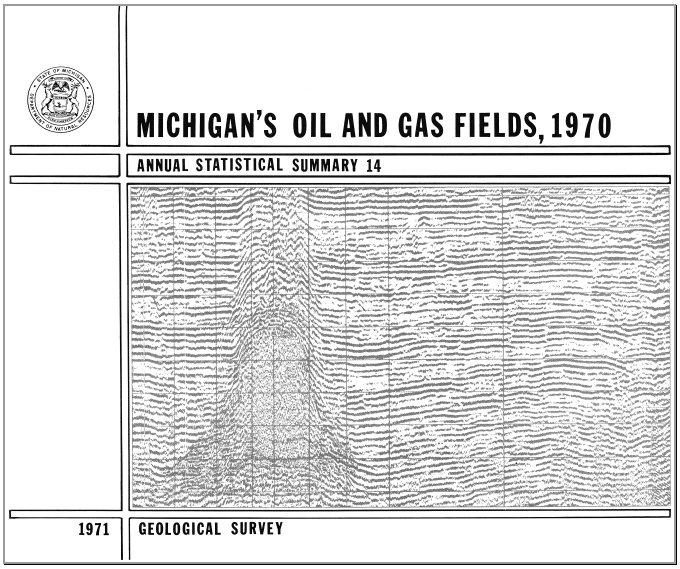

CONTENTS

MICHIGAN'S OIL AND GAS FIELDS, 1970

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ACKNOWLEDGEMENTS

The Geological Survey Division, Department of Natural Resources, being charged with the administration of the state's oil and gas laws, has maintained an exceptional collection of oil and gas field records for many years. The state's first oil field was discovered about 1886 at Port Huron, but its recognition as a petroleum province did not start until about 1925 when the Saginaw field was found. Information covering these early activities was published from time to time in various Survey publications. Eventually there evolved a small annual publication devoted solely to oil and gas activities.

The first oil and gas summary was published about 1932. The early issues, from 1932 through 1946, were unbound mimeographed pages summarizing some of the year's activities and statistical data. They were of limited distribution and few copies are now available. As the petroleum industry grew in importance to the state's economy, the summaries were expanded and improved in response to the needs of industry and government agencies for various kinds of oil and gas field

information. New items are added from time to time and others are deleted when no longer useful.

Some of the statistical data and other types of information maintained for incorporation into the summaries is also provided to such groups as the American Association of Petroleum Geologists, American Petroleum Institute, U. S. Bureau of Mines, the Independent Petroleum Association of America, and others for incorporation into their respective publications.

This issue thus brings together under one cover many oil and gas field statistical data not usually found in any other industry or government publication. Oil and gas field data of historical and general interest are included and thus preserved herein for future reference. This summary is, therefore, a source of information most useful in evaluating Michigan's past history and future prospects as an oil and gas province. Furthermore, the gathering, maintenance and compilation of the many data contained in the summary reflects, in part, the varied functions of the Oil and Gas Section of the Geological Survey.

The oil and gas summaries are not printed in large quantities. They are distributed to various government agencies in all 50 states, to numerous libraries in the United States and several abroad, and to many individuals and companies engaged in oil and gas or other mineral industries. Current and some back issues are available at nominal cost from Publications Room as noted inside the front cover.

Oil and Gas Section supervisors who directed staff members in the gathering and maintenance of basic records, and who assembled and contributed specific data are:

R. M. Acker, Geologist in charge, Oil and Gas Section.

V. F. Sargent, Geologist and Head, Regulatory Control Unit—Data under the headings "Number of Oil or Gas Wells" and "Brine Production" as shown in Table 3, and Tables 4 and 5 (Gas Storage Reservoirs).

W. G. Smiley, Geologist and Head, Production and Proration Unit—All oil and gas production data, valuations, refinery and LPG storage data, secondary recovery data, and oil recovery per acre drilled (Table 3).

G. D. Ells, Geologist and Head, Petroleum Geology Unit-General drilling statistics and well completion data, discovery well and deep test data, drilled acreage figures, cumulative records, and other summary information not specifically provided by those mentioned above.

Inquiries concerning information contained in this summary should be directed to the appropriate Oil and Gas Section unit personnel as noted above.

Oil and gas production figures cited herein are obtained from Michigan Department of Revenue records and are maintained and compiled by the Production and Proration Unit. Gas import figures are from Michigan Public Service Commission, Gas Section, compilations.

All hydrocarbon production figures are preliminary and subject to correction as warranted.

Cover Photo: Simulated seismic profile showing discontinuity and arching of lower reflecting horizons thus indicating an anomaly which may be a buried reef or a salt plug. The reef fields of northern Michigan have been found by seismic prospecting.

Manuscript preparation by G. D. Ells, assisted by secretarial and staff members of the Petroleum Geology and General Geology Units.

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Petroleum Geology Unit

Lansing, Michigan
June, 1971

INTRODUCTION

This issue of Michigan's oil and gas field statistical summary presents data related to various facets of the State's exploration and producing industry during 1970. Certain useful indicies which show the trend of activities from year to year are shown in chart form and compared, where useful, to data for prior years. In addition, the summary contains abundant information of an historical nature, useful in oil and gas field evaluation.

Certain figures for 1970, such as the number of exploratory, development, and service wells drilled, and the number of discoveries, may differ from figures reported by regional or national trade journals and by petroleum industry reporting services. Differences are minor and due to methods of gathering and reporting well drilling data, and determining a cutoff date for reporting statistics on a yearly basis.

The kinds of data listed herein are mainly derived from records received and maintained by the Geological Survey Division. The kinds of data reported in these oil and gas summaries have been treated uniformly from year to year and reflect as near as possible the actual figures that should be credited to the year as noted.

Part 1 of this publication summarizes significant information on oil and gas field activities and related work of the Oil and Gas Section of the Geological Survey during 1970. Part 2 contains specific information on Michigan's oil and gas fields and other related activities for 1970. Part 3 contains cumulative records of importance to the petroleum industry. Data for 1970 has been included in the cumulative records.

1970 STATISTICAL DATA

A total of 425 regular oil and gas permits were issued during 1970. They were divided as follows:

Exploratory wells . . .	165
Development wells . . .	144
Gas storage facility wells.	115
LPG storage	1

Included in the 425 permits was 1 issued to reopen and test a previously drilled dry hole. Also, 13 permits issued in 1969 and 1970 were terminated after permittee failed to commence drilling within 6 months after issuance of the permit. In addition, 30 deepening permits and 1 BDW permit were issued. No geological test permits were issued during the year. Table 2, page 10 shows the distribution of permits by county.

