

MICHIGAN'S OIL AND GAS FIELDS, 1974

## Contents

Acknowledgements .....	1
Introduction .....	2
<b>PART I</b>	
<b>GENERAL STATISTICAL INFORMATION.....</b>	<b>3</b>
Oil and Gas Permits .....	3
Permits Terminated in 1974 .....	3
Directionally Drilled Holes.....	4
Permits for Service Wells. ....	4
Well Completions.....	5
Well Completions by Majors and Independents in 1973.....	6
Well Completions by Majors and Independents in 1974.....	6
Drilled Footage .....	6
Oil and Gas Production .....	7
Oil and Gas Production by County .....	7
Condensate Production .....	8
Special Orders: No-Flare, Spacing and Proration, Explanation.....	8
Oil and Gas Valuation.....	8
Oil and Gas Imports and Exports .....	8
New Field and Pool Discoveries.....	9
Analysis of Discovery Wells by Geologic System .....	10

Drilling Objectives .....	10
State Oil and Gas Revenue .....	10
Well Records and Oil and Gas Maps.....	11
<b>PART 2</b>	
<b>OIL AND GAS FIELDS .....</b>	<b>11</b>
Part 2, Oil and Gas Fields, Explanation .....	11
<b>PART 3</b>	
<b>CUMULATIVE RECORDS .....</b>	<b>12</b>
Part 3, Cumulative Records, Explanations .....	12

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The Geological Survey Division's Oil and Gas Section, formerly called Oil and Gas Conservation Group, is composed of a Regulatory Control Units a Production-Proration Unit, and a Petroleum Geology Unit. A Cartographic sub-Unit is under the management of the Petroleum Geology Unit. Field operations are handled by personnel assigned to field offices located at Plainwell, Cadillac, Grayling, Gaylord, Mt. Pleasant, May City, and Lansing. Field activities are mainly those associated with the responsibilities of the Regulatory Control and Production-Proration Units, but do include the gathering of certain year-end oil-and-gas field statistics used in this report.

The compilation and assembly of various oil and gas data into a yearly report is a major responsibility of the Petroleum Geology Unit. Certain data collected by field office personnel are contributed by Unit supervisors under the general guidance of R. M. Acker, Assistant State Geologist and Chief of the Oil and Gas Section. Unit supervisors who contributed specific data to this report are:

V. F. Sargent, Supervisor, and S. L. Alguire, Field Coordinator, Regulatory Control Unit. Contribution: All data in columns under the headings "Number of Oil and Gas Wells" and "Brine Production" on Tables 2, 3, 4, and 5.

James S. Lorenz, Supervisor, Production and Proration Unit. Contribution: All Michigan oil and gas production data, oil import and export figures, monetary valuations, refinery and LPG storage data.

G. D. Ells, Supervisor, and B. L. Champion and staff, Petroleum Geology Unit. Contribution: All general drilling statistics and well completion data, discovery well and deep-test data, drilled acreage figures, cumulative records, and all other summary information not specifically provided by other Unit supervisors. Compilations, assembly and manuscript preparation by staff members of the Petroleum Geology Unit: G. D. Ells, Beverly L. Champion, Richard T. Lilienthal, D. Michael Bricker, and Margaret Schineman.

Gas import figures are obtained from the Gas Section, Public Utilities Division, Department of Commerce. Michigan oil and gas production figures maintained by the Production-Proration Unit are compiled from records

obtained from the Michigan Department of Treasury and from records filed by producers. All hydrocarbon production figures are preliminary and subject to correction as warranted.

The annual oil and gas summaries are not printed in large quantity. They are distributed to various state agencies in all 50 states and to many federal government agencies, to numerous libraries in the United States and several abroad, and to many individuals and companies engaged in petroleum or other mineral industries.

Current issues are available from Publications Room, Department of Natural Resources. A limited number of back issues are available from the Geological Survey Division.

Inquiries concerning information contained in this publication should be directed to the appropriate Unit supervisor as noted earlier.

Compilers: G. D. Ells  
B. L. Champion  
R. T. Lilienthal  
D. M. Bricker

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## INTRODUCTION

Oil and gas are two of Michigan's important mineral resources. This year, 1975, marks Michigan's fifth decade as an important oil and gas province, though the state's first field was established in 1886 at Port Huron. Recognition as an important petroleum province came as the result of development of the Saginaw field in 1925. But discovery of the Muskegon field in 1927 and the Mt. Pleasant field in 1928 opened the way for basin-wide exploration. Each year since then, new fields and pools have been discovered though the amount of exploratory and development drilling has varied considerably from year to year. Now, fifty years after Saginaw, records again show another upward trend in drilling and well completion and in production. This new cycle of activity, which began about 1969, is linked primarily to deeper Niagaran reef exploration in the northern and southern parts of the basin. The results of the new exploration and development cycle are reflected in a record increase in new discoveries and an upswing in the state's annual oil and gas production. Most of Michigan's oil and gas has been processed and used within the borders of the State and has thus directly contributed to Michigan's energy needs.

The value of Michigan produced crude oil and natural gas was calculated to be a little over \$189,900,000 in 1974 as compared with an estimated value of about \$76,907,000 in 1973. In addition, many millions of dollars were no doubt spent in lease and royalty payments, exploration and development drilling, and the many auxiliary activities connected with the extraction of these natural resources during 1974. It is clear that oil

and gas development is a major industry and contributes substantially to the State's economy each year. To help further the orderly development of Michigan's hydrocarbon resources, statistical and other useful data have been maintained and published for many years.

This issue of the oil and gas field statistical summary brings together data on various facets of Michigan's oil and gas industry during 1974. Certain indices which show the trend of activities from year to year are shown in chart form along with figures for prior years. Other charts show cumulative figures and other information of an historical nature, useful in oil and gas field evaluation. Furthermore, the gathering, maintenance and compilation of the data reflect, in part, the varied functions of the Oil and Gas Section (formerly Oil and Gas Conservation Group) of the Geological Survey Division.

Certain figures for 1974, such as the number of exploratory, development and service wells drilled and completed, and the number of new field and pool discoveries, may differ from figures reported for that year by regional or national trade journals or by industry reporting services. Preliminary 1974 oil and gas production and valuation figures cited in other publications may differ from those shown herein. The differences in the various statistics are generally minor and due to methods of gathering and reporting well data, determining cut-off dates for reporting statistics on a yearly basis, and the necessity of making estimates and projections of data for some types of reports.

Statistical data on Michigan oil and gas activities are also published by Oil and Gas News, Mt. Pleasant, Michigan; Petroleum Information, Incorporated, Denver, Colorado; American Petroleum Institute, Washington, D.C.; American Association of Petroleum Geologists, Tulsa, Oklahoma; Interstate Oil Compact Commission, Oklahoma City, Oklahoma; World Oil, Houston, Texas; and the Oil and Gas Journal, Tulsa, Oklahoma. The differences in figures which may occur in these publications from time-to-time are almost always caused by factors stated in the preceding paragraph.

Certain well completion data are provided to the American Petroleum Institute (API) and the American Association of Petroleum Geologists (AAPG) on a regular basis. Reports citing preliminary statistics are also prepared for the Interstate Oil Compact Commission (IOCC). API publishes the data in monthly and quarterly reports. Year-end printouts of the data furnished by the Geological Survey are made available to authors of the AAPG yearly Development Papers. Other organizations mentioned in the previous paragraph publish oil and gas statistics derived from other sources. Year-end figures published by API generally agree with figures for similar categories (e.g. exploratory wells) published in this summary. Differences which may occur are shown under the proper subject heading in this report.

