



O I L A N D G A S O C C U R R E N C E
I N
G R A T I O T C O U N T Y , M I C H I G A N

A thesis submitted to the Faculty of the
University of Michigan in partial fulfillment for the
requirements of the degree of Master of Science.

by...D. N. Rockwood.

T A B L E O F C O N T E N T S

	Page No.
Table of Contents-----	A.
List of Illustrations-----	B.
Introduction-----	1.
Structure-----	2.
Stratigraphy	
General Description of Formations-----	4.
Examination of Well Cuttings-----	13.
Description of Fields	
The Ashley Gas Pool-----	20.
The New Haven Gas Pool-----	24.
Cross Sections-----	34.
Conclusion-----	36.
References-----	38.

L I S T O F I L L U S T R A T I O N S

Fig. No.	Page No.
1-----Paleozoic Formations-----	5.
2-----Subsurface Contour Map on Top of Parma Sand, Elba township-----	22.
3-----Subsurface Contour Map on Top of Napoleon-----	23-A.
4-----Subsurface Contour Map on Top of Dundee-----	24-B.
5-----N.-S. Cross Section Showing Napoleon Tops-----	30.
6-----E.-W. Cross Section Showing Napoleon Tops-----	31.
7-----N.-S. Cross Section Showing Dundee Tops-----	32.
8-----E.-W. Cross Section Showing Dundee Tops-----	33.
9-----Producing Wells In New Haven township-----	26.
10-----Producing Wells in Sumner township-----	27.

I N T R O D U C T I O N

The purpose of this paper is to describe briefly the structure and stratigraphy of Gratiot County, Michigan in relation to oil occurrence, and to assist in directing possible future development in this county.

Located in central Michigan just south of the town of Mount Pleasant, Gratiot County is closely associated with the major producing structural trends in that portion of the state. Since 1927 when the Sun Oil Company brought in the relatively unimportant Ashley Gas Pool in Elba township in the southeast corner of the county, approximately 140 wells have been drilled. The majority of these were unsuccessful, but the development of the valuable New Haven Gas Pool may suggest other worthwhile accumulation yet unfound.

S T R U C T U R E

Most of the production in central Michigan is found either along or in association with a series of northwest-southeast trending structural highs. Extensions of three of these features have been found in Gratiot County.

The Greendale high passes through the extreme northeast corner of the county in Wheeler township. Commercial development in the adjacent Jasper and Porter townships to the north, centers interest in the continuation of this structure in Gratiot County.

The Broomfield high, which extends through the heart of the Mount Pleasant producing area has a poorly defined southeasterly extension into Gratiot County, described by Newcombe (1) as the "Alma high". This structure runs directly through the county from Seville and Pine River townships in the northwest to Elba township in the southeast. It was in association with this feature that the Ashley Gas Pool was discovered in Elba township in 1927.

The Austin-Montcalm high extends northwest from the western border of the county and lies partially in the townships of New Haven, North Shade and Sumner. The comm-

Page 3.

ercially important Crystal Oil and Gas Pool is located in adjacent Ferris and Crystal townships in Montcalm County. During the past two years the New Haven Gas Pool has been developed successfully in northern New Haven and southern Sumner townships.

S T R A T I G R A P H Y

Drilling operations in Gratiot County up to the present time have rarely been carried deeper than the Dundee Limestone. A few scattered wells are reported bottomed in the Detroit River Series and one well has supposedly penetrated the Sylvania formation. The validity of these observations has not been checked.

The Sylvania rocks in central Michigan, according to Newcombe (2), consist of fine grained sandstones and buff sandy and cherty dolomites with the upper portion of the formation generally containing a heavy brine. The sandstones are a characteristic pure white quartz sand. Frequently the formation is separated into two or more massive sandstones by layers of siliceous dolomite.

The Detroit River Series is abnormally thick (see Fig. 1, Page 5) which seems to indicate that the Sylvania may have been designated falsely in the log of one the wells (drilled under State Permit # 2034 in Sec. 27 of Bethany township). In general the Series consists of brownish and buff dolomites with anhydrite and salt layers. The formation may be porous near the top with water generally being found if such is the case.

PALEOZOIC FORMATIONS--GRATIOT COUNTY, MICHIGAN

SYSTEM	SERIES	FORMATION	OR GROUP	THICKNESS	
PERMO- (?) CARBONIFEROUS		"RED BEDS"		0'-180'	
			WOODVILLE(Ionia)		
PENNSYLVANIAN	POTTSVILLE	SAGINAW		0'-500'	
		PARMA		0'-220'	
MISSISSIPPIAN	CHESTERIAN	GRAND RAPIDS	BAYPORT	0'-100'	
	MERAMECIAN		MICHIGAN	0'-550'	
	OSAGIAN	MARSHALL	NAPOLEON	150'-560'	
			Lo. MARSHALL	150'-560'	
	KINDERHOOKIAN or CHATTANOOGAN		COLDWATER		600'-1100'
			SUNBURY		0'-100'
			BEREA		0'-270'
			BEDFORD	ELLSWORTH	400'-600'
			ANTRIM	(UPPER PART)	140'-460'
	DEVONIAN	SENECAN	ANTRIM	(LOWER PART)	140'-460'
ERIAN		TRAVERSE	THUNDER BAY	60'-800'	
			ALPENA		
			LONG LAKE		
			ROCK PORT		
				BELL	0'-80'
ULSTERIAN			DUNDEE		0'-300'
			MACHINAC		
ORISKANIAN			ORISKANY (?)		0'-5'
HELDERBERGIAN			DETROIT RIVER	LUCAS	0'-1060'
	AMHERSTBURG				
	ANDERDON				
	FLAT ROCK				
		SYLVANIA		0'-300'	

This chart was copied from a portion of a similar chart used by Newcombe in his "Geology of Michigan".

The Dundee Limestone beds in Gratiot County are buff to gray in color and are frequently cherty or fossiliferous. A porous layer is struck about twenty-five feet below the top of the Dundee and continues about thirty feet further into the formation. From that depth on it becomes more dense and compact. With the exception of this first porous zone, water is not known, even on the highest parts of structures, until at least ninety-five feet of the limestone has been penetrated.

The productive portion of the Dundee does not extend more than sixty-five feet below its top - the lower limit of the first porous zone - and consequently drilling operations are stopped at about that point as a rule. The thickness of the Dundee, therefore, is not known accurately as few wells have been drilled through the formation.

The Traverse Group consists of gray to bluish colored shales and gray, buff and brown limestones. It averages between five hundred and six hundred feet in thickness. Basal beds of the overlying Antrim Shale may be transitional with the upper gray shales of the Traverse, but the predominant brown and black color of the former as contrasted with the gray of the latter make for a comparatively sharp contact. The lower limit of the Traverse is marked by a series of sixty feet of shale which is correlated with the Bell Shale.

The beds in this group become progressively blacker in color and serve as an indicator of the nearness of the top of the Dundee formation.

A porous zone occurs about one hundred and twenty feet below the top of the Traverse and may contain oil, gas or water. No commercial production of importance has been found in this horizon within the county, but shows of oil and gas have been encountered in several of the wells. It is estimated that the porous zone is probably near the top of the Alpena Limestone member.

The Antrim Shale at the top of the Devonian is largely brown or black in color, exceeding four hundred feet in thickness and containing abundant pyrite. A series of brownish and gray limy beds occur about sixty to eighty feet above the base of the Antrim and constitute an excellent and easily recognizable marker. In some places they are partly concretionary and in general average about twenty-five feet in thickness.

The Bedford Shale and the Berea formation, generally included together as Berea in the well logs, are from thirty to eighty feet thick and are composed of sandy and shaly material. In certain portions of the eastern part of central Michigan, where the Berea is better developed as a thicker sandstone, oil and gas are found. Up to the present time, however, no commercial production has been found in the Berea in Gratiot County. Drillers frequently indicate it on their logs as the "Berea Grit".

The next youngest formation in the stratigraphic section is the Sunbury brown shale which usually can be recognized in the well cuttings, although drillers encounter difficulties in doing so when the samples are wet. The shale contains pyrite and will break up under the drill in the form of large chip-like fragments. It averages twenty feet from top to bottom and is seldom less than ten feet or more than fifty feet thick. The Sunbury is important as an indicator of the base of the overlying Coldwater shale section.

The Coldwater consists of gray, blue and pink shales with some red sand layers and ranges in thickness from nine hundred to over a thousand feet. Frequently a series of dark beds near its top serves as a marker definitely indicating that the drill has passed from the Lower Marshall into the Coldwater formation.

The Lower Marshall contains several beds of pinkish to red sandstones and red shales with the total thickness aggregating from fifty to two hundred feet. The red color is darker than that found in the overlying Napoleon and the formation has a finer texture. It tends to be micaceous, silty and shaly, and is more sharply differentiated from the Napoleon Sandstone than from the underlying Coldwater.

The Napoleon formation generally consists of white, gray or yellow sandstones with a few thin interbedded streaks of lime or gray shale partings. A greenish colored material, frequently

found in the sandstones, is attributed to the presence of glauconite. The formation may be shaly in the vicinity of structurally high areas.