The geographic distribution of oil and gas permits issued through a three-year period, including 1970, is as follows:

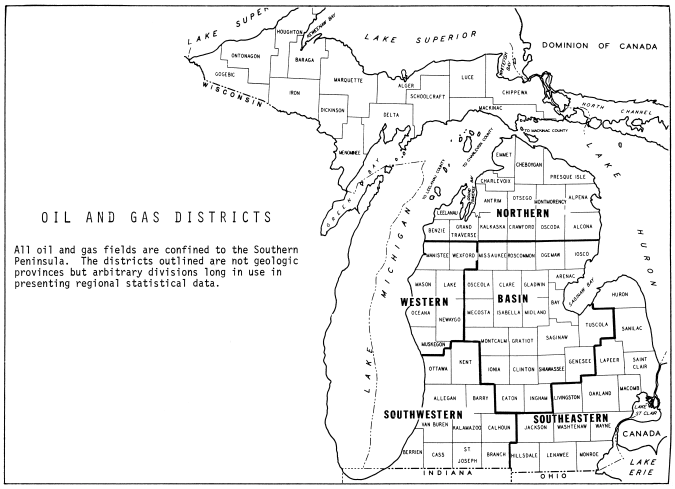
DRILLING PERMITS BY DISTRICT

DISTRICTS	Permits Issued		
	1968	1969	1970
Basin	88	113	169
Northern	17	32	52
Southeastern	143	126	121
Southwestern	61	41	33
Western	69	67	50
Totals	378	379	425

The fluctuation in regular permits issued for gas storage facility wells, LPG and other types over a three-year span is as follows:

TYPE OF SERVICE WELL	1968	1969	1970
Gas storage	27	48	115
LPG, Wtr. Inj., Brine Disposal, etc.	9	10	1
Totals	36	58	116

[Oil and Gas Districts (Map)]



* * * WELL COMPLETIONS * * *

There were 277 new-hole exploratory and development wells which reached total depth and were completed as producers or dry holes during 1970. The figure does not include service wells, old wells drilled to deeper objectives, reworks, or others not directly related to new-hole oil and gas exploratory or development drilling. In addition, 111 new-hole service wells were completed during the year. These do not include reworked wells. The fluctuation in exploratory, development and service well completions over a three year period are as follows:

EXPLORATORY AND DEVELOPMENT WELL COMPLETIONS

Year	Exploratory Wells			Development Wells			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
1968	9	4	151	61	8	100	333
1969	7	3	148	66	6	91	321
1970	8	6	139	43	9	72	277

SERVICE WELL COMPLETIONS

Year	GS	INJ	LPG	SWD	Totals
1968	27	2	6	0	35
1969	20	5	0	1	26
1970	110	0	3	0	113

The average depth of exploratory wells drilled in 1970 was about 4,025 feet as compared with an average depth of 3,445 feet the prior year. Development well depths averaged about 3,661 feet as compared with an average depth of 3,435 the prior year. Service well depths averaged about 1,463 feet. Most of them were completed in shallow Mississippian Stray Sandstone reservoirs. The fluctuation in total drilled footage, including a few old wells deepened to new objectives, over a three-year period is as follows:

Well Class	Amount of Drilled Footage		
	1968	1969	1970
Exploratory	522,384	544,160	615,952
Development	564,827	559,936	454,016
Service	76,026*	69,126**	162,344
	1,163,237	1,173,222	1,232,312

*Corrected figure. Shown as 776,026 in Annual Statistical Summary 10.

**Included LPG, GS, BDW, and water injection wells.

The following exploratory and development statistics and drilled footage figures for Michigan have been extracted from: Quarterly Review of Drilling Statistics for the United States, Vol. IV, No. 4, March 1971, American Petroleum Institute. The differences between these statistics and Geological Survey figures are very minor. They are due primarily to methods of establishing cut-off dates for handling statistics and internal decisions relating to final status of a completed well as determined by the Survey.

API EXPLORATORY AND DEVELOPMENT WELL COMPLETIONS

Year	Exploratory Wells			Development Wells			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
1970	9	7	139	40	12	76	283

API DRILLED FOOTAGE STATISTICS 1970

Exploratory Wells			Development Wells			Totals
Oil	Gas	Dry	Oil	Gas	Dry	
53,482	36,500	524,799	133,636	42,137	283,211	1,073,765

* * * OIL AND GAS PRODUCTION * * *

Oil production amounted to 11,693,488 barrels as compared with 12,212,882 barrels produced in 1969. Production from new pools found in 1970 may lessen the general decline, and this should be reflected in 1971 figures. Gas production increased from 36,162,173 Mcf to 39,252,013 Mcf. Again, the Albion-Scipio Trend pools produced about 47% of the states oil and about 29% of the gas in 1970.

Oil and gas production by individual field and pool is found in Part 2, Table 4. Annual and cumulative production by year, geologic formation, and county is found in Part 3.

Production by county is shown on the adjacent page, Table 2. Production by month and oil and gas district is as follows:

OIL AND GAS PRODUCTION BY MONTH

	Barrels Oil	MCF Gas
January	972,395	3,730,029
February	905,063	3,292,276
March	973,773	4,625,798
April	979,058	3,620,342
May	969,574	3,479,072
June	962,299	3,387,377
July	990,338	3,490,398
August	978,409	3,384,986
September	941,025	3,369,750
October	1,037,188	2,406,351
November	981,722	2,184,016
December	1,002,644	2,281,618
Totals	11,693,488	39,252,013

OIL AND GAS PRODUCTION BY DISTRICT

District	Barrels Oil	MCF Gas
Basin	3,577,620	1,629,319
Northern	947,750	644,354
Southeastern	4,706,538	32,203,445
Southwestern	2,096,526	4,774,816
Western	365,054	79
Totals	11,693,488	39,252,013

* * * OIL AND GAS VALUATION * * *

Effective November 30, 1970, there was a $.25 per barrel increase in sales price for all grades of Michigan oil. The average price paid at the wellhead was $3.10 per barrel. The value of this mineral resource amounted to $36,246,376 as compared with $37,494,318 in 1969.

The average price of Michigan produced gas sold at the wellhead was about $.27 per Mcf. The value of this product amounted to about $10,476,482 as compared with $9,296,332 in 1969.

The estimated value of LPG's produced in 1970 was about $2.52 per barrel, or about $.06 per gallon. The value of this product amounted to about $4,479,764 as compared with $5,332,053 in 1970.

* * * LPG PRODUCTION * * *

Total LPG production in 1970 amounted to about 1,777,684 barrels as compared with 2,115,894 barrels produced in 1969. LPG's are stripped from Michigan produced gas and gas imported via pipeline from western sources. Additional details on LPG production and gas plant operations are found in Part 2.

* * * OIL AND GAS IMPORTS AND EXPORTS * * *

Domestic imports of crude oil via pipeline from western and midwestern states in 1970 amounted to 24,462,575 barrels, a decrease from the 26,842,727 barrels imported in 1969. Canadian imports via pipeline from western Canada oil fields increased from 12,463,050 barrels in 1969 to 17,698,262 barrels in 1970. Total imports amounted to 42,160,837 as compared with 39,305,777 barrels in 1969. Exports of Michigan produced crude oil to northern Indiana (Ft. Wayne) and Ohio (Cleveland) refineries or terminals amounted to 512,335 barrels, a decrease from the 675,533 barrels exported in 1969. Imports and exports of crude oil by month are shown in chart form on the following page.