The data contained in this and previous issues of the oil and gas summary have been treated uniformly as near as possible from year to year, so they reflect as accurately as possible the actual figures and other information that should be credited to the year in review. The kinds of data found herein are mainly derived from records received and maintained by the Oil and Gas Section, Geological Survey Division. None of the data is derived from the aforementioned publications.

This publication is essentially divided into three parts. The first summarizes significant statistics on oil and gas field activities for 1974 and includes other related records kept by the Oil and Gas Section. Part 2 contains specific information on the State's oil and gas fields, gas storage fields and other related subjects. Part 3 contains cumulative records of import to the industry. Data for 1974 have been included in the Part 3 cumulative records.

## PART I 1974 STATISTICAL DATA

### \*\*\* OIL AND GAS PERMITS \*\*\*

Oil and gas drilling permits issued during 1974 began with permit number 29613 and ended with permit number 30115. The total number of permits issued during 1974 was 503 as compared with 444 in 1973. The initial classification of wells to be drilled under these permits was as follows:

INITIAL CLASSIFICATION	1972	1973	1974
Exploratory wells . . . .	211	225	299
Development wells . . . .	133	149	176*
Gas storage facility wells .	74	66	28
LPG storage operations . .	5	4	0
	423	444	503

\*Includes 11 water injection wells and 2 brine disposal wells.

The distribution of oil and gas permits according to districts (See oil and gas districts map) through a five-year period, including 1974, is as follows:

DRILLING PERMITS BY DISTRICT					
DISTRICTS	Permits Issued				
	1970	1971	1972	1973	1974
Basin	169	138	154	120	98
Northern	52	81	137	173	210
Southeastern	121	130	62	67	62
Southwestern	33	30	32	28	44
Western	50	46	38	56	89
Totals	425	425*	423*	444*	503*

\*Includes terminated permits. Permits issued under Act No. 61, Public Acts of 1939, as amended, are terminated six months after date of issue if actual drilling operations have not begun.

In addition to regular permits, 1 brine disposal permit (BDW 156) was issued. Deepening permits were issued for 45 wells during 1974 as compared with 24 the previous year. Deepening permits began with number 1712 and ended with number 1756. There was 1

geological test permit issued by the Mineral Wells Section during 1974.

Terminated permits were cited and listed for the first time in Annual Statistical Summary 16, 1972. Michigan's oil and gas permit system began in 1927 with the issuance of permit number 1, and the numbers have been issued in numerically consecutive order since then. Well locations for which permits have been issued but subsequently terminated are sometimes re-permitted under another number. Wells which have been drilled, plugged, or otherwise abandoned may also sometimes be reopened and reworked under a new permit number. Permit numbers issued for wells drilled under previous permits, or reissues for terminated permits, were cited and listed for the first time in Annual Statistical Summary 18, 1973.

The number of terminated permits and new permits for previously drilled or permitted locations has increased considerably the past few years. Several hundred such cases probably exist, most in connection with wells drilled years ago in gas storage reservoirs. Because well data, including permit numbers, are now being incorporated into computerized data systems, multiple permits for a single location may lead to problems. Therefore an attempt is being made to keep a published account of these possible sources of conflict.

### [Permits Terminated in 1974]

#### Permits issued in 1971 and terminated in 1971 or 1972

28322	28393	28542	28584	28638
28352	28466	28553	28595	28672
28366	28476	28555	28605	28673
28385	28490	28571	28615	28683
28386	28512	28578	28619	28719

#### Permits issued in 1972 and terminated in 1972 or 1973

28750	28849	28908	28963	29077
28751	28851	28933	29994	29098
28754	28855	28944	29005	29134
28779	28867	28945	29017	29139
28836	28871	28958	29044	29145
28844	28890			

#### Permits issued in 1973 and terminated in 1973 or 1974

29177	29257	29397	29451	29507
29180	29266	29406	29452	29508
29181	29289	29410	29466	29510
29184	29290	29411	29470	29518
29185	29341	29418	29488	29548
29190	29347	29419	29491	29561
29210	29356	29421	29499	29589
29228	29365	29426	29504	29592
29229	29368	29435	29505	29593
29231	29388	29443	29506	29608
29252	29390			

#### Permits issued in 1974 and terminated in 1974

29617	29652	29689	29745	29801
29626	29654	29690	29800	29802
29645	29676	29714		

New permits issued for a previously drilled well or for a previously issued but terminated permit.

28847	issued for well drilled or permitted under	15630
28941	"	17220
28942	"	17331
28985	"	10169
28992	"	5302
28993	"	5168
29008	"	25626
29024	"	26469
29161	"	2904
29162	"	3095
29163	"	3202
29233	"	26506
29249	"	19046
29357	"	22419
29359	"	22159
29710	"	29488
29729	"	29466
29730	"	29452
29731	"	29506
29772	"	29406
29774	"	29467
29801	"	26118
29803	"	29184
29805	"	29592
29816	"	29548
29825	"	29518
29890	"	29561
29891	"	29115
29928	"	29593
29932	"	29147
30045	"	29608
30046	"	29589
30062	"	29190

Directionally drilled holes. Environmental considerations have necessitated the drilling of a large number of directional holes since 1972. Many of these holes involve using the upper part of a previously drilled hole which was plugged-back to an appropriate depth after being completed as a dry hole. These directionally drilled holes fall in three main categories: 1) a single directional hole completed as a producer or D&A; 2) cases where two or more directional holes have been drilled to bottom-hole targets from the same surface location; 3) cases where one or more directional holes have been deviated to new bottom-hole targets after the original vertically drilled test failed to encounter Niagaran reefing. Each new directional hole, though drilled from the same surface location and using the upper part of a previously drilled hole, is treated as a separate test and is assigned its own unique permit number. All holes drilled from the same surface location retain the same well name and number as the original hole, except that the suffix "A", "B", "C", etc., is added to the well number. In some instances permits for directional holes were terminated and then subsequently re-permitted under a new number. An attempt has been made to record the permit numbers of directionally drilled tests for the benefit of those who may find the information useful in computer-well data systems.

<u>Permit numbers issued for directional holes in 1972.</u>			
28916	Otsego County	28988	Kalkaska County
28951	Otsego County	29038	Kalkaska County

Permit numbers issued for directional holes in 1973.

29175	Otsego County	29474	Gd. Traverse County
29344	Kalkaska County	29487	Otsego County
29345	Manistee County	29536	Gd. Traverse County
29354	Kalkaska County	29549A	Otsego County
29363	Kalkaska County	29550	Gd. Traverse County
29366	Kalkaska County	29573	Otsego County
29393	Gd. Traverse County	29577	Gd. Traverse County
29433	Otsego County	29600	Gd. Traverse County

Permit numbers issued for directional holes in 1974.

