

The structure of Clare County is known only in a general way by projecting the trends of the anticlines more thoroughly worked out in Isabella and Midland counties. (See pls. IV and V). The Greendale "high" seems to extend across from east of Farwell to near Temple. The northwest projection of the Saginaw trend may cross somewhere between southeastern Arthur township and northwestern Summerfield township. Cross folding with a northeast-southwest trend is apparent near the Clare gas field where the drilling is more closely spaced than in the rest of the county. The intensity and direction of the regional dip varies considerably in different parts of Clare County, but in general when not interrupted by local structures it is south and southwest.

After the discovery of the Clare gas field, the Decem Development Company drilled the first "wildcat" test on the F. S. Salter farm in the NE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 33, T. 18 N., R. 6 W., Freeman township (Elev. 1,071.5 feet). The well was 4,064 feet deep and after going through 463 feet of drift the Parma was struck at 1,050 feet, Michigan "stray sand" at 1,602, the Marshall at 1,657, Lower Marshall red rock at 1,748, the Berea at 2,665, the Traverse at 3,310, and the Dundee at 3,995. Showings of oil were found at 1,050 and 1,480 feet and gas at 3,160 feet. Water in abundance was encountered at 1,065 and 1,622 feet, $\frac{3}{4}$ bailer full per hour at 3,515, and Monroe (?) black water at 4,064. Operations were abandoned in January, 1930.

The Mammoth Oil Company of Michigan put down a well on property belonging to the Bothwell heirs in the SE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 16, T. 18 N., R. 4 W., Hatton twp. (Elev. 1,017 feet). It was completed at 4,092 feet and found the top of the rock at 515, the Parma at 900, the Marshall at 1,580, Lower Marshall red rock at 1,735, the Traverse at 3,404, and the Dundee at 4,072 feet. Water was struck at 1,602, 3,570-3,615, and 4,092 feet and the hole was abandoned in March, 1932.

The Clare Development Syndicate drilled to a depth of 3,840 feet on the Mary A. Hubel farm in the SW. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 27, T. 17 N., R. 4 W., Grant twp. (Elev. 846 feet). The drift was 355 feet thick and the Parma was struck at 1,040 feet, Michigan "stray sand" at 1,384, the Marshall at 1,460, Lower Marshall red rock at 1,555, the Berea at 2,564, the Traverse at 3,105, and the Dundee at 3,798. Water was tapped at 455, 1,384, and 3,833 feet. Abandonment took place in June, 1930.

The Peninsular Oil Company drilled a well 3,978 feet deep on the W. E. Bowler property in the SW. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 15, T. 17 N., R. 4 W., Grant twp. (Elev. 945 feet). There was 405 feet of drift and the Parma was at 989, Michigan "stray sand" at 1,446, the Marshall at 1,485, Lower Marshall red rock at 1,625, the Traverse at 3,220, and the Dundee at 3,905 feet. Showings of gas were found at 1,505, 3,220-50, 3,440, and 3,600 and some oil at 3,440-90. Salt water was struck in the Parma at 989, one bailer full in the Traverse at 3,460-75, and brine in the Dundee at 3,977 feet. The well was abandoned in August, 1931.

Although the logs of most of the wells in the Clare gas field will not be discussed, the Dundee test put down to 3,967 feet by McKay and Mercier on the Jas. McKay location No. 6, NE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 1, T. 17 N., R. 5 W., Surrey twp. (elev. 973 feet) is included here to show the results of temperature determinations. (See fig. 39). These observations of the temperature gradient were made by C. E. Van Orstrand of the U. S. Geological Survey in September, 1931. They seem to indicate an aver-

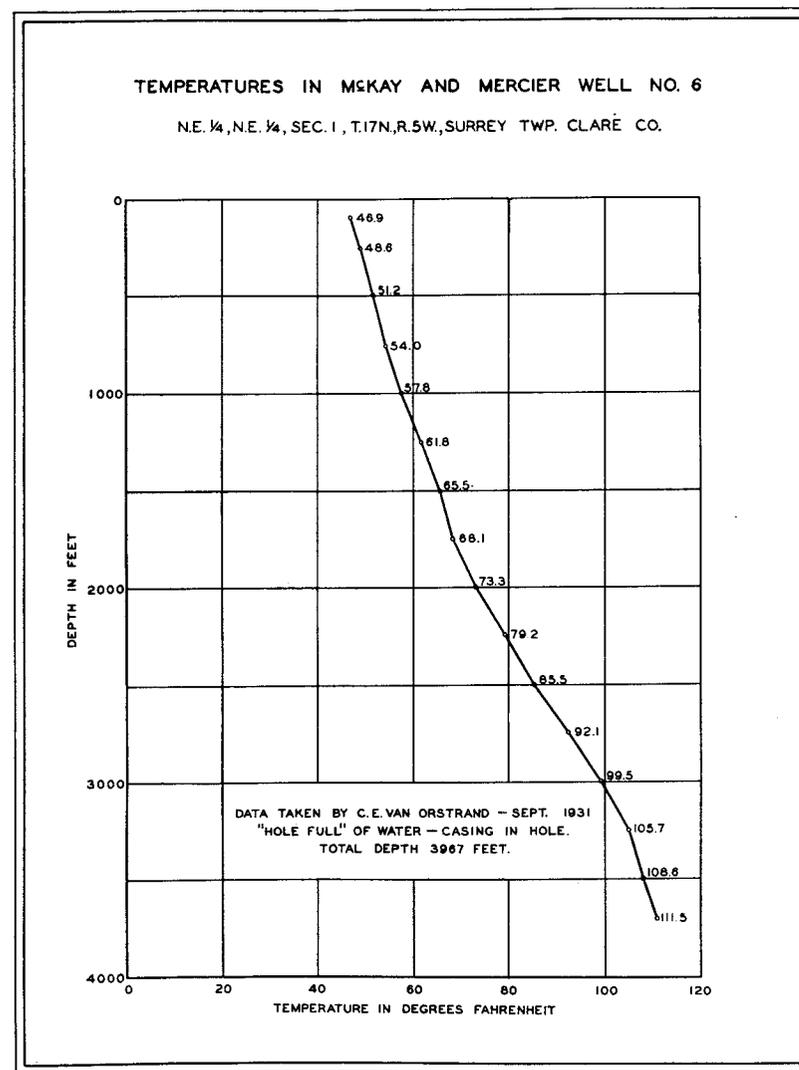


Figure 39. Temperatures in McKay and Mercier Well No. 6, NE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 1, T. 17 N., R. 5 W., Surrey twp., Clare County.

age increase in temperature of 1° Fahrenheit for every 56 feet in depth which according to the curve with but 4 marked changes in slope is comparatively regular. In this well the drift was 470 feet thick and the Parma was encountered at 985 feet, the Michigan "stray sand" at 1,458, the Marshall at 1,528, the Lower Marshall red rock at 1,645, the Berea at 2,657, the Traverse at 3,225, and the Dundee at 3,914. Water was struck at 1,458 feet and the hole filled up 3,400 feet with black sulphur water at 3,956, but the well has not been abandoned. (Jan. 1, 1933)

The Michigan Gas and Oil Corp. drilled a Marshall test 1,535 feet deep on the Daniel Coyne et al property in the SE.¼ SE.¼ sec. 18, T. 17 N., R. 4 W., Grant twp. (Elev. 960 feet). This well encountered 387 feet of drift and struck the Parma at 935, water at 940, the Marshall at 1,530, and salt water at 1,535 feet. The hole was abandoned in December, 1931.

The Theodore Oil Company drilled on property belonging to Thompson Bros. in the SW.¼ NE.¼ sec. 35, T. 19 N., R. 5 W., Greenwood twp. (Elev. 1,216.8 feet). According to scout reports 760 feet of drift was found in this well and the Parma was at 1,275, the Marshall at 1,710 (?), Lower Marshall red rock at 1,795, the Traverse at 3,500, and the Dundee at 4,180 feet. Water which about filled the hole was struck at 1,305, 1,710, and 4,242 feet. A good showing of high grade "live" oil was struck at 4,180-84 feet and made several barrels over night. The hole as completed in December 1932, was drilled to 4,245 feet but after additional testing it now stands at a depth of 4,234 feet.

The wells now drilling (Feb. 1, 1933) are the Ira Scheifley, Tr.—All American Fur Farm No. 1, SW.¼ SE.¼ sec. 21, T. 20 N., R. 5 W., Summerfield twp. (elev. 1,104.8 feet), and the Strange Oil and Gas Company—J. L. Littlefield No. 1, SW.¼ SW.¼ sec. 9, T. 17 N., R. 5 W., Surrey twp. (Elev. 1,047 feet). The Scheifley-Fur Farm well is down 1,000 feet, having struck the Parma (?) at 850 feet, "hole full" of water at 690, and oil with a "hole full" of water at 850 feet. The Strange-Littlefield well is down 3,210 feet and struck the Michigan "stray sand" at 1,578, the Marshall at 1,643, Lower Marshall red rock at 1,746, and the Traverse at 3,385 feet. Water which came up in the hole 70 feet in one hour was tapped at 1,583-86 feet.

GRATIOT COUNTY

The drilling for oil and gas in Gratiot County came largely from efforts to extend the Mount Pleasant production southward and to explore the Howell-Owosso "high" northward. The only commercial wells are in the southeastern corner of the county, and these are small. The "wildcat" test wells in the northern part of the county were fairly well scattered and thus helped to outline structural trends as a guide for future development. In all, fifteen wells have been put down for oil and gas since 1928. The structure as now interpreted is shown in Plates IV and V.

The Alma "high" extends northwest-southeast from Elba township in the southeast corner of the county to Seville township in the northwest corner. It is apparently a regional feature trending southeastward from the Broomfield "high" in Isabella County where gas has been found. The exact off-structure dip and closure of individual anticlines are unknown. The Greendale "high" probably crosses near the extreme northeast corner of the county in Wheeler township, but this area has not

been tested. Another high, about which very little is known, seems to trend across the four townships in the southwest corner of the county in a northwest-southeast direction.

Late in 1929, Ridenour and Snyder drilled on the I. J. Nelson farm, NE.¼ NE.¼ sec. 25, T.12N., R.4W., Seville township, Gratiot County (Elev. 772 feet). Marshall sandstone was found at 1,055, Lower Marshall red rock at 1,145, the Berea at 2,359, the Traverse at 2,791, Traverse limestone at 2,814, and the Dundee at 3,334 feet. Gas, oil, and water were struck at 3,339 feet. The well soon filled up about 2,000 feet, and at 3,370 feet there was 3,000 feet of water in the hole. It was drilled to 3,395 feet and finally plugged and abandoned.

The Twin City Oil and Gas Company put down a well in the NW.¼ sec. 1, T.12N., R.3W., on the C. H. Bigsby property, Pine River township, Gratiot County (Elev. 740 feet). This test encountered Marshall sandstone at 1,150, Lower Marshall red rock at 1,265, the Berea at 2,465, the Traverse at 2,916, and the Dundee at 3,460 feet. Salt water came in at 2,290 feet, and water was tapped in the Traverse at 3,070 and oil at 3,175 feet. A show of gas and oil was found in the Dundee at 3,475 feet, but water was struck at 3,490 feet, and the hole was plugged and abandoned at that depth.

The Ann Arbor Oil Company drilled on property belonging to J. D. McCallum in the SW.¼ NW.¼ sec. 6, T.12N., R.1W., Wheeler township (elev. 705 feet), where Marshall sandstone was struck at 1,210 feet, typical Lower Marshall red rock at 1,333, the Berea at 2,475, the Traverse at 2,954, and the Dundee at 3,539. The water horizons in the hole were at 30, 360, 455, 3,068, and 3,556 feet, and the well was abandoned as a dry hole in the Upper "Monroe Series" (Detroit River) at 3,827 feet.

A well was put down by the Macston Oil Company on the Cornwell estate in the SE.¼ SW.¼ sec. 27, T.12N., R.1W., Wheeler township (Elev. 708 feet). The Marshall was found at 1,060, Lower Marshall red rock at 1,170, the Berea at 2,285, the Traverse at 2,745, and the Dundee at 3,288 feet. Salt water was struck in the Dundee, and the hole was plugged and abandoned at 3,330 feet.

The Wittmer Oil and Gas Properties Company of Pittsburgh started a well on the W. H. Zimmerman farm, NE.¼ SE.¼ sec. 8, T.10N., R.1W., Hamilton township, Gratiot County (Elev. 697 feet). Drilling difficulty was experienced, and the hole was plugged at 1,140 feet after drilling to 1,200 feet. The Marshall was found at 858 and the Lower Marshall red rock at 963 feet.

Sam. M. Bacon of Saginaw drilled a "wildcat" well on the F. J. Gibbs farm in the NE.¼ SE.¼ sec. 1, T.10N., R.1W., Hamilton township (Elev. 666 feet). Marshall sandstone was struck at 863 feet, Lower Marshall red rock at 990, the Berea at 2,148, the Traverse at 2,625, the Dundee at 3,086, and black water from 3,135 to 3,185 feet. A showing of oil was found at 2,874 and gas at 3,120 feet, but the hole was plugged and abandoned in the Upper "Monroe" at 3,420 feet.

W. L. McClanahan put down a test for gas on the Robt. G. Waldron farm, NE.¼ NE.¼ sec. 28, T.10N., R.1W., Hamilton township (elev. 683 feet), in which he found the Parma at 501, the water at 520, a gas show at 550, more gas at 783, the top of the Marshall at 806, and water at 822 feet. The well was finished at 823 feet. It was not a commercial producer but showed the Michigan "stray gas sand" farther south than hitherto known.

The Fish Creek Oil Syndicate of Carson City drilled a test well on the N. Garner farm, NE.¼ SE.¼ sec. 10, T.9N., R.4W., North Shade township, which is reported to have gone to a depth of 800 to 900 feet without encountering the Marshall. Reliable records of the well are not available.

E. O. Pequinot et al drilled a deep well on the August Nass property, NE.¼ SE.¼ sec. 10, T.9N., R.2W., Washington township (Elev. 688 feet). Marshall sandstone was encountered at 803, Lower Marshall red rock at 868, the Berea at 2,092, the Traverse at 2,489, Traverse limestone at 2,529, and the Dundee at 2,975 feet. A showing of gas was found in the Dundee at about 3,020 feet, and the hole filled with water at 3,043, where it was plugged and abandoned.

Miller Bros. of Ashley, Michigan, drilled a Dundee test on the Belle Crook farm in the N.¼ NW.¼ sec. 10, T.9N., R.1W., Elba township, to a depth of 3,159 feet (Elev. 665 feet). The Parma was struck at 500, the Marshall at 712, Lower Marshall red rock at 792, the Berea at 2,063, the Traverse at 2,465, and the Dundee at 2,960 feet. Water was encountered at several places in the Saginaw formation and at 737 feet in the Marshall. Black water came in at 2,960 feet and possibly more water at 3,129 feet. A showing of gas was found at 500-510 feet, about a half million cubic feet of gas at 715-725 feet, and three showings of oil in the Traverse in the top few feet and at 55 and 145 feet in.

The discovery of shallow gas near Ashley in Elba township in 1927 led to the drilling of several more wells during the next few years. The Wolverine Natural Gas Company put down a test on the Rebecca Kerr farm, SE.¼ SW.¼ sec. 9, T.9N., R.1W., which was dry at a depth of 758 feet. The Parma "sand" was absent, and the Marshall was struck at 748 feet. The same company drilled a dry hole to a depth of 525 feet in the NW.¼ SW.¼ NE.¼ sec. 16, on the Lars P. Anderson farm (Elev. 655 feet). On the northeast corner of this 40 acre tract, Miller and Combs of Ashley brought in a gas well which gauged 1,301,850 cubic feet (Elev. 655 feet). The top of the Parma sand was 484 feet, gas was found at 486-496, and the depth of the well was 502 feet. They also struck 1,800,000 cubic feet of gas at 498-500 feet on the Rebecca Kerr farm, SE.¼ SW.¼ NE.¼ sec. 9 (Elev. 663 feet). A test by Miller and Combs on the J. I. Askegard farm, SE.¼ NW.¼ NW.¼ sec. 9 (elev. 656 feet), came in at 503-511 feet, with an estimated flow of 500,000 cubic feet of gas. It was drilled to the Marshall, found the top at 690, water at 700, and was completed at 712 feet.

ISABELLA COUNTY

The structural geology and the locations of wells in Isabella County are shown in Plates IV and V. Wildcat wells have been drilled in Coe, Deerfield, Denver, Gilmore, Isabella, Lincoln, Nottawa, Sherman, Union, Vernon, and Wise townships. Descriptions of these wells, the depths to the various formations, and some of the findings of oil and gas are given in Table XXI. In this table are included the wildcat wells drilled in the county from Jan. 1, 1928 to Jan. 1, 1933, excepting those close to the Mount Pleasant, Leaton, Vernon, and Broomfield pools.

JACKSON COUNTY

The structural geology of Jackson County is very vague since there are only four deep wells and some indefinitely determined trends of sug-

gested "highs" in adjoining counties. One anticlinal fold seems to extend from near the corner of Hillsdale and Lenawee counties, where they join with Jackson County on the south, to the northwestern corner of the county. There is further evidence of this high in the bedrock topography and certain irregularities in the geologic section of the region. A pronounced bedrock ridge parallels this fold on the southwest, and near Jackson the Michigan formation is missing with the Parma sandstone resting directly upon the Marshall. Another major anticline apparently crosses the northeast corner of the county, and there are also peculiar features of bedrock topography in this district.

The only recent well in Jackson County was drilled by the Hanover Development Company on the Alfred Folks farm, where the location was in the NW.¼ SW.¼ SE.¼ sec. 14, T.4S., R.2W., Hanover township (Elev. 1,045 feet). The Berea horizon is difficult to identify in this well, but it may be at 900 feet. The Traverse was struck at 1,520 feet, the Dundee at 1,689, and the total depth was 1,727 feet. Water was encountered at 252 and 1,527 feet, and gas showings occurred at 1,525, 1,669, and 1,700 feet.

KENT COUNTY

Kent County is on the west side of the Basin and, except where interrupted by local structures, the regional dip is northeast. Four principal lines of folding seem to cross the county, two in a northeast-southwest direction and two in a northwest-southeast direction. There is evidence of a "high" extending from the northwest corner of Byron township through Wyoming township near the east limits of the village of Grandville northeastward in the general direction but a little east of the village of Alpine. Another more or less parallel fold extends from the vicinity east of Caledonia toward northwestern Lowell township. By projecting structural trends from adjoining counties, northwest-southeast anticlinal folds apparently cross the southwest corner of the county diagonally through the center of Wyoming township and the southeast part of the county near the southeast corner of Lowell township. The drilling in the county has been fairly scattered, but the geologic structure of the area and the exact trends of folding are not very clear.

Activity in the Muskegon field led to operations for oil and gas in this part of western Michigan. In all, six deep wells and one test well were put down in Kent County during the Muskegon boom. Several of these had favorable showings of oil and gas, but none were commercial producers, and development in the county has practically stopped.

Paul Schulte of Chicago started a well near Cedar Springs in 1929, in the NW.¼ NE.¼ sec. 31, T.10N., R.10W. (elev. 870 ± feet), which is now shut down with the tools lost in the hole at 4,650 feet. It was deepened from 3,569 by A. J. Buck of Cedar Springs. The record of the upper part of the hole is rather poor and indefinite, but the Marshall was at about 775 feet, Lower Marshall red rock at 850, the Traverse at 2,440, the Dundee at 2,850, the Sylvania (?) at 3,575, the Salina at 4,046, and the Salina salt beds at 4,150. A showing of oil was found at 2,480 feet. There was a "hole full" of water at 1,200 and 2,483 feet and water in the Dundee and Upper Monroe at 2,890 and 3,015 feet.