1970 OIL IMPORTS (Bbls.)

	Domestic	Canadian	Total
January	1,597,107	1,825,345	3,422,452
February	1,192,598	1,808,128	3,000,726
March	2,089,158	1,839,448	3,928,606
April	2,086,744	1,127,849	3,214,593
May	2,122,157	1,281,158	3,403,315
June	2,268,391	1,124,010	3,392,401
July	2,404,363	1,198,777	3,603,140
August	1,814,571	1,392,939	3,207,510
September	2,409,532	1,392,902	3,802,434
October	1,957,882	1,610,417	3,568,299
November	2,513,469	1,437,814	3,951,283
December	2,006,603	1,659,475	3,666,078
Totals	24,462,575	17,698,262	42,160,837

Gas imports to Michigan markets and gas storage fields via pipelines, primarily from Texas, Louisiana, Oklahoma and Kansas fields, increased over 90 billion cf in 1970. Compilations by the Gas Section, Michigan Public Service Commission, show gas imports of 860,091,576 Mcf. as compared with 769,675,508 Mcf. in 1969. Monthly imports of gas in 1970 were as follows:

1970 PIPELINE GAS IMPORTS (Mcf.)

January	45,574,224
February	43,828,730
March	57,159,821
April	74,570,620
May	90,149,106
June	91,371,474
July	95,130,798
August	90,707,691
September	83,585,605
October	80,213,448
November	56,828,173
December	50,971,886
Total	860,091,576

1970 OIL EXPORTS (Bbls.)

January	57,872
February	50,591
March	50,045
April	48,471
May	46,271
June	17,196
July	58,958
August	39,610
September	41,001
October	37,012
November	30,456
December	34,855
Total	512,335

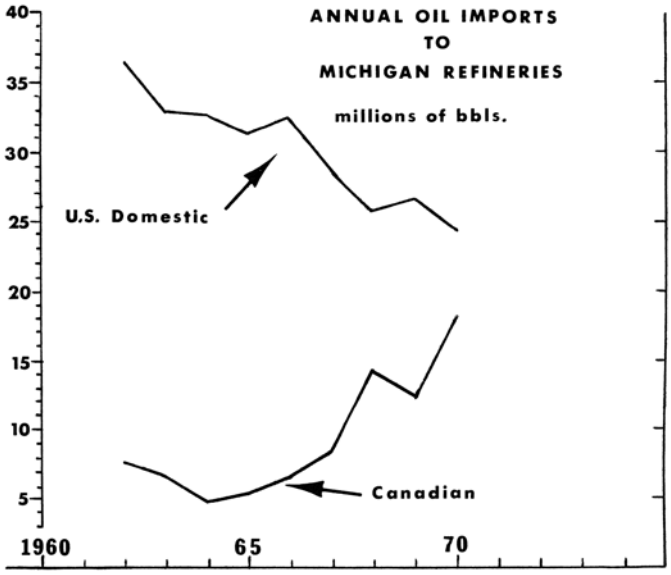


TABLE 1 -- OIL AND GAS PRODUCTION BY COUNTY IN 1970

County	Barrels Oil	MCF Gas
Allegan	130,485	274,220
Arenac	226,288	---
Barry	10,262	---
Bay	248,916	---
Calhoun	1,827,699	4,220,253
Clare	462,037	161,004
Crawford	495,816	484,466
Genesee	27,322	---
Gladwin	299,467	---
Gratiot	10,719	3,895
Hillsdale	2,601,532	5,089,598
Huron	1,412	---
Ingham	6,370	---
Isabella	200,784	29,811
Jackson	1,047,526	2,430,499
Kalkaska	164,574	---
Kent	62,668	11,436
Lake	211,809	---
Lapeer	61,993	45,433
Lenawee	214	7,036
Livingston	535	---
Macomb	5,103	6,646,184
Mason	37,115	---
Mecosta	172,480	104,003
Midland	184,299	---
Missaukee	558,806	664,962
Monroe	2,153	---
Montcalm	113,023	3,668
Muskegon	32,008	---
Newaygo	17,368	79
Oakland	442	---
Oceana	66,750	---
Ogemaw	299,023	373,286
Osceola	507,319	47,867
Oscoda	1,187	---
Otsego	284,680	159,892
Ottawa	59,478	268,906
Presque Isle	1,491	---
Roscommon	166,932	240,819
Saginaw	21,475	---
Shiawassee	9,026	---
St. Clair	976,631	17,984,692
Tuscola	63,324	---
Van Buren	5,933	---
Washtenaw	3,746	---
Wayne	5,244	---
Totals	11,693,487	39,252,013

TABLE 2 DRILLING PERMITS AND WELL COMPLETIONS BY COUNTY, 1970

TABLE 2 DRILLING PERMITS AND WELL COMPLETIONS BY COUNTY, 1970 (Sheet 1 of 2)

Classification of New Hole Completions

Does not include reworked wells or old wells drilled deeper

COUNTY	OIL AND GAS PERMITS ISSUED	OIL AND GAS TESTS Exploratory	OIL AND GAS TESTS Development	RESULTS Oil Wells	RESULTS Gas Wells	RESULTS Dry Holes	SERVICE WELLS G.S.	SERVICE WELLS L.P.G.	TOTAL COMPLETIONS
Alcona	1	1				1			1
Allegan	4	1	1			2			2
Antrim	3	3				3			3
Barry	1								0
Benzie	4	4				4			4
Branch	2	2				2			2
Calhoun	22	1	16	6		11			17
Cass	1	1				1			1
Cheboygan	2	2				2			2
Clare	35	1				1	34		35
Crawford	2		3	1		2			3
Eaton	6	4				4			4
Emmet	2	2				2			2
Genesee	13		10	9		1			10
Gladwin	2		1			1			1
Grand Traverse	7	4	1		2	3			5
Gratiot	2								0
Hillsdale	22	5	14	5	1	14			20
Ingham	7	3		1		2			3
Isabella	14	2	2	1		3	26		30
Jackson	6	3	1			4			4
Kalamazoo	1	1				1			1
Kalkaska	13	9	3	3	2	7			12
Lake	3	4	2	2		4			6
Lapeer	8		5	4		1			5
Lenawee	3	1				1			1
Livingston	8	2	4		4	2			6

Table 2 DRILLING PERMITS AND WELL COMPLETIONS BY COUNTY, 1970 (Sheet 2 of 2)

Macomb	15	17	2			19			19
Mason	8	6	3	1		8			9
Mecosta	6	3	2	1		4			5
Midland	1								0
Missaukee	4	1	3			4			4
Montcalm	29	7	5	3		9	9		21
Muskegon	4	3	3	1	1	4			6
Newaygo	6	2				2	6		8
Oakland	6	2	1			3			3
Oceana	26	15	10	2		23			25
Osceola	48	4	1	1		4	34		38
Oscoda	1								0
Otsego	15	3	9	4	1	7			12
Ottawa	1	1				1			1
Presque Isle	2	3				3			3
Sanilac	1	1				1			1
Shiawassee	1	1				1			1
St. Clair	51	22	22	5	4	35	1		45
St. Joseph	1	1				1			1
Tuscola	1	1			1				1
Wayne	1							3	3
Wexford	3	3				3			3
Totals 49 Counties	425	153	124	50	16	211	110	3	389

Includes 8 permits which were issued and terminated in 1970

* * * DISCOVERY WELLS * * *

The discovery-to-dry hole ratio for all exploratory wells drilled and completed during the year was about 1:11 compared with 1:12 in 1969. In the Northern District as outlined on the preceeding Oil and Gas District map, 31 exploratory wells were drilled and completed during the year. The discovery ratio in that district was a little better than 1:3, an exceedingly high success ratio. In 1969 the ratio was about 1:5 for the district. The new fields in the region, all Niagaran reef reservoirs, were found by seismic or gravimeter surveys.

