

MICHIGAN'S OIL AND GAS FIELDS, 1978

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The Geological Survey Division's Oil and Gas Section consists of a Regulatory Control Unit, a Production-Proration Unit, and a Subsurface and Petroleum Geology Unit. A Cartographic Subunit is under the management of the Subsurface and Petroleum Geology Unit. Field operations are handled by personnel assigned to field offices within DNR Regions II and III. A Regional Geologist, under the supervision of the Regional Director, guides the overall activities of the several field offices within his region. Field offices are located at Plainwell, Cadillac, Gaylord, Mt. Pleasant, Imlay City, and Rose Lake. 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 to a limited extent in this report.

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

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

James S. Lorenz, Supervisor, Production-Proration Unit. Contribution: All Michigan oil and gas production data, oil and gas valuation figures, import and export figures, LPG and condensate figures, secondary recovery projects (Table 5), and refineries.

G. D. Ells, Supervisor, and D. M. Bricker and staff, Subsurface and Petroleum Geology Unit. All general drilling statistics and well completion data, discovery well and deep test data, cumulative records, and all other summary information not

specifically provided by other Unit supervisors or by other agencies. Maintenance and compilation of statistics, assembly and manuscript preparation by staff members of the Subsurface and Petroleum Geology Unit: G. D. Ells, D. M. Bricker, R. C. Elowski, A. G. Ostrander, M. A. Morris, Margaret Schineman, and Diane Goerge.

The compilers also acknowledge the assistance of Gas Section personnel, Public Utilities Division, Department of Commerce, in providing figures on natural gas imports via interstate pipelines, and the Lands Division, Department of Natural Resources, in providing figures for state revenue derived from various oil and gas transactions.

Michigan oil and gas production figures maintained by the Production-Proration Unit are compiled by the Unit from records obtained from the Michigan Department of Treasury and from records filed by producers and purchasers. All hydrocarbon production figures cited herein are subject to correction as warranted.

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

Compilers: G. D. Ells
D. M. Bricker
R. C. Elowski
A. G. Ostrander
M. A. Morris

Lansing, Michigan
October, 1979

INTRODUCTION

To help foster the development of Michigan's hydrocarbon resources, statistical data have been maintained and published for many years. This issue of the oil and gas field statistical summary brings together information on various facets of Michigan's oil and gas industry activities. Certain indices which show the trend of these activities from year to year are shown in chart form along with figures from prior years. Other charts reflect cumulative data and other historical information useful in oil and gas field evaluation.

The information contained in this oil and gas summary has been treated as uniformly as possible from year to year so that the data reflect accurately the actual figures and other information that should be credited to this year. The data found herein are mainly derived from records maintained by the Oil and Gas Section, Geological Survey Division, Department of Natural Resources.

This publication is essentially divided into three parts. The first summarizes significant statistics on oil and gas field activities and includes numerous other related records kept by the Oil and Gas Section. Part 2 contains specific information on Michigan's oil and gas fields, gas

storage fields, and other related subjects. Part 3 contains cumulative records important to the oil and gas industry.

Certain well completion data are furnished to the American Petroleum Institute (API) and the American Association of Petroleum Geologists (AAPG) on a regular basis. Reports citing preliminary oil and gas statistics and production figures 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 are made available to authors of the AAPG yearly Development Papers and to others. Year-end figures published by API are in general agreement with figures for similar categories published in this summary. Differences which may occur are shown under the appropriate subject heading in this report. Oil and gas production data are supplied by request to the United States Bureau of Mines for publication in their minerals yearbook.

Statistical data on Michigan oil and gas activities, derived from outside sources, are also published by the 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 Oil and Gas Journal, Tulsa, Oklahoma.

It should be noted that certain figures for the number of exploratory, development, and service wells drilled and completed, the number of new fields and pools discovered, oil and gas production figures, and other data published in this summary may differ from figures reported by regional or national trade publications or by industry reporting services. The differences in the various statistics are generally minor and are due to methods of gathering and reporting well data, determining cutoff dates for reporting yearly statistics, and the necessity for making projections and estimates for certain types of reports.

Other factors which may result in statistical differences are internal decisions of the Oil and Gas Section regarding final year-end status of completed wells and decisions resulting from public hearings on oil and gas matters. For example, a well originally classified as a development well, and reported as such to one of the above organizations, may later be reclassified as the discovery well for a new pool or field, or a gas well might later be declared an oil well completion on the basis of new evidence. Frequently the changes in well status cannot be readily passed on to these outside organizations so that their records can be updated prior to publication of their final statistics. The discrepancies in year-end figures are almost without exception related to Niagaran reef exploration and development which has formed the largest part of Michigan drilling activities for the past several years.

PART I 1978 STATISTICAL DATA

*** OIL AND GAS PERMITS ***

Oil and gas drilling permits issued under Act 61, P.A. of 1939, as amended, during 1978 began with permit number 32107 and ended with permit number 32796. The total number of permits issued in 1978 was 690 as compared with 692 in 1977. The initial classification of wells to be drilled under these permits was as follows:

INITIAL CLASSIFICATION	1976	1977	1978
Exploratory wells	331	338	311
Development wells	253	296	298
Gas storage facility wells	36	53*	74
Brine disposal wells . . .	25	5	7**
	645	692	690

*Includes 2 LPG storage wells.

**Includes 4 water injection wells involved in secondary recovery operations.

The distribution of oil and gas drilling permits according to districts (see oil and gas districts map) through a five year period, including 1978, is as follows:

DISTRICTS ¹	DRILLING PERMITS BY DISTRICT				
	Permits Issued				
	1974	1975	1976	1977	1978
Basin	98	100	110	135	146
Northern	210	219	221	261	284
Southeastern	62	70	98	111	98
Southwestern	44	108	73	67	47
Western	89	156	143	118	115
Totals	503*	653*	645*	692*	690*

¹Includes terminated permits. Permits issued under Act 61, P.A. of 1939, as amended, are terminated one year after date of issue if actual drilling operations have not begun.

Since 1975, permits to drill wells for oil field brine disposal have been issued under the regular permit numbering system rather than under a separate permit numbering system as was done in the past. Deepening permits were issued for 25 wells during 1978 as compared with 51 the previous year. Deepening permits issued in 1978 began with number 1917 and ended with number 1941.

Michigan's oil and gas permit system began in 1927 with the issuance of permit number 1. Since then, permit numbers have been issued in numerically consecutive order. In many cases, wells which have been previously drilled and abandoned have been reopened and reworked under a new permit number. Also, some well locations for which permit numbers were issued but later terminated have been repermited and assigned new permit numbers. Such multiple permit numbers for the same well location may lead to some confusion. Therefore an attempt is being made to keep a published account of these possible sources of conflict. Terminated permits were listed for the first time in Annual Statistical Summary 16, 1972. Permit numbers issued for wells drilled under previous permits, or new permit numbers issued for terminated permits, were cited for the first time in Annual Statistical Summary 18,

1973. Permit numbers issued in 1978 for a previously drilled well or for a previously terminated permit are listed in Part 3. Permits terminated in 1978 are shown below.

[Permits Terminated in 1978]

Permits terminated in 1978			
1738*	31480	31742	31947
1887*	31484	31759	31953
1888*	31526	31766	31981
1894*	31531	31770	32025
31298	31532	31810	32042
31439	31573	31842	32057
31441	31617	31865	32088
31452	31688	31883	32102
31462	31694	31909	
31464	31701	31941	
31477	31741	31942	

*Deepening permits

Directionally drilled holes. Environmental and economic considerations have necessitated the drilling of a large number of directional holes since 1972, particularly to help locate Niagaran reefs. Many of these holes involve using the upper part of a previously drilled hole which, after being initially completed as a dry hole, was plugged back to an appropriate depth and directionally drilled to a more favorable subsurface location. These directionally drilled holes fall in three main categories: 1) a single directional hole completed as either a producer or a dry hole; 2) cases where two or more directional holes have been drilled to separate bottom-hole targets from the same surface location by using the same upper part of the hole; and 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 reefing. Only one producing well is allowed per well bore, regardless of the number of holes directionally drilled from the same well bore.

