

STATE OF MICHIGAN

DEPARTMENT OF CONSERVATION
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1960
SUMMARY OF OPERATIONS
OIL AND GAS FIELDS

AS COMPILED BY
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GENERAL ACTIVITIES

(Comparative Statistics 1959-60)

General oil and gas activity for 1960 was up very noticeably from the previous years. Exploratory and development well permits increased by 27% with 824 permits being issued for the year. Service wells accounted for 80 additional permits bringing the 1960 total to 904. Total permits issued for 1959 was 727 with 650 for development and exploratory wells and 77 for service wells.

As with permits, completions registered a noticeable increase (39%) from the previous year. This percentage increase does not include 80 service well completions in

1960 and 54 service well completions for 1959. Table I is a comparative summary of the exploratory and development completions for the two years.

OIL AND GAS FIELDS
SOUTHERN PENINSULA OF MICHIGAN
BY DISTRICTS

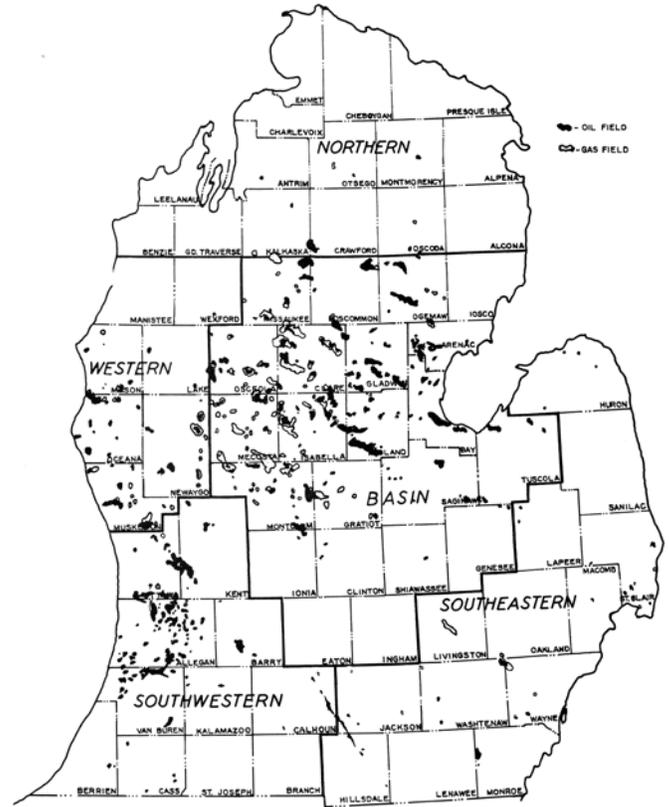


TABLE I
EXPLORATORY AND DEVELOPMENT
WELL COMPLETION SUMMARY FOR 1959
& 1960

	1959				Per- cent Success	1960				Per- cent Success
	Oil	Gas	Dry	Total		Oil	Gas	Dry	Total	
Exploratory Wells ¹	11	6	170	187	9.1	11	4	253	268	5.6
Development Wells ²	245	42	124	411	69.8	361	15	188	564	66.7
Totals	256	48	294	598	50.8	372	19	441	832	47.0

1. Does not include deepenings or wells which were not directly connected with exploratory activity for 1960.
2. Does not include wells drilled in connection with underground storage, water injection and reworks.

Regular exploratory and development footage drilled during 1960 totaled 2,970,667 feet. In addition, 16,143 feet were attributed to deepenings and 156,387 feet to gas storage, secondary recovery and brine projects. Of the regular footage drilled, exploratory wells accounted for 962,737 feet and development wells 2,011,105 feet.

During 1959 exploratory wells penetrated 632,909 feet and development wells 1,286,724 feet of sediments.

Oil production increased by 52.3% and gas by 23.12% over the previous year. The state produced 15,899,205 barrels of oil and 19,240,168 MCF of gas during 1960. The previous year totals were 10,438,608 barrels of oil and 15,626,227 MCF of gas.

EXPLORATION

Exploratory wells drilled during the year resulted: in four new oil fields, four new gas fields, one new oil pool, and six extensions for a 5.6% success ratio. Additional encouragement was noted when one gas field went on oil and a deepening resulted in a lower pay. These two wells have not been included on the exploratory statistics but are listed in Table VII.

