Onshore/Offshore Western Newfoundland
Prospects For Petroleum

PETROLEUM DIRECTORATE
SPECIAL REPORT PD 82-1

ISSUED UNDER THE AUTHORITY
OF

THE HONOURABLE WILLIAM W.MARSHALL
PRESIDENT OF THE EXECUTIVE COUNCIL
AND
MINISTER RESPONSIBLE FOR THE PETROLEUM DIRECTORATE
AND

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AUGUST, 1982

FORWARD

Earlier this year a call for the nomination of crown land in Western Newfoundland was issued and provided the means for interested parties wishing to obtain exclusive petroleum rights, to indicate their areas of Interest to government. Lands nominated in this call were subjected to a review process by various departments of the Provincial and Federal Governments to select the lands to be designated and to ensure that no obvious impediments existed on these lands with regards to environmental protection, social impact, town planning etc. In addition, consultation has taken place between officials of the Petroleum Directorate and interested parties and community groups on the West Coast to ensure that the designation process was taking place in an atmosphere of mutual understanding. These lands were temporarily designated on June1,1982, and since that time officials of the Petroleum Directorate have been visiting communities within the designated areas to Provide information to the residents and to receive comments. This process will lead to a final determination by the Minister of the acreage to be offered for exploratory permits.

As a result of these activities, the Petroleum Directorate is experiencing an ever increasing demand for information on of the geology, hydrocarbon potential and past exploratory work conducted in Western Newfoundland. The information which has been incorporated into this report attempts to provide a detailed and accurate account of the petroleum prospects in the nearshore and onshore areas of Western Newfoundland.

This special report was written by Judi Dobbin, David Hawkins and Martin Sheppard of the Resource Assessment Division. Gordon Gosse reviewed the manuscript prior to its publication. Thanks are due to Cindy Roche and Judy Ryall for typing this report and to George Morris, Ron Tucker and Beth Decker for drafting the figures.

As associated publication, (Petroleum Directorate Special Report PD 81-2 - The Petroleum Potential of Western Newfoundland Onshore Area) was released to the general public in October of 1981.

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Summary and Conclusions

The Paleozoic rocks of the Western Platform exhibit abundant evidence of hydrocarbon occurrences in the form of oil and gas seeps, bituminous residues and oil shales. These occurrences are confined to three distinct geological successions:

(a) Cambro- Ordovician autochthonous rocks
(b) Cambro-Ordovician allochthonous rocks
(c) Carboniferous rocks

It has been demonstrated that these rocks exhibit suitable source and reservoir rock characteristics necessary for the generation and accumulation of hydrocarbons and that favourable trapping and sealing mechanisms exist. As the autochthonous rocks have undergone only minor deformation they hold the greater potential of housing larger, undisturbed accumulations.Previous exploratory drilling has been concentrated in the allochthonous rocks, where subsurface data confirms the existence of hydrocarbons.In some areas the contact between the deformed transported rocks and the underlying undeformed platform carbonates is marked by only a gentle warp, and it is in these areas of limited deformation that relatively undisturbed reservoirs may be found.The only producing oil and gas field in the Maritime Appalachians occurs in Carboniferous strata, and although Carboniferous rocks have a restricted occurrence in Western Newfoundland,they too indicate favourable conditions for hydrocarbon accumulations. Indications are that the offshore extensions of these three potential reservoir horizons will exhibit similar qualities. This offshore area holds the greatest potential for accommodating later hydrocarbon accumulations.

Introduction

The Appalachian orogen is a northeast-trending belt of deformed rocks that lies southeast of the Canadian Shield and Interior Platform of central North America (Williams et al., 1974b). This system was once continuous with the Caledonian Mountain System in Europe, before the opening of the present Atlantic Ocean (**Figure1** **).**The Island of Newfoundland represents the northeastern termination of the exposed Appalachian System and has been presented by Williams (1964) as a two-sided symmetrical system, with stable Precambrian blocks to the west and east on either side of the Central Paleozoic Mobile Belt (**Figure 2**).The scope of this paper is confined to a discussion of the area west of the eugeosynclinal belt, where a distinct geologic province known as the Western Platform is exposed. The petroleum and natural gas potential is confined to the Western Platform and its offshore extension.

Regional Geology of the Western Platform

The Western Platform is underlain by Precambrian basement rocks (**Figure 3**),consisting of a complex assemblage of schists and gneisses which are cut by granitic and gabbroic and diabase dykes. The basement gneisses are locally overlain by plateau basalts (Williams and Stevens, 1969) and are uncomformably overlain by a succession of Lower Cambrian,dominantly clastic rocks. These clastics are westerly - derived and thicken to the southeast where they merge with metamorphic equivalents. Middle Cambrian to Middle Ordovician rocks record a period of extensive carbonate deposition. An accreting carbonate bank, which evolved upon the slightly submerged eastern edge of the continental margin, forms a broad, sinuous belt that extends from the Port au Port Peninsula to the tip of the Great Northern Peninsula. Carbonate deposition was abruptly terminated by the Taconian orogeny. The Tacanian orogeny did not significantly deform the Platform carbonates. Its effects were mainly confined to the Central Paleozoic Mobile Belt, where Intense deformation occurred (Williams, 1969). A thick allochthanous succession or klippe, from the Central Paleozoic Mobile Belt, was transported westward in a series of thrust slices where it was emplaced upon the autochthonous platform carbonates during Middle Ordovician time. The transported rocks range in age from Cambrian to Middle Ordovician and have been shown, in part, to be equivalent in age to the carbonate succession (Rodgers and Neale,1963). Two klippen have been identified on the Western Platform; (1) the Humber Arm Allochthon, which extends from the -Port au Port Peninsula to Daniel's Harbour, is composed predominantly of a carbonate facies in the north, and a more widespread clastic facies in the south (Rodgers and Neale, 1963) and (2) the Pare Bay Allochthon, which Is exposed on the tip of the Great Northern Peninsula, is predominantly a clastic succession (Cooper, 1937; Tuke, 1966). The stratigraphic relationships of the facies belts In Western Newfoundland are summarized in (**Figure 4**).A Middle Ordovician neoautochthonous sequence unconformably overlies the transported rocks on the Port au Port Peninsula and sets an upper time limit to the emplacement of the thrust slices (Rodgers, 1965). These rocks consist mainly of clastics with some limestone. Subsequent deposition on the Western Platform is recorded by local occurrences of Carboniferous strata which are believed to have accumulated in major structural troughs that extend from Nova Scotia to onshore Northern Newfoundland (Kelly,1967) and beyond (offshore). They consist of arkosic and micaceous sandstones, limy basal conglomerates, gypsum, fossiliferous limestones, siltstones and shales (Corkin, 1965).
The Paleozoic rocks of the Western Platform represent a highly complex depositional history where the total sedimentary succession has a probable thickness In excess of 10000 metres.

Tectonic History

The rocks of the Western Platform were affected by three periods of deformation during the Paleozoic Era, reflecting alternating tensional and compressional tectonic conditions.
As previously discussed, the Taconian orogeny, which took place during the Middle to Upper Ordovician, did not significantly affect the autochthonous carbonate succession. Deformation was restricted to the western margin of the eugeosynclinal belt where uplift and westward movement resulted in the emplacement of the klippen masses (Rodgers and Neale, 1963).

The second major Orogenic event has been dated postearly Devonian and pre-Carboniferous and Is referred to as the Acadian orogeny (Williams,1964).The Acadian orogeny did not have a major influence on the Precambrian basement complex or on the surrounding Paleozoic cover rocks except for a narrow belt of intense deformation along the eastern margin of the Platform. Within this narrow deformed belt, regional vertical extension occurred and northwest-southeast shortening initially formed a steep penetrative foliation and tight upright folds. This was followed by near-vertical shortening that formed crenulations and small folds. The deformation was terminated with northeast-southwest shortening which formed open, steeply plunging folds and kink bands (Williams, 1974b).These three strains are developed and superposed on both the autochthonous and allochthonous sedimentary rocks in the eastern par of the Western Platform. As a result, the base of the transported sequences in the Hare Bay area exhibit large-scale folding but the intensity of foliation and tight folding decreases southwestward until absent at the Port au Port Peninsula. The incompetent rocks of the klippen are generally more highly deformed than the underlying and surrounding competent autochthonous succession.