Occasionally the existence of red beds is noted in the Napoleon. The red color is undoubtedly caused by the reworking of the Lower Marshall beds and possibly by some material from the Coldwater formation. The color is rather pinkish and is found to a great extent in the cementing material. It may be carried away when the cuttings are washed causing the color to fade.

North of Gratiot County the Napoleon Sandstone is the principle horizon from which the Dow Chemical Company obtains heavy brine for the extraction of minerals. In Bethany township in the north of the county this company has located five brine wells.

In general the Napoleon Sandstone appears to range between sixty and one hundred feet in thickness, but it is quite variable through out the county. It is difficult in some wells to distinguish the contact between the Napoleon and the next younger series, the Michigan Sands. The author was unable to recognize any important break between the two formations, and in this respect agrees with E. W. Hard (3) who recently has completed a study of the Michigan "Stray" Sand.

It previously was thought that an important unconformity existing at the top of the Napoleon had caused both local and regional differences in these formations in central Michigan. Observations in Gratiot County, however, fail to reveal distinguishing

characteristics which could serve as indicators of a sharp contact.

The Michigan Series is characterized by gray and black shales, dolomitic bituminous limestones, some gypsum and anhydrite, and by a series of lenticular sand beds. Individual beds can not be traced, except for short distances, with any degree of accuracy.

A rather persistent sand or series of sands ranging from a few feet to thirty or forty feet in thickness is found near the base of the formation. The individual sand layers often are separated by gray shale partings or layers, and the Series on the whole is similar to the underlying Napoleon Sandstone. It is from these sands that the gas production is obtained in central Michigan.

The presence of the reworked Napoleon material in the Michigan sands makes it difficult to recognize the dividing line between the two formations. Frequently drillers place all gas-bearing sands in the Michigan Series, and then in adjacent wells at the same general horizon the sand will be classified as Napoleon when gas is not found.

Generally a brown dolomite or brown bituminous limestone bed, which is quite persistent in the structurally high areas and easily recognizable, may be found just above the sands at the base of the Michigan Series. Despite this fact it is hard to establish the contact between the Michigan and the Napoleon

from observations of well logs unless the wells in question have been drilled completely through the Napoleon and an accurate and complete record has been kept.

The Bayport Limestone, when present at the top of the Mississippian, is gray to buff in color and is usually sandy and impure in its upper part. It ranges from twelve to over one hundred feet in thickness and locally has been removed by pre-Pennsylvanian erosion.

The Parma sandstone is found at depths of five hundred to eight hundred feet, but is not recognized in all wells despite its unusual physical characteristics. It is a typically milky to clear white sandstone formation bearing water, and usually constitutes the first important water horizon to be penetrated after the drilling has reached bed rock. The difficulty in recognition of the Parma sandstone is the frequent occurrence of reworked and limy Bayport material. The Parma was laid down on the uneven erosional surface of the Grand Rapids group and varies in thickness from around twenty feet to about one hundred feet. Although it may rest on either shale or sandstone it is more commonly found on top of the Bayport Limestone.

The thickness of the Saginaw formation, which overlies the Parma sandstone, is dependent on pre-glacial topography and is thinner over the regional and local structures. Individual beds vary considerably in lithology and are usually hard to correlate over any distance through a study of well log records unless the wells are closely spaced. Occasionally certain dark colored

shales, coal beds, and sandstone members can be traced in this way for some distance. The Saginaw and Parma formations are referred to as the Pottsville Series and together have a thickness between three hundred and six hundred feet.

Above the Saginaw are found the "Red Beds", which are classified as Permo-Carboniferous and frequently are not reported in well logs. This fact does not imply their absence from the stratigraphic section in any particular locality. They may be quite thin and the drillers are apt to log them with the drift deposits, particularly since reworked material from the "Red Beds" is found in the basal Pleistocene clays. The upper portion of the stratigraphic section in the majority of well logs is extremely inaccurate and incomplete. Several hundred feet of sediment may be left undesignated by the non-committal statement of "No Record".

There are no outcrops of bed rock in Gratiot County and the surface features are limited to glacial drift. Thus it is necessary for geologists to obtain a knowledge of the stratigraphy by studying drillers' logs and examining well cuttings. Although wells have been put down in each of the sixteen townships, the records are either inaccurate or unintelligible in part with the drilling operations being too scattered to prove of great assistance in a complete study of the stratigraphy. For this reason future developments in Gratiot County may reveal that existing opinions of the formations and their characteristics need revision.

RESULTS OF EXAMINATION
OF WELL CUTTINGS

A set of well cuttings was examined under the binocular microscope in an effort to familiarize the author with the lithologic characteristics of the rocks penetrated by the drill in Gratiot County. It was hoped that a discovery of the existence of distinctive horizons or layers which would be of assistance in recognizing formations in drilling and in correlation of formations from one well to another might be made.

The samples examined came from the S. P. McConkey #1 well of the Carter Oil Company drilled under state permit # 3589 in Emerson Township in Gratiot County. The well, which was dry, is located in the northwest quarter of the northeast quarter of the northwest quarter of Section 23 in this township.

The author gratefully acknowledges the kindness of the Geological Survey of the State of Michigan in furnishing these well cuttings for examination.

The samples included a more or less complete section extending from the upper portion of the Saginaw formation of the Pennsylvanian into the upper portion of the Dundee Limestone of the Devonian.

The descriptions of the samples examined are as follows;

PENNSYLVANIAN:

- Saginaw: 345'-365'---Sand, both milky and clear, some yellow and greenish grains; few gray shale fragments.
- 365'-385'---Sand, both milky and clear, some yellow, orange and green grains; gray shale.
- 385'-421'---Clay and mud, gray; black shale.
- 421'-480'---Sand, milky to clear white, yellow and light green grains; dark gray shale.
- 480'-525'---Sand, white, limonite stains; pyrite; light green sand; gray shale.
- 525'-530'---Shale, thin dark brown; clay; sand, brown.
- 530'-535'---Shale, dark gray; sand, white; pyrite.
- 535'-542'---Shale, dark gray, fine, clayey.
- 542'-557'---Limestone, white; pyrite; shale, black.
- 557'-580'---Limestone, light gray; shale, black; pyrite in large amounts.
- Parma: 580'-590'---Sand, white, yellow, limonite-stained, green fragments; pyrite.
- 590'-600'---Sand, white and yellow; shale, gray; limestone, light gray.
- 600'-610'---Sand, white, yellow, green; shale, gray; limestone, gray; pyrite.
- 610'-650'---Sand, white, limonite-stained; shale, brown, black; limestone.

MISSISSIPPIAN:

- Michigan: 681'-700'---Limestone, light gray; shale, black; clay; little pyrite.
- 700'-720'---Limestone, light gray; shale, brown, black.

MISSISSIPPIAN (cont.)

- Michigan: 720'-736'---Sand, white, limonite-stained; limestone,
(cont.) light gray; shale, dark gray, black.
- 736'-750'---Limestone, light gray and green; shale,
dark gray.
- 750'-765'---Gypsum, white; shale, dark gray; sand,
light brown.
- 765'-771'---Shale, dark gray; dolomite, dark; py-
rite; gypsum, light.
- 771'-776'---Gypsum, gray in large amounts; lime-
stone, gray.
- 776'-794'---Limestone, dark gray; gypsum.
- 794'-798'---Sand, white; limestone, dark gray; py-
rite; gypsum; limonite.
- 798'-830'---Gypsum, light colored and large amounts;
limestone, gray; shale, black frag-
ments.
- 830'-875'---No Record.
- 875'-889'---Shale and Limestone, dark and gray.
- 889'-894'---Shale, black; gypsum, small amounts.
- 894'-911'---Limestone, gray, black, somewhat shaly;
gypsum.
- 911'-917'---Shale, dark and light gray.
- 917'-928'---Limestone, light mottled gray, somewhat
crystalline; gypsum; sand, yellow
and white.
- 928'-933'---Shale, gray; gypsum.
- 933'-940'---Sandstone, fine grayl shale, gray.
- 940'-946'---Shale, black; limestone, crystalline.
- 946'-954'---Sand, white, fine; shale, black; lime-
stone, fine gray.

MISSISSIPPIAN (cont.)

