

# MICHIGAN'S OIL AND GAS FIELDS, 1971

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## PREFACE

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

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

Each year since 1925, new oil and gas pools have been found at various places in the Southern Peninsula. A new cycle of exploration for Silurian reefs is currently underway in several parts of the basin but especially in the sparsely tested Northern District. Exploratory drilling in this region and elsewhere during 1971 resulted in 41 new fields or pools, the highest number since 1946 when 29 were found. General data on the new fields are included in this issue.

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

Some of the statistical data and other types of information maintained for incorporation into the summaries is also provided to such groups as the American Association of Petroleum Geologists, American Petroleum Institute, U. S. Bureau of Mines, Independent Petroleum Association of America, Interstate Oil Compact Commission and others for incorporation into their respective publications. Data is also frequently furnished to companies and individuals during the year.

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

## ACKNOWLEDGEMENTS

The several Sections of the Oil and Gas Conservation Group, Geological Survey, are responsible for the collection and maintenance of certain kinds of oil and gas field data. The compilation and assembly of the various data into a yearly report is done by the Petroleum Geology Section. Personnel who, under the general supervision of R. M. Acker, Assistant State Geologist, Oil and Gas Conservation Group, directed staff members in the gathering and maintenance of basic records and who contributed specific data are:

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

W. G. Smiley, Supervisor, and J. L. Lorenz, Production and Proration Section. Contribution: All

oil and gas production data, oil import figures, monetary valuations, refinery and LPG storage data, secondary recovery data, and oil recovery per acre drilled (Table 2).

G. D. Eells, Supervisor, and B. L. Champion, Petroleum Geology Section. Contribution: 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 those mentioned above.

Inquiries concerning information contained in this summary should be directed to the appropriate personnel as noted above.

Oil and gas production figures cited herein are compiled by the Production and Proration Section from records obtained from the Michigan Department of Revenue. Gas import figures are obtained from the Public Service Commission, Gas Section, compilations. All hydrocarbon production figures are preliminary and subject to correction as warranted.

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Lansing, Michigan  
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## INTRODUCTION

Oil and gas are but one of Michigan's important natural resources. The value of these raw products, nearly all of which were refined and used in Michigan, amounted to about \$49,293,264 in 1971. In addition, monies spent in leasing, exploration and development and other auxiliary activities contribute substantially to the State's economy each year. Statistical and other data, useful to further development of hydrocarbon resources, have been maintained for many years.

This issue of the oil and gas field statistical summary brings together data on various facets of the State's oil and gas industry during 1971. 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. The summary also contains abundant information of an historical nature, useful in oil and gas field evaluation. Furthermore, the gathering, maintenance and compilation of the many data reflects, in part, the varied functions of the Oil and Gas Section of the Geological Survey.

Certain figures for 1971, such as the number of exploratory, development and service wells drilled, and the number of new field and pool discoveries, may differ

from figures reported for the same year by regional or national trade journals, or by industry reporting services. The differences are generally minor and due to methods of gathering and reporting well drilling data, and determining a cut-off date for reporting statistics on a yearly basis.

The kinds of data listed herein are mainly derived from records received and maintained by the Oil and Gas Section, Geological Survey Division. The data contained in this and previous oil and gas summaries have been treated uniformly from year to year and reflect as near as possible the actual figures and other information that should be credited to the year in review.

Part I of this publication summarizes significant statistics on oil and gas field activities during 1971 and related records of the Oil and Gas Section during the year. Part 2 contains specific information on the States oil and gas fields, gas storage fields and other related subjects. Part 3 contains cumulative records of importance to the petroleum industry. Data for 1971 has been included in cumulative records.

## 1971 STATISTICAL DATA

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

Regular oil and gas permits issued during 1971 began with number 28322 and ended with number 28746. A total of 425 were issued to drill wells classified as follows:

Exploratory wells . . . .	173
Development wells . . . .	179
Gas storage facility wells . . . .	60
LPG storage operations . . . .	13

Included in the total were 5 permits issued to reopen and test previously drilled and abandoned dry holes. Also, 6 permits issued in 1971 and included in the yearly total were terminated in 1971 after permittees failed to commence drilling within 6 months after issuance of the permit. In addition to regular permits, 16 deepening permits and 3 BDW permits were issued. No geological test permits were issued during the year.



