OIL AND GAS IN KENT AND SOUTHERN LAMBTON COUNTIES, ONTARIO, CANADA

by

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HISTORY OF DEVELOPMENT

Interest in Ontario petroleum first began in 1857, when Mr. W. H. Williams of Hamilton began the distillation of a tarry bitumen in the vicinity of Oil Springs, Enniskillen township (Lambton county). Investigation proved that the asphaltic material became more fluid with depth, and a well was dug into the gravel above bedrock in 1858. This well, although not in bedrock, really was the first oil well dug in America, preceding the Drake well of Pennsylvania by a year. Encouraged by the Drake well, a well drilled 160 feet into the bedrock at Oil Springs in 1861 developed into a gusher which flowed uncontrolled for several days. Great drilling activity followed this auspicious beginning.

In the wild drilling that followed, a tremendous amount of oil was discovered, most of which was wasted. Winchell[1] estimates that during the spring and summer

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[1] Alexander Winchell: "Sketches of Creation," p. 286, 1870.

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of 1862 alone, over 5,000,000 barrels of oil floated off upon the waters of Black Creek, near Oil Springs. This forced the price of oil down to ten cents a barrel. By 1868, when markets and outlets for this oil had been

developed, the price rose and new areas were sought.

In 1862, the Mosa township (Middlesex county) portion of the Bothwell field was discovered. Moderate production followed until 1866, when water from abandoned wells ruined the northern portion of this field.

The Zone township (Kent county) section of the Bothwell field was opened up in 1869, following the impetus given the petroleum industry by White's anticlinal theory of oil accumulation. Also in 1869, oil was discovered in Euphemia and Dawn townships (Lambton county).

Raleigh township (Kent county) came to the fore in 1902 with one oil producing well. In January, 1903, twenty-five wells were being drilled. By April sixty wells were completed and ten more were being drilled. The initial well flowed 1,000 barrels a day, but by April, with the well on the pump, recovery had dropped to 25 barrels a day.

A small field, Wheatley, was outlined in Romney township (Kent county) in the period between 1902 and 1904. This field had, according to Williams,[2] four

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[2] M. Y. Williams; Geological Survey, Canada, Summary Report. 1919, Part E, p. 14.

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main wells producing from the Guelph. In 1904, 40 barrels a day were recovered from each of these four wells.

The Tilbury field (Kent county) was discovered in December, 1905. The initial well, after being shot, flowed 40 barrels of oil a day from a flow of 1500 barrels of salt water. This field produced from the Guelph formation. The first Guelph production had occurred in the Leamington field, Mersea township (Essex county) in 1905.

1906 was an important year for Ontario petroleum, as in addition to the above wells, the Romney township field was first drilled. This field had seven producing wells early in 1907, several of which had an initial production of over 1,000 barrels a day.

Little activity in Ontario and practically none in Kent and southern Lambton counties occurred in the ten year period, 1907 to 1917, following the Romney field. At the end of that period a deep well was drilled to the Trenton formation, 3183 feet, in Dover West township (Kent county). A small field was developed here.

The Raleigh field was brought in during 1919. Production was from the Onondaga.

Dawn township (Lambton county) had a new gas field in 1921. The initial production was 177,000 cubic feet of gas, thought to be from the top of the Guelph, 1615 to 1750 feet below the surface.

In 1923, a well having an initial production of 150 barrels a day was discovered at a depth of 3560 feet in Romney township. The oil came from a snadstone at the base of the Trenton. However, further extension of this field at this lower depth was not found profitable.

Since 1923, drilling and exploration has been rather sporadic. However, 1924, 1929, 1931, 1935, and 1936 were all rather active years. In 1936 oil was found in some of the gas wells of the Dawn gas field. In the Bothwell field, the same year, wells drilled in the 1860's have been cleaned out and are now being pumped continuously.

The main play has been in the southern part of Kent county. Romney township with its large gas field has received increased attention, as have Raleigh, Tilbury East, and to some extent Dover East townships, all of Kent county. Further interest has been shown in the eastern section where a few scattered wells testing that region have been drilled.

SOURCES OF GEOLOGIC DATA

Data for this report comes almost entirely from published well logs in the Annual Reports of the Ontario Department of Mines. For the most part these logs do not list lithologic units in terms of standard rock names, but give formational names, sometimes right and sometimes wrong, currently in use by drillers and geologists at the time of drilling. In the Hamilton and Onondaga formations divisional names like "upper soap" and "lower soap" can be used very well for stratigraphic correlation, but where formational names are used in an interval of several lithologic units, little close correlation can be attempted.

The Gulf Oil Company of Saginaw, Michigan, through the kindness of Jed B. Maebius, district geologist, supplied the writer with a set of samples taken from a deep well in Dover East township, near the town of Prairie Siding, Kent county. After a detailed examination of this set of samples (pages to), the printed logs giving lithologic sequences were divided into formations with tentatively placed boundaries. The published logs that give names only, were matched with the log of the deep well of Prairie Siding, and an attempt was made to correlate the recorded material and the author's observations.

In addition to well logs, reviews and summary papers were included in the Annual Reports of the Department of Mines. These reports cover the period from 1891 to 1939.

In becoming familiar with the stratigraphy of the area, reference was made to several publications of the Geological Survey division of the Canada Department of Mines. The principle publications are: A. F. Foerste, "Upper Ordovician Formations in Ontario and Quebec", Memoir 83, 1916; C. R. Stauffer's "The Devonian of Southwestern Ontario", Memoir 34, 1915; M. Y. Williams' "Silurian Geology and Faunas of Ontario Peninsula, and Manitoulin and Adjacent Islands", Memoir 111, 1919; Wyatt Malcolm's "The Oil and Gas Fields of Ontario and Quebec", Memoir 81; 1915; the Canadian Survey's "Oil and Gas in Eastern Canada", by G. S. Hume, Number 9 in the Economic Geology Series. The last mentioned report contained a bibliography of all source material, and was particularly valuable for the historical background and the summation of the individual fields.

Phillip Garvey studied Essex county, to the west of the area of this report, in a manner similiar to that followed here. His manuscript, entitled "Oil and Gas of Essex County, Ontario, Canada", was presented as a thesis in partial fulfillment of the Master's Degree requirement at the University of Michigan.

Dr. A. J. Eardley, of the Department of Geology at the University of Michigan, suggested the problem, contributed advice in working it out, and assisted in outlining and organizing the report.

STRATIGRAPHY

Introduction

The following description of formations is an attempt to summarize what is now known of the strata underlying Kent and the southern portion of Lambton county. The position of southwestern Ontario, midway between the well known stratigraphy of the State of New York and the widely drilled basin of Michigan, would make it an area of critical importance in correlating the two sections. Western Ontario, due to its saddle-like position between the two basins, was an area of fluctuating seas with consequent thickening and thinning, and interfingering of numerous formations.

The absence of outcrops within Lambton and Kent counties hampered the study of the stratigraphy and made correlations dependent upon well logs. Lithologic units were traced as well as possible from the observed outcrops at the northern and eastern borders of western Ontario across the local area by means of the logs.

