faults. The incompetent Humber Arm

beds were squeezed between these giving rise to complex superficial structures.

i) During the Silurian period the region possibly stood above sea level. Approximately 800 feet of non-fossiliferous possibly continental red-beds occur above the Long Point group and may well represent part of the Silurian.

j) During the Devonian there was submergence in the southern portion of the basin and deposition of the Clam Bank strata along the westcoast of the Port au Port Peninsula. The Long Point and Clam Bank groups have an extremely important bearing on the entire geological history of western Newfoundland. The two groups are the only existing record between the two local climaxes of the Teconian and Acadian orogenies. The coarse sands in the upper Long Point may record a later lesser pulse of the Taconic orogeny. The even coarser redbeds of the lower Clam Bank and the possible disconformity at their base would record the Salinic disturbance of Boucot (1963), and the redbeds at the top may indicate the beginning of the main Acadian orogeny (late early or early middle Devonian in the Maritime Provinces - "Acadia"),

k) The western portion of the peninsula was thrust northward intensifying the earlier Taconic folds and resulting in the overturning of the limestones of the Long Point and Clam Bank groups north of Round Head.

l) The Peninsula was bowed upwards with development of north-south faults and grabens, and the occurrence of vertical faulting near the middle of the peninsula in the vicinity of Piccadilly.

m) Uplift and erosion followed with the development of a mature topography.

n) Subsidence and the deposition of the Mississippian-Codroy group which is marked by a distinct angular unconformity.

o) Long erosional interval with removal of almost the entire Mississippian record with the exception of occasional patches of Codroy in scattered areas of the Peninsula.

p) The subsequent history of this area is obscure because lithified strata younger than upper Mississippian have not been identified.

q) The entire study area has been extensively and completely glaciated. Perched erratics occur on all hills within the area especially in the vicinity of the White Hills. Glacial striae are seldom seen on the Port au Port Peninsula, but those that are etched on the White Hills indicate a southwesterly flow of ice.

r) Modern marine and river terraces show the recent elevation of the area. An example of successive coastlines can be clearly observed from the top of Table Mountain looking in a northwesterly direction toward Two Guts Pond, (Plate XVIb).

RELATIONSHIP OF STRATIGRAPHIC AND STRUCTURAL COMPLEXITIES IN THE ROUND HEAD AREA

Because this area includes a drilling prospect (p 15) the structure will be discussed in detail.

The Long Point and Clam Bank groups form a structurally related sequence, being distinct from either the older Ordovician rocks or the younger Carboniferous strata, (p 156 to 158).

Sediments of the Green Point group lie next to and are faulted against younger Humber Arm rocks (Figure 5). The Green Point group is faulted out in a westward direction and the Humber Arm wedges out in the same direction. This results in the above two groups disappearing between the basal member of the Long Point group and the breccia of Round Head. To the writer an unconformity is the best explanation for the contact between the Round Head breccias and the Long Point group at Round Head. This unconformity would truncate already slightly deformed rocks. The Green Point strata were elevated to their present position by faulting at a later date. The overturning of the southern segment of the Long Point - Clam Bank sequence as described below would appear to be post lower Devonian and pre-Carboniferous in age.

The Long Point group which has the youngest Ordovician fossils in the area and the Clam Bank group which contains a Siluro-Devonian fauna are possibly separated by a disconformity but make up a single sequence of strata which forms the steeply dipping northwest limb of an assymetrical anticline, vertical at one end and overturned at the other.

Large mound shaped colonies of the Labyrinthites sp. a tabulate coral may be observed in the basal limestone member of the Long Point group, the heads of which are in a position of growth but are inverted due to overturning of the beds along the base of Long Point peninsula. These two groups are unique in that they are the only existing depositional record on the west side of the Appalachian geosyncline in Newfoundland between the early middle Ordovician and the late Early Carboniferous (late Mississippian), a period that elsewhere in the northern Appalachians included both the Taconian and the Acadian orogenies.

As stated previously the two groups underlie the whole of the Long Point projection of the Port au Port Peninsula and a strip to the southwest along the coast from the base of the point near Lourdes to Three Rock Point. The majority of the Long Point group is composed of poorly

exposed shales and sandstone but there does exist an extremely resistant ridge - forming basal limestone member, which strikes from the tip of Long Point to Lourdes and swings in a southwesterly direction for an additional 2 miles, it plunges from sight at this point to reappear at Three Rock Point, (see Figure 5). This same resistant basal unit forms the chain of islands known as Long Ledge located 8 miles northeast along strike from the tip of Long Point. The Clam Bank group parallels the shore for 5 miles in a northeasterly direction from Clam Bank Cove and for 3½ miles to the southwest, but the continuity of the group is broken at Clam Bank Cove. The beds of the two groups on Long Point strike northeast and dip northwest, but from a mile east of Lourdes to Three Rock Point all exposures dip southeast or south (here the strike is usually in the range of N 55° to 65° E but reaches extremes of N 25° E and S 85° E) and wherever outcrops can be found, the beds of the two groups are overturned.

Schuchert and Dunbar recognized the overturning in the Long Point formation, both at Lourdes and at Three Rock Point, but neither they nor Riley (1963) seem to have recognized it in the Clam Bank group, though all mention the well developed cross-bedding displayed. As a result of this their measured sections must be inverted;

in addition Sullivan whose measured sections are to be found in the Appendix of Rileys memoir (1963) added a basal unit to his section, which is obviously a repetition of much of the rest of the section. On the G.S.C. map 1117 A that accompanies Rileys memoir (1963), a syncline is placed between the opposed dips in the Clam Bank group, and an "open syncline" is mentioned in the accompanying text. The actual situation involved is that the strata pass from one dip direction to the other through the vertical as the northwestern limb of the Round Head anticline passes from assymetrical to slightly overturned. The cross bedding present gives additional evidence for the overturning of these beds.

Stratigraphic Relationships

The base of the Long Point group is exposed at Rocky Point which is located two miles east-northeast of Lourdes on the east coast of Long Point, (Figure 5). At this location the Long Point group can be observed to be resting in unconformable contact on beds of the Humber Arm group. To the south of the resistant basal unit of the Long Point group from where it swings in a southwesterly direction until it disappears from sight, three different

groups are found to be in contact with it. On the east side of Long Point immediately south of where the basal unit turns inland toward Lourdes, the shore exposures for approximately 0.3 miles are of sediments of the Green Point group. Lithologically these beds consist of greenish shale and mudstone, some chert, and numberous thin beds of lime-sandstone, lime-siltstone and fine-grained lime-breccia. On the basis of a graptolitic fauna these beds are assigned to the Green Point group, characterized by it's Tremadoc or lowest Ordovician fauna. Sections are given both by Schuchert and Dunbar (1934, p 45-46) and by the author. Further south along the coast beyond a small covered interval, are different beds composed of red and green fissile shale with thick beds of coarse rubbly, often friable greenish graywacke; these beds are unfossiliferous and are assigned to the Humber Arm group by all previous workers and are accepted as such by the present writer. These two groups are more distorted and variable in dip and strike than those of Long Point age, however, the general dip is acute and to the north, and sporadic outcrops indicate the majority of beds are standing on end.

At Lourdes and vicinity, in the area immediately south of the Long Point group, occasional outcrops of fine-grained sandstones occur, which are also considered

to belong to the Humber Arm group. To the southwest of Lourdes occurs the mountain known as Round Head, which is 3 miles long in the strike direction, and is constructed of a coarse limestone breccia which exhibits a vague indication of bedding. The brecciated inclusions being of undoubted Table Head origin. Talus on the northwest face of this structure obliterates the contact of the brecciated mass; to the east the contact is covered by marsh. Along the rest of the Round Head face the basal member of the Long Point group plunges from sight, and from this point a covered interval extends to the western coastal cliffs which here belong to the Clam Bank group. The brecciated mass of Round Head is bound on the south by an anticline of Table Head limestone which underlies the Humber Arm, west of Round Head, the nearest exposures south of the Long Point group occur at Three Rock Point and are again sandstones of the Humber Arm.

The stratigraphic lowest 280 feet of the Long Point group forms a resistant basal limestone member, (Figure 5 and Enclosure No. 1). This basal limestone forms a ridge from the tip of Long Point to Lourdes and 2 miles beyond in a west southwesterly direction. The basal member then disappears to reappear again 2½ miles away at Three Rock

Point. This ridge forms the cliffs along the entire eastern shore of Long Point peninsula and even where the ridge swings inland past Lourdes an obvious topographic limestone ridge occurs. The entire Long Point group was measured by the writer and the detailed stratigraphy worked out. This composite section can be found on page 100 of this report, together with a lithological log, Enclosure No. 12. The resistant basal limestone member, which includes units 1 to 3 can easily be recognized inland without any difficulty especially the rocks of units 2 and 3.

All previous workers in the area have postulated a continuous fault along the base of the Long Point group and have added another between the rocks assigned to the Green Point and those of the Humber Arm. The distortion of these groups coupled with the breccia of Round Head, and the difference in age between the various groups have been given as evidence. The only beds really distorted are those of the Humber Arm group, the distortion of which is probably related to their incompetence. The exceptional regularity and strike continuity of the basal limestone member of the Long Point group, except to the north of Round Head, seems to the writer however to make a continuous

fault unlikely. The contrast between this regularity and the variation in the age of the beds underlying the basal limestone suggests instead an unconformity. A fault may explain the absence of the basal limestone member of the Long Point group in front of Round Head, or alternatively it may be covered due to scree or absent because of non-deposition. However, the breccia is sedimentary and not tectonic in origin, and in addition the fragments of Round Head are of Table Head age and not Long Point as has previously been accepted.

The upper half of the Long Point group is very poorly exposed the greatest majority of which forms the dip slope of the cuesta and is covered by peat bog. Exposures occurring in the small brook close to the northern salient of Clam Bank Cove consist of medium bedded maroon coloured sandstone and shales which resemble the beds of the Long Point more than those of the Clam Bank group. It was from these beds however, that Kindle and Whittington in 1961 obtained a recognizable middle Ordovician fauna.

The contact between the Long Point and Clam Bank groups is not exposed at any point. Schuchert and Dunbar

(1934, p 70) suggested that the contact may be an unconformity, but in the majority of literature published since that date (1934) a fault has been suggested. A fault was demanded as long as the southeast dips of the Clam Bank strata were considered to bring it's youngest beds against those of Long Point age, however, these dips are overturned and the fault hypothesis is no longer necessary. The writer believes a large east-west right-lateral cross-fault separates the Long Point exposed in the brook flowing into Clam Bank Cove from those of the Clam Bank group which is exposed along the shore immediately to the north, (see Figure 5). In general, however, the close parallelism of strike and dip in the two groups over most of their extent makes a fault unlikely; whether the contact is an unconformity, a disconformity or gradational cannot be determined at this time.

The Clam Bank group consists of coarse grained, pebbly, cross-bedded, brick-red glauconitic sandstones and occasional shaly and siltstone horizons. Some of the units are extremely calcareous and grade into limy silt-stones and calcarenites a few of which are very fossiliferous.

The youngest Clam Bank beds exposed occur on a nose

a mile southwest of Clam Bank Cove, and the equivalent stratigraphic sequence occurs below in both directions along the shore, to Clam Bank Cove on the northeast side and to Salmon Cove on the southwest side. Both the top and bottom portions of this stratigraphic sequence are composed of brick-red, glauconitic, sandstones and between the two occur fossiliferous limestones, red mudstones, limy siltstones and arenaceous limestones.

The Clam Bank outcrops continuously along the shore in a northeasterly direction from Clam Bank Cove to Misty Point. For the majority of this distance an uninteresting, coarse-grained, brick red, glauconitic sandstone is exposed, only a few brachiopods were collected from a calcarenite in the vicinity of Winter-house. Except close to Clam Bank Cove older beds of the group come to the shore northeastward. A large cross-fault as suggested previously (p 154 and Figure 5), is postulated to occur at the northern end of Clam Bank Cove and numerous small ones are visable in existing exposures at this point. The section northeast of the cove is interpreted as a coarser version of the sequence southwest of the cove. A detailed description of the Clam Bank group as measured by the writer is to be found on page 109 of this report, plus a lithology log, (Enclosure 13).

If this above stratigraphy is correct a calculated figure of 1,500 feet can be estimated for the Clam Bank group from dip and width of outcrop. The above figure is only slightly less than the writer's measured section and the figures given by Schuchert and Dunbar, 1934.

Structural Relationships

The strike and dip to the north of the vertical basal limestone member of the Long Point, on the east side of Long Point peninsula is very regular and gradually flattens out as the northern tip of Long Point is approached at which place the dip is only 12^{o}, (Enclosure No. 1). Near the base of Long Point, however, both the resistant basal limestone member of the Long Point and Clam Bank groups change from this regular dip through the vertical to the overturned, and in so doing the strike swings more to the east, with the change occurring within the distance of a mile. The attitude of the Clam Bank group to the northeast of Clam Bank Cove is N 55^{o} E dipping 65^{o} to the SE, the outcrop at the Cove being interrupted by exposures of the highest part of the Long Point group. Exposures of the Clam Bank group reappear on the southwest salient of

the Cove with attitudes ranging from about the same to as far around as N 25° E dipping 45° to the SE. It is obvious that the strike is offset to the southwest of the Cove compared to that existing to the northeast. Travelling in a southeasterly direction the attitude stablizes itself at N 70° E dipping 45° to the SE, but before reaching Salmon Cove it changes to N 80° E dipping 70° to the SE and finally the exposures strike out to sea at N 85° W dipping 70° to the SW, always overturned, (see Figure 5). It is apparent that the Clam Bank group exposures on either side of Clam Bank Cove are broadly concave toward the sea, with the southwesterly outcrop being acutely curved at each end, resulting possibly from cross-faulting.

The basal member of the Long Point group changes direction even more than the Clam Bank group as it passes through the vertical. At the base of Long Point from the east coast to Lourdes the strike averages N 80° E and southwest from Lourdes the trend of the ridge changes to N 70° E but the actual attitudes of the limestone are within a few degrees of N 50° E dipping 50° to the SE. This would indicate that the basal member consists of a number of en echelon pieces separated, probably, by right-lateral faults. Two miles southwest of Lourdes the basal

member disappears but reappears again between Salmon Cove and Three Rock Point. The attitude of this outcrop at the latter location is about N 75° E dipping 42° SE, overturned. A large cross-fault at Salmon Cove brings the basal member of the Long Point group on the west against the Humber Arm group on the east.

The area in which the basal Long Point member strikes N 80° E, to the east of Lourdes, lies adjacent to the east-west cross-fault postulated to separate the northern and southern parts of the Clam Bank outcrop (p 154 and Figure 5) and produces the same kind and amount of right-lateral offset; perhaps they represent the same cross-structure. The resulting effect of the cross-structure and the change in strike has been to move the beds in the southern segment of the outcrop to the northwest relative to the northern segment, overturning them in the process. It is possible that the above beds were pushed to the north by a forward motion of the Round Head breccia mass and the rise and northerly movement of the anticline of Table Head strata that lies immediately to the south. The writer believes it is significant that both these structural features are centered south of the overturned segment.

SEDIMENTARY FACIES AND FAUNAL ENVIRONMENTS

Oil is known to be the product of the environment and the only direct indicator we have today of that environment is the facies. Environment, in turn, is controlled by the architecture of the basin at the time of deposition, and also the rate at which the sediments were deposited. For this reason a summary of characteristic environmental indicators observed on the Port au Port Peninsula are briefly discussed.

The Cambrian and Ordovician rocks on the west coast are recognized as part of the miogeosynclinal facies of the greater Appalachian geosyncline, (Schuchert and Dunbar, 1934 p 11; King, 1951 p 84). Thus, King, (1951 p 84 on a basis of lithologic and faunal similarity compares the Newfoundland sequence to that found further southwest in the central Appalachians (frontal zone of the Great Valley).

The lower Palaeozoic sediments of the study-area belong to two distinct but contemporaneous terranes, each several thousands of feet thick. One is composed of a sequence of shallow-water dolomites, limestones, and calcareous sandstones, which can conveniently be termed the carbonate sequence of the Cambro-Ordovician. Overlying this series is a clastic terrane consisting of deep-water shale, sandstone, and lime-

breccias of middle Ordovician age. The shallow-water environmental conditions of the carbonate sequence is strongly supported by sedimentary features, such as cross-bedding, ripple-marks and mud-cracks in calcarenites and limestones, and by a fauna of trilobites, gastropods, cephalopods, brachiopods and in addition, algae. Similar present day environmental conditions exist in the Bahamas and along the coastal areas of Florida.

In contrast to the above shallow-water indicators are the deep-water features of the middle Ordovician shale and sandstone units testified by graded-bedding and graptolitic assemblages.

The Cambrian fossils are principally trilobites; in the Ordovician they are graptolites, but in general the fauna is pelagic. Well sorted, graded sandstones, lime-breccia beds, the graywacke affinities of the non-calcareous sandstones and the fossils suggest that the rocks of the clastic terrane were deposited in deep water, where slow mud deposition was occasionally interrupted by turbidity currents and submarine slumping. In this way carbonates could be introduced into the clastic terrane from shoal banks or alternatively from areas of incomplete chemical weathering or rapid erosion. One point however, is reasonably certain, that the deep water

clastics of the Port au Port Peninsula were closely associated to the margin of the continental platform.

A characteristic sedimentary feature within the study area is apparent in both the Table Head and Humber Arm groups. Lithologically they both vary laterally, becoming more arenaceous towards the west where sandstones are more common while limestone conglomerates thicken considerably near the source of origin towards the east.

As mentioned previously the sediments of the carbonate terrane vary from carbonate mudstones through well washed friable calcarenites. Such a spectrum of textures indicates environments of deposition varying from restricted to open circulation, high energy conditions. Oolites are being formed today in very shallow agitated water as well as quiet water. Oolitic dolomites are typical of the Cambrian formations within the study area and appear to have formed in an agitated environment as they are clean, well sorted (resulting in porosity) and unfossiliferous. These oolites on close examination are also found to be cross-bedded, but commonly they are so homogenous that cross-bedding is difficult to detect even though it is present.

The stromatolitic biostromes of the Cryptozoon accumulations found in the March Point formation and the St. George group are the product of a littoral habitat of varying energy intensities. These stromatolites or algal mats developed on mud flats and vary in height from a foot to tens of feet and all have great lateral extent, (Plate VII). These biostromes in the St. George group on the south shore of the Port au Port Peninsula can be followed for several miles along strike before they are lost from view as a result of dip.