The distribution of permits by oil and gas districts through a five-year period including 1971 is as follows:

DISTRICTS	DRILLING PERMITS BY DISTRICT				
	Permits Issued				
	1967	1968	1969	1970	1971
Basin	91	88	113	169	138
Northern	11	17	32	52	81
Southeastern	178	143	126	121	130
Southwestern	72	61	41	33	30
Western	53	69	67	50	46
Totals	405	378	379	425*	425**

\*The following permits issued in 1970 were terminated in 1971 before drilling commenced:

27913	28140	28221	28228	28248	28282
28120	28181	28226	28234	28270	28313
28125	28218	28227	28239	28273	28314

\*\*The following permits issued in 1971 were also terminated in 1971:

28322	28366	28386	28466
28352	28385	28393	28476

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

TYPE OF SERVICE WELL	1967	1968	1969	1970	1971
Gas storage	24	27	48	115	60
LPG, Wtr. Inj., Brine Disposal, etc.	2	9	10	1	16
Totals	26	36	58	116	76

The distribution of 1971 oil and gas permits by county is shown on Table 1, page 5. In addition to issuance of permits for various types of wells, 120 applications were approved for rework operations on existing wells. Applications for transfer of ownership were received and processed for 870 wells during 1971.

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

There were 300 new-hole exploratory and development wells which reached total depth and were completed as producers or dry holes during 1971. The figure does not include service wells, old wells drilled to deeper objectives or reworks. The number of new-hole service well completions, mainly facility wells in gas storage reservoirs, amounted to 96 in 1971. The figure does not include reworks or old wells converted to service wells of various types. Well completion figures by county are shown on Table 1, page 5. Fluctuations in the number of new-hole completions and the resulting number of oil, gas or dry holes over a five year period are as follows:

Year	EXPLORATORY WELLS			DEVELOPMENT WELLS			Totals
	Oil	Gas	Dry	Oil	Gas	Dry	
1967	7	2	171	69	38	106	393
1968	9	4	151	61	8	100	333
1969	7	3	148	66	6	91	321
1970	8	6	139	43	9	72	277
1971	28	11	122	55	20	64	300

Year	SERVICE WELL COMPLETIONS				Totals
	GS	INJ	LPG	SWD	
1967	24	0	0	0	24
1968	27	2	6	0	35
1969	20	5	0	1	26
1970	110	0	3	0	113
1971	81	0	13	2	96

Certain completion data for exploratory, development and other types of wells are provided during the year for the American Petroleum Institute and the American Association of Petroleum Geologists. Statistical data published for Michigan by these agencies are correct but sometimes differ slightly from Geological Survey figures. The differences are primarily due to method of determining a cut-off date for handling statistics on a yearly basis and to internal decisions relating to year-end status of a completed well as determined by the Survey. The following exploratory and develop-well statistics have been extracted from the Quarterly Review of Drilling Statistics for the United States, American Petroleum Institute, Vol. V, No. 4, February, 1972, Table II and III, pages 16-17:

Year	API EXPLORATORY AND DEVELOPMENT WELL COMPLETIONS			Development Wells			Totals
	Exploratory Oil	Exploratory Gas	Exploratory Dry	Development Oil	Development Gas	Development Dry	
1971	26	13	122	55	20	66	302

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

The following figures from Survey records show the total drilled footage for 1971 and the 3 prior years:

Well Class	1968	1969	1970	1971
Exploratory	522,384	544,160	615,952	704,192
Development	564,827	559,936	454,016	554,968
Service Well (All types)	76,026	69,126	162,344	180,418
<b>Totals:</b>	<b>1,163,237</b>	<b>1,173,222</b>	<b>1,232,312</b>	<b>1,439,578</b>

Drilled footage figures extracted from the aforementioned API publication are as follows:

API DRILLED FOOTAGE FIGURES					
Exploratory Wells			Development Wells		
Oil	Gas	Dry	Oil	Gas	Dry
135,490	65,486	502,105	227,190	65,428	258,398

The average depth, statewide, of exploratory wells drilled in 1971 was 4,374 feet as compared with 4,025 feet the prior year. Development well depths averaged about 3,993 as compared with 3,661 the prior year. Service well depths averaged about 1,879. Most were completed in shallow Mississippian Stray Sandstone gas storage reservoirs. Drilled footage figures and average well depths for specific counties are shown on Table 1, page 5.

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

Oil production amounted to 11,893,411 barrels as compared with 11,693,488 barrels produced in 1970. The small increase reflects production from new fields in the northern District. Gas production decreased from 39,252,013 Mcf in 1970 to 25,930,622 Mcf in 1971. As new 1971 gas fields are brought into production, gas figures should increase in 1972. The Albion-Scipio

Trend pools again produced about 40% of the states oil and about 43% of the gas in 1971.

