CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

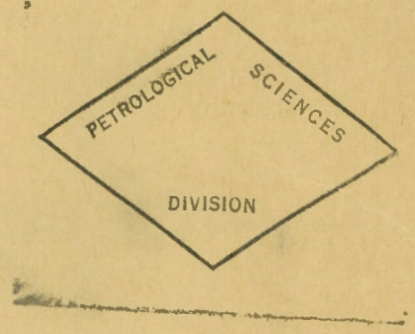
PAPER 40-22

PRELIMINARY REPORT

NATURAL GAS IN BRANTFORD AREA, ONTARIO

BY

J. F. Caley



OTTAWA

1940

CANADA
DEPARTMENT OF MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

Geological Survey

Paper 40-22

Natural Gas in Brantford Area, Ontario

By
J.F. Caley

Ottawa
1940

CONTENTS

Illustration

NATURAL GAS IN BRANTFORD AREA, ONTARIO

INTRODUCTION

This report is a brief account of the geological features of natural gas occurrences in Brantford area. It is condensed from a more complete and comprehensive memoir, now in press, dealing with all phases of the bedrock geology and the related economic products. The report is issued at this time in the hope that it may aid operators seeking to alleviate the present more or less acute natural gas situation recently brought about by various causes, which it is not necessary to enumerate here.

The region here designated the Brantford area includes about 4,800 square miles extending in an east-west direction from Dundas to Aylmer and in a north-south direction from Mount Forest to the north shore of Lake Erie. Within this area, commercial production of natural gas is at present confined to that part lying south of the latitude of Paris. The accompanying map illustrates this part of the region; it shows the positions of wells drilled to obtain natural gas and oil and also presents structure contours drawn on top of the Clinton formation.

During the earlier days of the industry numerous wells were drilled for which no records are now available; there is a strong possibility, therefore, that many wells

have been drilled that do not appear on the map. Appreciation of this fact is essential for anyone contemplating drilling in areas appearing as untested on the accompanying map.

A relatively small amount of drilling has been done north of this region and shows of gas have been obtained at several localities, but there has been no commercial production.

SUMMARY AND CONCLUSIONS

The part of Brantford area affording commercial production of natural gas lies south of an east-west line drawn through Paris. Within this southern part natural gas is drawn from four formations, all belonging to the Silurian; these are: the Clinton, which is productive over the greatest extent of territory; the Guelph; the Grimsby (Red Medina); and the Whirlpool (White Medina).

The regional structure as evidenced by the top of the Clinton (See accompanying map) is monoclinal, the strata dipping southerly at an average rate of 24 feet a mile. Small reversals of dip are common, but structural closure is rare. Variations in the rate and direction of dip have not been caused by folding of the strata, but are due to unequal settling of the beds, to variations in the thickness of groups of beds, etc.

Many wells have been drilled in many parts of the southern, productive district. There are, however, several areas of considerable extent in which few wells are recorded

(See accompanying map), but no records exist of many wells that were drilled in the earlier days of the gas industry and it may be that a considerable number of such wells were drilled in the otherwise apparently largely untested districts.

In the productive districts there are, here and there, groups of closely spaced productive wells constituting "gas fields". All these "fields" are not definitely limited by dry holes, and in many instances sporadically distributed producing wells occur in the less closely drilled areas intervening between the "fields". On the other hand, dry wells occur surrounded by producing wells.

There is no apparent relation between structure and the presence or absence of producing horizons. Apparently the accumulations of natural gas are due to the porous character of certain beds and the existence of gentle anticlinal rolls or decreases in the regional dip within circumscribed areas. As already stated, these favouring structures are not due to folding. For the most part they are so gentle that even in closely drilled areas they are not definitely detectable.

The presence or absence at any given locality of the features favouring accumulation of natural gas cannot be foretold. There is no evidence to indicate that these favouring features are confined to the producing parts of the southern productive district. They may be present in some

places within the untested or apparently untested intervening areas and, therefore, these intervening areas may properly be considered as worthy of attention.

In the districts north of the southern productive part of Brantford area, a relatively small amount of drilling has been done and shows of gas have been obtained at several localities, but there has been no commercial production.

In the northern, as yet unproductive, part of Brantford area, the only Silurian formation offering prospects of production is the Guelph, and this only in the western half of the area where it is covered by younger rocks. The only other prospective producing horizon in the north is the Trenton. This formation has so far failed to yield gas in commercial quantities.