The third and final phase of deformation that affected the Western Platform responsible for the mild, open folding and restricted of the Carboniferous strata (Fogwill,1966; Williams,1964; Poole1967).Most of the deformation is apparently related to recurrent movements of the Precambrian basement complex as the intensity of deformation decreases away from the mountains. It Is not known to what degree this Post-Carboniferous orogeny affected the earlier Paleazoic rocks. However, strike-slip faulting within the Carboniferous strata and recurrent ovements on pre-existing faults have been documented and may be attributed to this period ofdeformation.

Plate tectonic models for the development of the northern Appalachians have been presented by numerous workers (Wilson, 1966; Dewey, 1969; Bird and Dewey, 1970; Stevens, 1970; Church and Stevens, 1971; Dewey and Bird, 1971; Schenk, 1971; Williams and Stevens, 1974; Williams et al., 1974b). Most models refer to an ancient continental margin initiated during the Late Precambrian as a rift system that was accompanied by sedimentation and volcanism. The stable margin existed for at least 200 million years until the end of the Early Ordovician, when plate convergence resulted in the formation of a series of offshore island arcs. This activity was accompanied by: (1) the abduction of oceanic lithosphere and mantle across the continental margin onto the shelf; (2) deformation and metamorphism of the sediments bordering the continent; (3) the mass transfer of continental - slope sequences westward across the shelf; and (4) the transgression of clastic sediments towards the continental interior. The Taconian oragany caused destruction of the then existing continental margin through the closing of the proto - Atlantic Ocean. By the end of the Taconian orogeny the margin no longer represented a rifted zone of active deposition but rather had been transformed into a stable deformed zone. The deformed margin was later affected by the Acadian orogeny which caused further shortening and lateral compression through the continued closing and tightening of the already contracted proto-Atlantic (Williams and Stevens, 1974). A schematic model for the plate tectonic evolution of the Newfoundland Appalachians is illustrated in (**Figure 5**).

History of Petroleum Exploration in Onshore Western Newfoundland

Parson's Pond - St.Paul's Inlet Area

The presence of oil seepages were first identified in 1812 by a Mr. Parsons when he found an oily liquid which he collected and used as a cure for rheumatism (Henry 1910).

Fifty-five years later, a well was drilled in the area to a depth of 213 metres and encountered small amounts of oil. From the period 1893 to 1906, a total of thirteen additional wells are known to have been drilled. Records during this period were poorly kept and data regarding the depths drilled and amounts of oil and gas encountered is very limited. It has been documented, however, that four wells on the south side of the pond produced 1.59m3 (10 barrels) of oil per day during a two month interval and a well an the north side produced 0.79 - 0.95m3 (5-6 barrels) of oil per day for three months (Fogwill, 1966; Fleming, 1970). Periodic drilling in the area continued until 1965. A total of 27 wells are known to have been drilled, nine of which were seeping oil and/or gas in 1965 (Fogwill, 1966). The well locations are shown in (**Figure6**).

WELL LOCATIONS at PARSON'S POND and ST.PAUL'S INLET

In 1897 a well was drilled at St. Pauls Inlet 0.8 kilometres south of the narrows on the western shore and encountered oil and small quantities of gas. No further activities were conducted in that area until 1951-52 when John Fox drilled three additional holes. A more detailed account of these drilling activities are documented in Appendix 1.

Port au Port Peninsula

Oil seeps an the west side of Shoal Point were first reported in 1874 by J.P. Howley (Howley, 1875). The first drilling activity began in 1898 when four holes were drilled to depths ranging from 51 metres to 209 metres.Total production from these wells was as high as 3.18m^3 (20 barrels) per day.By 1928, a total of eleven wells are believed to have been drilled, however no drilling records are known to exist (**Figure 7**).

No further drilling activity is known to have occurred until 1965, when two wells were drilled to obtain stratigraphic and structural information. The first well did not encounter any indication of oil staining or porosity development (Golden Eagle, 1965a);the second well encountered traces of intercrystalline and pin-point porosity and indications of the presence of oil based on a bright lemon-yellow fluorescence in chip samples (Golden Eagle, 1965b). A more detailed account of the drilling activities in this area is provided in Appendix 1.

Deer Lake Area

Oil shales and gas occurrences have been noted in many places in the Deer Lake Carboniferous basin. Outcroppings of the oil shales range in thickness from a few centimeters to over two metres (Hatch, 1919) and have yielded 34 and 48 litres per tonne from surface samples. During the period from 1919 to 1920, three wells were drilled in the area and core samples yielded 114 litres of oil per tonne with a sulphur content of less than 0.28 percent, and 11 kilograms of ammonia sulphite per tonne. Gas was also encountered, but rates were not measured. Further evaluation commenced in 1955 when four additional wells were drilled (Figure 8). Two of the wells encountered significant gas shows but again the rates were not measured (Fleming, 1970). See Appendix I for a detailed account of exploratory drilling in this area. A summary of seismic activities is outlined in **Appendix III**.

Anguille Mountains and Flat Bay Area

While conducting a diamond drilling program to evaluate gypsum deposits in the Flat Bay area, two wells encountered significant oil and gas shows (McKillop, 1957) (**Figure 9**). One well encountered an appreciable gas pocket at 31 metres in a Mississippian anhydrite. Analysis of a sample indicated that the gas consisted entirely of methane and ethane. The other well encountered a Mississippian oil-bearing conglomerate at 107 metres, which stratigraphically underlies the gas-bearing anhyctrite. No further exploratory drilling has taken place in this area.

A well was drilled in the Anguille Mountains in 1973 primarily as a stratigraphic test to evaluate the oil and gas potential in an expected, thick Carboniferous section (Union Brinex Anguille H-98, Well History Report, 1973)(**Figure 9**). The well encountered a thick, but tight succession of micaceaus subarkosic sandstones and micaceous shales and did not encounter any oil or gas shows. See Appendix I for details.

Onshore Hydrocarbon Potential

Numerous occurrences of petroleum, natural gas and bituminous residues have been recognized in the Paleozoic rocks of the Western Platform. These hydrocarbon accumulations and occurrences are confined to three distinct geologic successions:

(a) autochthanous Cambro-Ordovician rocks
(b) allochthonaus Cambro-Ordovician rocks
(c) Carboniferous rocks

It is believed that favourable conditions existed for the generation and accumulation of significant volumes of hydrocarbons. Excellent source and reservoir rocks,seals and trapping mechanisms appear to be present in all three geologic successions.

a) Autochthonous Cambro-Ordovincian Rocks

Nearly all the formations in this succession exhibit favourable source and reservoir characteristics: algal and shaly limestones and bituminous shales are abundant on the Western Platform and can be considered excellent material for the generation of hydrocarbons. Rocks exhibiting reservoir characteristics are present in varying amounts and are primarily restricted to the platform carbonate succession, where coarse grained sandy limestones and vuggy, coarsely crystalline dolostones demonstrate petroliferous characteristics. Secondary reservoirs are likely to be present in the underlying Lower Cambrian succession, where conglomerates and arkosic sandstones, sandy oolitic limestones and archeocyathid reefs are developed. However, in the areas regarded as favourable for hydrocarbon accumulation, they occur at such great depths that they are considered economically unattractive targets.

Gently folded reservoirs in the autochthonous succession are believed to exist at a depth of approximately 1 500 metres in the Port au Port area and approximately 3 000 metres in the Parson's Pond area.