Each new directional hole, even if drilled from the same surface location and using the upper part of a previously drilled test, is treated as a separate test and is assigned its own unique permit number. Each additional hole drilled from the same surface location retains 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 repermited under a new number. An attempt has been made to record and publish permit numbers for directionally drilled tests for the benefit of those people who may find the information useful in computer-well data systems. Permit numbers issued for directional holes for 1977 and directional holes with two or more permit numbers are listed in Part 3. Permits issued in 1978 for directional holes are as follows:

Permit numbers issued in 1978 for directional holes

32107	Presque Isle County	32460	Manistee County
32112	Gd. Traverse County	32462	Kalkaska County
32120	Manistee County	32474	Gd. Traverse County
32122	Manistee County	32478	Manistee County
32126	Presque Isle County	32486	Kalkaska County
32130	Gd. Traverse County	32487	Manistee County
32133	Kalkaska County	32489	Macomb County
32134	Presque Isle County	32494	Oakland County
32140	Gd. Traverse County	32502	Kalkaska County
32141	Kalkaska County	32504	Calhoun County
32154	Gd. Traverse County	32505	Manistee County
32155	Manistee County	32507	Kalkaska County
32156	Gd. Traverse County	32508	Otsego County
32162	Manistee County	32509	Otsego County
32169	Wexford County	32510	Otsego County
32171	Manistee County	32516	Gd. Traverse County
32179	Gd. Traverse County	32522	Gd. Traverse County
32183	Gd. Traverse County	32527	Wexford County
32194	Oakland County	32528	Otsego County
32195	Oakland County	32531	Otsego County
32207	Otsego County	32533	Manistee County
32208	Manistee County	32548	Eaton County
32210	Gd. Traverse County	32550	Gd. Traverse County
32212	Kalkaska County	32573	Cheboygan County
32225	Macomb County	32576	Manistee County
32226	Macomb County	32583	Kalkaska County
32245	Oakland County	32589	Cheboygan County
32250	Presque Isle County	32597	Cheboygan County
32253	Manistee County	32600	Manistee County
32259	Gd. Traverse County	32602	Crawford County
32263	Kalkaska County	32604	Otsego County
32265	Manistee County	32605	Otsego County
32267	Manistee County	32606	Cheboygan County
32269	Cheboygan County	32476	Kalkaska County
32271	Presque Isle County	32621	Manistee County
32276	Otsego County	32622	Manistee County
32298	Otsego County	32623	Manistee County
32301	Manistee County	32624	Kalkaska County
32303	Kalkaska County	32625	Gd. Traverse County
32304	Presque Isle County	32630	Manistee County
32315	Presque Isle County	32632	St. Joseph County
32327	Macomb County	32634	Presque Isle County
32331	Otsego County	32665	Presque Isle County
32333	Montmorency County	32669	Presque Isle County
32337	Gd. Traverse County	32675	Gd. Traverse County
32342	Kalkaska County	32677	Presque Isle County
32350	Gd. Traverse County	32678	Manistee County
32352	Manistee County	32692	Otsego County
32354	Manistee County	32699	Manistee County
32357	Macomb County	32700	Manistee County
32371	Kalkaska County	32708	Manistee County
32374	Otsego County	32712	Presque Isle County
32386	Manistee County	32759	Otsego County
32388	Otsego County	32769	Presque Isle County
32391	Oakland County	32771	Presque Isle County
32399	Crawford County	32773	Gd. Traverse County
32404	Manistee County	32778	Kalkaska County
32411	Otsego County	32782	Otsego County
32414	Manistee County	32783	Kalkaska County
32420	Kalkaska County	32786	Presque Isle County
32445	Otsego County	32788	Gd. Traverse County
32450	Manistee County	32789	Kalkaska County
32451	Manistee County	32793	Ingham County
32455	Eaton County	32795	Calhoun County
32459	Manistee County		

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	1974	1975	1976	1977	1978
Gas storage	30	37	28	51	74
LPG, Water Injection	11	0	14	2	4
Brine Disposal	1	4	11	5	3
	42	41	53	58	81

Rework application, transfers of ownership, etc. In addition to issuance of permits for various types of wells covered under Act No. 61, P.A. of 1939, as amended, 146 applications were received and approved for rework operations on existing wells. Letters of termination were sent out for 41 previously issued permits. Transfers of ownership were processed for 258 wells. Corrections of location, well name, or other detail involving specific permits were made for 61 wells, and cancel and transfer of permit were made for 22 others. The surface location as well as the projected bottom-hole location is published for each permitted directionally drilled hole. After the well is drilled and the directional survey is filed, the correct bottom-hole location is determined from the survey record and then published as a correction for the initial projected bottom-hole location. Corrections of this type were published for 128 wells drilled during 1977 and 1978.

Oil and gas hearings. During 1978, Oil and Gas Section activities also included scheduling and preparation for hearings on oil and gas matters and the issuance of orders resulting from these hearings. These activities are summarized as follows:

Advisory Board Hearings held	8
Administrative Hearings held	20
Total Causes heard	34
Total Orders issued	30
Includes: 2 causes dismissed	
1 change in well allowable under Special Order 1-78	
1 change in well allowable under Special Order 1-73	
8 spacing orders	
7 exceptions to spacing orders	
1 compulsory pooling order	
3 unitization orders	
2 secondary recovery by waterflood	
1 lifting of No Flare order	
5 amendments to spacing orders	
3 abrogation of spacing orders	

***** WELL COMPLETIONS *****

There were 528 new-hole exploratory and development wells which reached total depth and were considered either completed producers with production casing set, or dry holes during 1978. The 528 wells considered as completed during the past year do not include service wells, old wells drilled to deeper objectives, or reworked wells. Well completion figures for individual counties are shown in Table 1. 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	
1974	54	39	173	80	22	62	430
1975	53	17	213	112	21	117	533
1976	30	36	234	90	21	99	510
1977	35	36	230	101	34	111	547
1978	29	25	214	117	32	111	528

There were 74 new-hole service well completions in 1978. The figure does not include reworked wells or old wells converted to gas storage facility wells. The fluctuation in the number of service well completions over a five year period is as follows:

Year	GS	INJ	LPG	BDW	Totals
	1974	38	13	2	
1975	37	0	0	1	38
1976	25	13	0	12	50
1977	43	2	1	4	50
1978	60	11	0	3	74

Drilling statistics for Michigan published by API and derived from data supplied by the Geological Survey (G.S.) are shown below, along with figures for 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, 1978, Annual Summary, 1978, American Petroleum Institute, Vol. XII, No. 4, March 1979, Tables I, II, III, and V, pp. 14-22.

Year	Exploratory Wells			Development Wells			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
1978	27	23	216	107	31	103	507
G.S.	29	25	214	117	32	111	528

Year	Oil Wells	Gas Wells	Dry Holes	Service Wells	Total Wells All Types
	1978	134	54	319	14
G.S.	146	57	325	74*	602

*API does not require information of wells drilled for gas storage. The Geological Survey considers gas storage wells as a class of service well. Sixty of the 74 service wells cited were gas storage facility wells.

Year	Oil	Gas	Total Producing Wells	Dry Holes	Total New-Field Wildcat Wells
	1978	26	23	49	216
G.S.	29	25	54	214	268

Major and independent company well completions. Requests are frequently made for statistics on major oil

company drilling activities in Michigan. The figures cited for the major companies do not include wells drilled by independents under farmout agreements with a major company or wells drilled by independents but partially supported by dry hole money or some other significant assistance from a major oil company. Independent oil companies, who have drilled most of Michigan's wells, are too numerous to cite individually. All figures cited for majors and independents were derived from inspection of operator names appearing on completion records. On the following chart, in cases where two or more companies were joint operators in a drilling venture, the well completion was attributed to the company whose name appears first (generally the major interest holder) on the official records. 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 of California. The preceding list is not official nor necessarily complete. A number of these companies or their affiliates drilled wells in Michigan this year.

