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MLM-EGSP-TPR-Q-015

PHYSICAL AND CHEMICAL CHARACTERIZATION OF DEVONIAN GAS SHALE

QUARTERLY STATUS REPORT
(JULY 1, 1980 - SEPTEMBER 30, 1980)

PREPARED BY R. E. ZIELINSKI,
PRINCIPAL INVESTIGATOR
AND
J. D. MOTEFF

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MOUND FACILITY
Miamisburg, Ohio 45342

operated by
MONSANTO RESEARCH CORPORATION
a subsidiary of Monsanto Company

for the
U. S. DEPARTMENT OF ENERGY
Contract No. DE-AC04-76-DP00053

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Executive Summary

Stratigraphic intervals were picked from geophysical logs for the following wells: OH-6-1, OH-6-2, OH-6-3, OH-6-4, OH-6-5, OH-5, OH-7, and PA-4. Geochemical data relevant to estimating potential hydrocarbon generation will be examined by interval in this quarterly. As will be shown later in this summary and in the text, the various geochemical properties of the well will vary with the interval.

Organic carbon contents were determined for samples from the OH-6-4, OH-7, PA-4, and MI-1 wells. The average total organic carbon (TOC) content for each well was 1.92 wt %, 2.01 wt %, 0.98 wt %, and 7.01 wt %, respectively. The values are compared to the averages of other wells in the Appalachian and Illinois Basin in Table A-1 of the Appendix.

Visual Kerogen Assessments were also completed for the OH-6-4, OH-7, PA-4, and MI-1 wells. Thermal Alteration Index (TAI) values determined for OH-6-4 and MI-1 suggest that the shale from these wells were moderately immature - TAI approximately 2.00 to 2.10. The shale from the OH-7 well matured slightly with depth from moderately immature (TAI = 1.76) to moderately mature (TAI = 2.30). The shale from PA-4 was very mature (TAI = 3.60).

The source of organic material was also determined by visual assessment of the kerogen. In the MI-1 well most of the kerogen was derived from herbaceous material. In PA-4 most of it was derived from woody-coaly material. The shallower intervals of OH-6-4 contained woody-coaly material (to the bottom of the Chagrin). Below the Chagrin, herbaceous material became the predominant source of kerogen. The Upper Olentangy and the Mahantango intervals in the OH-7 well contained kerogen derived chiefly from woody-coaly debris; the rest of the well had herbaceous material as the kerogen source.

Vitrinite Reflectance measurements were completed for the following wells: OH-6-1, OH-6-2, OH-6-3, OH-6-4, OH-6-5, OH-7, Ill-5, MI-1, and OH-5. The average R_0 values for each well were 0.51, 0.44, 0.42, 0.48, 0.37, 0.58, 0.56, 0.47, and 0.60, respectively. All these R_0 values are indicative of moderately immature shales. The ranges of the R_0 values in both the OH-7 and OH-5 wells, however, actually describe shales that have matured slightly with depth, from moderately immature ($\sim$ 0.50) to moderately mature ($\sim$ 0.66). The average R_0 values along with the TAI values for these wells are compared with others from the Appalachian and Illinois Basin in Table A-2 of the Appendix.

The Kerogen Elemental Composition was determined for samples from the OH-6-1, OH-6-2, OH-6-3, and OH-6-5 wells. The average H/C ratios for each well were 1.27, 1.32, 1.13, and 1.16, respectively. The average O/C ratios were 0.56, 0.58, 0.14, and 0.22, respectively. The relationship between the H/C and O/C ratios for individual samples suggest that all the samples tested were immature and most were deposited in an intermediate environment.

Lithological descriptions were also completed for samples from the OH-6-4, OH-7, PA-4, and MI-1 wells. All were 100% shale. Tasmanites were visible in samples from OH-7 and OH-6-4. None of the PA-4 or MI-1 samples displayed macroscopic Tasmanites.