The nomenclature employed here is that used by the latest author, R. B. Harkness, of the Ontario Geological Survey.[3] A significant chart by the Survey[4] is

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[3] R. B. Harkness: "Oil and Gas Fields of Ontario." Annual Report, Canada Department of Mines, Vol. XXXVII, Pt. V, pp. 51-52, 1926.

[4] Annual Reports of Department of Mines, Vol. XXXIV, Pt. V, p. 42, 1925.

Correlation chart taken from Annual Reports of Department of Mines.

Vol. XXXIV, Pt. V. p. 42, 1925

Time Scale	Logan's Terms	Most Recent Terms (1925)				Driller's Terms	
						Present	Proposed
Upper Dev.	Portage & Chemung	Port Lambton-DK. green sh. Huron- Bk. shale				Bk. sh.	Huron bk. shale
Mid. Dev.	Corniferous	Hamilton	Ipperwash- ls.			Top rk.	
			Petrolia- soft blue sh.			Up. soap	Petrolia shale
			Widder beds- ls. & sh.			Mid.lime	
			Olentangy- soft blue sh.			Low soap	
		Delaware	lt. gray ls.				
		Onondaga				Big lime	Big lime
		Springvale- white coarse Ss.					
		In Niagara peninsuh		In Essex county			
Low Dev.				BASSIN	Amherstberg, Anderdon, Flat rock — Lt. buff dol.		
	Oriskany	Oriskany		Sylvania- lt. coarse Ss		White sand	White sand
	Low. Helderbergian Group (Onondaga)	CAYUGAN	Akron	Dolomite	Rasin River, Put-in-Bay, Tymochtee, Greenfield — Lt. gray to brown-ish ls.	White lime	White lime
			Bertie	Water			
			Salina	Camillus	Camillus-sh., salt & gypsum	Salt & gyp. or lime & shale	Salt & gyp. & shale
	Guelph	NIAGARA		Guelph- yel. dols., blue bands at top		Guelph & Niagara lime	Guelph & Niagara lime
	Niagara		Lockport	Barton beds- yellow to gray			
				Gasport	dolomitic ls.		
				DeCew			
				Rochester-Hard dk. shale		Nia. sh.	Nia. sh.
Low Sil.	Clinton		Clinton	Irondequoit-coarse gray dol.		Clinton dol.	Clinton
				Reynolds-fine dark dolomite			
				Furnacefille-hard shale		Clinton shale	
	Medina		Medina	Thorold (Gray Band) gray Ss.			Wh. Thordd Ss.
				Grimsby-mottled red Ss.		Red Medina	Red Medina sand & sh.
				Cabot Head-soft red sh.			
			Cataract	Manitoulin-shaly dolomite		Blue sh.	Blue sh.
				Whirlpool- fine white Ss		White Medina	Whirlpool sand

Up. Ord.	Hudson River	Richmond	Queenston- soft red shale	Red sh.	Big red sh
			Meadowvale-soft gray shale	Hudson River	Big gray
			Streetsville Alternate soft & hard beds of gray sh, some impure ls.		
			Erindale		
		Dundas	Credit Humber Danford Rosedale soft gray sh. with a few beds of hard sh. & coarse gray ls.		
	Utica	Utica-Black shale		Utica shale	Utica bk. sh.
		Collingwood- Bk. sh. and ls.			
Low. Ord.	Trenton Black River	Trenton- Lt. blue-gray ls. Black River- Blue-gray ls., thin-bedded except at top, also green & red sh. at base		Trenton	Trenton
	Potsdam	Arkose- coarse sandstone		Potsdam	Arkose

reproduced (pages 9 to 10) in order to acquaint the reader with the different names that have been used by drillers and geologists in the past for the various lithologic units. All these various names are found in the literature, and the chart is very helpful in deciphering the printed well logs.

General Section

The following sediments overly the pre-Cambrian granite surface and have been subdivided as follows:

Arkose (Lower Ordovician ?). An arkose overlies the pre-Cambrian granite surface throughout the area. To the north in Dawn township, logs show the arkose to be from 5 to 23 feet thick. In Dover East township, the records of two wells, both of which penetrated granite, passed through 20 and 500 feet of arkose. From the other observations it would appear that the 500 foot arkose recording is in error. In other deep wells nearby none penetrated more than 62 feet of the arkose. In some earlier logs this arkose is reported as Potsdam, or a "sandy formation".

Although the Black River strata outcrop to the north on Manitoulin Island and to the east in New York State, none of the author's well logs distinguish these beds from the Trenton formation. In outcrop the Black

River is composed of a basal sandstone or an arkose, with overlying shales and limestone.

Trenton formation (Middle Ordovician). The Trenton consists of a series of gray and brown limestone, in places dolomitic and containing numerous shaly partings. The deeper wells that pass completely through the Trenton indicate that it is generally over 800 feet thick. To the north, in Dawn and Zone townships, a log shows the Trenton formation to be over 937 feet thick, but elsewhere it is approximately 875 feet. One rather prominent clay or shale layer was observed in several logs. It is from 2 to 11 feet thick and is commonly found about 375 feet below the top of the Trenton formation. Work on outcrops of the Trenton in both the Georgian Bay and Toronto region has led Raymond[5] to suggest that

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[5]P. Raymond: Geological Survey, Canada, Museum Bulletin, No. 31, p. 1, 1921.

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the upper portion of the limestone, correlated as Trenton, is really Cobourg limestone, of Utica age. However, this finer distinction is disregarded in all the published logs.

Utica shale (Upper Ordovician). It is rather difficult to pick out the Utica shale from the overlying Dundas and Richmond formations without making a detailed study of many logs of wells beyond the limits of the area here studied. However, drillers frequently indicate the

presence of a brown shale, calling it Utica. A black shale some places noted below the Utica is the Collingwood, and is generally 30 to 45 feet in thickness. The total thickness of the black Collingwood and the brown Utica, as indicated in logs, ranges from 100 to 225 feet, and is most commonly given as 120 feet.

Dundas (Lorraine) and the Richmond formations. (Upper Ordovician). The Dundas, formerly called the Lorraine due to its faunal relation with the Lorraine of New York State, and the Richmond formations are rarely separated in well logs. The lower lying Dundas formation consists of gray and bluish-gray shales, with some shaly-lime partings. The Richmond consists of gray shales with interbedded limestone. Drillers' logs usually make no mention of the limestone, merely including the Dundas and Richmond as the Hudson River gray-black shales.

The Queenston shale is the upper member of the Richmond formation, but due to its readily distinguishable lithologic character, it is generally noted separately. Although dominantly red in color, minor amounts of gray shale are found within the member. The logs examined in Lambton and Kent counties show the thickness of the Queenston to range locally from 110 to 350 feet, with 270 feet as the normal thickness. This thickness of red shales is rather surprising inasmuch as Malcolm[6] reports

[6]Wyatt Malcolm: "The Oil and Gas Fields of Ontario and Quebec". Memoir 51. Geological Survey, Canada Department of Mines, p. 24, 1915.

none observed on Manitoulin Island.