As the platform carbonate succession has undergone only minor deformation it has greater potential of housing larger, undisturbed reservoirs than rocks of the allochthonous sequence. Subcropping strata; gentle, broad anticlinal folds; and fault traps hold the most potential for larger accumulations. Facies changes will certainly play a role in the search for hydrocarbons, but in the early stages of exploration,stratigraphic traps will be difficult to identify and may consequently carry too high a risk to be considered viable economic targets.

(b) Allochthonous Cambro-Ordovincian Rocks

The source potential of the allochthonous sequence has long been questioned by previous writers (Lilly, 1965; Cote, 1962; Fogwill, 1966). There has been some evidence presented in the past, suggesting that the oil found in these rocks may not have necessarily originated within this succession, but that hydrocarbons, were generated in the autochthonous sequence and have since migrated into allochthonous reservoirs along permeable pathways. Oil seeps in the Port au Port and Parson's Pond areas occur the allochthonaus rocks, but it is of noted importance that, these oil occurrences exist in areas of intense faulting and folding. It is believed that the best source potential may well exist in the autochthonous rocks and that hydrocarbons may have migrated updip along fault planes, making their way to the surface as oil seepages. Local accumulations exist in discrete folded thrust sheets, and in some cases, hydrocarbons may be trapped beneath the allochthonous rocks in broad, gentle folds.

Lilly (1965) indicated that the contact between the deformed transported rocks and the underlying relatively undeformed platform carbonates is often the site of intense deformation and faulting, but in some areas this contact is marked only by a gentle warp. These areas of gentle warp could constitute relatively undisturbed traps and viable exploration targets.

Nearly all formations in the allochthonous succession exhibit favourable reservoir characteristics. Potential reservoirs range from thinly bedded limestones in association with lime breccias, to a clastic sequence of arkosic sandstones locally associated with pebbly conglomerates.

(c) Carboniferous Rocks

Carboniferous rocks have a restricted occurrence in Western Newfoundland, but are believed to have accumulated in deep basins within a large area of subsidence that extends from the Bay of Fundy to Northern Newfoundland. Strata rich in organic matter and in coaly and carbonaceous material as well as bituminous and sub-bituminous shales (Williams, 1973) 0 indicate that Carboniferous rocks in this area could have generated hydrocarbons.

Restricted surface occurrences indicate that porous sandstones and fractured or dolomitized limestones exist and these reservoirs might be capable of accommodating hydrocarbon accumulations in the subsurface. Indications are that a variety of both structural and stratigraphic trapping mechanisms could be present, such as, broad, open folds plunging towards the basins, tightly folded thrust faults, salt domes or salt-cored anticlines, and traps at the unconformity between the Carboniferous and underlying Paleozoic sediments (Fogwill, 1966).

There have been several indications of hydrocarbon occurrences in the Carboniferous strata of the Maritime provinces. Rare oil seepages have been noted in the coal mines of the Pictou coal field, Nova Scotia (Bell 1932) and surface indications of petroleum have been long recognized in the Lake Ainslie area, Cape Breton, (Norman, 1932). No commercial pools have been discovered to date however. In 1970, the Hudson's Bay Fina East Point E-49 well was drilled 32 kilometres northeast of East Point, Prince Edward Island. The well was drilled on a domal anticlinal structure believed to be the result of an intrusive salt body. No hydrocarbon reservoirs were established, but several gas shows were recorded by mud logging equipment. The well was re-entered four years later and flowed 155 000 m 3/d (5.5 MMCF/d) of gas from Pennsylvanian sandstones.

The only productive field in the Maritime Appalachians is the 7.8 square kilometre Stoney Creek field in New Brunswick. Discovered in 1909, the field has produced III 000 m 3 (700,000 barrels) of 370 (API) gravity oil and 728 x 106 m (26 BCF) of gas from Lower Mississippian multiple deltaic sandstones ("e, 1932; Norman, 1932). Present field production is low, only 10 143m 3/d (360 MCF/d) of gas and 4.13m 3/d (26 bbls/d) of oil.

Petroleum Occurrences

A detailed account of all petroleum occurrences recorded to date in published and unpublished reports is provided in Appendix II.

Onshore Resource Potential

The Resource Assessment Division has estimated the oil and gas potential of onshore Western Newfoundland using the Stoney Creek field in New Brunswick as a type hydrocarbon accumulation. Estimates of the resource potential are provided in **Table 1**.

Probability	**Recoverable Oil Resource**		**Recoverable Gas Resource**	
Level %	**$10^6 m^3$**	**STB**	**$10^{10} m^3$**	**BSCF**
90	0.16	1,000,000	0.07	25
50	1.59	10,000,000	0.70	250
10	7.95	50,000,000	3.52	1250

Table 1: Resource Potential of Onshore Western Newfoundland

These resource estimates are expressed in terms of the oil and gas which are perceived to be economically recoverable. In calculating the resource potential, it was assumed that there was a 50% chance of encountering either an oil or gas accumulation.These estimates were calculated on a volumetric basis using a modified Monte Carlo technique which is a procedure that simulates probability distribution by running many trials. The range of possible answers reflects different combinations of values selected at random from within specified ranges of input parameters. Each variable in the equation for the calculation of recoverable oil resource (7758 x Area x Net Pay x Porosity x (1-SW) x (1/B01) x Recovery Factor) is initially expressed in terms of a range of values reflecting the uncertainties about the factor. Random values for the particular variable under consideration are generated and these values are then entered into the volumetric equation. Many (<3000) recoverable resource numbers are generated. The resulting resource numbers are then arranged in ascending order and the 90th. , 50th. and 10th. percentiles are respectively quoted as the recoverable resource numbers with probabilities of occurrence of 10%, 50% and 90%. The most significant variables within the calculation are area and net pay. These values were estimated by utilizing all available exploratory data on the West Coast; by analogy to the Stoney Creek Field and from published accounts of productive fields along the Appalachian trend in the United States.It was further assumed that there is a 50% chance of a hydrocarbon accumulation occurring in a clastic or carbonate reservoir. The geologic parameters and results of the analysis are presented in **Tables 2, 3 and 4**. The values presented are based on limited data and represent only a preliminary analysis.

	Minimum	Most Likely	Maximum
Area (square kilometres)	0	2.6	12.9
Net Pay (metres)	0	3.0	30.0
Porosity (percent)	10.0	15.0	20.0
Water Saturation (percent)	15.0	25.0	45.0
B0I	1.1	1.2	1.3
Recovery Factor (percent)	10.0	20.0	30.0

Table 2: Summary of geologic parameters for a typical clastic reservoir.

	Minimum	Most Likely	Maximum
Area (square kilometres)	0	2.6	12.9
Net Pay (metres)	0	3.0	30.0
Porosity (percent)	5.0	7.0	12.0
Water Saturation (percent)	10.0	15.0	45.0
BOI	1.1	1.2	1.3
Recovery Factor (percent)	10.0	20.0	30.0

Table 3: Summary of geologic parameters for a typical carbonate reservoir.

Event	Probability of Occurrence
Dry Hole	0.9500
0.02 x 106 M3 of oil (100,000 STB)	0.0118
0.16 x 106 m 3of oil (1,000,000 STB)	0.0065
0.48 x 106 M3 of oil (3,000,000 STB)	0.0053
4.45 x 106 M3 of oil (28, 000, 000 STB)	0.0014
0.14 x 109 M3 of gas (5 BSCF)	0.0140
0.70 x 10.9 M3 of gas (25 BSOF)	0.0080
2.20 x 10 9M3 of gas (78 BSCF)	0.0030

Table 4: Probability of occurrence of oil and gas fields, Onshore Western Newfoundland

Summary

It has been demonstrated that the autochthonous succession exhibits favourable conditions for hydrocarbon generation and accumulation; that the allochthonous rocks contain known surface occurrences of hydrocarbons and potential subsurface reservoirs; and that the Carboniferous basins of the Atlantic Provinces are capable of producing oil and gas. Upon establishing favourable structural conditions, it is forseeable that any exploratory activity on the west coast of Newfoundland may be directed towards any or all of the above potential reservoir horizons. It is important to realize that restricted areas may be sites for multiple reservoirs where both autochthonous and allochthonous rocks may contain economically viable, pooled hydrocarbon accumulations.