STRATIGRAPHIC SYNOPSIS

System	Formation	Thickness in feet	Lithology
Devonian	Norfolk	0 - 410	Grey, blue, and brown limestone and chert
	Oriskany		Light grey sandstone
Silurian	Bertie-Akron	35 - 105	Brown dolomite, grey and bluish, argillaceous dolomite
	Salina	325 - 415	Argillaceous dolomite, calcareous shale, gypsum, anhydrite
	Guelph		Grey, buff, and brown dolomite
	Lockport	202 - 320	Light grey dolomite, brown, bituminous dolomite at the top

System	Formation	Thickness in feet	Lithology
	Rochester	0-80	Dark grey shale and calcareous shale
	Clinton	0-35	Grey crystalline limestone
	Thorold	0-15	Light grey and greenish grey sandstone
	Grimsby Cabot Head and Manitoulin	60-110	Red sandstone, red and grey, calcareous shale, grey and brown limestone
	Whirlpool	0-24	Grey, fine- to medium-grained sandstone
Ordovician	Queenston	360-500	Red, in part sandy, shale
	Meaford Dundas	640±	Chiefly grey shale with interbedded grey, impure limestone beds, the latter more common toward the top
	Billings	130±	Dark grey shale becoming black and bituminous toward the base
	Trenton and Older Palaeozoic Limestones	680±	Essentially grey and brownish, crystalline limestone and dolomitic limestone with partings and thin zones of grey and occasionally greenish shale
	Basal beds	1-30	Sandstone, arkose, arenaceous limestone, and dolomite
Precambrian			

PRODUCING HORIZONS

Commercial production comes entirely from rocks of Silurian age, the Medina, Clinton, and Guelph formations holding all the producing rocks. Four productive horizons are present within these formations, viz., the Whirlpool (White Medina), Grimsby (Red Medina), Clinton, and Guelph.

The Whirlpool consists of fine- to medium-grained, grey sandstone. It rests disconformably upon the Queenston formation and varies in thickness from mere traces of sand in wells from East Nissouri and North Oxford townships to about 24 feet as exposed on Nottawasaga River. Walpole, Tuscarora, Onondaga, Brantford, and Woodhouse townships hold wells that produce gas from this horizon.

The Grimsby does not outcrop in the Brantford area; it is present only in the southern part where it is concealed beneath younger rocks and is, therefore, known only from well samples. It consists of light grey and red sandstone and sandy shale with some grey shale. As seen at the outcrop in Niagara gorge[1] the Grimsby consists of irregularly distributed lenticular masses of sandstone separated by shale or sandy shale. Drilling indicates that the same conditions prevail in the Brantford area and production may come from almost any level within a maximum total thickness of about 45 feet. Walpole and Woodhouse townships are the chief areas producing from this horizon, although gas is also found in the Grimsby in Townsend, Middleton, Charlotteville,

[1] Caley, J.F.: Geol. Surv., Canada, Mem. 224 (1940).

and South Walsingham townships.

The Clinton does not outcrop in the Brantford area; it is present only south of the latitude of Galt and is concealed beneath younger rocks. It consists of grey and buff-coloured, crystalline or granular limestone. As interpreted by the driller, this horizon includes the underlying Thorold sandstone. The following are thicknesses of the Clinton proper, as determined from well samples:

Township	Thickness in feet
Malahide	25
Bayham	20
South Dorchester	25
Woodhouse	10
Charlotteville	20
Middleton	15
South Walsingham	25
Dereham	20
East Nissouri	25
North Oxford	30
North Easthope	20
Brantford	13
Tuscarora	10
Beverly	35

The Clinton is productive throughout the present producing part of the area with the exception of Dereham township. In that township production is from the Guelph. Few holes have been drilled as deep as the Clinton there and all have so far been non-productive.

The Guelph formation contains the highest producing horizon in the area. The number of drilling samples available is insufficient to permit determining the exact position of the productive beds, but they are high in the formation and apparently

within the upper few feet. This part of the Guelph is a grey, buff, or cream-coloured, crystalline and finely granular dolomite. At present all the production from Dereham township and much of that from Bayham and Malahide townships is from this horizon.

SUBSURFACE STRUCTURE

The accompanying map shows structure contours drawn on top of the Clinton formation. The general structure on this horizon has a southerly dip averaging about 24 feet a mile over the entire producing area. This apparently monoclinal regional structure shows local variations and reversals in dip, but there are few definite folds with structural closure. The folds that are indicated are so gentle that it seems better to attribute them to initial dip or differential settling rather than wholly to diastrophic movement.

A low anticlinal roll or elongate dome is indicated in the north-central part of Tuscarora township immediately south of Grand River. This structure has an easterly trend with a major axis about $1\frac{1}{2}$ miles long. It underlies the north half of River lots 30 to 40. A closure of about 30 feet is indicated. The southerly dip of the south limb is about 80 feet a mile; it decreases rapidly to the regional average. The reversal in the regional south dip that forms the north side of the structure appears to be considerably less in magnitude.

A similar structure is present in the west-central part of Onondaga township, where it underlies lots 10 to 15, concession III, and extends westward about ¾ mile into Brantford township. A closure of about 20 feet is indicated. The south flank dips at about 60 feet a mile and the north limb shows only a slight reversal of the regional south dip.

A small dome with a closure of about 20 feet underlies most of lots 1 to 3, con. II, Walpole twp.; this is probably little more than a bulge on the regional structure.