Major Company	Exploratory			Development			Service Wells*	Totals
	Oil	Gas	Dry	Oil	Gas	Dry		
Amoco	6	6	35	7	5	6	0	65
Getty	1	0	2	1	0	0	0	4
Marathon	0	0	0	9	0	0	5	14
Mobil	1	0	3	2	0	1	3	10
Shell	8	8	49	23	10	28	4	130
Sun	0	0	2	5	0	1	1	9
Union	0	0	0	6	0	0	0	6
Sub-totals	16	14	91	53	15	36	13	238
Independents	13	11	123	64	17	75	61	364
Totals	29	25	214	117	32	111	74	602

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

Total: Exploratory Wells 268; Development Wells 260; Service Wells 74.

Exploratory Wells drilled by Majors 45%.
Exploratory Wells drilled by Independents 55%.

Exploratory Discoveries made by Majors 56%.
Exploratory Discoveries made by Independents 44%.

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

Producing Development Wells drilled by Majors 48%.
Producing Development Wells drilled by Independents 52%.

Discovery Success Ratio (Number discoveries divided by total exploratory wells)--Majors 1:4; Independents 1:6.

Well casing used in 1978 well completions. Periodically, inquiries are made concerning the amount of casing (pipe) used in Michigan wells during a given year. Almost all oil and gas tests drilled in this state utilize rotary drilling techniques and require the setting of surface pipe and an intermediate casing string. A conductor pipe is set on many holes, and all wells

completed as producers require a string of production casing. Pipe size ranges and amounts have been determined from records of wells completed in 1978. For convenience, casing tallies have been related to a range of casing sizes as shown in the following chart.

	Conductor Pipe	Surface Pipe	Intermediate Pipe	Production Pipe
Casing Size Range Used	13"-20" Dia.	10"-13" Dia.	6"-10" Dia.	4-1/2"-6" Dia.
Normal Size Used	16"	11-3/4"	8-5/8"	5-1/2"
Average Weight	75#/ft.	53#/ft.	37#/ft.	19#/ft.
No. feet used (1)	27,939	255,357	1,229,494	1,255,417
Miles (2)	5.29	48.36	232.86	237.77
Tons (3)	1,047.71	6,766.96	22,745.64	11,926.46

- (1) Total footage: 2,768,207
- (2) Total miles: 524.28
- (3) Total tonnage: 63,668.76 based on an average weight for all sizes of 46# per foot.



[Oil and Gas Districts Map]

NEW WELL COMPLETIONS BY DISTRICTS, 1978

Classification of New Well Completions	Basin		Northern		Western		Southwestern		Southeastern		Totals	
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978
Exploratory Wells												
Oil	3	4	18	15	10	7	4	3	0	0	35	29
Gas	3	2	18	13	11	6	2	3	2	1	36	25
D & A	25	22	115	118	31	27	23	18	36	29	230	214
Total	31	28	151	146	52	40	29	24	38	30	290	268
Development Wells												
Oil	29	45	28	34	16	20	14	11	14	7	101	117
Gas	1	1	16	15	4	8	0	7	13	1	34	32
D & A	7	14	47	40	34	31	13	9	10	17	111	111
Total	37	60	91	89	54	59	27	27	37	25	246	260
Service Wells												
WI	0	9	1	2	0	0	1	0	0	0	2	11
BSM	2	1	0	1	2	1	0	0	0	0	4	3
GS	34	27	0	0	2	5	0	0	7	28	43	60
LPG	0	0	0	0	1	0	0	0	0	0	1	0
Total	36	37	1	3	5	6	1	0	7	28	50	74
Total Completions	104	125	243	238	111	105	57	51	82	83	597	602

GEOLOGICAL SURVEY DIVISION

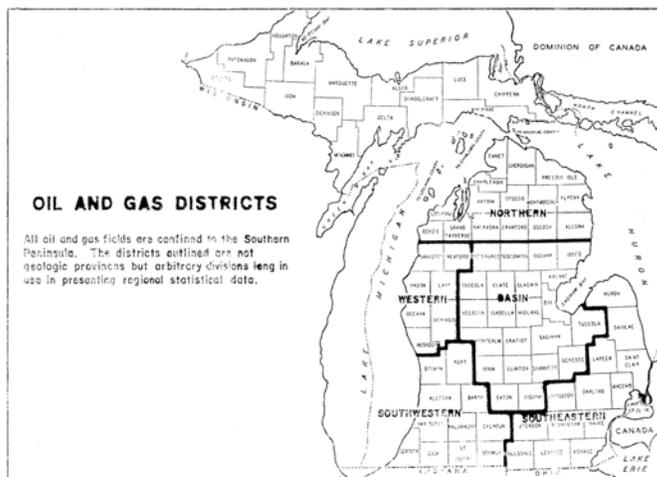
DNR REGION II FIELD OFFICES

- Gaylord (Otsego County)
- Cadillac (Wexford County)
- Mt. Pleasant (Isabella County)

DNR REGION III FIELD OFFICES

- Rose Lake (Clinton County)
- Plainwell (Allegan County)
- Imlay City (Lapeer County)

Dots show the general location of field offices within the several districts. These districts are arranged for administrative and regulatory purposes. Though frequently called oil-and-gas districts, they should not be confused with those shown below which have been in use for many years in presenting statistical data.



Drilled footage. The average depth, statewide, of exploratory wells drilled in 1978 was 4,558 feet compared with 4,900 feet in 1977. Development well depths averaged 4,524 feet compared with 4,343 feet in 1977. Service wells drilled in 1978 averaged 3,091 feet as compared with 1,830 feet in 1977. Drilled footage figures and average well depths for specific counties are shown in Table 1.

Total drilled footage figures from the Geological Survey Division records for 1978 and several prior years are as follows:

DRILLED FOOTAGE FIGURES—GEOLOGICAL SURVEY DIVISION

Well Class	1975	1976	1977	1978
Exploratory	1,397,144	1,448,933	1,474,814	1,220,144
Development	1,124,863	913,530	1,068,429	1,117,482
Service Wells (All types)	71,919	105,975	91,492	228,768
Total:	2,593,926	2,468,438	2,634,735	2,566,394

Drilled footage figures are furnished to the American Petroleum Institute and these are published as part of their quarterly and annual summary. Drilled footage

figures extracted from the 1978 API Annual Summary are as follows:

[Oil and Gas Production by County]

1978 API DRILLED FOOTAGE FIGURES					
Exploratory Wells			Development Wells		
Oil	Gas	Dry	Oil	Gas	Dry
128,774	114,735	983,621	474,158	138,454	488,159
Total Exploratory			Total Development		
Footage: 1,227,130 feet*			Footage: 1,100,771 feet**		
*API Table II, page 16			**API Table III, page 17		

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

* * * 1978 OIL AND GAS PRODUCTION * * *

Oil and gas production figures are derived from records submitted to the Production-Proration Unit, Oil and Gas Section, Geological Survey Division, Department of Natural Resources and from tax records from the Michigan Department of Treasury. Treasury Department records are primarily concerned with gross production figures needed to calculate revenues. These data are supported by reports required from producing companies and purchasers by the Geological Survey Division.

Delays in reporting and changes in methods of reporting used by producing companies and purchasers result in a continuous correction and refinement of production figures. Consequently all monthly, yearly, or other production figures are subject to corrections as warranted.

In an attempt to obtain national uniformity of data as recommended by the Interstate Oil Compact Commission, all annual and cumulative gas production figures for Michigan were converted to a standard base pressure for volumetric measurement of 14.73 pounds per square inch in 1978. This conversion and subsequent adjustment of gas production figures resulted in slight changes in cumulative production volumes in those fields which had been measured at varying pressure bases in prior years.