Offshore Hydrocarbon Potential

Studies on the distribution of Paleozoic formations in the northern Gulf of St. Lawrence have been carried out by various workers employing different techniques (Lilly, 1966a and b; Sheridan and Drake, 1968; Shearer,1973; Hobson and Overton, 1973; Haworth and Sanford,1976). Sophisticated seismic reflection profiling, extrapolation of the onshore geology,mapping of submarine exposures, widespread sampling of the surficial sediments, bedrock coring and bathymetric, gravity and magnetic field surveying have all assisted in the interpretation of the regional offshore geology.

Haworth and Sanford (1973) found that in areas where seismic penetration was poor, the best indications of lithological boundaries were provided by the morphology of the sea floor. High resolution Huntec profiles have provided clarity of bedrock morphology in some areas and have been utilized to determine potential drilling sites for bedrock cores.Haworth and Sanford (1973) prepared a geological map **(Figures 10a & 10b)** over the area on the basis of seismic data and rock core samples. The map indicates a major synclinal structure, its axis trending in a NE-SW direction. A depth of 4 kilometers has been suggested to the base of the Carboniferous, which forms the core of the syncline (Hobson and Overton, 1973). The axis of the synclinal structure lies between the offshore extension of the klippe rocks (Figure 10a) and a bathymetric channel known as the Esquiman Channel (trough) >**(Figure 11)**.It is immediately east of this offshore synclinal structure that the petroleum accumulations In the klippe rocks of the Port au Port Peninsula and Parson's Pond area occur (Figure I0a).A pronounced dip reversal has been identified approximately 8 kilometres offshore, extending along strike from the Port au Port Peninsula to Bonne Bay, and it has been Interpreted as where the Middle Ordovician necautochthonous rocks onlap the allochthon (Cumming, 1967a).

Haworth and Sanford (1973) have Identified a series of pronounced morphological lineaments, interpreted as faults, .'which created minor grabens. These faults are subparallel to a series of faults which lie between Point Riche and the Precambrian highlands of the Long Range Mountains. They are downthrown to the east which is in opposite direction to the throw of the onshore faults (Cummings, 1967a). There is little indication that the faulting has affected the offshore extension of the allochthon, except in the area offshore of Parson's Pond, where a major lineament terminates.

Presuming that the autochthonous and allochthonaus rocks offshore exhibit similar characteristics to their onshore counterparts, the offshore eastern margin of this synclinal basin holds potential for the updip accumulation of hydrocarbons. However, due to the lack of data offshore, no attempt was made to quantify the resource potential.

A tabulation of the geophysical surveys which have been conducted offshore of Western Newfoundland and which have been submitted to the Newfoundland and Labrador Department of Mines and Energy and the Petroleum Directorate is outlined in Appendix III.

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Introduction to Appendices

Petroleum exploration on the continental margin of Newfoundland and Labrador has largely overshadowed the Province's onshore hydrocarbon potential even though numerous petroleum occurrences have long been recognized on the West Coast. As early as 1812 an oily film smelling like kerosene was discovered floating on the surface of Parson's Pond. It was collected by the local people in that area and used as a treatment for rheumatism. Fifty-five years later an exploration program was initiated in the area and the wells that were drilled confirmed the existence of crude oil. In a letter dated January 25th., 1909, Mr. W.H. Rennie who was managing director of the St. John's Gas Light Company wrote, "In three months we used 13,000 gallons of this oil in our water gas plant, and we could have used a great deal more. It was a fine, light oil, practically sulphurless, and it appeared to us to contain a great deal of paraffin. We noticed that it was a remarkably clean oil, so very clean, in fact, that it did not dirty the barrels, and our manager reported it to be superior to Pennsylvania oil. The quality is beyond question.

A great interest was immediately aroused in the area and significant plans for the development of a large and permanent production, refining, transportation and distribution business were established. Unfortunately however, the exploration programs were conducted on a small scale due to inadequate investment thereby necessitating the employment of inexperienced labour and poor quality drilling materials.The operations did however, demonstrate the existence of oil but the lack of sufficient capital was too onerous to overcome and conseguently drilling operations were discontinued. Parson's Pond was not the only area that experienced a flurry of inspired and encouraged investors. Exploratory programs were conducted at St. Pauls Inlet, Deer Lake, Shoal Point, and more recently in the Anguille Mountains. Subsurface hydrocarbon occurrences were also encountered while conducting diamond drilling programs that were exploring for gypsum and zinc deposits. Water wells drilled at St. Pauls Inlet and at West Bay in the Port au Port Peninsula also encountered hydrocarbons which resulted in contamination of the water supply. Numerous surface seeps and shows have been discovered throughout the entire West Coast, but like Parson's Pond, the lack of qualified labour and equipment and the restricted financial capabilities of the investors forced an end to the search of this new resource.

Records were poorly kept while these activities were taking place and as a result a comprehensive and detailed documentation does not exist. The information which is provided in the following appendices is a summary of published and unpublished data and is meant to augment previous reports that have described the area. We feel this report offers the most accurate and detailed summary of events to date and hope it will stimulate and encourage further evaluation of the Province's onshore petroleum potential. The reports used to compile this compendium date as far back as the late 1800's and the data has been quoted as reported by the original authors.

Appendix I

A Chronological Summary of Onshore Exploratory Activity in Western Newfoundland

1812 Oil seep discovered by Mr. Parsons and used as a treatment for rheumatism.

1867 Mr. Silver put down a 213 metre well near the lake shore, 9.7 kilometres from its outlet; some oil was found (No. 1).

1893 Newfoundland Oil Company was formed and secured a large lease surrounding the lake. Commenced drilling near the site of the old well to a depth of 396 metres. Oil and gas were struck at 213, 317 and 376 metres (No. 2).

1894 Mr. Spotswood joins Newfoundland Oil Company.

1896 Mr. Spotswood cleans out hole already put down (No. 2) and yields a paying quantity of oil. The well was deepened to 439 metres but no more oil was found. It was plugged at 405 metres and torpedoed when 0.95m3 (6 barrels) were pumped out after the well had stood for several days. About 3.18m^3 (20 barrels) were obtained. In 1906, Mr.McGarvie reported that this well was still producing 0.08m^3 (1/2 barrel) per day, even though water was leaking in. Mr. Spotswood commenced another hole nearer the lake shore but was unable to complete it (No. 3).

1901 Howley (1901) reported that the Parson's Pond Oil Company engaged the services of an expert oil driller last season and purchased a new outfit of the latest and most approved pattern, with the intention of carrying out extensive boring operations on their claims. Owing to overlooked delays, it was decided to wait another season. He reported the 3 wells previously bored in this locality all showed oil in greater or less quantity.The first after being shot, is said to have yielded 2.86m^3 (18 barrels) of oil in the space of some forty or fifty minutes pumping.

1904 A well encountered a good flow of oil when it reached 367 metres and was completed to a depth of 659 metres. They attempted to shoot this well with dynamite but the charge failed to ignite and remained at the bottom leaving the hole too dangerous to be operated. The well was abandoned with 274 metres of oil in the hole (No. 4).

A 366 metres well was drilled near the tank house on the western side and was the first well to be shot. This well yielded only 0. 12m^3 (3/4 barrel) a day before the explosion; when put to pumping after the explosion, the yield was 0. 23m^3(1 1/2 barrels), and a fortnight later, 1.11m^3 (7 barrels (No. 5).

An unfinished hole reached 183 metres. No oil was struck but an abundance of gas was considered evidence of the existence of oil still lower down (No. 6).

A well on the northeast side was drilled to 468 metres. In 1904 it produced 0.32m^3 (2 barrels) and then ran dry. In 1905 it was exploded but showed no improvement and still ceased to produce anything (No. 7).