A low roll is present in the southwest part of Middleton township and underlies part of lots 2 to 5, concession IN, and most of lots 1 and 2, concession IIN. The structure trends generally southeast with a major axis about 2 miles long. The south flank dips about 80 feet a mile and the rate of dip is thought to decrease to the regional rate at a distance of about 1½ miles from the crest of the roll. On the north side, the regional southerly dip is resumed within approximately ¼ mile of the crest. A closure of 20 to 30 feet is indicated.

About 2½ miles east of the foregoing structure a very small doming of the Clinton is indicated beneath the northern part of lots 15 and 16, concession IIIS, and the south part of the same lots in concession IIS. It is slightly elongate with a major axis about ½ mile long, trending southeast. The south limb has a maximum dip of about 130 feet a mile; this decreases gradually attaining the regional average at an estimated distance of 1½

miles from the apex of the fold. On the north side the regional direction of dip is resumed within a distance of $\frac{1}{2}$ mile.

As already suggested, the fact that the foregoing structures are both extremely gentle and widely scattered render it much more likely that they are the result of uneven settling rather than of any tectonic movement. In some instances at least, the low doming may be due to reefs in the Clinton limestone. Reef structures are known elsewhere in this formation and can be seen at Niagara gorge in the upper Clinton and even projecting into the overlying Rochester shale.

PRODUCING FIELDS

Within the present producing region drilling has been concentrated in areas that for purposes of description may be referred to as "fields". In most cases these areas of concentrated drilling are not properly fields in the sense of being producing areas whose limits are definite and that are surrounded by stretches of country known to be non-productive. Although it is true that areas of concentrated drilling are separated by non-drilled regions of considerable extent, these latter do, in some instances at least, contain isolated, widely spaced producing wells.

The lack of well-defined structures suggests that structure resulting from diastrophic causes is not the major controlling factor in accumulation. This conclusion lends support to the belief that the present producing areas or "fields" may not constitute

separate fields and that the intervening, non-drilled areas may represent localities of potential production. The following remarks are based upon evidence drawn from wells for which data were available and which could be located in the field.

Brant County

The extreme eastern part of Brantford township together with the southern third of Onondaga and most of concessions V and VI Tuscarora township, constitute a "field". Gas is found in every part of this area, apparently regardless of structural conditions. Non-commercial wells occur sporadically throughout; in some instances these are surrounded by producing wells, a condition strongly suggestive of discontinuous porosity in the reservoir rock. About 20 per cent of the holes for which records are available were initially either dry or non-commercial. The Clinton and Whirlpool are the chief producing horizons and many wells draw from both. Producing depths range from 362 to 490 feet for the Clinton and 441 to 663 feet for the Whirlpool. The following log illustrates the detailed stratigraphy in this field:

Log of Hartley Well No. 3

Location: lot 16, concession III, Onondaga township

Formation	Depth in feet	Thickness in feet	Lithology
	0-110	110	No samples
Salina	110-150	40	Dark grey and greenish, limy shale; traces of anhydrite.
	150-155	5	Grey, crystalline dolomite.

Formation	Depth in feet	Thickness in feet	Lithology
Guelph Lockport	155-170	15	Grey, finely crystalline dolomite.
	170-190	20	Grey, finely granular dolomite.
	190-220	30	Grey and brownish, finely crystalline dolomite; traces of anhydrite at 205 feet.
	220-250	30	Light grey, finely granular dolomite; porous in lower 20 feet.
	250-270	20	Light buff, finely granular dolomite.
	270-300	30	Light buff, finely granular dolomite with some dark grey, limy shale.
	300-395	95	Brown and grey, finely granular dolomite; traces of anhydrite at 335 and 375 feet.
	395-410	15	Light grey, medium and coarsely crystalline dolomite.
Rochester	410-455	45	Dark grey, limy shale.
Clinton	455-468	13	Buff and grey, finely crystalline limestone with traces of grey shale.
Thorold	468-478	10	Light grey, medium-grained sandstone.
Cabot Head and Manitoulin	478-500	22	Red shale, sandy at base.
	500-520	20	Green shale, little red shale and grey limestone.
	520-540	20	Greenish grey shale.
	540-565	25	Grey, crystalline dolomite with small amount of grey shale and dolomitic shale.
Whirlpool	565-575	10	Light grey, medium-grained sandstone.
Queenston	575-576	1	Red shale.

Haldimand County

Drilling covers practically all the southern two-thirds of the part of Walpole township within the present area. The greatest concentration of wells is on lots 1 to 6, concessions I to IV; lots 7 to 12, concessions IV and V; and lots 13 to 18, concessions V to VIII.

Elsewhere within the first ten concessions the wells are more or less scattered, with the most extensive non-drilled areas in lots 1 to 6, concessions VI to X, and lots 7 to 15, concessions I and II. About 35 per cent of the wells for which records are available were initially dry or non-commercial. The Clinton and Grimsby are the chief producing horizons, although many wells yield from both and in some cases the Clinton and Whirlpool yield to the same well.