OIL AND GAS PRODUCTION BY COUNTY IN 1978		
County	Barrels Oil	MCF Gas
Allegan	118,246	65,072
Antrim	328,775	1,489,924
Arenac	162,164	0
Barry	6,938	0
Bay	154,838	0
Benzie	47,323	26,186
Calhoun	1,530,736	4,535,315
Cass	23,450	0
Cheboygan	2,899	0
Clare	329,498	46,172
Crawford	1,463,945	2,441,218
Eaton	357,710	3,182,682
Genesee	16,687	0
Gladwin	250,192	0
Grand Traverse	4,937,047	49,906,255
Gratiot	9,081	30
Hillsdale	941,519	3,252,659
Ingham	1,685,010	3,490,200
Isabella	107,159	0
Jackson	328,720	1,970,310
Kalamazoo	3,865,011	24,814,971
Kent	50,576	0
Lake	69,168	0
Lapeer	106,683	3,239
Lenawee	260	0
Livingston	880	1,274,959
Macomb	6,685	2,679,567
Manistee	7,978,033	26,877,199
Mason	245,964	2,384,962
Mecosta	24,095	34,318
Midland	149,922	0
Missaukee	625,036	351,078
Monroe	2,816	0
Montcalm	65,423	0
Montmorency	1,209	0
Muskegon	6,424	0
Newaygo	8,272	0
Oakland	558	16,748
Oceana	23,273	0
Ogemaw	589,070	187,245
Osceola	169,452	27,110
Oscoda	803	0
Otsego	6,094,111	16,005,339
Ottawa	64,367	79,681
Presque Isle	381	0
Roscommon	350,909	260,182
Saginaw	13,705	0
Shiawassee	6,738	0
St. Clair	622,522	1,676,305
Tuscola	54,731	0
Van Buren	7,772	0
Washtenaw	0	0
Wayne	7,646	0
Wexford	649,055	3,456,331
Totals	34,663,487	150,535,257

OIL AND GAS PRODUCTION BY DISTRICT IN 1978		
District	Barrels Oil	MCF Gas
Basin	5,121,420	7,579,017
Northern	16,741,504	94,683,893
Southeastern	2,018,289	10,873,787
Southwestern	1,802,085	4,680,068
Western	8,980,189	32,718,492
Totals	34,663,487	150,535,257

OIL AND GAS PRODUCTION BY MONTH IN 1978		
	Barrels Oil	MCF Gas
January	2,563,759	10,667,618
February	2,557,655	11,305,457
March	2,856,990	12,794,175
April	2,866,167	12,410,634
May	3,050,521	12,712,591
June	2,963,747	12,342,491
July	3,147,278	12,772,588
August	3,111,049	13,120,135
September	2,898,032	12,858,017
October	3,005,367	12,815,949
November	2,857,463	13,099,025
December	2,785,461	13,636,577
Totals	34,663,487	150,535,257

*** NATURAL GAS LIQUIDS ***

The amount of liquids produced from gas-condensate reservoirs associated with northern and western Michigan Silurian reefs increased during 1978. These liquids, produced from wells classified as gas wells, are included in the yearly oil production totals shown in 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 rates. There is no restriction on the amount of liquids produced along with the gas. Gas plants operated by Shell Oil Company and 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 condensate liquids:

CONDENSATE PRODUCTION	
Year	Barrels
1969	0
1970	18,946
1971	98,668
1972	125,768
1973	335,041
1974	1,187,498
1975	1,863,338
1976	1,896,870
1977	1,991,330
1978	2,295,263
Total	9,812,722

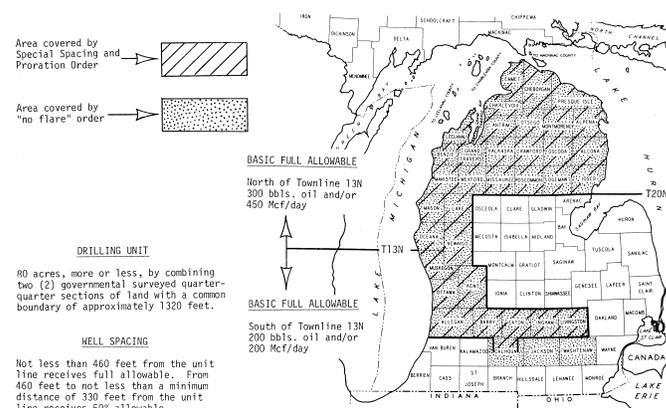
Gas plant operations are summarized in Table 6. It should be noted that the LPG recovery figures for the Amoco and Shell plants in Kalkaska County include stabilized condensate as well as LPGs.

A no-flare order, enacted as a conservation measure, 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 sale of the gas or an exception to the order is granted. Consequently, Special Order No. 3-71, amended, in effect since late 1971, tends to temporarily curtail production from Salina-Niagaran oil wells until gas gathering pipelines are laid and connections made.

Another order, Special Order No. 1-73, deals with spacing and proration of Salina-Niagaran wells in specific counties. This order established basic 80-acre drilling units (either stand-up or lay-down units) for Salina-Niagaran oil and/or gas wells and statewide proration for Salina-Niagaran oil reservoirs in the specified counties or parts of counties covered by the order. The area covered by the no-flare order and the spacing-proration order are shown on the map below along with information on the drilling unit, well spacing, and basic oil-gas allowables. These prudent and justifiable conservation measures effectively prevent waste of millions of cubic feet of valuable and much needed gas that might have been flared in past years, and these

measures should ultimately result in more efficient drainage of reef reservoirs and a greater recovery of the liquid hydrocarbons.

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



*** OIL AND GAS VALUATION ***

Records maintained by the Production-Proration Unit indicate the average price paid at the wellhead in 1978 for Michigan crude oil, including condensate, was \$12.34 per barrel compared with \$10.95 per barrel in 1977. The gross value of these products amounted to \$427,881,248 as compared with \$360,994,743 in 1977. The value of Michigan produced natural gas continued to rise in 1978. The average price of gas sold at the wellhead was \$1.11 per Mcf as compared with \$1.10 per Mcf in 1977. The gross value of this product amounted to \$166,920,524 in 1978 as compared with \$145,969,976 in 1977.

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

Total imports to Michigan refineries of U.S. domestic and foreign and Canadian crude oil amounted to 30,062,431 barrels in 1978, a decline from the 31,126,627 barrels imported in 1977. Imports of U.S. domestic and foreign crude to Michigan refineries increased from 22,890,304 barrels in 1977 to 24,223,605 barrels in 1978. Imports of Canadian crude via pipeline from western Canada oil fields continued to decline. Canadian imports amounted to 8,236,323 barrels in 1977 but declined to 5,838,826 barrels in 1978. The trend of U. S. domestic and foreign and Canadian imports to Michigan refineries from 1962 through 1978 is shown graphically. Imports by month during 1978 were reported by refineries as follows:

1978 CRUDE OIL IMPORTS (Bbls.)			
	Domestic and Foreign	Canadian	Total
January	1,652,009	249,852	1,901,861
February	1,868,074	512,786	2,380,860
March	1,948,660	478,204	2,426,864
April	1,596,626	787,512	2,384,138
May	1,608,829	391,850	2,000,679
June	1,649,666	193,800	1,843,466
July	1,840,569	258,524	2,099,093
August	2,952,233	431,459	3,383,692
September	2,169,290	849,611	3,018,901
October	2,020,213	307,579	2,327,792
November	2,019,266	555,859	2,575,125
December	2,898,170	821,790	3,719,960
Total	24,223,605	5,838,826	30,062,431

Most Michigan produced crude oil goes to Michigan refineries but some is exported. The amount credited to out-of-state terminals increased from 7,241,754 barrels in 1977 to 7,821,653 barrels in 1978. Records provided to the Production-Proration Unit by companies reporting exports of Michigan crude are as follows:

1978 CRUDE OIL IMPORTS (Bbls.)		
January		467,328
February		495,514
March		520,797
April		490,798
May		1,204,936
June		668,901
July		537,405
August		595,992
September		800,772
October		822,462
November		580,007
December		636,741
Total		7,821,653

Natural gas imports to Michigan markets and gas storage fields in 1978 via interstate pipelines, primarily from Texas, Louisiana, Oklahoma, and Kansas fields, amounted to 767,204,128 Mcf, a decrease from the 772,470,777 Mcf imported in 1977. Compilations by the Office of Gas Operations, Michigan Public Service Commission, show the following monthly imports during 1978:

1978 PIPELINE GAS IMPORTS (Mcf)	
January	61,087,176
February	55,651,302
March	69,862,152
April	65,060,533
May	67,302,921
June	67,033,368
July	69,443,003
August	62,664,419
September	51,689,415
October	53,758,109
November	70,883,127
December	72,768,603
Total	767,204,128