TABLE XXI.—Wildcat Wells

Permit	Company.	Farm.	Location.
931	Salt Creek Oil Co.	O. H. Adams	NW., NW. ¼ NW. ¼
738	St. Clair Oil and Gas Corp.	W. H. Thomas	SW. ¼ SW. ¼
1,073	Geneva Oil Co.	Nicholson	SW. ¼ SW. ¼
1,207	Apache Oil Corp.	F. Epple	SE., SE. ¼ NE. ¼
717	E. Brown Oil Dev. Co.	Geo. Mitchell	S. ½ SW. ¼
778	Chippewa Oil and Gas Co.	M. Bliss Keeler No. 1	SE. ¼ SE. ¼
694	Denver Oil Dev. Co.	R. Adams	NE. ¼ SE. ¼
818	Gordon Oil Co.	Isabella County State Bank	NW., SE. ¼ SE. ¼
731	J. M. Markle, Tr.	F. H. Dodds No. 1	NE. ¼ NW. ¼
605	J. M. Markle, Tr.	E. O. Graham	W. ½ NW. ¼
719	Mid-Michigan Oil Development Synd.	P. J. Marthey	W. ½ NE. ¼
780	Ohio Producing & Refining Co.	Keeler-Weideman	NW. ¼ SE. ¼
1,281	L. G. Thompson	Jno. D. Vandercook	SE., NE. ¼ SE. ¼
806	New York Petroleum Royalty Corp.	Q. L. Hughes	NE., NE. ¼ NE. ¼
1,235	F. L. Maire et al	E. F. Wilson Estate	NE., SE. ¼ NE. ¼
863	J. O. Duryee	Johnson-Bullard	SE. ¼ SW. ¼
827	Holsinger & Jordan	J. J. Radey	NE. ¼ SE. ¼
1,305	W. L. McClanahan, Inc.	John Pollard et al	NE., NW. ¼ SW. ¼
858	H. E. Pollock	Roy H. Zingery	SW. ¼ SW. ¼
730	West Virginia Oil Producing Co.	Jno. Roethlisbery	NE., NW. ¼ NE. ¼
1,153	Deerfield-Nottawa Oil and Gas Co.	Chas. E. Smith & A. J. Tillman	SW., SE. ¼ NE. ¼
1,025	Wm. Cline et al	C. K. Eddy Est.	S. ½ SE. ¼
686	St. Clair Oil and Gas Corp.	Chas. Marz No. 1	E. ½ SW. ¼
1,284	J. C. Arthurs, Inc.	A. Bowman	W. ½ N. ½ NW. ¼
1,070	Gibson, Johnson & Borden, Inc.	W. J. Mahar	NE., NE. ¼ SW. ¼
1,333	Thos. E. Currie et al	Ruth MacKenzie	C., SE. ¼ SE. ¼
1,208	Old Dutch Oil & Gas Co.	B. Loomis	SW., SW. ¼ SE. ¼
878	Uhl-Sarver-Raymer Well Drilling Co.	T. McManaman Estate	E. ½ W. ½ SE. ¼
707	H. E. Pollock	B. Campbell	SW. ¼ SW. ¼
823	St. Clair Oil and Gas Corp.	J. E. Walker	NW. ¼ NW. ¼
1,149	Michigan Gas & Oil Corp.	John Parker	C., NW. ¼ SE. ¼

in Isabella County*

Sec.	T. — R.	Elev.	Mar.	Red.	Berea.	Trav.	Dundee.	Monroe.	Gas.	Oil.	Water.	T. D.
4	Coe 13 N., 3 W.	Abandoned at 380 feet.										
28	13 N., 3 W.	810	1,290	1,390	2,540	2,955	3,630				3,649	3,667
7	Deerfield 14 N., 5 W.	946	1,370	1,540	2,568	3,097	3,682		1,366		3,725	3,734
20	Denver 15 N., 3 W.	715	1,263	1,407								1,510
35	15 N., 3 W.	729	1,160	1,315	2,550	2,940	3,556			3,048 3,601		3,625
27	15 N., 3 W.	739	(?)1,193	1,370		2,946	3,605				3,655	3,664
35	15 N., 3 W.	730	1,185	1,370	2,485	2,970	3,592				3,644	3,654
8	15 N., 3 W.	744	1,292	1,440	2,510	3,025	3,695			3,720	3,751	3,754
34	15 N., 3 W.	733	1,200	1,335	2,458	2,940	3,546			2,945	3,585	3,594
33	15 N., 3 W.	732	1,178			2,975	3,602				3,651	3,680
34	15 N., 3 W.	737	1,205	1,375	2,480	2,970	3,597			2,997	3,079	3,652
35	15 N., 3 W.	Abandoned at 668 feet.										
24	15 N., 3 W.	Shut down—bad hole at 315 feet.										
19	15 N., 3 W.	753	1,229	1,393	2,443	3,000	3,638		1,164	3,058 3,660	3,702	3,704
12	Gilmore 16 N., 5 W.	945	1,584	1,745		3,345	3,995				4,109 4,175	4,192
10	Isabella 15 N., 4 W.	779	1,485	1,640	2,690	3,200	3,842	3,948		4,452 4,482	3,989 4,020 4,520	4,595
23	15 N., 4 W.	754	1,267	1,550	2,625	3,130	3,806					3,891
1	15 N., 4 W.	781	1,320	1,430	2,495	3,018	3,674		1,302		3,750	3,797
25	15 N., 4 W.	754	1,365	1,500		3,060	3,703				3,743	3,788
24	Lincoln 13 N., 4 W.	809	1,295	1,400	2,546	3,040	3,632			3,649		3,699
35	Nottawa 15 N., 5 W.	823	1,400								1,400	1,411
11	Sherman 15 N., 6 W.	920	1,438	1,609							1,515	1,706
1	Union 14 N., 4 W.	756	1,403	1,525		3,100	3,741		3,653			3,805
27	Vernon 16 N., 4 W.	844	1,480	1,570	2,590	3,137	3,809			3,809	3,827	3,828
27	16 N., 4 W.	822	1,369	1,524	2,605	3,098	3,749				3,808	3,832
34	16 N., 4 W.	812	1,380							1,351	1,345	1,392
16	16 N., 4 W.	852	1,395	1,597		3,174	3,825				3,834	3,834
31	16 N., 4 W.	853	1,507	1,665	2,750	3,265	3,898		1,507			4,055
11	Wise 16 N., 3 W.	771	1,338	1,460	2,560	3,080	3,755					3,801
32	16 N., 3 W.	770	1,340	1,420	2,350	3,075	(?)3,685		1,362		3,768	3,795
7	16 N., 3 W.	810	1,331	1,490	2,519	3,075	3,724				3,825	3,831

*This table does not include wells in the Mount Pleasant (Chippewa twp.) Leaton, Vernon, or Broomfield pools.

The Kenyon Company drilled on the Ed. Gould farm, NW.¼ SW.¼ sec. 24, T.9N., R.10W., Courtland township (elev. 911 feet), and found several showings of oil, but the hole was plugged and abandoned at 3,000 feet. They struck the Marshall at 818, Lower Marshall red rock at 971, the Traverse at 2,480, and the Dundee at 2,900 feet. Oil was found at 2,557, 2,578, and 2,619 feet, fresh water (?) at 2,590, and salt water from 2,990 to 3,000 feet.

The East Ohio Gas Company of Cleveland, Ohio, under the name of R. W. Gallagher, Trustee, drilled a well near Silver Lake on the Wm. Pennington farm in the SE.¼ SW.¼ sec. 4, T.8N., R.10W., Cannon township, Kent County (Elev. 868 feet). Marshall sandstone was encountered at 697 feet, Coldwater red rock at 1,770, the Traverse at 2,345, and the Dundee at 2,757. Showings of oil were reported from 2,413 to 2,418, 2,663 to 2,672, 2,785 to 2,789, and 2,815 to 2,830 feet. Salt water was tapped at 2,418 and 2,830 feet.

Dillon and McFredrick put down a "wildcat" test in Cannon township on the J. A. Bullis property in the NE.¼ NW.¼ sec. 28, T.8N., R.12W. (Elev. 652 feet). In this hole, Marshall sandstone was struck at 540, the Lower Marshall at 626, Coldwater red rock at 1,630, the Traverse at 2,193, and the Dundee at 2,604 feet. A small amount of oil was found from 2,251 to 2,261 and 2,670 to 2,680 feet. Eight barrels of water per hour came into the hole from 2,261 to 2,275, and it filled up from the brine horizon at 2,296 to 2,331 feet. A small amount of brine was encountered at 2,530 feet and more in the Dundee at 2,680 where the well was abandoned.

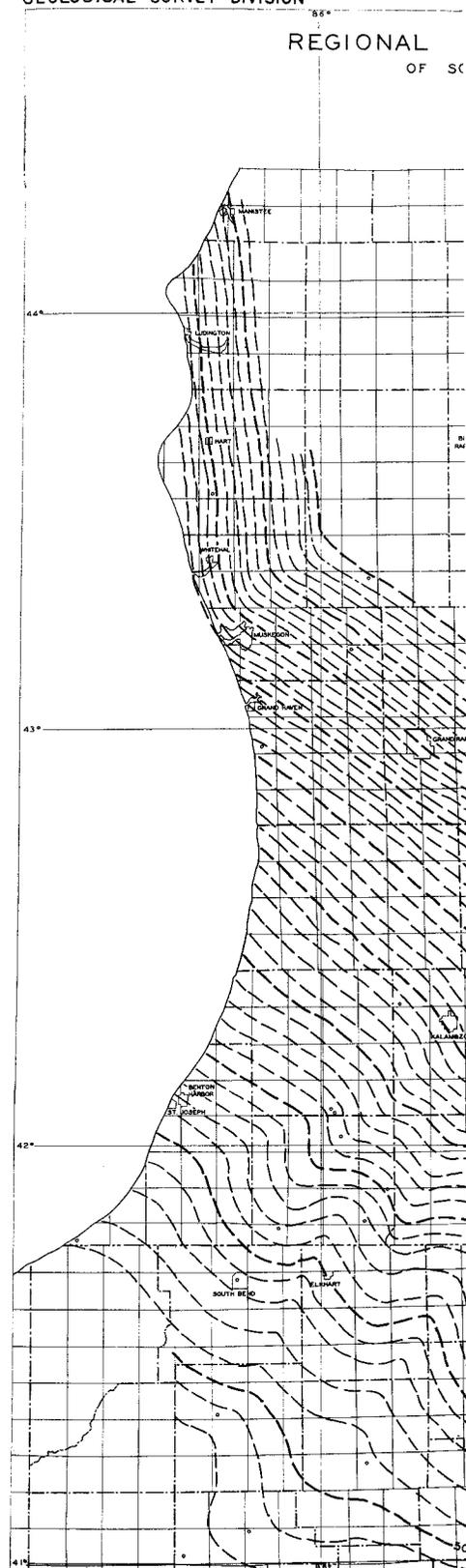
A test well was put down by J. Brooks Reed on the A. M. Cordes tract, SE.¼ SW.¼ sec. 1, T.7N., R.12W., Walker township (elev. 863 feet), but this hole was never drilled deeper than the Marshall.

The Mid-Continent Development Company drilled on the Garden Farm addition in the south part of Grand Rapids, sec. 19, T.6N., R.11W., Paris township (Elev. 691 feet). Because of the way the well was promoted and managed, considerable drilling difficulty was experienced in the upper part of the hole. Later, new management took over the project and the well was satisfactorily completed to a total depth of 2,467 feet. According to the best available records, Marshall sandstone was found at 149, Coldwater red rock at 1,236, the Traverse at 1,790, the Dundee at 2,090, and the Detroit River at 2,235 feet. Showings of gas were found at 325 and 2,244 feet, and the hole filled up with water soon after the latter showing was struck.

W. E. Lang of Lexington, Kentucky, and M. W. Shriver commenced a well on the I. Schondelmayer farm, center of SE.¼ sec. 36, T.5N., R.10W., Caledonia township (elev. 718 feet), which was completed at a depth of 2,224 feet in the name of the Kent-Barry Oil Company. The Lower Marshall was logged at 260, Coldwater red rock at 1,335, the Traverse at 1,812, the Dundee at 2,055, and the Detroit River at 2,195 feet. The depths of water horizons were 162 to 245, 345 to 380, 2,095, 2,195, and 2,218 to 2,230 feet. Small showings of oil were found at 1,885 and 2,095 feet.

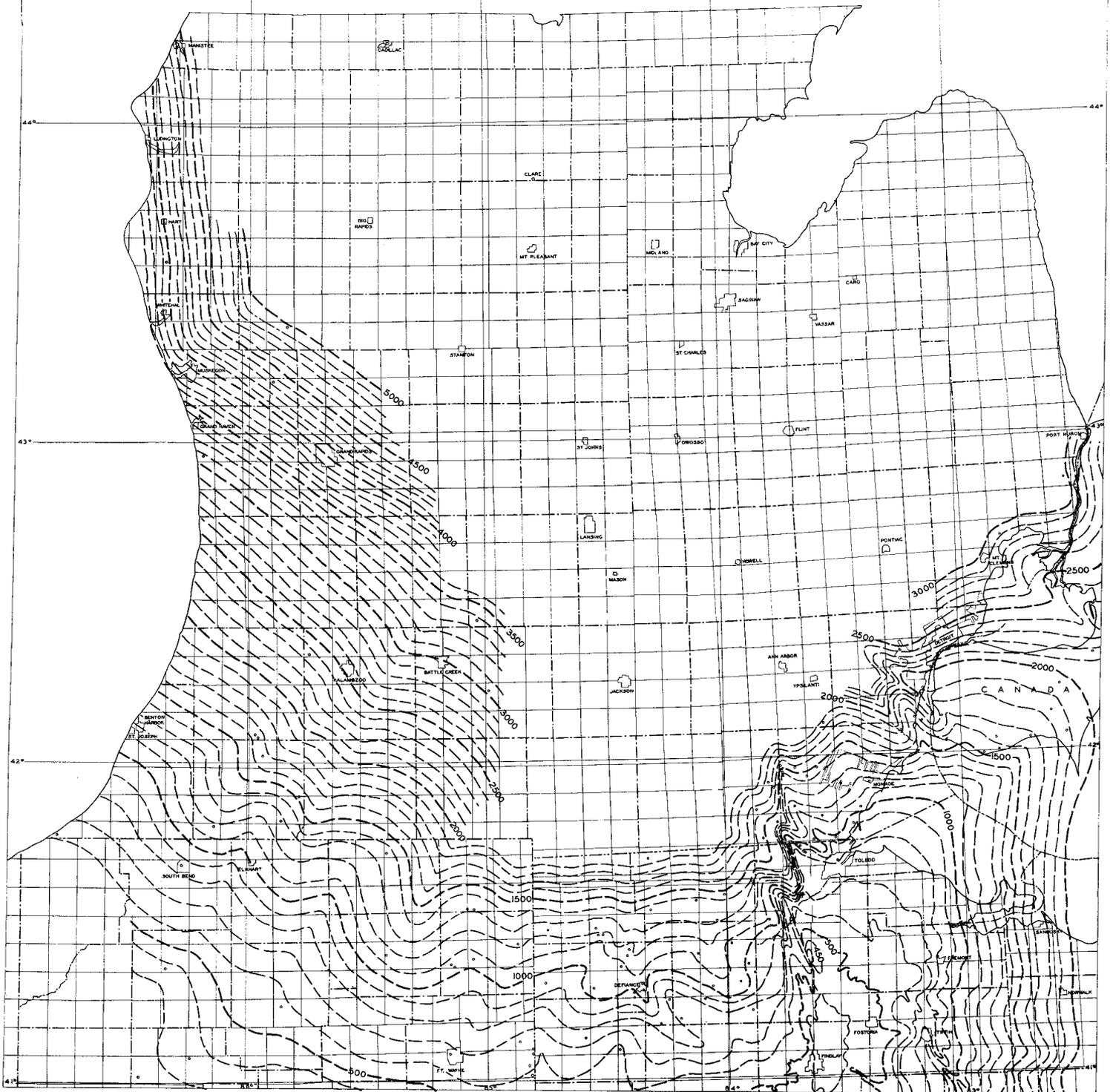
LAKE COUNTY

Lake County is on the northwest side of the Michigan Basin where the regional dip is generally southeastward. The structural geology of the county is known only from the four widely scattered wells that have



REGIONAL SUBSURFACE STRUCTURAL CONTOUR MAP

OF SOUTHERN MICHIGAN, AND PARTS OF NORTHERN OHIO,
INDIANA AND WESTERN ONTARIO
(DRAWN ON TOP OF TRENTON FORMATION)



been drilled in four different townships. These wells suggest that two highs cross the region in a northwest-southeast direction, and their trends appear to be extensions of folds worked out in adjoining counties and other districts. An indistinct line of anticlinal folding seems to cross from the southeast corner of Pleasant Plains township near Marlborough to the southwest corner of Sauble township. The other anticlinal trend is across the northeast corner of the county and seems to be traceable from southeastern Ellsworth township near Luther toward the corners of Manistee and Wexford counties on the north county line. Several small showings of oil were found in the two wells drilled in the western part of the county.

In 1928-1929, Fred J. Estes of Kentucky promoted a well, which was drilled to a depth of 2,801 feet, on the W. Kellogg property in the NW.¼ NW.¼ sec. 11, T.20N., R.11W., Dover township (Elev. 1,245 feet). Marshall sandstone was found at 1,165 feet, Antrim black shale at 2,685, and Coldwater red rock at 2,045, but the Traverse was not penetrated. Difficulties in drilling caused the hole to be plugged and abandoned.

F. A. Braendle drilled a test to a depth of 3,772 feet on the Jess Cummings farm in the SE.¼ SE.¼ sec. 32, T.18N., R.14W., Sweetwater township (elev. 821 feet), about 4 miles northeast of the small oil and gas wells in Logan township, Mason County. Napoleon sandstone was encountered at 485 feet (?), Lower Marshall red rock at 575, Coldwater red rock at 1,285, the Traverse at 2,135, the Dundee at 2,749, the Detroit River at 2,854, and the Sylvania at 3,655. A showing of oil was found in the Traverse from 2,199 to 2,202 feet, gas in the Monroe from 2,854 to 2,921 feet, and oil just above 3,665 feet. The water horizons were at 495, 2,202, and 3,665 feet, and the hole was plugged on October 24, 1930.

The Super Oil and Gas Company of Ludington drilled on the Edmund Skirven property, SE.¼ SE.¼ sec. 15, T.19N., R.14W., Sauble township, Lake County (Elev. 790 feet). Upper Marshall sandstone was struck at 555, Lower Marshall red rock at 690, Coldwater red rock at 1,280, the Traverse at 2,070, the Dundee at 2,790, the Detroit River at 3,040 (?), and the Sylvania at 3,520 feet. There were showings of oil from 1,730 to 1,750 and from 3,440 to 3,450, and water at 570, 2,205, and 2,870 feet. The total depth was 3,765 feet, where the well was plugged and abandoned in the winter of 1930.

Patterson and Day started a well in 1929 on the property of C. C. Davis et al in the NE.¼ SW.¼ sec. 19, Cherry Valley township (elev. 847 (?) feet), and drilled it to 2,998 feet or just above the Dundee, where it has been shut down ever since. Marshall sandstone was reported at 820 feet, the Lower Marshall at 1,020, Coldwater red rock at 1,647, and the Traverse at 2,536. Water was encountered at 980 and 2,546 feet.

LENAWEE COUNTY

Lenawee County is on the extreme southeast side of the Basin and just off the northwest flank of the Cincinnati arch where this structure plunges toward the Ontario peninsula (See fig. 40). The formations on the west side of this arch dip very steeply into the extreme eastern part of the county, but in the northeastern part of Macon township the Trenton may possibly be relatively high. A plunging nose, which seems to trend in a curve from a few degrees west of north to northwest

as it heads toward the center of the basin, begins on the south line near South Fairfield in Ogden township, extends a little west of Adrian and continues diagonally northwestward across Woodstock township in the northwest corner of the county. This region has not been tested for some time, but gas wells in the drift at Sprunk's greenhouse in Blissfield, and in Addison may lead to new drilling. Three deep wells were put down in the eastern part of the county near the Deerfield anticline where production had been found in the Trenton "rock."

Allen Borton started a well on the S. E. Lawerance farm in the SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 5, T.6S., R.5E., Ridgeway township, near the village of Britton (Elev. 715 feet). Drilling was carried on intermittently, and operations have been shut down at 1,910 feet since the spring of 1931. The Trenton was not reached. The first rock was the Berea formation, and samples indicated the top of the Antrim at 214, the Traverse at 365, the Dundee at 476 (?), the Detroit River at 595, the Sylvania at 815, and the Bass Island at 856 feet. Showings of oil and gas were not reported in the hole.

A deep well was drilled through the Trenton to a depth of 3,328 feet by the LaDu Oil Corporation on the Anna Long farm, NE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 2, T.7S., R.5E., Deerfield township (Elev. 707 feet). In this hole, the Traverse was found at 190, the Dundee at 320, the Sylvania at 575, the Bass Island at 650, the Niagaran at 1,385, the Cataract at 1,760, the Trenton at 2,373, and Lower Magnesian group at 3,122 feet. Small showings of oil were found at 850, 950, 1,100, 2,753, and 2,970 feet, and a fair showing of gas was struck from 1,245 to 1,280 feet. Water came into the hole from 3,325 to 3,328 feet.

The D-O-H-I Oil Corporation put down a well on the William Farrow farm in the SE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 13, T.8S., R.5E., Riga township, to a depth of 1,477 feet (Elev. 696 ft.). The Traverse was at 115 feet, the Dundee at 215, the Sylvania at 365, the Bass Island at 480, the Niagaran at 1,124, and the Clinton (?) at 1,371. Small showings of gas were reported at 70, 290, 308, 437, 555, 718, 775, and 824 feet, and oil was found in small quantities at 1,371 feet. Water was encountered at 105, 380, 458, 1,272, and 1,375 feet.

LEELANAU COUNTY

The regional dip in Leelanau County is generally southeast, but the rate is practically indeterminable because of the thick glacial drift and scarcity of wells. Undoubtedly, minor folding crosses the county because the trend of Central Michigan structures is in its direction.

The only deep well in the county was drilled in the years 1930 to 1932 by Clyde U. Smith, Trustee, on the Philip Heimforth farm in the SW. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 6, T.28N., R.11W., Elmwood township, to a depth of 2,475 feet (Elev. 673 feet). Antrim black shale was first penetrated beneath 435 feet of glacial drift, and then the Traverse was struck at 510, the Dundee at 1,305, the Detroit River at 1,432, the Sylvania at 1,992, and the Bass Island at 2,165 feet. Showings of oil were found at 1,230, 1,242, 1,915, and 1,990 feet and water at 1,230, 1,242, 1,335, 1,350, 1,570, 1,775, 2,125, and 2,360 feet. The water at 1,570 feet was reported to be fresh.

MACOMB COUNTY

The structural geology of Macomb County is uncertain, except in the immediate vicinity of Mount Clemens where most of the wells have been drilled. Here many of the logs are inaccurate. The regional dip in northern Macomb County seems to be almost north or possibly slightly northeast into a major syncline that apparently crosses the northeast corner of the county in Richmond township. A broad local structural arch extending from northeastern Lake township toward northwestern Shelby township is indicated by the contours on the Traverse (see pl. III), and some kind of gentle reversal in dip is suggested by the wells in the north part of Mount Clemens. Possibly this reversal is due to a cross fold that seems to extend southwestward from the vicinity of the village of St. Clair toward the north shore of Anchor Bay, where several wells have been drilled. Except for one hole in the northern part of Macomb County, the testing for oil and gas has been near Mount Clemens. Since 1928, six wells have been commenced and two of them drilled to the Niagaran.

After the completion in 1928 of the Otto Coulon No. 1 well, in the NW. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 4, T.2N., R.13E., the St. Clair Oil and Gas Corporation drilled 4 more wells in the same community.

The Otto Coulon No. 2 was in the S. $\frac{1}{2}$ N. $\frac{1}{2}$ SW. $\frac{1}{4}$ sec. 4, 150 feet from the north and 700 feet from the west property lines (Elev. 598 feet). The Traverse was found at 319 feet, and the well was drilled to 405 feet. Showings of gas were struck at 321, 350, and 400 feet.