29628	Kalkaska County	29943	Wexford County
29629	Gd. Traverse County	29946	Gd. Traverse County
29634	Ingham County	29948	Gd. Traverse County
29636	Ingham County	29950	Montcalm County (1)
29650	Otsego County	29951	Montcalm County (1)
29671	Otsego County	29952	Montcalm County (1)
29684	Gd. Traverse County	29953	Kalkaska County
29694	Manistee County	29956	Otsego County
29729	St. Clair County	29993	Kalkaska County
29746	Otsego County	29995	Otsego County
29804	Gd. Traverse County	30012	Kalkaska County
29810	Gd. Traverse County	30013	Macomb County
29828	St. Clair County	30017	Gd. Traverse County
29837	Montmorency County	30019	Kalkaska County
29839	Kalkaska County	30030	Otsego County
29840	Otsego County	30032	Kalkaska County
29853	Otsego County	30034	Gd. Traverse County
29881	Gd. Traverse County	30038	Gd. Traverse County
29887	Gd. Traverse County	30047	Gd. Traverse County
29889	Kalkaska County	30049	Macomb County
29900	Gd. Traverse County	30052	Gd. Traverse County
29906	Manistee County	30063	Gd. Traverse County
29910	Manistee County	30077	Manistee County
29911	Macomb County	30079	Ingham County
29912	Otsego County	30090	Gd. Traverse County
29918	Kalkaska County	30093	Kalkaska County
29919	Gd. Traverse County	30099	Kalkaska County
29927	Macomb County	30111	Eaton County
29929	Otsego County	30113	Gd. Traverse County
29934	Otsego County	30115	Manistee County

(1) Drilled to combat gas-well blowout in the Six Lakes gas storage field.

Directional holes with 2 or more permit numbers.

29629** and 29553	29995** and 29947
29671**, 29650** and 29478	30049**, 30013** and 29914
29729 and 29466*	30034** and 29955
29828 and 29451*	30052** and 30001
29900**, 29827 and 29426*	30077** and 29942
29912** and 29842	30099** and 30051
29918*** and 29839	30113*** and 30038
29929** and 29905	30115** and 30008

\*Terminated permit.

\*\*Directional hole drilled from plugged-back, vertically drilled dry hole.

\*\*\*Second directional hole drilled from a plugged-back directionally drilled dry hole.

Service well permits. The fluctuation in the number of permits issued to drill gas storage wells and other service well types over a five-year period is as follows:

SERVICE WELL PERMITS					
Type of Service Well	1970	1971	1972	1973	1974
Gas storage	115	60	74	66	30*
LPG, Water Injection	1	16	9	8	11
Brine disposal, etc.	-	3	1	1	1
	116	79	84	75	42

\*Includes 3 permits issued for brine wells converted to gas storage, and several permits issued to drill wells to combat a gas-well blowout in Six Lakes gas storage field.

The distribution, by county, of oil and gas and service well permits issued in 1974 is shown in Table 1.

In addition to the issuance of permits for various types of wells covered under Act No. 61, Public Acts of 1939, as amended, 108 applications were received and approved for rework operations on existing wells. Transfers of ownership were processed for 305 wells. Corrections of location, well name or other detail involving specific permits were made for 49 wells, and cancel and transfer of permit were made for 6 others. The projected subsurface bottom-hole location as well as the surface location is published for each permitted directionally drilled hole. After the well is drilled and the directional survey run, the correct subsurface bottom-hole location is determined and then published as a correction for the initial projected bottom-hole location. In 1974, 42 corrections of this type were published for wells drilled in 1973 and 1974.

### \*\*\* WELL COMPLETIONS \*\*\*

There were 430 new-hole exploratory and development wells which reached total depth, had production casing set and were considered either as completed producers or dry holes during 1974. The 430 wells considered as completed during the past year do not include service wells, old wells drilled to deeper objectives, or reworked wells. The fluctuation in the number of new-hole completions and the resulting number of oil, gas, or dry holes over a five-year period is as follows:

Year	Exploratory Wells			Development Wells			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
1970	8	6	139	43	9	72	277
1971	28	11	122	55	20	64	300
1972	34	23	124	50	15	62	308
1973	38	37	117	43	10	56	301
1974	54	39	173	80	22	62	430

There were 54 new-hole service well completions in 1974. Most were facility wells drilled in gas storage reservoirs. The figure does not include reworked wells or old wells converted to service wells of various types. The fluctuation in the number of service well completions over a five-year period is as follows:

Year	Service Well Completions				Totals
	GS	INJ	LPG	BDW	
1970	110	0	3	0	113
1971	81	0	13	2	96
1972	57	3	4	2	66
1973	60	5	2	1	68
1974	38*	13	2	1	54

\*Includes observation wells and wells drilled to combat gas-well blowout in Six Lakes gas storage field.

Well completion figures for individual counties are shown in Table 1. The number of well completions within the several oil and gas districts is shown in the chart below.

Classification of New Well Completions	Basin		Northern		Western		Southwestern		Southeastern		Total	
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
<b>Exploratory Wells</b>												
Oil	5	6	24	25	6	19	2	4	1	0	38	54
Gas	2	1	22	18	10	16	3	2	0	2	37	59
D&A	31	28	51	80	10	24	7	15	18	26	117	173
Total	38	35	97	123	26	59	12	21	19	28	192	266
<b>Development Wells</b>												
Oil	11	19	23	33	4	12	2	5	3	11	43	80
Gas	1	4	5	9	2	1	1	7	1	1	10	22
D&A	13	12	26	31	3	7	7	7	7	4	56	62
Total	25	35	54	73	9	20	10	19	11	16	109	164
<b>Service Wells</b>												
WI	5	13	0	0	0	0	0	0	0	0	5	13
BDW	0	0	0	0	0	0	0	1	1	0	1	1
GS*	29	12	0	0	17	5	3	0	12	21	61	38
LPG	0	0	0	0	0	0	0	2	1	0	1	2
Total	34	25	0	0	17	5	3	3	14	21	68	54
<b>Total Completions</b>	97	96	151	196	52	84	25	43	44	65	369	484

\*Includes gas storage observation wells.

As previously mentioned, certain completion data for exploratory, development and other types of wells are furnished the American Petroleum Institute (API) and The American Association of Petroleum Geologists (AAPG) during the year. Statistical data published for Michigan by these agencies are correct according to the information submitted and approved at the time. The figures published by these agencies frequently differ from those published later in the year by the Geological Survey. The differences in figures are primarily due to rules establishing a cut-off date for reporting or handling statistics on a yearly basis. Other factors are internal decisions of the Geological Survey in regards to final year-end status of a completed well and decisions stemming from public hearings on oil and gas matters. For example, a well originally classified as a development well may be later designated as the discovery well for a new pool or field, or a gas well might be declared an oil well completion. The discrepancies in final year-end figures are almost without exception related to Niagaran reef development or exploratory wells which have been the mainstay of Michigan drilling activities the past few years. Frequently, the changes in well status or classification cannot be readily passed on to API and AAPG so that their records can be updated prior to publication of their statistics.

Drilling statistics published by API and derived from data furnished by the Geological Survey is shown below in comparison with the same categories published herein as final year-end figures. API figures have been extracted from the Quarterly Review of Drilling Statistics for the United States, Fourth Quarter, 1974, Annual Summary, 1974, American Petroleum Institute, Vol. VIII, No. 4, April 1975, Tables I, II, III, and V, pp. 14-22.

Year	Exploratory Wells			Development Wells			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
1974	50	34	174	66	18	60	402
M.G.S.	54	39	173	80	22	62	430
TOTAL WELLS DRILLED IN MICHIGAN (API)							
Year	Oil	Gas	Dry	Service	Total Wells, All Types		
1974	116	52	234	12*	414		
M.G.S.	134	61	235	54*	484		

\*API does not require data on wells drilled in connection with gas storage operations. The Geological Survey considers gas storage wells as a class of Service well. 38 of the 54 Service wells listed by the Geological Survey (M.G.S.) were gas storage wells.

NEW-FIELD WILDCAT WELLS DRILLED IN MICHIGAN (API)					
Year	Oil	Gas	Total Producing Wells	Dry Holes	Total New-Field Wildcat Wells
1974	48	34	82	169	251
M.G.S.	54	39	93	173	266

Wells not included in 1974 API figures in the preceding charts will be accounted for in the 1975 figures. The important point to be made is that all Michigan wells are accounted for.