Norfolk County

Woodhouse township contains what might be called a western extension of the Walpole township producing area, although a sparsely drilled region intervenes between Walpole and the most thickly drilled part of Woodhouse township. In Woodhouse, most of the wells are in the southwest part, embracing lots 3 to 12, concession I; lots 3 to 9, concession II; lots 2 to 6, concession III; lots 1 to 10, concession B.F.; and lot 1, Gore. In addition, more scattered drilling has been done on lots 11, 12, 18, and 19, concession V; lots 12, 13, and 20, concession VI; and lots 13, 14, and 15, concession I. Extensive non-drilled areas are present in the northwest and central part of the township. Of 128 wells for which records are available, 16 were dry. The Clinton is the chief producing horizon, but the Grimsby also produces and in about 20 per cent of the wells the yield is from both horizons. Producing depths range from 860 to 1,093 feet for the Clinton and 874 to 1,138 feet for the Grimsby horizon. The following log shows the detailed stratigraphy in this district:

Log of Isaac Hewett Well No. 1

Location: lot 11, concession V, Woodhouse township

Formation	Depth in feet	Thickness in feet	Lithology
Norfolk	55-120	65	Brownish grey, fine, magnesian limestone; grey chert; traces of sand at 55 and 90 feet.
Bertie-Akron	120-195	75	Brown and grey, fine dolomite
	195-205	10	Brown, fine dolomite; little dark, limy shale.
Salina	205-280	75	Dark grey and greenish, limy shale; some gypsum.
	280-380	100	Brown, fine dolomite; some dark shale traces of gypsum.
	380-420	40	Dark grey, limy shale; traces of anhydrite.
	420-480	60	Brown, fine dolomite; little grey shale.
	480-500	20	Dark grey, limy shale; traces of anhydrite.
	500-520	20	Brown, fine dolomite; little dark, limy shale.
Guelph	520-600	80	Grey, finely granular dolomite.
Lockport	600-780	180	Cream-coloured, finely crystalline dolomite; traces of selenite at 740 and 770 feet.
	780-800	20	Brown, fine dolomite.
	800-810	10	Grey, limy shale.
Rochester	810-840	30	Dark grey, limy shale; little brownish limestone.
	840-880	40	Dark grey shale.
Clinton	880-890	10	Grey, crystalline limestone.
Thorold	890-900	10	Light grey sandstone.
Grimsby	900-920	20	Grey and greenish sandstone; little red shale.
	920-950	30	Greenish grey shale; little reddish impure lime and grey sandstone.

Formation	Depth in feet	Thickness in feet	Lithology
Cabot Head and Manitoulin	950-965 965-970 970-1000	15 5 30	Greenish grey shale. Grey dolomite. Greenish grey shale; little grey dolomite at 995 to 1,000 feet.
Whirlpool	1,000-1,010	10	Grey, medium-grained sandstone.
Queenston	1,010-1,015	5	Red shale.

Middleton township contains three distinct areas where drilling has been more or less concentrated. The most easterly is continuous with small producing areas in northeast North Walsingham township, northwest Charlotteville township, and southwest Windham township. The most westerly extends a short distance into Bayham township, Elgin county, where it joins the Eden field. These areas are separated by more or less untested localities, but structurally the three areas seem to be parts of a single, narrow, east-trending area extending from Bayham township eastward to Windham township. Gas is found practically throughout this area, though dry holes occur at several places. Such a condition indicates that dry holes do not necessarily define the limits of a field and favours considering the intervening, untested areas as being potential. About 25 per cent of the wells for which records are available were either initially dry or non-commercial. The Clinton is the chief producing horizon, but a few wells yield from the Grimsby in Charlotteville and Middleton townships. Producing depths for the Clinton horizon range from about 1,035 to about 1,329 feet. The following log shows the detailed stratigraphy of this area:

Log of J. Holtby No. 2 Well

Location: lot 6, concession VIII, Bayham township

Formation	Depth in feet	Thickness in feet	Lithology
Norfolk	270-440	170	Grey, fine limestone; dark, bituminous streaks from 380 to 440 feet.
	440-540	100	Grey, fine limestone; much grey chert.
	540-560	20	Coarse, grey sand with much chert.
Bertie-Akron	560-610	50	Brownish grey, fine dolomite with dark, bituminous streaks.
Salina	610-650	40	Grey, limy shale and brown dolomite; some gypsum.
	650-950	300	No samples.
	950-970	20	Dark grey, limy shale, traces of anhydrite.
	970-1,010	40	Brown, fine dolomite; traces of gypsum.
Guelph Lockport	1,010-1,260	250	Grey, cream, and brownish coloured, finely granular dolomite; traces of selenite at 1,070 and 1,130 feet.
Rochester	1,260-1,300	40	Dark grey, limy shale
Clinton	1,300-1,320	20	Brownish grey, granular dolomite.
Cabot Head and	1,320-1,400	80	Grey, greenish, and red shale; little reddish limestone; bryozoa fragments at 1,350 feet.
Manitoulin	1,400-1,430	30	Grey, crystalline limestone; little grey shale.
Whirlpool	1,430-1,440	10	Greenish shale with some white sandstone.
Queenston	1,440-1,450	10	Red shale.