A well an the northeast side was drilled to 537 metres when operations ceased as the drilling cable ran out. An oil shale was encountered at 442 metres and steadily yielded 0.72m^3 (4 1/2 barrels) of superior oil. In 1905 the well was re-entered and sunk to a depth of 869 metres. It began with a natural yield of 0.95m^3 (6 barrels) per day, but when shot dropped to 0. 16m^3 (1 barrel), rising gradually to 0.40m^3 (2 1/2 barrels). It was found that the oil, owing to its heavy body, had coagulated, or converted to wax. In oil men's terms, this well was "drowned out" (No. 8).

A 610 metre well on the western side is drilled.It leaked so much water that it never had a chance, it was simply flooded. After being exploded, it filled with water so quickly there was nothing to do but abandon it. The casing was pulled and the machinery removed (No. 9).

Company reports for the year 1904 indicate that 6 holes were completed (No. 8 was re-entered in 1905) and 2 were drilling (No. 10 and 11). All are accounted for.

During this year, 7.95m^3 (50 barrels) of oil were sent to Scotland for testing.

1905 A hole an the west side partly drilled in the previous year to 183 metres, was continued down to 625 metres. Oil was struck at 448 and 534 metres and averaged 0.32m^3 (2 barrels) per day. With three older wells it was put to pumping and after a few month's tests the following was the result:

	m3	Barrels
# 2 Spotswood well, yield per day	0.16	1
# 4 659 metre well, yield per day	0.24	1 1/2
# 5 366 metre wells, yield per day	0.24	1 1/2
# 10 625 metre well, yield per day	0.32	2

When the claim was vacated, this well was filled with oil and was flowing over the casing (No. 10).

A new well (north side of the lake), commenced the year before, was continued down to 473 metres where it encountered a good yielding stratum of oil from a 2.4 metre vein of soft shale. The shale yielded 0.79m^3 (5 barrels) per day for 5 months, excepting 4 weeks interruption. In putting the well to pumping several difficulties had to be overcome; the shale, being soft, came in with the oil and accumulated so thickly at the bottom of the well that the tubing was pulled and drilling continued for another 21 metres. The well was pumped 3 times weekly, sometimes more often, with the same steady results, averaging 0.79m^3 (5 barrels) daily (No. 11).

The 5 wells pumped (No. 3, 4, 5, 10 and 11) gave a total yield of 1. 67m^3 (10 1/2 barrels) daily. Altogether 111m^3 (700 barrels) were obtained from the 5 wells, of which 63m^3 (400 barrels) were stored in tanks and the other 48m^3 (300 barrels) consumed as fuel.

A well on the north side of the lake was drilled to 427 metres but yielded very little (No. 12).

Late in the season the property was visited by two Americans - one to shoot the wells and the other to select a site and make arrangements for the erection of a refinery. An up-to-date pumping apparatus was installed, and tanks of a capacity of 477m^3 (3000 barrels) were imported. Pumping commenced shortly before the season's work closed, and arrangements were made to continue it through the winter.

1906 At about this time Messrs. Angel and Miller went to the United States and Canada to collect information and get estimates for a refinery.

In January, 1906 the superintendent (Mr. Whelan) visited the place and in eleven days pumped 11m^3 (70 barrels) from one of the last wells put down. The refinery expert (Mr. McGarvie) recommended continuous pumping to prevent the wells from choking. He reported that if the 5 wells on the western shore had been properly looked after, the smallest producer would be yielding at least 0.48m^3 (3 barrels) per day.If some of the wells have ceased to produce it is not because they are exhausted, but because they have been drowned out owing to the water not having been thoroughly shut off in the first place and allowing the wells to lie for 2 or 3 years without being pumped.

When Mr. McGarvie returned from the claims, the directors decided to delay the purchase of a refinery, but recommended that work be continued.

1906 Two wells were put down on either side of the pond and totaled 915 metres of drilling (No. 13 and 14). The first encountered very little oil; the second was not completed before the cable gave out. It issued an unusual quantity of gas and was regarded as a natural gas producer. It showed streaks of oil in the 488 metres drilled and yielded 0.08m^3 (1/2 barrel) of oil per day.

Drilling operations were discontinued due to insufficient capital.

1907-1909 Much of the oil stored in tanks was lost when they became frozen and burst apart. During this time 127-143m^3 (800-900 barrels) were shipped to the gas works in St. John's to be used in conjunction with coal for enriching the gas supply.

1909-1920 No records.

1920-1925 Mr. Jack Henry, manager of the property, produced gasoline and kerosene from a still. It was assumed that the 3 Henry wells were drilled during this period (No. 15, 16 and 17). No. 15, known as J.D. Henry No. 2 well, was drilled to 335 metres and encountered petroliferous zones at 213 and 229 metres. Surface shows 330 millimetre and 152 millimetre casing present. In 1965 the well was making oil and a sample was sent to Golden Eagle for analysis. Oil can be dipped 0.46 metres below ground level. Well No. 16, known as the Palmer well, was drilled to 454 metres and produced at a rate of 0.08m^3 (1/2 barrel) per day. In 1965, oil was 91 metres from surface. No data on well no. 17.

1938 Brown carried out investigation on behalf of Anglo-Ecuadorian Oil Ltd. and reported a total of 24 wells of which two were over 457 metres deep, seven over 610 metres and two over 976 metres. Presumably, all these were drilled prior to 1925. This indicates that 7 additional wells were drilled for which there are no records.

1925-1951 No records.

1951-1952 John Fox drilled 2 wells (No. 18 and 19). Well no. 18 was drilled to a depth of 838 metres and encountered light gravity oil at 671 metres. The target depth was 915 metres but they ran out of cable and operations were haulted. 305 millimetre and 152 millimetre casing present. Well No. 19 was drilled to a depth of 457 metres. Some oil was bailed during drilling. Well burned before completion when it encountered high gas pressure.

1965 Fogwill visits the area and records a total of 26 wells.This would agree with Brown's (1938) total of 24 wells plus the 2 John Fox wells (1951 - 52).

1965 NALCO drill well, No. 65-1 (No. 20) an the north side. Well spudded in approximately 15 metres north of well No. 23. Target depth was 1524 metres plus but was abandoned at 1302 metres when considerable caving was encountered and the drill stem broken. Gas was encountered throughout the well, the best show at 1302 metres.Belching could be heard 9-12 metres from the well and continued for one month. Oil was encountered in small quantities below the Green Point/Humber Arm contact between 305 and 547 metres.

References: Fleming (1970); Fogwill (1966); Henry (1910); Howley (1901), (1909); Weatherhead (1922).

St.Pauls Inlet

1897 A well was drilled about I kilometre South of the narrows on the western shore to a depth of 518 metres. Oil was struck at 294, 303 and 314 metres. Small quantities of gas were encountered. The well was balled with a sand PUMP and 0.32m 3 (2 barrels) of oil were procured. The following morning the same operation was repeated and 0.24m3 (I 1/2 barrels) were obtained (No. 1) (Henry, 1910; Weatherhead, 1922; Lilly, 1965).
The work, however, was not continued and negotiations for the disposal of t@e lease were not successful, so the prospects of the area could not have been considered bright (Weatherhead, 1922).

1951-52 The John Fox Interests drilled 3 holes (No. 2, 3, and 4) (Fogwill, 1966).

1977 Four water wells were drilled in the general vicinity of the Fox penetrations. Tte wells were shallow, roughly 30 metres deep, and encountered oil.

Shoal Point

1874 Oil seeps reported by J.P. Howley on the west side of Shoal Point. Weatherhead (1922) reports a gas seep as well as oil on Shoal Point.

1898 Drilling activity is initiated. Howley (1899) reported that 4 wells were drilled by a Mr. Andrews of St. Stephen, New Brunswick. The first well was located 2.4 kilometres from the oil seeps. The wells range in depth from 51 to 209 metres. Howley (1901) further reported that three of these wells encountered oil, and that the shallow well is said to have produced 1.59m^3 (10 barrels) per day for a month. Weatherhead (1922) reports that production amounted to 3.18m^3(20 barrels) per day.