The Otto Coulon No. 3 in the same quarter section, but 310 feet from the north and 300 feet from the west property lines, was drilled to a depth of 660 feet (Elev. 593 feet). The drift was 295 feet in depth, the Traverse was at 330, and the Dundee at 555 feet. Mineral water was encountered at the bottom of the hole.

The Frank Blaisdell well in the SE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 5 attained a depth of 1,420 feet but was plugged back to 635 feet (Elev. 598 feet). The drift was 285 feet thick, the Traverse was found at 320, and the Dundee at 547 feet. There was a show of oil in the Dundee at 589 feet.

The only deep well in the Coulon district was the Fred Coulon No. 1, in the SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 5 (elev. 597 feet), drilled in the fall of 1929. In this well, the drift was 100 feet thick, the Traverse was at 325, the Dundee at 572, the Sylvania at 1,027, and the Salina salt at 1,482 feet. The well was finished at 2,564 $\frac{1}{2}$ feet in brown lime beneath the salt. Water was encountered at 654, 807, 947, and 1,002 feet.

A test well, 1,208 feet in depth, was put down in 1931-1932 by the Central Development Company on the Brewer property in the SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 33, T.5N., R.12E., Bruce township (Elev. 853 feet). According to information, this well entered the Coldwater formation at 92 feet and found the Berea at 728, and the Traverse at 1,108 feet. Showings of gas were reported at 609-618 feet and oil at 318 and 1,054 feet. Water, which filled the hole, was struck at 618 feet and sulfur water at 1,204 feet.

H. H. Brown, formerly of the St. Clair Oil and Gas Corporation, drilled a well 2,575 feet deep on the Gregory Krantz estate in Private Claim 193, T.3N., R.14E., Chesterfield township (Elev. 581 feet). The Traverse was penetrated at 435 feet, the Dundee at 670, salt at 1,895, and the Niagaran at 2,364. A small amount of gas was found at 426

feet, gas, oil, and water at 935, and showings of oil at 2,371 and 2,494 feet. Water horizons were at 691, 760, and 2,572 feet. The last showings were shot with 100 quarts of nitroglycerin without appreciable increase, and the hole was plugged and abandoned.

Another well being drilled by H. H. Brown on the Louis Bower et al property, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T.3N., R.14E., is now down about 495 feet. (Feb. 1, 1933)

MANISTEE COUNTY

The structural geology of Manistee County is very poorly understood, but the general dip is a little south of east at about 35 feet to the mile. A large number of salt wells have been drilled around Manistee Lake, but with the exception of one well in the northwest corner of Manistee County, there has been no prospecting for oil and gas beyond the immediate vicinity of the city of Manistee. The wells at Manistee indicate an anticlinal fold, but the location of the axis is difficult to determine.

There is evidence of a south dip both at Stronach and on the west side of Manistee Lake, but whether or not this dip has a southwest component cannot be definitely determined. The structure seems to trend from near the northwest corner of sec. 12, Filer township in the city of Manistee, eastward and possibly southeastward across Manistee Lake into sections 7, 8, 17, and 18, Stronach township. Another anticlinal fold possibly crosses Manistee County from the region between Bear and Portage lakes to near the southeast corner.

Ruggles and Rademaker finished a deep well, No. 24, near the salt plant in the SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 12, T.21N., R.17W., Filer township, to a depth of 5,280 feet in June, 1928 (Elev. 591 feet). The base of the drift was found at 590, the Traverse at 930, the Dundee at 1,590, Detroit River salt at 1,981, the Sylvania at 2,345, Salina salt at 2,960, the Niagaran at 4,195, the Manitoulin at 4,685, and the Trenton at 5,000 feet. Gas showings were found in the Ellsworth formation at 800 feet, the Sylvania at 2,350; oil in the bottom of the Salina at 4,060 feet, and dead oil with some gas in the Niagaran at 4,243 feet. Salt water was encountered at 2,460, 3,620, and 5,185 feet.

John H. Rademaker drilled a brine well to a depth of 2,410 feet on the east side of Manistee Lake in Government Lot No. 1, sec. 7, T. 21N., R.16W., which was completed in August, 1931. Brine was found in sandstone at 2,390 feet.

In November 1929, Tackett and Drake of Chicago started a well on the Manistee Sand and Dock property in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T.21N., R.17W., which was completed in the Upper Monroe to a depth of 2,000 feet (Elev. 638 feet). The Traverse was struck at 957, the Dundee at 1,645, and Detroit River salt at 1,945 feet. Showings of gas were found in the drift at 430 feet and near the base of the drift at 640 feet, in the Antrim at 855, the Traverse at 1,040, the Dundee at 1,647 and 1,710, and the Detroit River at 1,940 feet. Brine came into the hole at 1,018, 1,060, 1,647, 1,710, 1,875, and 1,940 feet. It was plugged and abandoned in May, 1930.

Smith and Macauley of Detroit drilled on the Lena Piellusch property in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 20, T.21N., R.16W., Stronach township to a depth of 2,041 feet (Elev. 612 feet). The top of the Traverse was at 1,030, Traverse limestone at 1,070, and the Dundee at 1,705 feet.

Some gas was found at 1,085 and oil with gas at 2,003 feet. There was salt water in the Traverse beneath the gas at 1,087 feet.

The Swastika Oil and Gas Company of Muskegon put down two wells northeast of Manistee which fairly well established the north reversal of the East Lake anticline. These wells were also interesting in that they were drilled through nearly 600 feet of glacial drift with a light rotary outfit and then completed with cable tools. The first well, 2,023 feet deep, was on the flats northeast of the lake on the property of the Louis Sands Lumber Company in the NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T.21N., R.16W. (Elev. 584 feet). The top of the Traverse was at 910, the Dundee at 1,610, and Detroit River salt at 2,000 feet. Water was encountered at 1,837 feet and a small amount of oil at 1,851 feet, but the hole was plugged and abandoned in the summer of 1930. The second test was on the W. H. Cromer farm in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T.22N., R.16W., Manistee township (Elev. 615 feet). The top of the Traverse was reported in the driller's log at 930 feet, but another source gave it as 1,050 feet, the Dundee was at 1,726 $\frac{1}{2}$ and Detroit River salt at 2,045 feet. There was a show of gas in the hole at 1,210 feet, and water came in at 980 and 1,731 feet.

The Fisher-Robbins Oil & Gas Company commenced a well on the Chamberlain Estate in the NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, T.24N., R.16W., Arcadia township, which was drilled to 890 feet (Elev. 602 feet). Some gas was found at 478 and 535 feet and water at 530, 712, and 835 feet. According to unreliable reports, the Traverse was at 860 feet, but this has not been confirmed. Operations at the well have been shut down for several years.

MASON COUNTY

The east and southeast regional dip in Mason County seems to flatten somewhat from that in Manistee County, and between Ludington and the southeastern corner of the county it appears to be between 22 and 23 feet to the mile. The only wells in the county are near Pere Marquette Lake in Ludington, between Ludington and Manistee in Grant township, and south of Walhalla in Logan township. From these few wells, it is difficult to determine local structural trends. A broad east-west high seems to extend across the bottom part of the southern row of townships, and the extension of the East Lake anticline in Manistee County may possibly cross the townships in the northeast corner of the county. The Logan township wells suggest a gentle southeast plunging nose, but the south well of the group, with the Traverse apparently high, was dry.

After the discovery of a small volume of gas in 1927 by the Logan Oil Company near the top of the Sylvania formation in a well in sec. 9, Logan township, the chief stockholders of this company, acting as trustees, started another well on the north side of the Pere Marquette River on the Geo. H. Young farm in the NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 9 (Elev. 666 feet). This well, the Young No. 2, struck the Coldwater red rock at 1,011, the Traverse at 1,850, the Dundee at 2,426, the Detroit River at 2,552, and the Sylvania at 3,139 feet. Considerable drilling difficulty was experienced with the hole, and although some favorable showings were found at about the same depth as in the first well, it was plugged and abandoned at 3,294 feet. A showing of Dundee oil was found at 2,439,

but water came in at 2,440 feet. The hole also filled up with water from near the top of the Sylvania, but a break in the pipe at about this time made it almost impossible to determine either the Sylvania gas or water horizons.

The second gas well in the district was the Taggart and Welch, F. Campbell No. 1, in the NW.¼ NW.¼ sec. 16 (elev. 666 feet), and when closed in on November 29, 1928, it was reported to have a capacity of about 500,000 cubic feet. Although drilled to a depth of 3,310 feet, the well was plugged back to 3,275 feet and shot twice, once with 60 quarts of nitroglycerin and once with 80 quarts. The top of the Coldwater red rock was at 1,004 feet, the Traverse at 1,830, the Dundee at 2,425, the Detroit River at 2,551, and the Sylvania at 3,226 feet. There were shows of oil and gas in the Ellsworth beds at 1,620 feet, in the top part of the Dundee, and in the Sylvania gas horizon from 3,234 to 3,238 feet.

Taggart and Welch next drilled on the L. N. Lake property in the NW.¼ SE.¼ sec. 10 (elev. 692 feet), and completed an oil well in the Traverse formation which filled up 1,150 feet with oil the first night. About 1,800 barrels were pumped from the well, but at present it is not operating. Coldwater red rock was struck at 1,061 feet and the Traverse at 1,890. The oil and gas "pay" occurred at 1,907½ feet, and the hole was drilled to 1,909 feet.

In an effort to find more Traverse oil, the same operators drilled 2 dry holes in sec. 10. The first of these was on the W. O. Lake farm in the NE.¼ SE.¼ sec. 10 (elev. 702 feet) and was drilled to a depth of 2,700 feet, where it was plugged and abandoned in April, 1929. Red limestone was struck near the base of the Coldwater at 1,074 feet, the Traverse at 1,895, the Dundee at 2,502, and the Detroit River at 2,579 feet. Water, struck at 1,928 feet, filled the hole to within 400 feet of the top. The second test, which was on the Harry Barnett property in the NE.¼ SW.¼ sec. 10, was drilled to about 2,300 feet. It was then allowed to stand with casing in the hole until November 1931, when it was cleaned out and deepened 20 feet. Here was encountered water which almost filled the hole.

The last well in the Walhalla region was the Taggart and Welch & Thompson Brothers—H. A. Barnett in the NW.¼ SW.¼ sec. 16 (Elev. 756 feet). This was drilled to a depth of 3,406 feet. The Coldwater red rock was at 1,131, the Traverse at 1,935, the Dundee at 2,544, and the Sylvania at 3,348 feet. There were showings of oil at 1,960 and 1,980 feet and gas at 3,350 feet. Two gas "pays" of 10,000 cubic feet each were encountered at 3,355 to 3,360 and 3,375 to 3,380 feet. Water was struck at 1,990, 2,015, and 2,558 feet. The quantity of gas was too small to save, and the well was plugged and abandoned in July, 1931.

M. I. Diamond of Chicago and his associates drilled 5 shallow wells and 1 deep well in Grant township in the northwest corner of the county. The discovery of a large flow of gas at the base of the drift in the first well caused the continuation of drilling. The Diamond-Thompson-Holland—M. I. Diamond No. 1 was in the SE.¼ NW.¼ sec. 15, T.20N., R.17W., Grant township (Elev. 654 feet). It was drilled to a depth of 634 feet and gauged 2½ million cubic feet of gas and 230 pounds rock pressure.

The same organization drilled on the Lee A. Lewis farm, in the NW.¼ SW.¼ sec. 15, to a depth of 2,385 feet (Elev. 654 feet). The Traverse

was encountered at 1,355, the Dundee at 2,035, and the Detroit River at 2,160 feet. Water was found at 1,424 feet and a "hole full" at about 2,260, but no showings of oil and gas were recorded.

The rest of the shallow wells put down by M. I. Diamond were between 600 and 700 feet deep. The J. B. Benson No. 1 was in the SE.¼ SE.¼ sec. 15 and had between 2 and 3 million cubic feet of gas at depths from 630 to 660 feet. At 660 feet, the hole filled up with water. The Joe Adamczak No. 1 was in the SW.¼ NE.¼ NW.¼ sec. 15 and was a dry hole at the same depth. The M. I. Diamond Fee No. 2 was in the SE.¼ NW.¼ sec. 15 (elev. 653 feet) and had gas in a fine sandy gravel from 640 to 643 feet, but it was plugged as a dry hole. The M. I. Diamond Fee No. 1, which was in the NE.¼ SW.¼ sec. 15, had gas at 640 and water at 650 feet.

MECOSTA COUNTY

Mecosta County is centrally located in the Michigan Basin just west of its deepest part and, although the prevailing regional dip is to the northeast, there seems to be also dips to the southeast and northwest. The regional structure is essentially a northeast plunging trough which is crossed by northwest-southeast lines of folding whose noses plunge into this trough. One of these lines of folding is the Broomfield "high" which trends from Isabella County across parts of Sheridan, Fork, and Chippewa townships (See pl. IV). Another line of anticlinal folding seems to cross from the southeast corner of the county toward Big Rapids, and a third may extend from southwestern Deerfield across Aetna township. The first of these "highs" is the only one about which there is a very definite information.

The first deep well in Mecosta County was completed by the Benedum Trees Oil Company on the F. I. Truman property, SW.¼ SW.¼ sec. 26, T.14N., R.8W., Morton township, to a depth of 4,737 feet (Elev. 1,001 feet). The Parma occurred at 885 feet, the Marshall (?) at 1,365, Lower Marshall red rock at 1,565, the Traverse at 3,040, the Dundee at 3,606, the Detroit River at 3,720, and the Sylvania at 4,687 feet. Water was found at 620, 3,612, 4,687, and 4,713 feet, and there was a showing of oil at 3,790 to 3,797 feet.

The Big Rapids Gas and Oil Corporation drilled a test on the Hans Anderson farm, NE.¼ NW.¼ sec. 14, T.15N., R.9W., Colfax township (Elev. 1,013 feet). The Parma was at 845 feet, the Napoleon (Upper Marshall) at 1,343, the Lower Marshall at 1,440, the Traverse at 3,020, the Dundee at 3,610, the Detroit River at 3,685, and the bottom at 3,742. Fresh water was found at 547 feet and brine at 895, 3,100, 3,150, 3,665, and 3,735 feet. A small show of oil and gas was found at 3,120 and some oil at 3,305 feet, but the hole was plugged and abandoned.

A well was drilled south of Remus by Lewis D. Mehrtens and others on the Michael Baumann farm, SE.¼ SW.¼ sec. 21, T.14N., R.7W., to a depth of 3,908 feet (Elev. 1,101.8 feet). This hole penetrated 693½ feet of drift. The stray gas sand in the Michigan series was at 1,498 feet, the Marshall at 1,545, Lower Marshall red rock at 1,655, the Traverse at 3,280, and the Dundee at 3,820. There was a small showing of black oil in the Michigan "sand" at 1,503 feet and brine in the Dundee at 3,895.

Benedum Trees Oil Company also drilled two wells in Sheridan township. The first of these on the William F. Grove Farm, NW.¼ NW.¼

SE.¼ sec. 14, T.15N., R.7W. (elev. 1,021 feet), was completed in the Detroit River formation to a depth of 3,904 feet. This well encountered the Parma at 1,050 feet, the Michigan "gas sand" at 1,387, the Napoleon at 1,491, Lower Marshall red rock at 1,692, the Traverse at 3,221, the Dundee at 3,792, and the Detroit River at 3,892. Gas was found in considerable volume at 1389-1393, 1615-1620, and black oil at 1,692 feet; a little gas was tapped from 2610-2690, but no favorable showings were found in the deeper Devonian formations. There was a "hole full" of water at 690 feet, water at 1,394, 1,395, and 3,860 feet, and a big flow at 3,982 feet. The second well, on the Clarence E. Brand farm, NW.¼ SE.¼ sec. 24, was drilled to a depth of 1,518 feet (Elev. 1,050 feet). The Parma was at 1,010 and the Marshall was at 1,502 feet, with water at 1,517 feet. The hole was plugged in February, 1931.

A further attempt to find the continuation of the gas horizons of the Grove well was made by the American Natural Gas Company on the Elmer E. Brehm farm, SE.¼ SE.¼ sec. 10 (Elev. 1,028 feet). The Michigan "stray gas sand" was at 1,406 feet, 12 feet lower structurally than in the Grove No. 1, and contained no gas. The Marshall was encountered at 1,488 feet, and brine was tapped at 1,503 feet, the bottom of the well.

MIDLAND COUNTY

The structure of the rocks in Midland County, as interpreted from wells drilled for oil, gas, and brine, is shown in Plates IV and V. The principle known structural features of the county are the Mount Pleasant trough in southwestern Greendale township, Jasper township, and southwestern Porter township; the Greendale "high" in Greendale township, west central Lee township, northeastern Jasper township, and Porter township; the Midland trough in Midland township, Homer township, northeastern Lee township, Jerome township, Geneva township, and southwestern Warren township; and a possible extension of the Saginaw "high" that would parallel the Midland trough on the north. The regional setting of these features is better shown in Plate III, which covers the entire southern peninsula.

The wildcat wells in the county were drilled with hopes of extending the areas of production in the Mount Pleasant, East Extension, and Porter pools. Some of them were along the trend of the Midland "high" and others, where operators anticipated some unusual change in the direction of the fold, were more off the flanks. The wells listed and described in Table XXII are the wildcat wells drilled for oil and gas since January 1, 1928, exclusive of those on the borders of the outlined pools. This table indicates the depths to the important formations penetrated and to the oil, gas, and water horizons. The wildcat wells were drilled in Geneva, Ingersoll, Jasper, Jerome, Lee, Midland, Porter, and Mount Haley townships, and several of them had large enough showings of oil and gas to indicate the extension of old pools or possibly the discovery of new ones.

MISSAUKEE COUNTY

The regional structure of southern Missaukee County seems to be somewhat affected by the northwest prolongation of the Midland trough. In the northern part of the county, the regional dip is mostly south-

ward, but there is evidence of north-south trending folds. The north-west trend of the Greendale "high" apparently crosses the southwestern corner of the county.

The first well in Missaukee County was drilled by Henry Miltner, Trustee, on the Miller-Browarsky-Gottschalk tract, NE.¼ NE.¼ sec. 24, T.24N., R.7W., Pioneer township (Elev. 1,295 feet). This test was the first in the State to find a real flow of "shale gas" in the Antrim black shale. The gas was struck at 2,630 feet. In June 1931, the well was shot with 110 quarts of nitroglycerin between the depths of 2,630 and 2,661 feet, and the initial production of 60,000 cubic feet was increased to 76,000 cubic feet. This gas is still shut in awaiting additional discovery. The formations in the well were penetrated as follows: the Marshall at 1,025, Lower Marshall red rock at 1,115, the Traverse at 2,842, and the Dundee at 3,528 feet. Besides the "shale gas," there was about 12,000 cubic feet of gas at 3,025, and showings of oil at 2,025 and 3,046 feet. The Dundee salt water at 3,580 was shut off in plugging back to shoot the shale gas "pay."

The Pioneer Oil and Gas Company drilled the second well in the region on the G. D. Miller property in the SW.¼ SW.¼ sec. 23, T.24N., R.7W., Pioneer township, to a depth of 3,742 feet (Elev. 1,419 feet). This hole encountered the Napoleon (Upper Marshall) at 1,035, Lower Marshall red rock at 1,175, the Traverse at 2,940, and the Dundee at 3,653 feet. The water horizons were 1,035 to 1,080 feet ("hole full" at 1,040), 1,150 to 1,175 ("hole full" at 1,155), 2,985 to 3,077 ("hole full" at 2,987), and 3,653 to 3,742 ("hole full" at 3,742). Some oil came in with the water at 2,987 feet and, when shut down at 3,055, the hole contained both water and oil.

MONROE COUNTY

The structural geology of Monroe County is interpreted from a sub-surface contour map (see fig. 40) drawn on top of the Trenton limestone of Ordovician age. The regional rise of the strata out of the Basin and the north end of the Cincinnati arch brings these rocks within easily accessible drilling range in southeastern Michigan. The formations in western Monroe County dip steeply westward off the arch, but there is a more gentle north dip in the central part of the county that suggests a terrace structure similar to other Trenton "rock" fields. However, the terrace is not flat like in northwestern Ohio. A northward plunging nose trends from Sylvania in Ohio toward Saline in Washtenaw County, and the small oil wells near Deerfield and Dundee are on this nose. It seems to be interrupted diagonally by a northwest-southeast anticlinal fold extending from southeastern Bedford township toward Petersburg. Another broad structural nose plunges from the vicinity of Strasburg toward West Sumpter and the Washtenaw county line, where it meets the north line of Monroe County.

Hess and Roy drilled a Trenton well on the Frank G. Brunt farm, NE.¼ NE.¼ sec. 9, T.8S., R.7E., Bedford township, which was completed in May, 1929 (Elev. 642 feet). The top of the white Niagaran was found at 725, the Trenton at 1,757, and the hole was drilled to 1,907 feet without favorable results.