A review of the data presented in this and the last quarterly[1] shows that the shale examined from all the OH-6 wells has undergone only a slight maturation. The Cleveland and the Lower Huron intervals in all these wells were high in organic material. The source of this organic material in the Cleveland interval alternated between woody-coaly and herbaceous debris, or a mixture of the two, and the material was deposited in an intermediate environment. This suggests that this interval has a fair potential to produce liquid and gaseous hydrocarbons. The Lower Huron interval has kerogen mainly derived from herbaceous material also deposited in an intermediate environment.

Samples from the OH-7 well were taken between the Chagrin and the Marcellus intervals. The shale from these deeper intervals show the slightly higher degree of maturation expected. R_o values were in the 0.60 range and TAI values were 2.30. The Lower Olentangy interval had the highest organic carbon content (6.76 wt %). All samples in that zone had kerogen derived from herbaceous debris. The Marcellus zone also had a relatively high amount of organic carbon.

The shale examined from the Ill-5 well has been slightly matured. The samples have kerogen predominantly derived from herbaceous material, and one area within the well has a very high organic content. This zone lies between 5085 and 5102 ft.

The PA-4 well was drilled into the Marcellus interval to 8000 ft. The high degree of thermal maturation at this greater depth was observed in the visual assessment of the kerogen from this well. All the samples had TAI values of 3.60 which describes a very mature shale. The amount of organic carbon present is relatively low and is predominantly derived from woody-coaly debris. The amount of organic matter, and its source and maturity, suggests that the shale now has a low potential for producing hydrocarbons and that much of this has already taken place in the generation of gaseous products. This is evidenced by low contents of dry gas released from the samples.

The shale examined from the OH-5 well is moderately immature to moderately mature. The Cleveland and the Huron intervals have high carbon contents (3.16 to 2.94 wt %). The source of organic matter in each of these zones is predominantly herbaceous debris.

The MI-1 well also has immature shale. It is very rich in organic carbon content which is derived chiefly from herbaceous material. The lack of woody-coaly debris suggests that this shale was deposited in an intermediate or marine type environment.

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I. INTRODUCTION

The general location of wells and corresponding well data used by Mound Facility in its EGSP study is indicated in Table 1 and Figure 1.

TABLE 1
Detailed description of EGSP well locations.

Appalachian Basin Wells

Mound Well	Well Name	State	County
PA-1	Minard Run Oil Co./ Minard Run Exploration #1	Pennsylvania	McKean
PA-2	C. E. Power Systems/ C. E. Power Systems #1	Pennsylvania	Allegheny
KY-4	Ashland Oil Co./ Skaggs-Kelley Unit #3-RS	Kentucky	Johnson
NY-1	National Fuel Gas Supply Corp./ #5213 (Jo) EGSP NY #1	New York	Allegany
KY-2	Columbia Gas Transmission Corp./ Columbia Gas #20,336	Kentucky	Martin
VA-1	Columbia Gas Transmission Corp./ Penn Va. Corp. Farm Well #20338	Virginia	Wise
WV-7	Mobay Chemical Corp./ H. Emch & A. Pyles Unit #1	West Virginia	Wetzel
WV-6	U. S. Dept. of Energy MERC #1	West Virginia	Monongalia
WV-5	Reel Drilling Co./ D/K Farm #3	West Virginia	Mason
11940	Consolidated Gas Supply Corp./ L. A. Bales #11940	West Virginia	Jackson
7239	Kentucky-West Virginia Gas Co./ Nicholas Combs #7239	Kentucky	Perry
OH-1	Canton Oil & Gas Co./ Glen-Gery #5-74S	Ohio	Carroll
OH-3	Thurlow Weed & Associates/ Louise Beckholt #1	Ohio	Knox
R-109	River Gas Company/ Florence L. House #R-109	Ohio	Washington

TABLE 1 (Continued)
Detailed Description of EGSP Well Locations.