The stromatolites observed within the March Point formation varied from those found in the overlying Ordovician which had the form of a continuous unbroken cover or mat. The underlying Cambrian stromatolites have the form of reef mounds between which are found intermittent sands. It is difficult to determine whether these mounds are the result of channeling or if they are dislodged portions of a continuous reef and therefore contemporaneous with reef growth or posthumous and in an environment different from that in which they grew. A possible evolutionary trend could also be suggested with a tendency towards aggregation taking place. However, the existing sands between individual algal mounds are well sorted, clean and porous indicating the existence of a potential reservoir. A prediction could also be made that coarse-grained, strongly cross-bedded sand bars, containing a considerable amount of

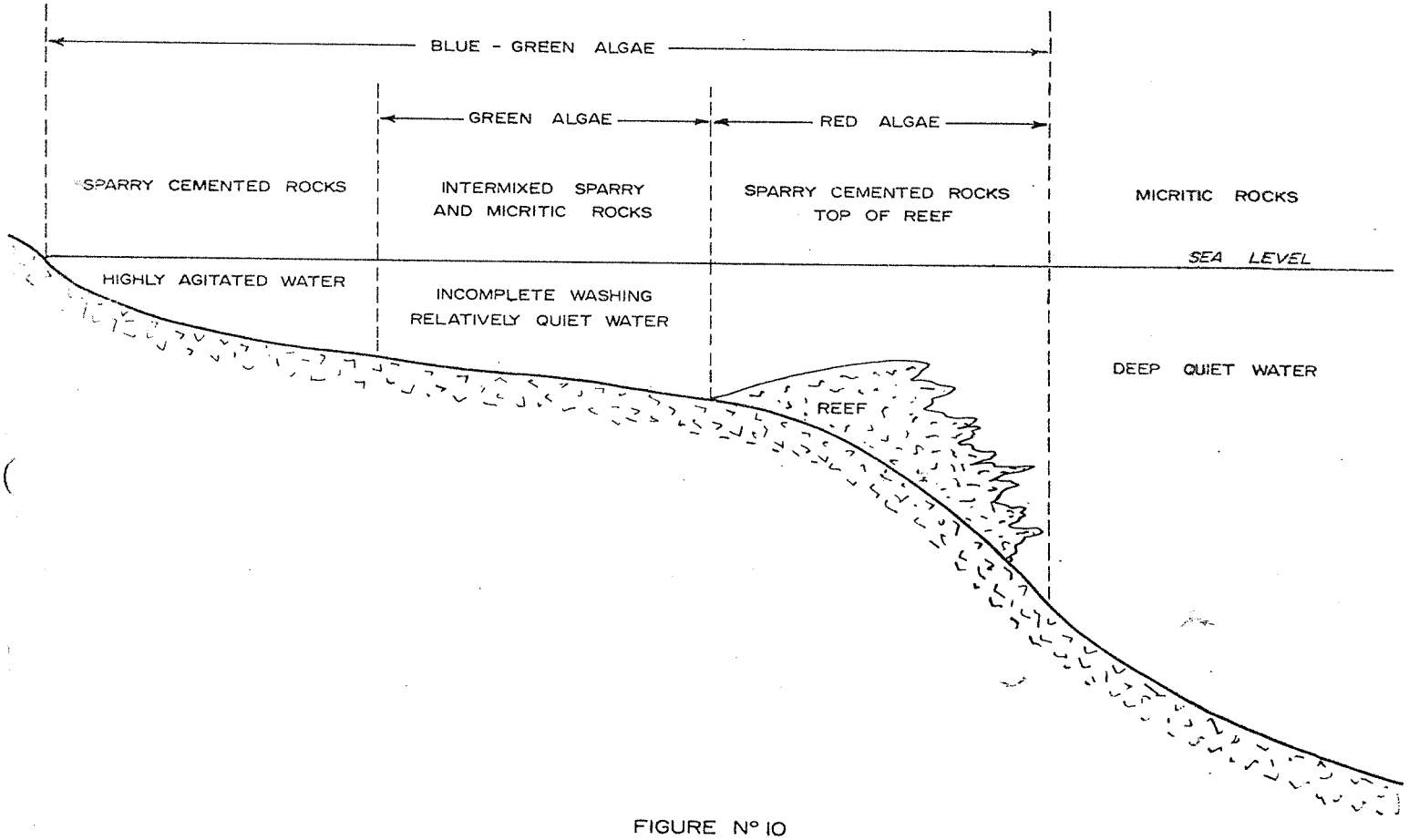


FIGURE N° 10

DIAGRAMMATIC CROSS SECTION SHOWING THE ENVIRONMENTAL RANGE OF CALCAREOUS ALGAE AND ASSOCIATED ROCK TYPES.

COMPILED BY H. CORKIN, DEC. 1964

detrital material may occur in close proximity to the above mentioned algal mounds.

The blue-green, calcareous algae, Cryptozoon proliferum cf C. fieldii Fenton and Fenton, found in the St. Georges group, belongs to the phylum Schizophyta. In habit the algae appears as compressed spherical cakes a foot or more in diameter, (Plate VII). This algal type also commonly forms wavy, mat-like layers that often appear as thin crumpled, wavy bedding in limestones. The cellular structure is seldom preserved but in cases where it is observed it is made up of filamentous layers which often encrust allochemical particles that are washed into its area of growth. Blue-green algae have been found in a number of depositional environments from tidal flats to fore reef. Therefore, it's use as an environmental indicator must be tempered with interpretations based on the associated rock types and fauna, (see Figure 10).

From a microscopic study of the lithology, supported by a few thin sections it is apparent that the associated rocks in the algal assemblages within the St. George group belong to the zone of incomplete washing. The matrix consists of a mixture of sparry and micritic rocks, typified by poor sorting as to grain size and occasional ripple marks which are diagnostic

of deposition in a relatively quiet water environment. This would suggest that in a basinward direction from the outcrop along the south shore of the peninsula there exists some barrier, possibly a reef in the general area of the prospect.

The negative effect of shells indicate prelithification dolomitization. Occasionally sediments surrounding shells are dolomitized but not the mud inside the shell (Unit 20 of the St. George group); or sometimes trilobite carapaces and included shells exhibit the same feature, (Unit 4 Petit Jardin formation). The differential permeability to magnesium - laden lithified mud proves that if dolomitization was postlithification, the material inside the shell would be dolomitized as well as the sediments outside. This primary process of dolomitization could well have improved the porosity aspects of certain reservoir horizons in the carbonate strata.

The sedimentary and organic complex of the carbonate terrane appears to be transitional in both composition and environment of accumulation, between the Cambrian stromatolitic mounds and Ordovician cryptozoon biostromes.

The synchronous relationship between the Green Point and St. George groups is adequately discussed on page 36 of this report. Irrespective of lithology the primary reservoir

facies are distributed in the shallow, basin flank or shelf areas. The deep depositional basin is not the usual habitat of porosity but the oil moves out of this area towards and into the increasing porosity up the basin flanks. Therefore, the stratigraphic position and the geographic extent of the Green Point (basin facies) and St. George (shelf facies) is of paramount importance in the evaluation of the petroleum potential of the Ordovician, not only in the Port au Port area, but in western Newfoundland. The break in slope where these two different depositional facies meet should prove to be an interesting and rewarding exploration area. All the known oil seeps in the St. Pauls - Parsons Pond area are from the argillaceous beds of the Green Point group.

OIL AND GAS POSSIBILITIES

In the preceeding pages of this report a general account has been given of the nature, compostion, occurrence, origin and development of the formations and groups found on the Port au Port Peninsula. It should be pointed out that the writer is at a disadvantage in being unable to compare or evaluate the study-area geologically with others on the west coast.

As a result of this study, the writer disagrees with previous workers (Johnson, 1941; Schuchert and Dunbar, 1934) who state that, the structural deformatinn along the west coast is too great for the retention of an important oil reserve. The above opinion undoubtedly is correct for fifty percent of the total areal extent of western Newfoundland, but is not qualified, and should not be applied to certain areas. For example, the lower Palaeozoic strata of the Northern Peninsula and the Port au Port Peninsula are not as intensely folded as other areas, but some asymmetrical folds are present, as for example the Goodyear anticline. The chances of petroleum recovery, from the Cambro-Ordovician beds of these two areas, are encouraging and should not be condemned by a dogmatic statement.

Oil seeps have been known in Newfoundland since 1812, many of which have been tested but often in an inefficient manner. The sediments of the Port au Port area are comparable to those of producing areas in the Appalachian basin to which this area is the northern extension, and the prospects for finding commercial reserves of oil and gas would therefore also appear to be favourable.

To date, none of the drilling has been conducted in a scientific or systematic manner and the testing has been done by inadequate, outmoded techniques. All wells have been shallow tests which have failed to adequately test and fully evaluate the existing formations and principal zones of interest. Drilling records are non-existent as are sample cuttings so the previous drilling operations cannot be evaluated. High drilling costs have hindered systematic exploration, but with improved portable drilling equipment future wells should be drilled with greater efficiency and at less cost.

The Cambro-Ordovician sediments of the Port au Port Peninsula are the least altered and affected on the Island. For this reason their stratigraphic and structural characters have been carefully examined and described in the preceeding pages. Only two areas on the Peninsula have been disturbed to any great

degree, these are a small wedge of Green Point limestones and shales which have been faulted into the sequence at Rocky Point, and a central nest of faults which trend in a north-easterly direction from Pigeon Head to Piccadilly Bay. It now remains to be shown how these factors influence the prospects of the Peninsula.

The Humber Arm group is not considered to be prospective on the Peninsula due to its greatly reduced thickness and contorted nature. In addition, potential commercial reservoirs are missing and there is a lack of adequate cover to the group. Evidences of petroleum in the Humber Arm group are common but hydrocarbons could not be considered as being present in commercial quantities. As a result of these manifestations drilling was undertaken in 1898 at a location on the west shore of Shoal Point a mile and a half from the tip where oil seepages were known. A total of seven wells were drilled, (Figure 4) with depths varying from 168 to 684 feet and a dark amber coloured oil obtained with a gravity of 31.2 API, see Appendix A. It is said that these wells produced collectively a maximum of 20 barrels per day. No drilling records are in existence so reservoir pressures are not available. The wells were subsequently abandoned and there has been no other attempt to work the area. Five of the wells have since disappeared due

to sea erosion and of the remaining two, one contains oil in the casing, (Plate XVIIIb).

Water wells drilled on the Humber Arm lowland between South Head and Lourdes in the majority of cases, are contaminated with oil and often to such a degree that they must be abandoned. The engineers at the United States Air Force Telecommunication Base at West Bay were forced to drill four wells before oil free water, fit for human consumption was obtained. In addition to this, the geological examination has shown the highly bituminous nature of the limestones of this group, which occasionally contain oil when freshly broken. On Victors Brook a broad band of these limestones with a concretionary bed is located a mile upstream the latter containing cavities which are plugged with a tarry residue when broken open. It is not certain if these tarry products are of primary or secondary origin. It would appear that the oil is formed in the shales of the group and accumulates in the limestones. The Humber Arm is mostly argillaceous and the limestones are so thin and shaly or have such an irregular development that it may be said that there are no suitable reservoir rocks in the group. The writer is of the opinion that the Humber Arm group on the Port au Port Peninsula is not of much importance as regards commercial oil production, but elsewhere on the westcoast of Newfoundland where the group is covered by

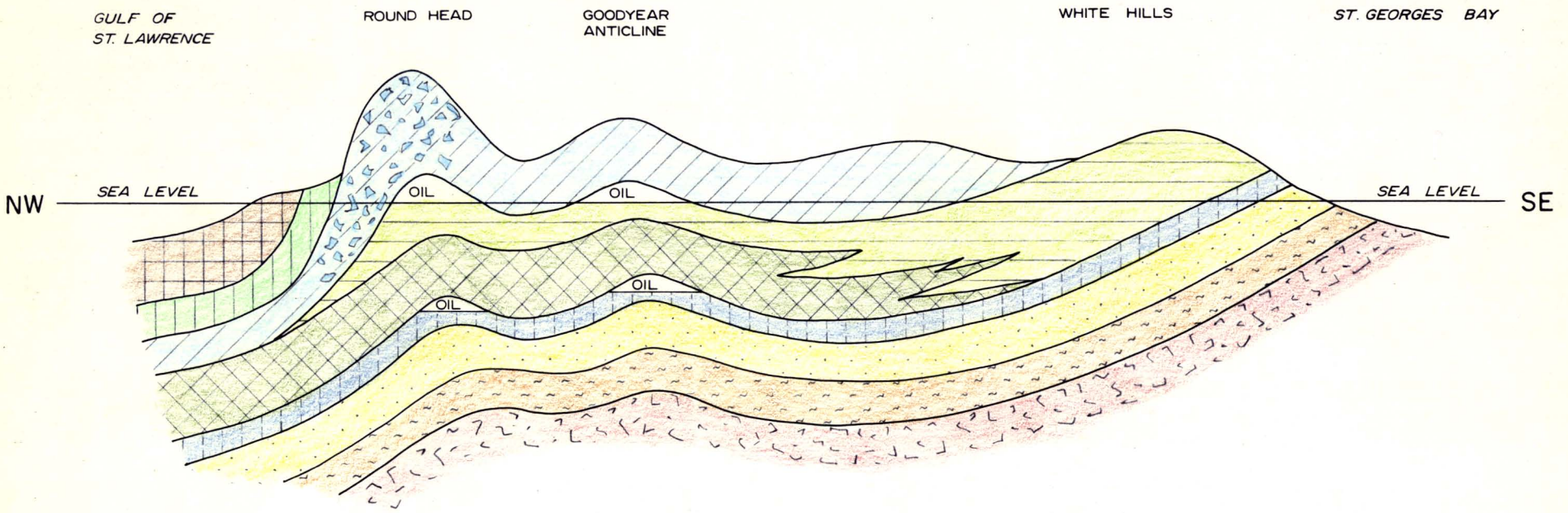


FIGURE N° 9

DIAGRAMMATIC PROFILE SHOWING THE SYNCHRONOUS RELATIONSHIP OF THE ST. GEORGE AND GREEN POINT GROUPS WITHIN THE PROSPECT AREA

NOT TO SCALE

CLAM BANK GR

LONG POINT GP.

TABLE HEAD BRECCIA

TABLE HEAD GP.

ST. GEORGES GP.

GREEN POINT GP.

PETIT JARDIN FM.

MARCH POINT FM.

KIPPEN FM.

PRECAMBRIAN

COMPILED BY H. CORKIN, DEC. 1964

Carboniferous sediments it's value as a source rock would be greatly enhanced.

The most promising reservoir and source beds in the area occur in the Cambrian and lower Ordovician which are in turn sealed by the impervious limestones of the Table Head group of middle Ordovician age. As shown in the cross-section profile, (Enclosure No. 3) the lower Ordovician and Cambrian beds are present under the Goodyear anticline although the axial plane of the fold may have migrated southward with depth.

The petroliferous source beds appear to occur in the Green Point and St. George groups (lower Ordovician) and Cambrian formations. It is therefore of fundamental importance that the facies relationship of the above two groups be accurately interpreted as both occur in juxtaposition as a result of faulting on the Port au Port Peninsula. Faunal studies show that both facies of the above groups are of equivalent age and the writer believes them to be synchronous, (Figure 9). The known oil seeps in the Parsons Pond - St. Pauls area are derived from the argillaceous beds of the Green Point group, the updip edge of which should be closely associated with the recommended drilling location.

Within the boundary of the Port au Port Peninsula, folds have been mapped both photogeologically and in the field, (Enclosure No. 2). Some of these structures exhibit sufficient cover and closure to be considered prospective. The writer considers that the most favourable location for a structural play with known closure and an inter-relationship of source and reservoir rocks lies to the south of Round Head, and is referred to in this report as the Goodyear anticline. This feature has a fracture exposed at surface, which should not be considered as being detrimental to it's hydrocarbon potential as there are many oil-anticlines throughout the world that are faulted and some to a major degree. The nest of normal vertical faults located in the central area of the Peninsula which cut obliquely to the structural trend enhances considerably the hydrocarbon possibilities to the west. The vertical displacement of strata would arrest migration of oil from the area. It is significant that all oil shows and indications occur to the west of this central faulted area.

Favourable reservoir and source rocks are present from the Cambrian to the top of the lower Ordovician. The aggregate thickness of sediments deposited in this sequence exceeds 5,500 feet, (if the authors interpretation of the synchronous relationship of the St. George and Green Point

groups, is accepted) with no visible metamorphic or igneous activity, as shown on the columnal section on Enclosure No. 1.

The oil and gas possibilities are summarized below according to formations and groups:-

Cambrian

1) Kippen Formation (Lower Cambrian)

This formation does not outcrop anywhere on the Peninsula. It does, however, occur as a faulted block to the east of Table Mountain. The lithology found at this location consists of bituminous black shales, dark brown limestones and fine grained, light brown sandstones. Bituminous shales are thought to be excellent source rocks for hydrocarbons and in addition these shales are in association with porous sandstones. However, it is not presently known what facies of these sediments occur in other areas, because of the lack of outcrop. Any wildcat drilled on the Port au Port Peninsula should test the Kippen formation.

The only Cambrian strata which are found in place within the whole basin area outcrops along the south shore of the Port au Port Peninsula east of Cape St. George. The beds belong to the March Point and Petit Jardin formations of middle and upper Cambrian ages respectively.

2) March Point Formation (Middle Cambrian)

It is believed that the thick orthoquartzite sequence of this formation are possible reservoirs and the common occurrence of large worm tubules is proof of their original organic content. In addition reservoir properties are present in oolitic dolomites and subordinate vuggy dolomites which are developed along with conglomeratic beds. Algal beds are found which are thought to be excellent source rocks for hydrocarbons.

3) Petit Jardin Formation (Upper Cambrian)

This formation is considered to have reservoir characteristics which are unequalled throughout the region.

Excellent to good porosity is found within a 160 foot interval, (unit 11) which is vuggy in nature at both the top and bottom. Clean oolitic dolomites with pin-point porosities are found at two horizons.

Partial dolomitization in some units of the Petit Jardin carbonates may have resulted in secondary porosity in certain horizons within the formation.

Ordovician

4) St. George and Green Point Groups (Lower Ordovician)

These two groups, regarded as synchronous, are the most promising rocks for hydrocarbons in the area. This is supported by the presence in the St. George group of thick widespread algal reefs associated with widespread bioclastic sediments, together with a multiple and variable faunal assemblages.

The St. George group is considered to be a shallow water facies and the Green Point group the basin facies, both being contemporaneous as to time of deposition.