- Michigan: 954'-959'---Sand, white; limestone, gray; dolomite,
(cont.) brown.
- 959'-982'---Sand, coarse white, pinish, some yellow;
limestone, brown fragments.
- 982'-985'---Sand, pinkish hues, dull red, white;
shale, black.
- Napoleon: 985'-997'---Sand, pink, white, yellow; shale, black.
- 997'-1011'---Sand, white, pink, yellow; shale, black.
- 1011'-1022'---Sand, white, yellow; shale, black, fine.
- 1022'-1030'---No Record.
- 1030'-1044'---Sand, white, yellow, green; garnet; py-
rite; shale particles.
- 1044'-1078'---Sand, pink, white, yellow, green.
- 1078'-1110'---Sand, white, pale pink, yellow, greenish,
garnet.
- Lo. Marshall: 1110'-1130'---Sand, white, darker pink, yellowish.
- 1130'-1153'---Sand, medium angular pale pink, fine
angular red crystalline; mica;
shale, black fragments.
- 1153'-1200'---Sand, fine angular reddish, yellow;
limonite; mica; shale, gray.
- Coldwater: 1200'-1205'---Shale, sugary dark gray.
- 1205'-1209'---Shale, calcareous gray.
- 1209'-1220'---Sand, fine yellowish brown; mica; lim-
onite; shale; limestone.
- 1220'-1225'---Sand, dull pink, white, green; mica;
limestone and shale, gray.

MISSISSIPPIAN (cont.)

- Coldwater: 1225'-1227'---Limestone, fine gray.
(cont.)
- 1227'-1242'---Sand, fine pinkish, yellow, white;
mica; limestone, gray; limonite.
- 1242'-1281'---Shale, gray; limestone, calcareous
gray; sand, brown; limonite.
- 1281'-1296'---Sand, gray; shale, gray.
- 1296'-1355'---Shale, gray and sandy.
- 1355'-1365'---Shale, darker and more arenaceous.
- 1365'-1476'---Shale, gray and sandy.
- 1476'-1620'---Shale, gray and sandy with more sand
appearing in the shale.
- 1620'-1668'---Shale, gray and sandy, slightly cal-
careous.
- 1668'-1690'---Shale, gray and sandy, non-calcareous.
- 1690'-1774'---Shale, gray and sandy, slightly cal-
careous.
- 1774'-1988'---Shale, gray and sandy, slightly cal-
careous at intervals.
- 1988'-2012'---Shale, somewhat gray and sandy.
- 2012'-2070'---Shale, gray and less sandy with in-
creasing calcareousness.
- 2070'-2179'---Shale, gray, less sandy, more calcar-
eous.
- 2179'-2190'---Shale, gray, less sandy, more calcar-
eous; limestone, gray.
- 2190'-2224'---Shale and limestone, gray and black.
- Sunbury: 2224'-2230'---Limestone, white, light gray; Shale,
black.

MISSISSIPPIAN (cont.)

Sunbury: 2230'-2251'---Limestone, white, gray; shale, gray.
(cont.) 2251'-2286'---Limestone, white, gray; shale in considerable amount, gray.

Berea: 2286'-2291'---Sand, white, gray; limestone, gray; shale, dark gray and black.
2291'-2297'---Shale, gray; limestone, gray; sand.
2297'-2303'---Shale, gray; sand, gray.

Antrim: 2310'-2441'---Shale, black.
2441'-2495'---Shale, dark gray, calcareous; limestone, gray in small amounts.
2495'-2615'---Shale, black with limey layers; limestone, brown.

-----DEVONIAN:

2615'-2647'---Shale, dark gray, calcareous, limestone, gray to black.
2647'-2680'---Shale, gray and black; limestone, white to gray; pyrite.

Traverse: 2680'-2700'---Limestone, gray and brown; shale, dark gray and black; pyrite.
2700'-2782'---Limestone, bluish gray, light brown, limonite stains.
2782'-2923'---Limestone, buff and gray; limonite.
2923'-2948'---Limestone, buff, fine calcite particles with cleavage clearly noted.
2948'-3020'---Limestone, gray and buff; few shaly partings and fragments.
3020'-3025'---Shale, dark gray, calcareous; limestone, fine light fragments.

DEVONIAN (cont.)

- Traverse: 3025'-3047'---No Record.
(cont.)
- 3047'-3055'---Limestone, fine white and gray.
- 3055'-3075'---Clay, light calcareous; limestone,
light gray or blue.
- Dundee: 3075'-3122'---Limestone, dark gray, considerable
massive black fragments, a few
white particles; pyrite; limon-
ite; shaly partings.
- 3122'-3195'---Limestone, dark gray, some brown;
limonite; shale, dark colored
in small amounts.
- 3195'-3200'---Limestone, fine black, white.
- 3200'-3213'---Limestone, fine particled; gray, tan
and white; limestone of a shaly
character; considerable limonite;
pyrite; shale, black fragments.
- 3213'-3244'---Limestone, fine grained sandy appear-
ance, gray and shaly; limonite.
- 3244'-3260'---Limestone, fine particled, sandy, gray,
limonite particles.

TOTAL DEPTH OF HOLE:

D E S C R I P T I O N O F F I E L D S

T H E A S H L E Y G A S P O O L

The Ashley Gas Pool is located slightly over a mile to the southeast of the town of Ashley in Elba township in the southeast corner of Gratiot County. It occurs along the top of the Alma high, a structure first named by Newcombe (4), which trends across the township in a northwest-southeast direction.

Production was discovered and initiated in 1927 by the Sun Oil Company, and since that date four other wells have produced gas. The gas is obtained from the Parma Sand, a comparatively shallow horizon at the base of the Pennsylvanian.

The total production never has been large and, in spite of efforts to extend the proven area, the producing property is restricted to a narrow strip running north and south across the top of the structure and measuring about one mile and a quarter in length and a quarter of a mile in width.

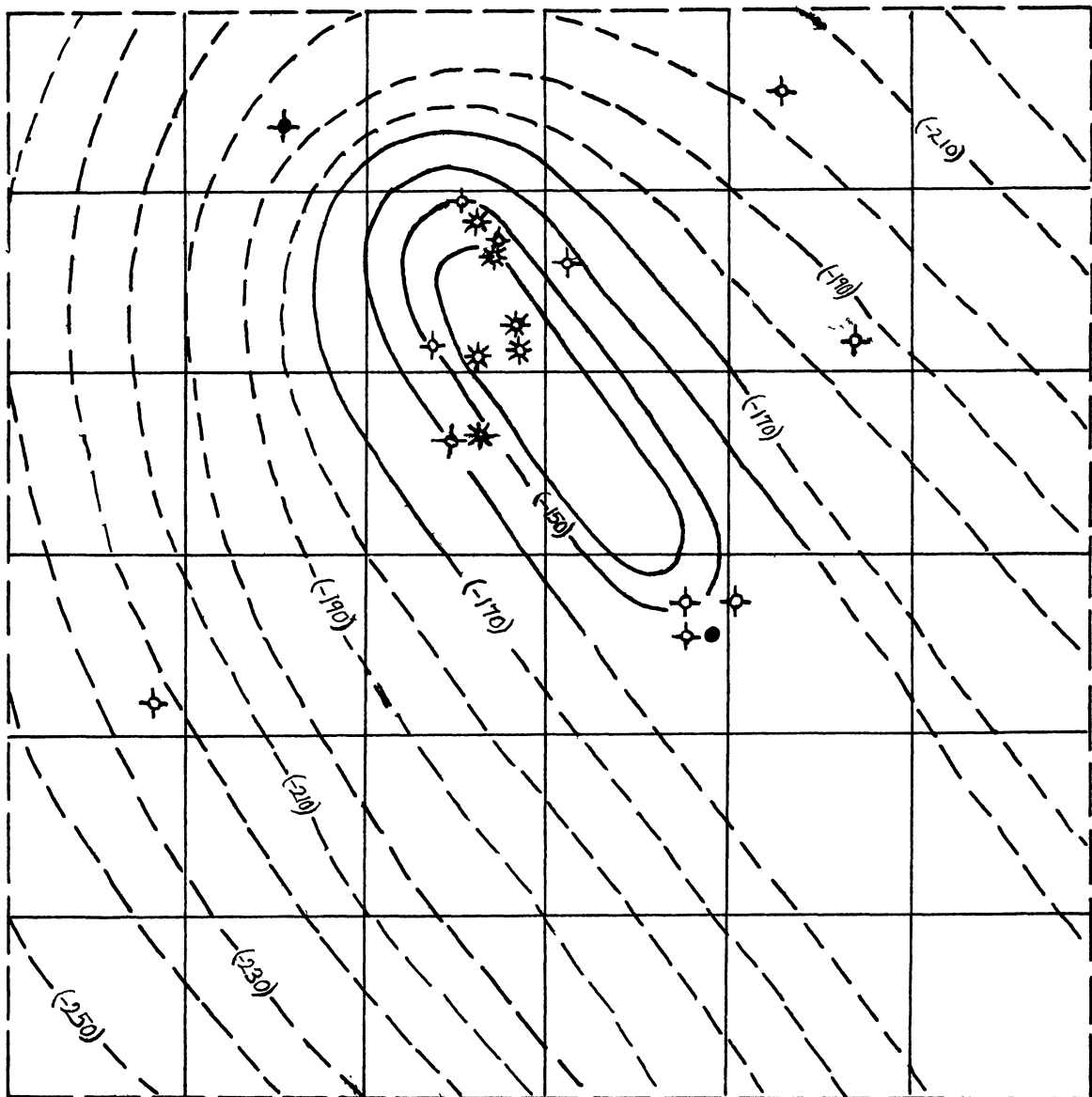
Water has appeared in all of the wells, and since the Parma Sand is an important water-bearing horizon it is evident that the production can not be continued for long despite the most careful operations. The closed-in rock pressure has declined steadily, probably due to the use of some of the gas for additional drilling operations. Unless new wells are dis-

covered in the near future, it is apparent that commercial production will cease in this field.

