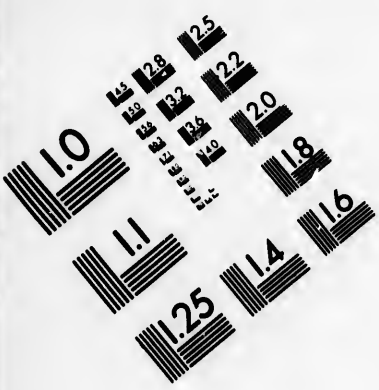

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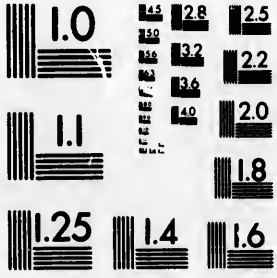

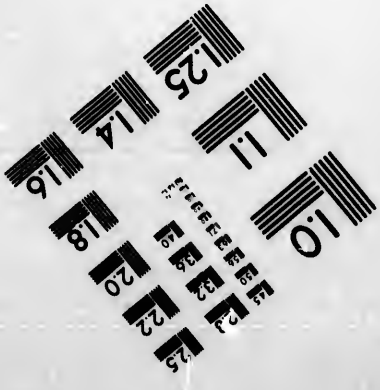

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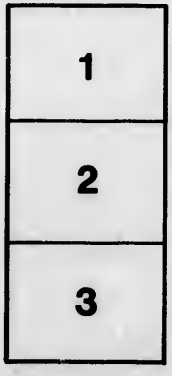

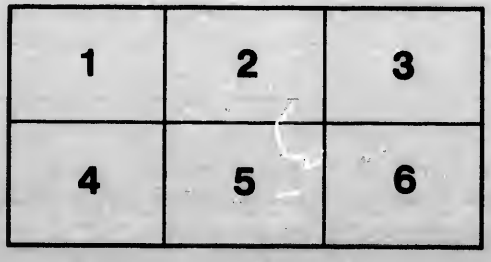

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ON THE GEOLOGY OF NATURAL GAS AND PETROLEUM IN SOUTHWESTERN ONTARIO

NOTES ON THE OCCURRENCE OF PETROLEUM IN GASPÉ, QUEBEC

BY

H. P. H. BRUMELL

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ON THE GEOLOGY OF NATURAL GAS AND PETROLEUM IN SOUTHWESTERN ONTARIO

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(*Read before the Society December 29, 1892*)

CONTENTS

The Areas under Consideration.

Gas-producing Area.—In that part of Ontario lying south and west of a line drawn from Toronto to Collingwood, operations in search of gas and petroleum have been carried on for a number of years. They have resulted in the discovery of two gas-producing areas of considerable extent, viz, that in Essex county, in the vicinity of Kingsville and Ruthven, and that in Welland county, in the neighborhood of Sherkston. Nor are the wells of these two fields the only producing ones, for many isolated borings, such as those at Cayuga, Dunnville and Mimico, afford no inconsiderable flows.

Oil-producing Area.—Petroleum has unfortunately been found in commercial quantities in but one county, that of Lambton, where there are two distinct pools, known as the Oil Springs and Petrolea fields. These pools have been drawn upon continuously since 1862, when the first flowing well was struck, in what is now known as the "upper vein." Following closely upon this discovery were more extended operations, which brought to light the present oil horizon, known as the "lower vein." The upper vein having long been exhausted, the source of supply has for years been in the lower, wherein wells affording as much as 7,500 barrels per day have been sunk.

Authorities indicated.—As I wish to treat more of the geologic than the historical side of the question, I will follow out the title of my paper, but before doing so cannot do better than refer those interested in the oil industry in Ontario to Dr Robert Bell's paper on "The Petroleum Field of Ontario," published in volume v, Transactions Royal Society of Canada, and to the report of the Division of Mineral Statistics and Mines, part S, Annual Report Canadian Geological Survey, volume iv, 1888–89.

Geologic Section of the Areas.—There is in that part of the province under consideration a series of rocks, lying in almost undisturbed position, ranging from the Trenton to the Portage formation, with an approximate total thickness of 4,100 feet, as follows:

	Formations.	Approximate thickness in feet.	Average thickness in feet.
Devonian	Portage and Chemung	25– 200	100
	Hamilton, about	350	350
	Corniferous	160– 300	230
	Oriskany	6– 25	15
Silurian	Lower Helderberg, Onondaga	300–1,000	650
	Guelph	140– 160	150
	Niagara	100– 130	115
	Clinton	30– 150	90
	Medina	600– 800	700
Cambro-Silurian	Hudson River	500– 900	700
	Utica	300– 400	350
	Trenton, Black River	600– 750	675
	Total		4,125

The geologic Formations involved.

Detailed Description essential.—To meet the requirements of this paper it is perhaps better to describe, so far as is known, the various formations in descending order.