Well completions by major and independent companies.

Requests were made the past year to provide statistics on the number of wells drilled and completed in Michigan by major and independent oil companies in 1973 and 1974. Although there appears to be no single definition of what constitutes a major company, the following companies are frequently cited as belonging in that category: Atlantic-Richfield, Cities Service, Continental Oil Company, Exxon, Getty Oil Company, Gulf Oil Company, Marathon Oil Company, Mobil Oil Corporation, Phillips Petroleum Company, Shell Oil Company, Standard Oil of California, Standard Oil of Indiana, Standard Oil of Ohio, Sun Oil Company, Texaco, Inc., and Union Oil Company of California. The foregoing list is not official nor necessarily complete. Some of these companies or their affiliates drilled wells in Michigan during 1973 and 1974. The figures cited for the major companies do not include wells drilled by independents as farmouts from a major company, nor do they include wells drilled by independents but partially supported by dry hole money, acreage contribution, or some other significant assistance from a major company. Independent companies, who have drilled most of the wells during Michigan's 50 year history as a petroleum province, are too numerous to cite individually. Figures cited were derived from inspection of names appearing on completion records.

[Well Completions by Majors and Independents in 1973]

WELL COMPLETIONS BY MAJORS AND INDEPENDENTS IN 1973							
Major Company	Exploratory			Development			Service*
	Oil	Gas	Dry	Oil	Gas	Dry	
Amoco	7	6	8	7	2	2	
Cities Service			1				
Marathon							1
Mobil	5		7	6		4	4
Shell	19	21	24	15	2	12	
Sun				1			2
Union Oil			1				
Totals	31	27	41	29	4	18	7
Independents	7	10	76	14	5	38	61
Grand Totals	38	37	117	43	9	56	68

\*Includes GS-OBS, LPG, WI, BDW wells.

Total: Exploratory Wells 192; Development Wells 108; Service Wells 68.

Exploratory Wells drilled by Majors 52%.  
Exploratory Wells drilled by Independents 48%.

Exploratory Discoveries made by Majors 77%.  
Exploratory Discoveries made by Independents 23%.

Development Wells drilled by Majors 47%.  
Development Wells drilled by Independents 53%.

Producing Development Wells drilled by Majors 64%.  
Producing Development Wells drilled by Independents 36%.

Discovery to Exploratory Dry Hole ratio - Majors 1.4:1;  
Independents 1:4.5.

[Well Completions by Majors and Independents in 1974]

Major Company	WELL COMPLETIONS BY MAJORS AND INDEPENDENTS IN 1974						Service*
	Exploratory			Development			
	Oil	Gas	Dry	Oil	Gas	Dry	
Amoco	8	6	8	4	2	2	
Getty	1		4	1		1	
Marathon				2			6
Mobil	2	1	6	7	1	2	6
Shell	30	22	50	34	9	19	
Sun				2		1	1
Texaco			1				
Total-Leonard			1			1	
Union Oil			1				
Totals	41	29	71	50	12	26	13
Independents	13	10	100	30	10	36	41
Grand Totals	54	39	171	80	22	62	54

\*Includes GS-OBS, LPG, WI, BDW wells.

Total: Exploratory Wells 264; Development Wells 164; Service Wells 54.

Exploratory Wells drilled by Majors 54%.  
Exploratory Wells drilled by Independents 46%.

Exploratory Discoveries made by Majors 81%.  
Exploratory Discoveries made by Independents 19%.

Development Wells drilled by Majors 53%.  
Development Wells drilled by Independents 47%.

Producing Development Wells drilled by Majors 60%.  
Producing Development Wells drilled by Independents 40%.

Discovery to Exploratory Dry Hole ratio - Majors 1:1;  
Independents 1:4.4.

**\*\*\* DRILLED FOOTAGE \*\*\***

The average depth, statewide, of exploratory wells drilled in 1974 was 5,166 feet compared with 5,278 feet in 1973 and 5,050 feet in 1972. Development well depths averaged 5,053 feet as compared with 5,262 feet in 1973 and 4,580 feet in 1972. Service wells drilled in 1974 averaged 2,808 feet in depth as compared with 1,768 feet in 1973. The greater depth is mainly attributed to facility wells drilled in deeper-depth Niagaran reef reservoirs. Drilled footage figures and average well depths for specific counties are shown in Table 1.

Total drilled footage figures from Survey records for 1974 and several prior years are as follows:

DRILLED FOOTAGE FIGURES-GEOLOGICAL SURVEY				
Well Class	1971	1972	1973	1974
Exploratory	704,192	913,797	1,013,470	1,374,285
Development	454,016	554,968	573,522	829,709
Service Well (All types)	180,418	110,177	132,577	151,661
Total:	1,439,578	1,605,860	1,719,569	2,355,655

Drilled footage figures are provided the American Petroleum Institute and these are published as part of their quarterly and annual summary. Drilled footage figures, extracted from the aforementioned 1974 API Annual Summary, are as follows:

1974 API DRILLED FOOTAGE FIGURES					
Exploratory Wells			Development Wells		
Oil	Gas	Dry	Oil	Gas	Dry
272,933	192,189	826,993	333,017	92,117	299,685
Total Exploratory			Total Development		
Footage: 1,292,115 feet			Footage: 724,819 feet		

The differences in total drilled footage figures as reported by API and by the Geological Survey are due to factors previously mentioned. API footage figures are correct on the basis of reporting-year criteria.

### \*\*\* 1974 OIL AND GAS PRODUCTION \*\*\*

Oil and gas production figures are derived from Michigan Department of Treasury tax records and records kept by the Production-Proration Unit, Oil and Gas Section, Geological Survey Division, DNR. Treasury Department records mainly are concerned with gross production figures needed to calculate revenues. These data are supported by records and reports required of producing companies and purchasers. Delays in reporting and methods of reporting used by producing companies and purchasers in handling crude oil and stable condensate from gas wells results in a continuous correction and refinement of production figures. Consequently all monthly, year-end, or other production figures are subject to minor corrections as warranted. Production figures as published herein for 1974 are considered correct to within - 1 percent.

Oil production, including stable condensate, amounted to 18,101,812 barrels as compared with a corrected year-end figure of 14,495,685 barrels produced in 1973. Gas production amounted to 69,806,374 Mcf as compared with a corrected year-end figure of 44,153,631 Mcf produced in 1973. Again, the increase in oil and gas production is directly related to the new Salina-Niagaran reef reservoir found since 1969 in the northern and southern parts of the Lower Peninsula. As of mid-1975s many oil and gas wells completed in the northern reef belt during the latter half of 1974 and the first half of 1975 were shut-in awaiting gathering facilities, or were shut-in under the no-flare order until market connections are made for the sale of oil-well gas. Most of these wells should be on line by the end of 1975. Production is expected to increase substantially during 1975.