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

Oil and gas production for specific counties during 1971 is shown on Table 1, page 5. Production by month and oil and gas districts during 1971 is as follows:

OIL AND GAS PRODUCTION BY MONTH		
	Barrels Oil	MCF Gas
January	937,283	2,584,155
February	880,585	1,863,181
March	994,696	2,505,728
April	976,183	2,465,831
May	1,033,095	2,261,334
June	986,566	1,985,579
July	984,192	1,876,683
August	996,524	1,841,740
September	1,009,191	2,116,651
October	1,013,556	2,093,912
November	1,019,298	2,039,459
December	1,062,242	2,296,369
<b>Totals</b>	<b>11,893,411</b>	<b>25,930,622</b>

OIL AND GAS PRODUCTION BY DISTRICT		
District	Barrels Oil	MCF Gas
Basin	3,965,826	1,435,055
Northern	1,647,083	3,286,879
Southeastern	4,175,631	16,945,842
Southwestern	1,779,654	4,262,444
Western	325,217	402
<b>Totals</b>	<b>11,893,411</b>	<b>25,930,622</b>

## [Permits, Well Completions, Drilled Footage, Table 1]

TABLE 1. DRILLING PERMITS, WELL COMPLETIONS, DRILLED FOOTAGE BY COUNTY, 1971  
Classification of New Hole Completions

Does not include reworked wells or old wells drilled deeper

COUNTY	OIL AND GAS TESTS		RESULTS				SERVICE WELLS		TOTAL WELLS DRILLED	TOTAL DRILLED FOOTAGE			Average Well Depth	
	Permits Issued	Completed	Oil Wells	Gas Wells	Dry	Co. S.	L. P. G.	Explor.		Devel.	Fac.			
Allegan	4	3	0	0	2	0	0	3	2,545	0	0	2,545	0	
Alpena	1	1	0	0	0	0	0	1	5,260	0	0	5,260	0	
Antrim	1	1	0	0	0	1	0	0	6,578	0	0	6,578	0	
Arenac	4	2	1	0	0	3	0	3	6,247	3,220	0	3156	0	
Berry	4	3	0	0	0	3	0	3	14,057	0	0	4686	0	
Bay	3	2	1	0	0	3	0	0	6,460	3,245	0	3235	0	
Benzie	2	1	0	0	1	0	0	1	5,445	0	0	5445	0	
Berrien	1	0	0	0	0	0	0	0	0	0	0	0	0	
Branch	1	1	0	0	0	1	0	0	3,515	0	0	3515	0	
Calhoun	16	6	7	0	2	11	1	0	22,669	30,155	3,301	4009	0	
Charlevoix	2	2	0	0	0	2	0	2	8,954	0	0	4477	0	
Clare	20	0	1	1	0	0	18	0	19	0	4,020	26,991	1532	0
Clinton	1	1	0	0	0	1	0	0	1	2,647	0	2647	0	
Crawford	1	1	0	1	0	0	0	0	1	7,300	0	7300	0	
Eaton	6	4	3	1	0	6	0	0	7	15,408	14,864	0	4325	
Genesee	10	1	8	6	1	2	0	0	9	3,228	20,273	0	2611	
Gladwin	13	3	3	2	0	4	0	0	6	11,853	11,738	0	3932	
Grand Traverse	8	3	1	1	1	2	0	0	4	18,077	6,486	0	6341	
Groton	2	2	0	0	0	2	0	0	2	6,315	0	0	3158	
Hillsdale	30	6	16	6	0	16	0	0	22	24,539	63,514	0	4002	
Ingham	40	11	24	21	1	11	14	0	35	52,789	95,920	0	4249	
Ionia	1	0	0	0	0	0	0	0	0	0	0	0	0	
Isabella	4	2	1	0	0	3	11	0	14	7,479	4,100	15,554	1938	
Jackson	12	8	2	0	0	10	0	0	10	37,385	9,365	0	4675	
Kalamazoo	31	17	12	6	14	5	3	0	23	119,499	40,355	0	6950	
Lake	3	1	1	1	0	1	0	0	2	3,352	3,550	0	3456	
Lapeer	8	0	6	5	1	0	0	0	6	0	17,018	0	2836	
Leanswee	4	4	1	0	0	5	0	0	5	14,002	1,968	0	3194	
Livingston	9	2	9	0	8	3	0	0	11	7,057	36,499	0	3960	
Macomb	1	2	0	0	0	2	0	0	2	6,661	0	0	3331	
Manistee	3	2	0	0	0	2	0	0	2	9,201	0	0	4951	
Mason	1	1	0	0	0	1	0	0	1	5,960	0	0	(3)	
Mecosta	7	4	0	0	0	4	0	0	4	10,580	1,250	0	2958	
Midland	0	1	0	0	0	1	0	0	1	3,518	0	0	3518	
Missaukee	2	0	0	0	0	0	0	0	0	0	0	0	0	
Monroe	1	1	0	0	0	0	0	0	1	2,575	0	0	2575	
Montcalm	11	2	0	2	0	8	10	0	20	6,157	27,962	11,276	2300	
Montmorency	1	1	0	0	0	1	0	0	1	4,833	0	0	4833	
Muskegon	0	0	0	0	0	0	0	0	0	0	0	0	0	
Newaygo	26	3	0	0	0	3	14	0	17	6,451	0	13,278	1161	
Oakland	1	0	6	0	4	2	0	0	6	0	26,036	0	4339	
Oceana	11	8	3	4	1	6	0	0	11	15,405	8,720	0	2193	
Ogemaw	2	1	1	0	0	0	0	0	2	10,195	3,728	0	6462	
Osceola	8	2	3	1	3	1	9	0	14	5,440	8,960	19,883	2449	
Oscoda	1	2	0	0	0	2	0	0	2	16,427	0	0	8214	
Otsego	32	13	11	11	0	13	0	0	24	80,107	70,216	0	6288	
Ottawa	2	2	0	0	0	2	0	0	2	4,373	0	0	2187	
Presque Isle	1	1	0	0	0	1	0	0	1	3,153	0	0	3153	
St. Clair	55	19	16	4	4	27	18	14	67	60,085	42,796	88,986	2864	
Tuscola	4	3	0	0	0	3	0	0	3	10,104	0	0	3368	
Van Buren	2	2	0	0	0	2	0	0	2	4,599	0	0	2300	
Washtenaw	8	2	0	0	0	2	0	0	2	9,702	0	0	4851	
Wayne	1	0	0	0	0	0	1	1	1	0	0	1,149	1149	
Westford	2	0	0	0	0	0	0	0	1	9,306	0	0	8306	
<b>Totals</b>	<b>425</b>	<b>161</b>	<b>139</b>	<b>83</b>	<b>31</b>	<b>186</b>	<b>81</b>	<b>15</b>	<b>396</b>	<b>704,192</b>	<b>554,968</b>	<b>180,418</b>		