Portage.—The Portage in Ontario consists of a series of fissile black bituminous shales and is developed almost altogether in the county of Lambton, where it acquires, according to Dr T. Sterry Hunt, a thickness of 213 feet, as shown in a boring made at Corunna.* These shales in a well bored at Sarnia show a thickness of 80 feet, and again, in a well sunk on lot 12, concession 10, Bosanquet township, they are seen to hav a total thickness of 95 feet. In both of these instances it lies immediately over the upper shale bed of the Hamilton formation, the upper limestone bed of which, found at Petrolea and elsewhere, is wanting. In the township of Dawn, and again east of Oil Springs, 70 feet of black shales are found. In this instance they rest upon the upper limestone of the Hamilton. In a syncline lying between Petrolea and Oil Springs, and separating the two fields, 40 feet of black shales are found in a well drilled on Fox creek, the elevation of which is considerably less than that of Oil Springs. These shales in no instance afford oil, but are probably the source of the considerable quantities of shale gas found in the overlying gravel and sand.

Hamilton.—The wells in Petrolea and Oil Springs and the greater number of those drilled in Lambton county show that the black shales of the

* Report of Progress, Geol. Survey of Canada, 1866, p. 247.

Portage group immediately overlie a limestone bed which constitutes the upper stratum of the Hamilton formation. This series of rocks consists of alternating beds of limestone and gray shales (known locally as "soapstone") and has a thickness, according to a drilling made at Kingstone's mills, Lambton county, of 396 feet. Dr Hunt* speaks of this well as being important in showing the thickness in Ontario of the middle and upper Devonian, which, if we add to the 396 feet found here the 213 feet of rocks belonging to the Portage found at Corunna, is 609 feet.

The record of the well at Kingstone's mills is as follows:

Clay	14 feet.
Black shale	50 feet, Portage.
Shales, soft, and limestone	396 feet, Hamilton.
Limestone, hard	44 feet, Corniferous.

At Petrolea the Hamilton is only 296 feet thick, as follows:

Limestone ("upper lime")	40 feet.
Shale ("upper soapstone")	130 "
Limestone ("middle lime")	15 "
Shale ("lower soapstone")	43 "
Limestone ("lower lime")	68 "

At Oil Springs, 8 miles southward, the formation shows evidence of having thinned out, the thickness there being only 240 feet according to the following record of many wells drilled on the eastern side of the field:

Limestone ("upper lime")	35 feet.
Shale ("upper soapstone")	101 "
Limestone ("middle lime")	27 "
Shale ("lower soapstone")	17 "
Limestone ("lower lime")	about 60 "

Corniferous.—Underlying the so-called lower lime of the Hamilton is a series of bituminous limestones constituting the Corniferous formation—the source of the oil of Lambton county. Regarding the distribution of this formation in Ontario, the following description is given:†

"The surface occupied by this formation in western Canada is probably between 6,000 and 7,000 square miles. A great part of this, however, is deeply covered with drift, so that the exposures are comparatively few. To the eastward this formation is bounded by the outcrops already assigned to the underlying strata, the limits of which in many parts have as yet been but imperfectly traced. The whole of the province to the west and south of this line belongs to the Corniferous forma-

* Report of Progress, Geol. Survey of Canada, 1866, p. 251.
† Geology of Canada, 1863, p. 362.

tion, with the exception of a belt of higher Devonian rocks which crosses the country from Lake Huron to Lake Erie and divides the region into two areas. These newer strata occupy a saddle-shaped depression in the great Cincinnati anticlinal, which runs nearly east and west through the peninsula, while the course of this depression or synclinal is nearly north and south from Plympton, on Lake Huron, to Orford, on Lake Erie. The belt of higher rocks has a breadth of only about twenty-five miles on the anticlinal between the Thames and Sydenham rivers, but on either side it spreads to the northeast and to the southwest along the shores of the two lakes."

In two wells, those of London and the "Test well," at Petrolea, the Corniferous is shown to have an approximate thickness of about 200 feet, consisting throughout of hard gray limestone. In all wells where this formation has been struck the rocks appear to have been of uniform character and to consist of white or grayish limestones holding nodules and layers of chert.

Oriskany.—The Oriskany formation is but slightly developed in Ontario, being entirely wanting in most of the wells sunk to or beneath its horizon; again, owing to the carelessness of drillers, its presence may not have been noted. In the townships of Oneida and north Cayuga, in Haldimand county, it is exposed and forms beds of sandstone aggregating at the most twenty-five feet in thickness. In many of the records obtained from drillers mention is made of a sandstone at about the summit of the Onondaga, but in most cases close inquiry has proven these statements to be fallible, the so-called sandstone being generally a granular dolomite. However, in two wells at least there is strong evidence of a sandstone occurring at a point near the position occupied by the Oriskany. One of these was a well drilled at Dresden, Camden township, Kent county, wherein the following record was met with, according to the driller:

Surface deposits	43 feet.
Shale, black	180 "
Limestone	12 "
Shale ("soapstone")	172 "
Limestone	75 "
Sandstone	44 "