Sheehan and Cilley put down a hole near Dundee on the Geo. P. Huntley farm in the NW.¼ NW.¼ sec. 15, T.6S., R.6E., Dundee town-

TABLE XXII.—Wildcat Wells

Permit.	Company.	Farm.	Location.	Sec.	T. R.
585	J. C. Arthurs	Geo. Histe	SW., SE. ¼ NE. ¼	10	Geneva, 15 N., 2 W.
767	Geneva Oil Co.	W. Henry	SW. ¼ SW. ¼	33	15 N., 2 W.
1269	W. L. McClanahan, Inc.	L. Hughes	SW., NE. ¼ NE. ¼	20	15 N., 2 W.
736	Midland Oil Dev. Co.	Geo. Buck	SE. ¼ NW. ¼	19	15 N., 2 W.
662	J. O. L. Spracklin	V. McClintic-Hood	NW. ¼ NE. ¼	29	15 N., 2 W.
1258	W. Hunter Atha	Chemical State Savings Bank	C., SW. ¼ SE. ¼	21	Ingersoll 13 N., 2 E.
1300	Michigan Pacific Oil and Gas Co.	Chas. S. Hoyt	NW., NW. ¼ NE. ¼	24	Jasper 13 N., 2 W.
1255	Fred Sias	Merryfield-M. Nelson No. 1	NE., NE. ¼ SW. ¼	17	Jerome 15 N., 1 W.
891	Chas. Strange	State of Michigan	NW., SE. ¼ SW. ¼	17	15 N., 1 W.
1360	Michigan Gas & Oil Corp., et al.	B. Rayner No. 1	SW., SW. ¼ SW. ¼	6	Lee 14 N., 1 W.
1238	E. B. Strom	D. A. Newland	SW. ¼ NE. ¼	19	14 N., 1 W.
1223	Theodore Oil Co.	S. M. Robinson	SW., SW. ¼ NW. ¼	26	14 N., 1 W.
1224	M. D. Wells and G. W. Miller	H. G. C. Thom	S. ½ SE. ¼	9	14 N., 1 W.
1028	Mid-Bay Oil Co.	C. W. Patrick	E. ½ W. ½ NE. ¼	24	Midland 14 N., 2 E.
862	Geneva Oil Co.	M. V. Warken	SW. ¼ SE. ¼	8	Porter 13 N., 1 W.
1170	Michigan Pacific Oil and Gas Co.	Jos. H. Otway, Jr. No. 1	NW., NW. ¼ NW. ¼	26	13 N., 1 W.
1289	Michigan Pacific Oil and Gas Co.	Jno. Otway No. 1	NE., SE. ¼ NE. ¼	27	13 N., 1 W.
1385	Michigan Pacific Oil and Gas Co.	Jos. H. Otway, Jr. No. 2	NE. ¼ SW. ¼	22	13 N., 1 W.
1428	M. M. Johnson and V. R. D. Kirkham	Frank Otway	NE., NE. ¼ NE. ¼	27	13 N., 1 W.
1231	The Pure Oil Company	F. Howland	SW., SW. ¼ SW. ¼	23	13 N., 1 W.
598	Sun Oil Company	L. H. Doyle No. 1	NE. ¼ NE. ¼	32	13 N., 1 W.
1226	J. M. Markle, Tr.	H. Sims	NE. ¼ SE. ¼	4	Mt. Haley 13 N., 1 E.
952	Ohio Oil Co.	T. B. Clapp No. 1	W. ½ SW. ¼	34	13 N., 1 E.

*This table does not include wells in the Mount Pleasant (Greendale Twp.), or East Extension (Greendale, Lee Twps.) pools.

in Midland County*

Elev.	Mar.	Red.	Berea.	Trav.	Dundee.	Monroe.	Sylvania.	Gas.	Oil.	Water.	T. D.
681	1,284	1,417	2,502	3,102	3,705					3,770	3,808
706	1,192	1,345	2,455	2,945	3,576						3,682
693	1,223	1,375	2,481	2,978	3,617				3,650		3,671
698	1,290	1,420	2,485	2,985	3,620			3,648	3,652	3,656	3,678
711	1,260	?	2,463	3,010	3,618					3,668	3,677
642	1,100	1,221	2,288	2,834	3,445	3,550	4,607	{ 4,607 4,637 }	4,651	{ 3,540 4,662 }	4,662
691	1,153	1,280	2,420	2,920	3,486			3,035		3,556	3,561
659	1,220	1,335	2,467	3,114	3,696					{ 3,808 3,958 }	3,958
662	1,278	1,390	2,480	3,120	3,705					3,960	3,975
669	1,170	1,295	2,425	2,920	3,540						3,548
667	1,163	1,287	2,390	2,915	3,545			3,560			3,604
665	1,163	1,269	2,383	2,922	3,551					3,668	3,668
656	1,180	1,305	2,425	2,905	3,594					3,835	3,837
677	1,180	1,285	2,439	2,962	?				3,800	{ 1,905 3,790 }	
663	1,060	1,160	2,304	2,820	3,398				3,413		3,464
683	1,064	1,156	2,281	2,765	3,382			3,417	{ 2,882 3,421 }		3,443½
687	1,095	1,182	2,304	2,785	3,382					3,477	3,480
682	1,072	1,165									
683	1,068	1,165	2,314	2,793	3,383				3,417	3,473	3,473
696	1,185	1,275	2,442	2,922	3,522					3,555	3,556
647	1,155	1,252	2,375	2,915	3,538				{ 2,418 3,541 }		3,615
687	1,029	1,180	2,317	2,829	3,432				2,950	3,510	3,517

ship (Elev. 695 feet). The top of the Trenton was at 2,227 feet, and there was a showing of oil reported at 975 and gas at 2,275 feet, but the hole was abandoned at 2,335 feet.

North of the old Deerfield Pool in western Monroe County, Wm. J. Morris, Trustee, made a Trenton test on the LaPointe & Dusseau farm in the NE.¼ NW.¼ sec. 19, T.6S., R.6E., (Elev. 709 feet). The Sylvania occurred at 270, the Bass Island at 390, the Niagaran at 1,100, and the Trenton at 2,125 feet. The Monroe-Salina showed some oil at 885 feet, and the Trenton had saturation at 2,202, 2,235-2,240, and showings in the cuttings down to 2,253 feet. The well was shot with 220 quarts of nitroglycerin from 2,202-2,253 feet, and the estimated initial production was 15 to 20 barrels per day.

W. J. Morris also drilled on the Arnold Reau farm in the SE.¼ SW.¼ sec. 18, T.6S., R.6E., (Elev. 706 feet). In this well the Guelph was found at 1,100 feet, the Trenton at 2,147, and, although water was struck at 2,262 feet, drilling was continued to 2,282 feet. Some gas and oil were found at 2,185 feet. The hole was plugged back from 2,282 to 2,262 feet with a lead plug and shot with 200 quarts of nitroglycerin between 2,188 and 2,248 feet, but the quantity of oil was not materially increased. Operations were abandoned in February, 1931.

A third test by W. J. Morris, on the Michael Lidster farm, NW.¼ NW.¼ NW.¼ sec. 18, T.6S., R.6E., was drilled through the Trenton to a total depth of 3,160 feet (Elev. 707 feet). The Sylvania was at 375, the Bass Island at 450, the Niagaran at 1,275, the Trenton at 2,243, and the first sandy beds, probably of St. Peter's age, at 2,965 feet. There were gas and oil at 825 feet and a showing of gas at 2,248, but water came in at 2,597 feet, and the hole was plugged and abandoned on June 10, 1931.

E. L. Dayton drilled a well near Cone on the Geo. Fasking farm in the NE.¼ NE.¼ sec. 30, T.5S., R.6E., Milan township (Elev. 692 feet). The hole went through the drift into the Bell shale, found the Sylvania at 520 feet and the Bass Island at 710, and it was shut down at 1,035 feet. A showing of gas was encountered at 663 feet. The Fasking No. 2 was in the SE.¼ NE.¼ sec. 30 (elev. 692 feet) and found the Dundee at 120 feet, water at 125, and black water at 640 feet, which filled the hole. This well is shut down at 650 feet.

Alfred Violette of Detroit commenced to drill in the summer of 1930 on the Nachtergale farm in the NE.¼ SW.¼ sec. 15, T.5S., R.7E., London township (Elev. 657 feet). The Sylvania was reported at 290 feet, and at 610 feet drilling operations were suspended and never started again.

MONTCALM COUNTY

The regional structure of Montcalm County is very much like Mecosta, although its location is not quite so far in toward the center of the "basin." The county is probably crossed by at least two lines of anticlinal folding more or less parallel to the Broomfield "high" of Isabella County. Similar northwest-southeast structural troughs to those in the central part of the "basin" separate the "highs." There is some evidence to support the idea that one of the "highs" crosses somewhere along a line from Crystal to Six Lakes and the other from Fenwick to near the village of Amble, which is between Lakeview and Howard City. However, the evidence of these "highs" is fragmentary, because there are only 3 deep wells

and 2 shallow Marshall tests in the county. These possible trends must be proved by further geophysical or drilling development.

The first wells in the county were drilled in 1928-29 to the Lower Marshall red rock by the Fish Creek Oil Company of Carson City. The Charles A. Ludwick No. 1 was in the SE.¼ SE.¼ sec. 36, T.9N., R.5W., Bloomer township (Elev. 792 feet). The top of the Marshall in this well was at 885 feet and the top of the red rock at 985. The Robert and Arthur Montgomery No. 1 was in the SE.¼ SE.¼ sec. 27 of the same township (Elev. 758 feet). The top of the Marshall was at 888, red rock at 988, and bottom of the well at 997 feet.

Bale, Hickey, and Snyder Bros. drilled a well to 4,385 feet near Lakeview on the Ernest Snyder farm in the NE.¼ SW.¼ sec. 20, T.12N., R.8W., Cato township (Elev. 938 feet). In this hole, the Parma was at 765 feet, the Marshall at 1,270, Lower Marshall red rock at 1,355, the Traverse at 2,860, Traverse limestone at 2,930, the Dundee at 3,375 (?), the Detroit River at 3,440, and the Sylvania (?) at 4,210. A showing of gas was found at 3,385 and 36° gravity oil at 3,496 feet. The hole was plugged back and shot from 3,496 to 3,506 feet, but the quantity of oil was not sufficient to profitably operate, and abandonment followed in October, 1929. The water horizons in the well were at 3,142 to 3,250 feet with sulfur water at 3,385 and 4,045 feet.

The Ionia-Montcalm Development Company put down a hole on the A. A. Herrick farm in the NW.¼ NW.¼ sec. 26, T.9N., R.6W., Bushnell township (Elev. 778 feet). The depth to the Parma was 445 feet, to the Marshall 949, to Lower Marshall red rock 1,028, to the Traverse 2,647, to the Dundee (?) 3,045, and to the bottom of the hole, 3,065. The only showing was a smell of gas in the Antrim black shale at 2,465 feet. Black sulfur water, which almost filled the hole, was tapped at 3,065 feet.

The Vestaburg Oil & Gas Company of Lansing drilled on the A. Anna farm in the NE.¼ SE.¼ sec. 27, T.12N., R.5W., Richland township, to a depth of 3,531½ feet (Elev. 901 feet). The Michigan "stray gas sand" was at 1,223 feet, the Marshall at 1,250+, Lower Marshall red rock at 1,310, the Traverse at 2,930, and the Dundee at 3,456. There was a million cubic feet of gas with water at 1,233-1,250, water at 1,280, a hole full of water at 3,030 and water at 3,458-3,461 feet. The well was plugged and abandoned in July, 1930.

The Hill Top Oil & Gas Company—J. Nobles No. 1, SW.¼ SE.¼ sec. 27, T.12N., R.5W., was never completed, and the A. Anna location followed this unsuccessful drilling project.

MONTMORENCY COUNTY

The important natural gas seepages in Montmorency County have been known for many years and have recently attracted new attention because of showings of gas in a well at Atlanta. These seeps are widely scattered throughout the central part of the county and often take the form of raised mounds similar to mud volcanoes and "boiling" springs. They are most numerous along a general line from sec. 34, T.30N., R.4E., to sec. 30, T.31N., R.1E., and many of them are close to Atlanta, the county seat. One occurrence has been reported from the middle of the Thunder Bay River, NW.¼ NW.¼ sec. 26, T.31N., R.4E., near Hillman. Several wells have been started in the vicinity of Hillman and one at Atlanta, but none of these reached a sufficient depth to test all the possible

Devonian "pay" formations. The regional structure shows in general a south dip which is locally southeast or southwest. Possibly there is a broad anticlinal nose trending a little west of north-south through the western tier of townships.

A well was drilled in 1927 on the Geo. Barrie farm, SE.¼ SW.¼ sec. 23, T.30N., R.4E., in which was found 206 feet of drift, black shale at 219 feet, and roily water at 500 feet. Frank Centala drilled on the Carrier farm about a mile north of Hillman in the NW.¼ NW.¼ sec. 24, T.31N., R.4E. (Elev. 768 feet?). The Traverse was struck at 416 feet, and the hole was 565 feet deep.

In the summer of 1929, a well was started on the John Wilder farm in the SE.¼ SE.¼ sec. 22, T.31N., R.4E., Hillman township, by Scott Stammler (Elev. 883 feet). Conflicting reports give the top of the Traverse at anywhere from 450 to 500 feet. The well is now shut down at about 1,120 feet.

In 1931-1932, George Stevens of Atlanta started a water well in Atlanta near his house in the NE.¼ SW.¼ sec. 12, T.30N., R.2E., which is now about 1,520 feet deep (Elev. 1,101 feet). Small showings of gas have caused considerable interest in this well, but delays have been frequent on account of light equipment, and the Dundee has not yet been penetrated. The drift was 368 feet thick, and the top of the Traverse was at 903 feet. There was gas in the brown shale at 717 feet, water at 850, and gas at 885, with a rock pressure of 180 pounds and a flow estimated at 20,000 cubic feet.

MUSKEGON COUNTY

The structure of the rocks in Muskegon County is better known than in many other parts of the State. The regional aspects of folding across the county have been interpreted in Plate III, and two contour maps of the Muskegon field (Muskegon and Laketon townships) are shown on a larger scale in Figures 27 and 28. There seems to be two important directions of anticlinal folding across the county, northwest-southeast and east-west. Drilling in the county has been carried on with the idea of finding new areas of production beyond the Muskegon field along both of these "trends." Although wildcatting has been somewhat disappointing, important showings of oil and gas have been found in several of these wells and further prospecting seems warranted in parts of Whitehall, Blue Lake, Dalton, Eggleston, Norton, Sullivan, and Ravenna townships. The structure of the rocks may possibly be favorable in southeast central Whitehall township; northeastern, central, and southwestern Blue Lake township; northwestern Dalton township; southeastern Eggleston township; southern Norton township; southeastern Sullivan township; and southwestern Ravenna township.

The wildcat wells in Muskegon County, exclusive of the oil field in Laketon and Muskegon townships, are listed in Table XXIII. These wells include several test holes drilled for structural information to the red limestone member in the Coldwater formation. The abbreviated logs of wells in the county drilled for oil and gas are tabulated showing the depths to "key" formations and the oil, gas, and salt water horizons. These wells are in Blue Lake, Cedar Creek, Dalton, Eggleston, Fruitland, Fruitport, Holton, Montague, Norton, Ravenna, Sullivan, and White River townships.

NEWAYGO COUNTY

A great deal of attention was focused on Newaygo County as likely "wildcat" territory after the discovery of the Muskegon field, and in all eighteen locations were made in the county. The county is on the west side of the Basin, and the average regional dip is eastward at 18 to 19 feet per mile. Two east-west anticlinal folds seem to cross the southern part of the county, and two folds with a curving northwest-southeast direction probably extend across the northern part. The east-west folds in southern Newaygo County are indicated near the Garfield-Asbland township line and near the Denver-Dayton and Sherman-Lincoln township lines. The suggested anticlinal folds in the northern part of the county trend from northeastern Big Prairie township to northeastern Beaver township and from northeast central Norwich township to northwestern Home township. The structural conditions in the county are better known in the southern half than in the northern, and it must be emphasized that these suggestions regarding folding in Newaygo county represent present interpretations which probably will be greatly changed by future drilling.

The Ichenberg Bros. et al Grass Lake Ranch well in the SW.¼ NW.¼ sec. 7, T.16N., R.11W. (elev. 1,060 feet), which was started in 1927, was taken over by the Newaygo Prospecting Company in 1929 and drilling resumed. Many delays have ensued, but the present depth is 2,123 feet (Jan. 1, 1933). The well struck salt water at the base of the drift at 740 to 755 feet, a showing of black oil at 772, and the Marshall at 1,195.

The Oceana Oil Corporation--Samuel Stitt No. 1, in the SE.¼ SE.¼ sec. 28, T.15N., R.14W. (elev. 890 feet), was commenced in 1929, but it was taken over by the Beaver Oil and Gas Company in 1932. The drift was 495 feet thick, and the Coldwater red rock occurred at 1,427, the Berea at 1,496 (?), and the Traverse at 2,256 feet. The well was plugged as a dry hole at 2,259 feet.

The Hesperia Petroleum Company started a well in 1929 on the W. A. Jones farm, NE.¼ SE.¼ sec. 20, T.14N., R.14W., Denver township (Elev. 786 feet). After a lapse of nearly two years, operations are again under way, and the present depth is 2,360 feet. The Coldwater red rock was at 1,350 and the top of the Traverse at 2,158 feet.

The Pennsylvania Oil and Gas Company drilled a test in 1929 on the W. A. Miller farm in the SE.¼ SE.¼ sec. 33, Goodwell township (Elev. 1,002 feet). The Marshall formation was at 1,065 feet, Coldwater red rock at 2,027, the Traverse at 2,760, the Dundee at 3,247, and the bottom at 3,260. In the top of the Traverse, oil was struck at 2,794 feet, and 800 feet of oil and 1,000 feet of water came into the hole. Water in the Marshall was struck at 1,170 feet and in the Dundee at 3,250 feet. There was a "hole full" at both depths. The well was plugged in January, 1930.

The Newaygo Gas and Oil Company started a deep well on the Bates farm in the NE.¼ SE.¼ sec. 12, T.13N., R.13W., Sherman township (elev. 821 feet), and operations are still under way at 6,002 feet (Jan. 1, 1933). The Marshall was struck at 815 feet, Coldwater red rock at 1,460, the Traverse at 2,408, the Dundee at 2,918, the Monroe at 3,030, the Sylvania at 3,590, the Salina at 4,115-5,475+, and the Niagaran at 5,526. There was water at 3,145 feet and a show of gas at 5,208 feet with much water at 5,215.

TABLE XXIII.—Wildcat Wells

Permit.	Company.	Farm.	Location.	Sec.	T. R.
794	Buchanan & Frye	Fruitvale Resort	E. 1/4 SW. 1/4 SE. 1/4	6	Blue Lake 12 N., 16 W.
269	J. F. Carpenter	J. O. Jensen No. 1	SE. 1/4 NE. 1/4	2	Cedar Creek 11 N., 15 W.
268	Creek Land Develop. Co.	Chas. Schorr	NE. 1/4 NE. 1/4	34	11 N., 15 W.
499	Hervey-Bolema Synd.	F. A. Gritzner	SW. 1/4 NE. 1/4	17	11 N., 15 W.
1419	Reed Oil Co.	Chas. Ewing	NE. 1/4 NW. 1/4	7	11 N., 15 W.
197	Shifting Sands Land Corp.	Shifting Sands Land Corp.	SW. 1/4 NW. 1/4	20	11 N., 15 W.
255	Eureka Oil Co.	R. Featherstone	SW. 1/4 SW. 1/4	35	Dalton 11 N., 16 W.
308	P. G. Fennell	H. Gustafson	SE. 1/4 SE. 1/4	19	11 N., 16 W.
1295	Muskegon Oil Corp.	M. Bard	NW., NW. 1/4 NW. 1/4	27	11 N., 16 W.
1383	Muskegon Oil Corp.	L. Price	NW., NE. 1/4 SW. 1/4	12	11 N., 16 W.
1418	Muskegon Oil Corp.	H. Kops	E. 1/2 NW. 1/4 NE. 1/4	22	11 N., 16 W.
1425	Muskegon Oil Corp.	O. Trumbull	NW., SW. 1/4 NW. 1/4	11	11 N., 16 W.
1319	Muskegon Oil Corp.	P. Wiersma	NW., SW. 1/4 NE. 1/4	14	11 N., 16 W.
318	Shoreline Corp.	Kelley (Bankers Trust Co.)	NW. 1/4 SW. 1/4	20	11 N., 16 W.
248	Sun Oil Co.	A. Grelewicz	SE. 1/4 NE. 1/4	26	11 N., 16 W.
74	Kundtz & Hulse, Inc.	H. J. Lageschulte	SW. 1/4 NE. 1/4	24	Eggleston 10 N., 15 W.
1151	H. & W. Feicke	H. & W. Feicke No. 1	SE. 1/4 SW. 1/4	1	Fruitland 11 N., 17 W.
1381	H. & W. Feicke	H. & W. Feicke No. 2	SE., SW. 1/4 SE. 1/4	1	11 N., 17 W.
1095	Reed Oil Co.	C. L. Bullock	S. 1/2 NE. 1/4	15	11 N., 17 W.
1036	Reed Oil Co.	H. Mann	N. 1/2 NE. 1/4	29	11 N., 17 W.
346	Cloverville Oil Co.	A. Borns	NE. 1/4 NE. 1/4	12	Fruitport 9 N., 16 W.
7D	H. Harper	Flora G. Cook No. 1	NE. 1/4 NE. 1/4	2	9 N., 16 W.
1078	W. E. Lang	F. Jonio	NE., NW. 1/4 SE. 1/4	30	9 N., 15 W.
613	Wright Oil Co.	B. Farr No. 1	NW. 1/4 NE. 1/4	26	9 N., 16 W.