Drilling in South Walsingham township is in part concentrated on lots 8 to 17, concessions B and A; and on lots 16 and 17, concessions I and II. Gas is found throughout this district, although about 20 per cent of the wells for which records are available were initially dry or non-commercial. The Clinton is the main producing formation, but in a

few wells both Clinton and Grimsby are responsible for the yield.

Producing depths for the Clinton range from 1,272 to 1,370 feet.

The following log shows the detailed stratigraphy here:

Log of Dominion Natural Gas Company Well No. 1

Location: lot 9, concession B, South Walsingham township.

Formation	Depth in feet	Thickness in feet	Lithology
Norfolk	290-450	160	Cream-coloured, finely crystalline, magnesian limestone; little chert at 370 feet; dark, bituminous streaks at 360 and 450 feet.
	450-485	35	No samples.
	485-495	10	Chiefly chert; some coarse sand.
	495-530	35	Brownish grey, fine limestone; much chert; some coarse sand.
	530-535	5	Chert, little fine sand
	535-550	15	Grey, fine limestone; much chert; little coarse sand.
	550-565	15	Chert; some clear, angular quartz grains.
	565-585	20	Chert; little coarse sand at 570 feet.
Bertie-Akron	585-655	70	Buff and brown, fine dolomite.
Salina	655-740	85	Dark grey, limy shale; traces of gypsum.
	740-790	50	Brown, finely crystalline dolomite.
	790-850	60	Dark grey, limy shale; little brown dolomite; traces of gypsum.
	850-860	10	Brown, fine dolomite; minor amount of grey, limy shale.
	860-940	80	Dark grey, limy shale; traces of gypsum.
	940-970	30	Brown, fine dolomite.
	970-1020	50	Dark grey, limy shale.

Formation	Depth in feet	Thickness in feet	Lithology
Guelph	1,020-1,035	15	Grey, finely granular dolomite; traces of selenite at 1,035 feet.
Lockport	1,035-1,210	175	Grey and brownish, finely crystalline dolomite.
	1,210-1,230	20	No samples.
Rochester	1,230-1,275	45	Dark grey shale.
Clinton	1,275-1,300	25	Grey, finely crystalline dolomite.
Thorold	1,300-1,315	15	Grey, medium-grained sandstone.
Grimsby	1,315-1,360	45	Red and grey sandstone with minor amount of red and greenish shale.

Only a few wells have been drilled in Houghton township, and of the 17 wells for which records are available, 4 were dry. Production is from the Clinton at depths between 1,382 and 1,423 feet, and one well is reported to yield from the Whirlpool.

Elgin County

Bayham township contains four separate areas of concentrated drilling. At the extreme northwest part on lots 1 and 2, concessions IX and X, and lots 4, 5, and 6, concession X, there are about 19 wells forming an extension of the Brownsville "field" of Dereham township. All but one of these wells

obtained commercial production from the upper part of the Guelph dolomite at depths between 895 and 960 feet.

The second producing locality includes lots 22 to 28, concession VIII and constitutes the Eden "field", already referred to as a westward extension of the Middleton township producing area.

The third locality is in the west-central part of the township and includes only about ten wells, on lots 1 and 2, concession V, and lots 1 to 4, concession IV. Of these, only five were commercially productive and three were dry; data regarding the remaining wells is lacking. Yield is from the Clinton formation at depths between 1,263 and 1,398 feet.

The fourth locality is in the south-central part of the township and includes the old Vienna "field". Most of the wells are in lots 11 to 16, concession I, and lots 12 to 25, concessions II and III. Of about 63 wells in this area for which records are available, 13 were either initially dry or non-commercial. Production is mainly from the Clinton at depths between 1,304 and 1,415 feet, but several wells yield from the Grimsby horizon. The log of J. Holtby No. 2 well on lot 6, concession VIII, already given, illustrates the detailed stratigraphy in Bayham township.

The Malahide "field" was discovered by the Union Gas Company of Canada, Limited, late in 1938 and is still being developed. When last visited by the writer (September, 1939) 18

wells had been drilled or were drilling; most of these are concentrated on lots 15 to 24, concession V, and lots 8 to 10, concession IV. Of the 18 wells, 8 were commercially productive, 6 were dry holes, and 4 were drilling. Since that time the number of wells in this field has more than doubled. The producing horizon varies from 9 to 45 feet below the top of the Guelph formation, the drilling depths being between 1,060 and 1,083 feet. Sufficient data upon which to work out the structure is not at hand. However, using the top of the Guelph as determined from well samples, there appears to be a low anticlinal roll or elongate dome trending generally northeast, with its major axis extending at least from lot 15 to lot 23, concession V. This apparent structure is bounded on the northwest side by a line of dry holes situated within $\frac{3}{4}$ mile of the crest. No definite indication of the probable southeast limit is as yet known to the writer. The following log shows the detailed stratigraphy of this field.