The Manitoulin dolomite is the lowest of the Silurian strata evident here. In this area according to Malcolm and the well logs, the dolomite is hard, bluish, and fine-grained. To the east, in Niagara Gorge, Malcolm states it is represented by shales. Extremes of 30 to 71 feet are given for the thickness of this strata, but the majority of wells list a figure of 45 feet.

Overlying the Manitoulin dolomite are shales known as the Cabot Head member. Although dominantly composed of shales, this member contains some limestone and is commonly sandy in the upper portion. Red and gray are the common colors. The sandy layer in this area is probably equivalent to the Thorold sandstone, which Hume[7] describes as grading into the Cabot Head to the north of Hamilton.

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[7] G. S. Hume: "Oil and Gas in Eastern Canada". Econ. Geol. Series, No. 9, Geological Survey, Canada Department of Mines, p. 24, 1932.

Clinton formation (Lower Silurian). The three members of the Clinton formation found along the Niagara River are not noted in the logs of any wells examined. Dark gray shales and dolomite make up the formation, with a common thickness of 35 feet.

Rochester formation (Middle Silurian). A dark gray shale is known to occur in the section overlying the

Clinton formation in Kent and Lambton counties. Inasmuch as most authors, for instance Hume[8], indicate that

[8]G. S. Hume: "Oil and Gas in Eastern Canada". Econ. Geol. Series, No. 9, Geological Survey, Canada Department of Mines, p. 24, 1932.

the Rochester shale thins and disappears just west and north of Hamilton, a well-founded doubt exists in the minds of stratigraphers as to whether or not the shale bed of Kent and Lambton counties is really the Rochester. However, as the term is now widely used among drillers, and is included in all logs reaching the Silurian beds, it has been retained in this report. It is possible that the shale is part of the upper Clinton. Such an idea might be inferred from the statement made in 1915 by Malcolm[9] that "at Cataract and northward it (the

[9]Wyatt Malcolm: "The Oil and Gas Fields of Ontario and Quebec". p. 32, 1915.

Lockport member) rests directly upon the Cabot Head shale, the Clinton and the Rochester formations of the Niagaran series being absent". A careful and extensive study of well samples would be necessary to check the suggestion. The Rochester as recorded in well logs is usually 45 feet thick in the northern part of the area, and 30 feet in the southern.

Lockport formation (Middle Silurian). The Lockport formation is made up of limestone and dolomite with a

little shale on top. The dolomite constitutes the bulk of the formation and is blue-gray in color, fine-grained and hard. Well logs usually give the thickness of the Lockport and Guelph together; they have a total thickness of 100 to 260 feet. The most common thickness recorded is 220 feet.

Guelph formation (Middle Silurian). A light gray to light brown colored dolomite overlies the Lockport and is rarely distinguished from it in well records. The upper portion of the Guelph is porous and it is thought that this surface was exposed to erosion at one time. Its porosity has been favorable for the accumulation of oil and gas, making the Guelph one of the main producing formations of Ontario.

Salina formation (Upper Silurian). The Salina formation of this portion of Ontario consists of alternating shales and dolomites. The shales are generally gray and the dolomites brown to buff in color. The thickness differs from well to well but in general it ranges from 550 to 600 feet. With the Bass Island dolomite directly overlying the Salina, it is rather difficult to separate the two formations. Therefore, the thickness of these two is very often given together. It is from 750 to 850 feet, depending largely upon the thickness of the Salina.

Bass Island formation (Upper Silurian). As stated above, the Bass Island dolomite is often included in the Salina formation in drillers' logs. When separated it is described as a brown to buff dolomite. Hume[10]

[10] G. S. Hume: "Oil and Gas in Eastern Canada". Economic. Geol. Series, No. 9, Geological Survey, Canada Department of Mines, p. 26, 1932.

gives a thickness of the Bass Island in this eastern section of 330 to 375 feet. However, in both printed logs, as well as the observed log, a thickness of approximately 105 to 160 feet was indicated.

Sylvania formation (Lower Devonian). The Sylvania sandstone is thought to be a windblown accumulation of sand. If such origin is true, its varying thickness can be understood. It is not generally a pure sandstone, but more commonly occurs as a fine sand in limestone and dolomite. Drillers usually place it in well logs under the heading "sharp lime". Frequently, logs include it with the Bass Island, if the latter is distinguished from the Salina in the log. The thickness of the Sylvania alone is about 20 feet, although Malcolm[11]

[11] Wyatt Malcolm: "The Oil and Gas Fields of Ontario and Quebec"., page 38, 1915.

includes figures suggesting that locally it thickens to as much as 85 feet.

Detroit River series (Lower Devonian). This series, which includes the Sylvania formation in its lowest part, is believed to be lower Devonian. Its fauna is much like that of the Onondaga, yet it has, according to Hume[12]

[12] G. S. Hume: "Oil and Gas in Eastern Canada". Econ. Geol. Series, No. 9, Geological Survey, Canada Department of Mines, p. 24, 1932.

been variously interpreted as late Silurian and early Devonian. The series above the Sylvania consists mainly of three formations of dolomite and limestone, brown and gray in color. A range of thicknesses from 280 to 340 feet is found in well logs. Exact thicknesses are rather difficult to determine from the drillers' logs, since so often the Detroit River and the Onondaga are lumped together, below which a "sharp lime", indicating the Sylvania, is recorded, with a thickness of 100 to 200 feet. Such generalizations are difficult to interpret accurately.

Onondaga formation (Middle Devonian). For a long time, the Oriskany sandstone was believed to extend westward through Lambton and Kent counties. Now, however, Stauffer[13] believes that the Oriskany extends

[13] C. R. Stauffer: "The Devonian of Southwestern Ontario". Memoir 34, Geological Survey, Canada Department of Mines, p. 5, 1915.

only as far west as the vicinity of Nelles Corners, which is just a few miles west of Hamilton. Isolated

patches, apparently, of the Oriskany have been recognised in well logs west of this position.

In the western part of Ontario, in the area studied, a sandstone is noted above the Detroit River series. This was interpreted to be the Springvale sandstone, which Stauffer[14] believes is the result of the reworking

[14] C. R. Stauffer: "The Devonian of Southwestern Ontario". Memoir 34, Geological Survey, Canada Department of Mines, p. 5, 1915.

of the Oriskany sandstone by the eastward encroaching Onondaga sea. The sandstone is about 40 feet thick in the Kent county area, and certain logs note that it contains considerable limey and dolomitic material. The sandy beds form the lower member of the Onondaga.

The Onondaga limestone itself has produced as much oil in Ontario as the Guelph. The limestone is present all over the southwestern portion of the Ontario peninsula. To the east, where it includes much chert, the limestone overlies the Oriskany sandstone. To the west in Kent and Lambton counties, where it is a gray to brown limestone, it lies on the Detroit River series. The thickness of the Onondaga generally ranges from 110 to 150 feet in the area. Definite figures are difficult to obtain as the Delaware formation is often grouped with the Onondaga.

Delaware formation (Middle Devonian). The Delaware formation is composed of gray and brownish limestone,

which according to Malcolm,[15] grades down into the Mack

[15] Wyatt Malcolm: "The Oil and Gas of Ontario and Quebec", pp. 41-42, 1915.