*This table does not include wells in the Muskegon field (Muskegon and Laketon townships).

in Muskegon County*

Elev.	Mar.	Red.	Berea.	Trav.	Dundee.	Monroe.	Gas.	Oil.	Water.	Total Depth.
616		984	1,327	1,736	2,226				2,229	2,245
719		1,218		2,205	2,413					2,461
619	212	{ 1,015 1,025 }		{ 1,785 1,826 l. s. }				1,832		1,878
668		1,081	1,472	1,881	2,265					2,327
Test well										
610		1,009	1,375	1,810	2,193				{ 2,175 2,252 }	2,252
649		972		1,845	2,142				2,230	2,232
666		998		1,767	2,203				{ 1,782 1,879 2,218 }	2,310
Test well										
Test well										
Test well										
Test well										
Test well										
671		1,045		1,812	2,255					2,487
654		1,010		{ 1,808 l. s. 1,773 }	2,182			1,815	2,255	2,262
660		1,085	1,210	1,880	2,263					2,275
683		1,048		{ 1,775 1,852 l. s. }	2,270	2,340			2,340	2,700
Drilling										
Test well										
Test well										
651		1,022		1,808	2,213				2,263	2,263
606				1,763	2,125				2,279	
639		982		{ 1,715 1,768 l. s. }	2,148			1,770	{ 1,795 1,920 2,230 }	2,250
626		916	1,323	1,669	2,070				{ 1,950 2,158 }	2,163

TABLE XXIII.—Wildcat Wells in

Permit.	Company.	Farm.	Location.	Sec.	T. R.
217	L. C. Patterson	F. Monette No. 1	SW., E. ½ SE. ¼	13	Holton 12 N., 15 W.
695	White River Oil Corp.	A. Collatz-E. Neuerdorff	SE. ¼ NW. ¼	29	Montague 12 N., 17 W.
438	White River Oil Corp.	D. MacDonald	S. ½ NE. ¼ NW. ¼	29	12 N., 17 W.
1043	White River Oil Corp.	W. Lipka	N. ½ NE. ¼ SE. ¼	19	12 N., 17 W.
943	White River Oil Corp.	J. A. Quinlan	SE., NW. ¼ NW. ¼	29	12 N., 17 W.
280	White River Oil Corp.	Village of Montague	SW. ¼ SW. ¼	21	12 N., 17 W.
113	S. B. Ridenour	Wm. Antisdale	SE. ¼ SE. ¼	2	Norton 9 N., 17 W.
296	Kemper & Boven, Trustees	F. Sayles No. 1	NW. ¼ NW. ¼	24	Ravenna 9 N., 14 W.
139	Muskegon Develop. Co.	Haas No. 1	SE. ¼ SW. ¼	26	9 N., 14 W.
101	O. C. Fink	C. W. Nash No. 1	SE. ¼ NW. ¼	20	9 N., 14 W.
412	W. W. Erdman	W. W. Erdman No. 1	SE. ¼ NW. ¼	11	Sullivan 9 N., 15 W.
764	H. Hanson Oil Synd.	W. Foot No. 1	NW., NE. ¼ NE. ¼	8	9 N., 15 W.
741	J. F. Johnston	C. Janicke No. 1	E. ½ NW. ¼	1	9 N., 15 W.
1154	H. C. Nelson	Arved Nelson	SE. ¼ NW. ¼	24	White River 12 N., 18 W.
1146	H. C. Nelson	Geo. T. Rose	SE., NE. ¼ NE. ¼	25	12 N., 18 W.
1234	H. C. Nelson	A. Runzel	NE., SW. ¼ NE. ¼	11	12 N., 18 W.
1384	H. C. Nelson	Geo. Waller	NE. ¼ SE. ¼	14	12 N., 18 W.

*This table does not include wells in the Muskegon field (Muskegon and Laketon townships).

Muskegon County*—Continued

Elev.	Mar.	Red.	Berea.	Trav.	Dundee.	Monroe.	Gas.	Oil.	Water.	Total Depth.
755		1,320	1,700	2,082	2,533				{ 2,150 2,450 }	2,671
633		858	1,280	1,710					1,730	2,060+
643		860	1,275	1,657	2,059		{ 1,275 1,700 }	1,215	2,100	2,100
659		885	1,300	1,660	2,076			1,970	{ 1,680 2,108 }	2,214
638		870	1,300	1,645				1,110		1,725
590		830		1,620	2,025		{ 1,685 1,720 }		2,065	2,065
600		905		1,705	2,186			{ 2,186 2,220 }	1,985	2,237
Abandoned										
Test well										
664	400	1,115	1,136	1,846	2,231				2,306	2,310
Abandoned location										
662	360	1,068		{ 1,810 1,870 l. s. }	2,245		2,055	{ 1,810 2,130 }	{ 2,135 2,300 }	2,300
663		1,071	1,480	1,843	2,210					2,260
667	315	890		1,660	2,072				2,084	2,335
Test well										
679		871		1,635	2,084				1,750	2,100
655		824		1,620	2,028		1,800			2,077

The Sherman Oil and Gas Company drilled on the Joe Hoppa farm in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 22, T.13N., R.13W., Sherman township (Elev. 861 feet). The Traverse was found at 2,410 feet, the Dundee at 2,889, and the well bottomed at 2,960. Traverse water came in at 2,460 feet.

The Shell Petroleum Corporation sunk a well on the Mrs. B. Ridderman tract in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, T.13N., R.13W., Sherman township, to a depth of 3,111 feet (Elev. 897 feet). The Marshall was found at 890 feet, Lower Marshall red rock at 970, Coldwater red limestone at 1,670, the Traverse at 2,418, the Dundee at 2,932, and the Detroit River at 3,005. The water horizon in the Traverse was from 2,485 to 2,490 feet, and the Dundee at 3,085 feet. The well was plugged and abandoned in September, 1929.

The D. E. Uhl Company drilled a test on the David E. Uhl ranch in the N $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 20, T.13N., R.12W., Everett township (Elev. 827 feet). It encountered the Marshall at 853 feet, Coldwater red rock at 1,673, the Traverse at 2,425, the Dundee at 2,920, and the Monroe at 3,155. A showing of gas was found at 2,450 feet in the Traverse and from 3,018 to 3,025 feet in the Dundee, and oil at 3,225 feet in the Monroe. Drilling was carried on to 3,653 feet where the well was abandoned in October, 1929.

The Ranke Oil and Gas Company drilled on the J. Horner farm in the SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T.13N., R.12W., Everett township (elev. 804 feet), and struck the Traverse at 2,383 feet, and the Dundee at 2,862. Salt water was tapped at 2,428 feet, and the well was drilled into the Dundee to a total depth of 2,925 feet.

The Butler Syndicate made a Traverse test on the Ardell E. Douglass tract in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 26, T.13N., R.12W., Everett township, which was completed in March 1931, at a depth of 2,610 feet (Elev. 876 feet). The Marshall was found at 1,000 feet, Coldwater red rock at 1,832, the Traverse at 2,572, and water at 2,594.

The Atlantic Exploration Company put down a well on the Elwin J. Stone farm, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T.12N., R.14W., Sheridan township, to a depth of 2,174 feet (Elev. 725 feet). The Marshall was struck at 575 feet, Lower Marshall red rock at 692, Coldwater red rock at 1,367, the Traverse at 2,140, and Traverse limestone at 2,150. Salt water and a showing of oil were struck at 2,174 feet, and the hole was completed in the fall of 1930.

The Hervey Syndicate started a well in 1929 on the O. E. Atwood and Company tract in the NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, T.12N., R.13W., Garfield township (Elev. 730 feet?). The drift was 384 feet thick, and the Marshall was struck at 760 feet, Coldwater red rock at 1,390, the Traverse at 2,201, and a showing of oil and water from 2,220 to 2,222 feet. The well has been shut down for over two years.

A well was also drilled by the Hervey Syndicate on the Max Baumgartner farm in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, Garfield township (Elev. 747 feet). In this test, the Marshall was found at 598 feet, Lower Marshall red rock at 650, Coldwater red rock at 1,440, the Traverse at 2,236, and Traverse limestone at 2,260 feet. Water was struck in the Marshall at 598 and 631 feet; and gas, oil, and water in the Traverse at 2,288-2,290 feet. The hole was plugged in May, 1930.

A well, started by the Oakwyn Oil Company in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 14, T.12N., R. 13W., Garfield township, was drilled to 370 feet and the rig then moved off the location.

The Melrose Oil and Gas Company drilled on the Woodward and Hatch property in the SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, T.12N., R.12W., Brooks township (Elev. 743 feet.) The Marshall was at 770 feet, Lower Marshall red rock at 835, Coldwater red limestone at 1,640, the Traverse at 2,390, the Dundee at 2,846, and the bottom depth at 3,100. In the Traverse, oil and gas, together with some water, was struck at 2,415 feet, and several flows followed. The well was tubed, pumped 15-20 barrels in 24 hours, and later swabbed a similar amount. After pumping for two weeks with hardly any oil resulting, the well was shut down at noon on July 3, 1929. After being shut down only a short time, it flowed nearly 100 barrels of oil. Since then, the well has produced considerable oil at irregular intervals. The hole was drilled below the oil horizon until water was tapped in the Monroe at 3,025 feet, after which it was plugged back to 2,550 feet.

Carl Prather put down a well on the G. R. Stacy farm, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 11, T.11N., R.14W., Bridgton township (Elev. 730 feet). The Marshall was found at 531 feet, Coldwater red rock at 1,331, the Traverse at 2,100, and the Dundee at 2,528. Salt water came in at 2,144, and at 2,548 feet, where the hole was plugged and abandoned in June, 1929.

Maire, Caswell, and Smith of Lima, Ohio, drilled on the O. E. Atwood and Company farm in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 6, T.11N., R.13W., Ashland township, to a depth of 2,675 feet (Elev. 617 feet). The Marshall was encountered at 500, Lower Marshall red rock at 570, Coldwater red limestone at 1,292, the Traverse at 2,048, and the Dundee at 2,496 feet. A showing of oil was found in the Traverse, but water was struck beneath the Dundee at 2,660-2,675 feet.

The Atlantic Exploration Company drilled a deep test in Ashland township, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, on the W. H. Brydges farm (Elev. 883 feet). This well, which went to a total depth of 5,661 feet, was finished and abandoned in the Cincinnati series without going to the Trenton. The Marshall was at 850, Coldwater red rock at 1,680, the Traverse at 2,417, Traverse limestone at 2,438, the Dundee at 2,857, the Sylvania at 3,455, the Salina at 4,025, the Niagaran at 5,124, and Manitoulin limestone at 5,405. The Traverse "pay" at 2,458 had a gas flow lasting about 12 minutes and a slight showing of oil, which was followed by a big flow of water at 2,459 feet. More water was struck in the Traverse at 2,565 and in the Dundee at 2,957 feet. There was a showing of gas in the Salina at 4,325 and about 60,000 cubic feet of gas in the Niagaran at 5,295 feet. The well was plugged back to this latter depth and shot once with 20 quarts and again with 100 quarts of nitroglycerin from 5,285-5,300 feet, but it was finally completed as a dry hole on September 21, 1930.

The same company drilled on the John Bailey property in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T.11N., R.13W., to a depth of 2,303 $\frac{1}{2}$ feet (Elev. 781.5 feet). In this hole the Marshall was at 700 feet, red Lower Marshall at 735, Coldwater red limestone at 1,495, and the Traverse at 2,255. There was a show of oil and salt water in the Traverse at 2,296 feet, and the well was plugged in October, 1930.

OCEANA COUNTY

The location of Oceana County directly north of Muskegon County caused the drilling of a large number of widely scattered "wildcat" wells. These indicate that the regional dip, which is north of east in the south-

ern part, changes gradually to southeast in the northern part. This change is due to the broad regional eastward pitching syncline in the two southern rows of townships. That an east-west to northeast-southwest local anticlinal fold may border this syncline on the south is suggested by the important showings of oil from wells near the south county line and the structural nose close to the south line of Greenwood township. A broader east-west plunging nose that may change in direction to southeast, as it extends into the eastern part of the county, seems to border this major Oceana County syncline on the north through southern Weare, Crystal, and Colfax townships. This may be in some way related to the structure suggested by wells in Leavitt township. Other small structural "highs" are indicated a little east of the southwest corner of Grant township and near the middle of Benona and Shelby townships, but they are yet to be proved.

Drilling activity increased in 1932 with the discovery of oil in the Traverse in the DuVall, Thoren, et al—Weirich No. 1, NE.¼ SE.¼ sec. 31, T.15N., R.16W., Elbridge township (Elev. 722.6 feet). This well has been shut in pending litigation, but several rigs are now on the ground in the locality, and oil and gas operations are in progress throughout the county. The summary of the results of drilling since 1928 will proceed with the townships from north to south.

Varner and Lockwood have started a well on the Orin L. Flood property in the SW.¼ NW.¼ sec. 34, T.16N., R.18W., Pentwater township (elev. 618.3 feet), which has reached a depth of 443 feet. (Jan. 1, 1933).

Muskegon Oil Corporation drilled a test well on the V. J. Boone farm, SE.¼ SE.¼ sec. 3, T.16N., R.17W., Weare township, to a shallow depth.

Chas. W. Teater put down a deep well on the Oceana Live Stock Company (Stewart) ranch in the NE.¼ NW.¼ sec. 11, T.16N., R.15W., Colfax township, to a depth of 3,322 feet (Elev. 800 feet). The bedrock was at 402, the Marshall at 480, Lower Marshall red rock at 540, Coldwater red limestone at 1,160, the Traverse at 1,955, the Dundee at 2,530, and the Sylvania at 3,284 feet. There was a showing of oil at 1,580 feet and water at 420, 2,010, and 3,320 feet. The well was plugged in August, 1930.

Edward DuVall of Blue Island, Illinois, pioneered development in Golden township and completed the first well in September, 1928. This well, which was on the Carrie E. Mears property, NE.¼ SE.¼ NE.¼ sec. 36, T.15N., R.19W. (elev. 596 feet), found Coldwater red rock at 685 and the Traverse between 1,500 and 1,550 feet. There was a showing of gas beneath the red rock at 798 and some oil in the Traverse at 1,576 feet. Water was struck at 1,591 feet, where the well was abandoned.

The second well on the Mears property was in the SW.¼ NW.¼ sec. 36, T.15N., R.19W. (elev. 593 feet), and went to a depth of 1,596 feet where water in the Traverse was struck. Coldwater red rock was struck at 700, Traverse limestone at 1,565 feet, and no showings were encountered.

The next project was a well on the C. F. Fiel farm, SW.¼ NE.¼ sec. 31, T.15N., R.18W., which went through the Dundee to a depth of 2,268 feet (Elev. 629 feet). The Traverse "pay" was from 1,635 to 1,645 feet and showed oil, gas, and water. There was more water at 1,840 and some gas at 1,968 feet, and the Dundee was reported at 2,085 feet. The hole was taken over and plugged by the Red Rock Oil and Gas Corporation.

Edward DuVall also drilled on the Wm. Schultz farm, NW.¼ NW.¼ sec. 12, T.15N., R.18W., to a depth of 2,275 feet (Elev. 669 feet). In this hole, Coldwater red rock was found at 815 feet, the Traverse formation at 1,630, and the Dundee at 2,159. Salt water was tapped at 1,705-10 and 2,030 feet, and there was some gas in the top of the Traverse at 1,627-30 feet. The Dundee pay horizon was at 2,174 feet, but no oil, gas, or water was reported.

The Red Rock Oil and Gas Company put down a shallow test on the M. E. Skidmore farm, SW.¼ NE.¼ sec. 19, T.15N., R.18W., to a depth of 950 feet (Elev. 598 feet). The top of the Coldwater red rock was found at 725 feet.

The discovery well, causing recent activity in Oceana County, (Edward DuVall et al—Oscar Weirich No. 1), was in the NE.¼ SE.¼ sec. 31, T.15N., R.16W., Elbridge township (Elev. 722.6 feet). This test found Coldwater red rock at 1,043 and the Traverse at 1,862 feet. The present depth of the well is 1,894 feet, and it has flowed a total of 400 barrels of oil by heads at the rate of about 90 barrels per day. The pay was struck on July 30, 1932, but the control head has been opened only a few times because the title to the property is being contested. The oil is dark brown, smells of sulfur, and tests 34° Be. gravity at 72° F. temperature.

The second well in the district was the L. E. DuVall No. 1 on the J. C. Wallace Estate, SW.¼ SW.¼ sec. 32, T.15N., R.17W. (Elev. 731.5 feet). Coldwater red rock was found at 1,077 feet, the Traverse at 1,855, Traverse limestone at 1,930, and the bottom of the hole at 1,934 feet. There was a showing of oil at 1,460-65 feet and water at 1,934, which filled the hole.

A. S. Cochran drilled on the Hannum farm, SW.¼ NE.¼ sec. 31, T.15N., R.16W., to a depth of 2,407 feet (Elev. 720 feet). The Coldwater was encountered at 505, Coldwater red rock at 994, Traverse limestone at 1,900, and the Dundee at 2,399 feet. Water was struck at 1,903, and the hole filled up with water at 2,406 feet.

The Pennsylvania Oil and Gas Company drilled in 1929 on the Bert Snow farm, NW.¼ SE.¼ sec. 23, T.15N., R.15W., Leavitt township (Elev. 830 feet). The Marshall was found at 540, Lower Marshall red rock at 620, Coldwater red limestone at 1,240, the Traverse at 2,072, the Dundee at 2,565, the Detroit River at 2,637, the Sylvania at 3,248, the Bass Island at 3,290, and the bottom of the hole at 3,503 feet. Several important showings of oil and gas were found at 1,380, 2,666, and 3,252-64 feet. Water was reported at 417, 595, and 2,098 feet. The well was shot twice with 30 quarts of nitroglycerin between 3,252-3,264 and 2,663-2,670 feet, but it was finally plugged and abandoned.

The Johnson Oil and Refining Company put down a well on the M. Sippy farm, NE.¼ NW.¼ sec. 14, T.15N., R.15W., to a depth of 3,305 feet (Elev. 827 feet). The Marshall was at 252, Coldwater red rock at 1,239, the Traverse at 2,010, Traverse limestone at 2,061, the Dundee at 2,559, the Detroit River at 2,634 (?), and the Sylvania at 3,235 feet. A showing of gas at 2,085 and a rainbow of oil at 2,695 feet were found, but water came in at 2,065-70 and 2,695 feet. The hole was plugged and abandoned in August, 1930.

In 1932, the Johnson Oil and Refining Company drilled on the A. F. Sippy farm in the NE.¼ SW.¼ sec. 27, T.15N., R.15W., and after finding

the Coldwater red rock at 1,322 abandoned the test at 1,335 feet (Elev. 844 feet.) They have commenced the Sippy No. 2 in the SE.¼ NW.¼ sec. 24, T.15N., R.15W.

The Muskegon Oil Corporation drilled a shallow test on the F. Burmeister farm, SE.¼ NE.¼ sec. 34, T.14N., R.18W., Benona township. Edward DuVall also drilled in the NE.¼ NE.¼ sec. 1 of the same township on the Byron Curtis farm (elev. 672 feet) to a depth of 1,365 feet and found the upper red rock of the Coldwater at 845 feet. A showing of oil was encountered beneath the red rock in a shaly lime horizon at 913 feet.

The Muskegon Oil Corporation put down a Traverse test on the Jerry Zavel property, SE.¼ SW.¼ SW.¼ sec. 8, T.14N., R.17W., Shelby township (Elev. 774 feet). This well, after going through 430 feet of drift, struck Coldwater red rock at 1,025 and the Traverse at 1,780 feet. Salt water was found in the Traverse at 1,875, and the total depth was 1,890 feet.

The Oceana Petroleum Company (later Blue Arrow Petroleum Company) drilled a deep well on the J. Vanderwaal farm, SW.¼ NE.¼ sec. 33, T.14N., R.17W., Shelby township, near the village of New Era (Elev. 769 feet). Coldwater red rock was at 1,075 feet, the Traverse at 1,840, the Dundee at 2,330, the Detroit River at 2,450, the Sylvania (?) at 2,848, Salina salt at 3,179, the Niagaran at 4,045, the Manitoulin at 4,380, and the Trenton at 4,760. The hole was drilled 115 feet in the Trenton to a depth of 4,875 feet. Salt water was encountered at 1,915, 2,334-40, and 3,360 feet, and the well was abandoned on December 24, 1931.

The Muskegon Oil Corporation put down a shallow test well on the Mrs. Mildred Shaw farm, SW.¼ NE.¼ sec. 27, T.14N., R.16W., Ferry township.

Shuler, Brooks, and Jetter started a well on the G. A. Beem farm, SE.¼ SE.¼ sec. 27, T.14N., R.15W., Newfield township (elev. 785 feet), which has been shut down since 1929 at a depth of 2,653 feet. The Marshall red sandstone was at 640, Coldwater red rock at 1,313, the Traverse at 2,116, the Traverse limestone at 2,147, and the Dundee at 2,595 feet. The salt water in the Traverse was struck at 2,160 and in the Dundee at 2,647 (?) feet.

The Sankey Oil and Gas Company drilled on the Frank Darlington property, SW.¼ SE.¼ sec. 9, T.14N., R.15W., to a depth of 2,796 feet (Elev. 831 feet). The Marshall was found at 647, Coldwater red rock at 1,372, the Traverse at 2,160, and the Dundee at 2,680 feet. There was a showing of oil at 2,680-83 feet and of gas at 2,684 feet. Salt water was struck at 541, 2,650, and 2,689 feet, and the well was plugged in September, 1929.

The Muskegon Oil Corporation drilled a Coldwater red rock test on the Wm. E. Kinster farm, SE.¼ SW.¼ sec. 17, T.13N., R.17W., Grant township. The Iroquois Oil Company drilled in 1929-30 on the Iroquois property, SW.¼ SE.¼ NW.¼ sec. 35, T.13N., R.17W., to a depth of 2,236 feet (Elev. 650 feet). In this well, the Marshall was found at 378 feet, Coldwater red rock at 970, the Traverse at 1,735, Traverse limestone at 1,775, and the Dundee at 2,216. There was a light show of oil at 1,829 feet, and water at 1,775, 2,008, and 2,236 (?) feet.

The North American Trust Company also drilled to 2,298 feet on the Iroquois Oil Company tract in the NE.¼ NW.¼ sec. 25, T.13N., R.17W.

(Elev. 745 feet). The Marshall was near the base of the drift, but not definitely identified, and Coldwater red rock was at 1,016, the Traverse at 1,795, Traverse limestone at 1,839, and the Dundee at 2,251 feet. The water horizons were at 1,855-1,910, and 2,265 feet, and the well was abandoned in June, 1930.

The Fruitvale Land and Lot Owners put down a well to the Traverse on the C. J. Sipple Company property, SW.¼ SW.¼ sec. 23, T.13N., R.16W., Otto township (elev. 681 feet), which found a good showing of oil and gas at 1,950-54 feet. After drilling to 1,960 and allowing to stand, there was 130 feet of oil in the hole. Tubing and rods were run, and during one week the well pumped 30 barrels of oil. Another week it pumped 20 barrels of oil along with water, and there was about 900 feet of fluid in the hole. The well was finally plugged and abandoned at 1,968 feet. According to reports, the Marshall was at 620 feet, Coldwater red rock at 1,335, the Traverse at 1,908, and Traverse limestone at 1,948.