The most significant discoveries (and exploratory failures) were drilled in the Northern District. The majority of failures were drilled on geophysical anomalies, presumably reflecting Niagaran reef build-ups. Also of importance, a new reef area was opened up at the southern edge of the Basin District in Ingham. The new reef discovery marks the first commercial oil or gas production from Ingham County. Elsewhere in the state, most discoveries were found in established producing regions. The locations of new fields and pools are shown on map segments below and on center spread.

Few of the new discoveries appear to have an ultimate oil or gas yield greater than a Class E field as defined below. Some of the new reef fields have been tentatively rated as Class D. The classifications are based on potential yields as defined by the American Association of Petroleum Geologists, Committee on statistics of Drilling.

Class A - Over 50 million barrels oil or 300 BCF gas
Class B - 25-50 million barrels oil or 150-300 BCF gas
Class C - 10-25 million barrels oil or 60-150 BCF gas
Class D - 1-10 million barrels oil or 6-60 BCF gas
Class E - 1 million barrels or less oil or less than 6 BCF gas
Class F - Abandoned as non-profitable

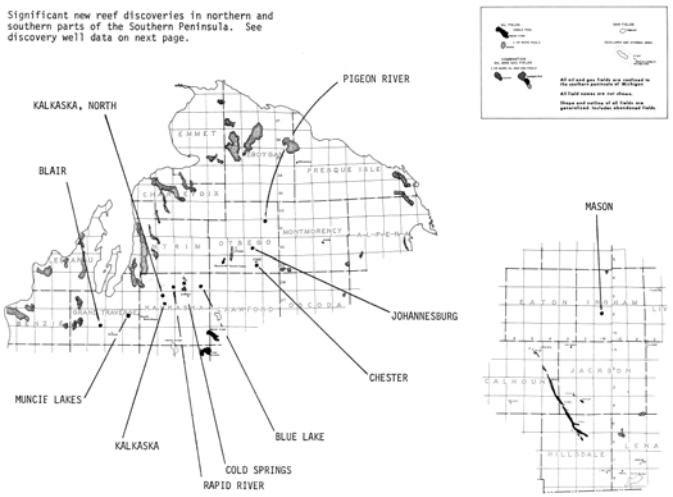
From stratigraphically youngest to oldest, about 1% of all exploratory wells were quit in Mississippian, Michigan Stray-Marshall sandstone formations; 10% in Devonian, Traverse Limestone; 8% in Devonian, Dundee and 8% in Reed City rocks; 1% in Devonian Detroit River Group rocks; 57% in Middle Silurian, Niagaran rocks; 3% in Middle Ordovician, Trenton-Black River rocks; 11% in St. Peter Sandstone and Prairie du Chien rocks; and about 1% in Cambrian or older rocks. Several hundred feet of basement rock was drilled in the single Precambrian test, Livingston County. The sizeable increase in wells drilled only to Niagaran rocks (about 37% in 1969) reflects the high interest in Niagaran exploration in the northern part of the state. An analysis of discoveries according to reservoir formation for a three-year period is shown on the following chart.

ANALYSIS OF DISCOVERY WELLS BY GEOLOGIC SYSTEM

System	Formation or Pay	Number of Discoveries 1968	1969	1970
Pennsylvanian		-	-	-
Mississippian	"Michigan Stray Ss."	1	-	-
	"Berea"	-	-	2
Devonian	Antrim Shale	-	-	-
	"Traverse Lime"	6	3	-
	Dundee	1	-	1
	"Reed City"	1	-	2
	Detroit River "Sour Zone"	-	1	1
	Richfield	1	1	-
Silurian	Salina A-1 or A-2	-	-	-
	Niagaran Reef*	4	4	12
Ordovician	Trenton-Black River	-	1	-
	Prairie du Chien	-	-	-
Cambrian	(Gas Shows Reported)	-	-	-

* Most reefs also have associated Salina A-1 oil or gas pays.

Significant new reef discoveries in northern and southern parts of the Southern Peninsula. See discovery well data on next page.



1970 DISCOVERY WELLS

Field	County, Location, Permit No.	Operator and Lease	Comp. Date	Depth to Pay	Total Depth	Initial Production n=(N)IP BOPD	Initial Production t=(T)IP MCFGPD	Prod. Form.	Basis for Loc.	AAPG Pool Class
NEW FIELDS										
Blair	Grand Traverse 34-26N-11W SP 27977	Shell Oil Co. Thomas #1-34	6-8	5826	6316		5543[t] & Cond.	Niagaran	Seis.	E
Blue Lake	Kalkaska 28-28N-5W SP 28229	Amoco Production Co. State-Blue Lake #1-28	12-3	7105	7450		3000[t] Cond.	Niagaran	Seis.	D
Cold Springs	Kalkaska 21-28N-6W SP 27866	Amoco Production Co. Simpson #1	1-20	6764	7315	F100[t]		Niagaran	Seis.	D
Columbus Sec. 32(a)	St. Clair 32-5N-15E SP 27864	Collins Bros. Oil Bartell & Ricossa Comm. #1	12-14	2983	3023		2300[t]	Niagaran	Sub.	E
Fostoria	Tuscola 14-10N-9E SP 28104	A. G. Hill Roy Brown et al #1	7-31	1514	3267		SIGW	Berea	Sub.	E
Fountain	Mason 12-19N-16W SP 28158	Miller Bros. J. & E. Lavas #1	10-6	2442	2448	P35[t]		Reed City	Sub.	E
Johannesburg	Otsego 21-30N-2W SP 28089	Shell Oil Co. J. E. Donovan #1-21	8-30	5772	6483	F898[t]		Niagaran	Seis.	E
Kalkaska	Kalkaska 28-27N-7W SP 28081	Shell Oil Co. Longfield #1-28	8-4	7129	7415	F117 Cond. & 2538[t]		Niagaran	Seis.	E
Kalkaska, North	Kalkaska 5-27N-7W SP 28131	Shell Oil Co. State-Kalkaska #1-5	9-11	6318	6911	F329[t]		Niagaran	Seis.	F
Luther, North	Lake 8-19N-11W SP 27723	Bermax Oil Co., Inc. Konarski #1	1-20	3518	3555	P14[t]		Reed City	Sub.	E
Mason	Ingham 16-2N-1W SP 28173	Mobil Oil Corp. Ellsworth Brown #1	9-29	4165	4537	F322 & 393 Mcf.		Niagaran	Seis.	E
Muncie Lakes	Grand Traverse 8-26N-9W SP 28161	Shell Oil Co. State-Union #1-8	10-17	6267	6666		6620[t] & Cond.	Niagaran	Seis.	E