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

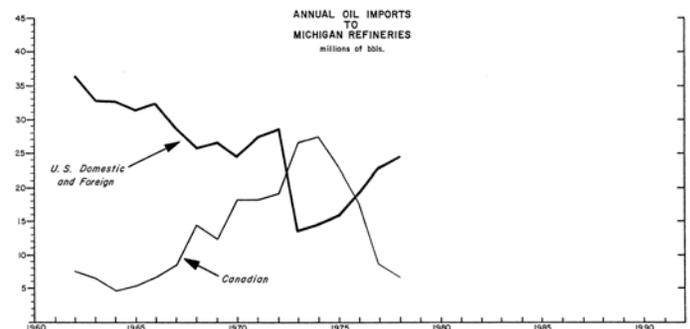
Once again Silurian reefs were the main type of oil and gas trap found this year. All appear to have been located by seismic exploration methods. Most were found along the northern reef trend extending from Mason County to Presque Isle County. Others were found in the southern part of the basin in the Calhoun-

Eaton-Ingham County area, and in the Macomb-St. Clair County area of the Southeastern District.

All the new discoveries are tentatively classified as Class E pools having possible oil and gas recoveries as defined by the Committee of Statistics of Drilling, American Association of Petroleum Geologists. These classes, shown below, 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

Michigan wells are initially classified as near as possible according to guidelines established by AAPG and API (AAPG Bulletin, Vol. 58/8, August 1974, pp. 1501-1503). Classifications such as exploratory, development, and the various types of service wells, 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. Gas storage facility wells, water injection wells and other types of service wells are generally designated as such by the operator. The Lahee classification system for designating exploratory or development wells 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 area! 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.



1978 DISCOVERY WELLS												
County	Location	Field Name	Operator and Lease	Permit Number	Depth to Pay	Total Depth	Initial Production to (T)IP	Initial Production to (N)IP	Initial Production to (M)IP	Producing Formation	Basin For Loc.	AMP Pool Class
Calhoun	NEW FIELDS	Clarence	J. O. Wutch	32259	3196	3307				S104-Gauge Not Available	Salina A-1 Carb.	Seis. E
Calhoun	26-15-6W	Conis	Fortuna Oil Co.	31998	2926	3007	2 +50 Mcrft +20 BWD			Salina-Niagaran	Acreeage E	
Calhoun	16-15-6W	Lee (Ext. Disc.)	Collins Bros. Oil Co.	31740	3084	3306				S104-Gauge Not Available	Niagaran	Acreeage E
Calhoun	24-15-6W	Lee	Alex J. Mymachod	31867	3132	3256	318 +178 Mcrft			Niagaran	Acreeage E	
Calhoun	34-15-6W	Lee	Robert J. Hennes	32280	2985	3165				250 Mcrft +240 BWD	Salina A-1 Carb.	Acreeage E
Cass	31-75-14W	Jump Lake	Vernon E. East	32484	724	730	F15 ⁿ				Traverse	Acreeage E
Eaton	1-10-3W	Hanlin	Anoco Production Co.	32548*	3813	4190	213 +140 Mcrft				Niagaran	Seis. E
Grand Traverse	14-26W-11W	Blair	Getty Oil Co.	32142	5767	5930	421 +1350 Mcrft +20 BWD				Niagaran	Seis. E
Grand Traverse	22-26W-11W	Blair	North. Mich. Exp. Co.	32248	5634	5958				98 Cond./Day +3024 Mcrft	Niagaran	Seis. E
Grand Traverse	9-26W-10W	East Bay	Traverse Corp.	32037*	5603	5956	452 +700 Mcrft				Niagaran	Seis. E
Grand Traverse	25-27W-10W	East Bay	Shell Oil Co.	31895	5930	6062	301 +285 Mcrft +19 BWD				Salina-Niagaran	Seis. E
Grand Traverse	27-25W-11W	Mayfield	Shell Oil Co.	32336	6547	6767				61 Cond./Day +2743 Mcrft	Niagaran	Seis. E
Grand Traverse	35-26W-10W	Paradise	Shell Oil Co.	32154*	6616	6762				102 Cond./Day +2979 Mcrft	Niagaran	Seis. E
Grand Traverse	17-26W-9W	Union	Anoco Production Co.	31692	6448	6540				96 Cond./Day +3600 Mcrft	Niagaran	Seis. E
Grand Traverse	20-26W-9W	Union	Anoco Production Co.	32375	6400	6731				4300 Mcrft	Niagaran	Seis. E
Grand Traverse	21-26W-9W	Union	Anoco Production Co.	31364	6758	6889				155 Cond./Day +3500 Mcrft	Niagaran	Seis. E
Grand Traverse	22-26W-9W	Union	Anoco Production Co.	32401	6740	6881				78 Cond./Day +4000 Mcrft	Niagaran	Seis. E
Grand Traverse	31-26W-9W	Union	Anoco Production Co.	32274	6608	7082				S104-Gauge Not Available	Niagaran	Seis. E
Grand Traverse	20-27W-9W	Whitewater	Anoco Production Co.	32515	6095	6360	312 +268 Mcrft				Niagaran	Seis. E
Ingham	17-1N-2W	Onondaga	Mobil Oil Corp.	32051	3604	3907	73 +1400 Mcrft				Niagaran	Seis. E
Ingham	18-1N-2W	Onondaga	Kulka & Schmidt & Mich. Oil Co.	32024	3686	3820	220 +158 Mcrft				Niagaran	Seis. E
Ingham	18-1N-2W	Onondaga	Michigan Oil Co.	32402	3597	3700				552 Mcrft	Salina-Niagaran	Seis. E
Isabella	13-13N-6W	Holland	Chase Oil Corp.	32382	1314	1328				1500 Mcrft	Michigan Stray	Acreeage E
Kalkaska	16-28N-5W	Blue Lake	Traverse Corp.	32723	7062	7213	467 +888 Mcrft				Niagaran	Acreeage E
Kalkaska	20-28N-5W	Blue Lake	Anoco Production Co.	32117	6956	7207	364 +275 Mcrft				Niagaran	Seis. E
Kalkaska	8-28N-5W	Boonman	Shell Oil Co.	32303*	6710	6842				3 Cond./Day +1232 Mcrft +37 BWD	Niagaran	Seis. E
Kalkaska	36-28N-6W	Cold Springs	Anoco Production Co.	32193	6988	7425				148 Cond./Day +3300 Mcrft	Niagaran	Seis. E
Kalkaska	11-27N-7W	Kalkaska	Shell Oil Co.	32488	6876	6950	300 +451 Mcrft				Niagaran	Seis. E
Kalkaska	24-27N-7W	Kalkaska	Shell Oil Co.	31949*	7101	7242				133 Cond./Day +5566 Mcrft +42 BWD	Niagaran	Seis. E
Livingson	11-1N-6E	Green Oak	Aeruck Corp.	31993	3612	3998				3.1 Mcrft	Niagaran	Seis. E
Manistee	17-24N-13W	Cleon	Reef Petroleum Corp.	32055*	5408	5823				24 Cond./Day +588 Mcrft +50 BWD	Niagaran	Seis. E
Manistee	29-24N-13W	Cleon	Traverse Corporation	31958	5664	5770				85 Cond./Day +933 Mcrft +45 BWD	Niagaran	Seis. E
Manistee	32-24N-13W	Cleon	Shell Oil Co.	32068	5363	5773	298 +478 Mcrft				Niagaran	Seis. E
Manistee	2-22N-16W	Manistee	Kirby Exploration Co.	32103	4162	4480	213 +270 Mcrft +138WD				Niagaran	Seis. E
Manistee	31-22N-16W	Manistee	Shell Oil Co.	31819	4021	4330				3111 Mcrft	Niagaran	Seis. E
1978 DISCOVERY WELLS CONTINUED												
Manistee	24-22N-17W	Manistee	Energy Acquisition Corp.	32354*	3862	3993	20 +2 BWD				Niagaran	Seis. E
Manistee	20-23N-14W	Maple Grove	Wolverine Gas & Oil Co., Inc.	32167	5068	5260	F312 +624 Mcrft				Niagaran	Seis. E
Manistee	20-24N-14W	Springdale	Shell Oil Co.	32045	4764	4915	336 +330 Mcrft				Niagaran	Seis. E
Manistee	35-24N-14W	Springdale	Shell Oil Co.	32105*	5026	5417	253 +1434 Mcrft +3 BW				Niagaran	Seis. E
Missaukee	30-22N-6E	Falmouth-Dundee Pool	Dart Oil & Gas Corp.	32351	3951	5250	45 +126 Mcrft				Dundee	Acreeage E
Montmorency	14-32N-1E	Montmorency	North. Mich. Exp. Co.	32222	4633	4785	276 ^t				Niagaran	Seis. E
Newaygo	23-14N-11W	East Goodwell-Dundee Pool	Hansen Brothers	32446	3294	3314	30 ^t			300 Mcrft	"Berea"	Acreeage E
Oceana	14-13N-17W	Rothbury	Clarence Crawford	31736	1103	1120						Acreeage E
Otsego	35-30N-3W	Bagley	Anoco Production Co.	31806	6270	6435	475 +310 Mcrft				Niagaran	Seis. E
Otsego	5-29N-2W	Chester	Anoco Production Co.	32157	6340	6580	456 +390 Mcrft				Niagaran	Seis. E
Otsego	34-30N-2W	Chester	Anoco Production Co.	32335	6364	6523	387 +360 Mcrft				Niagaran	Seis. E
Otsego	11-29N-3W	Otsego Lake	Shell Oil Co.	31989*	6448	6665	411 +619 Mcrft				Niagaran	Seis. E
Otsego	29-29N-3W	Otsego Lake	Shell Oil Co.	32032*	6412	6778	476 +554 Mcrft				Niagaran	Seis. E
Presque Isle	19-33N-2E	Allis	Shell Oil Co.	31966*	3765	4002	334 +291 Mcrft				Niagaran	Seis. E
Presque Isle	26-34N-4E	Bismarck	Mich. Nat. Res. Co. & Petro., Inc.	32071	3395	3494				S104-Gauge Not Available	Niagaran	Seis. E
Presque Isle	1-33N-3E	Case	Shell Oil Co.	32314	3608	3846				240 Cond./Day +4616 Mcrft	Niagaran	Seis. E
Wexford	1-24N-12W	Wexford	Shell Oil Co.	32348	6167	6612				128 Cond./Day +2707 Mcrft	Niagaran	Seis. E
Wexford	4-24N-12W	Wexford	Shell Oil Co.	32013	6095	6316				64 Cond./Day +3119 Mcrft +52 BWD	Niagaran	Seis. E