Since the Parma Sand was deposited on an extremely irregular surface occasioned by post-Mississippian erosion and has been subjected to erosion itself in the geologic past, it is variable in extent and thickness. In some places it is lacking entirely or at least is not recognizable in the well cuttings. Therefore a contour map on top of the Parma Sand cannot be very accurate. However on the basis of some seventeen well logs, an attempt has been made to contour on this formation in Elba township.

Comparison of the map (Fig. 2.) with those drawn on top of the Napoleon in the Mississippian (Fig. 3.) and on the Dundee in the Devonian (Fig. 4.) shows that the Alma high is apparently dying out with depth. Therefore the probability of production from deeper horizons is slight. A closure of around thirty feet is shown in the map drawn on top of the Parma Sand (Fig. 2.). Contours on top of the Napoleon (Fig. 3) show a pronounced "nose" structure without definite closure. Contours on the Dundee (Fig. 4) indicate a broad low fold in Elba township faintly reflecting the more pronounced folding of the higher horizons. A study of the three maps reveals that the folding becomes progressively less northwestward along the trend of the high. A comparison of the Parma and Napoleon maps shows that the axis of the Alma high shifts

SUBSURFACE CONTOUR MAP
ON TOP OF PARMA FORMATION
IN ELBA TOWNSHIP

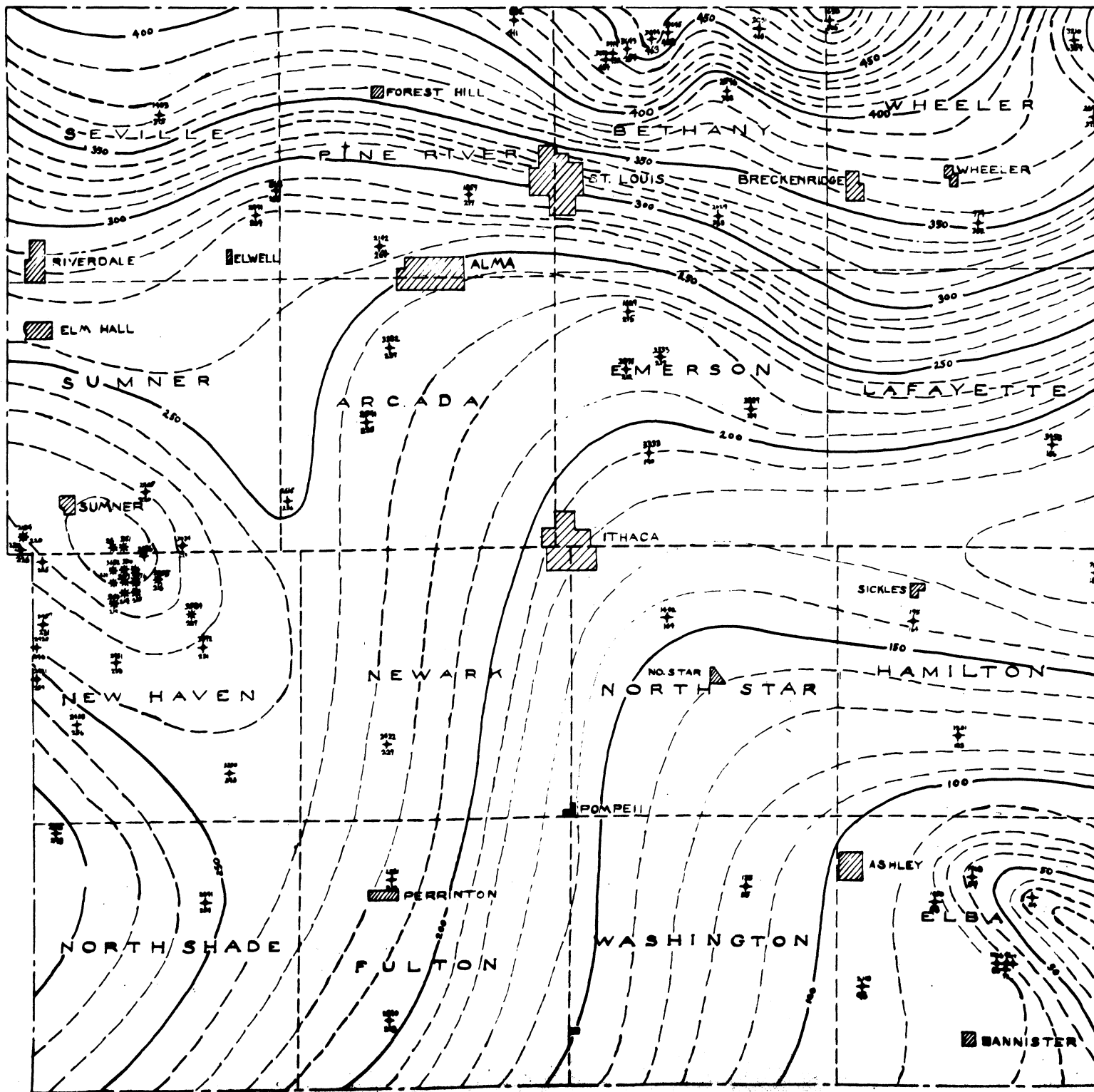


Contour Interval equals ten feet
Scale one inch equals one mile..

to the northeast with depth.

Shows of oil and a little gas have been found in the Traverse formation of the Devonian in certain wells which were drilled deeper following the failure to discover gas in the Parma. One well, located just off the southeast tip of the closure as interpreted in Fig. 2., came in with an initial production of twenty five barrels of oil per day from the Traverse. It is extremely doubtful whether sufficient folding and closure exist in this formation to favor the development of important commercial production.

SUBSURFACE CONTOUR MAP ON TOP OF NAPOLEON



EXPLANATION

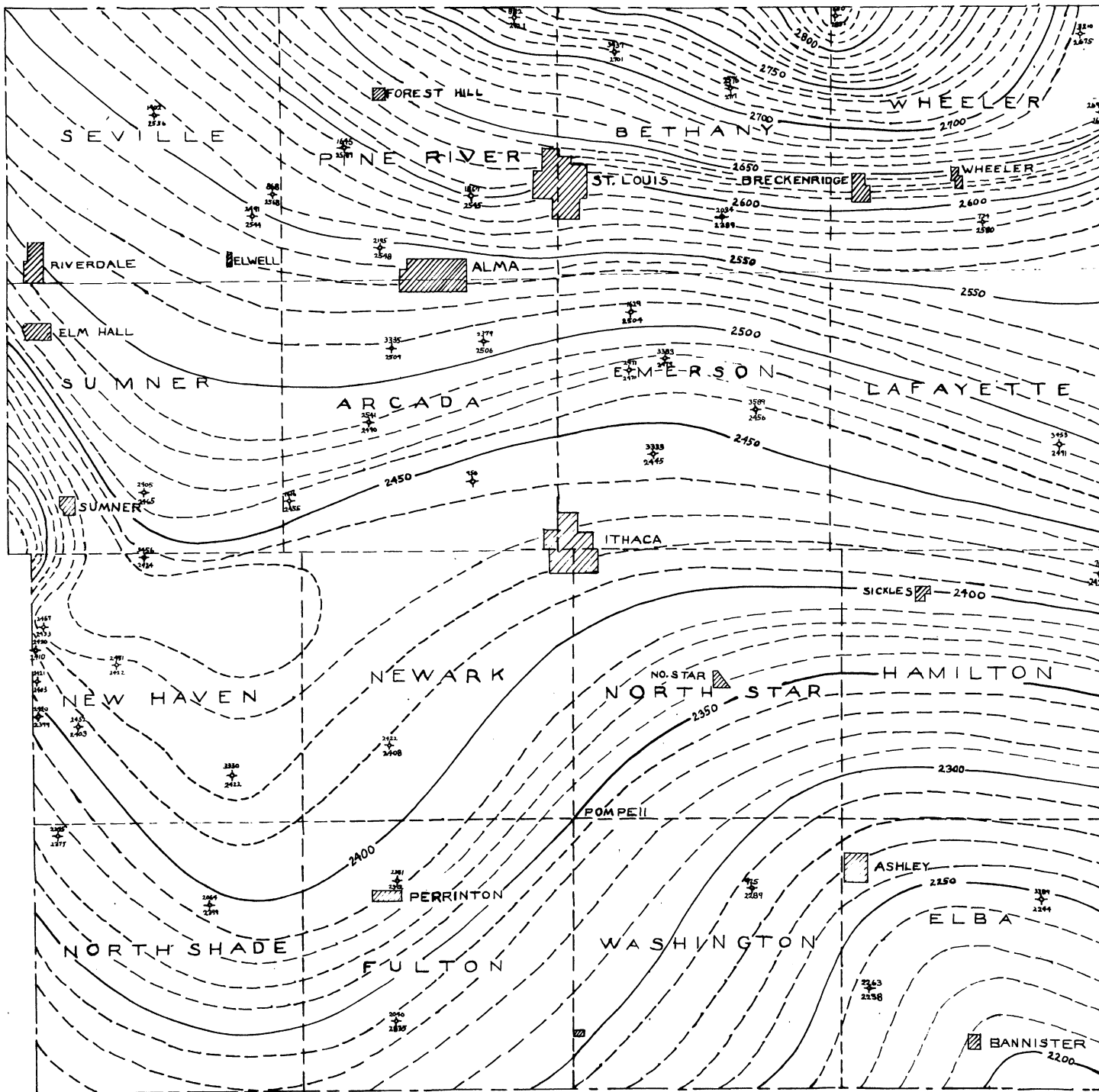
- LOCATION
- OIL WELL
- ✦ GAS WELL
- ✧ DRY HOLE
- ◆ GAS SHOW
- ✦ OIL SHOW