OIL AND GAS PRODUCTION BY DISTRICT IN 1974		
District	Barrels Oil	MCF Gas
Basin	5,441,749	7,086,213
Northern	8,297,920	43,269,053
Southeastern	2,817,464	13,539,033
Southwestern	1,230,132	4,716,358
Western	314,547	1,195,717
Totals	18,101,812	69,806,374

OIL AND GAS PRODUCTION BY MONTH IN 1974		
	Barrels Oil	MCF Gas
January	1,338,594	4,110,683
February	1,119,459	3,882,838
March	1,354,585	4,462,952
April	1,367,625	4,292,464
May	1,571,624	5,567,700
June	1,530,669	6,212,945
July	1,545,787	6,566,296
August	1,626,054	6,535,511
September	1,603,733	6,650,841
October	1,701,664	7,350,197
November	1,619,904	7,431,705
December	1,642,665	6,742,242
Totals	18,101,812	69,806,374

### [Oil and Gas Production by County]

OIL AND GAS PRODUCTION BY COUNTY IN 1974		
County	Barrels Oil	MCF Gas
Allegan	85,877	189,828
Antrim	36,454	130,722
Arenac	179,534	---
Barry	10,351	---
Bay	197,976	---
Calhoun	1,000,098	4,434,697
Clare	322,305	102,012
Crawford	647,113	266,367
Eaton	79,553	467,075
Genesee	37,079	---
Gladwin	254,909	---
Grand Traverse	738,530	10,716,229
Gratiot	704	2,669
Hillsdale	1,441,141	4,615,596
Huron	111	---
Ingham	2,017,295	5,238,536
Isabella	126,319	---
Jackson	524,390	2,389,768
Kalkaska	2,834,757	25,105,565
Kent	68,203	7,446
Lake	88,380	---
Lapeer	70,566	30,045
Livingston	---	487,938
Macomb	2,759	787,418
Manistee	13,076	---
Mason	152,340	1,191,154
Mecosta	40,921	18,235
Midland	159,969	---
Missaukee	701,702	660,347
Monroe	5,516	---
Montcalm	88,266	---
Muskegon	9,792	---
Newaygo	11,400	---
Oakland	---	968,603
Oceana	34,531	---
Ogemaw	464,486	263,665
Osceola	362,663	---
Oscoda	879	---
Otsego	4,038,542	7,050,170
Ottawa	58,115	84,387
Presque Isle	469	---
Roscommon	338,428	333,674
Saginaw	16,597	---
Shiawassee	5,564	---
St. Clair	764,373	4,259,665
Tuscola	47,479	---
Van Buren	7,488	---
Washtenaw	1,280	---
Wayne	7,328	---
Wexford	5,028	4,563
Totals	18,101,812	69,806,374

Oil and gas production figures for individual fields and pools and cumulative production from these fields during 1974 are found in Part 2, Tables 2 and 3. Table 2 lists all the Salina-Niagaran reef fields and pools assigned to the northern reef belt. Table 3 lists all other fields and pools including Salina-Niagaran found in the southern part of the basin. Annual and cumulative production

figures by year and by geologic formation are found in Part 3 of this and preceding annual summaries.

Oil and gas production continued to increase statewide mainly due to continued development of the Niagaran reef belt extending from western Mason County northeasterly through Manistee County, northwestern Wexford County, Grand Traverse and Kalkaska Counties, southeastern Antrim County, Otsego County, and into northwestern Montmorency County. The spread of these reef fields across northern Southern Peninsula Counties is shown on the map accompanying Table 2.

A no-flare order, enacted as a conservation measure, tends to temporarily curtail production from Salina-Niagaran oil wells in specified areas of the State. Special Order No. 3-71, amended, in effect since late 1971 prohibits the flaring of oil well gas and requires Salina-Niagaran oil wells in specified counties to be shut in until a market connection is achieved for the gas or an exception to the order is granted.

Another order, Special Order No. 1-73, deals with spacing and proration of Salina-Niagaran oil wells in specific counties. This order established basic 80-acre drilling units for Salina-Niagaran oil and/or gas wells and statewide proration from Salina-Niagaran oil reservoirs in these specified counties. The counties covered by the no-flare order and by the spacing-proration order are shown on the inset map along with information on the drilling unit, well spacing, and basic oil-gas allowables. Both orders may be rescinded or revised as warranted. These prudent and justifiable conservation measures effectively prevent waste of millions of cubic feet of valuable and much needed gas, and should ultimately result in more efficient drainage of reef reservoirs and a greater recovery of the liquid hydrocarbons.

**\*\*\* NATURAL GAS LIQUIDS \*\*\***

The amount of liquids produced from gas-condensate reservoirs associated with northern and western Michigan reef traps continues to increase. These liquids, produced from wells classified as gas wells, are included in the yearly oil production totals cited in various tabulations in this publication. Wells officially determined to be gas wells are assigned to the Public Service Commission for well connection permits and determination and jurisdiction of gas production allowables. There is no restriction on the amount of liquids produced along with the gas. Gas plants operated by Shell Oil Company and by Amoco Production Company in Kalkaska County strip natural gas liquids from the gas. The liquids are then sold to another company through the Shell pipeline that terminates at Marysville, Michigan.

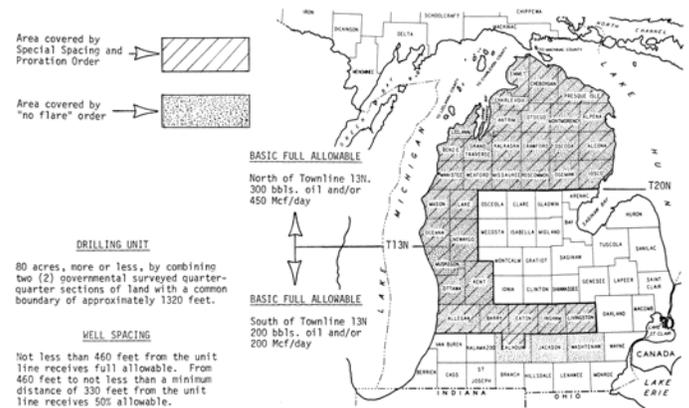
An attempt has been made to maintain records of condensate production from the northern reef reservoirs discovered since 1969. Production-Proration Unit records show the following figures for liquids classified as condensate:

**[Condensate Production]**

CONDENSATE PRODUCTION	
Year	Barrels
1969	0
1970	18,946
1971	98,668
1972	125,768
1973	335,041
1974	1,187,498
Total	1,765,921

Gas plant operations are summarized in Table 7. It should be noted that the LPG recovery figures for the Amoco and Shell plants in Kalkaska County include stabilized condensate as well as LPG's.

**[Special Orders: No-Flare, Spacing and Proration, Explanation]**



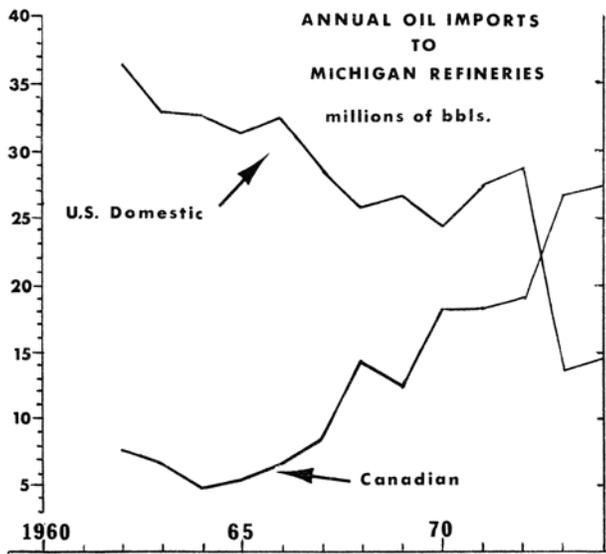
**\*\*\* OIL AND GAS VALUATION \*\*\***

The average price paid at the wellhead for Michigan produced crude, including condensate, was \$8 56 per barrel compared with \$4.07 per barrel in 1973. The gross value of these products amounted to \$154,746,373 as compared with \$59,412,710 in 1973.

The average price of Michigan produced gas sold at the wellhead was \$.50 per Mcf as compared with \$.39 per Mcf in 1973. The gross value of this product in 1974 amounted to \$35,181,955 as compared with \$17,494,727 in 1973.