Mound Well	Well Name	State	County
OH-4	Monsanto Research Corp./Bessemer and Lake Erie Railroad Co. #3	Ohio	Ashtabula
PA-3	Monsanto Research Corp. Pennsylvania DER/Presque Isle State Park #1	Pennsylvania	Erie
OH-5	Columbia Gas Transmission Corp./ D. M. Wakefield #10148-7	Ohio	Lorain
OH-6-1	Mitchell Energy Corp./#1-5 Carpenter	Ohio	Gallia
OH-6-2	Mitchell Energy Corp./	Ohio	Gallia
OH-6-3	Mitchell Energy Corp./L. McCombs #1-6	Ohio	Gallia
OH-6-4	Mitchell Energy Corp./1-8 straight	Ohio	Gallia
OH-6-5	Mitchell Energy Corp./Carter #1-9	Ohio	Gallia
OH-7	Columbia Gas Transmission Corp./ Anna Meleski #20143	Ohio	Trumbull
PA-4	Gruy Federal, Inc./DOE/ Glen McCall #5	Pennsylvania	Indiana
TENN-9	Gruy Federal, Inc./DOE/ Gruy Federal #1	Tennessee	Grainger
Illinois Basin Wells			
IND-2	Indiana Geol. Survey/ Clark State Forest SDH-290 EGSP #2	Indiana	Clark
Ill-4	Rector & Stone Drilling Co./ Missouri Portland #1	Illinois	Hardin
I-1	Tri-Star Producing Co., Inc./ Lancaster #1-D	Illinois	Effingham
P-1	Energy Resource of Ind., Inc./ Phegley Farms, Inc. #1	Indiana	Sullivan

TABLE 1 (Continued)
Detailed Description of EGSP Well Locations.

Mound Well	Well Name	State	County
O-1	Orbit Gas Co./ Ray Clark #1	Kentucky	Christian
Ill-5	Gruy Federal, Inc./DOE/ Simpson #1	Illinois	Wayne
MI-1		Michigan	Otsego