Marcellus shale to the east. In the western region, it lies directly on the Onondaga, and is very difficult to distinguish from that formation. Where separated from the Onondaga in logs, it is recorded as being 50 to 60 feet in thickness. Stauffer[16] believes it to be between

[16] C. R. Stauffer: "The Devonian of Southwestern Ontario". Memoir 34, Geological Survey, Canada Department of Mines, pp. 137-138 and 214, 1915.

the Hamilton and Onondaga in age; i.e., roughly equivalent to the Marcellus shale.

Hamilton formation (Middle Devonian). In this area the Hamilton is divided into four parts. The lowest is the Olentangy shale - the "lower soap" of the drillers. To the north it logs 40 feet thick, but to the south it is consistently recorded over 70 feet, commonly over 100 feet, and in a few places over 200 feet in thickness. Stauffer[17] comments on a similiar situation in the

[17] C. R. Stauffer: "The Devonian of Southwestern Ontario". Memoir 34, Geological Survey, Canada Department of Mines, p. 9, 1915.

vicinity of Sarnia, and suggests that part of it may include the succeeding subdivision which contains more shale.

Overlying the Olentangy are the Widder beds - the "middle lime" of the drillers. This member is chiefly

limestone with a few shale breaks. It is rather difficult to get an accurate thickness of this formation as the limestone rarely exceeds 12 to 20 feet and the shale is easily confused with both the under-and overlying formations. However, with the shale of these beds included, this member of the Hamilton has a total thickness of 50 feet approximately.

The Petrolia shale member is above the Widder beds. This consists of black shale, ranging from 100 to 130 feet in thickness at Petrolia. In Tilbury East township (Kent county), it has been logged as thin as 60 feet, but to the south in Raleigh township, frequent thicknesses of 120 feet have been found. Wide variations are seen in local areas.

The Ipperwash limestone member is the drillers' "upper lime". It is composed of a gray limestone with some shale. It is 40 feet or less in thickness. Due to its nearness to the surface, pre-Glacial and Glacial erosion have cut down in places into this shale and have locally partially removed it.

Huron formation (Upper Devonian). Overlying the Ipperwash is another thickness of black shale, usually called brown in drillers' logs. This is known as the Huron shale, and due to erosion, pre-Glacial or Glacial, this formation is not generally present and hence, not

recorded in well logs. However, in the portion of the area shown in the east-west cross-section, through southern Euphemia and Dawn townships, and just to the south in northern Zone, Camden, and Chatham townships, a continuous layer of the Huron shale is present. This ranges from a few inches to as much as 200 feet in thickness. It is possible that the unusual thickness is due to the inclusion of a portion of the Portage-Chemung groups, namely the Port Lambton shales. The well records are not complete enough to attempt a separation of these shale beds. While the Port Lambton shales are known to be present in the northwestern portion of the area examined, the few logs available did not furnish sufficient information to allow the writer to distinguish between the Port Lambton and the Huron shale.

Glacial and Recent deposits (Pleistocene and Recent.)

One of the factors that accounts for the difficulty in studying the geology of the region is the thick mantle of glacial deposits that masks practically all the underlying bedrock. Thicknesses up to 200 feet of the glacial and recent alluvial material are known from well drillings, but the usual thickness is 150 feet in the south and 50 feet in the north.

PRAIRIE SIDING DEEP WELL LOG

Prairie Oil and Gas Company, Con. 5, southwestern corner lot 5, 100 feet north of Thames River, near village of Prairie Siding, Dover East township, Kent county, Ontario. Elevation - 580 feet. Gas at 3002 - 700,000 cu. ft., 3185 - 900,000 cu. ft. Well plugged back to 3237 feet. Drilled, August 1938.

Delaware formation		Thick.	Depth
Unavailable		301	301
Limestone	gray and gray-brown	9	310
"	gray dense, some flakes of iron	15	325
"	light tan, chalky appearance, some iron	10	335
"	dense gray brown	10	345
Onondaga formation			
Limestone	light tan and gray, chalky appearance, some clear pure white ls. Fossil fragments.	40	385
"	light tan. Chalky appearance	20	405
"	ditto, grinds fine. Some iron	20	425
Limey chart	dense, fine-grained, light gray	10	435
Limestone	gray-brown.	15	450
"	light brown and white. Some dense cherty lime. Fossils.	10	460

Springvale Sandstone (?)

Sand	small gains. Cemented with lime. Much ls., some iron	30	490
Limestone	coarse, gray and sandy	10	500

Detroit River series

Limestone	light tan. Coarse	15	515
"	light brown. Coarse granular. Some ground fine. A little iron, some very thiny bedded shale.	45	560
Dolomite	gray-brown. Coarse - granular. A little thin-bedded shale.	7	567
"	gray, fine-grained. Pure white gyp.	8	575
"	light brown, clear colorless gyp.	35	610
"	gray, some brown	10	620
"	coarse, dark "coffee" brown	8	628
"	light gray-brown	11	639
"	dark gray-brown. Some gypsum	36	675
"	gray and white and gray-brown. Coarse grained, some gypsum.	110	785

Sylvania sandstone

Dolomite	gray and white. Arenaceous. Coarse grained, chalky.	20	805

Bass Island

Dolomite	gray and white. Grinds fine.	25	805
"	ditto. Coarser fragments. Some chert.	35	865

Chert	gray and white. Some limey material.	30	895
Chert	ditto. Some dense, dark brown dolomite	10	905
Dolomite	dense, dark brown.	5	910

Saline formation

Chert	some dense gray limestone,	18	928
Dolomite	dark brown, crystalline. Chert	7	935
"	light buff, crystalline.	20	955.
"	brown.	10	965
"	gray and light brown.	40	1005
"	light gray.	15	1020
"	light gray and brown. Grinds fine. Brown has sugary appearance.	90	1110
"	dense dark blue-gray. Shale and gypsum.	125	1235
"	tan and brown dense, fine-grained. A little gypsum	43	1278
"	dark blue-gray. Gypsum.	17	1295
"	tan, dense, fine-grained crystalline. Includes some dense dark gray ls.	75	1370
"	dense gray and brown. Some brown chert.	55	1435
"	dense fine-grained brown, sugary	13	1448
"	dense fine-grained gray.	10	1458
"	dense fine-grained gray and sugary brown.	30	1488
"	ditto, with sugary white limestone.	4	1492

Dolomite	dense, sugary brown, some dense, brown, non-crystalline limestone.	36	1528
"	dense light brown to buff, non-crystalline. Iron flakes	12	1540
"	dark gray brown, crystalline, sugary appearance.	25	1565
Shale	very dark gray-black	25	1580
"	dark gray-brown. Sugary	18	1598
Dolomite	light brown, sugary. Thin top layer of pure white crystalline dolomite.	47	1645
"	light gray crystalline. A little iron.	7	1652