A. Anderson, Trustee for the same group, drilled a well on the Freedman and Strauss property, NW.¼ NW.¼ NW.¼ sec. 35, T.13N., R.16W., which is now shut down at 2,342 feet (Elev. 625 feet). Coldwater red rock was at 1,017 feet, the Traverse at 1,853, Traverse limestone at 1,898, and the Bell shale at 2,270. A showing of oil, gas, and water was struck at 1,905 feet.

The Decem Development Company put down a well 2,625 feet deep on the farm belonging to T. Veenstra and Sons in the SW.¼ SE.¼ sec. 26, T.13N., R.15W., Greenwood township (Elev. 768 feet). The Marshall was at 470, Lower Marshall red rock at 545, Coldwater red rock at 1,278, the Traverse at 2,015, and the Dundee at 2,505 feet. Salt water was struck at 2,153, 2,245, and 2,618 feet, and the well was plugged in June, 1929.

OGEMAW COUNTY

This county is on the northwest side of the Michigan Basin and structurally about 1,000 feet higher than its deepest part. The regional dip is generally southwestward, except where interrupted by local folds. The most pronounced of these folds, which is sometimes known as the West Branch anticline, has several hundred feet reversal and strikes northwest across Mills and probably eastern West Branch townships. The extension of this fold northwestward seems to veer somewhat to the north. (See pl. III.) A smaller anticlinal fold trends diagonally across Logan township in a northwest-southeast direction. Except for private core drilling and geophysical surveys, the rest of the county is entirely unexplored.

The Sun Oil Company drilled a dry hole in 1931 on the Frank Bernard property in the SE.¼ SE.¼ sec. 16, T.22N., R.4E., Logan township, to a depth of 3,025 feet (Elev. 841 feet). The Berea was at 1,435, the Traverse at 1,965, the Dundee at 2,735, the Detroit River at 2,925, and total depth at 3,020 feet. Gas in small quantities was found at 1,460 and 2,332-35 feet, and oil at 1,980-82. Salt water was encountered at 1,982-87, and at 2,905 feet black water filled up the hole 2,500 feet in ten days.

The Pure Oil Company drilled the first deep well on the West Branch structure on the William T. Yeo property, NE.¼ NE.¼ sec. 2, T.21N., R.2E., Horton township (Elev. 832 feet). The Berea was struck at 1,167, the Traverse at 1,680, the Dundee at 2,482, the Detroit River at 2,755, and the Sylvania at (?) 5,100 feet. Showings of oil and/or gas occurred at

1,830, 2,086, 3,583, 3,592, 3,604, and 5,180 feet. Salt water was struck at 2,086, 2,690, 2,720, 3,250, 5,044, 5,061, 5,124 feet, and the hole was completed and plugged in September, 1932.

OSCEOLA COUNTY

Osceola County is in the general trough of the Michigan Basin where it commences to pitch southeastward toward center. There are only two deep wells in the county, but they suggest that the Broomfield "high" extends diagonally northwestward across Evart and the northeast corner of Hersey townships. The Mount Pleasant trough probably continues from southwestern Clare and northwestern Isabella counties northwestward across the central region of Osceola County. The northwest extension of the Greendale "high" may cross some part of Marion township and the northeast corner of Middlebranch.

The Mellon-Pollock Oil Company of Pittsburgh put down a well on the Elwyn Johnson farm, SE.¼ SW.¼ sec. 35, T.18N., R.10W., Lincoln township (Elev. 1,227 feet). The Parma was found at 1,020, the Marshall at 1,436, Lower Marshall red rock at 1,625, the Traverse at 3,130, and the Dundee at 3,734 feet. The total depth was 3,836 feet. A show of gas was struck at 3,400, water at 3,748, and oil with some water from 3,822½ to 3,827 feet. This showing made 4 barrels of crude in 8 hours. More water came in at 3,833 and at 3,836 feet, and the hole filled up 1,000 feet in 30 minutes. The well was completed as a dry hole in October, 1930.

Ed. DuVall started a well at Reed City in the NE.¼ SE.¼ sec. 9, T.17N., R.10W., Richmond township, but failed to land the drive pipe and the test was abandoned at 545 feet.

Core testing was carried on in the county by the Grayling Development Company et al., and in conjunction with the Sun Oil Company a large hole was drilled in the SW.¼ SE.¼ sec. 2, T.17N., R.9W., Hersey township (Elev. 1,059 feet). About 10,000 cubic feet of gas was struck at 1,298 feet and a little more gas at 1,335. The top of the Michigan "stray sand" was at 1,324, the Marshall at 1,400, and the bottom of the hole at 1,512 feet. The well was plugged and abandoned in August, 1931.

OTTAWA COUNTY

Many wells have been drilled in Ottawa County as a result of the Muskegon field and, although commercial production has not been found, there have been several favorable showings of oil and gas. The regional position of the county with respect to the major structure of the State is similar to Muskegon County, and in the eastern and northern parts the formations are found at similar depths. The southeastern corner of the county is somewhat farther up the side of the Basin than Muskegon County. In general, the regional dip is northeast at the average rate of about 18 or 19 feet per mile.

The southeast extension of the Muskegon anticline should continue across some of the townships in northeastern Ottawa County. This trend may be in a general northwest-southeast direction from the northwest corner of Polkton township to the southeast corner of Tallmadge. Wells have not been drilled in this district, but the abnormally wide spacing of contours (see pl. III) and the continuity with the direction of the

northwest-southeast axis of the Muskegon fold seem to be evidence of this trend. A well in the southern part of Crockery township, which was regionally high, may have been on the west flank of the fold.

A broad trough seems to extend almost north-south across the county from the Zeeland-Jamestown township line toward the center of Chester township. Parallel highs apparently cross the eastern half of Jamestown township and the western half of Zeeland township. That some kind of a structure exists between Holland and Zeeland is indicated by the showings of oil in the Terbeck well, sec. 21, T.5N., R.15W. North of Holland, an east-west anticlinal fold across southern Olive township probably accounts for a showing of oil in the Traverse in the Telder well, sec. 35, T.6N., R.15W.

The deepest well* in the State was drilled by the Michigan Petroleum Company on the Charley E. Moe farm, SW.¼ SE.¼ SE.¼ sec. 6, T.9N., R.13W., Chester township (Elev. 704 feet). According to scout reports, this well found the rock at 251, Coldwater red rock at 1,278, the Traverse at 2,020, the Dundee at 2,433, and the Trenton at 5,031 feet. The total depth was 6,310 feet. There were showings of gas at 1,345 and 5,303 feet, and salt water at 2,075-80, 2,493, and 5,490 feet. The hole was completed as a brine well in October, 1930.

Howard L. Foster put down a well in 1930 on the Jacob W. Bush property, NW.¼ SW.¼ sec. 4, T.9N., R.13W., (elev. 719 feet), which found the Coldwater red rock at 1,310, the Traverse at 2,039, and the Dundee at 2,439 feet. The total depth was 3,036 feet.

Howard L. Foster also drilled on the Sophia L. Seelman tract, SE.¼ SW.¼ sec. 7, T.9N., R.13W., to a depth of 2,656 feet (Elev. 714 feet). The Marshall was at 370, Coldwater red rock at 1,258, the Traverse at 1,955, the Dundee at 2,397, and the Detroit River at (?) 2,510 feet. Fresh water was tapped at 306 feet and salt water at 2,032, 2,400 and 2,510 feet.

The Spring Lake Oil Syndicate put down a test in 1928 on the Eibert Vos property, SW.¼ of SE.¼ sec. 14, T.8N., R.16W., Spring Lake township (Elev. 519 feet). The Coldwater red rock was at 985 feet and the Traverse at 1,740, with the total depth at 1,820 feet. Salt water was struck in the Traverse at 1,815 feet.

The Ottawa Petroleum Company drilled a well in Crockery township on the Comstock Konkle farm, NW.¼ SE.¼ sec. 27, T.8N., R.15W. (Elev. 609 feet). This test struck Coldwater red limestone at 945, the Traverse formation at 1,681, the Dundee at 2,066, and was bottomed at 3,116 feet. The salt water horizons occurred at 1,905, 1,980, 2,190, and 3,105-10 feet. The well was plugged in October, 1929.

The Wright Oil Company organized by Kelly Goldboss of Chicago put down a deep well on the Joseph Kluting farm, SW.¼ NW.¼ sec. 10, T.8N., R.13W., Wright township (Elev. 737 feet). Lower Marshall red rock was at 415, Coldwater red rock at 1,275, the Traverse at 2,005, the Dundee (?) at 2,502, Salina salt at 3,246, the Niagaran at 4,190, the Manitoulin at 4,375, and the total depth at 4,750 feet. There were showings of gas at 1,318, 3,540, 4,160-78, 4,400 feet, and the water was struck at 2,050, 2,151 and 2,445 feet. Drilling operations were carried on during 1929-30, but the well was not plugged until January, 1932.

*The Newaygo Gas and Oil Company Bates No. 1 in the NE.¼ SE.¼ sec. 12, T.13N., R.13W., Sherman township, Newaygo County is now over 6400 feet deep (July 1, 1933).

R. R. Miller et al drilled a Trenton test near Agnew on the Paul Sako property, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T.7N., R.16W., Grand Haven township (Elev. 613 feet). Coldwater red rock was found at 745, the Traverse at 1,476, the Dundee (?) at 1,850, the Sylvania at 2,370, the Bass Island at 2,439, the Salina at 2,515, the Manitoulin at 3,432, and the Trenton at 3,710 feet. The depth of the well was 3,839 feet, and it was abandoned in October, 1930. There were showings of oil at 3,089-3,130 and 3,852 $\frac{1}{2}$ -57 $\frac{1}{2}$ feet. The lower "pay" horizon was shot with 60 quarts of nitroglycerin which somewhat increased the flow of gas. Salt water was struck at 1,578-83 feet.

The first well in East Olive township was on the Fred Stone farm, sec. 3 (p. 265, Pub. 37, pt. III). In 1929, the Dixie Oil Company drilled on the G. H. Telder property, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T.6N., R.15W., to a depth of 2,205 feet (Elev. 615 feet). This well encountered Coldwater red limestone at 822, the Traverse at 1,536, Traverse limestone at 1,594, the Dundee (?) at 1,797, and the Detroit River (?) at 1,886 feet. A showing of oil was struck at 1,603 feet, but water came in at 1,810 and 1,900 feet, resulting in abandonment.

Corbitt and Thornton drilled a well 2,007 feet deep on the Ponstantine farm, SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 21, Blendon township, which was completed a dry hole at 2,032 feet (Elev. 655 feet). The depth to Coldwater red rock was 885, to the Traverse 1,590, to Traverse limestone 1,653, and to the Dundee 1,830 (?) feet. Salt water was struck at 1,670-75 and 1,790 feet.

The Muskegon Oil Corporation put down a well near Holland on the J. Essenburg farm, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T.5N., R.16W., Park township (elev. 605 feet), in which Coldwater red shaly limestone was struck at 675 and the Traverse at 1,392 feet. Water was tapped in the Traverse at 1,535, and the well was abandoned in March, 1929.

The Henry Vrieling No. 1 well of the Ottawa Development Company in Lot 2, SE $\frac{1}{4}$ sec. 21, T.5N., R.15W. (elev. 602 feet), was the first in Ottawa County to show any substantial amount of oil. This oil was in the Traverse from 1,495 to 1,520 feet, and the pay was shot. The original quantity of 1 to 2 bailers full was increased to about 3 barrels the next morning, but the well was finally plugged and abandoned as a dry hole. Coldwater red rock was at 721, the Traverse at 1,426, the Monroe at 1,659, and the bottom of the hole at 1,966 feet. Salt water was tapped at 1,645, 1,652, and 1,695 feet.

The Muskegon Oil Corporation drilled shallow red rock core tests on the L. E. Bareman farm, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 8, T.5N., R.15W., and on the J. C. Dunton farm, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T.5N., R.15W.

The Ottawa Development Company put down its third test in the vicinity of Holland on the H. Terbeck farm, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T.5N., R.15W., Holland township, to a depth of 1,624 feet (Elev. 618 feet). Coldwater red rock was struck at 754 and the Traverse at 1,510 feet, but the Traverse "pay" carried no oil, and the well was plugged and abandoned.

SAGINAW COUNTY

Saginaw County has been the scene of a small amount of drilling since 1928, including several inside locations in the old Saginaw Pool, one deep well on top the Saginaw anticline, and several tests seeking

extensions to the Greendale, Saginaw, and Birch Run structures. The southeast extension of the Greendale "high" through Porter township, Midland County, into Jonesfield township, Saginaw County, is fairly well established, but where it goes from there is a mooted question. At first, it was thought to be headed toward St. Charles, but two structurally low wells in this general vicinity suggest that it may be farther north running in a more easterly direction and joining with the fold near Birch Run. Another possibility is that it may trend farther to the south toward the southeast corner of Maple Grove township.

New commercial pools have not been found along the northwest or southeast directions of the Saginaw anticline, and developments in these areas have been discouraging*. Comparisons with the Muskegon and Mount Pleasant structures show that the trace of the axis of this fold may be more arcuate than originally thought. If this supposition is true, then an eastward extension of production from Saginaw through southern Buena Vista township in the general direction and vicinity of the Michigan Central branch to Denmark Junction is possible.

The nose of the Saginaw structure seems to plunge steeply northwestward into a north-south saddle, but beyond this saddle to the northwest the same line of folding may trend across the northeast corner of Titabawassee township. A favorable showing of oil in a well near Free-land may have some bearing on this interpretation of the Saginaw "high." The trough which trends from near Bay City toward North Star, Gratiot County, seems regional in scope, however, and may modify all of the major lines of northwest-southeast folding in this part of the State. This is suggested by structural conditions in the western and southwestern parts of Saginaw County.

Alvin H. Weber, Trustee, drilled a well on the Wm. Kirchner farm, NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T.13N., R.3E. (Elev. 674.4 feet). The Marshall was at 1,040, Lower Marshall red rock at 1,145, the Berea at 2,203, the Traverse at 2,816, and the Dundee at 3,450 feet. Gas and oil were struck at 3,664, but salt water came in directly below at 3,665-68 feet, and the next morning there was 1,800 feet of fluid in the hole. Of this, 500 feet was oil, a sweet crude of 31° Be. gravity. After some testing, the well was drilled on to 4,375 feet, where it was finally abandoned. More salt water was found at 4,200-4,210 feet.

W. Hunter Atha drilled on the T. A. Murphy property in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 22, T.12N., R.2E., Richland township, to a depth of 3,358 feet (Elev. 642 feet). The Marshall was at 940, Lower Marshall red rock at 1,045, the Traverse at 2,656, the Dundee at 3,222, and salt water came in at 952 and 3,354 feet. The well was completed in August, 1932.

The Saginaw Prospecting Company and Sun Oil Company drilled several inside locations in the Saginaw Pool from 1928 to 1932, but the well of chief interest was the deep test of the former company on the Saginaw Water Works property, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T.12N., R.4E., City of Saginaw (Elev. 599 feet). In this well, the Parma was penetrated at 310, the Marshall at 625, Lower Marshall red rock at 744, the Berea at 1,811, the Dundee at 2,913, the Detroit River at 3,147, the Sylvania at

*In December 1932, a small oil well in the Berea was brought in by the Smith Petroleum Company on the Johns et al farm, SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 21, T.10N., R.6E., Birch Run township (Elev. 640 feet). Marshall sandstone was found at 326, the Berea at 1,530, and the "pay" at 1,544-40 feet. After shooting with 70 quarts of nitroglycerin from 1,532 $\frac{1}{2}$ to 1,551 $\frac{1}{2}$ feet, the well made (Jan. 1, 1933) about 8 to 10 barrels of oil and 15 to 20 barrels of water daily.

3,882, and it went to the depth of 3,970 feet. Oil was originally found in the Berea, and the additional "pays" after deepening into the Dundee and Detroit River formations were at 2,970-76, 3,225, 3,551-55, 3,624, 3,780-82, and 3,861 feet. The horizon at 3,551-55 showed hydrogen sulfide gas, oil, and water. The oil was 44° Be. gravity and in sufficient quantity to swab 40 barrels the first 24 hours and 7 barrels per day thereafter. The numerous salt water horizons in the Monroe series occurred at 3,131-47, 3,235-51, 3,525-30, 3,861-67, and 3,882-93 feet.

Dr. L. C. M. Conley of Detroit drilled a deep test on the Conrad Kueffner farm, SE.¼ SE.¼ sec. 32, T.12N., R.6E., Blumfield township, which finished at the depth of 3,523 feet (Elev. 632 feet). The Marshall was found at 600, Lower Marshall red rock at 695, the Berea at 1,846, the Traverse at 2,326, the Dundee at 2,922, and the Detroit River at 3,105 feet. Several oil showings were found in this hole, but it was finally abandoned in January, 1930.

The Smith Petroleum Company drilled a shallow test on the Clara M. Studor property in the NE.¼ SE.¼, Sec. 14, T.11N., R.2E., Fremont township (elev. 614 feet), which found the Marshall at 855 and Lower Marshall red rock at 955 feet. The total depth was 980 feet, and the well was finished in June, 1932.

Wm. E. Caster et al also drilled a test near St. Charles on the Sidney S. Williston farm in the NW.¼ SW.¼ sec. 22, T.11N., R.3E., Swan Creek township (Elev. 585 feet). The Parma was struck at 390 feet and contained an oil show and a hole full of water. The Marshall was at 745, Lower Marshall red rock at 842, the Berea at 1,938, and Berea salt water at 1,973-76 feet. The well was completed on April 8, 1932 to a depth of 1,995 feet.

A new well near Birch Run was put down by the Smith Petroleum Company very close to some old Dundee production on the Mike Courtney lease, NE.¼ sec. 29, T.10N., R.6E., Birch Run township. This test was on the John Poellet farm in the NW.¼ NE.¼ SW.¼ sec. 29. (Elev. 640 feet). The Marshall sandstone was found at 378 feet, the Berea at 1,592, and the hole was lost at 1,672 feet, plugged and abandoned.

S. M. Bacon and others drilled a deep well on the George Somers farm, NW.¼ NW.¼ sec. 35, T.9N., R.1E., Chapin township, which was completed in September 1930 as a dry hole at 5,340 feet (Elev. 683 feet). The depth to the Marshall was 655 feet, to the Berea 1,956, to the Traverse 2,377, to the Dundee 2,837, to the Detroit River 3,103, to the Sylvania 3,730, to the Bass Island 4,034, and to the Salina salt 4,347. Water was struck at 985 and 2,908 feet, a smell of oil at 3,080 and 3,160 feet, and an oil showing at 3,906 feet.

The Smith Petroleum Company put down a well on the Miller Chase farm in the NE.¼ NE.¼ sec. 21, T.9N., R.2E., Brady township, to a depth of 2,960 feet (Elev. 669 feet). The Parma was at 470, the Marshall at 675, Lower Marshall red rock at 827, the Berea at 1,949, the Traverse at 2,375, and the Dundee at 2,849 feet. Black water came in at 2,960 feet, where the hole was abandoned on October 12, 1930.

SHIAWASSEE COUNTY

The structural geology of Shiawassee County is closely related to the northwest extension of the Howell anticline, Livingston County. The regional dip, is generally northwest, with the main anticlinal folds plung-

ing in that direction, and the rate seems to be somewhat greater than in adjoining counties. Apparently the axis of the Howell "high" veers somewhat to the north in crossing Shiawassee County, but it again takes the general northwest course before it crosses Gratiot County. The trend is approximately from the southeast corner of Perry township to the northwest corner of Owosso township and thence more to the west across Fairfield township to Elba township, Gratiot County.

The discovery of Traverse oil in west central Shiawassee County, together with the regional contours (see pl. III) indicated by the new wells, suggests cross structure (at an angle to the northwest-southeast trend) in the vicinity of Shiawassee town. There seems to be an almost north-south high branching off the main Livingston County arch (Howell anticline) from south central Antrim township to northeast Caledonia township. However, it is also possible that the fold may extend more nearly in a northeast-southwest direction.

The structural lows, as now defined, extend from near Shaftsbury in Woodhull township toward Ovid and Elsie, and from Lennon in Venice township to a little east of Chapin. These structural troughs vary in width and are probably crossed by minor highs which may have trapped small local oil and gas pools.

C. H. Ladd, Trustee, started a well in 1931 on the Fred Brooks farm, SW.¼ NE.¼ sec. 33, T.7N., R.3E., Caledonia township (elev. 811 feet), which is now shut down at 1,260 feet. Samples of the cuttings indicate that the Lower Marshall was struck at 425 and the Coldwater at 620 feet.

The Owosso Prospecting Company drilled on the Frank Thompson property, SE.¼ SE.¼ sec. 14, T.7N., R.3E., to a depth of 2,588 feet (Elev. 747 feet). The depth to the Marshall was 296, to the Lower Marshall 320, to the Berea 1,636, to the Traverse 2,071, and to the Dundee 2,502 feet. Salt water was found at 296, 320, 1,686, 2,140-47, and 2,136 feet, and the well was completed in January, 1931.

The discovery of oil in the Traverse in the O. L. Barnebey—John M. Galloway No. 1, NW.¼ NE.¼ sec. 11, T.6N., R.3E., Shiawassee township, was made in May, 1930 (Elev. 784 feet). The Marshall was found at 140 feet, the Lower Marshall at 200, the Berea at 1,350, the Traverse at 1,850, some gas at 1,807, an oil show at 1,807-10, and the oil "pay" at 1,810-14. The initial production was estimated at 40 barrels, but the well made 180 barrels the first 24 hours and 500 barrels in all. A week after completion it was pumping 15 barrels of oil and 50 barrels of water per day. The hole was deepened in August to 2,410 feet, the Dundee was found at 2,197, and the Monroe at 2,265 feet. Salt water was struck at 1,375, 1,900, 2,260 feet, and black water at 2,268-73 feet. After being plugged back to 1,840 feet, the well was shot three times, but the shot went off twice in the Antrim and once in the pay, ruining the hole. It was abandoned in June, 1931.