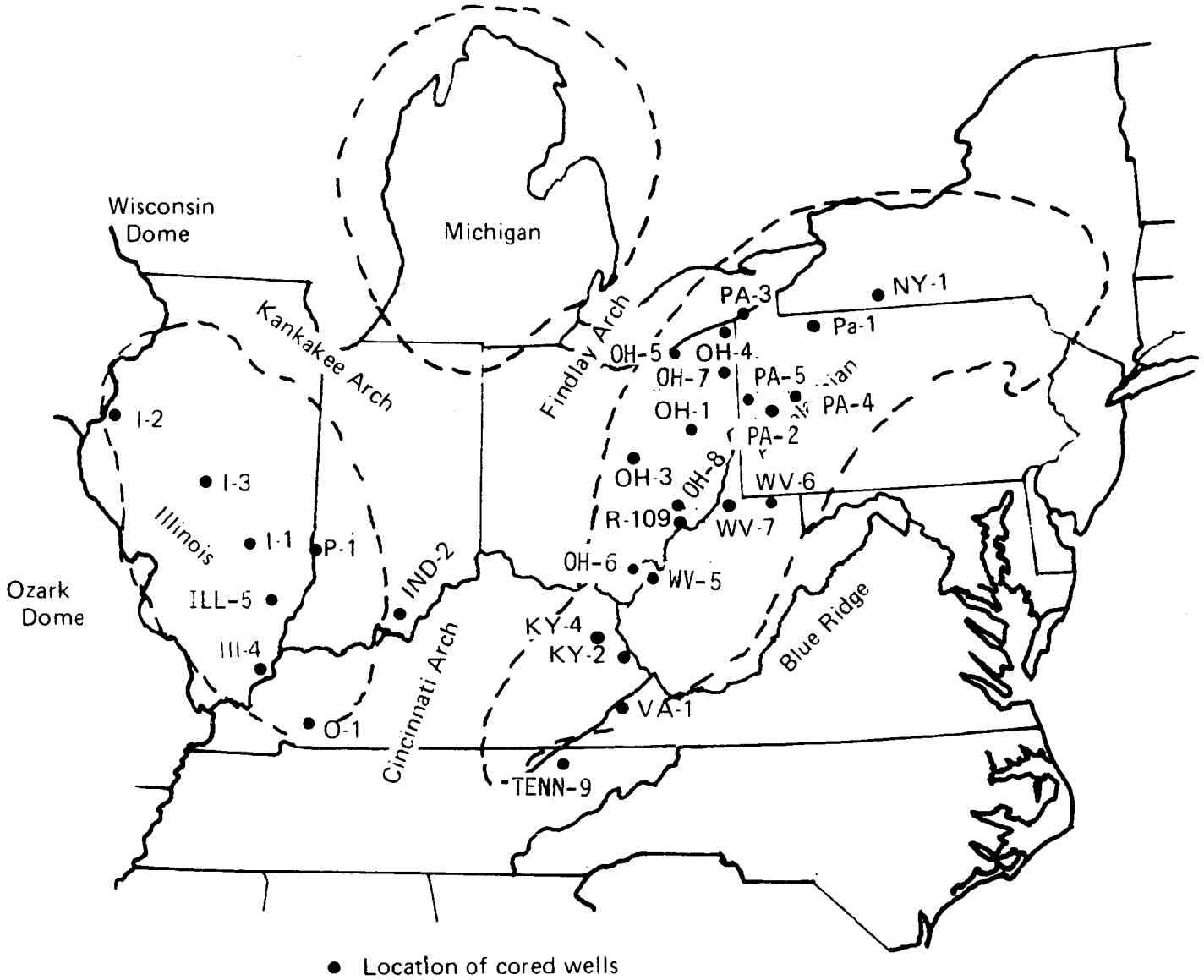

Figure 1
The distribution of cored wells in the Illinois and Appalachian Basins.

II. GEOCHEMISTRY

A. OH-6-1 (Gallia County, Ohio)

1. Stratigraphic Intervals

Table 2 identifies the stratigraphic intervals selected from geophysical logs of the OH-6-1 well. The data accumulated for the OH-6-1 well samples have been averaged by interval and are also listed in Table 2.

2. Kerogen Elemental Composition

The three major factors which determine hydrocarbon potential are organic carbon, thermal maturation, and organic source. The latter two can be evaluated by elemental analysis of the kerogen.[2]

Nonmarine environments tend to accumulate material rich in aromatics. The elemental ratio of O/C in this type of material is high while the ratio of H/C is low. (Curve C in Figure 2). Kerogen deposited in a marine environment, in contrast, is rich in aliphatic structures. The ratio of O/C in these structures is low and the ratio of H/C is high (Curve A in Figure 2). Organic matter with a high O/C ratio has the potential for generating hydrocarbon gases. Organic matter with a high H/C ratio has the potential for generating hydrocarbon liquids. There is an environment between marine and nonmarine (Curve B in Figure 2) that contains both types of organic structures and therefore possesses the potential to generate both liquid and gaseous hydrocarbons.

As the kerogen thermally matures, the original H/C and O/C ratios will be altered. Initially oxygen is eliminated decreasing the O/C ratio, and subsequent hydrocarbon production will decrease the H/C ratio. These effects are indicated by the arrow near Curve C in Figure 2. By plotting O/C vs. H/C on Figure 2, the degree of maturation can be evaluated.

The kerogen elemental composition of three samples from the OH-6-1 well was determined (Table 3). The first sample was taken from the Cleveland shale interval and had H/C and O/C values of 1.04 and 0.47, respectively. The last two samples were taken from the Lower Huron interval and had H/C and O/C values of 1.48, 0.81, and 1.29, 0.39, respectively. These data are plotted in Figure 2. Sample OH-6-1-7 (O/C = 0.81) is off scale on the figure but would be in close proximity to the other two points. These data show that the shale in both intervals has undergone only moderate thermal maturation and that the organic matter was deposited in an intermediate type environment.