Again, in a well sunk near Dresden, on lot 3, concession 2, Camden township, the following section was, according to the driller, obtained:

Surface deposits	60 feet.
Shale, black	20 "
Limestone	30 "
Shale ("soapstone")	204 "
Limestone	117 "
Sandstone	46 "

Onondaga and Lower Helderberg.—Beneath the Oriskany, when present, and usually directly underneath the Corniferous Limestone, is a long series of limestones, dolomites, marls, shales, gypsum, and salt constituting the Onondaga, which for convenience can be made to include the Lower Helderberg. This formation acquires a thickness, in the salt region of Huron county, of at least 1,500 feet, according to the following very accurate record made by Dr T. Sterry Hunt* of a well sunk at Goderich by Mr Henry Attrill, of that place:

	Feet.	*Inches.*
Surface deposits	78	9
Dolomite, with thin limestone layers	278	3
Limestone, with corals, chert and beds of dolomite	276	0
Dolomite, with seams of gypsum	243	0
Variegated marls, with beds of dolomite	121	0
Rock-salt, first bed	30	11
Dolomite, with marls toward the base	32	1
Rock-salt, second bed	25	4
Dolomite	6	10
Rock-salt, third bed	34	10
Marls, with dolomite and anhydrite	80	7
Rock-salt, fourth bed	15	5
Dolomite and anhydrite	7	0
Rock-salt, fifth bed	13	6
Marls, soft, with anhydrite	135	6
Rock-salt, sixth bed	6	0
Marls, soft, with dolomite and anhydrite	132	0
Total depth	1,517	0

As to what is the greatest actual thickness of the formation it is impossible to say, as data regarding its lower measures are wanting. In none of the records obtained has there been definitely noted the red and greenish shales indicative of the base of the formation in New York state. According to the records of wells sunk for gas in Bertie township, Welland county, it has there a total thickness of 390 feet, consisting of gray and drab dolomites, black shale and gypsum, and in a well at Petrolea it was found to be 905 or more feet thick, as follows:

Limestone, hard, white	500 feet.
Gypsum	80 "
Salt and shale	105 "
Gypsum	80 "
Salt and shale	140 "

The formation may be thicker, as drilling ceased in the salt and shale.

*Report of Progress, Geol. Survey of Canada, 1876-77.

Guelph.—Underneath the Onondaga is met with, over a considerable portion of the province, a series of yellowish to brown and in places bituminous dolomites, having a probable thickness of not more than 160 feet and known as the Guelph formation. These beds have been pierced in many wells in Ontario, but efforts to obtain from drillers definite information as to their thickness and character have been useless, nor has it been found possible to draw any distinction, in records of wells so far obtained, between the dolomites of this formation and the gray dolomite of the Niagara, which immediately underlies it. In the wells of the Bertie township, Welland county, gas field are found about 240 feet of dolomites of Guelph and Niagara age, and in number 1 well sunk by the Port Colborne Natural Gas Light and Fuel company in Humberstone township, Welland county, there are found, according to the driller, 30 feet of shaly dolomite and 188 feet of brown dolomite, with dark-blue shales toward the bottom. In the town of Paris a well was sunk in which 99 feet of Guelph dolomite was found immediately underlying the Onondaga. The boring was not continued beyond this depth, so it is impossible to say what thickness the formation attained at this point.

Niagara.—The Niagara formation, the upper beds of which are composed of dolomites, as stated above, has a probable thickness in Welland county of about 140 feet, made up of gray dolomites reposing upon about 50 feet of dark shale. It extends throughout the province in a northwesterly direction to Cabotshead, where, according to the Geology of Canada, 1863, it would have a thickness of about 450 feet, and is composed of a whitish subcrystalline limestone. On the Welland canal, near Thorold, is seen the following section in ascending order:*

Bluish-black bituminous shale	55 feet.
Bluish-gray argillaceous limestone	8 "
Dark bluish bituminous limestone	8 "
Light and dark-gray magnesian limestone	26 "
Bluish bituminous limestone	7 "
Total	104 "

This section does not include two [illegible] beds of bluish-gray magnesian limestone which may be of Clinton age, though toward their summit holding two species of fossils characteristic of the Niagara series in New York, nor does it reach the summit of the formation. In Essex county the beds met with in the various wells sunk near Kingsville and Ruthven at a depth of from 1,000 to 1,100 feet consist of a light yellowish-gray vesicular dolomite which is probably of Niagara age. It is from this dolomite that the large flows of gas have been obtained.

*Geology of Canada, 1863, p. 322.