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

Total imports of domestic and Canadian crude oil amounted to 42,099,556 barrels, an increase over the 39,775,383 barrels imported in 1973. Imports by month during 1974 are tabulated below. The trend of imports to Michigan refineries from 1962 through 1974 is shown graphically.



Imports of U.S. domestic crude oil to Michigan refineries via pipeline from western and midwestern states increased during 1974. Imports of domestic crude amounted to 14,781,592 barrels compared with 13,949,230 barrels in 1973.

Imports of Canadian crude via pipeline from western Canada oil fields continued to increase. Canadian imports to Michigan refineries amounted to 27,317,964 barrels in 1974 as compared with 26,826,153 barrels in 1973.

1974 CRUDE OIL IMPORTS (Bbls.)

	Domestic	Canadian	Total
January	1,075,459	2,348,620	3,424,079
February	1,151,848	2,252,997	3,404,845
March	1,419,768	2,166,032	3,585,800
April	1,299,556	2,474,662	3,774,218
May	1,195,570	2,591,178	3,786,748
June	1,263,974	1,804,662	3,068,636
July	1,161,638	2,473,928	3,635,566
August	1,520,215	2,359,688	3,879,903
September	1,409,841	2,601,009	4,010,850
October	1,297,058	1,802,970	3,100,028
November	765,987	2,404,202	3,170,189
December	1,220,678	2,038,016	3,258,694
Totals	14,781,592	27,317,964	42,099,556

The bulk of Michigan produced crude oil goes to Michigan refineries but some is exported. 1974 exports amounted to a little over 15% of the state's total production. The amount of Michigan produced crude credited to terminals in Indiana, Ohio, Pennsylvania and New York was 2,766,486 barrels as compared with 2,661,533 barrels in 1973. All Mobil Oil Corporation crude produced from reef reservoirs in southern Michigan is credited to export. Shell Oil crude from northern Michigan reef reservoirs goes to Michigan refineries and some is credited to a terminal in Buffalo, New York. Records kept by the Production-Proration Unit show the following exports, by month, of Michigan produced crude:

1974 CRUDE OIL EXPORTS (Bbls.)

January	. . . . .	234,432
February	. . . . .	191,423
March	. . . . .	210,459
April	. . . . .	228,754
May	. . . . .	167,342
June	. . . . .	209,745
July	. . . . .	179,666
August	. . . . .	173,871
September	. . . . .	179,034
October	. . . . .	182,363
November	. . . . .	316,701
December	. . . . .	492,696
Total		2,766,486

Gas imports to Michigan markets and gas storage fields in 1974 via pipelines, primarily from Texas, Louisiana, Oklahoma and Kansas fields, amounted to 851,903,391 Mcf, a decrease from the 907,122,475 Mcf imported in 1973. Compilations by the Gas Section, Michigan Public Service Commission, show the following imports, by months, during 1974:

1974 PIPELINE GAS IMPORTS (Mcf)

January	. . . . .	49,814,985
February	. . . . .	50,373,651
March	. . . . .	68,405,353
April	. . . . .	74,516,384
May	. . . . .	84,976,087
June	. . . . .	88,768,158
July	. . . . .	90,212,500
August	. . . . .	76,467,735
September	. . . . .	86,273,793
October	. . . . .	75,954,739
November	. . . . .	55,108,151
December	. . . . .	51,031,855
Total		851,903,391

**\*\*\* NEW FIELD AND POOL DISCOVERIES \*\*\***

Silurian reefs were again the main type of oil-and-gas trap found in 1974. Most were found in the northern reef trend extending from the Western District through part of the Northern District. Others were found in the southern part of the basin in the Calhoun, Eaton and Ingham County area, and in Macomb County in the Southeastern District. Of the 93 exploratory wells initially classified as 1974 discoveries, 91 were Niagaran age reef reservoirs. Statewide, 35% of the exploratory wells considered as 1974 completions resulted in new discoveries as compared with 39% in 1973, 32% in 1972, 24% in 1971, 10% in 1970, and 6% in 1969 when the Niagaran reef play began in northern Lower Michigan. Again, all new Niagaran reefs were located by seismic surveys.

All the new discoveries are tentatively classified as Class E pools having possible oil and gas recoveries as defined by the Committee on Statistics of Drilling, American Association of Petroleum Geologists. These classes, as follow, are used to give some estimate or measure of reserves found by a discovery well.

- 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

An analysis of 1974 discovery wells according to geologic system and an analysis of drilling objectives penetrated at total depth by wells completed in 1974 follows. The high percentage of wells drilled only to Niagaran rocks, as shown by the latter analysis, reflects the high interest in reef exploration in the northern counties of the Lower Peninsula and in the potential reef belt around the southern edge of the basin. Potentially productive formations above the Niagaran were presumably tested but few shows were reported.

[Analysis of Discovery Wells by Geologic System]

ANALYSIS OF 1974 DISCOVERY WELLS BY GEOLOGIC SYSTEM				
System	Formation or Pay	Number of Discoveries		
		1972	1973	1974
Pennsylvanian		-	-	-
Mississippian	"Michigan Stray Ss."	-	-	-
	"Berea Sandstone"	-	-	-
Devonian	Antrim Shale (Gas)	-	-	-
	"Traverse Lime"	1	-	-
	Dundee	1	-	1
	"Reed City"	-	-	-
	Detroit River "Sour Zone"	1	-	-
	Richfield	-	-	-
Silurian	Salina A-1 or A-2	2	6	-
	Niagaran reef*	53	69	91
Ordovician	Trenton-Black River	-	1	1
	Prairie du Chien	-	-	-
Cambrian	(Gas shows reported in past years)			

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

[Drilling Objectives]

DRILLING OBJECTIVES IN MICHIGAN				
System	Formation or Pay	Percentage		
		1972	1973	1974
Pennsylvanian		-	-	-
Mississippian	"Michigan Stray Ss."	15.0	11.1	3.9
	"Berea Sandstone"	-	-	-
Devonian	Antrim Shale (Gas)	-	-	-
	"Traverse Lime"	3.2	1.6	.9
	Dundee	4.6	3.2	3.9
	"Reed City"	1.9	1.9	1.2
	Detroit River "Sour Zone" & Richfield	4.3	1.4	4.1
Silurian	Salina-Niagaran	61.9	74.1	81.0
Ordovician	Trenton-Black River	3.2	3.0	3.2
	St. Peter Ss. or Prairie du Chien	4.8	3.0	1.0
Cambrian or Precambrian	Undifferentiated	1.1	.8	.8

Michigan wells are initially classified as near as possible according to the guidelines established by AAPG and API (AAPG Bulletin, Vol. 58/8, August 1974, pp. 1501-1503). Classifications are made after inspection of appropriate oil and gas maps and noting the location of the test in reference to established fields, dry holes, etc. The Lahee classification system is particularly adaptable

to structural traps but does not adapt to all situations involving small reefs such as are found in Michigan. Because of the apparent small areal extent of most reefs as shown by seismic anomalies and the close proximity of one reef to another, especially in the northern and southern reef belts, it has become increasingly difficult to classify with certainty all new well locations as exploratory or development. Reservoir performance may show that a well previously classified as a development well should actually be considered as being in a separate reservoir or pool. Likewise, a so-called discovery well may actually turn out to be a development well to a nearby reef reservoir. A discovery well may be completed as an oil well but at sometime later be reclassified as a gas well and, conversely, a gas well may be later reclassified as an oil well. Discovery wells credited to 1974 are shown on the forthcoming list. The listing includes a few reclassifications made necessary for reasons previously mentioned.