These two groups are marked by a prominent lateral lithofacies change from north to south and is considered of importance in forming stratigraphic traps. Highly organic sediments in the form of bioclastic limestones and bituminous shales are present in the Green Point group which would provide an excellent source for hydrocarbons. The shelf carbonates, (St. George group) to the south, associated with stromatolitic biostromes, (Plate VII) and coarse grained, arenaceous limestones with occasional vuggy dolomites, have excellent reservoir characteristics. The dolomites were found to emit a strong fetid odor when struck with a hammer.

Sedimentary conditions of lower Ordovician time throughout the study area are believed similar to those of the Swan Hills oil field of north-central Alberta, where widespread porous, bioclastic middle Devonian carbonates are found.

Emphasis is placed on the importance of these lower Ordovician sediments for hydrocarbon potentialities.

5) Table Head Group (Middle Ordovician)

This group is composed predominantly of lithographic

limestone with a thickness in excess of 800 feet so would form an effective seal to all underlying beds.

6) Humber Arm Group (Middle or Upper Ordovician)

As mentioned previously this group is not considered to be prospective on the Peninsula due to it's greatly reduced thickness. There is a lack of suitable reservoirs and also of edequate cover or cap rock to the group. In other areas of the west coast where the Humber Arm is adequately covered by Carboniferous strata this group could be considered as an important source rock.

7) Long Point Group (Middle or Upper Ordovician)

The sediments of this group consist of a cyclic deposition of siltstones, limestones and shales. A well developed basal limestone member also occurs with an abundant fauna. They are believed to be favourable source rocks rather than reservoir rocks as the limestones did not show macroscopically visible porosity.

8) Clam Bank Group (Siluro-Devonian ?)

This group represents a near-shore deposit with well-sorted, well-rounded sandstones and conglomerates, with occasional fossiliferous limestone beds. The association with glauconite implies that these sediments were laid down in a shallow and open embayment. The sandstones are porous and lacking in any major secondary constituents and are such that they would provide an efficient reservoir. The updip edge of these sediments are exposed so the group as a whole is not considered to be prospective.

Carboniferous

9) Codroy Group (Upper Mississippian)

These deposits are confined to a few scattered localities and are not considered to be of value as hydrocarbon prospects on the Port au Port Peninsula.

The writer during this field study proved conclusively the existence of both source and reservoir rocks but was unable to obtain direct evidence of the source-reservoir relationship. An interfingering association is important to the subsequent migration and trapping of oil but is by no means essential. The source-reservoir relationship should be evaluated in its broadest application until definite information is obtained from drilling. There is for example a common tendency to favour a source stratigraphically well below the occurrence, rather than a lateral source from contemporaneous or from unconformably overlapping sediments.

In summary, the presence of known closed anticlinal structures on the western half of the Port au Port Peninsula, with known source and reservoir rocks indicates that this area is a promising hunting ground for oil and high pressure gas. The Goodyear anticline located to the south of Round Head, (Enclosures No. 1 and No. 2) has structural conditions suitable for oil-accumulation resulting from a combination of good source beds and good possibilities for migration. Three different types of hydrocarbon traps may be encountered below this feature. These traps may result from porous strata being faulted against non-permeable beds, stratigraphic traps caused by the wedging out in an updip position of the Green Point

strata against those of the St. George group and finally as a result of reservoir horizons being thrown into folds. The latter two types of traps would be the most likely to be encountered and would be the most favourable from a commercial viewpoint.

The writer is of the opinion that the Goodyear anticline has good prospects, and in consideration of the fact that a full test of the stratigraphic section may not be warranted at this time it is strongly recommended that the top of the Cambrian be penetrated. A test to the Cambrian would involve a drilling depth of 3,500 feet and should evaluate the St. George and Green Point groups which are the primary objectives of this prospect.

If commercial production is obtained from the Goodyear anticline other anticlines on the southwest portion of the Peninsula exist, (Enclosure No. 2, subdivision "D") considered of secondary importance at this time would then warrant testing. It would then be recommended that further evaluation of these indicated areas of high structural relief be made at some point by seismograph or shallow structure test drill.

APPENDIX A

Shoal Point Oil Analysis

Listed below is the analysis of the crude oil sample from Shoal Point forwarded to the laboratory of Golden Eagle Refining Company of Canada Limited, St. John's, during the later part of August 1964.

Gravity degrees API		31.2
B.S. & W. Vol. %		0.2
Salt Content (PTB)		14.0
Sulphur Wt. %		0.27
Distillation:	IBP	81
	5	210
	10	256
	20	400
	30	498
	40	552
	50	566
	55	570
Max. E.P. Obtainable		574
% Rec.		60%
Viscosity on bottoms (SSF @ 122°F)		160
Sulphur Wt. % (bottoms)		0.30
Pour Point degrees F.		-35

The above analysis shows the crude to be of good quality. This is indicated first by the low sulphur, 0.27 weight percent and secondly by a low salt content. The Shoal Point crude indicated the following yields:-

			Vol. %
Naphtha st.	-	330 degrees E.P.	14
Mid-distillate	-	600 degrees E.P.	43
Bunker C 180 Vis SSF @ 122°F.			43

The Shoal Point sample indicates a low sulphur crude with approximately 45% yield of Bunker C fuel oil. The material would be very suitable for processing at the refinery.

APPENDIX B

Bucyrus - Erie Cable Tool Rig Model 36-L

Plate XX

Outlined below are the manufacturers ratings for the Cable Tool Rig located at St. Pauls. The information was obtained from the, "Composite Catalog of Oil Field Equipment and Services" 1960-61, 24th Edition, Vol. 1, p 938, Pub. by World Oil.

This mobile, drilling and servicing spudder handles top-to-bottom drilling to 3,500 feet; servicing (over the whole range of workover operations) to 4,000 feet, swings up to 5,000 lbs. of tools.

The rigs are equipped with a 54 foot derrick capable of handling static casing loads to 120,000 lbs. with auxiliary A - frame, telescopes to 33 feet, 10 inches for fast, safe road travel. Optional 70 foot tripod derrick handles casing loads to 300,000 lbs.

Maximum line pulls for bull reel in low gear is 32,500 lbs; for sand reel, 12,800 lbs; for calf reel, 22,000 lbs.

Two speeds forward and one reverse speed on all drums and catheads. Free-wheeling for lowering.

The entire unit is powered with one 150 hp. Cummins diesel motor.

The Bucyrus - Erie Company has since gone into liquidation.

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THE PETROLEUM GEOLOGY

OF THE

PORT AU PORT PENINSULA

Newfoundland

PART

II

PLATES

by

H. CORKIN

Calgary, Alberta. March 1965.

LIST OF PLATES

Part II

Plate VI	Folding in the Humber Arm group. The boulder stands 7 feet high. Approximately two and one half miles northeast of The Gravels. Plate V is the continuation of this folding and occurs immediately to the left of this photo.
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Plate X	Basal resistant member of the Long Point group, showing stromatolite developments and heads of Labyrinthites. Shore of Long Point, east of Black Duck Brook.
Plate XI	Overfold in the limestones of the Table Head group at Cape Cormorant.
Plate XII	Slumping carbonate cliffs of the Table Head group south of Big Cove on the Gulf of St. Lawrence coast of the Peninsula.
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Plate XVa	Cambrian limestones of the Petit Jardin formation, one half mile east of Grand Jardin.
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Plate XVIIa	A limestone cave in the Table Head group (Ord.) filled with sediments of the Codroy group (Mississippian), in "The Narrows" of Aguathuna Quarry.
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Plate XVIIIa	St. George group strata exposed on the west wall of Abrahams Cove.
Plate XVIIIb	The casing of an abandoned oil well from which a sample of crude was analysed - see Appendix. Located on the west shore of Shoal Point one and one half miles south of the tip.
~~Plate XIXa~~	Humber Arm strata, located on the northern salient of Big Cove. Note the basal conglomerate in the top left corner of photo.
~~Plate XIXb~~	Conglomerate of the Codroy group of Mississippian age. Red Island.
Plate XX	Bucyrus - Erie Cable Tool Rig stacked at St. Pauls immediately north of the village.

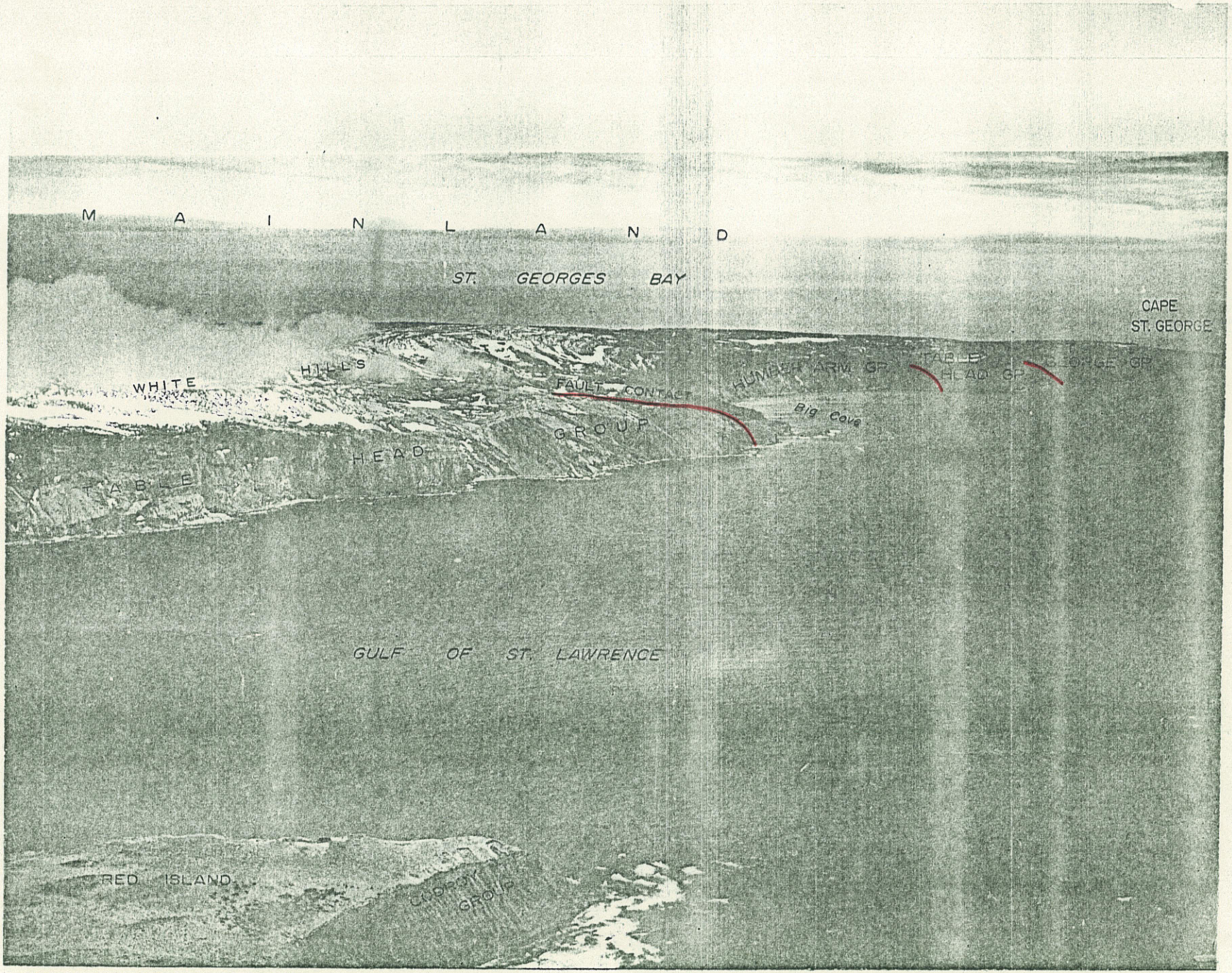


PHOTO: COURTESY NATIONAL AIR PHOTO LIBRARY

OBLIQUE AERIAL PHOTOGRAPH LOOKING IN A SOUTH SOUTH-WESTERLY DIRECTION. RED ISLAND IS IN THE FOREGROUND, BIG COVE AND CAPE ST. GEORGE IN THE MIDDLE DISTANCE AND THE MAINLAND IN THE BACKGROUND.

PLATE I

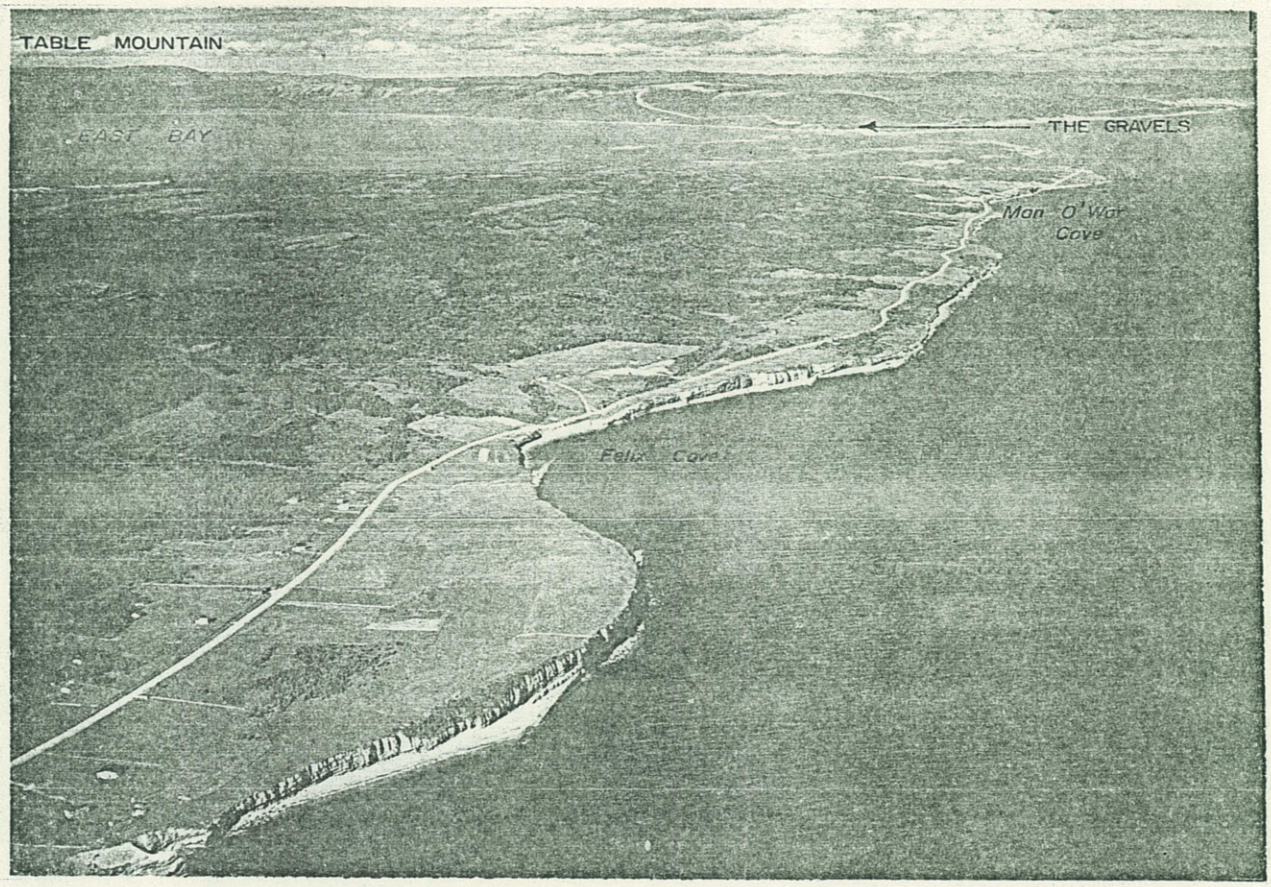


PHOTO : COURTESY NEWFOUNDLAND TOURIST DEVELOPMENT OFFICE

AERIAL PHOTOGRAPH LOOKING EAST TOWARDS THE MAINLAND FROM CAMPBELLS COVE ON THE SOUTH COAST OF PORT AU PORT PENINSULA

PLATE II

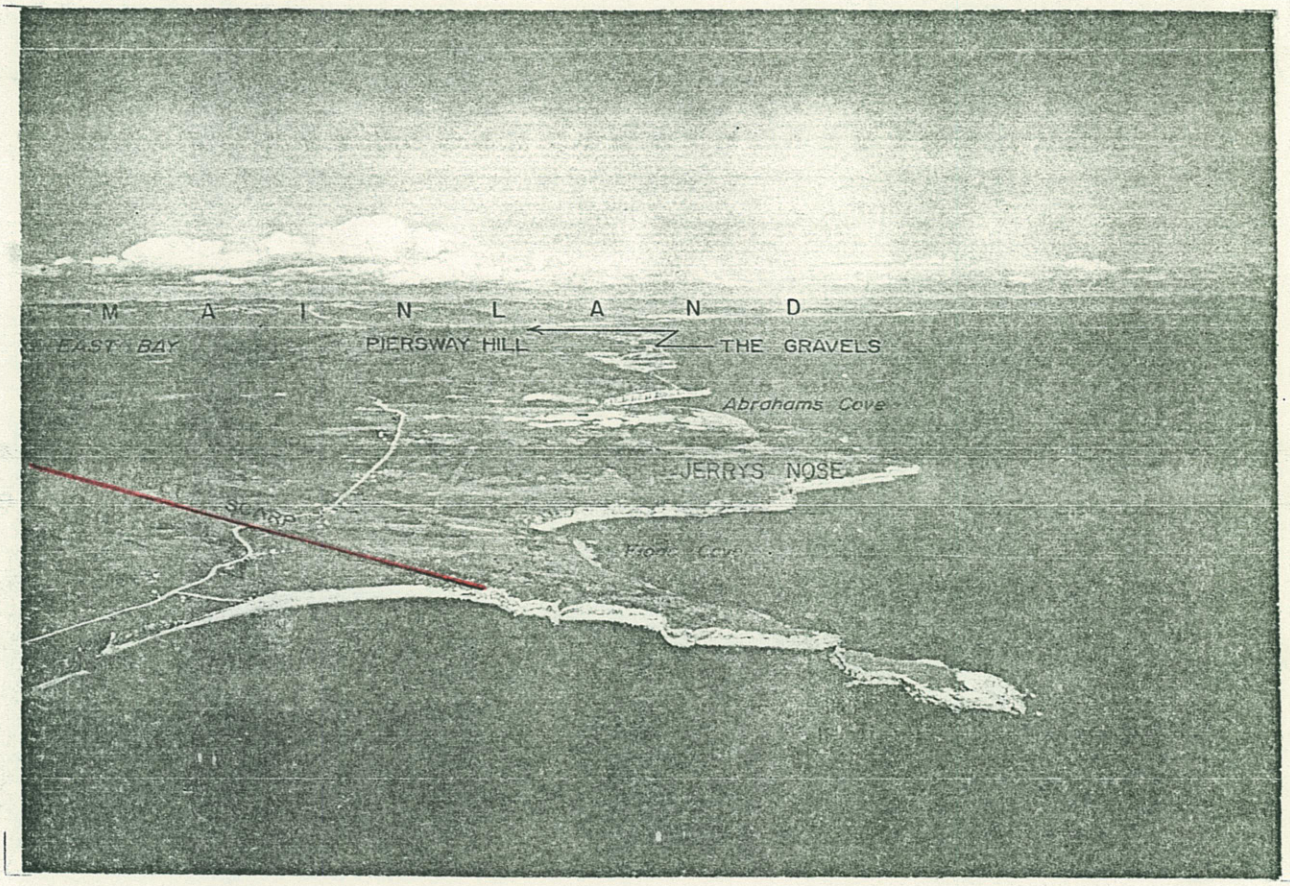


PHOTO : COURTESY NEWFOUNDLAND TOURIST DEVELOPMENT OFFICE

AERIAL PHOTOGRAPH LOOKING EAST TOWARDS THE MAINLAND FROM SHIP COVE ON THE SOUTH COAST OF PORT AU PORT PENINSULA.