1899-1927 No records.

1928 Baker (1928) reports that a total of 11 wells had been drilled and he succeeded in locating 8 of the old drilling-sites. He reported "I have no doubt that a submarine seepage does exist, for on the occasion of my visit, I was able to stand and watch the waves breaking in, each one of which would, an receding, leave a characteristic oily foam amongst the beach boulders". He was informed by a man who had worked on the drilling operations that two of the holes reached a depth of 244 metres and that these were probably the deepest. The man reported that oil was usually encountered between 122 and 137 metres.

1934 Schuchert and Dunbar (1934) report that 9 wells were drilled by an English company around 1900 and that the maximum depth reached was 366 metres.

1938 Brown (1938) reports that "during the next 10 years after the drilling of Shoal Point in 1898, 11 wells in all were drilled and 2 of them are reported to have reached depths between 183 and 244 metres. The wells are all close together, at least 8 being within a one hectare area on the north end of the point and 2 of these are now beyond the rapidly eroding shoreline. The remaining 3 could not be located and they are assumed to be out in the water. Oil was observed in 6 of the 8 wells, one boring was dry and the other below tide level and inaccessible.

1964 Joint exploration program undertaken by Brinex and Golden Eagle Oil and Cas Ltd. Detailed geological evaluation by Corkin.

1965 Shoal Point # 1 and # 2 are drilled by Brinex and Golden Eagle Oil and Gas Ltd. Shoal Point # 1 was drilled to a depth of 804 metres. A slight tarry residue appeared in samples from 171 to 174 metres. No porosity or oil staining was encountered. No drill stem tests were run. One care was cut from 397.9 to 399.4 metres. An abandonment plug of 40 sacks of cement was set in the top of the surface casing. Casing was cut off 0.9 metres below ground level and a steel plate was welded on (Golden Eagle,1965a). Shoal Point # 2 was drilled to a depth of 712 metres. Traces of intercrystalline and pin-point porosity, oil staining and fluorescence were encountered at numerous depths.The only drill stem test that was conducted was a misrun and recovered 110 metres of drilling mud. Six swab tests were performed; all reported no fluid entry. Swab test # 2 recovered a slight oil slick TSTM. Six cores were cut, all with 100% recovery. Production casing landed at 695 metres; 98 metres of this casing was subsequently backed off and recovered.

Installed 178 millimetre x 51 millimetre swage valve and 51 millimetre 907 kilogram plug valve on top of casing (Golden Eagle, 1965 b).

Sea erosion has covered all but 2 of the wells drilled, one of which is seeping oil from the casing (Fogwill, 1966).

Deer Lake

1917 Landell-Mills (1921) started work in the area;prior to the war, a local syndicate sunk 2 wells, each to a depth of 244 metres; no results were obtained (No. 1 and 2). They appear to have been sited with little regard for geological structure.

1919 Three wells in the western district were drilled to obtain core in the Lower Carboniferous. The first of these wells was drilled to 156 metres and deepened to 231 metres. It was a 127 millimetre diameter hole and was located on the Nichols Brook block. The well tapped a considerable supply of inflammable gas under high pressure and had a strong smell of petroleum. On several occasions the well erupted salt water with great violence; and the strong gas pressures prevented drilling for some days. The eruptions of' gas were sufficient to lift the tools, and brine and mud would be blown out of the well with great violence". The well was examined 12 months after drilling had been shut down and gas was still being briskly given off. Cores indicate that several horizons of oil shale were encountered. The well was left clear to the bottom, so that with heavier type of equipment it could be continued down at a future date. The top section of casing was left in the well and the orifice covered in. (No. 3)

The second well was a 127 millimetre diameter boring put down with light equipment in claim 77. At 24 metres solid rock had still not been encountered. It was felt that they were drilling in a pre-Pleistocene valley filled with post-glacial accumulations and drilling was haulted (No. 4). The crews moved eastward into claim 74. The third well was located in Claim 74, Humber River Rapids and was drilled to 97 metres. The rocks encountered were sandstones, grits, conglomerates and marls with thin developments of coal seems. The frequent alternation of hard conglomerates composed of large quartz pebbles, with beds of soft friable marl caused frequent difficulty for the drillers (No. 5).

References: Landell-Mills (1921), (1954); Cullingham (1969).

1950 Baird conducts investigation for the Geological Survey of Newfoundland (Fleming, 1970).

1954 Claybar Uranium and Oil Ltd. and Newkirk Mining Corporation and Associates conduct detailed geological mapping by H.J. Werner (1955) and propose 4 deep diamond drill holes.

1955-56 The first Newkirk hole (Claybar Hole No. 1) was collared on the axis of a broad anticline in the Rocky Brook Formation 2.0 kilometres downstream from Big Falls an the Humber River. The hole (No. 6) went to 474 metres and encountered the following:

34.1-35.7 metres	petroliferous shale
51.5-53.0 metres	petroliferous shale
77.7-78.4 metres	petroliferous shale minor gas show
85.7-86.9 metres	petroliferous shale
136.6-137.8 metres	small gas show
351.8-353.4 metres	appreciable gas under high pressure also salt water (Fogwill, 1966)

Werner (1955) reported that the gas caught fire and caused the drillers to abandon operations for at least 3 days. Then the gas-producing horizon was sealed off with concrete and drilling continued (Fleming, 1970). The second well (Claybar Hole No. 2) was collared in the Big Falls Formation on Main Dam Road, 19.3 kilometres southwest of the f irst hole (No. 6). It went to 848 metres and no hydrocarbon zones were encountered (No. 7)

Werner proposed two more drill sites, one 4.0 kilometres southeast of No. 6 and another 6.4 kilometres northeast of No. 6 (Fogwill, 1966). Claybar Hole No. 3 (No. 8) was drilled to a depth of 724 metres and encountered small amounts of gas at 352 and 359 metres.

Claybar Hole No. 4 (No. 9) was drilled to a depth of 157 metzes and did not encounter any hydrocarbons (Fleming, 1970). Having found gas in two of the holes drilled, all the available information was reviewed by J.C. Sproule and Associates, consultant petroleum geologists. They recommended that a 2134 metre hole be drilled near Junction Brook and Williams (1958) also recommended that the program be continued. However, following the drilling of Claybar No. 4, no further exploration was undertaken.

1981-82 Earth Sciences Department at MUN undertake project funded by Shell Canada and Shell Explorer as part of their commitments under R & D, E & T provisions. Project will study the tectonic, sedimentary and thermal evolution of Carboniferous basins of Western Newfoundland with emphasis on the Deer Lake Basin.

Anguille Mountains

1973 Union Oil Company of Canada Ltd.and Brinex drilled the Union Brinex Anguille H-98 well. The well was drilled to a depth of 2311 metres. No hydrocarbons were encountered and only traces of poor porosity were developed. The rocks were highly fractured and up to 19m^3 (120 barrels) of fresh water flowed from the well per hour. The entire hole was air drilled and open hole tested; the well flowed only water. Three abandonment plugs were set (Union Brinex Anguille Well History Report, 1973).

Flat Bay

1956 Mckillop encountered an appreciable gas pocket and an oil show while drilling for gypsum 1.6 kilometres southeast of Flat Bay station. The hole was collared in the Codroy Group and the gas pocket was encountered in an evaporite at 31 metres. A pressure of 48 kilopascals was measured but this fell to 1/2 this amount in 1 1/2 hours. The gas was analyzed in Ottawa as natural gas, almost entirely methane and ethane (No. I).

Droplets of liquid petroleum were observed exuding from the last 6 metres of another hole;from 114 to 120 metres. This 6 metres of conglomerate was interpreted as Anguille (No. 2).