SCALE - 1" = 3 MILES

✦ } UPPER NO. - STATE PERMIT
 250 } LOWER NO. - DEPTH BELOW SEA LEVEL

■ BANNISTER

SUBSURFACE CONTOUR MAP ON TOP OF DUNDEE



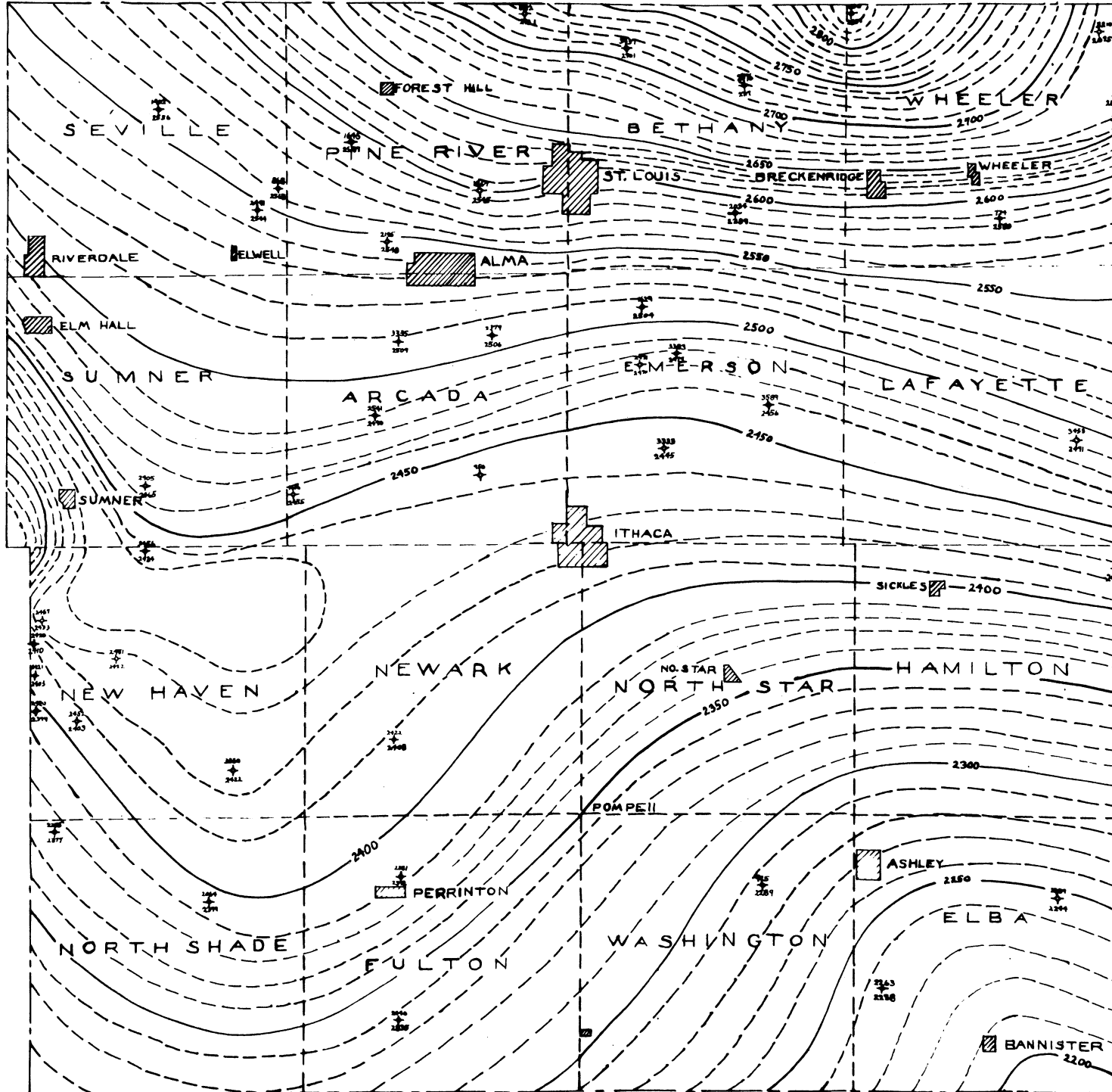
EXPLANATION

- LOCATION
- OIL WELL
- ★ GAS WELL
- ✦ DRY HOLE
- ✦ OIL SHOW
- ★ GAS SHOW

SCALE - 1" = 2 MILES

2422 } UPPER NO. = STATE PERMIT
250 } LOWER NO. = DEPTH BELOW SEA LEVEL

SUBSURFACE CONTOUR MAP ON TOP OF DUNDEE



EXPLANATION

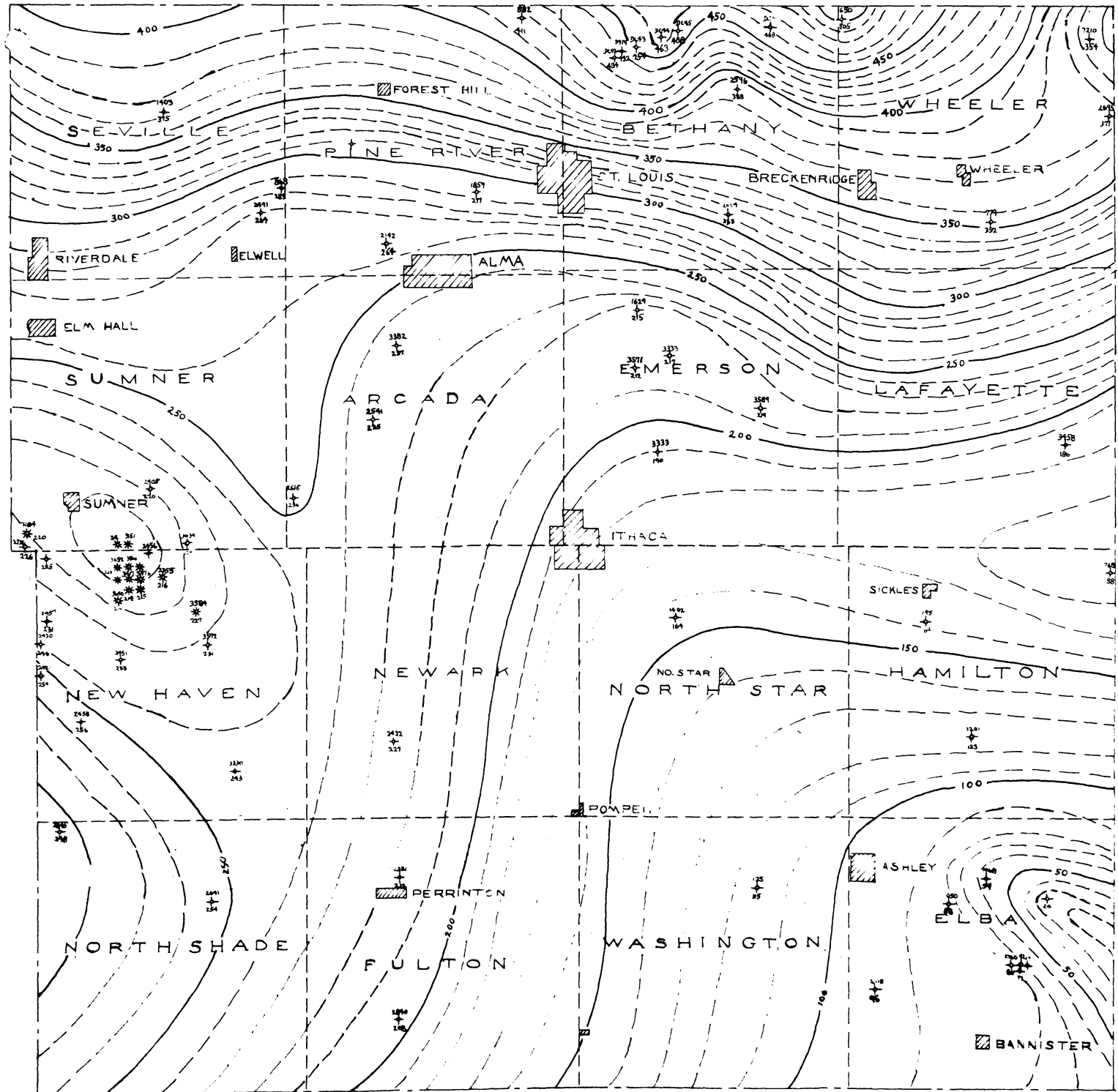
- LOCATION
- OIL WELL
- * GAS WELL
- ⊕ DRY HOLE
- ⊕ OIL SHOW
- * GAS SHOW