NEW FIELDS, Continued

Pigeon River	Otsego 4-31N-1W SP 28006	Northern Michigan Exploration Co. State-Charlton #1-4	6-28	4766	5270	F829[t]		Niagaran	Grav.?	E
Rapid River	Kalkaska 24-28N-7W SP 28230	Amoco Production Co. State-Rapid River #1-24	12-15	6590	6810	F266 & 1700 Mcf.		Niagaran	Seis.	D

NEW POOL DISCOVERIES

Chester(b)	Otsego 15-29N-2W SP 27917	Shell Oil & M. L. Welch State-Chester #N-1	4-30	5930	6697		2811[t] & 79 Bbls. Cond.	Niagaran	Sub.	D
Home, Sec. 26	Montcalm 27-12N-6W SP 27978	Burks White Harold Graham #2	5-15	3513	3520	F5/hr.		Dundee	Sub.	E
Otter Lake(c)	Genesee 11-9N-8E SP 27599	Hobson Oil Co. Leo Sammon #1	8-25	2968	3142	F100[t]		Det. River Sour Zone	Sub.	E
Rich(d)	Lapeer 21-10N-10E SP 26866	Huron Oil & Mid-State O. & G. Gary Eymon #1	7-13	1380	PBTD 1489		SIGW	Berea	Sub.	E

(a) 1969 discovery reported in 1970 statistics.
(b) Drilled as development well. New pool discovery in Upper Niagaran reef section.
(c) Completed as D & A in 1969. See footnotes, page 49, Table 3
(d) Completed as D & A in Richfield in 1969. PB to Berea in 1970.

NOTE: t=T(IP) refers to initial production after acid, sand-fracture, or a combination of well stimulation methods.

n=N(IP) refers to natural potential or production.

DEEP TESTS

County Location	Permit Number	Operator and Lease	System and Formation	Total Depth	Basis for Loc.	Explo. Class	Remarks
Alcona 30-28N-5E	28231	North American Drlg. Co. #2 Cranberry Ranch	Sil., Niagaran	6560	Acreage	NFW	
Antrim 36-29N-7W	28021	Shell Oil Co. #1-36 Sanders	Sil., Clinton	6637	Seis.	NFW	
Antrim 13-29N-5W	27931	Shell Oil Co. #1-13 State-Mancelona	Sil., Niagaran	6635	Seis.	NFW	
Antrim 32-29N-5W	28184	Pan American Petrol. Corp. #1-32 State-Mancelona	Sil., Clinton	7024	Seis.	NFW	
Benzie 27-26N-13W	28132	Pan American Petrol. Corp. #1-27 State-Inland	Sil., Clinton	5391	Seis.	NFW	
Benzie 33-26N-14W	28034	Shell Oil Co. #1-33 State-Homestead	Sil., Clinton	4955	Seis.	NFW	
Benzie 1-25N-14W	28109	Northern Mich. Explor. Co. #1-1 State-Weldon	Sil., Clinton	5250	Grav.?	NFW	
Benzie 29-25N-14W	27899	McClure Oil Co. #1 State-Weldon	Sil., Clinton	5003	Grav.?	NFW	
Cheboygan 34-34N-1E	28084	McClure Oil Co. #1-34 State-Forest	Sil., Niagaran	3678	Grav.?	NFW	
Cheboygan 3-33N-1W	27976	Shell Oil Co. #1-3 State-Nunda	Sil., Clinton	4276	Seis.	NFW	S. G. on D.S.T.
Crawford 21-25N-4W	28110	Union Oil Co., California #C-4 State-Beaver Creek	Ord., St. Peter	10,142	-	DPT	PB to Richfield
Emmet 2-36N-5W	28177	Atlantic Inland Oil Corp. #1 Jurek	Sil., Clinton	2478	Acreage?	NFW	
Emmet 35-37N-4W	28212	Atlantic Inland Oil Corp. #1 White & Burns	Ord., St. Peter	3958	Acreage?	NFW	
Grand Traverse 32-27N-12W	28041	A. G. Hill #1 Pattinson	Sil., Clinton	5280	Grav.	NFW	
Grand Traverse 32-27N-10W	27860	Northern Mich. Explor. Co. #1 Goff et al	Sil., Niagaran	5894	Grav.?	NFW	
Ingham 29-3N-2E	28145	Mobil Oil Corp. #1 Bearse & Hill	Sil., Cabot Head	4980	Seis.	NFW	
Ingham 21-3N-2E	27910	Mobil Oil Corp. #1 Jorgensen et al	Sil., Cabot Head	5003	Seis.	NFW	
Kalkaska 8-28N-6W	28108	Sorvat Oil Co. #1 Stein	Sil., Clinton	7152	Grav.?	NFW	
Kalkaska 23-27N-8W	28024	Northern Mich. Explor. Co. #1-23 State-Kalkaska	Sil., Clinton	7015	Grav.?	NFW	
Kalkaska 16-26N-5W	28187	Shell Oil Co. #L-16 Consumers Power Co.	Sil., Niagaran	8018	Seis.	NFW	
Livingston 11-3N-5E	27986	Mobil Oil Corp. #1 Messmore	Precambrian	7589	Grav. Geomorph.	NFW	S. O. & G. in Trenton
Muskegon 1-12N-18W	28208	The MOCO #1 Lowden	Sil., Niagaran	3850	Grav.?	NFW	
Newaygo 11-11N-13W	28137	Chapman Drlg. & Tribal Oil #1 Brydges	Ord., Black River	6201	Sub.	NFW	S. G. in Silurian
Newaygo 8-15N-14W	27893	Island Lake Oil & Gas #1 Andrews et al	Sil., Clinton	5460	Sub.	NFW	
Oakland 35-4N-8E	28258	Texaco, Inc. #1 Huntoon	Cambrian?	6500	Grav.	NFW	
Oceana 12-13N-17W	28169	McClure Oil & Patrick Pet. #1 Huls	Sil., Clinton	4330	Grav.?	NFW	
Oceana 14-15N-18W	28220	McClure Oil & Patrick Pet. #1 Longcore et al	Sil., Clinton	4200	Grav.?	NFW	
Oceana 14-14N-18W	28178	McClure Oil & Patrick Pet. #1 Diepen	Sil., Clinton	4092	Grav.?	NFW	
Oceana 20-14N-17W	28203	Chapman Drlg. & Tribal Oil #1 Garcia Comm.	Sil., Clinton	4245	Grav.?	NFW	
Otsego 3-32N-1W	28103	Pennzoil United, Inc. #1-3 State-Corwith	Sil., Clinton	4870	Acreage?	NFW	
Presque Isle 35-34N-4E	27920	Pan American Petrol. Corp. #1 Trapp	Sil., Clinton	3734	Seis.	NFW	
Presque Isle 7-34N-5E	27874	McClure Oil Co. #1 Bruning et al	Sil., Niagaran	3205	Grav.?	NFW	S. O. & G. on D.S.T.
Presque Isle 23-33N-2E	28083	McClure Oil Co. #1-23 State-Allis	Sil., Niagaran	3984	Grav.	NFW	
Shiawassee 5-5N-2E	27907	Mobil Oil Corp. #1 Jelinek-Ferris Unit	Cambrian	7056	Grav.?	NFW	
Wexford 10-24N-12W	28222	Shell Oil Co. #1-10 Copley	Sil., Niagaran	6446	Seis.	NFW	

ALL DEEP TESTS WERE DRY AND ABANDONED.