Subsurface geology continued to be the main exploratory tool. However, approximately 35% of these tests were based in part or totally on gravity interpretations. Numerous exploratory tests were also drilled in southcentral Michigan on the so-called trend geology in the Albion-Scipio area. The exploratory methods attributed to the 15 discoveries can be broken down as follows: Subsurface geology - five; trend geology - six; gravity - three; and nontechnical - one.

Geophysical activity was at a fairly high rate throughout the year with most of the work being in the nature of gravity meter surveys. As many as 14 gravity crews were working in the state at different intervals of time. One and two seismic crews were in the state for about a six-month period during the year. In addition, some resistivity and magnetometer work was done. The greater amount of geophysical exploration was conducted in the southwestern and southeastern districts, although several gravity crews surveyed sections of the northern district and the northeastern part of the basin district. The various districts are indicated on the Inside of the front cover.

Lease brokers and company land men were quite active in the state with most of the larger acreage programs being in the outer districts around the flanks of the Basin. Undeveloped acreage under lease, as reported by 18 companies, totaled 3,617,993 acres. The State of Michigan reported 369,607 acres of state land under lease.

FORECAST

In view of the large amount of undeveloped acreage under lease and the present deeper formational successes. It would seem reasonable to forecast a definite increase in exploratory drilling for the coming year. A good deal of this activity should be in the outer districts where these formations are at a relatively shallow depth. However, at least 4 deeper tests will be drilled in the central basin district. Unlike exploratory

drilling, development activity will probably be below the 1960 level. The fast pace set in 1960 in south-central Michigan has fallen off considerably. Some of the slack in drilling activity has been taken up by the recent developments in eastern Michigan, however, it is doubtful that this increase will reach the previous magnitude of the south-central Michigan play.

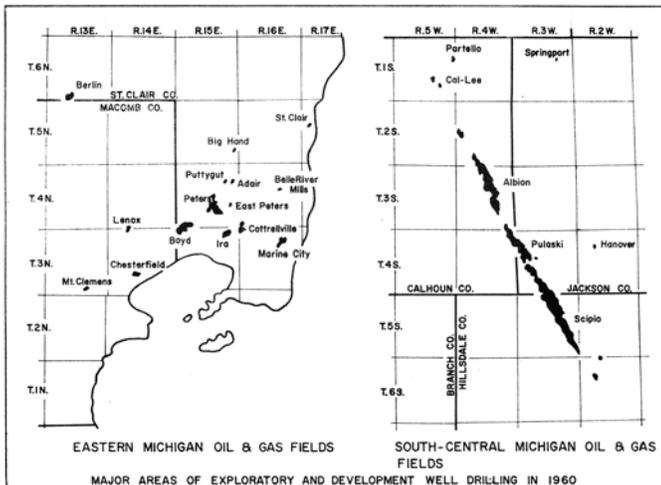
SOUTH CENTRAL MICHIGAN DEVELOPMENTS

The Albion-Pulaski-Scipio Trenton-Black River fracture trend, as outlined on page 5, continued to have most of the drilling activity during 1960. New pools and extensions extended the fracture zone to its present length of about 38 miles. Five of the discoveries recorded were extensions to the trend as developed in 1959; one discovery was classified as a new pool named Cal-Lee, T.1S., R.5W. The Cal-Lee Pool is presently the northwest terminus of the fracture zone. A total of 235 oil wells were completed along the trend in 1960 and 7,921,989 barrels of oil and 2,837,807 MCF of gas were produced. Operators are still actively drilling inside acreage and also trying to extend the present limits of the trend.

Outside the trend area, the Trenton-Black River exploratory tests have had little success. One new gas pool, Springport, T.1S., R.2W., was discovered in 1960. The one well is still being tested and makes a minor amount of oil with the gas. Several dry holes have been drilled in the area. The other noteworthy discovery was first drilled in 1959. This pool (Hanover, T.4S., R.2W.) was put on gas production late in the year. The test subsequently went on oil and produced as high as 500 barrels of oil per day on initial tests. It is presently prorated at 150 barrels of oil per day. Several other wells have been drilled in the area but all of these have been dry.

Substantial shows of oil and gas in the Basal Salina-Niagaran carbonates of the Silurian in and around the Cal-Lee Pool and the Partello reef pool has added to the oil and gas possibilities in those areas.