Includes permits which were issued and terminated in 1971. Includes 2 BW connected with LPG operations. For statistical purposes, a well is considered to be completed if it was drilled to total depth, casing and tubing run, perforated or treated, and was designated as a producer, dry hole, or service well during or at the end of the calendar year.

(1) One well dual discovery Traverse Oil and Niagara gas.  
(2) Includes 1 test hole which was re-drilled from surface.  
(3) Drilled footage includes two old wells drilled deeper.

## [Oil and Gas Production by County]

OIL AND GAS PRODUCTION BY COUNTY IN 1971		
County	Barrels Oil	MCF Gas
Allegan	121,900	259,667
Arenac	230,749	---
Barry	11,524	---
Bay	233,977	---
Calhoun	1,532,604	3,794,507
Clare	393,954	188,023
Crawford	524,318	495,120
Genesee	68,242	---
Gladwin	278,597	---
Grand Traverse	3,483	---
Gratiot	6,931	3,240
Hillsdale	2,355,817	5,170,583
Huron	440	---
Ingham	347,580	---
Isabella	186,813	2,338
Jackson	848,546	2,365,958
Kalkaska	302,369	368,836
Kent	58,185	10,596
Lake	185,626	---
Lapeer	81,325	52,300
Lenawee	205	3,025
Livingston	---	---
Macomb	4,006	1,323,422
Mason	29,377	---
Mecosta	101,325	80,825
Midland	184,702	---
Missaukee	545,279	561,941
Monroe	2,162	---
Montcalm	122,600	---
Muskegon	19,979	---
Newaygo	16,185	402
Oakland	697	---
Oceana	74,049	---
Ogemaw	345,927	336,744
Osceola	621,562	11,096
Oscoda	1,902	---
Otsego	814,760	2,422,923
Ottawa	50,557	197,675
Presque Isle	251	---
Roscommon	208,597	250,847
Saginaw	21,431	---
Shiawassee	7,356	---
St. Clair	873,238	8,030,554
Tuscola	60,205	---
Van Buren	4,884	---
Washtenaw	4,933	---
Wayne	4,262	---
<b>Totals</b>	<b>11,893,411</b>	<b>25,930,622</b>



## \*\*\* LPG PRODUCTION \*\*\*

Total LPG production in 1971 amounted to about 1,451,956 barrels as compared with 1,777,684 barrels produced in 1970. LPG's are stripped from Michigan produced gas and gas imported via pipeline from western sources. Additional details on LPG production and gas plant operations are found in Part 2, page 34.

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

The average price paid at the wellhead for Michigan crude, including condensate, was \$3.27 per barrel. The value of this mineral resource amounted to as compared with \$36,246,376 in 1970.