Discovery wells credited to 1978 may show a few wells that were reclassified during 1979. Reservoir performance may show that a well previously classified as a development well should actually be considered as 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. Also, 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 later be reclassified as an oil well. Changes in classification may be the result of action by the regulating agency after enough data has been accumulated on the well or wells, or may result from new data presented at public hearings and the decision of the Supervisor of Wells after thorough consideration of the new data.

An analysis of discovery wells according to geologic system and an analysis of drilling objective penetrated at total depth follows.

[Analysis of Discovery Wells by Geologic System]

ANALYSIS OF 1978 DISCOVERY WELLS BY GEOLOGIC SYSTEM

System	Formation or Pay	Number of Discoveries		
		1976	1977	1978
Pennsylvanian		-	-	-
Mississippian	"Michigan Stray Ss."	1	-	1
	"Berea Sandstone"	-	-	1
Devonian	Antrim Shale	-	3	-
	"Traverse Lime"	2	1	1
	Dundee	1	-	2
	"Reed City"	-	-	-
	Detroit River	-	-	-
	"Sour Zone"	-	-	-
	Richfield	-	1	-
Silurian	Salina E Zone	-	-	-
	Salina A-1 or A-2	-	1	2
	Niagaran reef*	62	65	47
Ordovician	Trenton-Black River	-	-	-
	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		
		1976	1977	1978
Pennsylvanian		-	-	-
Mississippian	"Michigan Stray Ss."	4.1	7.7	8.9
	"Berea Sandstone"	.5	-	.2
Devonian	Antrim Shale	-	.7	-
	"Traverse Lime"	5.2	4.2	2.4
	Dundee	9.2	6.7	5.8
	"Reed City"	.5	.2	.9
	Detroit River	-	-	-
	"Sour Zone" & Richfield	4.0	2.7	7.7
Silurian	Salina-Niagaran	72.5	70.5	69.6
Ordovician	Trenton-Black River	2.9	5.9	3.4
	St. Peter Ss. or	-	-	-
	Prairie du Chien	.9	1.1	1.1
Cambrian or Precambrian	Undifferentiated	.2	.3	-

The wells listed as 1978 Niagaran reef discoveries are subject to reclassification as to product. Future development may also indicate reservoir connection with a nearby reef reservoir previously classified as a discovery and thus reclassified to development well status.

Note: t = (T)IP refers to initial production after acid sandfracture, or a combination of well stimulation methods.
n = (N)IP refers to natural initial potential or production.
Cond. = barrels condensate

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

Total State revenue credited to 1978 and derived from royalty, rental, bonus from lease sales, and application-assignment fees amounted to \$19,392,210.27 This figure is derived from these components.

Hydrocarbon royalties	
Oil & Condensate	\$11,555,561.70
Gas, Casinghead gas, LPG and Shut-in royalty	6,689,194.32
Subtotal	\$18,244,756.02
Rentals	\$ 1,131,238.25
Bonus	14,483.00
Application-Assignment fees	1,733.00
Subtotal	\$ 1,147,454.25
Total Revenue	\$19,392,210.27

Oil and gas revenue figures according to year and source are found in Part 3.

***** WELL RECORDS AND OIL AND GAS MAPS *****

OIL AND GAS WELL RECORDS. Descriptive geological logs and driller's logs are available for over 32,000 tests, including exploratory, development, facility and other types of wells. Individual well records may be purchased at a nominal 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 oil and gas field maps are available for every county in the Southern Peninsula. The maps show locations of oil and gas test 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 or tracings 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 Division upon request.

[Permits, Well Completion, Drilled Footage, Table 1]

TABLE 1 DRILLING PERMITS, WELL COMPLETIONS, DRILLED FOOTAGE BY COUNTY, 1978
Classification of New Hole Completions
Does not include reworked wells or old wells drilled deeper