TABLE 2
Stratigraphic Intervals and Geochemical data for OH-6-1

Stratigraphic Interval	Depths (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Cleveland	1770-1814	11.79	0.47	2.00	W-C	4.8	88.3
Chagrin	1814-2007	0.30			W-C	0.17	0.54
Middle Huron	2134-2318	3.33			W-C	0.22	8.4
Lower Huron	2318-2563	2.44	0.53	2.08	H	9.8	19.1

TABLE 3

Kerogen Composition for the
OH-6 Series of Wells

Mound Sample Number	Weight Percent (Ash Free) C	H	N	O	Weight Percent Ash	Atomic H/C	Atomic O/C
OH-6-1-001	57.15	4.98	1.79	36.07	13.62	1.04	0.47
OH-6-1-007	44.47	5.52	1.97	48.04	1.57	1.48	0.81
OH-6-1-013	60.44	6.54	1.92	31.10	12.44	1.29	0.39
OH-6-2-004	73.60	8.95	2.37	15.08	36.22	1.45	0.15
OH-6-2-011	55.80	5.51	1.73	36.88	14.49	1.17	0.50
OH-6-2-017	38.39	4.31	1.24	56.06	9.49	1.34	1.10
OH-6-3-004	76.39	7.22	2.31	14.07	3.80	1.13	0.14
OH-6-5-003	72.15	6.89	2.52	18.43	6.88	1.14	0.19
OH-6-5-013	67.04	6.66	3.76	22.53	0.36	1.18	0.25