Log of E. Brown No. 2 Well

Location: lot 21, concession V, Malahide township

Formation	Depth in feet	Thickness in feet	Lithology
Norfolk	295-407	112	Brown and cream-coloured, fine limestone; little chert at 335 and 379 feet
	407-484	77	Cream-coloured, fine limestone with dark, bituminous streaks.
	484-596	112	Light buff limestone; minor amount of chert throughout.
	596-624	28	Chert; small amount of grey sand.
	624-631	7	Cream-coloured, fine limestone; little chert.

Formation	Depth in feet	Thickness in feet	Lithology
Bertie-Akron	631- 684	53	Brown and grey, finely crystalline dolomite.
Salina	684- 700	16	Dark grey, limy shale.
	700- 722	22	Brown, fine dolomite; some dark, shaly limestone.
	722- 821	99	Dark grey, limy shale; small amount gypsum.
	821- 877	56	Brown, fine dolomite; traces of gypsum.
	877- 920	43	Dark grey, limy shale; traces of gypsum.
	920- 941	21	Brown, fine dolomite; little dark, limy shale; traces of gypsum.
	941- 993	52	Dark grey, limy shale; minor amount gypsum.
	993-1,018	25	Brown, fine dolomite; traces of gypsum.
	1,018-1,050	32	Dark grey, limy shale.
	1,050-1,068	18	Brown, fine dolomite; traces of gypsum.
Guelph	1,068-1,199	131	Grey and brown, crystalline dolomite.
Lockport	1,199-1,300	101	Buff and cream-coloured, crystalline dolomite.
	1,300-1,354	54	Brown and grey, finely cyrstalline dolomite.
Rochester	1,354-1,403	49	Dark grey shale, limy in the upper part.
Clinton	1,403-1,428	25	Grey and buff limestone.
Cabot Head and Manitoulin	1,428-1,503	75	Grey shale; small amount of grey, crystalline limestone.
	1,503-1,525	22	Grey, crystalline limestone; little grey shale.
Whirlpool	1,525		Traces of grey sandstone.

Oxford County

Most of the Brownsville field is in the southwest part of Dereham township, but the "field" extends southward into Bayham township. It was discovered in 1935. The general area embraces lots 21 to 27, cons. XI and XII, Dereham tp., as well

as lots 1 and 2, cons. IX and X, and lots 4 to 6, con. X, Bayham tp.

Of the 83 wells in this field for which records are available, 72 came in with commercial production and 6 were dry holes; information regarding the remaining wells is lacking. The producing horizon varies from 5 to 61 feet below the top of the Guelph formation and is reached at depths between 895 and 960 feet. The thickness of the producing zone is about 18 feet in one well and about 6 feet in some others. Several producing wells have been added to this field since 1938.

Lack of sufficient well samples and difficulty in recognizing the Salina-Guelph contact in drillers' logs rendered an attempt to contour the top of the Guelph unsuccessful. In discussing the structure of this field, Evans[1] states that

---

[1]Evans, C.S.: Ont. Dept. of Mines, vol. 46, pt. 5, 1937, p.100.

"the water data indicate that the structure of the Brownsville field is only a minor modification of the regional dip, since the sulphur water from the Detroit River series rises in all wells to or near the surface. Moreover, in one well, Preston, No. 1, a sulphur water struck in the Guelph at 968 feet below the surface rises to the top of the well".

The following log shows the stratigraphy of this field:

Log of R. W. Hawkins No. 1 Well

Location: lot 22, concession XI, Dereham township

Formation	Depth in feet	Thickness in feet	Lithology
Norfolk	175-355	180	Cream-coloured and brownish grey, finely crystalline limestone. Protosalvinia at 175 feet; Bryozoa at 195 feet; traces of selenite at 210 feet; dark, bituminous streaks at 350 and 355 feet.
	355-485	130	Brownish grey, fine limestone; little chert throughout; sand at 480 and 485 feet.
	485-500	15	Chert; little grey limestone and some sand.
Bertie-Akron	500-585	85	Brown, finely crystalline dolomite; some grey shale in lower 15 feet.
Salina	585-600	15	Brownish grey, fine dolomite; traces of anhydrite.
	600-655	55	Greenish grey, limy shale; traces of anhydrite.
	655-680	25	Dark grey, limy shale; much anhydrite.
	680-715	35	Brown, fine dolomite; little anhydrite.
	715-725	10	Dark grey, limy shale; traces of anhydrite.
	725-790	65	Brownish grey, fine dolomite; traces of anhydrite.
	790-840	50	Dark grey, limy shale; little anhydrite.
	840-865	25	Alternation of grey shale and brown dolomite; traces of anhydrite.
	865-915	50	Brown, fine dolomite; little grey shale.
	915-930	15	Grey, limy shale; much anhydrite.
	930-975	45	Brown, fine dolomite; shale at 945 feet.
Guelph	975-1,040	65	Grey and brownish, finely granular dolomite.
Lockport	1,040-1,195	155	Brownish grey, crystalline dolomite.
Rochester	1,195-1,240	45	Dark grey shale; little grey limestone at 1,215 and 1,235 feet.