Reference: Fogwill (1966)

Summary of Drilling Activity

1. Parson's Pond	27 wells
2. St.Pauls Inlet	8 wells
3. Shoal Point	13 wells
4. Deer Lake	9 wells
5. Anguille Mountains	1 well
6. Flat Bay	2 wells
Total	60 wells

Appendix II

Petroleum Occurrences in Western Newfoundland

1. CODROY VALLEY AREA
a) Codroy The show occurs near Codroy at the southwestern end of St. George's Bay. "Hayes and Johnson (1938) noted the occurrence of a bituminous residue in the Black Cove limestone of the Lower Codroy Group(Fleming, 1970).

2. CRABBES RIVER AREA
a) Highlands The occurrence is situated near Highlands an the southern share of St. George's Bay. Here bituminous limestones similar to those at Codroy occur (Fleming, 1970).

b) Black Point "Johnson (1951) notes the fairly common occurrence of hydrocarbon residues and occasional droplets of oil in pore spaces of Carboniferous limestones in the St. George's Bay area. The most notable occurrence is limestone exposures at Black Point, 14.5 kilometres southwest of St. Fintans, where white limestone, so saturated with bitumen, is rendered a black color" (Fogwill, 1966).

3. ST. GEORGE'S AREA
a) Flat Bay "The most significant shows of oil and gas were obtained during the course of a diamond drilling program conducted by the Mineral Resources Division to investigate deposits in the "Lower Codroy" Group just south of Flat Bay (McKillop, 1957). In one hole gas was

encountered at 31 metres having passed through the gypsum zone and into anhydrite. The hole was terminated at 34 metres, still in anhydrite. The gas pressure was measured at 48 kilopascals but this dropped to half the figure following 1 1/2 hours of free flow. The gas was sampled and analyzed and found to be essentially methane and ethane. In another hole, drilled to 120 metres to penetrate the evaporites and intersect the underlying rocks, a petroleum-bearing conglomerate was intersected from 107 metres to the end of the hole. This occurrence was described by McKillop (1957) as follows: "Petroleum was present in the conglomerate to the extent that droplets oozed from the core along its total length. After a few days the droplets became diffused to cover most of the surface of the core coloring it dark brown. The conglomerate, interpreted to be Anguille, was overlain by limestone, anhydrite and gypsum, in that order" (Fleming, 1970).

4. PORT AU PORT PENINSULA AREA

a) Winterhouse "The occurrence is located 4.5 kilometres northeast of Lourdes, 198-503 metres east of Highway 464. Approximately 4.5 kilometres northeast of Lourdes near the road to Winterhouse there is reportedly, although information on this particular occurrence is sparse, petroleum seeps in red clastic sediments of the Clam Bank Formation (Dept. of Mines and Energy Mineral Inventory Project, 1978).

b) West Bay "In the lowlands of West Bay, Port au Port Peninsula, underlain by "Western Zone" rocks the majority of the wells drilled for drinking water are too contaminated with hydrocarbons for human consumption" (Fogwill, 1966) Cumming (1965) reported oil films floating on the waters of brooks flowing into West Bay.

c) Shoal Point Oil and gas seeps reported by various workers as early as 1897. See Appendix I for details.

d)Victor's Brook On Victor' s Brook, Port au Port Peninsula, a broad band of limestone blocked the descent of logs floated down the river and had to be removed by blasting, when they were found to contain cavities filled with oil" (Weatherhead, 1922).

e) Port au Port Peninsula (location unknown) "The "White Hill" limestone has been found to emit an odour of petroleum when some of the upper beds were sharply struck and quickly smelled (Weatherhead, 1922).

f) Port au Port Peninsula (location unknown) Johnson (1951) reported that the Table Head limestones are almost uniformly petroliferous, that is, they give off a strong odour of oil when struck with a hammer and they often contain residues in cracks and pore spaces (Fogwill,, 1966).

g) Port au Port Peninsula (location unknown) Cumming(1965) reported the following surface hydrocarbon occurrences on the Port au Port Peninsula: a) oil shales and petroliferous limestones incorporated into the Humber Arm; (Western Zone) shales, b)tar blebs in limestone breccias of the Round Head area,c) tarry bitumen in Ordovician limestone fractures and d) extensive exposure of bituminous dolomite of the Lower Ordovician;St.George Group.

5. PORT AU PORT BAY AREA

a) Port-au Port Bay East "On the east side of Port au Port Bay, small quantities of bitumen are found
in volcanic rocks of the "Humber Arm" series of Ordovician age" (Baird and Snelgrove, 1953).

b) East and West Bay "On the shores of East and West Bays of Port au Port irregular hard concretionary limestones were sometimes seen to contain bituminous material; (Weatherhead, 1922).

c) Point au Mal "The occurrence is located in a coastal exposure on the eastern side of Port au Port Bay approximately 299 metres south of Two Guts Pond. The nearest community, Point au

Mal, approximately 3 kilometres to the NNE, is approximately 13 kilometres NNW of the center of Stephenville. The exposure of bituminous dolomite of the Lower Ordovician;St. George Group. The occurrence is reported to be oil saturated sandstone of the Humber Arm; Group; Dept.of mines and Energy, Mineral Inventory Project, 1978).

6. FOX ISLAND RIVER AREA

a) Fox Island River or Bennois Brook "At the outlet of Bluff Head Brook, just north of the Head, a purplish-coloured dolomite or limestone of a brecciated structure rests upon sandstone, which is itself underlaid by bituminous limestones and shales. Veins of calc spar frequently contain nests or strings of jet-black crystalline bitumen. Following the course of the river a succession of bituminous limestones, with partings of dark brown and black bituminous shales, rise in cliffs of about 46 metres high on both sides of the river. The darker coloured shales are very bituminous, and burn with a bright clear flame when exposed to a strong heat for a lengthened time, but without producing any ash, although much gas is evolved (Howley, 1875).

b) Phillips Brook Walthier (1949) reported loose sandstone blocks, maybe of the Blow-Me-Down formation, were observed rich in hydrocarbons along the south branch of Phillips Brook, a tributary of Fox Island river in Port au Port Bay. When broken open the blocks smelled strongly of kerosene" (Fogwill,1966).

7. LEWIS HILLS (INLAND) AREA

a) Stephenville to Corner Brook Walthier (1949) observed 25 to 76 millimetre veins of black, glassy bitumen cutting the Western Zone rocks, particularly the volcanics in the area from Stephenville to Corner Brook (Fogwill, 1966).

8. LEWIS HILLS AREA

a) Serpentine Valley Weatherhead (1922) observed oil in sandstone, presumably of the "Blow-Me-Down" Formation, in the Serpentine Valley of the Lewis Hills area.

b) Serpentine Valley The occurrence is located in Reid Lot Valley 203 in the Humber Arm area.Stevens (1965) noted that bitumen is found filling fractures in the rocks, but is confined to rocks stratigraphically above and including, the Middle Arm Point Formation. He specifically reports local bitumen lined joints in white weathering siltstones of the Blow-Me-Down Brook Formation. Furthermore, Stevens (1965) also reports a sedimentary sequence, just north of Number Four Mine Brook, consisting of greenish shale, greenish glauconitic sandstone and rusty weathering; locally oil-bearing grey limestone, which may belong to either the uppermost transitional portion of the Middle Arm Point Formation or the Woods Island; Member of the Blow-Me-Down Brook Formation (Boyce, 1982).

9. BAY OF ISLANDS AREA

a) Benoits Cove In the vicinity of Benoits Cove in the Bay of Islands a small seep of oil has been observed from a Silurian outcrop (Landell-Mills, 1921).

b) Goose Arm In Goose Arm, near Penguin Head, Bay of Islands, a dolomitized, vuggy zone of algal pseudomorphs in the upper part of the St. George Group, just beneath the Table Head, is notable sulfurous(Lilly, 1963).

c) Bay of Islands (location unknown) In his map area in the Bay of Islands, Lilly (pers. comm.) says that in places the upper dolomite member of the St. George Group stinks of oil (Fogwill, 1966).