The Glennbrook Oil Company sunk a well on the Frank Strauch farm, NE.¼ NW.¼ sec. 11, T.6N., R.3E., to a depth of 2,010 feet (Elev. 812 feet). The Marshall was at approximately 240 feet, the Berea at 1,418, and the Traverse at 1,800. The top of the Traverse limestone was at 1,835 feet, and there was one showing of oil at 1,808 and another at 1,844 feet, but water was struck directly underneath the second showing. Other water bearing beds were at 245, 275, and 770 feet.

O. L. Barnebey drilled a second well which was on the W. A. Grumley farm, NW.¼ NE.¼ sec. 14, T.6N., R.3E. (Elev. 794 feet). In this test, the Marshall was found at 170, the Lower Marshall at 200, the Berea at 1,380, the Traverse at 1,709, Traverse limestone at 1,705, and the total depth was 1,843 feet. Salt water was struck at 880, 1,390, 1,802, and 1,830 feet, and abandonment took place in November, 1931.

O. A. Daniels started operations on several community leases in southwestern Shiawassee County and drilled one deep well on the Miles Crawford farm, NW.¼ SE.¼ sec. 1, T.5N., R.1E., Woodhull township (Elev. 848 feet). The depth to the Marshall was 697 feet, to the Lower Marshall 790, to the Berea (?) 1,930, to the Traverse 2,313, to the Dundee, 2,660, to the Detroit River 2,856, and to the bottom of the hole 2,965. Some gas and water were found in the Upper Marshall and a showing of gas and oil in a "pay" horizon at 2,313 feet; salt water at 2,050-65 and 2,295-2,315 feet; and black water at 2,794 feet. The well was plugged and abandoned. The Hugattie Oil Company, previously organized by O. A. Daniels in the Muskegon field, sunk a test on the Budd Pulver farm, NE.¼ NE.¼ sec. 21, (elev. 841.5 feet), in which the Marshall was found at 762 feet and the Lower Marshall at 800. The well is shut down at 920 feet.

The Amber Oil Company put down a well on the C. Lobdell farm, SE.¼ SW.¼ sec. 24, T.5N., R.3E., Antrim township, to a depth of 1,870 feet (Elev. 855 feet). The Berea was at 945, the Traverse at 1,326, the Dundee at 1,730, and the Monroe at 1,848 feet. Salt water was struck at 1,430 feet, and the well was completed and plugged in November, 1930.

ST. CLAIR COUNTY

St. Clair County is on the southeast border of the Michigan Basin and well down on the west flank of the northeast end of the Cincinnati arch. A line of folding which seems to be a continuation of the "highs" early worked out in the vicinity of Oil Springs and Petroleum, Lambton County, Ontario, extends across the northern part of the county. Regionally, the county may be in a saddle joining the Michigan "basin" and the Appalachian geosyncline, and this may account for some of the folding which crosses the trend of the Cincinnati arch in this particular region.

The anticlinal folds are only partially worked out in eastern St. Clair County, but they are projected into the western part of the county to indicate possible trends. These "highs" seem to extend northwest-southeast from the southeast corner of Fort Gratiot township to the northwest corner of Clyde township, thence nearly east-west across Greenwood, Brockway, and Lynn townships; east-west from the northeast corner of Port Huron township toward Goodells; and apparently southeast from St. Clair toward Fair Haven. A syncline or trough extends southeastward across the county from the middle of Berlin township to near Marine City in southern China township, and thence eastward into Ontario.

The wells are not scattered enough to accurately determine the regional dip, but in general it is west and northwest into the Basin. The Devonian rocks either underlie the drift or are relatively close to the surface, the Traverse, Dundee, and Monroe beds occurring at shallow depths.

Smith and Perry drilled in 1930 on the Chas. Gardner farm, NE.¼

NE.¼ sec. 28, T.8N., R.16E., Grant township (elev. 729 feet), and found the Traverse at 499, the Dundee at 873, and water at 1,265 feet. The total depth was 1,270 feet.

B. P. Pattison put down a shallow well on the Sarah M. Routley property, NW.¼ SW.¼ sec. 21, T.7N., R.17E., Fort Gratiot township (elev. 614 feet), on the Port Huron anticline and struck the Dundee at 603 feet with a showing of oil from 633 to 660 feet. After drilling to 1,200 feet, the hole was plugged back to 655 feet and shot with 60 quarts of nitroglycerin between 633 and 655 feet. Operations are shut down, but the test has not been plugged and abandoned.

The Diamond Crystal Salt Company (Division of General Foods Corporation) drilled its No. 13 well in Lot No. 3 south of Pine River (elev. 585± feet), and about 600 feet east of the No. 12 well that had initially 1,200,000 cubic feet of gas in the Salina from 2,483 to 2,500 feet. This new well was completed late in 1928 as a small producer of gas. Well No. 14 was drilled on the west outskirts of St. Clair village on Private Claim 306, T.5N., R.16E., about 300 feet from the St. Clair Oil and Gas Corporation—Theodore Ruff No. 1. This hole penetrated the Berea at the base of the drift, the Traverse at 540, the Dundee at 790, the Detroit River at 895, the Sylvania at 1,280, the Bass Island at 1,375, Salina salt at 1,655, and went to 2,203 feet without production.

The St. Clair Oil and Gas Corporation drilled 4 wells in the vicinity of St. Clair, one of which encountered pre-Cambrian rocks. The Theodore Ruff well, west of town, was in Private Claim No. 306, T.4N., R.16E., south of the road and east of Pine River (Elev. 620 feet). The Traverse was at 520, Traverse limestone at 552, the Dundee at 790, salt (?) at 1,780, and the bottom of the hole at 2,645 feet. Sulfur water was struck at 900 feet and salt water at 2,640-45 feet.

The well on the Mary E. Fitton property in the SW.¼ SW.¼ sec. 3, T.4N., R.16E., China township, was sunk to 2,785 feet (Elev. 630.5 feet). The Traverse was found at 540 feet, the Dundee at 812, the Detroit River at 920 (?), the Sylvania at 1,318, the Bass Island at 1,410, Salina salt at 1,675, and the Niagaran at 2,685. The total depth was 2,785 feet. Mineral water was struck at 900-920 feet, and the hole was plugged and abandoned in July, 1930.

The St. Clair Oil and Gas Corporation—Fannie McCartney No. 1 was in the NW.¼ NE.¼ sec. 26, T.5N., R.16E., St. Clair township (Elev. 628 feet). The drift was 190 feet thick, and the Traverse was at 575, the Dundee at 840, the Detroit River at 960, the Sylvania at 1,460, the Salina at 1,700, the Niagaran at 2,735, and the bottom of the hole at 2,760. Mineral water was struck at 960 feet, and there was a showing of oil and gas from 2,735 to 2,752, which was shot with 140 quarts of nitroglycerin. The hole was plugged and abandoned in July, 1930.

The deep well that went into granitic rocks was the Geo. Hurst No. 1, SE.¼ NW.¼ sec. 26, T.5N., R.16E. (Elev. 620 feet). This test struck the Traverse at 575, the Dundee at 820, the Monroe at 950, the Sylvania at 1,100, Salina salt at 1,690, the Niagaran at 2,745, the Manitoulin at 2,970, the Trenton at 3,695, the Beckmantown at 4,590, and the Lake Superior (Potsdam) at 4,675 feet, and was finished below 4,950 feet. The water horizons were at 910, 3,662, and 4,675 feet. The well was abandoned in May, 1930.

Alfred C. Waters, Trustee, put down a shallow well on the Johnson tract, Private Claim No. 5, T.2N., R.16E., Clay township (elev. 577 feet), and encountered 23,000 cubic feet of gas at 113 feet and water at 160 feet. The Traverse was at 348, Traverse limestone at 350, and the total depth was 365 feet.

The Islands Oil and Gas Company of Pontiac drilled on Harsens Island on the Peter Krispen farm, Private Claim No. 4, T.2N., R.16E., and the well is now shut down at 2,400 feet (Elev. 577 ? feet). The Bedford formation was the first rock struck, and the depth to the Traverse was 330, to the Dundee 565, to the Detroit River 680, to the Sylvania 960, to the Bass Island 1,045, to Salina salt 1,540, and to the Niagaran 2,135 feet. The bottom of the hole was in the Cataract formation. Salt water was struck at 735 and 965 feet, and in the Niagaran (?).

VAN BUREN COUNTY

Van Buren County is on the southwestern margin of the Michigan Basin, where the regional dip is northeast at about 11 to 12 feet per mile. The Devonian "pay" rocks are shallow, the Traverse being found at depths ranging from 850 to 1,100 feet. The Trenton of Ordovician age is within easy reach of the drill. From the present evidence, the folds seem to be broad, gentle flexures that trend northeast-southwest and plunge toward the center of the "basin." However, the gentle regional dip suggests that there may be east-west or northwest-southeast folds that have not yet been found because of the lack of sufficient data.

The known lines of anticlinal folding, where favorable oil showings were struck, extend from southwestern Decatur township to southeastern Alma township and southeastern Covert township to northwestern Bloomingdale township. Attention was first directed to Van Buren County by the discovery of a shallow oil well in the Traverse south of Decatur where several wells were drilled. Most of these wells were dry. The Traverse production did not hold up and since there was no oil in the Trenton, operators have been slow to start new projects.

In the north part of the county, Gibson, Johnson, and Borden, Inc., and the Dixie Oil Company drilled on the John Krocke et al farm in the SE.¼ NW.¼ sec. 23, T.1S., R.16W., Geneva township, to a depth of 2,001 feet (Elev. 672 feet). This well struck Coldwater red rock at 450 feet, the Traverse at 1,049, Traverse limestone at 1,083, the Dundee (?) at 1,215, the Detroit River at 1,308, the Sylvania at 1,485, and the Bass Island at 1,566. The water horizons were encountered at 1,090-97, 1,560, and 1,720 feet. The hole was completed in April, 1930.

The Bi-County Fuel and Gas Company put down a Trenton test on the Emmanuel Old Home property, SE.¼ NE.¼ sec. 34, T.2S., R.17W., Covert township (Elev. 690 feet). Beneath the drift, the rock at the surface was in the Ellsworth formation. The Traverse was struck at 932, the Detroit River at 1,150, the Sylvania at 1,729, the Niagaran at 2,000, the Trenton at 2,352, and the well was drilled to 2,536 feet. There were showings of gas at 967, 1,030-34, 1,093-1,150, 1,729-85 feet, and water at 1,093, 1,550, 1,785, 2,463, and 2,530 feet. The hole was plugged and abandoned in December, 1929.

The Kirby Orchard Company drilled a well on their farm in the NW.¼ NW.¼ sec. 26, T.2S., R.17W., Covert township, which is now shut down at 1,020 feet (Elev. 702 feet). The drift was 362 feet thick, and the

Coldwater red rock was at 410 feet, top of Traverse limestone at 1,012, and a show of gas at 1,020 feet. Directly below the gas horizon, the hole filled with water. Operations on this well have been suspended now for about two years.

The Vermont Petroleum Development Company of Rutland, Vermont, drilled on the Anton Fier farm in the E.½ SW.¼ sec. 31, T.4S., R.14W., to a depth of 1,309 feet (Elev. 752 feet). The red limestone in the Coldwater was found at 377 feet, the Traverse at 882, the Monroe at 1,185, and the Sylvania (?) horizon at 1,254. A showing of oil was struck at 933 feet, water at 954, and heavy black oil at 1,260. The hole was plugged and abandoned in June, 1928. The same company also put down a well on the L. Witkowski tract in the SE.¼ NW.¼ sec. 21, T.4S., R.14W., Decatur township. In this test, the depth to the Coldwater red limestone member was 450 feet, to the Traverse 938, to the Monroe 1,177, and to the bottom of the hole 1,426. An oil showing was reported at 1,218-20 feet, and salt water struck at 1,018 almost filled the hole at 1,175 feet. The well was plugged and abandoned in August, 1928.

In 1928, a test was started on the Burget High farm, SW.¼ NW.¼ sec. 33, T.4S., R.14W., by the Decatur Lease Holding Company. They had trouble with the drive pipe at 370 feet, where it became "frozen," and the well was never completed.

The Wolverine Oil and Exploration Syndicate put down a Trenton test in 1929 on the A. D. Vought farm, SE.¼ NE.¼ sec. 32, T.4S., R.14W., which reached a depth of 2,523 feet (Elev. 761 feet). This was the third well on the Vought farm, two shallow tests having been drilled in 1927-28. The red rock member of the Coldwater was struck at 409 feet, the Traverse at 915, and Traverse pay at 969 to 979½ feet. The pay was shot with 40 quarts nitroglycerin from 909½ to 979½ feet, and according to reports the production was increased from 16 barrels before the shot to 50 barrels afterwards. On the 28th of August, 1929, the well was pumping between 10 and 11 barrels per day, but in the winter of the same year it was deepened to the Trenton. According to the samples of the cuttings, the Dundee (?) was at 1,075, the Detroit River at 1,160, the Sylvania at 1,275, the Bass Island at 1,320, the Niagaran at 1,625, the Manitoulin (?) at 2,220, and the Trenton at 2,420 feet. No water or oil was reported from the Trenton, and the well was abandoned in April, 1930.

The Dayton Oil and Gas Company drilled a well on the Carl W. Warner farm, SE.¼ NW.¼ sec. 29, T.4S., R.14W. (Elev. 754 feet). Red limestone in the Coldwater was found at 365 feet, the Traverse at 875, the Dundee (?) at 1,040, the Detroit River at 1,125, and the Sylvania at 1,200 feet, and the hole was drilled to 1,301 feet. There was a small showing of oil from 924 to 929, more oil from 948 to 950, water at 1,125, and gas at 1,135 feet. The well was completed in July and abandoned in October, 1930.

WAYNE COUNTY.

Since 1927 when the W. E. Ellis well, NE.¼ NE.¼ sec. 35, T.4S., R.10E., was drilled 2,820 feet deep, into the Trenton with a small showing of oil (Pub. 37, pt. III, pp. 205, 214, 215) there has been no further prospecting for oil and gas in the Detroit River area. However, in view of deepening the Livingstone Channel along the course of the river east

of Grosse Isle new structural subsurface studies were carried on. Some of the excavation already under way corroborates these studies and because of the regional importance of structure in this district, they are presented here. (See fig. 41).

The Stony Island anticline described by W. H. Sherzer (Pub. 12, p. 214) was first recognized in an earlier excavation of the Livingstone Channel. The observations at that time showed the strike of the axis as about $N.40^{\circ}W.$, and the steeper southwest limb dipping $S.50^{\circ}W.$, in the bed of the river at an angle of $1^{\circ}58'$ or 181.2 feet per mile. The new determinations indicate the strike of the axis of the fold as approximately $N.30^{\circ}W.$, and the southwest steep dip varying between 158.4 and 190.6 feet per mile or an angle of $1^{\circ}43'$ to $2^{\circ}4'$. These check very closely, as can be readily seen.

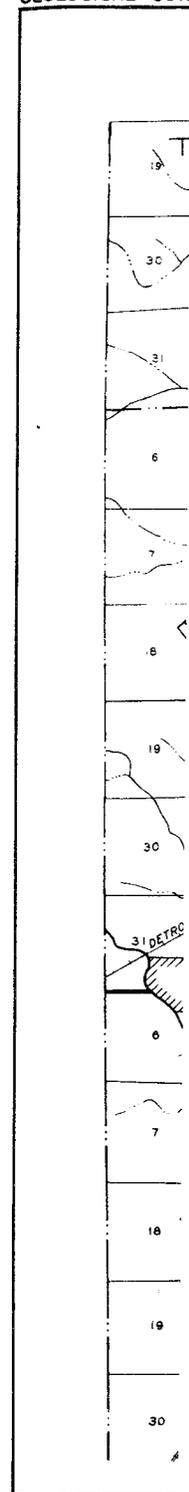
The rocks in the Anderdon quarry across the river near Amherstburg, Ontario, dip strongly in a $S.23^{\circ}W.$ direction, at an angle of more than $3^{\circ}15'$ in the Patrick quarry near the south end of Grosse Isle in a $S.30^{\circ}W.$ direction at an angle of $1^{\circ}30'$ to 2° , and in the Sibley quarry between Trenton and Wyandotte in a $S.85^{\circ}W.$ direction at an angle of $2^{\circ}10'$ to $2^{\circ}30'$. These figures in comparison to the direction of dip in the bed of the river suggest a progressive northward change in the trend of the axis of the anticline on the Ontario side from north-south to northwest-southeast, and thence more northerly again after crossing the river. This seems to be borne out by recent explorations for glass sand south of Amherstburg. The structure as most recently interpreted and drawn on top the Sylvania sandstone is shown in Figure 41. It extends in a direction a little west of north from near Bar Point to Amherstburg, and thence gradually veers from $N.30^{\circ}W.$ to almost $N.50^{\circ}W.$ The northwest prolongation of the axis (called Wyandotte anticline by R. A. Smith in Pub. 14, pp. 105, 106) apparently goes through somewhere between Sibley quarry and Wyandotte, but the unreliability of many well records in this vicinity makes it questionable whether the structure is forked as shown or simply indented by a local depression.

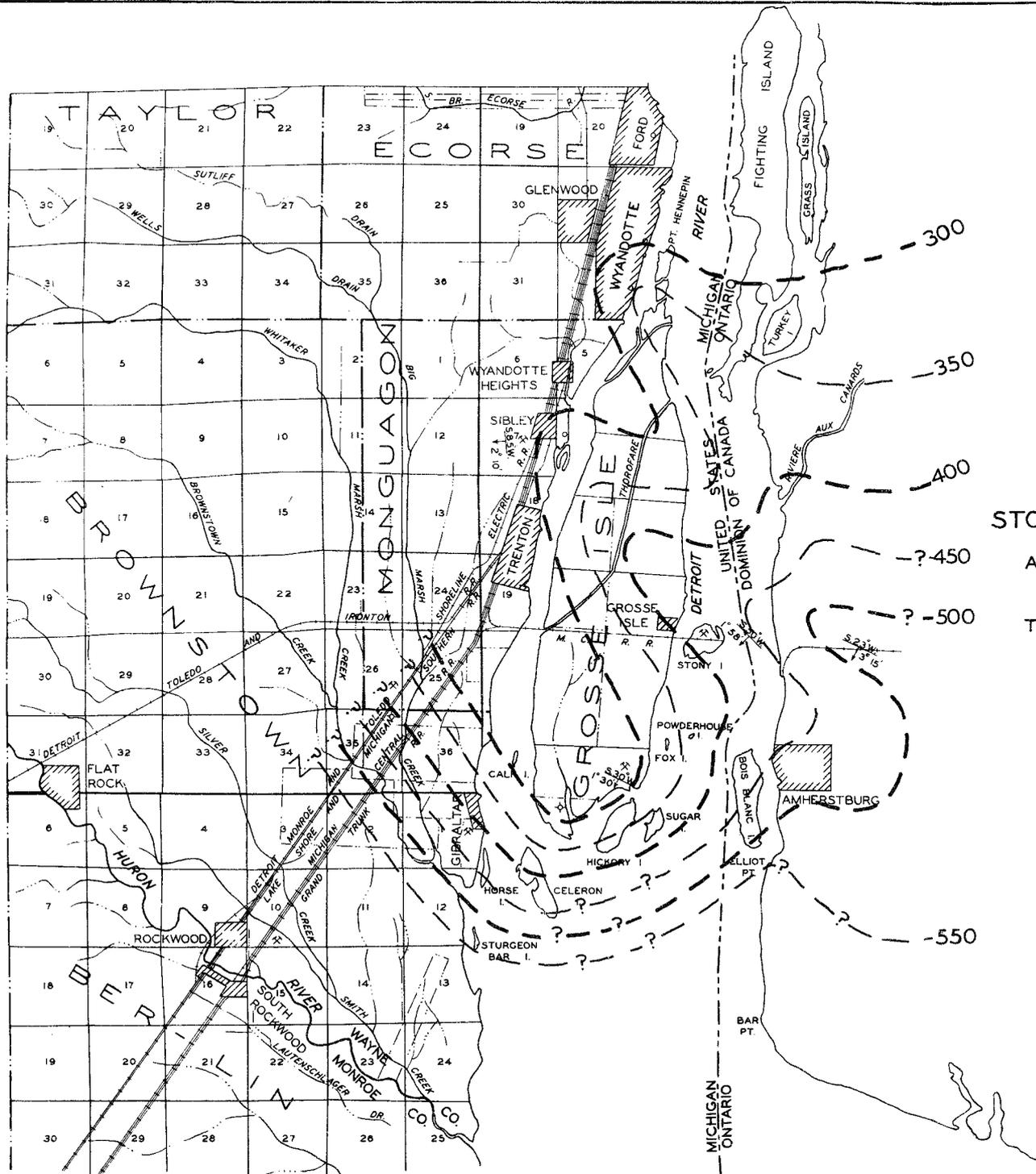
The magnitude and the changing direction of the axis of the Stony Island anticline is about the same as other structures in Michigan where oil and gas is found. (See pls. IV and V)

It is seemingly a fold coming off the north end of the Cincinnati arch where that feature plunges to the northeast. (See fig. 40) Farther to the northwest and almost in direct line with the trend of this fold is the Howell structure, Livingston County. It would seem fairly logical to assume, therefore, that these two structures are on the same line of folding and should join across Wayne County along a general trend between South Lyon, Oakland County, and the vicinity of Wyandotte. (See pl. III). The frequent showings of oil and gas in water wells west and south of Redford and in the area northwest, southeast, and north of Wayne (Pub. 12, pl. XXV) may not only be due to the exposure of Antrim shale beneath the drift, but also to up-dip migration localized on the flatter northeast side of this structure. Much is yet to be learned about the structural geology of Wayne County.

The Solvay Process Company drilled their No. 36 salt well in 1930 on Brady Island, T.2S., R.11E., to a depth of 1,620 feet.