Formation	Depth in feet	Thickness in feet	Lithology
Clinton	1,240-1,260	20	Grey, crystalline limestone.
Cabot Head and	1,260-1,295	35	Greenish grey shale; little grey and red, impure limestone.
	1,295-1,335	40	Grey and green shale; little grey limestone.
Manitoulin	1,335-1,350	15	Grey, crystalline limestone.
Whirlpool	1,350-1,360	10	Grey shale; some light grey sandstone.
Queenstone	1,360-1,365	5	Red shale.

RESERVOIR ROCKS

The main reservoir rocks are the sandstones of the Thorold, Grimsby, and Whirlpool, and limestones of the Clinton and Guelph formations.

The Whirlpool sandstone is composed chiefly of fine to medium, subangular quartz grains that for the most part are secondarily enlarged. The porosity is primary and has been estimated at about 10 per cent.

The Grimsby consists of red and grey, medium-grained sandstone with shaly zones and lenticular masses of sandstone enclosed by shale or sandy shale. The porosity is primary and probably more or less discontinuous, as evidenced by the irregularity in production from this horizon.

The Thorold is a quartz sandstone of rounded, subangular, and even angular, grains with an average diameter of 0.1 mm. Argillaceous materials form about 20 per cent[1] and include chlorite,

[1] Alling, H.L.: Proc. Rochester Acad. Sci., vol. 7, No. 7, 1936, p. 196.

muscovite, and rusty biotite.

The Guelph is a dolomite fairly uniform in both physical and chemical characters. The percentage porosity and its origin are speculative. The primary effective porosity is in all probability low. The effective porosity is probably secondary and due to solution and leaching. Porosity may not be confined to the present producing part of the Guelph. The gas obtained from the Guelph may have its source in the bituminous Eramosa and lower Guelph beds, and possibly its upward migration may have been arrested by the less pervious overlying Salina beds. If such is the case, all the rocks through which the gas passed on its way to the present place of accumulation must also be porous.

ACCUMULATION

Structure resulting from diastrophic causes does not appear to be the principal factor controlling the accumulation of natural gas in the Brantford area and, therefore, it might be thought that the chances of obtaining some gas are equally good throughout the area.

The Grimsby does not outcrop in the Brantford area, but where it does, as in the Niagara gorge and elsewhere, it holds lenticular masses of sandstone completely enclosed in argillaceous sandstone or shale. Such lenses could act as traps to migrating gas and even if the voids in the sandstone did not amount to more than 10 per cent the largest lenses might easily account for wells affording considerable production.

In the case of the Thorold sandstone it was found by Stewart[1] that the most highly productive wells are located where the sandstone is purest, whereas in the dry holes and small producers it is highly dolomitic.

[1] Stewart, J.S. : Personal communication

Very little is known regarding the conditions giving rise to accumulations in the Whirlpool, but differential cementation probably plays a leading part.

The Clinton is known to contain reefs of considerable size in other areas. It is suggested that reefs, if present in the Brantford area, may arrest migration and so play some part in causing accumulation. The widespread production from this horizon, however, suggests that other and more important causes of accumulation are operative.

In the Guelph formation, gas in commercial quantities has, so far, been found only in the upper 60 feet or so, and the overlying Salina is a less pervious formation. It may be, therefore, that suitable porosity at the top of the Guelph, together with resistance offered to further migration by the Salina, may account for the accumulation.

It is the writer's belief that porosity, differential cementation, and stratigraphic form, combined with gentle anticlinal rolls and local flattenings of the regional structure, account for the gas fields so far discovered in the Brantford area. If these conclusions are valid, it follows that much of the untest-

ed country that in the southern part of the Brantford area intervenes between producing areas may properly be considered worth testing.

PRODUCTION

The total production[1] from the Brantford area in 1938 (exclusive of the yield from Walpole township, for which figures are not available) was 1,243,788 M. cubic feet. Of this volume, Brant county produced 135,348 M. cubic feet; Norfolk county 437,867 M. cubic feet; Elgin county (Bayham township) 113,651 M. cubic feet; and Oxford county (Brownsville field)[2] 556,922 M. cubic feet.

[1] Harkness, R.B. : Ont. Dept. Mines, vol. 48, pt. 5, 1939, p.2

[2] Dereham tp., 506,005 M. cu. ft.; Bayham tp., 50,917 M. cu. ft.

OTHER AREAS

That part of Brantford area north of the area illustrated by the accompanying map has so far failed to yield natural gas or oil in commercial quantity.