[Major Areas of Exploration and Development Well Drilling in 1960]



EASTERN MICHIGAN DEVELOPMENTS

A sudden shift of interest in drilling and exploration programs was noted during 1960, particularly in the later part of the year. This shift was an increased exploration for Niagaran reefs in eastern Michigan (see page 5). The development of some of the older reefs, such as, Boyd, Ira, and Peters, plus the discovery of the Belle River Mills, Berlin, Lenox, and Puttygut reefs instigated a boom atmosphere in that area. Part of the results of this increased activity can be seen in the discovery of several new reefs early in 1961. The 1961 reef discoveries are listed below:

1. Adair T.4N. - R.15E. 3. East Peters T.4N. - R.15E.
2. Big Hand T.5N. - R.15E. 4. Mt. Clemens T.3N. - R.13E.

The reefs have been classified as biohermal. They are mainly characterized by unstratified coral buildups, with crude sorting around the flanks. Oil and gas is being produced from the overlying A1 dolomite and the reef. The high relief and small lateral extent of the buildups has been difficult to find by subsurface geology. Consequently, the main exploration tool for this area, other than drilling, is the gravity meter.

Marketing facilities, relative shallow depth, accessibility and later storage possibilities make the eastern Michigan play very attractive. Consequently, numerous independents and a few major companies have leased large blocks of acreage in that area. The extensive development program now being conducted will add measurably to the State's reserves of both gas and oil. Also, the current program should manifest itself in other areas of the state where a limited amount of reef production has already been found.

Relative importance of the older formation discoveries and developments to the petroleum industry of the state are exemplified on the production tables in the summary.

The Salina-Niagaran and Trenton-Black River carbonates accounted for 71.2 per cent of the gas and 52.7 per cent of the oil produced during the year. As a comparison in 1955 the same formations produced only 1.2 per cent of the oil and 33.3 per cent of the gas. The Silurian and Ordovician sediments will play an important part in the future oil and gas developments in Michigan.

OIL FIELD BRINE

Michigan oil fields were producing a total of 170,997 barrels of brine per day at the end of 1960. This is a decrease of 1,608 barrels per day as compared with a total of 172,605 barrels per day at the end of 1959.

Table II is a record of Michigan oil fields which were producing in excess of 2,000 barrels of brine per day and the percentage factor of the total produced from these fields in relation to the total daily brine produced in the state.

TABLE II

Field	1960	1959	1958	1957	1956	1955
Coldwater	30,965	28,592	29,344	33,704	33,256	29,799
Reed City	19,248	19,984	21,785	22,385	23,822	24,907
Stony Lake	10,488	11,983	10,215	8,561	7,062	7,139
Deep River	10,011	9,426	11,321	13,020	11,729	10,538
Porter	9,235	10,749	11,719	11,963	12,292	12,604
Pentwater	8,935	7,060	9,455	8,725	8,129	8,196
Freeman-Redding	7,777	7,484	12,247	12,612	11,930	12,734
Kimball Lake	4,947	4,835	4,405	10,004	10,040	12,276
Adams, North	4,888	4,888	5,392	5,759	5,449	5,387
Reynolds	4,236	3,136	2,251	1,139	478	174
Prosper	4,125	3,300	3,302	3,513	3,644	3,544
Vernon	3,706	3,706	2,530	2,910	2,825	2,825
Sylvan	2,830	4,698	4,598	6,950	6,407	4,830
Ewart	2,700	2,960	3,460	4,685	4,610	5,590
Clayton	2,620	3,035	3,763	4,456	2,477	2,390
Winterfield	2,383	2,188	4,071	4,327	4,612	3,624
Albion-Pulaski-Scipio Fork	2,348	2,177	60	-	-	-
	2,111	5,191	6,481	7,758	12,115	16,475
Total (18 Fields)	133,553	135,392	146,399	162,471	160,877	163,032
State Total	170,997	172,605	179,231	195,630	195,563	202,361
Percent State Total	78.1	78.4	81.7	83.1	82.3	80.6

Of the eighteen fields tabulated, nine had an increase in the daily amount of brine produced, seven a decrease, and two remained the same. The most significant increases were in the Coldwater, Pentwater, Prosper, and Reynolds fields. The substantial decrease in brine produced in the Fork, Porter, Stony Lake, and Sylvan fields is due to plugging and abandonment of wells and to numerous nonproductive shut-in wells pending disposition.

Operators in Michigan oil fields were returning 168,466 barrels of brine per day to approved subsurface formations. This was 98.5 per cent of the total brine produced. Of the remaining 1.5 per cent, or 2,531 barrels, 1,512 barrels were being used for commercial purposes, lease operations, and by county road commissions for road maintenance, and 1,019 barrels were being disposed of in surface pits and released in small widely scattered amounts in accordance with temporary arrangements with operators.