* * * DEEP TESTS * * *

No firm criteria have been established for designating dry-hole exploratory wells in the Michigan basin as important deep tests. Selections are most often based on the geologic age of the strata penetrated in reference to the location of the test within the basin, and the relative abundancy of similar tests in the area. Actual drilled depth is not the determining factor. For example, most of the nearly 1300 wells drilled to date in St. Clair County have reached total depth in Middle Silurian-Niagaran rocks. These wells are scattered throughout the county, so it is unlikely that any future exploratory well reaching total depth in Silurian rocks would be classified as a deep test. Only a few wells in St. Clair County have penetrated Ordovician or older strata. Any well drilled in St. Clair County to strata older than Silurian would probably be considered as a deep test at this stage of development.

Deeper pool tests in designated fields may also qualify as deep tests. Table 3, Michigan Oil and Gas Fields, shows the deepest depth and formation or pool penetrated and tested. The deepest hole drilled to date was located in the Rose City field, Ogemaw County, and reached a total depth of 12,996 feet in Cambrian rocks. The deepest hole drilled during 1970 was a deeper pool test in the Beaver Creek field, Crawford County. Total depth for this well was 10,142 feet in St. Peter sandstone. It is the first well to be drilled to Ordovician rocks in Crawford County.

Exploratory wells designated as deep tests are listed on the preceding pages. All were dry holes and most were drilled in connection with Niagaran exploration in the northern part of the basin. One Precambrian test was drilled northeast of the Howell anticline, Livingston County. Precambrian age determinations have been made by Mobil Oil Corporation but have not been released to the public. The location of Precambrian tests drilled in the Southern Peninsula are listed on page 60. Well records are available for all listed wells.

* * * STATE ACREAGE UNDER LEASE * * *

State-owned lands under lease for oil and gas development as of December 31, 1970 amounted to 981,934 acres. Revenue from oil and gas rental, royalty and other fees for the year 1970 amounted to $560,029.48. No bonus moneys were received for 1970. The above data was provided by the Lands Division of the Department of Natural Resources.

PART 2, OIL AND GAS FIELDS

EXPLANATION

Part 2 brings together general information mainly on Michigan's oil and gas fields, gas storage reservoirs, LPG storage facilities, gas plant operations and refinery facilities. Oil and gas fields are listed alphabetically by field name. Developed and undeveloped gas storage reservoirs, all of which were originally classified as oil or gas accumulations, are also integrated in the listing, but for convenience they are also shown on separate tables.

MICHIGAN OIL AND GAS FIELDS, TABLE 3 The symbol on the left margin of the table indicates the official classification of fields and pools at the end of the year. Field names are listed in the second column and the producing pool, or pools, are shown under the heading Producing Formation or Pool. Most fields consist of one pool with oil or gas production coming from a single formation. Some fields have 2 or more separate pools, each producing from a different formation or stratigraphic interval and at a different depth.

Location of Fields according to township, range and sections are found at the bottom of the field block. The Listed sections are those which have, or have had, producing wells assigned to the field.

The Pay Zone part of the table generally refers to data for the discovery well. The indicated pay thickness generally relates to the amount of pay opened or perforated in the discovery well and does not necessarily indicate total net pay for the reservoir.

The Deepest Formation Tested column indicates the deepest total depth and formation penetrated in the field.

The Number of Oil and Gas Wells column indicates the number of successful field wells drilled in the field to the end of the specified year, the number completed as producing wells during the year, the number of producing wells abandoned during the year, the number producing at the end of the year, and the number shut-in or shut-down at the end of the year. Most of the latter category are producible wells, but for various reasons they were not in operation.

The Drilled Acres column indicates the total number of acres assigned to the field or pool according to individual well drilling units assigned to each producing well completed in the field or pool. A field may have a 10 or 20-acre drilling unit for one pool and a 40-acre drilling unit for a deeper formation pool within the field. During the development of a field or pool, the drilling unit size may change, thus subsequent wells are assigned acreage accordingly. In past years, drilling units generally have been 10, 20, or 40 acres. During 1969, a few new pools in the Northern District were assigned 80, 160, and 640-acre units. Gas well units, especially for Michigan Stray Sandstone reservoirs, have generally been 160-acre units. Other sizes currently in use for gas wells are 40, 80, 320, and 640-acre units. Changes in drilling units, off pattern wells, etc. complicate the maintenance of accurate acreage figures during the life of a given field or individual pool. The figures cited in the column are not entirely accurate, but do provide as near as possible an indication of the areal size of the field. Where possible, drilled acreage is shown for individual pools. The figures do not indicate the areal extent of the oil or gas reservoir.

Recovery Per Drilled Acre figures for oil pools result from dividing the drilled acres figure into the cumulative oil production figure.

GAS FIELDS. Because of slow field development, small reserves, or lack of marketing facilities, some fields are listed as "shut-in" and show no production figures. Others produce small quantities of unmetered gas and are not considered commercial. Production from these fields is used for domestic purposes and, in some cases, lease fuel.

GAS STORAGE RESERVOIRS. Most gas storage reservoirs were originally classified as gas fields or pools. Upon depletion or near depletion of native gas, they were converted to storage reservoirs. Undeveloped gas reservoirs are gas pools that have been designated to become storage reservoirs at some future time.

The producing sections listed in gas storage reservoir tables do not necessarily relate to current gas storage area or boundaries. The sections, or parts of sections, listed are those which contained at least one producible oil or gas well assigned to the field or pool prior to conversion to gas storage. Also, the sections do not necessarily relate to potential or future gas storage area or boundary.

LPG STORAGE. Surface and underground storage facilities for liquified petroleum gas.

OIL WELL GAS. This is casinghead gas produced incidental to the production of oil from pools or fields generally classified as oil accumulations.

OIL AND GAS WELL RECORDS. Descriptive geological logs and drillers logs are available for over 27,500 Michigan oil and gas tests, including exploratory and development wells. Individual logs may be purchased at small cost from the Geological Survey Division.

WELL SAMPLE SETS. Well cuttings for over 9,000 wells are available for inspection at the Geological Survey, Lansing, Michigan. Samples are contained in glass vials arranged in open trays. The Survey does not maintain a core collection.

Other sample and core repositories are located at:

Subsurface Laboratory, Department of Geology, University of Michigan, Ann Arbor, Michigan.

Department of Geology, Wayne State University, Detroit, Michigan.

Department of Geology, Western Michigan University, Kalamazoo, Michigan.

Department of Geology, Michigan State University, East Lansing, Michigan.

Department of Geography, Central Michigan University, Mt. Pleasant, Michigan.