PLATE III

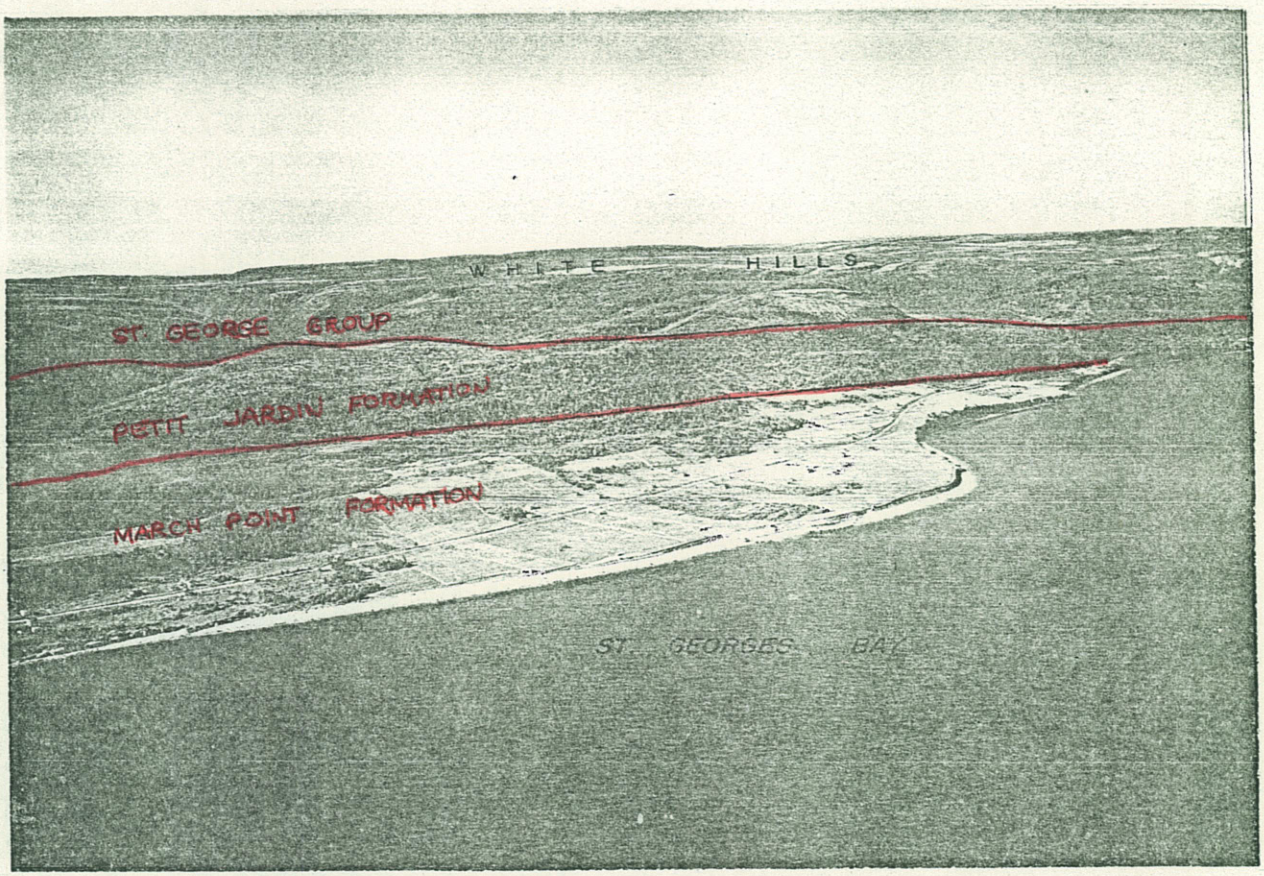


PHOTO : COURTESY NEWFOUNDLAND TOURIST DEVELOPMENT OFFICE

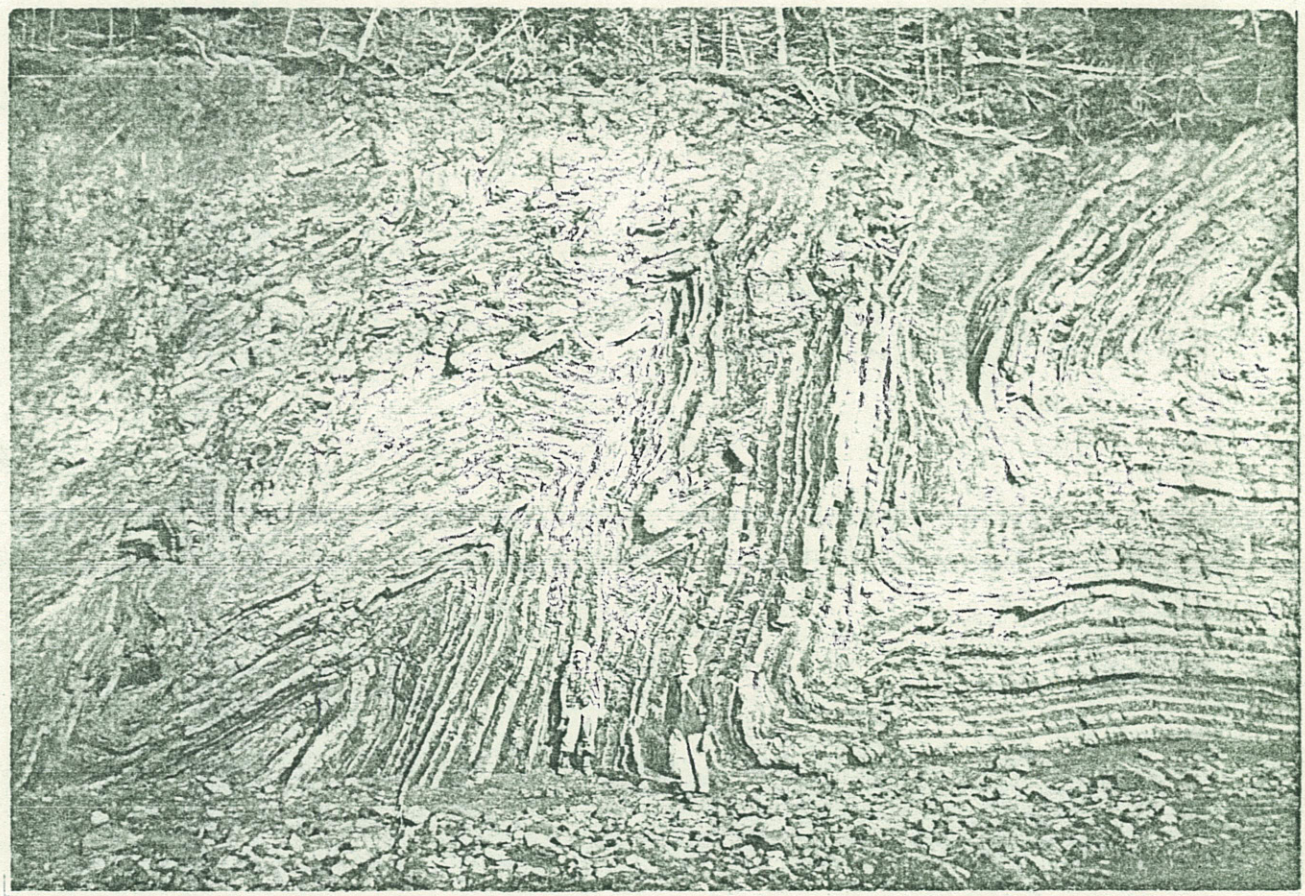
AERIAL PHOTOGRAPH OF THE MARCH POINT SETTLEMENT FROM THE SOUTHWEST.

THE WHITE HILLS FORM THE SKYLINE.

PLATE IV

BASAL HUMBER ARM CONGLOMERATE 1.5 MILES NORTHEAST OF THE GRAVELS

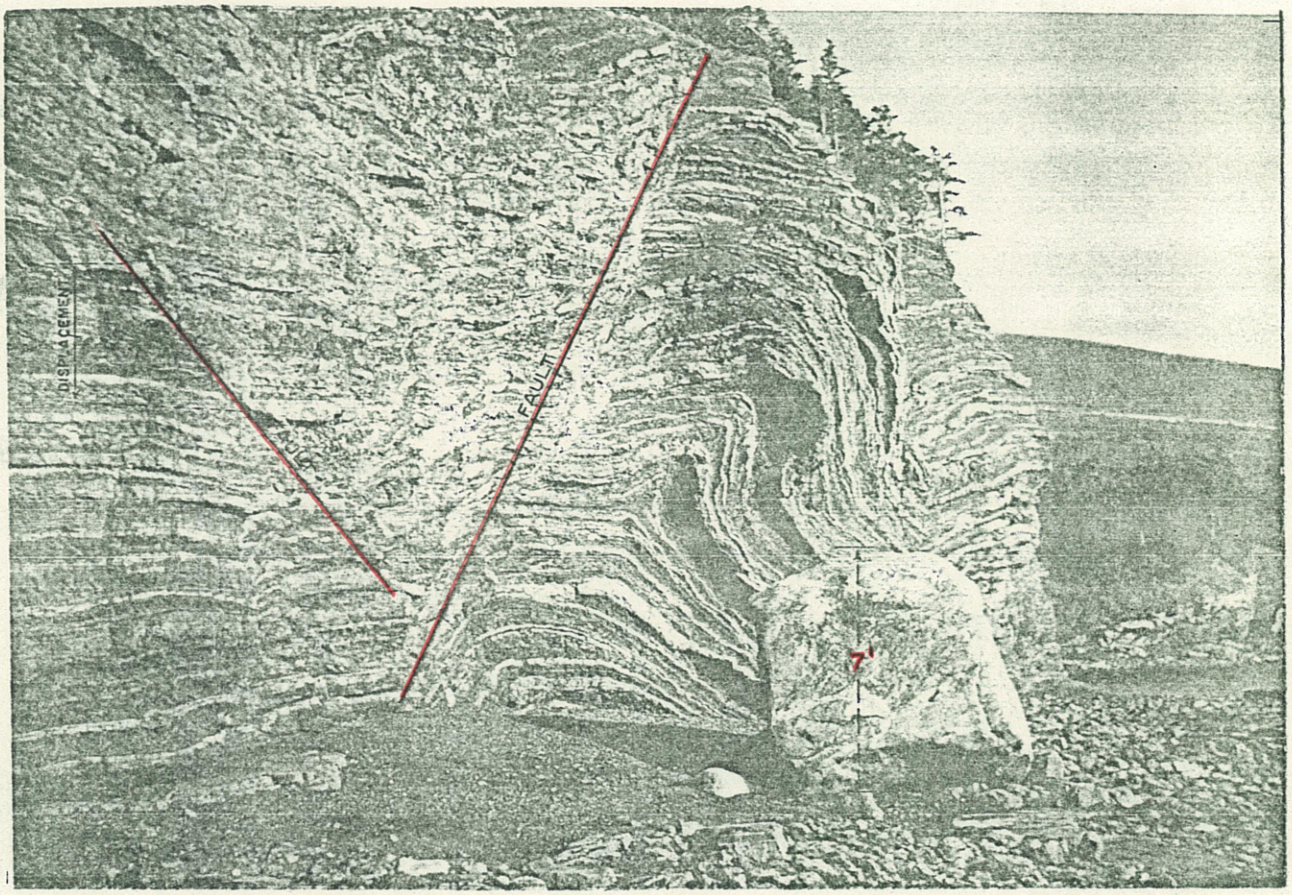
PLATE V



FOLDING IN THE HUMBER ARM GROUP, APPROXIMATELY 2.5 MILES NORTHEAST OF THE GRAVELS

PLATE VI IS THE CONTINUATION OF THIS FOLDING AND OCCURS IMMEDIATELY TO THE RIGHT OF THIS PHOTO.

PLATE VI



FOLDING IN THE HUMBER ARM GROUP. THE BOULDER STANDS 7 FEET HIGH. APPROXIMATELY 2.5 MILES NORTHEAST OF THE GRAVELS. PLATE V IS THE CONTINUATION OF THIS FOLDING AND OCCURS IMMEDIATELY TO THE LEFT OF THIS PHOTO.

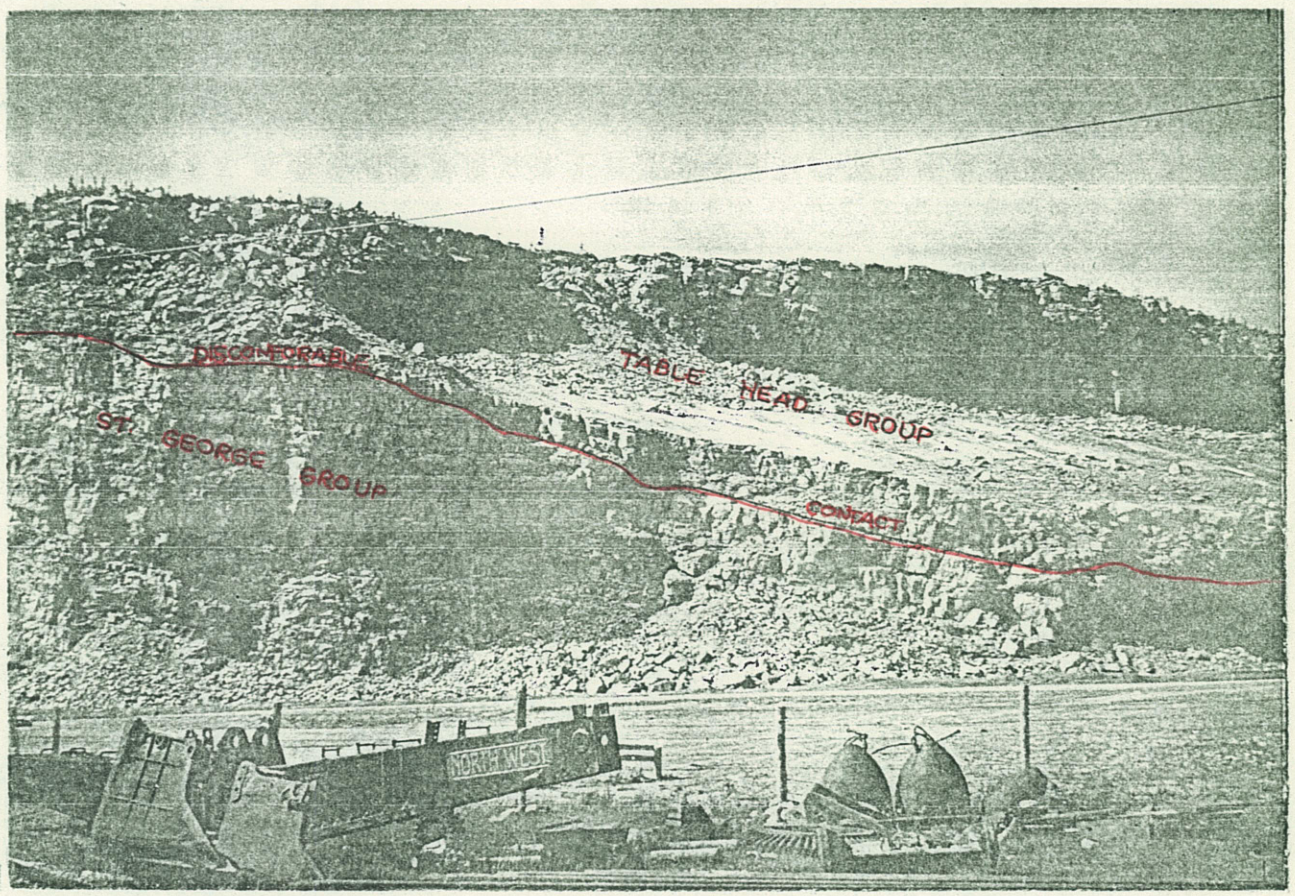
PLATE VII

ALGAL BEDS IN THE ST. GEORGE GROUP 0.5 MILE NORTHEAST OF THE GRAVELS.

PLATE VIII

DISCONFORMABLE CONTACT OF THE ST. GEORGE AND TABLE HEAD GROUPS
0.25 MILE NORTHEAST OF THE GRAVELS.

PLATE IX



DISCONFORMABLE CONTACT OF THE ST. GEORGE AND TABLE HEAD GROUPS.
PHOTO TAKEN AT AGUATHUNA QUARRY.