Guelph and Lockport

Dolomite	light brown, sugary. Crystalline appearance. Thin layer of gray crystalline ls. at 1690	48	1700
"	ditto. Grinds very fine and evenly	20	1720
"	gray brown crystalline, fine-grained and grinds fine.	5	1725
"	ditto 1700-1720. Grinds fine.	40	1765
"	sugary gray-brown. Some iron	13	1778
"	ditto 1700-1720.	17	1795
"	ditto above, coarser fragments. Some gray-brown ls. Tan surgary layer and iron flakes 1810-1820	45	1840
"	light gray and gray brown. Light tan layer at top.	25	1865
"	light sugary brown.	15	1880
"	light gray and white. Crystalline. Iron stains common. Grinds fine.	40	1920

Rochester and Clinton formations

Shaly dolomite	blue-gray and gray-green, fine-grounded, non-crystalline.	22	1942

Cabot Head member

Shale	red and green limey shale. Red appears weathered.	38	1980
"	Green.	15	1995
"	purple. A little red and some green limey shale.	50	2045

Manitoulin member

Dolomite	gray-white and gray-green, cherty. Fine-grained and crystalline. Some limestone	55	2100
"	blue-gray (green when wet), fine-grained, non-crystalline	10	2110

Queenston member

Shaly ls.	red. Fine-grained, non-crystalline "grainy" appearance. Includes similar beds of green. Latter predominates below 2250. Orange gypsum below 2300.	285	2395

Richmond Dundas, and Utica formations.

Shaly ls.	blue-gray (gray-green when wet) dense. Iron around 2490, 2560-2580. Occasional red shale fragment.	375	2770
"	ditto above, except a darker blue-gray.	98	2868

Trenton formation

Limestone	light-brown, crystalline. Grinds fine. Sandy appearance. Gray-brown layer around 2960. Omittance between 2985-2990, no lithologic change. Dolomitic at top.	132	3000
"	gray-brown. Grinds fine after first five feet. Gas at 3002.	25	3025
"	ditto. 2868-3000	5	3030
"	dolomitic. Gray-brown. After first five feet grinds fine like 2868-3000. Crystalline.	44	3074
"	dolomitic. Gray-brown. Coarse fragments.	5	3079
"	dolomitic. Ditto above, grinds fine.	6	3085
"	dolomitic. Ditto above. Coarser fragments and somewhat darker.	4	3090
"	dolomitic. Ditto above. Grinds fine. Some dark gray limey shale at 3130.	40	3130
"	dolomitic. Light brown to dark gray-brown. Coarse fragments.	6	3136
"	dolomitic. Ditto above, grinds fine. Dark ls. increases at 3155	59	3195.
"	dolomitic. Ditto above. Dark gray or black limestone increases with depth. Much gray-white limestone. Some gray-brown dolomite.	55	3250
Dolomite	gray-brown. Closely resembles 3030-3074. Grinds fine.	24	3274
Bottomed at 3274.	Plugged back to 3237.		

ONONDAGA-HAMILTON CROSS-SECTION

Records of numerous shallow wells permitted a rather detailed study of the Hamilton group of formations in Kent and Lambton counties. Two cross-sections were constructed from the information at hand, one in an east-west direction through Sombra, Dawn, and Euphemia townships in Lambton County (section AA^1), and one in a southwest-northeast direction across Kent County (section BB^1). The three lower units of the Hamilton, namely, the Olentangy shale, the Widder beds, and the Petrolia shale, are continuous under both counties. The fourth and upper unit, the Ipperwash limestone, however, is either cut out by erosion and the glacial drift or not distinguished from the Huron or the Petrolia shales in the logs.

The Petrolia shale thins noticeably in the area underlying Camden township, and this thinning is also observed northeastwards in Zone Township where erosion has cut down through the overlying Huron shale. The Petrolia shale, "upper soap", thickens to the southwest, however, and in southern Chatham Township it equals if not exceeds its average thickness as seen to the extreme north.

The Widder beds retain a nearly even thickness throughout the area, tending to thicken somewhat to the south.

The underlying Olentangy shale, the "lower soap" of the drillers, is thin at the north, and has a thickness of about 20 feet. This shale, however, thickens rapidly in central Camden Township, and reaches a maximum thickness of 204 feet in the southern portion of that area. From Camden Township to the southwest it things gradually to an approximately uniform thickness of 30 or 40 feet, except for an increase locally to 70 feet in central Dover East Township. It appears that where the Petrolia thickens the Olentangy thins, and vice versa.

The information on the overlying Ipperwash limestone is too fragmentary to enable the writer to draw any definite conclusions regarding it. In Section AA' twenty-two deep wells permit a fairly satisfactory construction of the major lithologic units down to the Lower Silurian strata. It does not reveal distinctly any unconformable relations, but, nevertheless, the cross-section does not help the writer to shed any light on such perplexing stratigraphic problems of Ontario, as the Onondaga-Detroit River relation, the Sylvania-Oriskany relation, and the Bass Island-Salina relation.

Although the wells in the cross-sections are plotted to a datum plane, sea level, no conspicuous structure is revealed. A structure contour map on the Onondaga shows several local highs and lows, however, and these will be discussed under the next heading.

STRUCTURE

Southwestern Ontario lies at the intersection of two major structures, the Michigan basin and the Finley arch of the Cincinnati uplift. The Michigan basin trends southeastward and the Finley arch northeastward. The two cross at right angles. The resultant structure is a broad saddle. Kent and Lambton counties are situated in the central part of the saddle where the strata are nearly horizontal except for local variations.

Pirtle[18] has shown the relationship of the two trends in a subsurface map contoured on the Trenton limestone. Figures taken from the map indicate that the top of the Trenton near Finley, Ohio lies at a depth of approximately 500 feet below sea level. To the north the elevation drops to more than 2500 feet below sea level in the vicinity of Petrolia (Lambton county), Ontario. From there, the strata rise slowly to the north, where the Trenton surface is recorded at less than 500 feet below sea level in Gray county, Ontario. The saddle aspect of the structure is shown

[18] George W. Pirtle: "Michigan Structural Basin and Its Relationship to Surrounding Areas". AAPG Bulletin 16, No. 2, p. 147, 1932.

by the fact that the surface of the Trenton drops approximately to 10,000 feet below sea level in both the Michigan and Allegheny basins.

The minor structures of the area as interpreted from well logs, appear to be a group of small scattered domes and basins with no recognizable alignment. The apparently unrelated domes are concentrated along the eastern, southern, and southwestern portions of the area. The central and northwestern sections are of lower elevation, and in general show moderate relief resulting in broader structures with lesser dips.

Extending northward from the southwestern corner of the area (Tilbury East and Dover West, and to some extent Dover East townships) is a rather distinct high that trends north-south. This is a third high parallel with two others immediately adjacent on the west that were reported by Garvey.[19]

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[19] P. Garvey: "Oil and Gas of Essex County, Ontario, Canada". Unpublished thesis. 1941.