PART 3, CUMULATIVE RECORDS

EXPLANATION

Part 3 contains cumulative statistics principally of oil and gas production, well completions, and oil field brine production and disposal from 1925 through the most recent year-end compilations.

OIL AND GAS PRODUCTION TABLES. Oil and gas production figures for individual years prior to 1960 can be found in issues of "Summary of Operations, Oil and Gas Fields" for 1962 and prior years, and in "Michigan's Oil and Gas Fields" 1963 to present. The tables show the year of the first recorded production from a particular formation, and the yearly and cumulative production totals from 1925 through the most recent year-end compilations. Cumulative oil and gas production by county is shown on a separate table. Refer to Part 1 for county production figures for the past year, and prior issues for previous years.

CUMULATIVE WELL COMPLETIONS. These tables show the cumulative number of yearly completions in a county. Well density figures include field development wells, exploratory wells, and service wells of all types.

DRILLING PERMITS, WELL COMPLETIONS, FIELDS DISCOVERED. These tables show the number of drilling permits issued by year from 1927 through the most recent year-end compilations. Initial classification of well completions by year, the number of new fields or pools discovered, and the number of producible oil or gas wells on a yearly basis are all shown on the same table.

BRINE PRODUCTION AND DISPOSAL. Oil field brine production records prior to 1937 are incomplete. This table shows the reported amount of produced brine and the method of disposal from 1937 to present. Most oil field brine is now returned to subsurface formations. Small quantities are used for dust control or ice and snow removal on county roads in local areas. A small amount of brine is also disposed in burning pits. Brine production and disposal figures should not be considered entirely accurate.

SERVICE WELLS. Service wells as listed in this publication are those wells which were drilled to serve some purpose other than the initial production of oil or gas. Oil or gas wells are sometimes converted to salt water disposal, observation, or facility wells in gas storage or pressure maintenance projects. There are several types of service wells:

LPG Wells. These are wells drilled for underground storage of liquified petroleum gas. In Michigan, these storage reservoirs are in man-made cavities in salt beds. The cavities have been made by dissolving the salt with water and then pumping out the brine.

Gas Storage Wells. These are wells drilled in gas storage reservoirs. They are frequently referred to as facility wells, and are generally used to inject gas into or extract gas from the reservoir. Certain facility wells may sometime in the history of the field be used as salt water disposal wells or observation wells.

Observation Wells. Most observation wells are related to gas storage projects. They are used to observe underground movement of gas, brines, and other fluids, or to observe pressures.

Brine Disposal Wells. These wells are used in the disposal of oil and gas field brines back into some suitable subsurface formation. Brine disposal well permits are issued for these wells.

Injection and Pressure Maintenance Wells. These are wells used in secondary recovery, or pressure maintenance projects. They may be new wells drilled specifically for injection or pressure maintenance, or they may be converted oil or gas wells; their status can change from time to time.

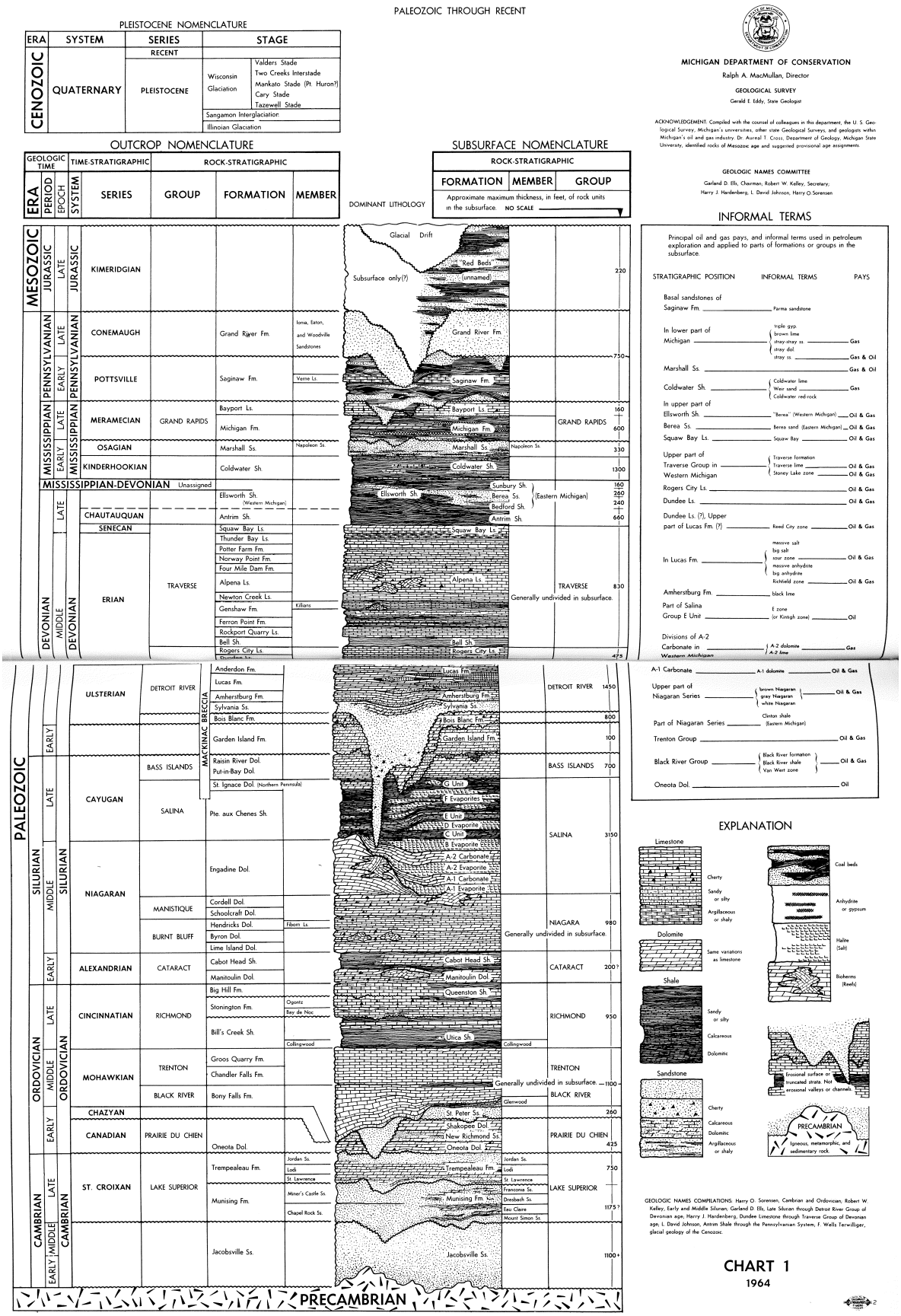
Oil or gas wells are sometimes converted to salt water disposal, observation, facility wells in gas storage reservoirs, or water injection wells used in secondary recovery or pressure maintenance projects. The types of service wells listed under "Classification of Well Completions" does not include oil or gas wells converted to service wells.