GENERALIZED COLUMNAR SECTION OF MICHIGAN
MICHIGAN GEOLOGICAL SURVEY DIVISION

SYSTEM, SERIES	FORMATION, GROUP	LITHOLOGY	THICKNESS	ECONOMIC PRODUCTS
RECENT				
PLEISTOCENE	GLACIAL DRIFT	SAND, GRAVEL, CLAY, boulders, marl	0-1000	SAND, GRAVEL, PEAT, MARL, FRESH WATER
"PERMO-CARBONIFEROUS"	"RED-BEDS"	SHALE, CLAY, SANDY SHALE, gypsum		
PENNSYLVANIAN	GRAND RIVER	SANDSTONE, sandy shale	80-95	BUILDING STONE, FRESH WATER
	SAGINAW	SHALE, SANDSTONE, limestone, coal	20-535	SHALE, COAL, FRESH WATER, BRINE, GAS
MISSISSIPPIAN	BAY PORT	LIMESTONE, SANDY OR CHERTY LIMESTONE, SANDSTONE	2-100	LIMESTONE, FRESH WATER
	MICHIGAN	SHALE, gypsum, anhydrite, sandstone	0-500	GYPSUM
	"MICHIGAN STRAY"	SANDSTONE	0-80	GAS
	MARSHALL	SANDSTONE, sandy shale	100-400	FRESH WATER, BRINE BUILDING STONE
	COLDWATER	SHALE, sandstone, limestone	500-1100	SHALE, FRESH WATER
	SUNBURY	SHALE	0-140	
	BEREA - BEDFORD	SANDSTONE, SHALE	0-325	GAS, OIL
	ELLSWORTH - ANTRIM	SHALE, limestone	100-950	SHALE, GAS
DEVONIAN	TRAVERSE	LIMESTONE, SHALE	100-800	LIMESTONE, OIL, GAS, FRESH WATER
	BELL	SHALE, Limestone	0-80	SHALE
	ROGERS CITY-DUNDEE	LIMESTONE	0-475	LIMESTONE, OIL, GAS, FRESH WATER
	DETROIT RIVER	DOLOMITE, limestone, salt anhydrite	150-1400	LIMESTONE, DOLOMITE, OIL, GAS, SALT, BRINE, FRESH WATER
	SYLVANIA	SANDSTONE, SANDY DOLOMITE	0-550	GLASS SAND, FRESH WATER
	BOIS BLANC	DOLOMITE, CHERTY DOLOMITE	0-1000	
SILURIAN	BASS ISLAND	DOLOMITE	50-570	DOLOMITE, FRESH WATER
	SALINA	SALT, DOLOMITE, Shale, anhydrite	50-4000	SALT, GAS, OIL
	NIAGARAN (Guelph - Lockport - Engadine) (Manistique - Burnt Bluff) (Cataract)	DOLOMITE, Limestone, shale	150-800	LIMESTONE, DOLOMITE, OIL, GAS, FRESH WATER
	ORDOVICIAN	CINCINNATIAN (Richmond) (Maysville - Eden)	SHALE, LIMESTONE	250-800
TRENTON-BLACK RIVER		LIMESTONE, DOLOMITE	200-1000	OIL, GAS, LIMESTONE, FRESH WATER
ST. PETER		SANDSTONE	0-150	FRESH WATER
OZARKIAN OR CANADIAN	PRAIRIE DU CHIEN	DOLOMITE, Shale	0-410	
	HERMANVILLE	DOLOMITE, SANDY DOLOMITE, sandstone	15-500	
CAMBRIAN	LAKE SUPERIOR (Munising) (Jacobsville)	SANDSTONE	500-2000	BUILDING STONE FRESH WATER
ALGONKIAN	KEWEENAW (Copper formations)	LAVA FLOWS, conglomerate, shale, sandstone	9800-35000	COPPER, SILVER, ROAD METAL, SEMI-PRECIOUS GEM STONES
	KILLARNEY GRANITE	GRANITE, GNEISS, diorite, syenite		
	HURONIAN (Iron formations)	SLATES, HEMATITE, SCHIST, QUARTZITE, GRANITE, marble, dolomite	2000+	IRON ORE, ROOFING SLATE, ROAD METAL, GRAPHITE MARBLE
ARCHEAN	LAURENTIAN	SCHIST, GNEISS, GRANITE		ROAD METAL, BUILDING STONE, VERDE ANTIQUE, TALC, GOLD
	KEEWATIN	SCHIST, GREENSTONE, SLATE		ROAD METAL