AREAS FAVORABLE FOR PROSPECTING

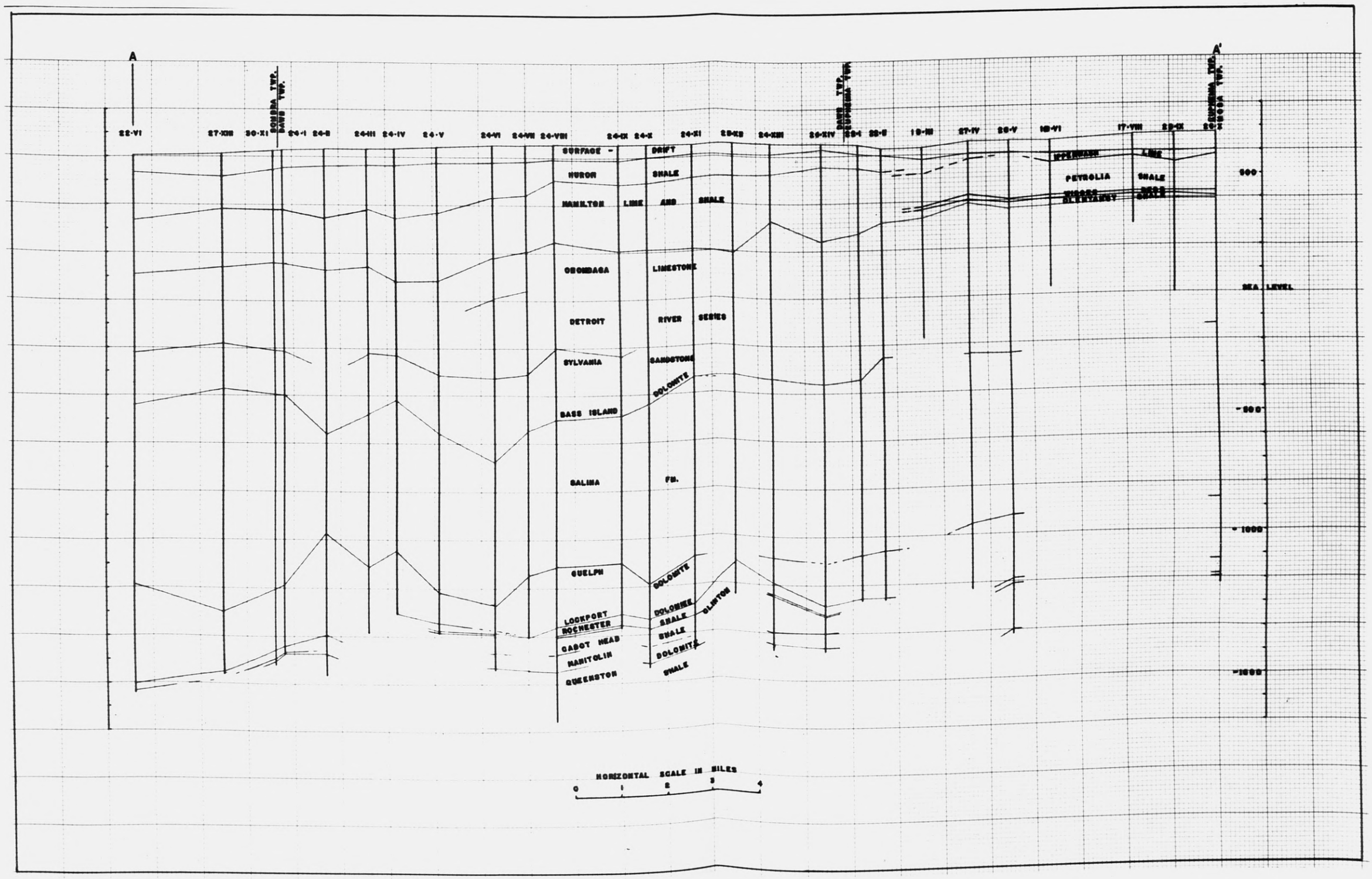
The following areas appear to offer encouragement for future investigation and prospecting. They may be divided into three types.

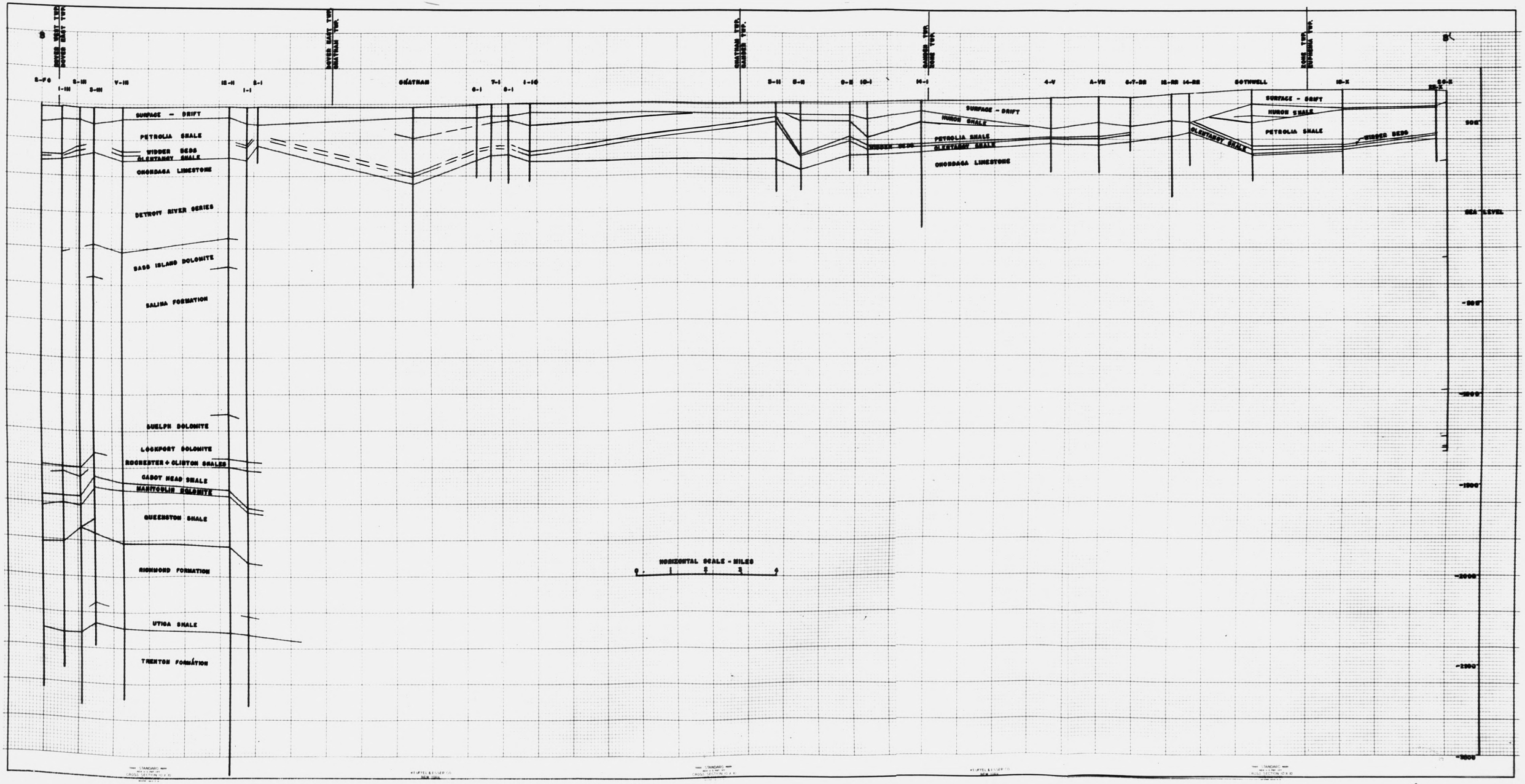
The first type consists of the areas in which closure has been found as a result of the author's investigation. The reasons for the lack of previous exploration in these areas are unknown. One of the undeveloped areas of known closure is in the vicinity of the town of Harwich, Howard township. Approximately eight miles to the south, near the town of Blenheim, Harwich township, another section having a closure would again suggest favorable conditions for oil accumulation. In the southern portion, a dome exists in lots 15 to 25, concessions III and IV of Romney township. Inasmuch as adjacent similar structures contain oil, the prospects here also appear favorable.