PLATE X

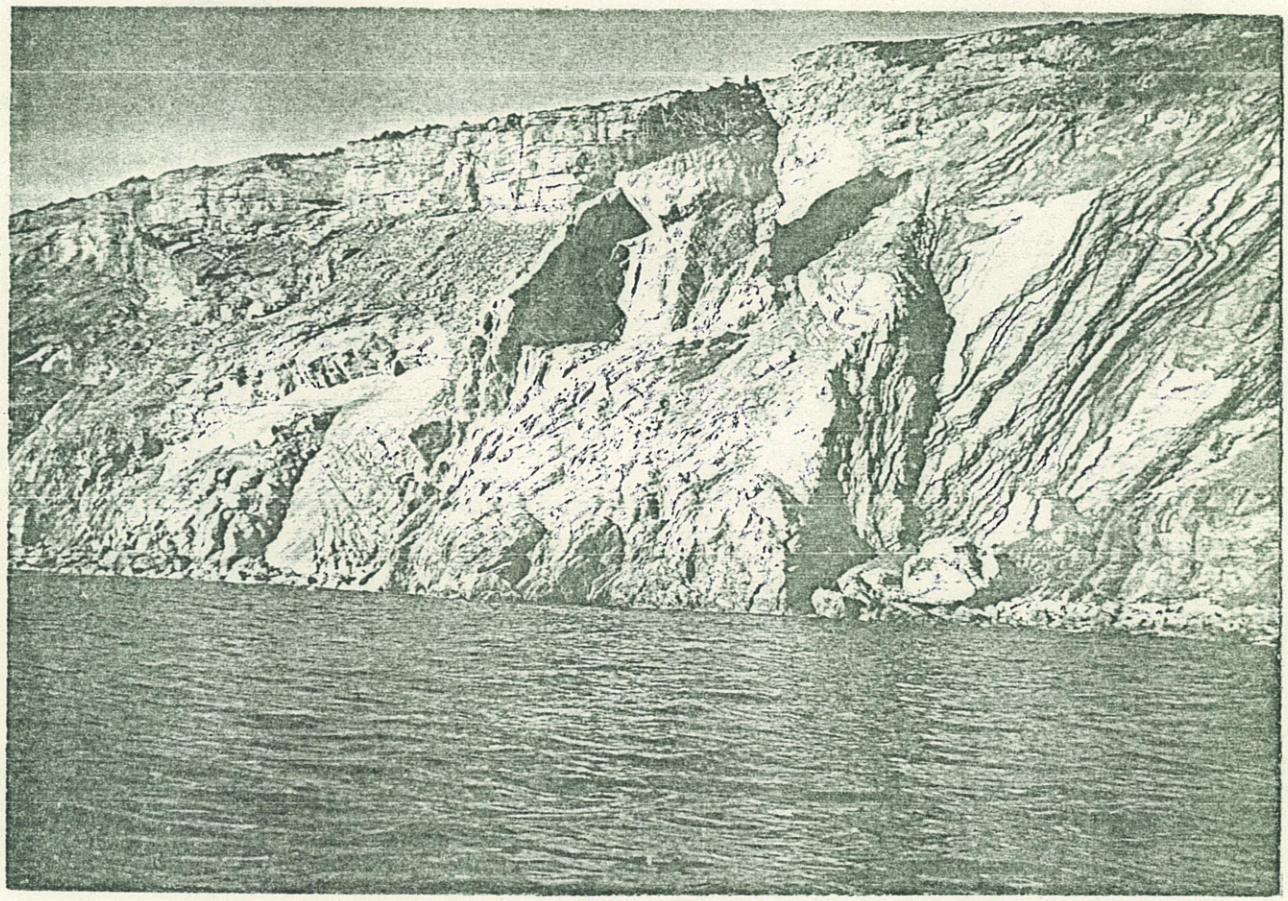
BASAL RESISTANT MEMBER OF THE LONG POINT GROUP, SHOWING STROMATOLITE DEVELOPMENTS AND HEADS OF LABYRINTHITES.

SHORE OF LONG POINT, EAST OF BLACK DUCK BROOK.

PLATE XI

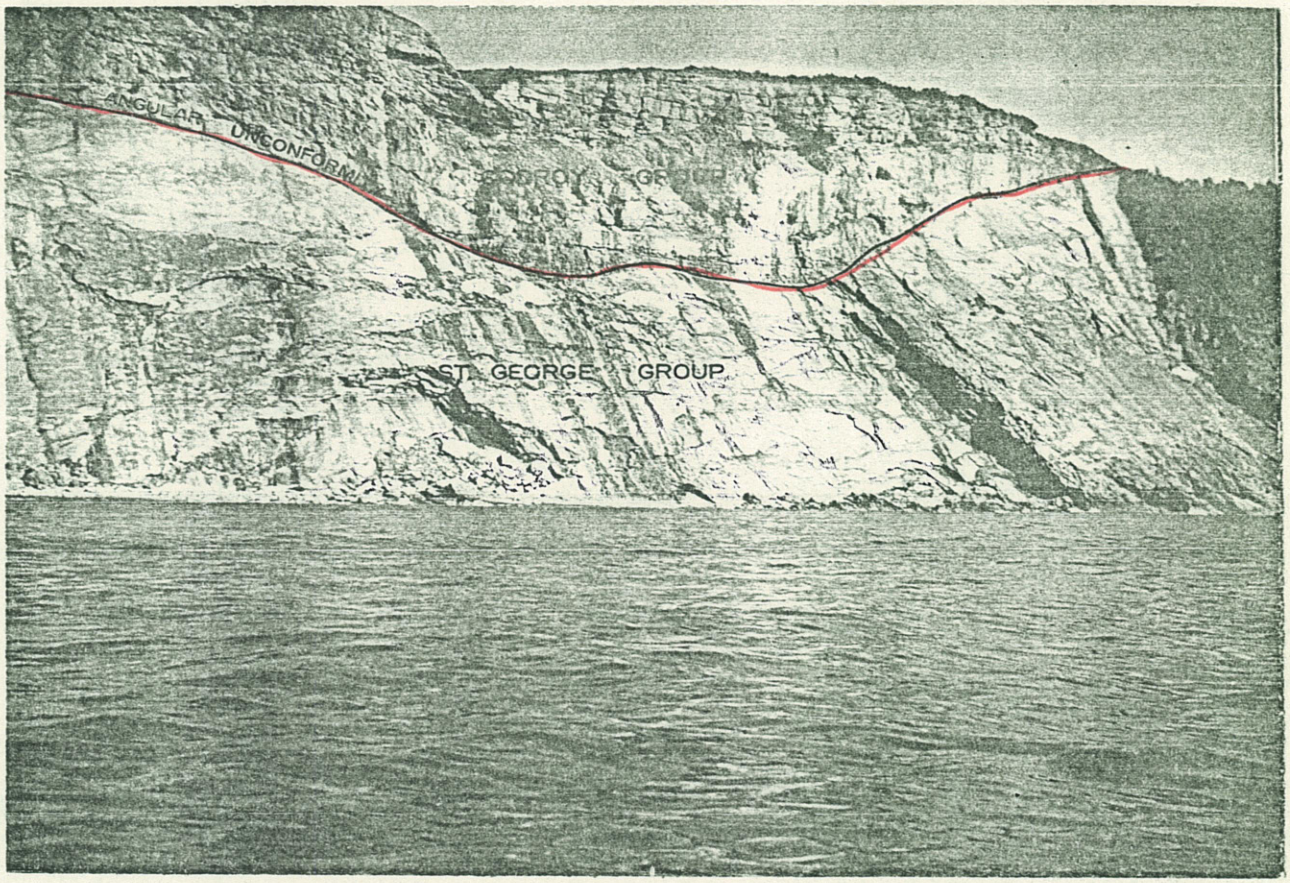
OVERFOLD IN THE LIMESTONE OF THE TABLE HEAD GROUP AT CAPE CORMORANT.

PLATE XII



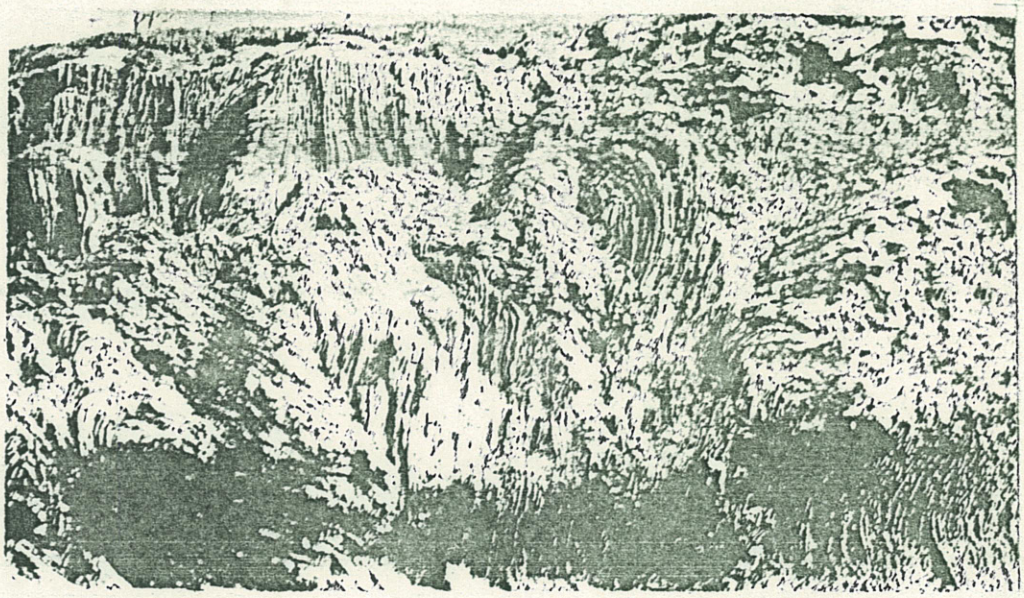
SLUMPING CARBONATE CLIFFS OF THE TABLE HEAD GROUP SOUTH OF BIG COVE ON THE GULF OF ST. LAWRENCE COAST OF THE PENINSULA.

PLATE XIII



ANGULAR UNCONFORMITY BETWEEN MISSISSIPPIAN (CODROY GROUP) AND ORDOVICIAN (ST. GEORGE GROUP), 0.25 MILE NORTH OF CAPE ST. GEORGE

PLATE XIV a



CONTORTED AND FRACTURED SHALES AND LIMESTONES OF THE HUMBER ARM GROUP, FOUR MILES SOUTH OF THE TIP OF SHOAL POINT.

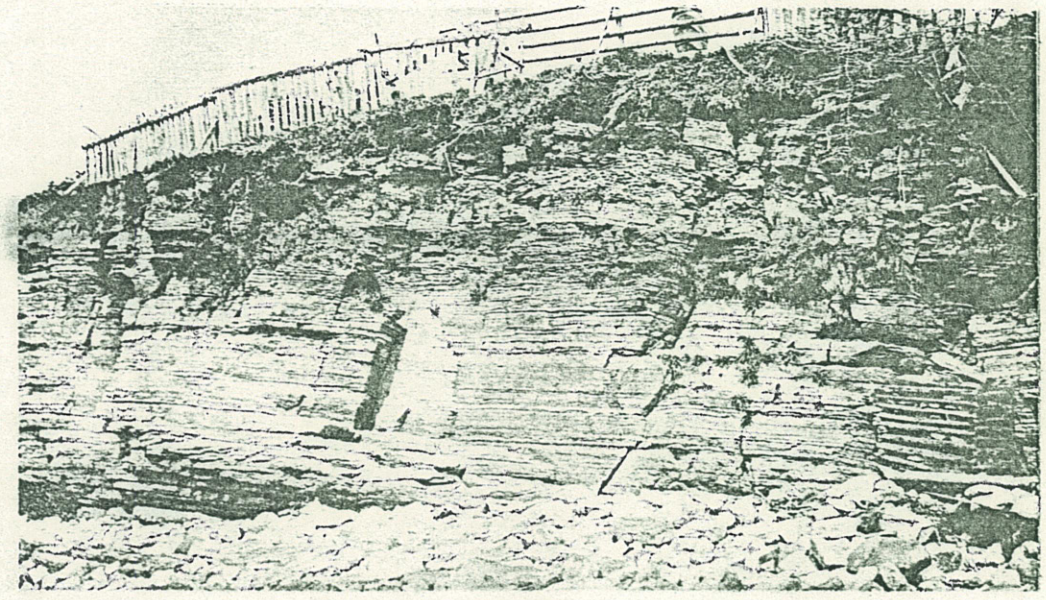
PLATE XIV b

SHALES AND LIMESTONES OF THE UPPER TABLE HEAD GROUP, NEAR CAPE CORMORANT

PLATE XV a

CAMBRIAN LIMESTONES OF THE PETIT JARDIN FORMATION, 0.25 MILE NORTH OF GRAND JARDIN

PLATE XV b

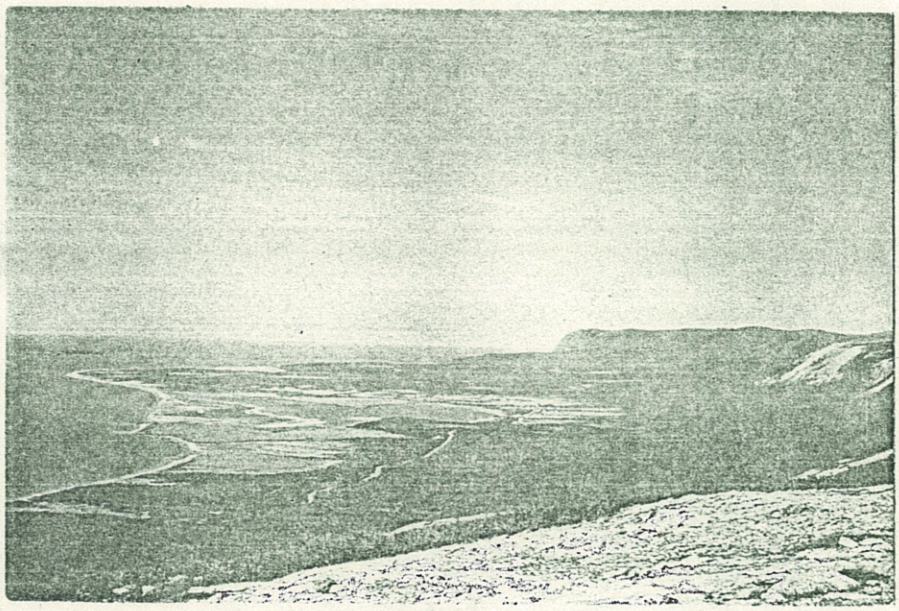


CAMBRIAN SANDSTONES OF THE MARCH POINT FORMATION, 0.5 MILE EAST OF GRAND JARDIN

PLATE XVI a

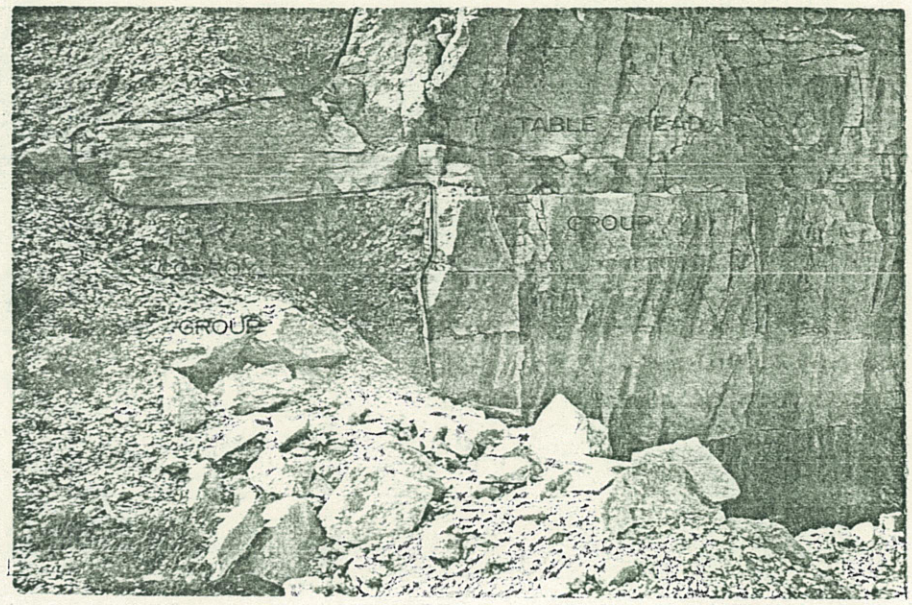
GYPSUM CLIFFS OF THE CODROY GROUP OF MISSISSIPPIAN AGE. EXPOSED ON ROMAINES BROOK ON THE NORTH SIDE OF THE HIGHWAY.

PLATE XVI b



A SEQUENCE OF ANCIENT SHORELINES. VIEW LOOKING NORTHWEST FROM TABLE MOUNTAIN ACROSS TWO GUTS POND TO FOX ISLAND IN THE DISTANCE.

PLATE XVII a



A LIMESTONE CAVE IN THE TABLE HEAD GROUP (ORD.) FILLED WITH SEDIMENTS OF THE CODROY GROUP (MISS.), IN "THE NARROWS" OF AGUATHUNA QUARRY.

PLATE XVII b

A BOULDER OF TABLE HEAD LIMESTONE WHICH SLUMPED INTO SEMI-LITHIFIED CODROY SEDIMENTS DURING THEIR DEPOSITION. PHOTO LOCATED IN "THE NARROWS" OF AGUATHUNA QUARRY.

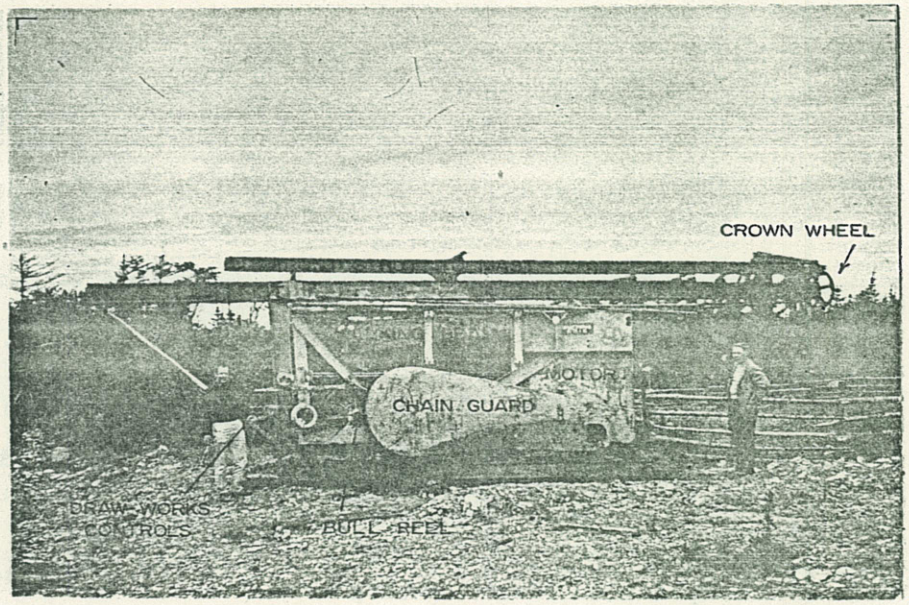
PLATE XVIII a

ST. GEORGE GROUP STRATA EXPOSED ON THE WEST WALL OF ABRAHAMS COVE.