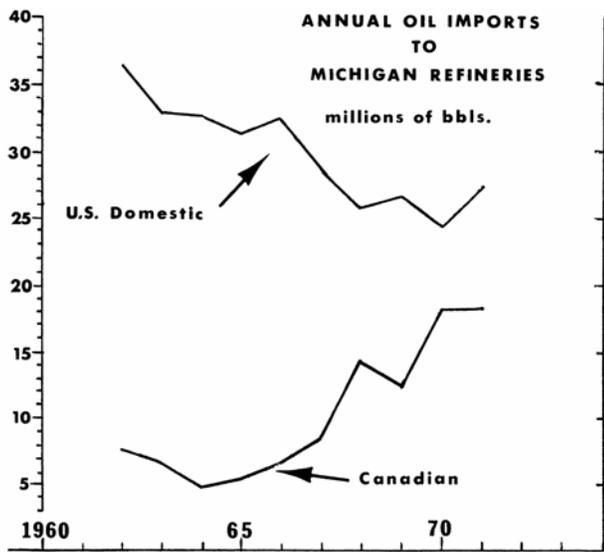
The average price of Michigan produced gas sold at the wellhead was about \$.26 per Mcf. The value of this product amounted to about \$6,775,629 as compared with \$10,476,482 in 1970.

The estimated value of LPG's produced in 1971 was about \$2.52 per barrel, or about \$.06 per gallon. The value of this product amounted to about \$3,658,929 as compared with \$4,479,764 in 1970.

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

Imports of domestic crude oil via pipeline from western and midwestern states in 1971 amounted to 27,428,311 barrels, an increase over the 24,462,575 barrels imported in 1970. Imports of Canadian crude via pipeline from western Canada oil fields increased from 17,698,262 barrels in 1970 to 17,723,813 barrels in 1971. Total imports to Michigan refineries amounted to 45,152,124 barrels as compared with 42,160,837 barrels in 1970. Imports by month during 1971 and the trend in imports from 1962 through 1971 are shown below.

	1971 CRUDE OIL IMPORTS (Bbls.)		
	Domestic	Canadian	Total
January	2,478,742	1,490,972	3,969,714
February	2,295,910	1,316,513	3,612,423
March	2,427,180	1,380,158	3,807,338
April	2,424,979	1,391,395	3,816,374
May	2,719,775	1,286,123	4,005,898
June	2,666,517	1,101,310	3,767,827
July	2,405,565	1,281,206	3,686,771
August	1,598,394	1,585,651	3,184,045
September	2,160,121	1,748,361	3,908,482
October	2,048,049	1,929,721	3,977,770
November	2,180,290	1,558,911	3,739,201
December	2,022,789	1,653,492	3,676,281
<b>Totals</b>	<b>27,428,311</b>	<b>17,723,813</b>	<b>45,152,124</b>



Exports of Michigan produced crude oil to northern Indiana (Ft. Wayne) and Ohio (Cleveland) refineries or terminals amounted to 1,021,228 barrels, an increase over the 512,335 barrels exported in 1970. Oil exports by month are as follows:

1971 CRUDE OIL EXPORTS (Bbls.)	
January	90,255
February	82,482
March	97,799
April	97,426
May	78,070
June	84,544
July	75,576
August	72,854
September	90,625
October	91,113
November	73,470
December	87,014
<b>Total</b>	<b>1,021,228</b>

Gas imports to Michigan markets and gas storage fields via pipelines, primarily from Texas, Louisiana, Oklahoma and Kansas fields, increased over 49 billion cubic feet in 1971. Compilations by the Gas Section, Michigan Public Service Commission, show gas imports of 909,209,140 Mcf during 1971 as compared with 860,091,576 Mcf in 1970. Monthly imports of gas during 1971 were as follows:

1971 PIPELINE GAS IMPORTS (Mcf)	
January	48,193,404
February	48,747,093
March	59,621,643
April	77,565,343
May	87,577,029
June	95,714,687
July	93,012,738
August	92,886,784
September	93,842,952
October	87,630,623
November	63,802,262
December	60,614,582
<b>Total</b>	<b>909,209,140</b>

### \*\*\* EXPLORATORY WELL DRILLING OBJECTIVES \*\*\*

The following chart shows the approximate percentage of exploratory wells (including 2 Precambrian disposal wells) that tested and reached total depth in various rock units in 1970 and 1971. See Stratigraphic Chart for formation succession.