The second type of area favorable for oil prospecting includes those in which closure is suggested but not entirely defined. An example of this type is the northern portion of Dover East Township, Kent County. Another location where a structure is suggested, is in

the extreme northeastern and northwestern portions of Euphemia township (Lambton county). Productive areas surround the structures, and they, therefore, appear favorable for prospecting.

The third type of area includes those in which little work has been done to date. An example of such an area is found in the northern portion of Sombra township, Lambton County. Little data on this region has been found, but from the scanty information available, the writer believes that additional prospecting would be of value.


A
A'
22-VI
27-XII
30-XI
24-I
24-II
24-III
24-IV
24-V
24-VI
24-VII
24-VIII
24-IX
24-X
24-XI
25-XII
24-XII
25-I
25-II
19-III
27-IV
28-V
18-VI
17-VIII
22-IX
SURFACE - DRIFT
HURON SHALE
HAMILTON LIME ARD SHALE
ONONDAGA LIMESTONE
DETROIT RIVER SERIES
SYLVANIA SANDSTONE
BASS ISLAND DOLOMITE
SALINA FM.
GUELPH DOLOMITE
LOCKPORT DOLOMITE
ROCHESTER SHALE
GABOT HEAD SHALE
MANITOLIN DOLOMITE
QUEENSTON SHALE
CLINTON
PETROLIA
SHALE
900
SEA LEVEL
-500
-1000
-1500
HORIZONTAL SCALE IN MILES
0 1 2 3 4


B
RIVER WEST TWP.
DOVER EAST TWP.
RIVER EAST TWP.
CHATHAM TWP.
CHATHAM TWP.
HARDER TWP.
HOWE TWP.
HOWE TWP.
SUPERIOR TWP.
B'
S-VI
S-III
I-III
S-III
V-III
II-II
S-I
I-I
CHATHAM
G-I
T-I
S-I
I-16
S-II
S-II
O-II
10-I
14-I
4-V
A-VII
O-7-22
12-22
14-22
SOTHWELL
15-X
25-X
26-S
SURFACE - DRIFT
PETROLIA SHALE
WIDDER BEDS
OLENTANGY SHALE
ONONDAGA LIMESTONE
DETROIT RIVER SERIES
BASS ISLAND DOLOMITE
SALINA FORMATION
GUELPH DOLOMITE
LOCKPORT DOLOMITE
ROCHESTER & CLINTON SHALES
CABOT HEAD SHALE
MANITOULIN DOLOMITE
QUEENSTON SHALE
RICHMOND FORMATION
UTICA SHALE
TRENTON FORMATION
HURON SHALE
SEA LEVEL
-500'
-1000'
-1500'
-2000'
-2500'
-3000'
HORIZONTAL SCALE - MILES
0
1
2
3
4
STANDARD
KRUPPEL & ASSOCIATES
CROSS SECTION NO. 10
CROSS SECTION NO. 9
CROSS SECTION NO. 8

STRUCTURE CONTOUR MAP OF

KENT AND SOUTHERN PART OF LAMBTON COUNTIES, ONTARIO

CONTOURED ON THE ONONDAGA LIMESTONE

- SCALE -

MILES

LIGHT BLUE - 400- - FEET YELLOW - 500- - FEET

MEDIUM BLUE - 378-400 " ORANGE - 175-500 "

DARK BLUE - 350-375 " BROWN - 150-175 "

R O M N E Y

L A K E S T. C L A I R

E A S T D A W N

D A W N T O W N S H I P

S O M E R S E T

S O M E R S E T

Z O N E

E U P H E M I A

D A W N

A

A'

Malden # I

Recorded by A.J. Eardley

		Thickness	Depth to Bottom of Unit
Drift		46	46
Sylvania			
	Limestone, crystalline, grey and tan	29	75
	Limestone, sugary, light brown, vugs	10	85
	Sand, clear, rounded, not frosted, medium quartz	24	109
	Limestone, crystalline grey, imbedded sand gra ins	6	115
	Sand, same as above, except grains smaller	24	139
	Limestone, crystalline, grey, imbedded sand grains	5	144
	Limestone, crystalline, grey and light brown some white limey chert(?)grains	18	162
	Sand, same as above, some thin grey, cryst., limestone	18	180
Bass Island			
	Limestone, crystalline, light brown, some white dense chert	26	206
	Chert and limestone, white and sandy appearance	10	216
	Sand, ditto. Some large fragments of quartzite	5	221
	Limestone, crystalline, grey	6	227
	Sandstone, calcareous, and white chert	6	233
	Sandstone, chert, and limestone	18	251
	Limestone, crystalline, light brown, some chert	6	257
	Limestone, ditto, some dark brownll ms. Much chert	29	286
	Limestone, fine, sugary, tan, some chert	53	339
	Limestone, grey, fine, few quartzite grains	5	344
	Limestone, sugary tan. Some black shale	58	402
	Shale, grey, and limestone, fine grey	3	405
	Limestone, sugary tan	18	423
	Shale, calcareous, grey, some chert and limestone	7	430
	Limestone, sugary tan	15	445
	Limestone, sugary tan and fine grey, some gypsum	16	461
Salina			
	Limestone, crystalline grey, shaley phases	18	479
	Limestone, fine-dark grey, some pinkish brown	101	580
	Limestone, sugary light brown	21	601
	Limestone, grey and light brown	24	625
	Limestone, sugary light tan	12	637
	Limestone, tan and shale, grey. Some grey lms.	18	655
	Limestone, sugary tan	12	667
	Limestone, fine grey	36	709
	Limestone, fine grey and sugary light brown some dark translucent brown	118	827
Guelph			
	Limestone, translucent light brown	23	850
	Limestone, ditto, grinds fine	62	912
	Limestone, sugary grey	12	924
	Limestone, sugary white, light brown gas 928- 31	12	936
	Limestone, ditto, iron concretions	12	948
	Limestone, coarsely crystaline,light brown,white gypsum	24	972
	Limestone, ditto grinds very fine, salt water	21	991

Hole bottomed at 991
Malden #2 correlates about 4 feet deeper than #1.