Clinton.—The Clinton, on entering Canada through the Niagara peninsula, consists of a band of green shale 24 feet thick underlying 18 feet of limestone, though in the wells of the Provincial Natural Gas and Fuel company in Bertie township the shales are apparently entirely wanting, the formation consisting, it is said, of 30 feet of white crystalline dolomite, which is grayish toward the base. In number 1 well of the Port Colborne company there were found beneath the dark shales, indicative of the base of the Niagara, 72 feet of marls and dolomites, which are in all probability attributable to the Clinton. The formation appears to thicken toward the northwest, gradually diminishing again, as proved by the exposure which trends to the north from Hamilton toward Collingwood, a little south of which it takes a sweep to the westward. In Wentworth county, in the township of Flamborough West, the Clinton is seen to rest upon about 8 feet of whitish sandstone, constituting the "gray band," which is apparently missing in Welland county, but on the northern extension of the formation proves a very conspicuous feature, forming a terrace upon which the shale and limestone of the upper part of the Clinton occur. In the many records of wells drilled in the interior of the province evidence is wanting to estimate the thickness or character of the Clinton, though in one, that of a boring at Waterloo, there were said to have been found 114 feet of blue shale lying immediately above red shale undoubtedly of Medina age. In all probability there have been included in this 114 feet the dark shales of the Niagara.

Medina.—Following immediately upon the Clinton and, where present, the sandstone of the gray band is a great thickness of red and white sandstones and red and green shales which constitute the Medina. This formation has its greatest thickness in the Niagara peninsula, gradually diminishing toward the north, where, at Cape Commodore, in Grey county, there are seen beneath the Clinton limestone 109 feet of red and green shales resting upon strata of the Hudson River formation. In number 1 well, drilled in Port Colborne by the Port Colborne company, the measures penetrated for a distance of 770 feet were—

Red shale, with thin bands of white sandstone	50 feet.
Red and white sandstone	53 "
Soft red shale, with bands of gray and green	667 "
Total	770 "

Drilling ceased at this point at a distance of at least 200 feet above the base of the formation, as in a well on lot 6, concession 15 of Bertie township, there were found 1,000 feet of strata attributable to the Medina. The best record of the upper beds of the formation is that of the bottom

of number 1 well, drilled by the Provincial company, on lot 35, concession 3, Bertie township, and which is as follows:

Red sandstone	55 feet.
Red shale	10 "
Blue shale	5 "
White sandstone	5 "
Blue shale	20 "
White sandstone ("gas-rock")	16 "
Total	111 "

Throughout the gas-fields of Bertie and Humberstone townships this section of the upper beds of the formation appears to be quite constant, only very slight variations being noted. The most marked is that in number 9 well, drilled by the same company, and wherein was found—

Red sandstone	55 feet.
Red shale	10 "
Blue shale	5 "
White sandstone	20 "
Blue shale	12 "
Total	102 "

The second white sandstone bed beneath was penetrated only four feet.

In a well sunk on lot 11, concession 7, Barton township, Wentworth county, and about forty miles to the northwest of the above-mentioned, there were found 595 feet of red shale, with bluish bands, lying immediately above the bluish shales of the Hudson River. Again, a few miles northwest of this place, and at the insane asylum in Hamilton, there were said to have been found 634 feet of red shale, and at Dundas, three miles north of this, in a well sunk in the valley and begun in the Medina, there were found 400 feet of red shale, in both instances resting upon the Hudson River shales. To go back to the eastward again, there were found in a well at Saint Catharines 548 feet of red shale. This does not, however, show the entire thickness of the measures, which in a well at Thorold, eight miles southward, proved to be 930 feet thick, as follows:

Red sandstone	30 feet.
Shale	57 "
Gray sandstone	30 "
Red shale	813 "
Total	930 "

Many other records of wells bored into or through this formation are at hand, which go to show that it varies locally as to thickness, yet constantly diminishes toward the north. Of the formation in the western part of the province but little is known, as west of London, where it consists of 500 feet of red shale, it has not been reached in the borings thus far put down.

Hudson River.—The Hudson River, which is next met with, plays a very unimportant part in the geology of gas and oil in Ontario, and consists, in that part of the province under consideration, of a series of shales and limestones immediately underlying the red and green shales of the Medina. Unfortunately the great area of its supposed exposure north of Toronto is overlaid with drift, but where the exposures are to be seen they consist, as in the township of Toronto, Peel county, "of a series of bluish-gray argillaceous shales enclosing bands of calcareous sandstone sometimes approaching to a limestone and of variable thickness."* These sandstone bands are slaty in places, though at times having a solid thickness of a foot. The formation has been reached in a considerable number of wells—among others, those at Saint Catharines, Thorold, number 14 of the Provincial company, in Bertie, all in the Niagara peninsula; Swansea and Mimico, near Toronto; Toronto, Hamilton, Brantford and London, where it was penetrated for 150 feet and found to consist of limestone and shale. In the wells at Swansea and Mimico there were found 440 and 493 feet respectively of bluish-gray shale. This does not of necessity represent the total thickness of the formation at these points, as boring began upon it immediately beneath the surface deposits. In the Thorold well, where the formation was met with at depth, it was found to consist of 700 feet of blue shale, and at Saint Catharines it had a similar character and thickness. It is quite probable that in the various borings limestone was found, though on account of its shaly character it was termed shale by the drillers.