COUNTY	OIL/GAS PERMITS ISSUED	OIL AND GAS TESTS			RESULTS			SERVICE WELLS			TOTAL WELLS DRILLED	TOTAL DRILLED FOOTAGE			Average Well Depth
		Explor.	Completed	Devel.	Oil Wells	Gas Wells	Dry Holes	Completed	B.D.W.	Explor.		Devel.	Fac.		
Alcona	1	1	0	0	0	1	0	0	1	2,030	0	0	0	2030	
Allan	4	2	4	3	0	3	0	0	6	6,454	11,721**	0	0	3029	
Antrim	1	1	0	0	0	1	0	0	1	2,364	0	0	0	2364	
Arenac	2	2	0	0	0	2	0	0	2	6,103	0	0	0	6103	
Bay	2	0	0	0	0	0	0	0	0	0	0	0	0	0	
Calhoun	20	13	16	5	10	14	0	0	29	41,483	60,882	0	0	3530	
Cass	5	3	6	5	0	4	0	0	9	2,536	5,390	0	0	881	
Cheboygan	24	11	3	3	0	11	0	0	14	44,993	8,700	0	0	3835	
Clare	21	1	11	10	0	2	0	0	12	5,315	56,798	359*	0	8203	
Crawford	10	1	11	7	3	2	0	0	12	7,168	61,371	0	0	5712	
Eaton	13	6	4	2	0	8	0	0	10	22,368	16,166	0	0	3853	
Genesee	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Gladwin	3	0	2	2	0	0	0	0	2	0	9,003**	142*	0	4373	
Grand Traverse	81	38	44	14	15	53	0	0	82	231,908	242,766	0	0	5789	
Gratiot	3	0	0	0	0	0	3	0	3	0	0	0	0	3,270	
Hillsdale	7	3	12	7	0	8	0	0	15	12,401	44,852**	0	0	3817	
Ingham	6	7	5	4	1	7	0	3 ⁽¹⁾	15	27,466	19,686	11,415	0	3904	
Isabella	6	5	3	0	2	6	0	0	8	17,172	6,764	0	0	2992	
Jackson	2	1	0	0	0	1	0	0	1	5,686	0	0	0	5686	
Kalamazoo	2	1	0	0	0	1	0	0	1	3,000	0	0	0	3000	
Kalkaska	60	31	21	12	8	32	0	0	52	209,233	124,190	0	0	6412	
Kent	3	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lake	2	0	0	0	0	0	2	0	2	0	0	0	7,898	3949	
Lapeer	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lenawee	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Livingston	5	5	0	0	1	4	0	0	5	18,059	0	0	0	3612	
Macomb	10	3	6	0	0	9	0	0	9	10,213	20,867	0	0	3453	
Manistee	87	30	50	24	9	47	0	1	81	127,993	224,448	2,294	0	4441	
Mason	7	2	2	0	1	3	0	0	4	12,000	6,963	0	0	4741	
Mecosta	8	1	0	0	0	1	7	0	8	3,916	0	9,895*	0	1726	
Midland	4	2	2	1	0	3	0	0	4	7,727	6,946	0	0	3668	
Missaukee	29	1	16	14	0	3	0	1	18	5,250	82,677	4,155	0	5116	
Montcalm	14	1	0	0	0	1	13	0	14	3,136	0	16,896	0	1431	
Montmorency	12	7	0	1	0	6	0	0	7	33,194	0	0	0	4742	
Newaygo	6	1	1	1	0	1	3	0	5	3,314	1,131	3,673*	0	1624	
Oakland	16	5	5	0	1	9	0	0	10	21,568	17,900	0	0	3947	
Oceana	5	4	0	0	1	3	0	0	4	15,933	0	0	0	3983	
Ogemaw	14	0	9	9	0	0	0	5 ⁽¹⁾	14	0	24,828	13,904	0	2767	
Oscoda	4	0	0	0	0	0	4	0	4	0	0	12,150*	0	3038	
Otsego	44	25	9	11	0	23	0	3 ⁽¹⁾	37	134,712	42,744	16,055	0	5230	
Ottawa	4	0	0	0	0	0	0	0	0	0	0	0	0	243*	
Presque Isle	51	31	1	1	2	29	0	0	32	99,366	3,383	0	0	3211	
Roscommon	5	0	2	2	0	0	0	1 ⁽¹⁾	3	0	9,585	4,375	0	4653	
Saginaw	3	1	0	0	0	1	0	0	1	2,952	0	0	0	2952	
Sanilac	2	1	0	0	0	1	0	0	1	2,356	0	0	0	2356	
St. Clair	49	7	2	0	0	9	28	0	37	19,760	7,107	122,044	0	4025	
St. Joseph	2	2	0	0	0	2	0	0	2	2,233	0	0	0	1122	
Tuscola	8	1	6	5	0	2	0	0	7	3,880	21,284	0	0	3595	
Van Buren	7	3	1	1	0	3	0	0	4	5,560	1,123	0	0	1671	
Washtenaw	5	5	0	0	0	5	0	0	5	16,918	0	0	0	3384	
Wexford	8	3	6	2	3	4	0	0	9	19,168	36,503	0	0	6186	
TOTAL	690	268	260	146	57	325	60	14	602	1,216,888	1,180,738	228,768	0		

- *Includes some facility footage credited to old wells drilled deeper.
- **Includes some development footage credited to old wells drilled deeper.
- ***Includes some exploratory footage credited to old wells drilled deeper.
- (1) Water injection wells involved in secondary recovery operations.

PART 2

EXPLANATION

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

TABLES 2, 3 and 4 list Michigan's oil and gas fields and gas storage reservoirs. 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. Except as provided by

special orders covering drilling units, rules promulgated under Act No. 61, P.A. of 1939, as amended, call for a minimum 40-acre unit consisting of a governmental quarter-quarter section of land. Special Order No. 1-73 calls for basic 80-acre drilling units for Salina-Niagaran or deeper tests in specified areas of the state. These 80-acre units are formed by two governmental quarter-quarter sections of land having a common boundary of approximately 1320 feet. In past years drilling units have been 10, 20 or 40 acres for oil wells. A field may have had 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. 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, or a unit size based on seismic and reservoir data. Reef reservoirs, especially in the northern reef trend, have been assigned 80, 160, 640, or a unit based on seismic data. Changes in drilling units, off-pattern wells, etc., complicate the maintenance of accurate figures during the lifetime of a given field or pool.

Recovery Per Acre Drilled figures for oil pools are derived by dividing the cumulative production figure by the drilled acres figure.

Gas Fields, Gas-Condensate Fields. Some fields are listed as "shut-in" and show no production figures. In the case of Niagaran reef fields classified as gas-condensate reservoirs, virtually all those listed as shut-in at the end of the year were waiting pipeline construction or gas-handling facilities. Others, mainly small dry-gas reservoirs in shallower formations, are listed as shut-in because of slow field development, small reserves or lack of marketing facilities. 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. 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 gas storage operations. Further, the listed sections do not necessarily relate to potential or future gas storage area or boundary. The table listing undeveloped gas storage reservoirs has been discontinued.

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 Division, Michigan Department of Natural Resources, Lansing. Samples are contained in glass vials arranged in open trays. In addition, several thousand shallow geological test samples are also available for inspection. The Division does not maintain a core collection. Other sample and core repositories, not connected with the Division, 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 productions 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.

ABBREVIATIONS

A.A.P.G.	American Assoc. Petrol. Geol.	NFW	New Field Wildcat
A.P.I.	American Petroleum Institute	(N) I.P.	(Natural) Initial Production or Potential
(A) I.P.	(Acid) Initial Production or Potential	Niag.	Niagaran
A-1 Carb.	A-1 Carbonate	Nt.	Nontechnical
A-2 Carb.	A-2 Carbonate	OBS	Observation Well
Bbls.	Barrels	OP	Out Post Well
B.B.	Bois Blanc formation	Ord.	Ordovician
B.D.	Brine Disposal	OWDD	Old Well Drilled Deeper
BDW	Brine Disposal Well	P.D.C.	Prairie du Chien formation
BOPD	Barrels Oil Per Day	Penn.	Pennsylvanian
B.R.	Black River	Pilot Wtr.	Pilot Water
Camb.	Cambrian	P.M.	Pressure Maintenance
"Camb."	Unidentified Cambrian	Prod. Form.	Producing Formation
Cat.	Cataract formation	R.C.	Reed City formation
c.f.p.b.	Cubic feet per barrel	RW	Reworked Well
C.H.	Cabot Head formation	Rich.	Richfield formation
Cinn.	Cincinnatian	Sag.	Saginaw formation
Cl.	Clinton formation	Sal.-Niag.	Salina-Niagaran
Cold.	Coldwater formation	SD	Shut Down
Compl.	Completion	Seis.	Seismograph
Coop.	Cooperative	SO & G	Show Oil and Gas
D & A	Dry and Abandoned	S.P.	St. Peter formation
Dev.	Devonian	Stray	Michigan Stray formation
D.R.	Detroit River formation	Sub.	Subsurface geology
D.R. SZ	Detroit River Sour Zone	SW	Service Well
Dres.	Dresbach formation	SWD	Salt Water Disposal
Dd., DD	Dundee	Sylv.	Sylvania formation
Dd.-R.C.	Dundee-Reed City	SZ	Sour Zone (in Detroit River)
DPT	Deeper Pool Test	Thick.	Thickness
E.C.	Eau Claire formation	(T) I.P.	(Treatment) Initial Production or Potential
Explor.	Exploratory	Trav.	Traverse
Fran.	Franconia formation	Tremp.	Trempealeau formation
Geo. Test	Geological Test	Trenton-Blk. River	Trenton-Black River
G.O.R.	Gas-Oil Ratio	Unit.	Unitized
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.		