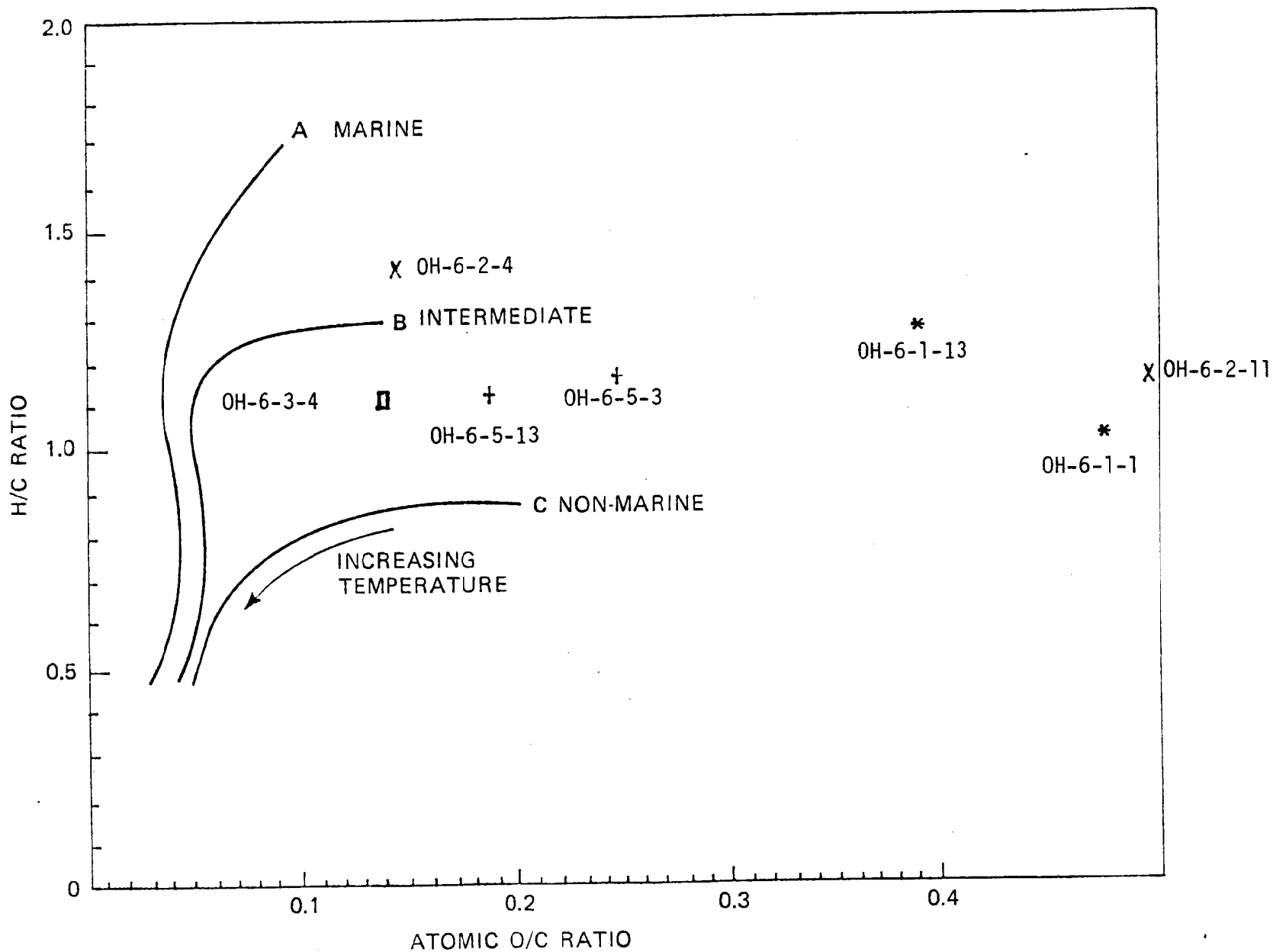

Figure 2: Atomic Ratio Results for OH-6-1, OH-6-2, OH-6-3 and OH-6-5

3. Vitrinite Reflectance

Another method for evaluating thermal maturation is vitrinite reflectance analysis. Vitrinite is a common constituent of sedimentary organic matter. The intensity of light reflected by vitrinite (vitrinite reflectance, R_o) increases with thermal maturity in an irreversible reaction. Those samples containing indigenous vitrinite material were used to determine thermal maturity.[3] These samples are designated with an asterisk '*'.

Measurements were made on the same three samples used in the elemental kerogen composition evaluation. The sample from the Cleveland shale had an R_o value of 0.47 (Table 4). The two samples from the Lower Huron interval had R_o values of 0.52 and 0.53. These values would indicate that the shale in both intervals is moderately immature[3], in agreement with the kerogen composition study.

B. OH-6-2 (Gallia County, Ohio)

1. Stratigraphic Intervals

The stratigraphic intervals identified in the OH-6-2 well are listed in Table 5 along with average values for data accumulated by interval.

2. Kerogen Elemental Composition

Ther kerogen elemental composition for three samples from the OH-6-2 well was determined (Table 3). As in the case of the OH-6-1 samples, the first was taken from the Cleveland shale interval and the other two from the Lower Huron interval. The H/C and O/C values for the Cleveland sample (OH-6-2-3) were 1.45 and 0.15, respectively. The H/C and O/C values for the Lower Huron samples (OH-6-2-13 and -17) were 1.17, 0.50 and 1.34, 1.10, respectively. The wide range of O/C values when plotted on the O/C vs. H/C plot (Figure 2) implies a large variance in thermal maturity between samples. This may be misleading because of the difficulty in measuring the oxygen content of kerogen. However, the data do suggest that the kerogen has generally undergone little thermal maturation. The organic matter in OH-6-2-13 was deposited in an intermediate type environment. The organic matter in sample OH-6-2-17 and the Cleveland sample (OH-6-2-3) was deposited in a marine environment.

3. Vitrinite Reflectance

The variation in maturity does not show up in the vitrinite reflectance measurements performed on these samples (Table 6). R_o values were 0.44-0.45. But these data do agree with the kerogen analysis and describe an immature shale.

TABLE 4
Vitrinite Reflectance Summary
for OH-6-1

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-6-1-001	1812	Cleveland	(1)*	50	0.35	0.57	0.47
			(2)	10	0.61	0.85	0.72
OH-6-1-007	2345	Lower Huron	(1)*	30	0.38	0.64	0.53
			(2)	17	0.66	0.95	0.74
OH-6-1-013	2498	"	(1)*	45	0.42	0.63	0.52
			(2)	12	0.65	1.08	0.79

TABLE 5
Stratigraphic Intervals and Geochemical data for OH-6-2

Stratigraphic Interval	Depths (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Beford	1608-1728	1.27		2.10	W-C	4.1	4.7
Cleveland	1728-1764	6.91	0.44	2.10	H	21.7	33.3
Lower Huron	2260-2498	3.90	0.45	2.10	H	8.8	29.0