**\*\*\* STATE OIL AND GAS REVENUE \*\*\***

Public lands located in the Southern Peninsula and under lease for oil and gas amounted to 1,577,095 acres as of August 31, 1975. Most of the acreage is in northern counties now being heavily explored for Salina-Niagaran reef reservoirs.

The amount of land under lease for oil and gas has varied from year to year, and revenues closely follow the high and low points. Records show a previous high of about 935,000 acres under lease in 1951 and 1952, and then a gradual decline to about 150,000 acres in 1958. From 1958 the amount increased to about 640,000 acres in 1962. From 1962 the amount of acres under lease for oil and gas decreased to about 290,000 in 1966. From 1966, when interest was renewed in deeper exploration around the northern edge of the basin, leasing again increased to its present high level of more than one and one-half million acres.

At a State oil and gas lease sale held August 18-19, 1975, a total of 170,165.04 acres were offered but only 58,385.55 acres were leased. The average bid per acre was \$8.75. The highest bid per acre was \$920.00. In contrast, the June, 1974 sale offered 348,405 acres of which 217,506 were actually leased. The total bid in the sale amounted to \$7,131,540.00 and the average bid per acre amounted to \$32.79. The highest bid in the June, 1974 sale was \$16,250.00. This high bid established a record bid of \$1,300,000 for an 80-acre parcel in Grand Traverse County.

Total State revenues from royalty, rentals, bonus, and application-assignment fees from 1927 through 1974 amounts to \$61,116,768.74. Revenue figures according to year and source are shown on page 60, Part 3.

## \*\*\* WELL RECORDS AND OIL AND GAS MAPS \*\*\*

OIL AND GAS WELL RECORDS. Descriptive geological logs and drillers logs are available for over 29,000 oil and gas tests, including exploratory, development, facility and other types of wells. Individual logs may be purchased at small cost from the Geological Survey Division. Electric or radiation logs of any type are not available for distribution or sale.

OIL AND GAS FIELD MAPS. Blueprint copies of county oil and gas field maps are available for every county in the Southern Peninsula. The maps show locations of oil and gas tests but do not show geological data or structural contour lines. County map scales are 1" = 1 mile. Blueprint field maps are available for many oil and gas fields. These maps show well locations, well permit numbers, operators and lease names. They do not show geological data or structural contour lines. Field map scales are mainly 4" = 1 mile. All manuscript maps from which blueprint copies are made are posted on a regular basis. An oil and gas field maps list may be obtained from the Geological Survey upon request.



## PART 2 EXPLANATION

Part 2 brings together general information on Michigan oil and gas fields, gas storage reservoirs, LPG storage facilities, gas plant operations, refinery facilities and other items.

TABLES 2 and 3, MICHIGAN OIL AND GAS FIELDS. The symbol on the left margin of the table indicates the official classification of fields and pools at the end of the year. Classifications may be changed as warranted. Official field names are listed alphabetically in the first 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 reservoir within a formation. Some fields have two or more separate pools, each producing from a different formation or stratigraphic interval and at a different depth. Most multi-pool fields are associated with a common structural feature. Salina-Niagaran reef oil or gas accumulations are mostly single-pool fields. Some, however, have several separate reef reservoirs designated as Pool A, Pool B and so on. Most have been so designated by administrative action following public hearings. Also, a few of the listed fields actually consist of two or more hydrocarbon accumulations which for administrative purposes have been consolidated under one field name.

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 or pool. The

geographic location of fields and pools can be found by township and range on the center-spread oil and gas field map. Due to space limitations, all field names are not shown on the map.

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

The Deepest Formation or Pool Tested column indicates the stratigraphically oldest formation penetrated and the deepest total depth reached beneath the field area. Data in these columns are updated periodically.

The Number of 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 specified year, the number abandoned during the year and the number of active wells at the end of the specified year.

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 unit for a deeper formation pool. During the development of a field or pool the drilling unit size may change. Subsequent wells are assigned acreage values in accordance with the new unit size. In past years drilling units have been 10, 20 or 40 acres. Reef reservoirs, especially in the northern reef trend, have been assigned 40, 80, 160 and 640-acre units, or a unit size based on seismic and reservoir data. 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 lifetime of a given field or pool. Though figures cited in the column are not entirely accurate, they do provide as near as possible an indication of the areal size of the field. The figures do not indicate the areal extent of the oil or gas reservoir.

Recovery Per Acre Drilled figures for oil pools are derived by dividing the cumulative production figure by the drilled acres 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. Other fields, not considered to have commercial size gas accumulations, produce small quantities of unmetered gas which 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 storage reservoirs are gas pools that have been

designated to become storage reservoirs at some future time. The producing sections listed on 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 storage operations. Further, the listed 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.

**NATURAL GAS LIQUIDS (CONDENSATE).** Natural gas liquids are those portions of reservoir gas which are liquified at the surface in lease separators, field facilities, or gas processing plants. These liquids include but are not limited to: ethane, propane, butanes, pentanes, natural gasoline and condensate. On Tables 2 and 3 of this report, condensates from Michigan gas-condensate fields are shown under the oil production column.

**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. In addition, several thousand shallow geological test samples are also available for inspection. The Survey does not maintain a core collection. Other sample and core repositories, not connected with the Survey, are located at:

Subsurface Laboratory, Department of Geology, The 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 Geology, 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 other than for individual fields were discontinued in 1968. These tables listed the reported amount of produced brine and the method of disposal from 1937 up to 1967. Most oil field brine is still 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 of in burning pits.

**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.

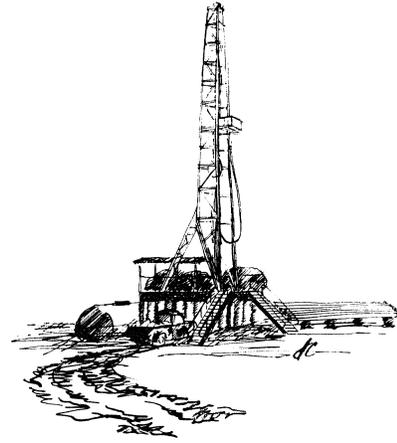
**Observation Wells.** Most observation wells are related to gas storage projects. They are used to observe underground movement of gas, brines and other fluids, or to observe pressures.

**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" do not include oil or gas wells converted to service wells.



STATE OF MICHIGAN  
William G. Milliken, *Governor*

DEPARTMENT OF NATURAL RESOURCES  
Howard A. Tanner  
*Director and Supervisor of Wells*

GEOLOGY DIVISION  
Arthur E. Slaughter  
*State Geologist and Assistant Supervisor of Wells*

NATURAL RESOURCES COMMISSION  
Carl T. Johnson, *Chairman* Cadillac

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# STRATIGRAPHIC SUCCESSION IN MICHIGAN

PALEOZOIC THROUGH RECENT

MICHIGAN  
DEPARTMENT OF NATURAL RESOURCES  
Howard A. Tanner, Director  
  
Geological Survey Division  
Arthur E. Slaughter, State Geologist

ACKNOWLEDGEMENT: Compiled with the counsel of colleagues in this department, the U. S. Geological Survey, Michigan universities, other State Geological Surveys, and geologists within Michigan's oil and gas industry. Dr. A. W. T. Cross, Department of Geology, Michigan State University, identified rocks of Mesozoic age and suggested provisional age assignments.