DRILLING OBJECTIVES			
System	Formation or Pay	Percentage	
		1970	1971
Pennsylvanian	"Michigan Stray Ss."	1.0	1.5
Mississippian	"Berea Ss."		
Devonian	Antrim Shale		
	"Traverse Lime"	10.0	8.0
	Dundee	8.0	9.0
	"Reed City"	8.0	4.0
	Detroit River)		
	"Sour Zone") . . . .	1.0	3.0
	Richfield )		
Silurian	Niagaran	57.0	54.0
Ordovician	Trenton-Black River	3.0	9.0
	St. Peter Ss. or		
	Prairie duChien	11.0	10.0
Cambrian	Undifferentiated)		
Precambrian	Undifferentiated) . . .	1.0	1.5

The sizeable percentage of wells drilled only to Niagaran rocks reflects the high interest in Niagaran reef exploration in the northern part of the state and around the southern edge of the basin.

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

Statewide, the discovery-to-dry hole ratio for all exploratory wells drilled and completed during the year was about 1:3 as compared with 1:10 in 1970. However, nearly 54% of new field discoveries were made in the northern oil and gas district. The discovery ratio in this 15-county area was about 1:3 in 1971, 1:3 in 1970 and about 1:5 in 1969. Nearly all new fields in this district resulted from geophysical surveys, mainly seismic. Reservoir rocks are Niagaran reefs but a few discovery wells were also perforated and completed in the overlying Salina A-1 Carbonate unit as well as the reef. In Ingham County at the southern edge of the basin district, 4 new reef fields were found during the year. Also of significance, a Niagaran reef oil field was found in the northwestern corner of Crawford County, thus opening up another county for Silurian exploration. Elsewhere in the state, new fields and pools were found in well established regions of oil and gas production. The new fields and pools are listed on following pages and included in the comprehensive tables of oil and gas fields, Part 2.

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



EXPLANATION

IMPORTANT DEEP TESTS							
County Location	Permit Number	Operator and Lease	System and Formation	Total Depth	Basis For Loc.	Explo. Class	Remarks
Alpena 32-31N-5E	28583	Union Oil Co., California G. C. Smith #1	Sil., Clinton	5260		NFW	S.G. on D.S.T. in Al Carbonate
Antrim 27-29N-6W	28324	Shell Oil Co. Elkins #1-27	Sil., Niagaran	6578		NFW	
Benzie 28-29N-13W	28341	Amoco Production Co. State-Cofax #1-28	Sil., Niagaran	5445		NFW	
Charlevoix 35-33N-5W	28474	Union Oil Co., California P. F. Jankowski #1	Sil., Clinton	4347		NFW	
Charlevoix 15-32N-6W	28438	Union Oil Co., California A. J. Valler #1	Sil., Clinton	4607		NFW	
Grand Traverse 11-26N-11W	28564	Northern Mich. Explor. Co. Holbrook #1-11	Sil., Niagaran	5744		NFW	
Ingham 10-1N-1W	28654	Don Scott Drig. Co., Inc. Osborn-Deming et al #1	Sil., Niagaran	3910		NFW	
Ingham 25-2N-1W	28607	Mobil Oil Corp. Walter Kranz, Jr. #1	Precambrian	7866		NFW	
Kalkaska 3-20N-5W	28631	Miller Brothers A. E. Atwood #1	Sil., Clinton	7062		NFW	
Kalkaska 8-26N-8W	28679	State-Boardman Unit #2-8	Sil., Clinton	6900		NFW	S. Sour gas on D.S.T. in Niag.
Kalkaska 2-27N-7W	28622	Shell Oil Co. Lagomarcino #1-2	Sil., Clinton	7080		NFW	
Manistee 25-24N-15W	28522	Shell Oil Co. Lagomarcino #1-30	Sil., Clinton	4771		NFW	S.G.
Manistee 30-24N-14W	28513	Lagomarcino #1-25	Sil., Clinton	5125		NFW	Recovered wtr.
Mason 26-17N-17W	28202	R. J. Gorman Helenius #4	Dev., Reed City	2354		DPT	S.S.O.
Mercola 18-16N-10W	28539	D. J. Hall & Century Oil Todd & Fed. Land Bank #1	Dev., Reed City	3635		DPT	
Montmorency 22-32N-2E	28695	McClure Oil Co. State-Montmorency #1-22	Sil., Niagaran	4833		NFW	
Oceana 26-16N-18W	28552	J. R. Barwick State-Pentwater #1	Sil., Niagaran	4078		DPT	
Ogemaw 28-23N-3E	28456	Amoco Production Co. A.B.G. Hunt Club #1	Ord., St. Peter	10,195		NFW	
Oscoda 16-28N-1E	28546	Amoco Production Co. Garland #1	Sil., Clinton	7573		NFW	
Otsego 36-30N-3W	28376	Southern Ill. Oil Prod. State-Bagley #1-36	Sil., Niagaran	6500		NFW	S.G. in A2 Carb.
Otsego 11-30N-1W	28636	Shell Oil Co. Black #1	Sil., Niagaran	6254		NFW	
Otsego 19-31N-1W	28576	Woody's Oil & Gas, Inc. A. Williams #1	Sil., Niagaran	5580		NFW	
Otsego 17-30N-2W	28463	H. H. Gumpel & Assoc. Schmitz & Condelio #1-17	Sil., Niagaran	6325		NFW	
Otsego 29-30N-2W	28343	Southern Ill. Oil Prod. State-Chester #1-29	Sil., Niagaran	6442		NFW	
Otsego 19-32N-1W	28656	North American Drig. Co. Song of Morning Ranch #1-19	Sil., Niagaran	4883		NFW	S.G. in Antrim
Otsego 23-31N-2W	28518	A. G. Hill N. & B. Schrader #1	Sil., Niagaran	5604		NFW	
St. Clair 7-5N-17E	BD #151	Consumers Power Co. C.P.C. #1-7 BOW	Precambrian	4732		Brine Disposal	
St. Clair 7-5N-17E	BD #152	Consumers Power Co. C.P.C. #2-7 BOW	Precambrian	4700		Brine Disposal	
Tuscola 15-10N-9E	28551	Petrotech, Inc. R. Brown et ux #1	Dev., Richfield	3200		DPT	
Van Buren 16-15-14W	28590	Miller Brothers Donald & Sylvia Jolicoeur #1	Ord., St. Peter	3422		DPT	
Washtenaw 6-15-3E	28620	William S. Albers Hannawald #1	Ord., Black River	5008		DPT	V.S.S.O. & G. in Trenton
Wexford 31-24N-9W	28535	Shell Oil Co. Stol1 #1-31	Ord., Cincinnati	8304		NFW	