PLATE XVIII b

THE CASING OF AN ABANDONED OIL WELL FROM WHICH A SAMPLE OF CRUDE WAS ANALYSED - SEE APPENDIX. LOCATED ON THE WEST SHORE OF SHOAL POINT 1.5 MILES SOUTH OF THE TIP.

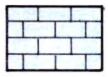
PLATE XX

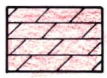


BUCYRUS - ERIE CABLE TOOL RIG STACKED AT ST. PAULS
IMMEDIATELY NORTH OF THE VILLAGE

TABLE III

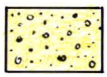
LITHOLOGICAL CONVENTIONS


LIMESTONE

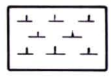

DOLOMITE

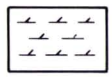

SHALE

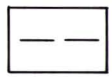

SILTSTONE

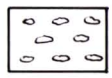

SANDSTONE


QUARTZITE

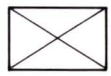

CALCAREOUS


DOLOMITIC


ARGILLACEOUS


CONGLOMERATE


BRECCIA


COVERED SECTION


ALGAE


FOSSIL


CONCRETION

CHERT , BLACK

CHERT , WHITE

G GLAUCONITE

MICACEOUS

CARBONACEOUS

P POROSITY

UNCONFORMITY

MINOR UNCONFORMITY

FAULT


TRUE THICKNESS UNCERTAIN

59°10' 59°00' 58°50' 58°40'

48°45'

48°40'

48°35'

48°30'

G U L F O F

S T . L A W R E N C E

LONG POINT

FOX ISLAND

PORT AU PORT BAY

ROCKY POINT

SHOAL POINT

ROUND HEAD ANTICLINE

GOODYEAR

THREE ROCK PT.

WEST BAY

EAST BAY

SOUTH HEAD

PICCADILLY BAY

RED ISLAND

CAPE CORMORANT

WHITE HILLS

SHEAVES HEAD

Lower Cove

PIGEON HEAD

JERRYS NOSE

PIERWAYS HILL

Big Cove

Big Cove

SETTLEMENT OF DE GRAU

MARCH PT.

CAPE St. GEORGE

ST. GEORGES BAY

A

B

C

D

A'

B'

C'

D'

E

E'

F

F'

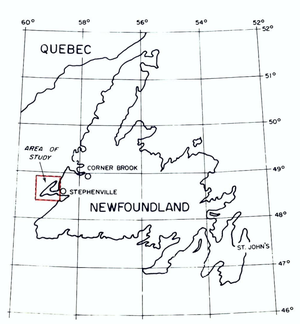
G

G'

12B(82)

FIELD GEOLOGY BY H. CORKIN
DURING AUG. AND SEPT. 1964

DRAWN BY A. WERSE, JAN. 1965
GOLDEN EAGLE OIL AND GAS LIMITED



INDEX MAP

STRUCTURAL SUBDIVISIONS

A	EASTERN AREA
B	CENTRAL FAULTED AREA
C	NORTHWESTERN AREA
D	SOUTHWESTERN AREA
	STRUCTURAL SUBDIVISION BOUNDARY

ENCLOSURE N° 2

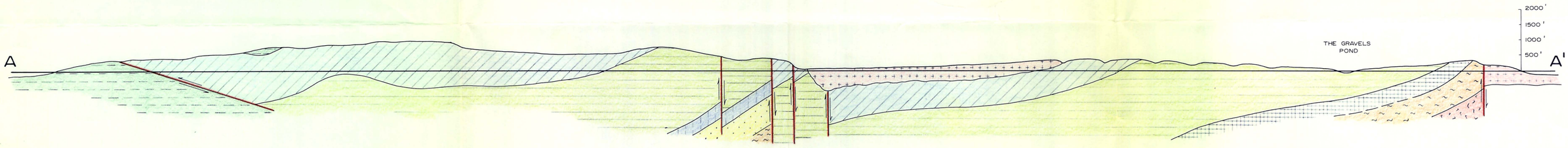
STRUCTURE OF THE PORT AU PORT PENINSULA NEWFOUNDLAND

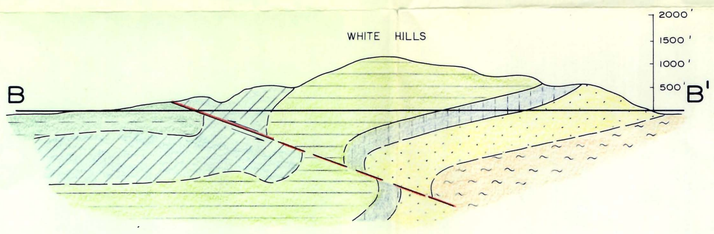
SCALE : 1 INCH = 1 MILE OR 1 : 63 360

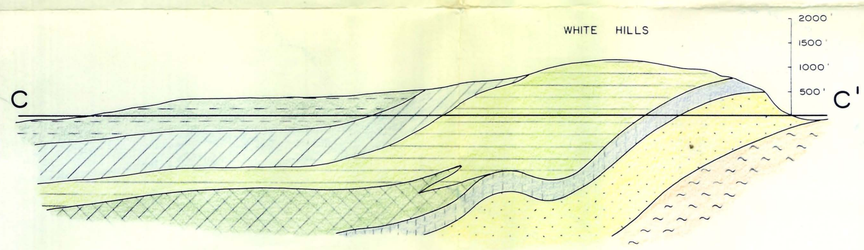
1 0 1 2 3 4 5 6 MILES

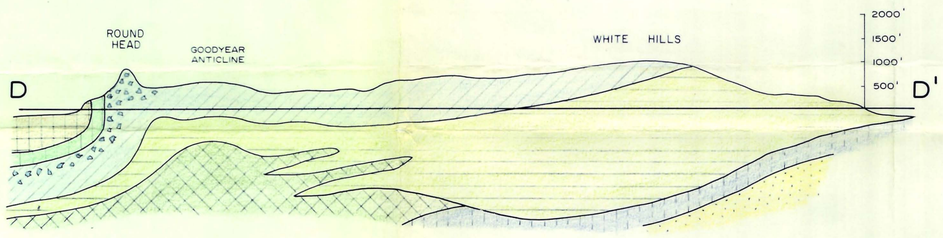
GEOLOGICAL SYMBOLS :

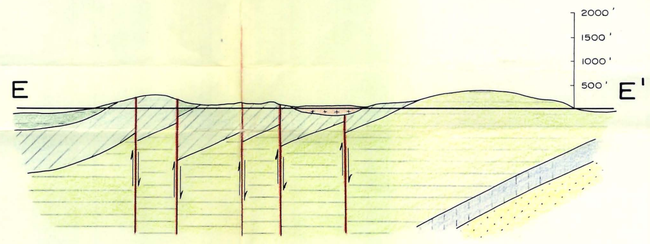
STRATA HORIZONTAL	ANTICLINE
STRATA VERTICAL	SYNCLINE
OVERTURNED BEDS	FAULT { ARROWS SHOW MOVEMENT
DIP AND STRIKE	FAULT { U = UP, D = DOWN
DIRECTION OF PLUNGE	LINE OF CROSS SECTIONS (A — A')

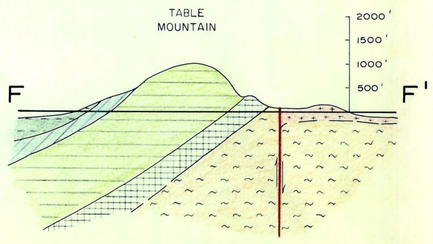


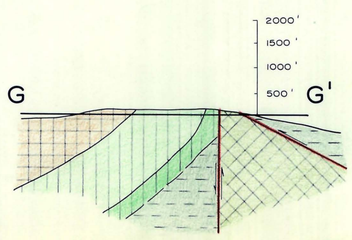


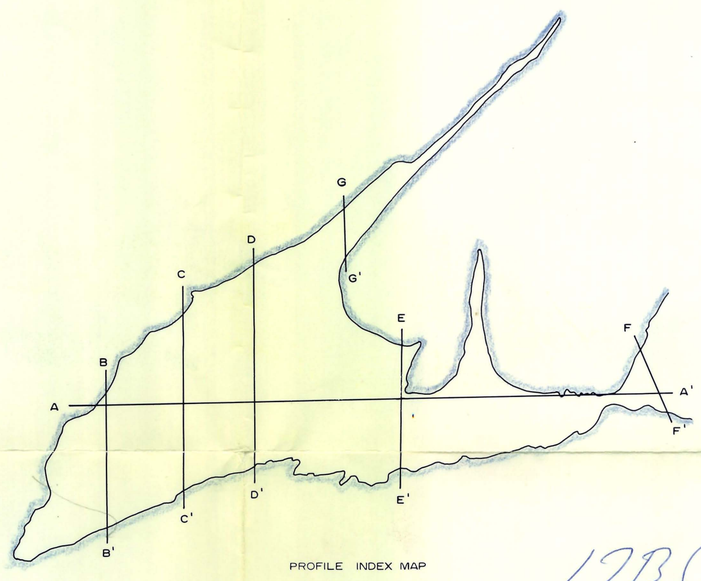












PROFILE INDEX MAP
SCALE : 1 INCH = 4 MILES

12B(82)

LEGEND

- CODROY GP.
- CLAM BANK GP.
- LONG POINT GP.
- HUMBER ARM GP.
- TABLE HEAD GP.
- ST. GEORGE GP.
- GREEN POINT GP.
- PETIT JARDIN FM.
- MARCH POINT FM.
- KIPPEN FM.
- CAMBRIAN UNDIVIDED
- PRECAMBRIAN

ENCLOSURE Nº 3

STRUCTURE PROFILES
PORT AU PORT PENINSULA
NEWFOUNDLAND

HORIZONTAL SCALE : 1 INCH = 1 MILE
VERTICAL SCALE : 1 INCH = 2000 FEET

AUTHOR : H. CORKIN, OCT. 1964
GOLDEN EAGLE OIL AND GAS LIMITED

GEOLOGICAL SYMBOLS

- FAULT | ARROWS SHOW MOVEMENT
- A — A' BASE LINE — SEA LEVEL
- FORMATION CONACT

DRAWN BY A. WERSE, FEB. 1965

NEWFOUNDLAND

PORT AU PORT PENINSULA

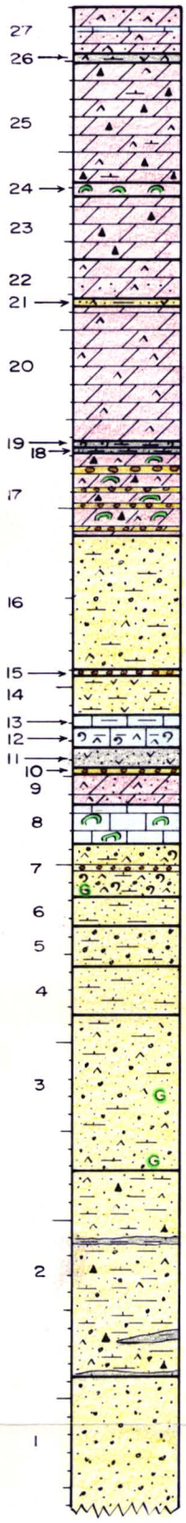
MARCH POINT FORMATION

STRATIGRAPHIC COLUMN

LOCATION - SECTION MEASURED ASCENDING FROM THE ANTICLINAL AXIS LOCATED 1.5 MILES SOUTHWEST OF MARCH POINT TO THE CONTACT WITH THE PETIT JARDIN FORMATION 2.5 MILES TO THE NORTHEAST.

SCALE : 1 INCH = 100 FEET

H. CORKIN MEASURED IN SEPT. 1964



UNIT N°	DESCRIPTION
27	DOL - lt. brn., f. grd., med. bdd., tr. p.p. porosity, fri., aren., carb., tr. of thn. layers of oolitic LST.
26	SH - dk gy./blk., silty /aren., carb., sl. calc., micro-mica.
25	DOL - dk./dk. brn., med. grd., often oolitic, v. sl. calc., v. thn. bdd., often lam., carb., fair porosity, CHT. - blk. & brn., pbls. com.
24	DOL - med. gy., lith., med. bdd., Algal heads com., tr. SH.
23	DOL - med. gy., v.f./f. grd., thn./med. bdd., occ. vugs, v. hd., dns., occ. CHT. pbls., blk. & brn.
22	DOL - med./dk. gy., oolitic thru., thn. bdd., carb., sl. aren., v. hd., dns.
21	SLTST. - med. gy., thn. bdd., fri., calc., sl. carb., v. arg., mica., glauconitic
20	DOL - lt./med. brn., lith./v.f. grd., oolitic thru., carb., med. bdd., resis. wthg., v. hd., dns.
19	SH. - greenish-gy., plty., arg., calc., brit., Brachs. com.
18	SH. - maroon/dk. brn., slty., fiss./sub-fiss., dolic., sl. carb., sft.
17	DOL - lt./med. brn., lith., oolitic thru., med./mass. bdd., occ. algal heads, v. res. to wthg. sl. carb., v. hd., dns., four thn. calc. CGL. are present, tr. brn. CHT. incl.
16	SS. - lt. gy., f./med. grd., thn. bdd., clyey in pt., calc., v. sl. carb., med. hd., v. well cmtd. with a calc. mtx., ti.
15	CGL. - med./dk. gy., v. resis., calc sdy. mtx., incl. of QTZ. & CHT. pbls.
14	SLTST. - med. gy., v.f. grd., thn. bdd., calc., micro-mica., med. hd., dns.
13	LST. - lt. gy., f. grd., plty./thn. bdd., poor p.p. porosity, gyp., v. hd.
12	LST. - lt./med. gy., f. grd., thn. bdd., knobbly tex., sl. carb., arg., Trilo. com.,
11	SH. - med./dk. gy., papy/thn. bdd., slty., mica.
10	CGL. - red-brn., incl. of CHT. & QTZ.
9	DOL - med. gy., v.f./f. grd., thn. bdd., slty./aren., carb., hd., ti.
8	LST. - med. gy., crypto/micro xln., thn. bdd., knobbly tex., occ. Algal heads, med. hd., dns.
7	SS. - greenish-gy., v.f./f. grd., plty. thn. bdg., fri., v. carb., calc., glaucic., occ. CGL., ti., worm tubes, few Trilo & Gast.
6	SLTST. - lt./med. gy., v.f. grd., med. bdd., v. arg., calc., med. hd., brit., ti.,
5	SS. - crm./lt. yel., f. grd., med. bdd., calc., cln., hd., worm tubes
4	SS. - med. brn., f./med. grd., thk./mass. bdd., fe. stng., tr. poor p.p. porosity, calc., hd.
3	SS. - crm./lt. yel., med. grd., thk. bdd., bdg. reg., fair/gd. porosity, carb., mica., sl. glaucic., ripple mks. & x-bdg., large worm burrows com.
2	SS. - blk., red & grn., v.f. grd., thn. bdd., poorly srtd., occ. rdd. CHT. pbls., well cmtd., carb., calc., arg., hd., ti., occ. thn. SH. horizons
1	SS - wht./crm., f./med. grd., med. bdd., x-bdd. in pts., fri., cln., non-calc., tr. poor p.p. porosity, v. hd., ti.

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 4

NEWFOUNDLAND

PORT AU PORT PENINSULA

PETIT JARDIN FORMATION

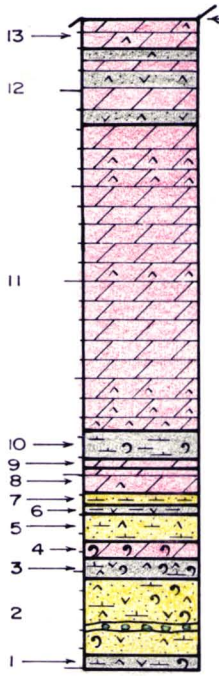
STRATIGRAPHIC COLUMN

LOCATION - SECTION WAS ASCENDED FROM THE CONTACT OF THE MARCH POINT FORMATION LOCATED 0.75 MILES SOUTHWEST OF BIG COVE TO A CONSPICUOUS FAULT ON THE WEST SIDE OF THE SAME COVE

SCALE : 1 INCH = 100 FEET

H. CORKIN

MEASURED IN SEPT. 1964



DESCRIPTION

FAULT CONTACT WITH ST. GEORGE GROUP

13 DOL. - lt. brn., v. f. xln., well cmted, non-calc. cmt., v. sl. carb., med./thk. bdg., cliff forming, v. hd., dns.

12 DOL. - lt. brn., crypto/finely xln., carb., arg., med. hd., dns., intbdd. with SH. - lt./med. gy., aren., v. thn. bdd., carb., v. mica.

11 DOL. - lt./med. gy., med./thk. bdd., reg. bdg., cliff forming, med. grd., some horizons have gd. porosity, vugs at top & btm. of unit, v. sl. carb. in pt., med. hd.

10 SH. - med./dk. gy., slty., v. thn./papy. bdg., fiss./sub-fiss., calc., arg., soft, Brachs.

9 DOL. - med. gy., micro-xln., v. thn. bdd., lam., clyey., carb., brit., dns.

8 DOL. - lt./med. brn., oolitic, v. thn. bdd., tr. p.p. porosity, v. sl. carb., med. hd.

7 SLTST. - med. gy./lt. brn., v. f. grd., calc., v. sl. arg., well cmtd., hd., ti.

6 SH. - lt. brn., plty., non-calc., arg., micro-mica., sft.

5 SLTST. - lt./med. gy., med. bdd., aren., calc. fri., v. sl. carb., med. hd.

4 DOL. - med. gy./med. brn., oolitic/v. f. grd., tr. p.p. porosity, carb., Trilo.

3 SH. - dk. greenish-gy., slty., pyritic, v. sl. calc., carb., Trilo. com.

2 SLTST. - med. gy., med. bdd., aren., calc., sl. carb., mica., dns., ti., a 3 inch CGL. occurs, tr. Trilo.

1 SH. - med./dk. gy., papy./v. thn. bdd., fiss./sub-fiss., mica., calc., Trilo. com.

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 5

NEWFOUNDLAND

PORT AU PORT PENINSULA

GREEN POINT GROUP

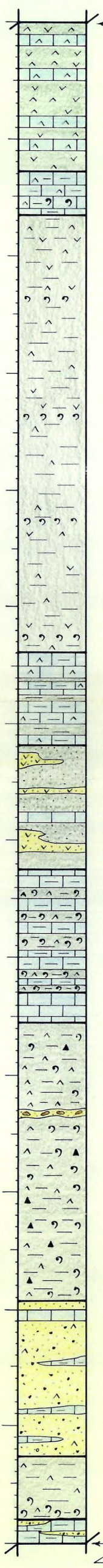
STRATIGRAPHIC COLUMN

LOCATION - SECTION MEASURED FROM A FAULT CONTACT WITH THE HUMBER ARM GROUP, 1.25 MILES NORTHEAST OF THE VILLAGE OF WEST BAY TO A SIMILAR FAULT CONTACT WITH THE LONG POINT GROUP, A THIRD OF A MILE FURTHER TO THE NORTH.