STRATIGRAPHIC SUCCESSION IN MICHIGAN

PALEOZOIC THROUGH RECENT

MICHIGAN
DEPARTMENT OF NATURAL RESOURCES
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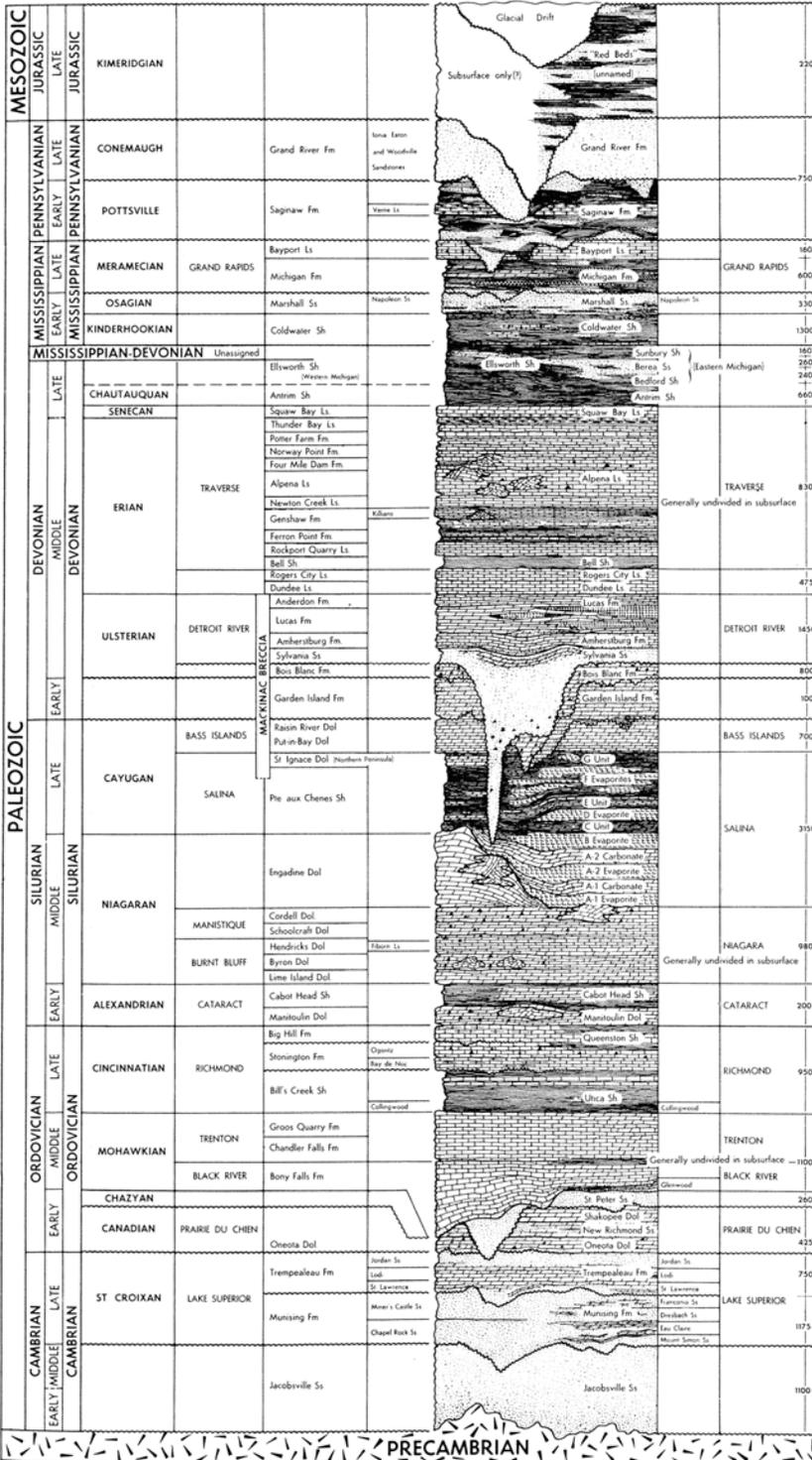
Geological Survey Division
Arthur E. Slaughter, State Geologist

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PLEISTOCENE NOMENCLATURE			
ERA	SYSTEM	SERIES	
		RECENT	PLEISTOCENE
CENOZOIC	QUATERNARY	Wisconsin Glaciation	Valders Stage
			Two Creeks Interstade
			Markate Stage (H. Huron?)
			Cary Stage
			Tazewell Stage
		Sangamon Interglaciation	
		Illinoian Glaciation	

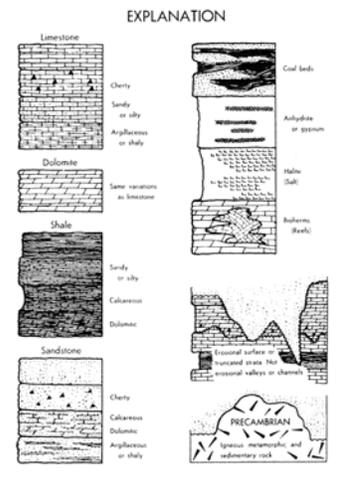
OUTCROP NOMENCLATURE						
ERA	PERIOD	EPOCH	SYSTEM	ROCK STRATIGRAPHIC		
				SERIES	GROUP	FORMATION
						MEMBER

SUBSURFACE NOMENCLATURE		
ROCK STRATIGRAPHIC		
FORMATION	MEMBER	GROUP
Approximate maximum thickness, in feet, of rock units in the subsurface		
NO SCALE		



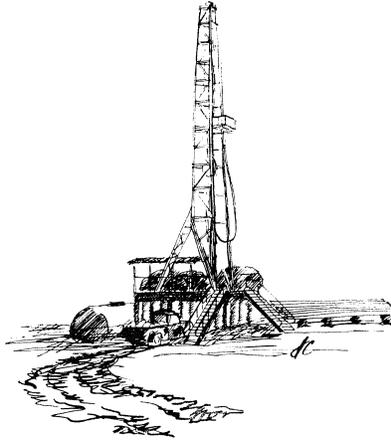
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Harry J. Hardenberg, I. David Johnson, Henry O. Sorenson

INFORMAL TERMS		
Principal oil and gas plays and informal terms used in petroleum exploration and applied to parts of formations or groups in the subsurface	STRATIGRAPHIC POSITION	INFORMAL TERMS
	Basal sandstones of Saginaw Fm	Permian sandstone
	In lower part of Michigan	triple apt. zone unconformity or tray del. trap or
	Marshall Ss	Gas & Oil
	Coldwater Sh	Gas & Oil
	In upper part of Ellsworth Sh	Collapsive zone
	Berea Ss	Wet sand
	Squire Bay Ls	Coldwater red rock
	Upper part of Traverse Group in Western Michigan	Gas & Oil
	Rogers City Ls	Traverse formation
	Dundee Ls	Traverse line
	Dundee Ls (?), Upper part of Lucas Fm (?)	Traverse line zone Stoney Lake zone
	In Lucas Fm	Oil & Gas
	Ambersburg Fm	massive salt big salt
	Part of Salina Group E Unit	massive anhydrite big anhydrite Ritchfield zone
	Divisions of A-2 Carbonate in Western Michigan	black lime
	A-1 Carbonate	l. zone (or Knapp zone)
	Upper part of Niagara Series	l. zone
	Part of Niagara Series	black shale Benton (Michigan)
	Trenton Group	Black River formation Black River shale Van Wert zone
	Onondaga Dol	Oil & Gas



GEOLOGIC NAMES COMPILED BY: Harry O. Sorenson, Cambrian and Ordovician; Robert W. Kelley, Early and Middle Silurian; Gerard D. Ell, Late Silurian through Devon River Group of Devonian age; Harry J. Hardenberg, Dundee Limestone through Traverse Group of Devonian age; I. David Johnson, Antrim Shale through the Pennsylvanian System; F. Wells Tazewell, general geology of the Cenozoic.

CHART 1
1964



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