Utica.—The Utica formation, upon which the Hudson river rests, is found, wherever met with in drillings, to consist of a series of dark-brown bituminous shales, becoming in places bluish toward their base, and having a thickness of from 200 to 400 feet. Of its exact thickness in any well it is very difficult to speak, on account of the similarity between its upper members and the lower strata of the Hudson river.

Trenton and Black River.—Beneath the Utica shales there is met with a thick series of bluish limestones, which constitute the Trenton formation, including also the Black River. This series, which is regarded as the Mecca of all Ohio drillers, has proved itself, in Ontario, to be com-

*Geology of Canada, 1863, p. 212.

paratively barren of gas or oil. Of its productive properties, however, more will be said later. In eastern Ontario it covers a large area, but west of Toronto and Collingwood the series is overlaid by the Utica and newer formations, with the exception of a small area in the vicinity of Collingwood, where it is seen to consist of bluish limestone, having a slight dip to the southwest. In the few wells wherein it has been reached the character of the rocks is apparently unchanged, though its thickness varies considerably. For instance, at Whitby, east of Toronto, it has a thickness of 600 feet; at Toronto, 585 feet; Swansea, 602 feet; Collingwood, 553 feet, and Saint Catharines, 667 feet, in all of which places the formation was entirely traversed, the drillings, with the exception of the well at Saint Catharines, ceasing on the striking of the Archean rocks immediately beneath. In the case of the boring at Saint Catharines the drill penetrated 27 feet of white quartzose sandstone, which may be Paleozoic or belong to the arkose beds.

Geologic Horizons in Ontario yielding Gas and Oil.

OIL WELLS IN THE CORNIFEROUS LIMESTONE.

Age and Depth.—Of the occurrence of petroleum in Ontario but little can be said. In Lambton county, where it has been produced for 30 years, it is found in the Corniferous limestone at a depth of about 475 feet, the record of a well bored near the Imperial refinery, Petrolea, being as follows:

Formation.	*Strata.*	*Thickness in feet.*
	Surface deposits	104
Hamilton	Limestone	40
	Shale	130
	Limestone	15
	Shale	43
	Limestone	68
Corniferous	Limestone, soft	40
	Limestone, gray, oil rock	25
	Depth	465

Annual Output of Oil.—Some 3,000 wells are now producing and afford about 800,000 barrels per annum, making the average daily production about two-thirds of a barrel per well. The oil is dark-colored and of from 31° to 35° Baumé in gravity; nor is it an oil that can be easily refined, on account of the considerable proportion of sulphur it contains in a form as yet undetermined.

Chemical Composition of the Oil.—According to returns received from the refineries for the year 1889 it has a commercial content of—

Benzine and naphtha	1.6	per cent.
Illuminating oil	38.7	"
Paraffine, gas and other oils and wax	25.3	"
Waste (coke, tar and heavy residuum)	34.4	"
	100.0	"

The Corniferous petroliferous over a wide Area.—While the Corniferous affords commercial quantities of oil only in Lambton county, explorations have proved it to be petroliferous over a wide extent of country, including the northern part of Kent, the eastern part of Middlesex, and southern part of Oxford. In the county of Essex oil has been found at two points, presumably in the Niagara or upper strata of the Clinton. At Comber, in this county, small quantities of heavy black oil were found in a hard limestone at 1,270 feet, and again at Walker's well number 2, on lot 8, concession 6, Colchester township, oil similar in appearance and gravity was found at 1,000 feet in a brownish limestone. This well is said to have pumped five barrels per day.

THE MEDINA AS AN OIL-PRODUCER.

The only other formation wherein oil has been struck is the Medina, in which, in Humberstone township, Welland county, it has been noted in two wells. These are on lots 11 and 12, concession 3, and are said to have flowed four and two barrels each per day respectively. The oil occurs in the second white sandstone bed, about 100 feet beneath the summit of the formation. The oil is of light claret color, of about 45° Baumé gravity, and is apparently free from sulphur. Further work in search of this oil has not yet been undertaken.

GAS-BEARING HORIZONS: CLINTON, MEDINA AND OTHERS.

Localities indicated.—Gas is found in large quantities at two horizons only, viz, one, which is still doubtful though in the neighborhood of the Clinton, in Essex county; and in the Medina, in Welland. In the former county, in the vicinity of Ruthven, Gosfield township, there have been sunk several wells, in three of which were found large quantities of gas, in each case emanating from a gray vesicular dolomite at a depth of about 1,000 feet.