GEOLOGIC NAMES COMMITTEE  
Garland D. Eli, Chairman, Robert W. Kelley, Secretary  
Harry J. Hardenberg, I, David Johnson, Harry O. Sorenson

PLEISTOCENE NOMENCLATURE

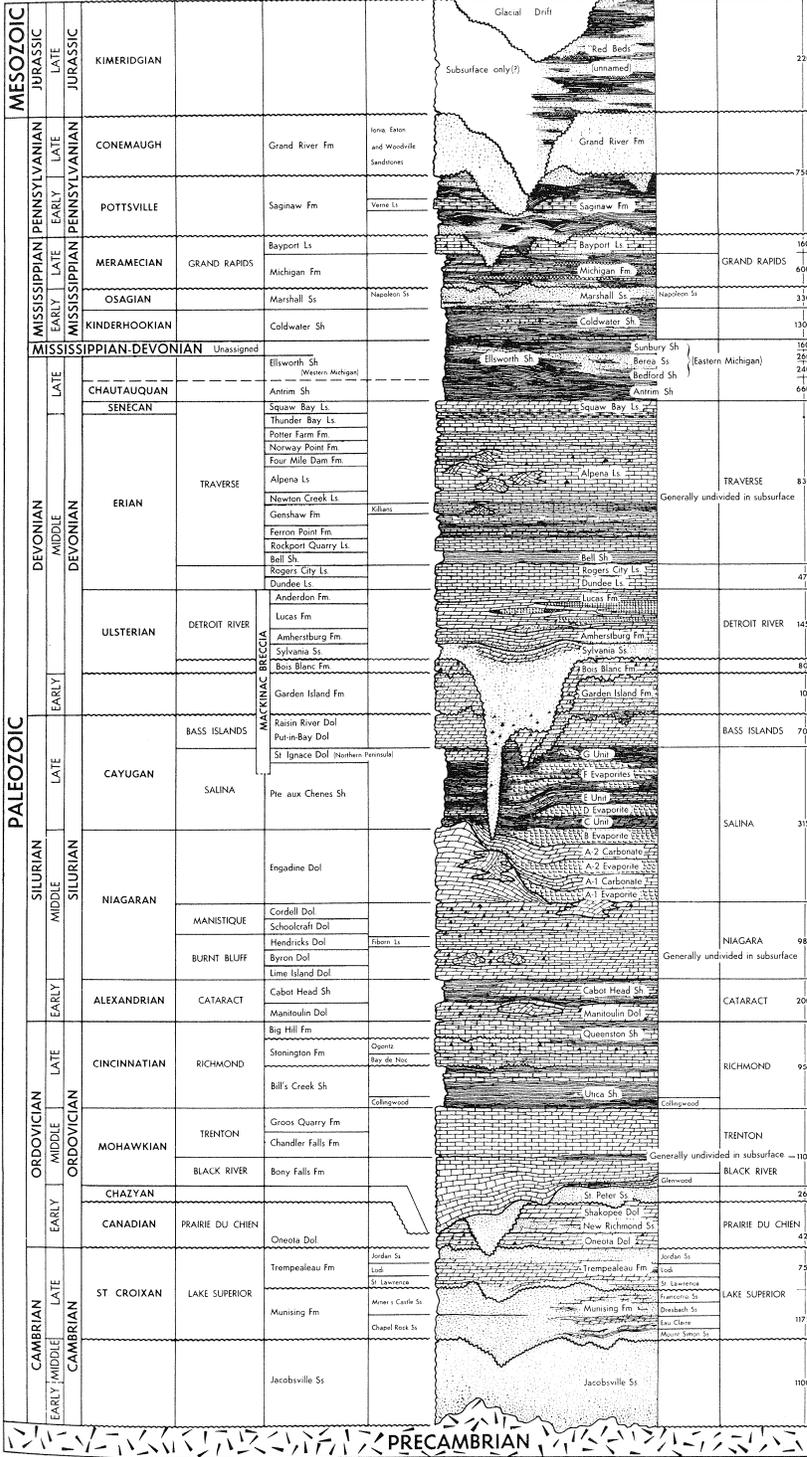
ERA	SYSTEM	SERIES	STAGE
CENOZOIC	QUATERNARY	PLEISTOCENE	Valders Stage
			Wisconsin Glaciation
			Two Creeks Interstade
			Mankato Stage (Pr. Huron?)
			Cary Stage
			Tazewell Stage
			Sangamon Inter-glaciation
			Illinoian Glaciation

OUTCROP NOMENCLATURE

GEOLOGIC TIME	TIME-STRATIGRAPHIC		ROCK-STRATIGRAPHIC		
	ERA	PERIOD	SERIES	GROUP	FORMATION
					MEMBER

SUBSURFACE NOMENCLATURE

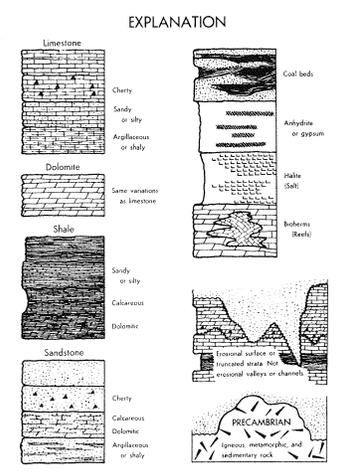
ROCK-STRATIGRAPHIC		
FORMATION	MEMBER	GROUP
DOMINANT LITHOLOGY		
Approximate maximum thickness, in feet, of rock units in the subsurface. NO SCALE		



INFORMAL TERMS

Principal oil and gas pays, and informal terms used in petroleum exploration and applied to parts of formations or groups in the subsurface.

STRATIGRAPHIC POSITION	INFORMAL TERMS	PAYS
Basal sandstones of Saginaw Fm	Perme sandstone	
In lower part of Michigan	trale gyp (brown line may vary in may del may as	Gas Gas & Oil
Marshall Ss	Coldwater line	Gas & Oil
Coldwater Sh	Wet sand (Coldwater red rock)	Gas
In upper part of Ellsworth Sh	Brown sand (Western Michigan)	Oil & Gas
Berea Ss	Berea sand (Eastern Michigan)	Oil & Gas
Saginaw Bay Ls	Saginaw Bay	Oil & Gas
Upper part of Traverse Group in Western Michigan	Traverse formation Traverse line (Shooby Lake zone)	Oil & Gas Oil & Gas
Rogers City Ls		Oil & Gas
Dundee Ls		Oil & Gas
Dundee Ls (?), Upper part of Lucas Fm (?)	Reed City zone	Oil & Gas
In Lucas Fm	massive salt big salt near zone massive anhydrite	Oil & Gas Oil & Gas
Amherstburg Fm	black line	
Part of Salina Group E Unit	E zone (or Keigh zone)	Oil
Divisions of A-2 Carbonate in Western Michigan	A-2 dolomite A-2 line	Gas
A-1 Carbonate	A-1 dolomite	Oil & Gas
Upper part of Niagara Series	(brown Niagara gray Niagara white Niagara)	Oil & Gas
Part of Niagara Series	Clinton shale (Eastern Michigan)	Oil & Gas
Trenton Group		Oil & Gas
Black River Group	(Black River formation Black River shale Van Wert zone)	Oil & Gas
Onondaga Dol		Oil



GEOLOGIC NAMES COMPILATIONS: Harris O. Sorenson, Cambrian and Ordovician; Robert W. Kelley, Early and Middle Silurian; Garford D. Eli, Late Silurian through Detroit River Group of Devonian age; Harry J. Hardenberg, I, Devonian Limestone through Traverse Group of Devonian age; L. David Johnson, Antrim Shale through the Pennsylvanian System; F. Willis Fowler, general geology of the Cenozoic.

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