10. DEER LAKE AREA

a) Deer Lake The oil shales are confined to the northwest end of Deer Lake and extend in a northeasterly direction along the Upper Humber River for 29 kilometres; (Corkin, 1965).

b) Deer Lake The western portion of the Deer Lake district contains a number of seams of oil shale (Landell-Mills, 1921).

c) Deer Lake The writer some years ago, visited a solid bitumen occurrence in the St. George dolomite, 8 kilometres west of Deer Lake. The solid, black bitumen was up to 152 millimetres wide with an exposed length of at least 1.5 metres. A sample was taken and should be available at the laboratory of the Newfoundland Mines Branch(Fogwill, 1966).

d) North Brook In the vicinity of North Brook,there are numerous pockets of bitumen, mostly to be found at the junction of the Lower Carboniferous shales with the older (Silurian) limestones; (Landell-Mills, 1921).

e) Nicholsville The showing is located on Reid Lot 36 about 61-91 metres off the north side of the Goose Arm road and 6.4 kilometres from its intersection with the Northern Peninsula Highway. The solid bitumen occurs in limestone in an old shaft about 2.4 metres deep now caved in. It is stated that the material was mined for asphalt around or before the turn of the century (Dept. of Mines and Energy, Mineral Inventory Project, 1981).

11. HUMBER VALLEY AREA

a) Humber River Four exploratory wells were drilled by laybar Uranium and Oil Limited and Newkirk mining Corporation in 1955-56. See Appendix I for details.

b) Humber River "The occurrence is located an the western side of the Humber River about 3.5 kilometres downstream of Little Falls. The occurrence forms black streaks conformable to bedding in tan sandstone of the Humber Falls Formation. In thin section, bitumen can be seen to partially fill pore space as botryoidal clumps (Dept. of Mines and Energy, Mineral Inventory Project, 1981).

c) Sir Richard Squires Provinicial Park Fourteen occurrences have been documented on the banks of the Humber River in the vicinity of Big Falls and Little Falls within Sir Richard Squires Provincial Park. These oil shales are dark brown on fresh surfaces and have a brownish streak. They commonly contain fossil fish and plant debris. They are Interbedded with thin bands of oolitic carbonate and grey siltstones and mudstones (Dept. of Mines and Energy, Mineral Inventory Project, 1981).

d) Cormack The occurrence is located along an unnamed brook at a point 0.6 kilometres along a line orthogonal to the main highway running through Cormack. The oil shale is dark grey, calcareous and laminated. Disseminated pieces of fossil plant material is present(Dept. of Mines and Energy, Mineral Inventory Project, 1981).

e) Rocky Brook "The occurrence is located on the east branch of Rocky Brook about 200 metres upstream from where it crosses the main highway through Cormack. The oil shale is interlaminated with grey calcareous mudstone. A thin section shows that the kerogen is concentrated in very thin seams. As the kerogen content decreases, the amount of carbonate (in the form of microlenses or postules) increases(Dept. of Mines and Energy, Mineral Inventory Project, 1981).

12. SOPS ARM AREA

a) Taylor Brook "The locality lies along the southern side of Taylor Brook near some prominent meander bends about 5 kilometres east of the Sops Aim Highway (# 77). The occurrence occurs as a pore filling in red pebbly conglomerate" (Dept. of Mines and Energy, Mineral Inventory Project, 1981).

13. ST. PAULS AREA

a) St. Pauls Inlet Four exploratory wells were drilled in the area. See Appendix I for details.

14. PARSON'S POND AREA

a) Parson's Pond Oil seeps reported by various workers as early as 1812. A total of 27 exploratory wells are known to have been drilled. See Appendix I for details.

b) Thompson's Island Not far off the western shore of Parson's Pond, between No. 3 location and Deep Water Point, is Thompson's Island. On it there is a seepage of oil in dry weather, and large quantities of natural gas come to the surface of the lagoon off the eastern point of the island. Drillers have frequently heard explosions and seen the water lifted by gas to the height of a barrel(Henry, 1910).

15. GREAT NORTHERN PENINSULA AREA

a) Daniel's Harbour to River of Ponds Watson (pers. comm.), 1965) reported that during diamond drilling for zinc on their concessions between Daniel's Harbour and River of Ponds, Leitch Gold Mines frequently encountered petroliferous zones in their core of the St. George carbonates. All this drilling was shallow - 152 metres or less' (Fogwill, 1966).

b)Portland Creek to Port Saunders Small bitumen-filled fractures in the "Table Head" were observed by Nelson (1955) in his map area from Portland Creek to Port Saunders(Fogwill, 1966).

16. ST. JOHN BAY AREA

a) Port au Choix Cumming (1965) reported bituminous dolomite in the upper part of the St. George Group exposed at Port au Choix, 80 kilometres north of Parson's Pond (Fogwill, 1966).

b) Port Saunders to Castors River In thin sections of both the St. George and Table Head rocks, Woodard (1957), working between Port Saunders and Castors River, observed a dark brown interstitial material which he interpreted as some type of hydrocarbon(Fogwill, 1966).

c) St. John Island A brown hydrocarbon stain is reported in Table Head limestones on St. John Island(Cote, 1962).

17. CONCHE AREA

a) Piler Bay, Cape Rouge Peninsula Baird (1966) reported the occurrence of numerous small pockets of a dense, bituminous material in the Pilier Bay area of the Cape Rouge Peninsula. He also noted the occurrence, in several parts of the section, of shales that give off a strong petroliferous odour when freshly broken, this odour being especially strong in the limy shales. Although there had been previous reports of oil seeps and cannel coal, Baird was unable to find the reported occurrences. Oil seeps had been reported by Murray (1865) and Johnson (1941). Snelgrove (Snelgrove and Baird, 1953) reported the occurrence of cannel coal at Pilier Bay(Fleming, 1970).

b) Conche The Conche and Cape Rouge Peninsulas, on the east side of the Great Northern Peninsula, are underlain by Carboniferous rocks which contain petroleum residues(Fleming, 1970).In the Carboniferous patch at Conche, oil shales occur scattered in thin layers over a stratigraphic section of about 152 metres, aggregate thickness of oil shales being less than 15 metres. Snelgrove (revised) reports volatiles 36%, fixed carbon 35% and ash content of 29% from a bituminous shale from this area(Fogwill, 1966).

Appendix III

Onshore and Offshore Geophysical Surveys Conducted in Western Newfoundland

OPERATOR	YEAR	LOCATION	DATA ACQUISTION BY	LENGTH OF SURVEY	TYPE OF COVERAGE
Voyager Petroleum Ltd.	1970	Rich Point, Straits of Belle Isle	Catalina Exploration & Development Ltd.	90km	Reflection
Mobil Oil Canada Ltd.	1971	St. George's Bay	Geophysical Service Inc.	248km	Reflection
Mobil Oil Canada Ltd.	1973	St. George's Bay	Geophysical Service Inc.	303km	Reflection (gravity data collected simultaneously)
American Ultramar Ltd.	1977	St. George's Bay	Geophysical Service Inc.	90.34km 15.28km	Reflection Refraction

Table 1: Offshore geophysical surveys (data submitted to the Newfoundland and Labrador Department of Mines and Energy and the Petroleum Directorate).

OPERATOR	YEAR	LOCATION	DATA ACQUISTION BY	LENGTH OF SURVEY	TYPE OF COVERAGE
Earth Sciences Dept. Memorial University	1981	Deer Lake Basin	Earth Sciences Dept. Memorial University	approximately 28.5km	Reflection
Earth Sciences Dept. Memorial University	1981	Deer Lake Basin	Earth Sciences Dept. Memorial University	Regional Survey	Gravity
Earth Sciences Dept. Memorial University	1981	Deer Lake Basin	Earth Sciences Dept. Memorial University	Regional Survey	Magnetics

Table 2: Onshore geophysical surveys (data submitted to the Newfoundland and Labrador Department of Mines and Energy and the Petroleum Directorate).