SCALE - 1" = 2 MILES

2412 } UPPER NO. - STATE PERMIT
250 } LOWER NO. - DEPTH BELOW SEA LEVEL

GRATIOT COUNTY
MICHIGAN

SUBSURFACE CONTOUR MAP ON TOP OF NAPOLEON



EXPLANATION

- LOCATION
- OIL WELL
- * GAS WELL
- ✕ DRY HOLE
- ◆ GAS SHOW
- ☆ OIL SHOW

SCALE - 1" = 2 MILES

$\frac{242}{250}$ } UPPER NO. = STATE PERMIT
 250 } LOWER NO. = DEPTH BELOW SEA LEVEL

N E W H A V E N G A S P O O L

The New Haven Gas Pool is located in the northern portion of New Haven township and the southern extremity of Sumner township in Gratiot County. It is an eastward extension of the Crystal-Ferris Oil and Gas Field in Montcalm County which borders Gratiot County on the west. The production is found on an anticlinal "nose" extending eastward off the Austin-Montcalm high which trends northwest-southeast.

The pool was discovered in November, 1935 when the Crystal Oil and Gas Company brought in their R. B. Shaver # B-1 well with an initial production of 10,000,000 cubic feet of gas from the lenticular sands in the Michigan formation of the Mississippian. In the next twelve months considerable drilling followed the successful completion of the discovery well, with the result there are at present some twenty producing wells in the two townships.

The proven area in the Mississippian in New Haven and Sumner townships at present is a more or less rectangular strip about two and a half miles in length and a mile and a half in width with the longer axis of the rectangle trending northwest and southeast.

The total initial production of the pool based on the initial productions of twenty two wells in New Haven township

and four in Sumner township was 240,640,000 cubic feet of gas. As may be seen from the accompanying charts (Fig. 5, Page 26 and Fig. 6, Page 27), the Wiser Oil Company owns the three leading wells in the pool. Their F. M. Brown # 1 was brought in with an initial production of 26,000,000 cubic feet. The average initial production in the field was 9,255,384 cubic feet of gas.

For some time the consensus of opinion was that the production in the New Haven Gas Pool was found entirely in the lenticular sand series in the lower portion of the Michigan formation, but it appears that some of the production is derived from the similar underlying Napoleon Sandstone or Upper Marshall formation. Drillers experience considerable difficulty in distinguishing the contact between the two formations unless they drill through the Napoleon to the Lower Marshall. Since the gas is found either in the Michigan or the Napoleon, the Lower Marshall is seldom penetrated. Thus it is easy to see how the drillers believe they are obtaining the gas from the Michigan when actually they may have drilled into the Napoleon.

It is difficult to determine from the drillers' logs the exact location of the Napoleon-Michigan contact in the New Haven Gas Pool. This is due in part to the previously mentioned similarity in the two formations as well as to the negligence of the drillers in including accurate and complete descriptions of the

P r o d u c i n g W e l l s

i n

N e w H a v e n T o w n s h i p

Permit	Producing Company & Owner	Initial Production	Prod. Depth
# 3630	Wiser Oil Company	26,000,000 cu. ft.	951'-971'
# 3484	Wiser Oil Company	24,500,000 cu. ft.	965'-980'
# 3537	Wiser Oil Company	23,707,000 cu. ft.	940'-972'
# 3726	Hyatt - Norton	18,000,000 cu. ft.	962'-973'
# 3617	Massigan Gas Corp.	14,770,000 cu. ft.	982'-1010'
# 3585	Massigan Gas Corp.	13,757,000 cu. ft.	989'-1009'
# 3541	Massigan Gas Corp.	13,630,000 cu. ft.	1006'-1015'
# 2778	Crystal Oil & Gas Co.	10,000,000 cu. ft.	938'-944'
# 3355	American Production Co.	8,355,000 cu. ft.	967'-985'
# 3110	New Haven Oil & Gas Co.	8,200,000 cu. ft.	955'-960'
# 3696	W. E. Ross	7,975,000 cu. ft.	959'-976'
# 3721	Wiser Oil Company	7,825,000 cu. ft.	969'-976'
# 2956	Crystal Oil & Gas co.	6,900,000 cu. ft.	955'-969'
# 3500	Massigan Gas Corp.	6,625,000 cu. ft.	969'-1002'
# 3641	Leslie T. Barber	6,400,000 cu. ft.	991'-1011'
# 3476	Massigan Gas Corp.	6,350,000 cu. ft.	1012'-1021'
# 3631	Wiser Oil Company	6,225,000 cu. ft.	970'-976'
# 3294	Gordon Oil Company	5,444,000 cu. ft.	949'-971'
# 3418	Massigan Gas Corp.	5,075,000 cu. ft.	955'-980'
# 3682	Superior Drill & Prod.	2,860,000 cu. ft.	996'-1009'
# 3735	Wiser Oil Company	1,500,000 cu. ft.	955'-979'
# 3584	Wiser Oil Company	238,000 cu. ft.	961'-965'

P r o d u c i n g W e l l s
i n
S u m n e r T o w n s h i p

Permit	Producing Company & Owner	Initial Production	Prod. Depth
# 2141	Hirzel Leland Develop. Co.,	5,774,000 cu. ft.	968'-972'
# 3470	R. N. Burch, Trustee	3,970,000 cu. ft.	968'-971'
# 3035	Barnky Gas Company Inc.	3,880,000 cu. ft.	978'- ? '
# 3185	Allied Petroleum Corp..	2,680,000 cu. ft.	1000'-1001'

lithologic descriptions.

Although it is probable that no sharp contact exists between the two formations a subsurface contour map has been drawn on top of the Napoleon. The contact was carefully selected by scrutinizing the logs and the author believes the horizon picked to be the same in all cases. Subsequent detailed examination of well cuttings under a binocular microscope of all the wells in this area will undoubtedly necessitate material revision of the contours, but it is felt that the submitted map is the best that can be drawn on the basis of drillers' logs.

It is believed that the gas of the Napoleon and the Michigan "Stray" Sand has accumulated in close proximity to the contact and that reservoir rocks have been both the sands above and below the dividing line. This is suggested by the fact that gas is obtained in some wells from a series of sands which are separated by non-productive layers.

It is interesting to note that while oil is obtained from the Dundee formation of the Devonian in the Crystal Oil and Gas Field just over the county line to the west in Montcalm County, no oil has as yet been obtained from the Dundee in New Haven and Sumner townships.

It seems probable that there is a thinning of the interval between the Dundee and the gas producing sands in Montcalm County indicating more folding on top of the Dundee and