Depth at which Gas is found.—In Welland county, wherein the gas field covers a much greater area than that of Essex, the gas is found almost entirely in the Medina sandstone, about 100 feet below the summit of the formation and at a depth of about 830 feet. The record of number 1

well, drilled on lot 35, concession 3, Bertie township, by the Provincial Natural Gas and Fuel company, is a follows:

Formation.	*Strata.*	*Thickness in feet.*
	Surface deposits	2
Corniferous	Dark-gray limestone	23
Onondaga	Gray and drab dolomites, black shales and gypsum	390
Guelph and Niagara	Gray dolomite	240
Niagara	Black shale	50
Clinton	White crystalline dolomite, gray toward bottom	30
Medina	Red sandstone	55
	Red shale	10
	Blue shale	5
	White sandstone	5
	Blue shale	20
	White sandstone ("gas-rock")	16
	Total	846

Records of twenty-eight Wells.—In the above well 2,000,000 cubic feet of gas per day were struck at a depth of 836 feet, or six feet in the second white sandstone bed. This company have drilled some thirty wells, the records of which do not differ materially from that given above, though capacity varies greatly, as may be seen from the following table:

Number of the well.	*Cubic feet per day.*	*Number of the well.*	*Cubic feet per day.*
1	2,050,000	15	50,000
2	375,000	16	12,500,000
3	600,000	17	2,500,000
4	2,200,000	18	2,000,000
5	8,500,000	19	1,500,000
6	70,000	20	300,000
7	3,000,000	21	None.
8	47,000	22	2,600,000
9	3,500,000	23	30,000
10	4,500,000	25	500,000
11	300,000	26	2,750,000
12	5,500,000	27	None.
13	300,000	28	Limited.
14	5,000		

Gas-bearing Bed of the Medina.—In all of these wells, with the exception of number 22, the entire flow was obtained from the second white sandstone bed of the Medina; nor are these the only wells producing large quantities of gas from that horizon, as shown below.

Daily Capacity of some of the Wells.—The largest gas well is that known as Coste number 1, drilled by the Ontario Natural Gas company on lot 7, concession 1, of Gosfield, and carried to a depth of 1,021 feet, wherein

at 1,017 feet a flow of gas equal to 10,000,000 cubic feet per day was found. Another was drilled by the Citizens' Gas, Oil and Piping company of Kingsville on the road allowance about 55 yards west of the above-mentioned well, and afforded 7,000,000 feet per day, from a rock similar in character and depth to that in Coste number 1. On lot 7, concession 1, of Gosfield, the Citizens' company again drilled and found gas to the extent of 2,500,000 cubic feet per day, and I understand that the Ontario company have been quite successful in a boring made southeast of their Coste number 1, having obtained there a heavy flow, estimated at 7,000,000 feet per day. All efforts to find gas north and northwest of this group of wells have been futile, the beds being found to be flooded with salt water.

Other Localities.—Among other lesser producers may be mentioned Carrolls, in Humberstone township, which afforded 1,000,000 cubic feet per day. At Cayuga, in Haldimand county, west of Welland, a considerable flow was found in the Medina as well as at Dunnville, about midway between Port Colborne and Cayuga. In wells bored to or through the Medina north and northwest of Welland, and the wells mentioned above, the formation has been found to be practically barren of gas, the only boring wherein it was noted being at Beeton, where in a soft sandstone just beneath the surface deposits a small quantity occurred.

The Clinton as a Gas-producer.—The Clinton in a small number of wells has afforded large quantities of gas, the most marked instances being those in Welland county, known as Near's, Reebe's and Hopkins' number 2, each of which produced 400,000 cubic feet per day, and the Mutual company's well, which produced 1,500,000 cubic feet. These wells are all in that district wherein the Medina is so productive, a fact that rather tends to suggest that the gas is adventitious. Outside of this county the Clinton has not as yet produced a single cubic foot of gas. Exception must, of course, be taken to this statement if it be proved that the productive horizon in Essex county is in that formation.

The Niagara as a Gas-producer.—In Welland county the Niagara also is a large producer of gas, well number 22 of the Provincial company affording 1,850,000 cubic feet per day from the limestones of the upper part of the formation, while in a well sunk a few miles north of this, at Niagara Falls South, a flow of 50,000 cubic feet was obtained in the shales beneath the limestone.

OTHER GAS-BEARING FORMATIONS.

There now remain to be spoken of only three formations which have afforded gas, though only as yet in small quantities. They are the Onondaga, the Trenton, and a sandstone of age anterior to the latter.

The Onondaga as a Gas-producer.—The occurrence of gas in the Onondaga, even in the small quantities noted, is unique. At Blyth, Huron county, and in the midst of a considerable number of wells bored in the salt region, a well was drilled which afforded, according to the driller, the following record:

Surface deposits	104	feet.
Limestone	300	"
(?)	346	"
"Black shale"	100	"
"Hard rock"	170	"
Shale	105	"
Rock-salt	90	"
Total	1,215	"

In the black shales considerable quantities of gas were obtained, not, however, sufficient to be of commercial value.