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.

TABLE 2, 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. 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 District, have been assigned

Designation of a dry-hole exploratory well as an important deep test is most often based on the geologic age of the strata penetrated in reference to the location of the test within the basin, and the relative abundance of similar tests in the area. Actual drilled depth is not the determining factor. For example, most of the 1356 wells drilled to date in St. Clair County have reached total depth in Silurian-Niagaran age rocks. These wells are scattered throughout the county, so it is unlikely that any future test reaching total depth in Silurian rocks would be designated. However, only a few wells in St. Clair County have penetrated Ordovician or older rocks. Any exploratory well drilled to strata older than Silurian would probably qualify as a deep test until Ordovician or deeper tests become fairly common in the county and the distribution of these tests widespread. Deeper pool tests in designated fields may also qualify as deep tests. Table 2, Michigan Oil and Gas Fields, shows the deepest depth and formation or pool penetrated and tested beneath the field area.

40, 80, 160 and 640-acre units. Gas well units, especially for Michigan Stray Sandstone reservoirs, have generally been 160-acre units. Other sizes currently in use for gas wells are 40, 80, 320 and 640-acre units. Changes in drilling units off-pattern wells, etc. complicate the maintenance of accurate acreage figures during the 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 figure 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, 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 Table 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.

**OIL AND GAS WELL RECORDS.** Descriptive geological logs and drillers logs are available for over 28,500 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 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" does 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  
Ralph A. MacMullan, Director  
  
Geological Survey Division  
Arthur E. Slaughter, State Geologist

PLEISTOCENE NOMENCLATURE			
ERA	SYSTEM	SERIES	STAGE
CENOZOIC	QUATERNARY	RECENT	Valderr Stade Two Creeks Interstade Mankato Stade (Huron?) Cary Stade Tazewell Stade
		PLEISTOCENE	Wisconsin Glaciation Sangamon Interglaciation Illinoian Glaciation