Approximately 2 million cubic feet of gas was found in a water well about one mile from Belleville, and the discovery started some activity





STRUCTURE OF STONY ISLAND ANTICLINE

AND SURROUNDING TERRITORY

CONTOURS DRAWN ON
TOP OF SYLVANIA SANDSTONE
(MIDDLE MONROE)

CONTOUR INTERVAL — 50 FEET

BY
R. B. NEWCOMBE
1932

SCALE
1 INCH = 1 MILE

near this village. The well was about 87 feet deep, and the gas had a rock pressure of 16 pounds. Other shallow wells were drilled in the district with water well machines, but gas flows were found in only a few cases, and the volume was comparatively small. No deep tests were made, and interest in the region has now died down.

WEXFORD COUNTY

The rocks in Wexford County dip southeastward at about 21 or 22 feet to the mile, but there is very little known about the structural geology of the county. During 1930-31, three deep wells were drilled, but two of these were within a mile of each other and showed only the local dip. However, it is probable that the extension of the Greendale "high" from central Michigan will extend across the northeast part of the county and include sections of Haring, Cedar Creek, Colfax, and Greenwood townships. The belt extending diagonally across the center of the county from the southeast corner to the northwest corner seems regionally low and a continuation of the Mount Pleasant trough (See pl. III). The Broomfield "high" may extend into the county and continue across the western and southwestern parts.

The two wells north of Cadillac seem to throw some light on structural conditions in this part of the county. Considering the prevailing regional dip, the northerly one of these wells, which had several important showings of oil and gas, is higher than it should be. The dimensions and trend of the fold causing this accumulation are difficult to determine on the meager evidence available, but these wells seemingly indicate favorable prospects to the north and northeast.

The first deep well to penetrate bedrock in Wexford County was the Marble-Cove Oil Company—Chas. R. Smith No. 1 in the NE.¼ NE.¼ NW.¼ sec. 28, T.22N., R.9W., Haring township (Elev. 1,296 feet). The glacial drift was 720 feet thick, and the rocks at the base were in the Saginaw formation. The Bayport was at 910, the Marshall at 1,410, the Berea at 2,260, the Traverse at 3,120, the Dundee at 3,800, the Detroit River at 3,900, and the bottom of the hole at 3,950 feet. Showings of oil were found at 3,905 and 3,912-35 feet, and the "pay" horizons were shot with 100 quarts of nitroglycerin without favorable results. The water horizons were at 1,330-34, 1,395, and 3,950 feet. Abandonment took place in September, 1930.

C. R. Smith, Trustee, drilled north of Smith No. 1 on the John Jorgensen property, SE.¼ NW.¼ sec. 21, T.22N., R.9W., to a depth of 4,141 feet (Elev. 1,321 feet). The record was poor in the upper part of the hole, but the Marshall was encountered at 1,370, the Traverse at 3,100, the Dundee at 3,812, and the Detroit River at 3,895 feet. Showings of oil were found in several horizons in the well. At 3,167 feet, there were about 1½ barrels of oil, but water came in at 3,170. Oil was struck at 3,215 with water underneath at 3,216-19; at 3,948-50 with water at 3,955; and at 4,005 with water at 3,970-4,005 feet. Gas was struck above this last "pay" at 3,995 feet. None of these showings made commercial production, and the well was plugged in May, 1931.

The Cummer-Diggins Company drilled a well 3,860 feet deep on their own property in the SW.¼ NW.¼ sec. 26, T.23N., R.11W., Antioch township (Elev. 1,325 feet). This test, which was regionally farther up the dip than the other two in Wexford County, struck the Marshall at 750

feet, the Lower Marshall at 825, Coldwater red rock at 1,640, the Traverse at 2,485, the Dundee at 3,180, the Detroit River at 3,285, and Detroit River salt at 3,432. There were no showings of oil and gas, and water was struck in the Traverse at 2,490 feet. The well was completed and plugged in October, 1931.

MISCELLANEOUS COUNTIES

The remaining counties in which drilling for oil and gas has been carried on are put together in a miscellaneous group. In some of these counties, preliminary core drilling and geophysical prospecting have been included in the development program of interested companies. In each, there has been anywhere from one to four deep wildcat tests.

The reason for discussing miscellaneous counties in a group apart from the others is because there is so little geological information about them, and the showings of oil and gas have not been large enough to attract widespread notice. Their prospects for oil and gas may be as great or even greater than other counties where geological structure is better known or showings have been more favorable.

Alcona County: In 1929, C. Wilbur White of Chicago, drilled on the John McDonald farm, SW.¼ SE¼ sec. 22, T.26 N., R.8E., to a depth of 600 feet (Elev. 670 feet). A showing of gas, with water directly beneath was reported at 240 feet, and the hole filled up with water at 510 feet. The formation record was difficult to interpret in all its details.

Alpena County: The Bradley Oil and Gas Company drilled a shallow Dundee test on the Fred N. Potter farm, SE¼ SE¼ sec. 20, T.31N., R.8E. (elev. 670 feet), in which the Dundee was struck at 725, water at 762, and the hole was bottomed at 862 feet. The well was abandoned in November, 1929. The Riverside Syndicate drilled a second well on the Potter farm, SE¼ SW¼ sec. 20 (elev. 670 feet), in which water was struck at 60 feet, the Dundee at 563 (?), water at 580, the Detroit River at 800, and a showing of oil at 807 feet. The well was completed in October 1930, at 836 feet.

The Exploration Company put down a well on the Thos. Wilson farm in the NE¼ NE¼ sec. 7, T.32N., R.6E., Long Rapids township, to a depth of 1,317 feet (Elev. 820 feet). The Dundee was found at 423, the Detroit River at 665, and the Sylvania at 1,249 feet. There was a showing of oil at 325-30 feet. Water was struck at 870 and 910-45 feet, black sulfur water at 950-85, and black water at 1,143. The well was plugged in March, 1930.

Notman and Aubin drilled on the Robert F. Diamond property, NE¼ NE¼ sec. 25, T.30N., R.6E., Wilson township (Elev. 845 feet). The depth to the Traverse was 488 feet, to the Dundee 1,260, and to the bottom of the hole 1,285. Water was struck at 720, 940, and 1,276 feet. The hole was abandoned in November, 1929.

Barry County: The Muskegon Development Company drilled in Barry County on the William Hughes farm, NW¼ SW¼ sec. 34, T.1N., R.9W., to a depth of 1,980 feet (Elev. 950 feet). The well went through 202 feet of drift into the Marshall and found the red rock in the Coldwater at 1,202, the Traverse at 1,630, the Dundee at 1,861, and the Detroit River at 1,970 feet. About one-half barrel of water per hour was struck in the Dundee at 1,888-94, and the test was abandoned in October, 1930.

The Barry Oil Development Company commenced a well on the A. O.

Kinne farm, NE¼ NW¼ NE¼ sec. 11, T.3N., R.8W., Hastings township (elev. 891 feet), which struck the Marshall at 385 feet, the Lower Marshall at 550, the Coldwater at 600, and it is now down to 1,140 feet.

Berrien County: The Blatchford Oil and Gas Exploration Company of Chicago drilled on the J. K. Blatchford property, NW¼ SW¼ sec. 11, T.3S., R.17W., Watervliet township (Elev. 650 feet). The Traverse was at 910, Traverse limestone at 997, the Detroit River (?) at 1,170, the Sylvania (?) at 1,690, and the total depth was 1,861 feet. A showing of gas was struck in the Traverse, and gas and oil in the Monroe at 1,702-06 feet. There was a "hole full" of salt water at 1,285, 1,340, 1,483, 1,693, and 1,750 feet. The well was finally abandoned as a dry hole in February, 1930.

Gibson, Johnson & Borden, Inc., and the Dixie Oil Company put down a shallow well on a community lease (Smith farm) in the NW¼ SE¼ SW¼ sec. 15, T.4S., R.18W., Benton township, to a depth of 882 feet (Elev. 644.5 feet). The Coldwater red rock was found at 240, the Traverse at 745, and water in the Traverse at 795 feet. The well was completed in June, 1930.

W. E. Eldredge, Trustee, drilled a well on the Fred J. Wetterau property, SE¼ of NW¼ SE¼ sec. 10, T.8S., R.21W., New Buffalo township (elev. 667 feet), which struck the Traverse at 365 and the Monroe-Salina at 545 feet, and was finished at 1,775 feet in June, 1930. Salt water was found at 453, sulfur water at 545, more salt water at 660 and 1,425, and fresh water at 1,715 feet. Emil Michalski, Trustee, put down the Wetterau No. 2 well nearby in the NW¼ SE¼ sec. 10, T.8S., R.21W. (elev. 671 feet), which encountered the Traverse at 387 feet, and was completed as a dry hole at 462 feet.

Branch County: Gibson, Johnson & Borden, Inc., drilled the only recent deep well in Branch County on the Miles Teller farm, Center, N.½ NE¼ sec. 11, T.8S., R.8W., Noble township (Elev. 946 feet). The depth to the Traverse was 925, to the Dundee 1,070, to the Detroit River 1,140, to the Sylvania 1,259, and to the bottom of the hole 1,385 feet. Water horizons were encountered at several places in the drift, and salt water was struck at 1,005, 1,130, and 1,360-85 feet. The well was completed in August, 1930.

Calhoun County: The St. Clair Oil and Gas Corporation put down a deep well north of Marshall on the O. S. Hubbard farm, SW¼ NE¼ sec. 14, T.2S., R.6W., Marshall township, to the depth of 4,571 feet (Elev. 963.5 feet). The Coldwater red shale (Berea horizon?) was struck at 1,315 feet, the Traverse at 1,632, the Dundee at 1,830, the Detroit River at 1,920, the Sylvania at 2,320, the Bass Island at 2,435, the Niagaran at 2,960, the Trenton at 3,963, and the St. Peter at 4,564. A showing of gas and "hole full" of water were reported at 2,900 feet. The well was plugged in September, 1931.

Cheboygan County: W. M. Brown et al drilled in the SE¼ NE¼ sec. 12, T.33N., R.3W. (elev. 778 feet), to a depth of 1,694 feet, and the Traverse limestone was at 115, the Dundee at 795, and the Detroit River at 1,045 feet. The well was plugged in January, 1929. In the second well on the Brown property, near the first location in about the center of the same forty acre tract (elev. 778 feet), the Traverse was found at 115, the Dundee at 783, water at 820, and the Monroe at 1,040 feet. A showing of oil at 1,185 feet was shot with 60 quarts of nitroglycerin without

favorable results, and the well has been shut down at this depth ever since.

Clinton County: Wm. E. Caster put down a shallow well on the Julia S. Curtis farm, NW.¼ NW.¼ sec. 12, Duplain township, to the depth of 670 feet (Elev. 696 feet). The Parma was at 465, Parma water at 520, the Marshall at 655, and the well was abandoned in November 1931.

Delta County: The only recent test for oil in the Upper Peninsula was drilled 1,250 feet deep by A. P. Crell on the Bay de Noc Company property, SW.¼ SW.¼ sec. 20, T.42N., R.19W. The first rocks penetrated in the well were in the Cincinnati group, and the Trenton was found at 355, the St. Peter at 635, the Beekmantown at 780, and the Lake Superior at 990 feet. Water was struck in the St. Peter and Lake Superior formations, and the hole was completed as a fresh water well in October, 1929.

Eaton County: A few shallow core tests and 4 deep wells were put down in Eaton County from 1928-32. E. W. Heisey and C. A. Ralph drilled on the J. Parker farm in the NW.¼ NE.¼ sec. 17, T.4S., R.5W., Roxand township, to a depth of 2,322½ feet (Elev. 882 feet). The Parma was at 400 feet, the Marshall at 560, Coldwater red rock at 1,819, the Berea at 1,891, and the Traverse at 2,202. Water was struck at 200, 400, 585, and 2,262 feet. The hole was abandoned in December, 1930.

Norris and Smith put down a well on the Frank J. Wright farm, SW.¼ SW.¼ sec. 28, T.3N., R.5W., Chester township (Elev. 926 feet). The Parma was struck at 215, the Marshall at 514, the Coldwater at 794, Coldwater red rock at 1,735, the Berea at 1,787, the Traverse at 2,018, and the hole was drilled to 2,183 feet. There was fresh water at 685 and 1,350, and salt water at 2,165 feet. The well was plugged in July, 1929.

Norris and Smith drilled another well in Eaton County on the Gertrude and Lois Krusen property, SW.¼ NW.¼ sec. 28, T.2N., R.5W., Carmel township (elev. 904 feet), which found the Marshall at 310, Coldwater red rock at 1,590, and the Traverse at 1,910 feet. Salt water was struck at 2,018, and the hole was abandoned at 2,025 feet.

The Wittmer Oil and Gas Properties Company of Pittsburgh drilled at Bellevue on property of the Alpha Portland Cement Company, NW.¼ SW.¼ sec. 28, T.1N., R.6W., Bellevue township (Elev. 864 feet). In this test, the Marshall was struck at 200 feet, the Lower Marshall at 260, Coldwater red rock at 1,370, the Berea (?) at 1,422, the Traverse at 1,720, the Detroit River at 2,030, the Bass Island at 2,585, Salina salt at 3,200, the Niagaran at 3,410, the Manitoulin at 3,675, the Trenton at 4,263, and the depth was 4,405 feet. The water horizons were at 200, 1,827-35, 3,025, and 3,075 feet. The well was abandoned in September, 1930.

Emmet County: The North States Oil Company started a well on the K. R. Beak property, SW.¼ SW.¼ sec. 16, T.37N., R.5W., Center township, which was drilled to 1,200 feet (Elev. 737 feet). The Traverse formation was found beneath 409 feet of drift, and the Dundee was at 592 feet.

Genesee County: Gibson, Johnson and Borden, Inc., drilled on the Earl Munsell property, NE.¼ NW.¼ sec. 21, T.9N., R.7E., Thetford township (Elev. 792 feet). The Parma was at 204 feet, the Marshall at 490, the Lower Marshall at 585, the Berea at 1,700, the Traverse at 2,163, and the total depth was 2,503 feet. There was water in the Cold-

water at 1,115 and a "hole full" in the Traverse at 2,230 feet. The well was plugged and abandoned in December, 1930.

Huron County: The Pure Oil Company, after test well prospecting, drilled 3 deep wells in northwestern Huron County. The first, on the John Dressler farm, NW.¼ SW.¼ sec. 26, T.16N., R.9W., Fair Haven township, went through the Dundee to the depth of 3,005 feet (Elev. 601 feet). The second, on the William Radloff property, in the SE.¼ SE.¼ sec. 5, T.15N., R.10E., Brookfield township, finished as a Berea test at 1,584 feet (Elev. 633 feet). The third well was on the John Englehardt farm, NE.¼ SE.¼ sec. 36, T.16N., R.9W., and was completed at 1,540 feet (Elev. 622 feet). All these wells were plugged and abandoned in 1929.

The Pacific Exploration Company of New York City did some structural test drilling and then put down a deep well on the Wm. Ballagh farm, NE.¼ NW.¼ NW.¼ sec. 32, T.15N., R.12E., Sheridan township, to 4,095 feet (Elev. 744 feet). The hole entered the rock in the Marshall formation, and the Lower Marshall was at 70 feet, the Berea at 1,402, the Traverse at 1,961, the Dundee at 2,645, the Detroit River at 3,014, and the Sylvania (?) at 3,925. Water was struck at 703, 1,424-80, 2,840-80, and 3,615 feet. The well was completed during August, 1932.

Ingham County: In 1929-30, the Hilmur Oil Company of Lansing drilled a well to the Dundee on the E. C. Potter farm, NW.¼ NW.¼ sec. 21, T.4N., R.2E., Locke township (Elev. 915 feet). The depth to the Parma was 421, to the Marshall 760, to the Lower Marshall 815, to the Berea 1,940, to the Traverse 2,313, to the Dundee 2,595, and to the bottom of the hole 2,625½ feet. Water was struck in the Dundee at 2,619½-2,625½, and the well was abandoned in February, 1930.

The same organization, under the name of Amos Turner, Trustee, drilled on the E. Doolittle farm, NE.¼ NE.¼ sec. 14, T.4N., R.2E., to a depth of 651 feet (Elev. 899 feet). The Marshall was struck at 625 feet and being structurally low, the well was abandoned.

Iosco County: The Sun Oil Company carried on some test well drilling and put down a deep well on the E. A. Miller farm, NW.¼ NE.¼ sec. 31, T.22N., R.5E., Reno township (Elev. 818 feet). The Lower Marshall red rock was at 303 feet, the Berea at 1,580, the Traverse at 2,158, the Dundee at 2,923, and bottom of the hole at 3,163. Water was struck at 730, 1,230, and 1,267 feet, and black sulfur water at 3,151 feet. Small showings of gas were reported at 1,225 and 3,153 feet, but the hole was plugged in January, 1930.

D. E. Wilson, Trustee, drilled in the same township on the W. J. Hill farm, SE.¼ SW.¼ sec. 19, T.22N., R.5E. (Elev. 828 feet). The depth to the Marshall was 280 feet, to the Lower Marshall 360, to the Berea 1,652, to the Traverse 2,190, to the Dundee 2,976, and to the bottom of the hole 3,156. Water was struck at 767, 1,325, and 3,156 feet. The well was abandoned in July, 1930.

Gibson, Johnson & Borden, Inc., put down a test on the Robert H. Watts farm in the center, S.½ NW.¼ sec. 34, T.22N., R.6E., Grant township (Elev. 684 feet). The Marshall was encountered at 335, the Lower Marshall at 435, the Berea at 1,795, and the Traverse at 2,430 feet. The well was finished at 3,040 feet without reaching the Dundee, and water was found at 300, 885, 1,175, 1,885, and 1,935 feet. The well was plugged in October, 1930.

Kalamazoo County: Reid & Mackey and Norris & Smith drilled a well to the Trenton on the Burt Caldwell farm, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 32, T.1S., R.12W., Alamo township (Elev. 790 feet). The red limestone in the Coldwater was at 740 feet, the Traverse at 1,270, the Dundee at 1,480, the Detroit River at 1,580, the Sylvania at 1,776, the Bass Island at 1,950, the Niagaran at 2,527, the Manitoulin at 2,704, the Trenton at 3,168, and the total depth was 3,348. Sulfur water was struck in the Sylvania at 1,835 and salt water at 3,280 and 3,294-96 feet. A gas and oil showing was found at 1,343; oil, gas, and water at 1,352, and gas at 1,880 feet. The well was completed in September and plugged in November, 1930.

Kalkaska County: After considerable core testing, the Grayling Development Company, together with the Muskegon Oil Corporation, drilled a deep well on State land in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T.26N., R.5W. (Elev. 1,120 feet). This hole was drilled into the Dundee formation and finished at 2,887 feet, where it was plugged and abandoned in May, 1930.

Oakland County: The Milford Oil and Gas Syndicate drilled on the John Houghton property in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T.2N., R.7E., Milford township (Elev. 969 feet). Below 243 feet of glacial drift, the well penetrated the Coldwater formation and found the Berea at 569 feet, the Traverse at 905, the Dundee at 1,236, the Detroit River at 1,428, and the Sylvania at 1,750. The total depth was 2,038 feet. Water was struck at 257, 575, and 1,257 feet, a showing of oil at 1,113, and sulfur water at 1,600 feet. The well was completed in March, 1932.

The Smith Petroleum Company drilled just off the north flank of the southeast extension of the Howell "high" on the W. K. Smith farm, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T.1N., R.7E., Lyon township, to a depth of 1,035 feet (Elev. 936 feet). The hole went through 267 feet of drift into the Berea, and the Traverse was struck at 520, the Dundee at 830, and the Detroit River at 1,020. Water came in at 270-80, $\frac{1}{2}$ bailer full heavy oil and water at 527-31, and black water at 920 feet. Abandonment took place in March, 1932.

Presque Isle County: Claude F. Palmer put down a well for the Lobdell-Emery Manufacturing Company on the Albert E. Meyer property, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T.35N., R.2E., Allis township (Elev. 787 feet). The depth to the Dundee was 187 feet, to the Detroit River (?) 480, to the Sylvania 950, to the Bass Island, 1,294, and to the bottom of the hole, 1,402. Water was struck in the Sylvania at 1,100 feet, and the well was abandoned in October, 1930.

Roscommon County: Several core holes were put down in Roscommon County by the Grayling Development Company, but no deep tests resulted from this prospecting. The development of the West Branch structure in Ogemaw County may soon lead to drilling in the western part of this county.

Sanilac County: The old well on the Frank Obee farm, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 17, T.14N., R.14E., Minden township (elev. 805 feet), was drilled deeper in 1930, but very little accurate detail was learned about the well. According to reports, the Berea was at 1,170, salt water at 1,200-10, and the Traverse at 1,660 feet. The present depth is 1,676 feet.

The Sanilac Prospecting and Development Company put down a well near Lake Huron on the Lizzie Murry property, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16,

T.13N., R.16E., Forester township (elev. 592 feet), which struck the Berea at 492, the Traverse at 888, the Dundee (?) at 1,512, and continued to 1,610 feet, where it is now shut down.

The Shepherd Oil and Gas Company drilled a well on the Art. Vincent farm, in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T.10N., R.16E., Lexington township, to the depth of 2,012 feet (Elev. 752 feet). The Berea was at 521, the Traverse at 980, and the Sylvania at 1,927 feet. Showings of gas were reported at 1,370, 1,758, and 1,932 feet and oil at 1,955 feet. The water horizon in the Dundee was at 1,635 feet, and the well was completed as a dry hole in November, 1931.

The K-Barr Oil and Gas Company drilled on the Joe Kolodziej farm, in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 28, T.11N., R.15E., Washington township, and the well is now shut down at 1,975 feet (Elev. 779 feet). The Berea was at 542, the Traverse at 1,019, the Dundee at 1,586, and the Monroe at 1,719 feet. The black water was struck at 1,642 and a showing of gas at 1,758 feet, but operations on the well have been suspended since early in 1932.

St. Joseph County: Mrs. Lillian Mahnke commenced a well on the L. Mahnke farm in the SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, T.6S., R.11W., Lockport township, which has now reached the depth of 1,025 feet (Elev. 833 feet). Red rock in the Coldwater was at 445 and 512, and the Traverse was at 940 feet.

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