The Trenton as a Gas-producer.—The Trenton formation has not as yet afforded any considerable quantities of gas, though pierced at many points, the most westerly being Stratford, where it was found at 2,360 feet and penetrated for 24 feet, where a heavy flow of salt water caused the abandonment of the work. Coming eastward, the point where it was next struck was on lot 16, concession 15, Brantford township, Brant county, where it was reached at a depth of 1,950 feet and a small quantity only of gas obtained at its summit. At Dundas, near Hamilton, in Wentworth county, it was struck at 1,430 feet and found to be barren. Again, at Thorold, Welland county, about 40 miles east of Hamilton, the Trenton was struck at 1,905 feet and penetrated for 525 feet, where a very small flow of gas was noted. About 8 miles north of this, at Saint Catharines, it was again reached, being struck at 1,506 feet and found to be barren, although the entire formation was traversed. Again east of Thorold and on lot 6, concession 15, of Bertie township, it was struck at 2,525 feet in well number 14 of the Provincial company, wherein it was traversed for 195 feet without affording gas. The foregoing three wells are the only ones in which the Trenton was reached south of Lake Ontario. On the northern side, however, it has been met with in all wells drilled close to the lake shore. In Toronto several wells were sunk, operations commencing upon the Hudson River formation and the drilling continued deep into or through the Trenton without finding gas; but at Mimico, about 8 miles west, three wells have afforded small quantities, the greatest flow being about 50,000 cubic feet per day. In and around Collingwood several wells, beginning in the upper beds of the formation and continued to its base, afforded small flows, the greatest being about 6,000 cubic feet per day.

It will thus be seen that in Ontario the Trenton as a large producer has proved so far anything but successful. Even at Dundas, on the crown of the Dundas anticlinal, no gas was found. There, however, remains in the western and southwestern portion of the province a large area as yet untouched, wherein it may afford large quantities and prove of as great value as it has further southward, in Ohio.

The following table exhibits the position of the Trenton in southwestern Ontario in regard to tide level.

Locality of well.	Elevation of well above tide.	Elevation of summit of Trenton.	Thickness of Trenton.	Elevation of base of Trenton.	Gas in Trenton—cubic feet per day.
	Feet.	*Feet.*	*Feet.*	*Feet.*	
Toronto, Swansea	347	— 296	602	— 898	None.
Mimico	280	— 443	.....	Not reached.	About 5,000
Collingwood, City	592	Begun on	Trenton..	+ 39	" 5,000
" Delphi.	600	+ 552	.....	Not reached.	" 6,000
Dundas	About 300	— 1,130	.....	....do	None.
Saint Catharines	297	— 1,209	667	— 1,876	None.
Thorold	517	— 1,388	.....	Not reached.	Very small.
Provincial company, number 14	About 620	— 1,905	.....	....do	None.
Brantford	672	— 1,278	.....	....do	Very small.
Stratford	1,185	— 1,175	.....	....do	None.

Unfortunately no analyses or close examinations have as yet been made of the Trenton limestone in that part of the province under consideration, the only analyses available being those of specimens from quarries considerably to the east of the portion where it is under cover.

An unusual Occurrence of Gas.—A rather peculiar occurrence of gas is that found in the well near Saint Catharines. In this boring a yellow quartzose sandstone beneath the Trenton limestone was penetrated for seventy-seven feet and afforded a small quantity of gas, insufficient for commercial purposes.

Forthcoming Publication on the Subject.

In closing, I should like to draw attention to the fact that a detailed description of wells bored in Ontario, accompanied by maps and sections, is now in press and will shortly be issued by the Canadian Geological Survey. In this will be found a more or less complete narrative of boring operations up to the close of the calendar year 1890.

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NOTES ON THE OCCURRENCE OF PETROLEUM IN GASPÉ, QUEBEC

BY H. P. H. BRUMELL

(*Read before the Society December 30, 1892*)

CONTENTS

EARLIER HISTORY.

The Locality indicated.—Operations in search of petroleum have been carried on in a desultory manner for about 30 years in the vicinity of Gaspé basin, Gaspé county, Quebec, without as yet any economic result. The presence of oil at depth has, however, been proved through the efforts of "The Petroleum Trust," an English company, which has been operating on the southwest side of Gaspé bay, in the neighborhood of and to the south of Gaspé basin.

The Oil-bearing Formation described.—In the eastern part of the Gaspé peninsula there is a great thickness of sandstones resting conformably upon almost as great a thickness of limestones, the whole being of lower Devonian and possibly partly Upper Silurian age. According to Dr R. W. Ells,* these sandstones have a thickness of about 3,000 feet, while the

* Report of Progress, Geol. Survey of Canada, 1880-82, p. 5 D D.

underlying limestone is estimated at about 2,000 feet. These rocks are largely developed in the vicinity of Gaspé bay, where they form a series of almost parallel anticlinals, on or near the axes of which the greater part of the exploratory work has been done.