SCALE : 1 INCH = 100 FEET

H. CORKIN

MEASURED IN SEPT. 1964



UNIT N°	DESCRIPTION
	FAULT CONTACT WITH HUMBER ARM GROUP
11	11 SH. - blk./dk.gy., clyey., bit., fiss./sub-fiss., carb., micro-mica., brit., soft, intbdd. occ. with LST. - med.gy. f.grd., thn.bdd., bdg. ireg. due to fault ctct., v. aren., carb., micro-xln. porosity, well cmtd, sl.fri., med. hd.
10	10 LST. - dk.gy., med. bdd., lith., arg., sl. carb., gypsiferous in pt, occ. pyrite cubes are found as incl., two Gast. were found
9	9 SH. - blk./v.dk. brn, clyey, reces. wthg., v.thn./thn. bdg., bit. thru., arg., fiss./sub-fiss., carb., micro-mica., pyritic, sft., occ. thn. Graptolitic bds. occur
8	8 LST. - med. gy., lith., thn./med. bdd., arg., sl. carb., brit., fetid odour, hd., dns., unfoss., occ. SH. strgs. are found, are bit., gy.-grn., brit., non-calc.
7	7 SH. - med./dk.gy., choc.-brn. in pt., thn. reg. bdg., aren., grades to a f.grd. SLTST. - lt./med. gy. v. mica., brit., med. hd., ti., tr. of thn. strgs. of med. gy. LST.
6	6 LST. - med. gy., lith., thn. bdd., fetid odour, v. arg., dns., med. hd., intbdd. with SH. - dk. gy./blk., v. thn. bdd., arg., carb., sub-fiss., bit, gypsiferous, pyrite nod. com., sft., Graps. v. com.
5	5 LST - dk.gy./dk.brn., lith., thn.bdd., small calcite filled vugs, sl. gypsiferous, unfoss., hd., dns.
4	4 SH. - blk./dk.grn., clyey./silty. tex., arg., bds. up to 4" thk, v carb., bit., fiss./sub-fiss., Graps. com. thru. unit., occ. CHT. pbls. - blk. & dk. brn., highly polished, rdd., a Lst. CGL is loc. 75' from top of unit
3	3 SS. - lt.gy./v. lt. brn., ferr., v.f./f grd., thn/med. bdd., ireg. bdg, sl. carb., sid in pt, non-calc., well cmtd., ti., hd., resis to wthg., intbdd. with occ. LST. - med./dk gy., crypto/micro-xln, thn ireg. bdg., arg., v.hd., dns.
2	2 SH - dk brn./blk., some bottle-grn., thn. wavy bdg., fiss/papy., v. bit., carb., arg., pyric nods., non-calc., Graps near base
1	1 LST. - dk. gy., lith./crypto-xln., thn.bdd., arg., micro-mica., contorted, tr. SS. - lt.gy./v. lt brn., v f/f.grd., thn. bdd., calc., hd., ti.
	FAULT CONTACT WITH LONG POINT GROUP

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 6

NEWFOUNDLAND

PORT AU PORT PENINSULA

ST. GEORGE GROUP

STRATIGRAPHIC COLUMN

LOCATION - SECTION MEASURED FROM THE CONTACT WITH THE TABLE HEAD GROUP, 200 YARDS NORTHWEST OF THE GRAVELS AND CONTINUES AS FAR AS BIG COVE IN A WESTWARD DIRECTION ALONG THE SOUTH COAST OF PENINSULA

SCALE : 1 INCH = 100 FEET

H. CORKIN — MEASURED IN SEPT. 1964

UNIT N° — DESCRIPTION

Massive LST containing num. Gast.

53 LST. - lt. brn., lith., thinly lam., plty bdg.
52 LST. - lt. gy., lith., med. bdd., Algae
51 LST. - reddish - brn., lith. /v.f.gr., thn./thk. bdd., hackly, scattered qtz. geodes
50 Algal bed
49 LST. - brn. /olive grn., v.f. grnd. /lith., thn. /med. bdd., hackly, ti., minor thnly. lam. grn. SH. beds
48 LST. - lt. /med. gy., v. f. gr., thn. /med. bdd., cherty, foss. incl. Brachs., Gast., Algae
47 LST. - shaly, lt. brn. / pale grn., v.f.g., plty. bdd., lam. in pt.
46 LST. - med. gy., lith., thk. /mass. bdd., hackly frac., arg., dns.
45 LST. - med. gy., lith., mass. bdg., algal
44 LST. - lt. brn., lith., thn. /thk. bdd., hackly frac. in pt., dns., algal
43 CGL. - brn. - grn., incl. pea size, mtx. slt., fri., calc., wvy. bdd., Cht., Algae
42 LST. - lt. brn./gy., dns., thk. bdd., hackly frac., fetid od. when struck
41 LST. - gy., lith., thn. bdd., Sh. - rd. & grn., fragl., intbdd. algal
40 LST. - crm. /lt. brn., lith., thick bdd., hackly
39 DOL. - lt. brn., lith. /v.f. gr., thk. bdd., occ. intbd. of calc. rd. & grn. SH., few bds. of mass. gy. LST.

38 Covered interval between the north and south bars of The Gravels
Isolated outcrops of occ. DOL. & LST.
LST. - v. fosiferous, mainly Brachs.

37 DOL. - lt. gy., lith. /v.f. gr., thn. irreg. bdg., v. sl. calc., med. hd., dns.

36 LST. - med. gy., lith., lam., v. arg., Brachs. com.
35 DOL. - crm. /v. lt. brn., f. /med. grd., med. bdd., v. hd., hackly frac.
tr. LST. - med. gy. med. grd., ireg. bdd., well cemtd., med. hd.
34 LST. - lt. /med. gy., med. gred., med. bdd., w. cmtd., Algal thru, med. hd., dns.
33 DOL. - lt. brn., lith., plty. bdg., lam., hackly frac., brit.
32 LST. - med. /lt. gy., thn. /med. bdd., lith., arg., w. cmtd., hd
31 CGL. - lt. /med. brn., mtx. of sd., pbl. of CHT. & LST. pea grd. in size
30 LST. - med. gy., v.f. grd., thn. bdg. /platy, ireg. bdg., med. hd., dns., Algal thru
29 LST. - lt. /med. gy., v.f. /f. grd., thk. /mass. bdg., p.p.p., wvy. bdg., some lam. beds,
sl. /v. aren., CHT. nod. com., num. vugs filled w. calcite

28 DOL. - med. brn., lith., platy /thn. bdd., lam., hackly frac., hd., dns.

27 LST. - lt. /med. gy., lith., thn. bdd., arg., num. Gast.

26 LST. - med. gy., lith. /v.f. grd., thn. ireg. bdg., rbly. aprnc, med. hd., dns.

25 Calc. Algal bd.
24 DOL. - med. brn., lith., thn. bdd., hackly frac., hd., dns.

F ← Normal fault breaks section at this point (throw approx. + or - 40'

23 DOL. - lt. brn. /lt. gy., lith., thk. bdd., hackly frac., reg. bdg., v. hd., dns., CHT. beds com.

22 LST. - med. gy., v.f. grd., thn. /med. bdd., sl. lam. in pt., num. CHT. inclsions, med. hd., w. cmtd., Algal in pt.

21 DOL. - med. gy. /lt. brn., f. grd., thn. /med. bdd., w. cmtd., dns., Algal thru, CHT. pbls. com.

20 DOL. - crm. /lt. brn., lith., thn. bdd., contains a Gast. bank assemblg., tr. intbd. LST. - lt. gy.,
crs., thn. bdd., sl. p.p.p., med. hd., tr. CHT. - blk. & wht.

19 LST. - lt. gy., lith., thk. /mass. bdg., w. cmtd., v. hd., dns., Algal thru.

18 LST. - lt. gy., lith., thn. /med. bdd., bdg. v. ireg., blk. CHT. thru., v. fossiferous w. Brachs. & Gast. sp.

17 LST. - lt. gy. /brn. gy., f. /crs. grd., mass. bdg., v. p. poros., CHT. thru., Algal in pt., ireg. bdg., med. hd.

16 LST. - a.a. but reg. bdg.

15 DOL. - lt. brn. /crm., v.f. grd., plty. /thn. bdd., hackly frac., w. cmtd., dns., med. hard, reg. bds.

14 LST. - v. lt. /lt. gy., v.f. grd., thn. bdd., nodar tex., Algae v. com., hd
13 CHT. - blk. /gy., lith., mass. bdd., conch. frac., v. hd., dns.

12 DOL. - v. lt. /lt. brn. /pale grn., med. grd., thn. bdd., reg. bdg., p.p.p., hd., tr. occ. CHT. - blk. /rd. - brn.
& LST. - lt. gy., lith., v. thn. bdd.

11 LST. - lt. /med. gy., lith. /v.f. grd., v. thin /thn. bdd., nodar tex., Algal thru., v. hd., dns.,
at 20' in unit is a 1' thk. CGL. - incl. are LST.

10 LST. - lt. /med. gy., v.f. /f. grd., thn. bdd., nodar tex., Algal thru., v. sl. p.p.p., ripple marks com.,
tr. SH. & DOL. bds., 3 thn. bds. of CGL.

9 DOL. - med. gy., wthrs. crm. /lt. brn., lith. /v.f. gr., thn. /thk. bdd., reg. bdg., shly. in pt., med. hd.
num. calcite filled vugs, hd., dns.
Quartzitic bed 2' thk. 50' below top of unit
2' Algal bd. 63' below top of unit

8 DOL., LST. & SH.
DOL. - med. brn., lith., plty. /thn. bdd., nodar tex.
LST. - med. /dk. gy., lith., mass. bdd., dns.
SH. - med. gy. /grn., sl. calc., fiss., arg.

7 LST. - lt. /med. gy., v.f. gr., thn. /thk. bdg., sl. lam. in pt., dns., Algal thru.

6 DOL. - med. brn. /yell., lith., med. bdd., tr. Qtzt. - pink

5 LST. - med. gy., v.f. gr., v. thn. /thn. bdg., aren., p.p.p., nodar tex. in pt., mainly dns.

4 DOL. - lt. gy., lith., mass. bdg., v. sl. calc., hd., dns.

3 LST - lt. /med. gy., plty., brit., fos. zone contains Brachs. & Gasts.

2 DOL. - lt. gy., lith., mass. bdg., v. sl. calc., hd., dns.

1 DOL. - med. gy., lith. /v.f. gr., med. bdd., occ. calcite filled vugs,
some blk. CHT. incl., dns., v. hd.
Contact with Cambrian covered

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 7

NEWFOUNDLAND

PORT AU PORT PENINSULA

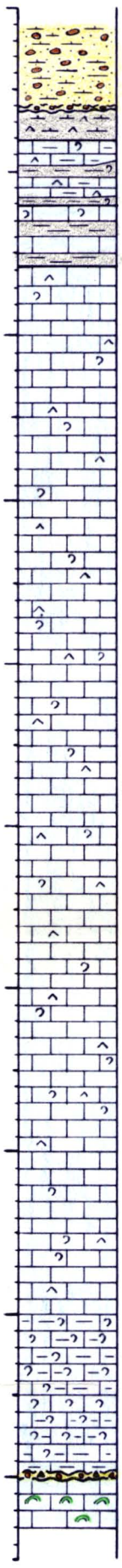
TABLE HEAD GROUP

STRATIGRAPHIC COLUMN

LOCATION - SECTION MEASURED FROM THE CONTACT WITH THE HUMBER ARM GROUP, 1.5 MILES NORTHEAST OF PORT AU PORT TO THE CONTACT WITH THE ST. GEORGE GROUP, 1 MILE SOUTHWEST

SCALE : 1 INCH = 100 FEET

H. CORKIN — MEASURED IN SEPT. 1964



UNIT Nº

DESCRIPTION

CGL. - containing pbls. of gy. lst., mtr. of red & grn. sh. & lt. grn. ss. (BASE OF HUMBER ARM GP.)

6: CGL - lt./med brn., aren., fine grnd., irreg. & wvy. bdg., Fe stnd. thru, incl. are all Lst., often pinches out completely.

5: SH. - blk, papy./v. thn bdd., lam. in pt., fiss./sub-fiss., carb., calc., arg., v. gypsiferous.

4: LST. & SH.: LST. - 70%, med./dk. gy., f. grnd., thn./med bdd., reg. bdg., arg., v.sl. carb., coq. in pt., marly, occ. vug. med. hd., dns.
SH. - 30%, med./dk. gy., papy. bdg., v. sl. gypsiferous, micro-mica., sl. carb., v. calc., fiss./sub-fiss., Graps. com.

3: LST. & SH. - intbd. a.a., LST. - dk. gy./blk., v.f. grnd., thn./med. bdd., reg. bdg., sm. tex., v. well silicified, sl. arg., fetid odor, lmnic. stning., Brachs. & Trilo
SH. - med. gy., clyey, v. thn. bdd., fiss., brit., non-calc.

2: LST. - med. gy., v.f./f. grnd., thk./mass bdd., reg. bdg., well cmtd. w. calcite, resis., arg., sl. carb., occ. ripple marks, fossils occ. thru unit, - Brachs., Gast. & Plcy.

Conc. of Gast. in this lwr. 100' intv. where lst. is v. arg.

1: CGL. - rd.-brn., aren., fri, pbls. consist of cht., qtz. & lst., calc., recessive wthrg., ds.

LST. - lt. brn, lith., thinly lam., plty bdg., algal in pt. (TOP OF ST. GEORGE GP.)

TO ACCOMPANY NEWFOUNDLAND REPORT BY H. CORKIN, DEC. 1964

ENCLOSURE Nº 8

NEWFOUNDLAND

PORT AU PORT PENINSULA

HUMBER ARM GROUP

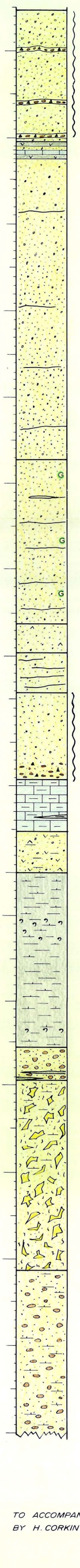
STRATIGRAPHIC COLUMN

LOCATION - DESCENDING SECTION MEASURED FROM THE SOUTHWEST SALIENT OF THREE ROCKS COVE IN A SOUTHWESTERLY DIRECTION TO THE CONTACT WITH THE TABLE HEAD GROUP AT CAPE CORMORANT

SCALE : 1 INCH = 100 FEET

H. CORKIN

MEASURED IN SEPT. 1964



UNIT N°

DESCRIPTION

13 13 SS. (Qtzose) - lt./med. gy., wthrs. grn., v.f. grd., thn./med bdd., x-bdg com., fri., non-calc., occ. thn cglic bds. a few inches thick, containing QTZ & CHT incl. of approx. pea size

12 12 SH. - med. gy./dk. grn., papy./plty. bdg., fiss., non-calc., sl. mica., brit., occ. thn stringers of dolic LST & SS.

11 11 SS. - (Qtzose) lt. brn./gnn., wthrs. dk. grn, f./crs. grd., med bdd, x-bdg, cln., occ. ripple marks, a few thnly. lam. fiss. shly bds.

10 10 SS. (Qtzose) - lt. grn., wthrs dk. grn., f./crs. grd., thn/med bdd, reg. bdg., minor x-bdg., tr. Glauc., non-calc, fri., poorly cmtd., tr. poor p.p.p., occ. v. thn. bds. of med. gy. fiss. SH.

9 9 SS. (Qtzose) - med. brn./med. grn., wthrs. dk. grn., crs. grd., thn./med. bdd., v. aren., fri., fr. porosity thru unit, v. sl. carb., non-calc., brit.

8 8 SS (Qtzose) - lt. brn., wthrs. med. grn., crs. grd., thk. bdd., ireg. bdg., x-bdg. com., arg., non-calc., w. cmtd. with Cly., v. hd., ti., resist wthrg., tr. thn. bds. of sft. grn. fiss. SH.

7 7 SS. (Qtzose) - med. brn./med. grn., wthrs. dk. grn.-gy., med. grd., thn. bdd., reg. bdg., w. sort., fri., poorly cmtd., fr. porosity, non-calc., v. aren., brit., sl. reses. wthrg., cglic. near base with CHT & QTZ pbls.

6 6 LST. - lt. gy., wthrs. same, v f./f. grd, thn bdd., sl. ireg. bdg., v. arg., lmnic. in pt., v. w. cmtd., occ. small calcite filled vug, med. hd., ti., tr. of lt. gy.-grn. fiss. SH.

5 5 SS. (Qtzose) - med. gy./med. brn., wthrs. dk brn, v.f. grd., thn. bdd., reg. bdg., sl. arg., carb. in pt., non-calc., micro-mica., well cemtd. with cly., x-bdg. com., ti.

4 4 SH. - v. dk. gy./blk., wthrs. med gy., v sl. arg., v. gypsiferous in pt., papy./v. thn bdg., sl. disturbed bds. but not faulted, sl. lmnic. stng., calc., reces. wthrg., occ. Brachs. & Graps. collected in zone 60' from top of unit

3 3 CGL. - lt. gy./lt. brn., crs. bldrs. up to 4' dia., mass. bdg. when present, aren. qtzose mtx., poorly cmtd., fri., fr./med. porosity, LST. bldrs. & pbls., minor shly. ptgs. near base

2 2 BREC - crm./lt. brn, wthrs. same, v. poorly srtd., mass. bdd./being completely absent, LST. incl. are crs. & ang., size ranging from 2"/4', mtx. of aren LST grdg./SS in btm. 100', v. well cmtd with calcite, ti, resis. wthrg.