ABBREVIATIONS

A.A.P.G.	American Assoc. Petrol. Geol.
A.P.I.	American Petroleum Institute
(A) I.P.	(Acid) Initial Production or Potential
A-1 Carb.	A-1 Carbonate
A-2 Carb.	A-2 Carbonate
Bbls.	Barrels
B.B.	Bois Blanc formation
B.D.	Brine Disposal
BDW	Brine Disposal Well
BOPD	Barrels Oil Per Day
B.R.	Black River
Camb.	Cambrian
"Camb."	Unidentified Cambrian
Cat.	Cataract formation
c.f.p.b.	Cubic feet per barrel
C.H.	Cabot Head formation
Cinn.	Cincinnatian
Cl.	Clinton formation
Cold.	Coldwater formation
Compl.	Completion
Coop.	Cooperative

D & A	Dry and Abandoned
Dev.	Devonian
D.R.	Detroit River formation
D.R. SZ	Detroit River Sour Zone
Dres.	Dresbach formation
Dd., DD	Dundee
Dd.-R.C.	Dundee-Reed City
DPT	Deeper Pool Test
E.C.	Eau Claire formation
Explor.	Exploratory
Fran.	Franconia formation
Geo. Test	Geological Test
G.O.R.	Gas-Oil Ratio
Grav.	Gravity Gravimeter
GS	Gas Storage
GSW	Gas Storage Service Well
Gw	Glenwood
Incs.	Includes
Inj.	Injection
L.P.G.	Liquid Petroleum Gas
Marsh.	Marshall formation
MCF	Thousand Cubic
MCFGPD	Thousand Cubic Feet Gas Per Day
Mich.	Michigan formation
Miss.	Mississippian
M.S.	Mt. Simon ss.
NFW	New Field Wildcat
(N) I.P.	(Natural) Initial Production or Potential
Niag.	Niagaran
Nt.	Nontechnical
OBS	Observation Well
OP	Out Post Well
Ord.	Ordovician
OWDD	Old Well Drilled Deeper
P.D.C.	Prairie du Chien formation
Penn.	Pennsylvanian
Pilot Wtr.	Pilot Water
P.M.	Pressure Maintenance
Prod. Form.	Producing Formation
R.C.	Reed City formation
RW	Reworked Well
Rich.	Richfield formation
Sag.	Saginaw formation
Sal.-Niag.	Salina-Niagaran
SD	Shut Down
Seis.	Seismograph
SO & G	Show Oil and Gas
S.P.	St. Peter formation
Stray	Michigan Stray formation
Sub.	Subsurface geology
SW	Service Well
SWD	Salt Water Disposal
Sylv.	Sylvania formation
SZ	Sour Zone (in Detroit River)
Thick.	Thickness
(T) I.P.	(Treatment) Initial Production or Potential
Trav.	Traverse
Tremp.	Trempealeau formation
Trenton-Blk. River	Trenton-Black River
Unit.	Unitized

STRATIGRAPHIC SUCCESSION IN MICHIGAN



TECHNICAL STAFF AND ORGANIZATION CHART

Geological Survey Division
DEPARTMENT OF NATURAL RESOURCES

OIL AND GAS ADVISORY BOARD

Oil and gas industry representatives appointed to advise Supervisor of Wells.

DIVISION CHIEF

Arthur E. Slaughter, *State Geologist and Supervisor of Wells*

As State Geologist formulates policy, supervises budget, and directs the over-all program of the Geological Survey. As Supervisor of Wells administers the oil and gas conservation laws and mineral well laws. Represents Governor in Interstate Oil Compact Commission.

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Lansing, Michigan 48926 517-373-1256

MINERAL WELL ADVISORY BOARD

Representatives of mineral well or related industries appointed to advise Supervisor of Wells on matters covered by the Mineral Well Act.

GLACIAL AND ENVIRONMENTAL GEOLOGY

Maps surface formations. Investigates and reports on glacial features and Pleistocene geology. Advises on the occurrence and significance of glacial deposits relative to land use and environmental planning.

William M. Iversen, *Geologist*

ADMINISTRATIVE SERVICES

Manages fiscal and property accounts and personnel records. Liaison with Administrative Services Division. Coordinates stenographic and clerical services in the Survey.

Bernard O. Crothers, *Office Manager*

MINERAL WELL SECTION

Supervises, regulates and enforces mineral well operations as defined in Act 315, P. A. 1969. The Act covers brine wells, disposal wells, test wells, and wells drilled for storage use.

Robert E. Ives, *Geologist in Charge*

UPPER PENINSULA OFFICE

Conducts geological investigations in Upper Peninsula as consultant to State Geologist. Reports on geology, hydrology, quality, and development of water resources. Water Well consultant to other divisions. Participates in education-oriented activities.
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GENERAL GEOLOGY SECTION

Manages geological information center, including reference indexes and library services. Supervises publication and distribution of reports and maps. Coordinates mapping programs, participates in education-oriented activities, and supervises in-service training.

Dorothy M. Skillings, *Geologist*

MINING AND ECONOMIC GEOLOGY SECTION

Prepares valuations of all metallic mining properties. Investigates economic minerals as consultant to State Geologist and other state administrators. Represents Division in cooperative geologic mapping programs involving Precambrian formations of western Upper Peninsula. Compiles mineral statistics in cooperation with U. S. Bureau of Mines. Prepares mineral kits.

Harry J. Hardenberg, *Geologist in Charge*
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Harry O. Sorensen, *Geologist*
R. Thomas Segall, *Geologist*

OIL AND GAS SECTION

Supervises and coordinates overall oil and gas activities of the Petroleum Geology Unit, Regulatory Control Unit and Production and Proration Unit. Schedules hearings conducted by the Board and promulgates the formal orders of the Supervisor of Wells. Liaison with the State Public Service Commission which supervises the production of natural gas.

Robert M. Acker, *Geologist in Charge*

WATER SECTION

Investigates the geology, hydrology, quality and development of water resources, frequently as consultant to the State Health Department and the Water Resources Division. Represents Survey in cooperative programs involving water resources. Liaison with water well industry. Water well consultant to other divisions. Supervises preparation and distribution of water well logs.

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William A. Walden, *Geologist*
Elmore E. Eltzroth, *Geologist*
Kenneth Childs, *Geologist*

PETROLEUM GEOLOGY UNIT

Supervises collecting and interpreting petroleum geology data, as consultant to Supervisor of Wells and other state administrators. Supervises oil well sample program. Prepares and distributes oil well logs and oil and gas maps. Publishes oil and gas field development and statistical data.

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Irvin V. Kuehner, *Geologist*
Robert A. Dunn, *Geologist*
Lyle D. Taylor, *Cartographic Draftsman*

REGULATORY CONTROL UNIT

Supervises issuance of permits to drill oil and gas tests and wells. Implements orders of Supervisor of Wells on drilling locations and patterns, casing programs, and brine disposal. Supervises plugging and abandoning procedures. Supervises collecting oil well drilling records.

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Samuel L. Alguire, *Geologist and Supervisor of Field Offices*
Harold E. Rickard, *Department Executive*
Richard A. Lehtola, *Geologist*

PRODUCTION AND PRORATION UNIT

Supervises collecting and interpreting reservoir engineering and production data for applying production controls. Implements proration orders of the Supervisor of Wells. Liaison with oil producers on proration and production regulations.

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