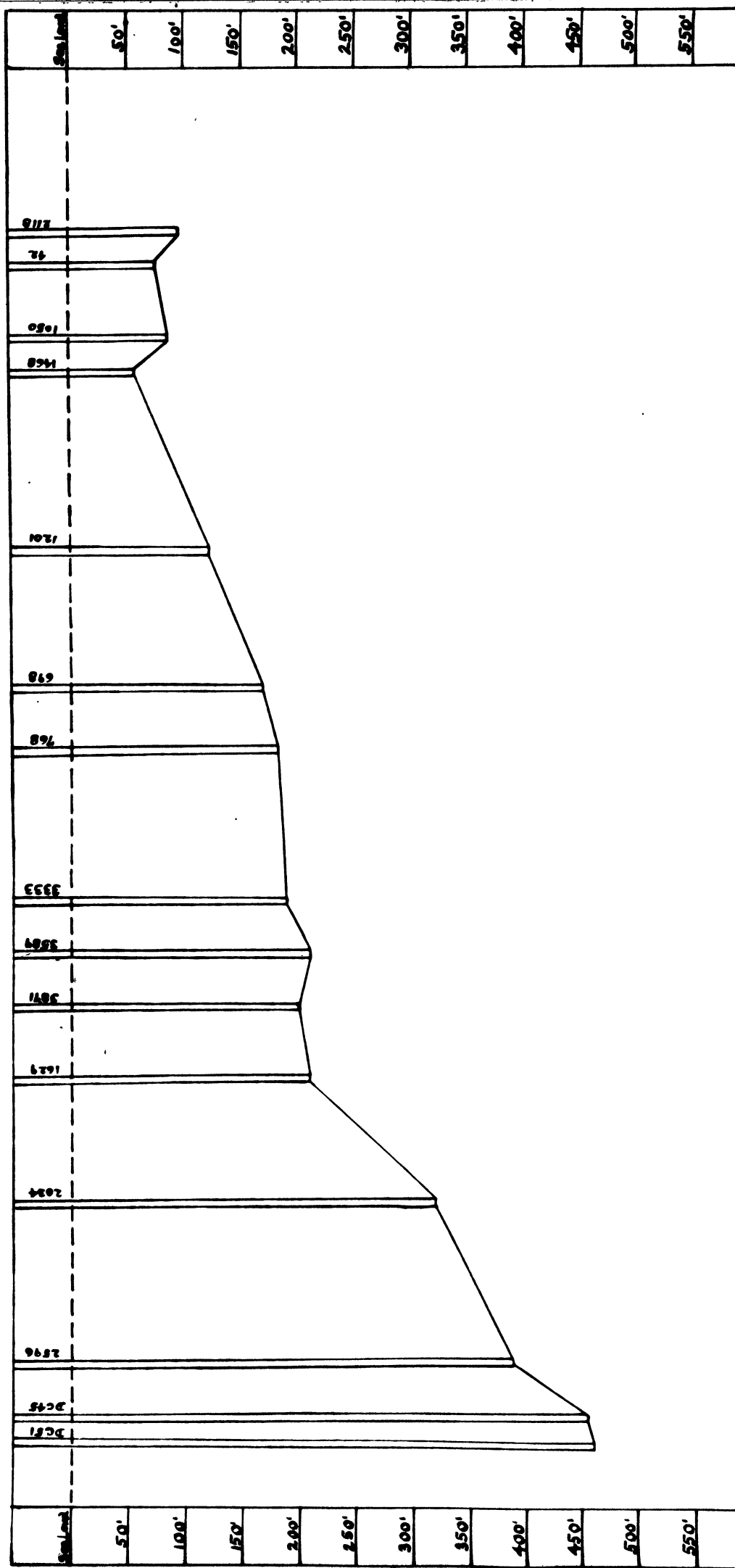
thus affording a better trap or reservoir for the accumulation of oil. The Dundee formation in New Haven and Sumner townships may be far less porous than westward over the county line. This is an important consideration as elsewhere in the central Michigan area production in the Dundee is controlled by porous layers in the upper part of the formation.

It is possible that deeper drilling in the New Haven Gas Pool may discover at some future date Dundee oil below the Mississippian Gas sands. Up to the present time only one well in the gas productive area has penetrated to the Dundee Limestone. This well proved to be dry in both the Michigan "Stray" and the Dundee, and for this reason would not seem to condemn the latter formation for commercial production in this area. The porosity of the limestone might be quite variable in different portions of the limestone within the potential productive area, so we can not depend on the evidence offered by a single well,

With practically every well put down within the producing area finding commercial gas at shallow depths, it will probably be some time before wells are drilled into the deeper Dundee and until then the Dundee production can not be determined.