In this northern region, the Silurian stratigraphy shows some changes from that of the producing region. The dominantly arenaceous Grimsby and Thorold are replaced by the argillaceous Cabot Head beds. The Clinton is not known to be present north of the latitude of Kitchener, and the Whirlpool, although it persists along the east boundary of the area, is represented only by traces of sand in wells from East Nissouri, North Oxford, and Minto townships, and is not recognized at all in North Easthope town-

ship. Thus, of the Silurian producing horizons in the south, only the Guelph presents any prospects of production in the northern region, and for more than half of this region these prospects do not seem bright. The Guelph outcrops at many localities; sections ranging from a few feet to over 80 feet have been seen. It is highly probable that where Guelph forms the youngest bedrock, any gas it may have contained would long since have been dissipated. However, where the Guelph is buried beneath younger rocks, as for example in the western half of the region, upward migration of any gas in them may have been arrested by the overlying Salina. Possibly the gas would migrate up the dip and be lost at the outcrop except in so far as presence of favourable structures or variations in degree of porosity might arrest and trap some of this gas.

The prospects of obtaining production from the Ordovician rocks of this northern part of Brantford area do not seem very good, but the absence of gas in commercial quantity has not been proved. The detailed lithology of the Ordovician formations is illuatrated by the following log:

Log of Rockwood Oil Company Well

Location: lot 6, concession IV, Eramora township

Formation	Depth in feet	Thickness in feet	Lithology
	0-180	180	No samples
Lockport	180-210	30	Light bluish grey, coarsely crystalline dolomite.
	210-220	10	Grey, crystalline dolomite with much pyrite
Cabot Head	220-260	40	Red and greenish grey shale with some red and grey, limy shale.

Formation	Depth in feet	Thickness in feet	Lithology
Manitoulin	260-280	20	Grey, crystalline dolomite with little greenish grey shale.
Whirlpool	280-300	20	Light grey to white, medium-grained sandstone.
Queenston	300-740	440	Red shale
Meaford	740-880	140	Grey and greenish grey shale with frequent grey, crystalline limestone bands.
	880-950	70	No samples
Dundas	950-1,380	430	Grey shale with occasional, thin, limestone bands.
Billings	1,380-1,420	40	Dark grey shale.
	1,420-1,510	90	Dark grey to black, bituminous shale.
	1,510-1,720	210	Grey and brown, crystalline limestone with occasional, dark, shale partings.
Trenton and older Palaeozoic limestones	1,720-1,790	70	Grey, limy shale with minor amounts of grey, crystalline limestone, greenish, limy shale, and light grey, flaky "Kaolinite".
	1,790-1,890	100	Grey, shaly limestone with small amount of greenish and grey shale.
	1,890-1,930	40	Grey, finely crystalline limestone.
	1,930-1,970	40	Grey, limy shale.
	1,970-2,000	30	Grey, shaly limestone.
	2,000-2,060	60	Brownish grey, finely crystalline limestone, with cream-coloured, dense, limestone at 2,030 and 2,060 feet
	2,060-2,140	80	Brownish, finely crystalline limestone
Basal beds	2,140-2,170	30	Greenish, fine-grained sandstone with minor amount of grey limestone and shale.
Precambrian	2,170-2,180	10	

The occasional limestone beds of the Meaford and Dundas might function as reservoirs under favourable conditions of structure and porosity. The Trenton is the most favourable formation; like most limestones, however, its value as a reservoir rock depends greatly on the presence of secondary porosity. This is usually developed by the leaching action of circulating ground water, and hence presupposes a period of erosion. The top of the Trenton is an erosion surface in the Manitoulin Islands and Georgain Bay districts, but Sproule[1] states that in the southern of the two districts the period of erosion was much shorter. Possibly still farther south in Brantford area there may have been no erosion interval and porosity may be lacking.

[1] Sproule, J.C.: Geol. Surv., Canada, Mem. 202, 1936, p. 99.

Reliable data are too meagre and scattered to indicate whether favouring structures are present in the Ordovician beds. The strata as a whole have a gentle dip toward the southwest.

Widely spaced drilling has penetrated the Ordovician rocks in Perth, Oxford, and Wellington counties with no encouraging results.

A well on lot 3, con. VIII, North Easthope tp., was drilled to the Precambrian in 1937, but neither oil nor gas was encountered.

In 1909, a deep well was sunk in North Oxford township near

Beachville. It penetrated the Trenton to a depth of 530 feet, but is reported to have encountered neither oil nor gas.

On the south half of lot 7, con. IV, Puslinch tp., a well was drilled to a depth of 2,670 feet. An estimated flow of 20,000 cubic feet of gas was obtained in limestone at a depth of 2,326 feet. In 1933 a second well on the same lot reached a depth of 2,531 feet, entering the Precambrian at 2,360 feet. A show of gas was struck at 2,357 feet in, according to the driller's log, the basal beds of the Ordovician.

In 1900 a well was drilled on lot 6, con. V, Pilkington tp., and furnished sufficient gas for two stoves. The gas was reported to come from a depth of 2,335 feet, or about 645 feet below the top of the Trenton. In the same year, a well on lot 5, con. III, Peel tp., reached a depth of 2,573 feet. It entered the Precambrian at 2,526 feet. A small flow of gas was struck at 2,506 feet, some 688 feet below the top of the Trenton.

In 1919 a well was drilled on lot 6, con. IV, Eramosa tp., to a depth of 2,180 feet. It reached the Precambrian at 2,170 feet. A show of gas was reported, but the exact horizon is not known.