1 1 CGL - med gy, wthrs same, incl. of LST pbls, well cmtd, aren, limy mtx, v hd, resis wthrg., ti., top surface mounded & ireg

TO ACCOMPANY NEWFOUNDLAND REPORT BY H. CORKIN, DEC. 1964

ENCLOSURE N° 9

NEWFOUNDLAND

PORT AU PORT PENINSULA

HUMBER ARM GROUP

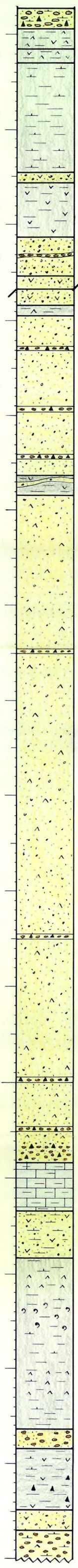
STRATIGRAPHIC COLUMN

LOCATION - DESCENDING SECTION ON VICTOR'S BROOK.
MEASURING STARTED APPROXIMATELY ONE MILE FROM THE MOUTH
AND PROCEEDED UPSTREAM IN A SOUTHWESTERLY DIRECTION FOR
A DISTANCE OF TWO MILES.

SCALE : 1 INCH = 100 FEET

H. CORKIN

MEASURED IN SEPT. 1964



UNIT N°	DESCRIPTION
19	CGL. - gy. Lst. pbls., CHT. & SH. incl., semi-fri., calc., slty. mtx., dns.
18	SH. - vcol., mainly blk. & lt. grn., papy. / v. thn. bdd., fiss. / sub-fiss., arg., carb., sl. micro-mica.
17	SH. - vcol., maroon & lt. grn., papy. bdd., ireg. bdg., fiss., arg., micro-mica, non-calc., carb., gypiferous.
16	SH. - lt. / med. gy., v. thn. / plty. bdd., reg. bdg., v. sl. calc., lam. towards base of unit, sl. arg., sub-fiss., brit.
15	SS. - qtzose., lt. / med. brn., f. grnd., thn. / med. bdd, micro-mica, well srtd., non-calc., well cmtd., cly. mtx., occ. Lst. pbl. intbd. in SH.
14	SH. - med. gy / pale grn., v. ireg. bdg., fiss., gypiferous, non-calc., sl. arg., micro-mica, brit.
13	SS. - qtzose., lt gy. / lt grn, f. / med. grnd., thn. bdd., ireg. bdg. tr. x-bdg. fri., occ. CGL. stringers with pbls. up to one inch in dia.
12 F	SS. - qtzose, med. grey / med. grn., f. grnd., carb. thru, v. fri., poorly cmtd, non-calc., micro-mica., tr. poor p.p. porosity. (A thrust fault breaks this unit.)
11	SH. - lt. gy. / lt. grn., thn / plty. bdd., ireg. bdg., non-calc., clyey., lmnic., lam. in pt., v. sl. carb., brit.
10	SS. - qtzose, lt. / med. brn., wthrs. same, v. f. / f. grnd., x-bdg. charact., lam. thru., fri. in pt., mainly well cmtd., dns., ti., non-calc., An occ. thn. CGL. bd. a few inches thk. cont. pea sized pbls. of CHT. & QTZ.
9	SH. - lt. grn., papy. / plty. bdd., sl ireg. bdg., non-calc, gypiferous., sl. mica., sub-fiss., brit., tr. SS. a.-a. but more aren. & wthrd.
8	SS. - qtzose., lt. / med. brn., some grn., wthrs. dk. brn., Fe stng., f. grnd., med. bdd., occ. x-bdg., carb. thru., non-calc., v. fri., poorly cmtd., tr. poor p.p. porosity., occ. CGL. stringers cont. CHT. & QTZ. pbls. in shy. ptgs.
7	LST. - lt. gy., wthrs. same, f. grnd., thn. bdd., reg. bdg., occ. calcite filled vugs, arg., well cmtd., hd., dns.
6	SS. - qtzose., lt. / med. brn., v. f. grnd. / f. grnd., thin bdd., poor porosity, sl. arg., mica., cmtd. with cly., some x-bdg., ti.
5	SH. - v. dk grn. / blk., tissue / thn. bdg., v. fiss., lmnic, v. sl. calc., certain units are carb., gypiferous, reces. wthrg., Brachs. collected 50' from top of unit
4	CGL. - lt. brn., v. f. / f. grnd., aren. qtzose. mtx., well cmtd with cly., incl. of grn. SS. & gy. LST., resis. wthrg.
3	SH. - lt. gy. / blk., arg., v. fiss., sl. calc., micro-mica. in pt., occ. brn. CHT. pbls., recess. wthrg.
2	SS. - qtzose., lt gy. / lt. grn., thn. bdd., reg. bdg., v f. grnd., cly. mtx., non-calc., mica., cont. occ. LST. incl. approx. 0.5 inch. in dia.
1	CGL. - med. gy., wthrs. lt. / med. brn., ireg. bdg., calc. sdy. mtx., v. sl. carb., v. poorly srtd., v. hd., dns.

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 10

NEWFOUNDLAND

PORT AU PORT PENINSULA

HUMBER ARM GROUP

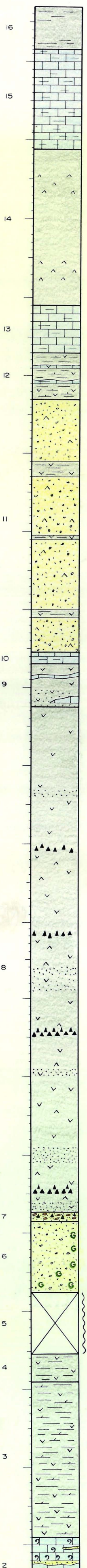
STRATIGRAPHIC COLUMN

LOCATION - DESCENDING SECTION APPROXIMATELY THREE MILES SOUTH OF THE TIP AND PROCEEDING SOUTHWARD ALONG THE WEST SIDE OF SHOAL POINT TO THE BASE.

SCALE : 1 INCH = 100 FEET

H. CORKIN

MEASURED IN SEPT. 1964



UNIT N°

DESCRIPTION

16 SH. - maroon, med. grn & dk. gy., papy. /thn. bdd., strata almost vertically dipping, clyey., fiss. /sub-fiss., arg. in pt., non-calc., sft., brit.

15 LST. - med. /dk. gy., wthrs. med. gy., lith. /micro-xln., thn. ireg. bdg., lam. in pt., sl. arg., dns., ti.

14 SH - jet blk., clyey., tissue thn. bdg., ireg. bdg., gypiferous thru., non-calc., bit., v. fiss., v. sft., carb. in pt., brit.

13 LST - med. gy., wthrs. v. lt. /lt. gy., micro-xln., thn. /thk. bdd., v. sl. arg., occ. calcite filled vugs, well cmtd., hky. frac., sl. fetid od., med. hd., dns., ti.

12 SH. - med. grn., wthrs. same, v. thn. /thn bdd., sl. ireg. bdg., calc., v. sl. arg. in pt., micro-mica., fiss., v. sft. /sft., tr. of intbd. LST. - a.a.

11 SS. & SH.
SS. - lt. grn., wthrs. med. grn., crs. grnd., thn /med. bdd., p-p. porsity., sl. carb., poorly cmtd., fri., occ intbd. of SH. - med. gy. /pale grn., mica., arg., fiss. /sub-fiss., non-calc., sft.

10 LST. - med. gy., wthrs. same, lith., gypiferous., lmnic., hky. frac., arg., hd., dns., ti.

9 SH - dk. grn. /blk., v. thn. /thn. bdd., fiss., non-calc., lam., aren towards base, micro-mica., brit. recess. wthrg., occ. thn. strg. of lt. brn. lith. LST.

8 SH. - vcol. in red, maroon & grn., tissue /v. thn. bdg., v. ireg. dipping bds., fiss. & rotten, sl. folding, silty in pt., non-calc., carb in pt., mica., sft., occ. thn. bds. of ang. brn. & blk. CHT.

7 CGL. - med. brn. /grn., mass. bdg., well srtd., aren. mtx., similar to a grit, pbls. of CHT. & QTZ. v. hd., well cmtd., resis.

6 SS - med. grn., wthrs. same, med. /coarse grnd., med. bdd., sl /v. glaucic., cln., fr. porsity., fri., sl. Fe stng. near base of unit, resis. wthrg., med. hd.

5 COVERED INTERVAL - indications are that this unit consists of variegated v. fiss. SH.

4 SH. - red - brn., v. thn. /thn. bdg., bds. reg. dipping at 29° NW., arg., ferr., non-calc., ripple marks com., micro-mica., some cloritic SH., tr. of bentic bds.

3 SH. - med. gy. /dk brn., tissue /papy. bdg., v. fiss., reces. wthrg., dolic., arg., micro-mica., v. sl. gypiferous., brit.

2 LST - med. gy., wthrs. v. lt. brn., f. grnd., well cmtd., hky. frac., fet od., resis., v. hd., dns., Brachs. com., occ. strg. of SS. - lt. /med. gy., some lt. grn., qtzose, calc. mtx., glauc. thru., dns., ti.

1 SH. - vcol., thn. bdd., non-calc., mica. in pt, sl. fiss., fragal., brit., recess. wthrg., small SS. concretions

REST OF SECTION COVERED

TO ACCOMPANY NEWFOUNDLAND REPORT BY H CORKIN, DEC. 1964

ENCLOSURE N° 11

NEWFOUNDLAND

PORT AU PORT PENINSULA

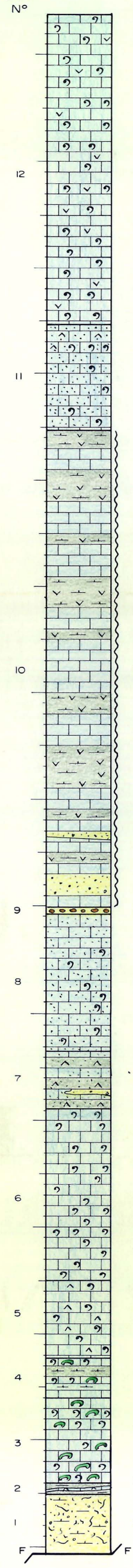
LONG POINT GROUP

STRATIGRAPHIC COLUMN

LOCATION - DESCENDING SECTION FROM THE CONTACT WITH THE CLAM BANK GROUP AT MISTY POINT, THE WESTERN SALIENT OF BLACK DUCK COVE. THE OUTCROP EXTENDS ALONG THE WEST SHORE OF LONG POINT IN A NORTHEASTERLY DIRECTION TO WITHIN 0.5 MILES OF THE LIGHTHOUSE. AT THIS POINT THE SECTION IS CONTINUED ON THE EASTERN SHORE OF LONG POINT AND IS WELL EXPOSED CONTINUOUSLY TO WITHIN 1.5 MILES OF THE VILLAGE OF WEST BAY.

SCALE : 1 INCH = 100 FEET

H. CORKIN — MEASURED IN SEPT. 1964



UNIT N°	DESCRIPTION
12	12 LST. - lt.gy. /gy.-grn., lith./micro-xln., thn. bdd., reg. bdg., mica., med. hd., dns., ti., reces. wthrg., v fossiferous with mainly Brachs., coq. bds.
11	11 LST. - v. lt. gy. /med. gy., pale grn. in pt., f. grnd. thru., v. thn./thn. bdd., reg. bdg., v. aren., fri., sl. carb. near top of unit, fracs. into plty talus, num. calcite strings., well cmtd. mtx., brit., ti., occ. fossiferous - Brachs.
10	10 LST. & SH. LST. - v. lt./lt. gy., v.f. grnd., thn. reg. bdg., v. well cmtd. mtx., occ. calcite filled vugs SH. - pale grn./lt. gy., clyey., thn bdd., calc., lam. in pt., micro-mica., brit., tr. of SS. - lt. brn., f. grnd., thn. bdd., calc., located towards base of unit
9	9 CGL. - med. gy., bdg. absent, LST. incls., well cmtd. sdy. mtx., non-calc., v. hd., ti.
8	8 LST. - lt./med. gy., lith./f. grnd., thn./med. bdd., aren., cln., p-p. porsity., sl. fet. od., hky. frac, med. hd., occ. fossiferous with Brachs.
7	7 LST. & SH. LST. - a.a. but unfoss. SH. - olv.-grn./dk. grn., clyey., plty., reg. bdg., carb., non-calc., slty., v. well lam., ripple marks, brit., tr. of SS.
6	6 LST. - lt. gy., wthrs. lt. brn., v.f./crs. grnd., thn. bdd., ireg. bdg., v. calc., Shell frags. com., v. well cmtd., hky. frac., Brachs. & Gasts. com.
5	5 LST. - v. lt. gy., wthrs. lt. gy., f. grnd., thn. bdd., ireg. bdg., fet. od., v. calc., carb., Shell frags. com., hd., dns., ti., occ. foss. incld. - Brachs., Gasts., Plcys. & Bry., worm burrows
4	4 LST. & SH. LST. - lt./med. gy., wthrs. lt. brn., micro-crpxln., v. thn. bdd., ireg. bdg., rubbly algal app., v. calc., calcite strgs. com., arg., med. hd., dns., ti., ripple marks com., foss. incld. - Brachs, Gasts., Trilos & Corals SH. - blu-gy., papy./v. thn. bdg., calc., clyey., brit.
3	3 LST. - v. lt. gy., wthrs. lt. gy., med./thick bdd., sl. ireg. bdg., v. calc., v. f./f. grnd., Shell frags. com., num. Algal lumps & heads of Corals ranging from 3 inchs / 3 ft. across, lattice dev. in pt., other foss. incld. - Brachs., Orthos. & Bry., algal mat. v. porous
2	2 LST. & SH. LST. - lt. gy., crpxln., med. bdd., nod. tex., arg., med. hd., dns., ti., SH. - intbd., lt. brn./lt. grn., clyey., thn bd., carb., non-calc., brit.
1	1 CALCERENITE - qtzose lmy. SS., lt. brn./lt. gy., v.f./f. grnd., thn./med. bdd., aren., fri., v. calc. mtx., poor/fair porsity., reces. wthrg., x-bdg. com.
F	F

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 12

NEWFOUNDLAND

PORT AU PORT PENINSULA

CLAM BANK GROUP

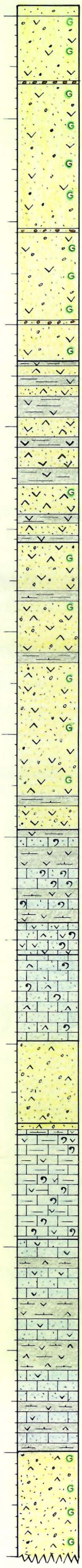
STRATIGRAPHIC COLUMN

LOCATION - THE SECTION COMMENCES AT A POINT 1.25 MILES SOUTHWEST OF CLAM BANK COVE. FROM THIS POINT THE SECTION DESCENDS IN A NORTHEASTERLY DIRECTION ALONG THE COAST TO THE CONTACT WITH THE LONG POINT GROUP AT MISTY POINT, LOCATED ON A SALIENT TO THE WEST OF BLACK DUCK BROOK.

SCALE : 1 INCH = 100 FEET

H. CORKIN

MEASURED IN SEPT. 1964



UNIT N°	DESCRIPTION
11	11 SS. (qtzose) - typical redbeds, brick red, wthrs. reddish-brn./choc. brn., med./crs. grnd., med. bdd., thnly. lam., ferr. stng., fri., non-calc., poorly cmtd., tr. of fr/gd. porsity., glauic., mica., x-bdd., ripple marks mud cracks com., occ. CGL. - brnish-red, wthrs same, aren. mtx., bd. 18 inchs. thick, CHT. & QTZ pbls. range in sizes up to 0.5 inchs. in dia., v well cmtd., resis., v. hd., ti.
10	10 SH. & SLTST. SH. - v. similar to mudstone, reddish-brn., wthrs same, ferr., plty., non-calc., arg., marly in pt., micro-mica., glauic., med. sft., intbdd. with SLTST. - dk. red, wthrs. red-brn., v. f. grnd., thn. bdd., well cmtd. with cly., mica., carb., med. hd., ti.
9	9 SS. (qtzose) - typycal redbeds, brick red, wthrs same, f./med. grnd., thn./med. bdd., thnly. lam towards base of unit, x-bdg. com., occ. ripple marks, non-calc, glauic., sl. carb., v. mica., f. porsity., fri., med. hd. but brit., occ. worm casts, tr. of SH. - reddish-brn, thn bdd., arg., v. sl. calc., ferr., brit.
8	8 LST. & SH LST. - med. gy./lt. grn., wthrs. lt. gy., lith./micro-xln., thn./med. bdd., sl. ireg. bdg. in pt., occ. calcite filled vugs, aren., v hd., ti., v. fossiferous with Brachs. & a few Corals, intbdd. with SH. - med. gy., thn bdd., clyey., micro-mica, sub-fiss., v. sl. calc., brit, ripple & mud cracks com.
7	7 LST. - med./dk. gy., wthrs. lt. gy., crpxln, thn. reg. beds, aren, sl. carb., micro-mica, ripple marks, hky. frac., fetid od., calcite strgs., v hd., occ. Brachs. & Shell frags.
6	6 LST. - med. gy./lt grn, wthrs lt. gy., v f. grnd., med. bdd., poor/fr porsity., v. aren, carb., mud cracks com., brit, mainly ti., occ. Plcy. shell impressions
5	5 SS. (qtzose) - red bed aprnc., brick red, wthrs dk red/choc - brn., v f./f. grnd., thn/med bdd, x-bdg. com., aren, fri., brit, poor/fr porsity., sl carb., ferr., resis wthrg.
4	4 SS. & SH. SS. - a.a., intbdd with SH. - calc. mudstone, med grn/brn, micro-mica, sl. arg., fiss./sub-fiss., plty., pyric, sft.
3	3 LST. - lt gy., wthrs. med gy., lith, med reg bdg., arg., mica, sl fetid od., ripple marks, med hd., ti., occ. Brachs. & Gasts.
2	2 LST. & SH. LST. - lt./med gy., wthrs med gy., v.f./f grnd., thn bdd., reg bdg., v aren., micro-mica, poor p-p porsity., sl fri., brit., calcite strgs., med hd., intbdd. with SH. - similar to mudstone, brick red, wthrs red brn., plty., v. slty. in pt., v. thn bdd., lam. near base, sl. aren., carb., calc., micro-mica., brit.
1	1 SS. - (qtzose), typical red beds, brick red, wthrs. red brn., f./med. grnd., med. bdd., x-bdg. com., thnly. lam. in pt., tr. poor p-p porsity., occ ripple marks, poorly cmtd., fri., carb., glauic., brit., mainly ti.
	CONTACT COVERED

TO ACCOMPANY NEWFOUNDLAND REPORT
BY H. CORKIN, DEC. 1964

ENCLOSURE N° 13