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

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

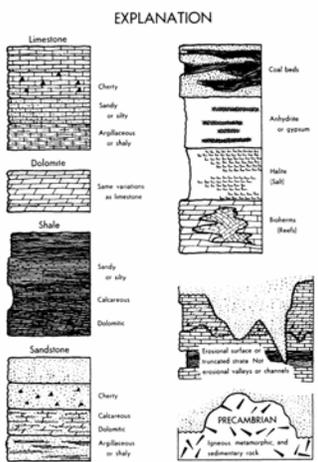
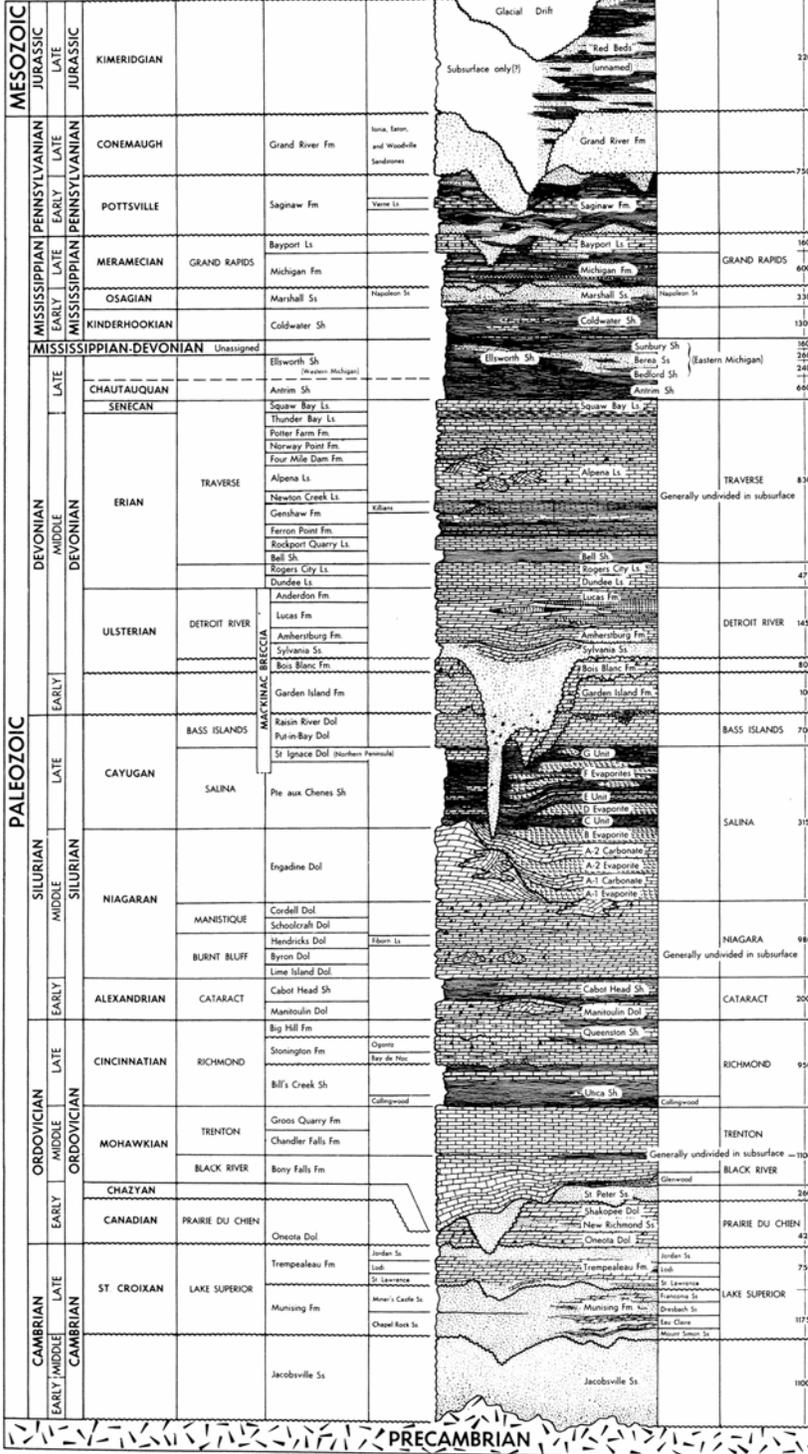
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GEOLOGIC NAMES COMMITTEE  
Garland D. Ells, Chairman; Robert W. Kelley, Secretary;  
Harry J. Hasenberger, I. David Johnson, Harry O. Sorenson

### 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	_____	_____
In lower part of Michigan	_____	_____
Marshall Ss	_____	_____
Coldwater Sh	_____	_____
In upper part of Ellsworth Sh	_____	_____
Berea Ss	_____	_____
Saginaw Bay Ls	_____	_____
Upper part of Traverse Group in Western Michigan	_____	_____
Rogers City Ls	_____	_____
Dundee Ls	_____	_____
Dundee Ls (?) Upper part of Lucas Fm (?)	_____	_____
In Lucas Fm	_____	_____
Ankerberg Fm	_____	_____
Part of Salina Group E Unit	_____	_____
Divisions of A-2 Carbonate in Western Michigan	_____	_____
A-1 Carbonate	_____	_____
Upper part of Niagara Series	_____	_____
Part of Niagara Series	_____	_____
Trenton Group	_____	_____
Black River Group	_____	_____
Ontonagon Dol	_____	_____



GEOLOGIC NAMES COMMITTEE: Harry O. Sorenson, Chairman and Chairman; Robert W. Kelley, Secretary; Harry J. Hasenberger, I. David Johnson, Harry O. Sorenson.

**CHART 1**  
1964

TECHNICAL STAFF AND ORGANIZATION CHART  
 Geological Survey Division  
 DEPARTMENT OF NATURAL RESOURCES