LOG OF GAR WOOD WELL:- LOT 33, CONCESSION 3, MALDEN TOWNSHIP.
GEORGE WILLITTS, BOTHWELL, DRILLER.
NAME MALDEN #1
ELEVATION 576

FORMATION.	DEPTH FROM SURFACE	THICKNESS.	
SURFACE MISSING	46	46	
DETROIT RIVER SERIES.			
MEDIUM GREY DOLOMITE LIMESTONE, SANDY AT BASE	85	39	
MEDIUM WHITE QUARTZ SAND	109	24	
MEDIUM WHITE LIMEY SANDSTONE	115	6	
MEDIUM WHITE QUARTZ SAND	142	27	
MEDIUM GREY SANDY DOLOMITE LIMESTONE, CHERT	191	49	
MEDIUM GREY DOLOMITE LIMESTONE, CHERT	219	25	
FINE TO MEDIUM SANDY GREY LIMESTONE, CHERT	221	5	
MEDIUM GREY SANDY DOLOMITE LIMESTONE, CHERT	251	30	
FINE TO MEDIUM GREY CHERTY DOLOMITE	286	35	
BASS ISLAND SERIES:			
QUITE FINE CRYSTALLINE, LIGHT BUFF, LIGHT GREY, AND GREY DOLOMITE	449	163	
SALINA SERIES:			
FINE GREY DOLOMITE, SHALY DOLOMITE, SOME ANHYDRITE	479	30	
GREY SHALEY DOLOMITE, DOLOMITE SHALE, ANHYDRITE	502	23	
GREY SHALEY DOLOMITE, FINE BUFF DOLOMITE, ANHYDRITE	508	6	
GREY SHALEY DOLOMITE, DOLOMITE SHALE, ANHYDRITE	577	69	
FINE BUFF DOLOMITE, SOME SHALEY DOLOMITE	625	48	
FINE LIGHT BUFF DOLOMITE	637	12	
FINE BUFF AND GREY DOLOMITE, A LITTLE SHALEY DOL	703	66	
FINE BUFF DOLOMITE, 50% BUFF ANHYDRITE	709	6	
FINE BUFF DOLOMITE, SHALEY DOLOMITE	719	10	
FINE BUFF DOLOMITE	729	10	
GREY SHALY DOLOMITE, DOLOMITE SHALE, ANHYDRITE, FINE BUFF AND GREY DOLOMITE	789	60	
FINE BUFF AND GREY DOLOMITE, SHALY DOLOMITE, BUFF ANHYDRITE	827	38	
AS ABOVE WITH 60% BUFF ANHYDRITE	844	17	SHOW GAS AT 835
FINE GRANULAR BUFF DOLOMITE	930	86	
MOSTLY WHITE ANHYDRITE	936	6	
GUELPH:			
MEDIUM LIGHT BUFF DOLOMITE	948	12	
MEDIUM LIGHT BUFF AND LIGHT GREY DOLOMITE	972	24	GAS AT 960 PROBABLY
FINE TO MEDIUM LIGHT BUFF DOLOMITE	991	19	FROM 948
SALT WATER	991	BOTTOM OF HOLE.	

REPORT FROM UNION GAS CO.

CHAS S. EVANS, GEOLOGIST.

ARMIN A. DARMSTAETTER
DETROIT, MICHIGAN

345 ARDEN PARK,
MARCH 15, 1940

DEAR MR. EARDLEY;

WHEN I GOT HOME TODAY I HAD A LETTER FROM MR. WILLITTS MY DRILLER, IN WHICH HE ENCLOSED A LOG OF THE MALDEN #1 WELL, MADE BY CHAS S. EVANS OF THE UNION GAS CO, CHATHAM. I COPIED IT AND AM ENCLOSING A COPY TO YOU SO THAT YOU MIGHT POSSIBLY GET THEIR NOMENCLATURE. I NOTICE THEY PLACE THE GUELPH AT A DIFFERENT LEVEL THAN YOU HAVE. HE MAKES A NOTE TOO THAT THE GAS IS COMING FROM THE TOP OF THE GUELPH, WHICH AS I REMEMBER YOUR STATEMENTS, WAS YOUR OPINION.

I THINK I MENTIONED TO YOU THAT THE UNION GAS CO., ARE VERY MUCH INTERESTED IN THE TERRITORY.

VERY TRULY YOURS,

Armin Darmstaetter

I AM GOING TO PICK UP MY SON TOMORROW AT ABOUT THREE, IF THERE IS ANYTHING YOU WOULD LIKE TO TALK TO ME ABOUT LEAVE WORD WITH HIM AT THE VAUGHAN DORMITORY.

Malden #1

Record by A. J. Eardley

	Thickness	Depth to Bottom of unit
← Drift	46	46
Sylvania Limestone, crystalline, grey + tan	29	75
Limestone, sugary, light brown, vugs	10	85
Sand, clear, rounded, not frosted, medium quartz	24	109
Limestone, crystalline grey, imbedded sand grains	6	115
Sand, same as above, except grains smaller	24	139
Sylvania Limestone, crystalline, grey, imbedded sand grains	5	144
Limestone, crystalline, grey + light brown, some white limey chert(?) grains	18	162
Sand, same as above, some thin grey, cryst. limestone	18	180
Bass Island Limestone, crystalline, light brown, some white dense chert	26	206
Chert and limestone, white + sandy appearance	10	216
Sand, ditto. Some large fragments of quartzite	5	221
Limestone, crystalline, grey	6	227
Sandstone, calcareous, and white chert	6	233
Sandstone, chert, + limestone	18	251
Limestone, crystalline, light brown, some chert	6	257
Limestone, ditto, Some dark brown lms. Much chert	29	286
Limestone, fine sugary, tan, Some chert	53	339
Limestone, grey, fine, few quartzite grains	5	344
Limestone, sugary tan. Some black shale	58	402
Shale, grey, + limestone, fine grey	3	405
Limestone, sugary tan	18	423
Shale, calcareous, grey, Some chert + limestone	7	430
Limestone, sugary tan	18	448
Limestone, sugary tan + fine grey, Some gypsum	16	464
Salina Limestone, crystalline grey, shaley phases	18	482

Limestone, fine - dark grey, some pinkish brown	101	479
Limestone, sugary. light brown	21	580
Limestone, grey and light brown	24	601
Limestone, sugary light tan	12	625
Limestone tan + shale, grey. Some grey lms.	18	637 655
Limestone, sugary tan	12	
Limestone, fine grey	5	667
Limestone, sugary tan	36	673
Limestone, fine grey ▽ sugary light brown Some dark translucent brown	148	709
Guelph		
Limestone, translucent light brown	23	827
Limestone, ditto, grinds fine	62	850
Limestone, sugary gray	12	862 #2
Limestone, sugary white, light brown	12	924 925-30
Limestone - gas 928-31 "		
Limestone, ditto, " "	12	936
Limestone, coarsely crystalline white gypsum light brown	~~24~~	948 gyp. 962-7
~~Limestone, ditto, white gypsum~~	~~7~~	~~971~~
Limestone, ditto grinds very fine, salt	221	972
~~Bottom~~ → water		991

Hole bottomed at 991

Malden #2 correlates about # feet deeper than #1.


UNIVERSITY OF MICHIGAN
3 9015 00326 9233

COPY 1

THE UNIVERSITY OF MICHIGAN

TO RENEW PHONE 764-1494

DATE DUE