N-S CROSS SECTION A-A' SHOWING NAPOLEON TOPS

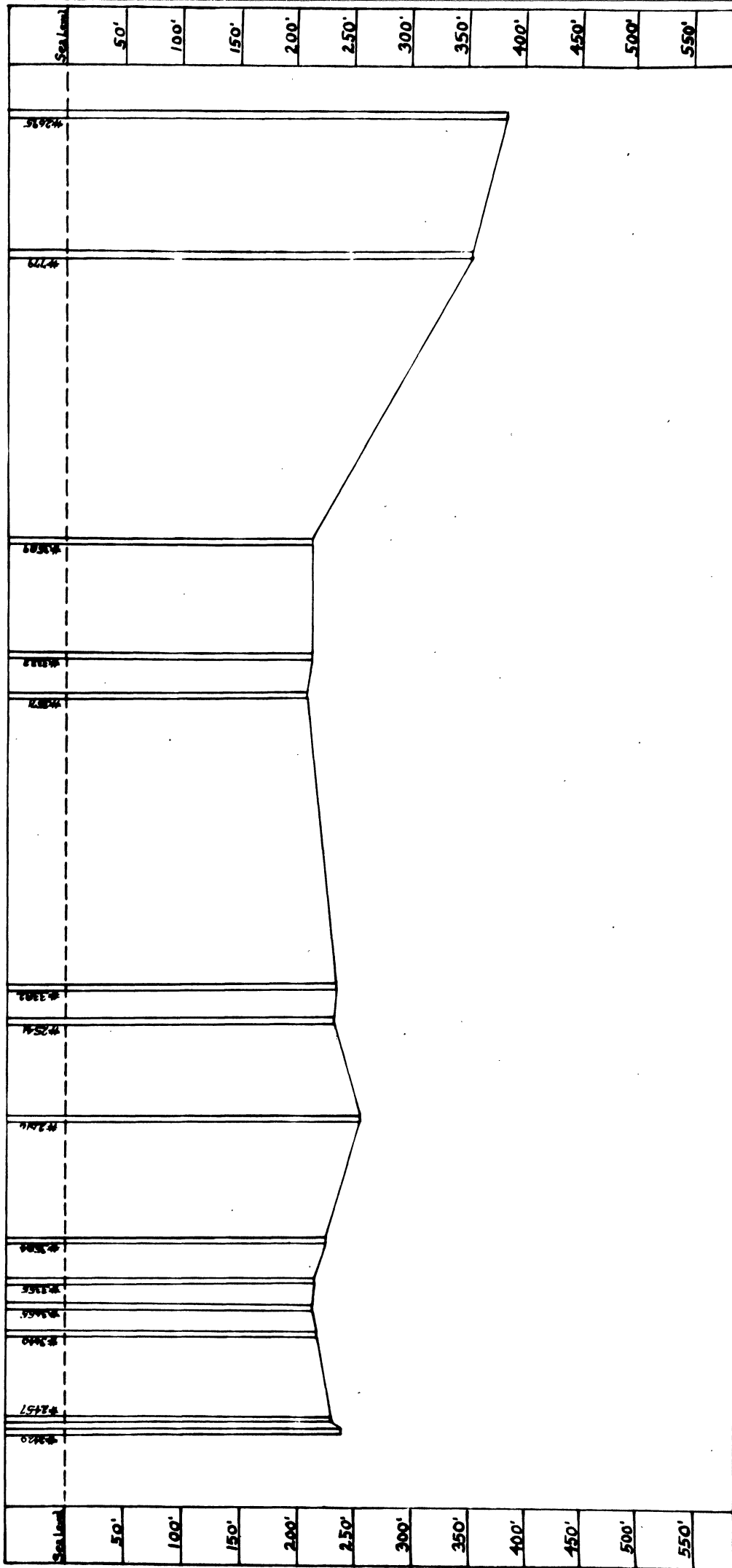
BETHANY EMERSON HAMILTON ELBA



SCALE 1"=2 MILES

E-W CROSS SECTION B-B' SHOWING NAPOLEON TOWNSHIP

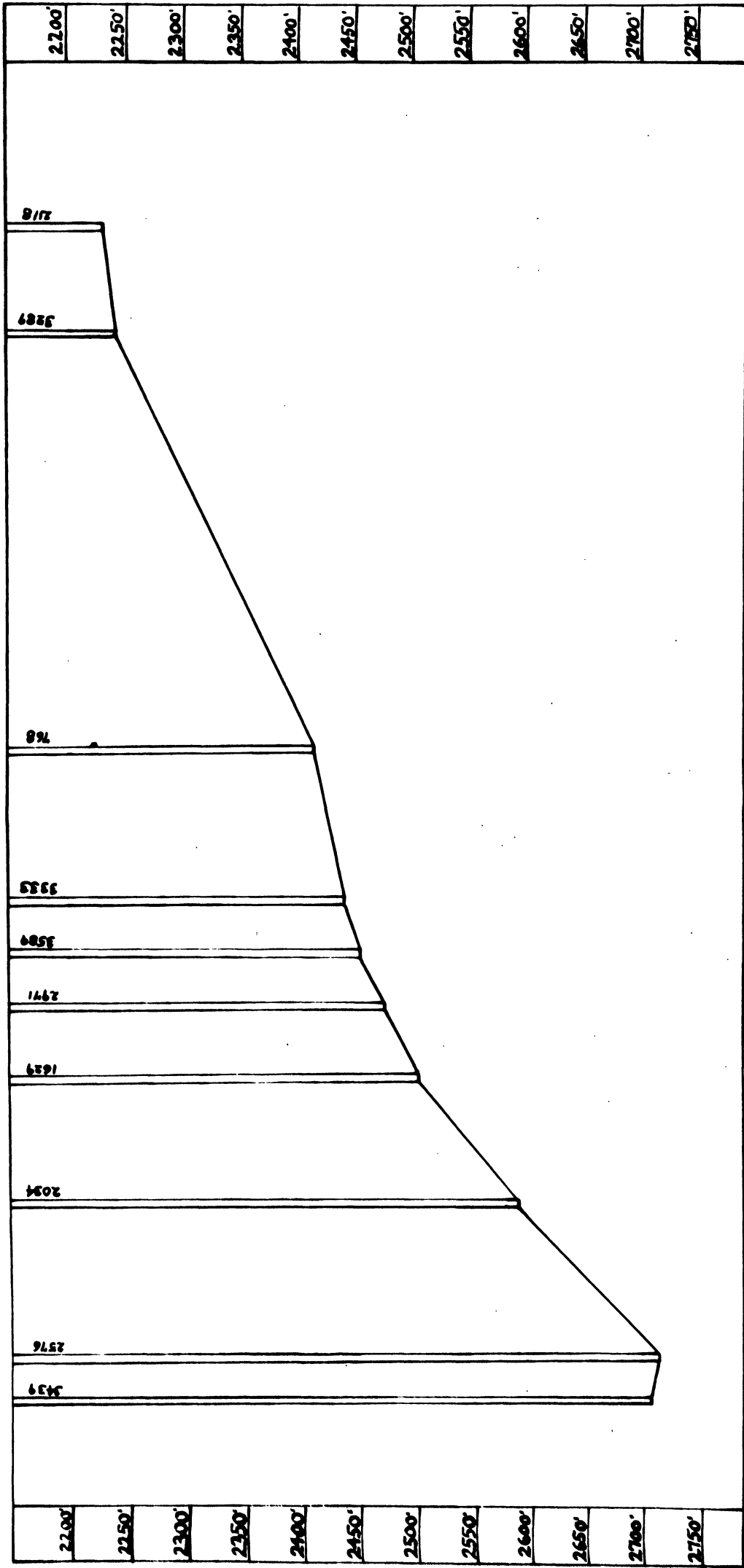
NEW HAVEN ARCADA EMERSON WHEELER



SCALE 1"=2 MILES

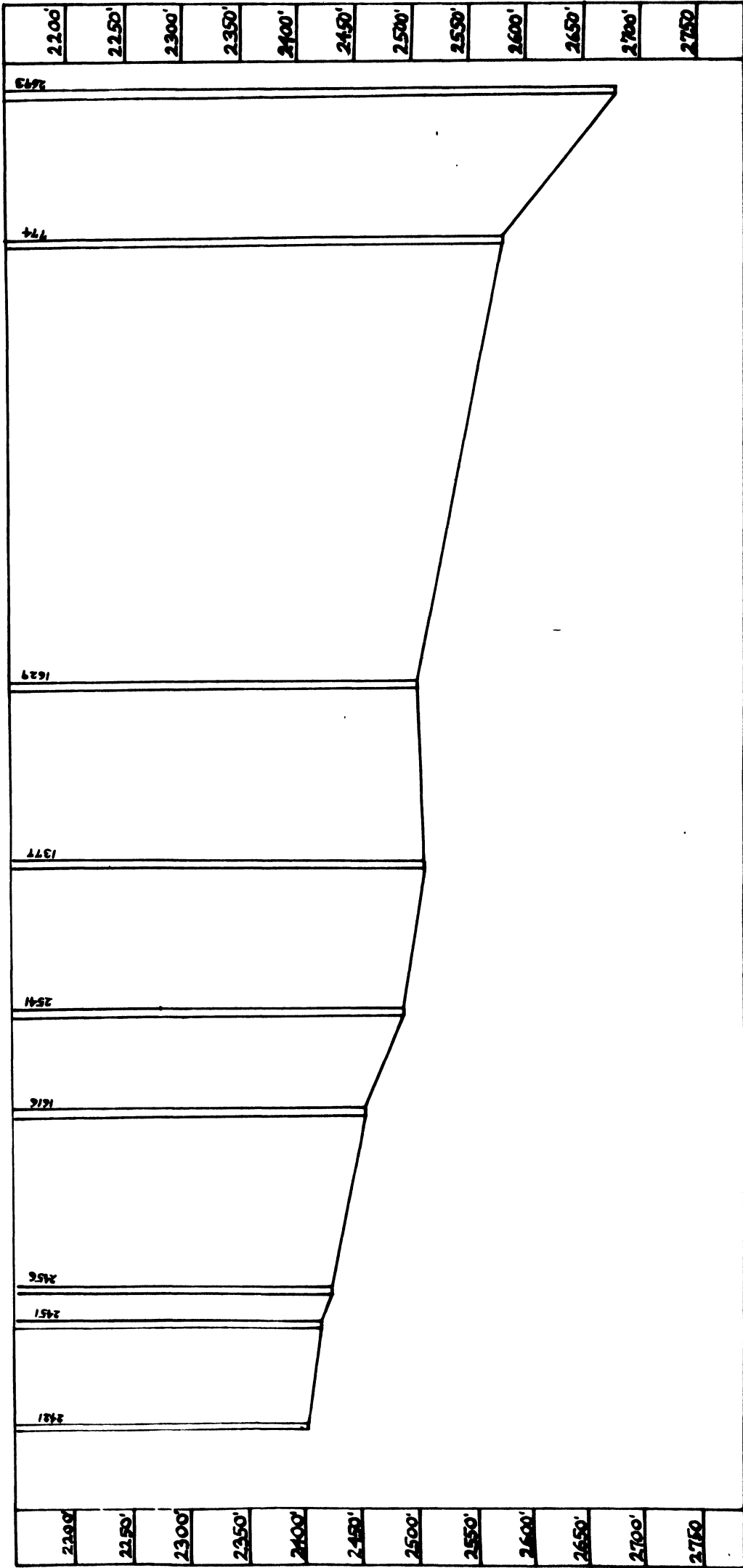
N.-S. CROSS SECTION C-C' SHOWING DUNDEE TOPS

BETHANY EMERSON HAMILTON ELBA



SCALE 1" = 2 MILES.

E.-W. CROSS SECTION D-D' SHOWING DUNDEE TOPS
NEW HAVEN A R C A D A E M E R S O N W H E E L E R



SCALE 1" = 1 MILES

CROSS SECTIONS

Four cross sections (Figs. 5, 6, 7, and 8 on Pages 30, 31, 32, and 33 respectively) have been constructed showing the top of the Napoleon and the top of the Dundee Formations. They were chosen as carefully as possible with a view to offering a conception of the structure in the vicinity of the two producing fields and in proximity to the known highs.

Sections A-A' and B-B' taken approximately at right angles to each other represent the top of the Napoleon. The former extends across the county from north to south while the latter runs from east to west.

Sections C-C' and D-D', also taken at about ninety degrees to each other, indicate the top of the Dundee with the former running from north to south and the latter from east to west.

An examination of Section B-B' reveals a pronounced structural high in New Haven township in the locality of the New Haven Gas Pool. A broader less pronounced upwarp is noted in Emerson township and represents the northwest extension of the Alma high.

Section A-A' shows a pronounced dip to the north along the trend of the Alma high from Elba township to Bethany township.

Section C-C' shows a dip to the northwest along the trend of the Alma high with a broad flattening of the dip in the northern part of Bethany township and in Elba township across the top of the anticline.

Section D-D' indicates a gradual eastward dip on the top of the Dundee in New Haven township with a sudden steepening of this dip in Emerson and Wheeler townships. The subsurface contour map on top of the Dundee (Fig. 4.) shows more pronounced folding in both of these locations.

C O N C L U S I O N

Gratiot County has definite possibilities for future development of commercial production of petroleum. It has already been pointed out that oil may be found in the Dundee Limestone in the New Haven Gas Field. In addition the definite limits of the gas producing area in New Haven and Sumner townships have not been established as yet, and it seems likely that attempts at extending the pool will meet with partial success at least.

Further developments or extensions of the Ashley Gas Pool are not apt to prove of commercial value. However it is possible that drilling on the flanks of the Alma high in Elba township may be successful. The existing production is spotty and apparently the gas is not necessarily found in wells adjacent to producing ones. Hence additional drilling may find new productive spots.

It is possible that Dundee production may be discovered in the northern portions of Bethany and Wheeler townships. Figs. 3 and 4 indicate folding in that area and oil is being obtained immediately to the north in Jasper and Porter townships.

The remainder of the county does not appear particularly favorable for the production of oil and gas. Attempts to extend existing fields may bring to light additional information which

will cause a revision of the opinions of the structure, and it is possible the future may see other producing areas in Gratiot County. On the basis of the data at hand, this does not seem likely.

In summing up we would like to mention again the seeming lack of a sharp contact between the Michigan "Stray" sands and the Napoleon formation. Many geologists describing far larger portions of the state of Michigan have mentioned an easily recognizable unconformity between the two formations. No evidence supporting the existence of such an unconformity has been found.

As a result the author is convinced that a considerable number of the wells thought to be producing from the Michigan sands are actually producing from the Napoleon, and that rather than one or two reservoir rocks, a large number of intermittent sands occurring in both formations have served as reservoir rocks and traps.

R E F E R E N C E S

- (1) "Geology of Michigan" by Newcombe.
- (2) "Geology of Michigan" by Newcombe.
- (3) "The Michigan Stray Sand" by E. W. Hard.
- (4) "Geology of Michigan" by Newcombe.

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