Dr R. W. Ells, in the report cited above, speaks of these anticlinals as follows:

"The rocks of the series have a considerable development on the several rivers that flow into Gaspé bay, where they lie in shallow basins, bounded by the anticlinals, which bring into view the strata of the lower or Gaspé limestone series. These basins are at least four in number, the dividing anticlinals being known as the Haldimand, the Tar Point, the Point Saint Peter, and the Percé, the most southerly yet recognized. On the south side they rest upon rocks of the Silurian system. The whole formation may therefore be said to occupy a geosynclinal basin, the western limit of which has not yet been traced, but which will probably be found to be continuous with the basin recognized on the Cascapedia river, and thence extending to the Metapedia."

Former Knowledge concerning the Locality.—In the "Geology of Canada," 1863, page 789, the following mention is made of the various natural oil springs of the district. This includes probably all that was known of the occurrence of oil in Gaspé up to that date:

"At the oil spring, at Silver brook, a tributary of the York river, the petroleum oozes from a mass of sandstone and arenaceous shale, which dips southeastwardly at an angle of 13° and is nearly a mile to the south of the crown of the anticlinal. The oil, which here collects in pools along the brook, has a greenish color and an aromatic odor, which is less disagreeable than that of the petroleum of western Canada. From a boring which has been sunk in the sandstone to a depth of about 200 feet there is an abundant flow of water, accompanied with a little gas and very small quantities of oil. Farther westward, at about twelve miles from the mouth of the river, oil was observed on the surface of the water at the outcrop of the limestone. Petroleum is met with at Adams' oil spring, in the rear of lot B of York, nearly two miles east of south from the entrance of Gaspé basin. It is here found in small quantities floating upon the surface of the water, and near by is a layer of thickened petroleum, mixed with mold, at a depth of a foot beneath the surface of the soil. A mile to the eastward, at Sandy beach, oil is said to occur, and, again, at Haldimandtown, where it rises through the mud on the shore. These three localities are upon the sandstone and on the line of the northern anticlinal which passes a little to the north of the Silver Brook oil spring. Farther to the southeast, on the line of the southern anticlinal and about two miles west of Tar Point, which takes its name from the petroleum found there, another oil spring is said to be found, three-quarters of a mile south of Seal cove. On the south side of the Douglastown lagoon, and about a mile west of the village, oil rises in small quantities from the mud on the beach. A well has here been bored to a depth of 125 feet in the sandstone, which dips to the southwest at an angle of 10°, but traces only of oil have been obtained. Farther to the westward oil is said to occur on the second fork of the Douglastown river. Traces of it have also been observed in a brook

near Saint George's cove, on the northeast side of Gaspé bay. In none of these localities do the springs yield any large quantities of oil, nor have the borings, which have been made in two places, been as yet successful. The above indications are, however, interesting, inasmuch as they show the existence of petroleum over a considerable area in this region, some part of which may perhaps furnish available quantities of this material."

Recent Exploitation.

History of later Operations not fully known.—Regarding later operations but little is known, as owing to the distance from our usual fields of work and the disinclination of operators to impart information it has been found impossible to closely follow actual operations. However, this much is known, that oil has been found at some depth, though in small quantities.

Notes on past and present Investigations.—The following notes are gleaned from a report on mines and minerals of the province of Quebec recently prepared by J. Obalski, M E, supplemented by information obtained by the writer:

At Sandy Beach, on lot B, York township, two wells were sunk about 20 years ago, one of which is said to have afforded oil, and about a mile above Douglastown, on the southern side of the Saint John river, a well was sunk 125 feet without successful result. At Silver Brook two wells were bored to a depth of 800 and 900 feet respectively, both showing the presence of petroleum, and on the southern side of the York river, near Silver Brook, two borings were made by the Gaspé Oil company to a depth of 700 and 800 feet, in neither of which was oil struck. Subsequent to these a well was sunk at Sandy Brook to a depth of 700 feet, in which oil was found, though in small quantity. The oil, a specimen of which was collected in 1882 by the writer, was brought to the surface of a small pool by the water, which flowed in considerable quantity from the boring, and was a heavy black oil of about 25° Baumé gravity.

In 1888 the International Oil company of Saint Paul, Minnesota, sunk a shallow well, which was in 1889 deepened to 450 feet without finding oil. The lands and plant owned by this company were in the same year taken over by "The Petroleum Trust," which has since sunk five wells in the district. In one of these, bored at Seal cove, a short distance south of the crown of the Tar Point anticlinal, they have met with a small quantity of high-grade oil. According to one of the drillers, the boring reached a depth of 3,000 feet, of which the upper 2,150 consisted of yellow and white sandstone, followed by 850 feet of bluish shaly limestone, in which, at a depth of about 2,600 feet from the

surface, the oil was found. The oil, which is green in color, is of about 38° Baumé gravity, has an aromatic odor, and is bright ruby red by transmitted light.

Continuation of Investigations probable.—The company working at present expect to continue operations, the results of which, in view of the probable exhaustion in the near future of the Petrolea field in Ontario, will be watched with interest.