TABLE 6
Vitrinite Reflectance Summary
for OH-6-2

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-6-2-004	1734	Cleveland	(1)*	10	0.37	0.51	0.44
			(2)	7	0.54	0.70	0.63
			(3)	6	0.84	1.21	1.03
OH-6-2-011	2324	Lower Huron	(1)*	8	0.38	0.53	0.45
			(2)	2	0.57	0.63	0.60
			(3)	3	0.79	1.02	0.94
OH-6-2-017	2474	"	(1)*	44	0.35	0.55	0.44
			(2)	14	0.59	0.75	0.66

*Indigenous population

C. OH-6-3 (Gallia County, Ohio)

1. Stratigraphic Intervals

Table 7 identifies those stratigraphic intervals identified on the geophysical logs taken of the OH-6-3 well.

2. Kerogen Elemental Composition

The kerogen elemental composition was determined for only one sample from the OH-6-3 well (OH-6-3-4, Table 3). The sample is from the Cleveland interval and the H/C and O/C values are 1.13 and 0.14, respectively. When the O/C value is plotted vs. the H/C value (Figure 2) the location of the point suggests the kerogen is immature and was deposited in an intermediate type environment.

3. Vitrinite Reflectance

The vitrinite reflectance measured for this sample was 0.42, indicating the shale is moderately immature (Table 8).

D. OH-6-4 (Gallia County, Ohio)

1. Stratigraphic Intervals

The stratigraphic intervals drilled in the OH-6-4 well are identified in Table 9. Average values for data for this well are listed by interval.

2. Organic Carbon Content

The total organic carbon (TOC) content was determined for 81 samples from the OH-6-4 well (Table 10). The TOC content ranged from 9.53 wt % to 0.16 wt % (avg. = 1.92 wt %) with certain intervals definitely having more organic carbon present than others. The average TOC content for the Cleveland shale was 6.37 wt % while the Bedford interval above and Chagrin below only had average TOC contents of 0.30 wt % and 0.46 wt %, respectively. The Upper, Middle, and Lower Huron intervals had average contents of 2.15 wt %, 1.53 wt %, and 3.88 wt %, respectively. The Sunbury and Berea intervals at the top of the well had average organic carbon contents of 0.57 wt % and 0.40 wt %, respectively. Figure 3 is a plot of TOC vs. depth for the entire well.

3. Vitrinite Reflectance

Thirteen samples from this well were analyzed for vitrinite reflectance (Table 11). The R_o values on the average increased with depth from 0.42 in the Sunbury to 0.49 in the Huron intervals. All R_o values were indicative of a moderately immature shale.

TABLE 7
Stratigraphic Intervals and Geochemical data for OH-6-3

Stratigraphic Interval	Depths (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Bedford	1890-2000	0.42		2.00	W-C	1.0	0.6
Cleveland	2000-2040	7.67	0.42	2.08	H	6.4	41.5
Chagrin	2040-2224	0.49		2.10	W-C	2.9	2.7
Lower Huron	2546-2791	6.55		2.10	H	18.6	19.6

TABLE 8
Vitrinite Reflectance Summary
for OH-6-3

Mound Sample Number	Depth (feet)	Well Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-6-3-004	2021	Cleveland	(1)*	30	0.32	0.51	0.42
			(2)	25	0.54	0.81	0.66
			(3)	5	1.01	1.63	1.24

*Indigenous population

TABLE 9
Stratigraphic Intervals and Geochemical data for OH-6-4

Stratigraphic Interval	Depths (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Sunbury	1825-1852	0.57	0.42	2.10	H	35.9	22.7
Berea	1852-1875	0.40		2.10	H+W-C	9.2	2.6
Bedford	1875-1980	0.30		2.10	W-C	2.4	0.4
Cleveland	1980-2018	6.37	0.47	1.93	H+W-C	32.3	26.1
Chagrin	2018-2200	0.46	0.48	2.08	W-C	5.7	1.1
Upper Huron	2200-2350	2.15	0.49	2.10	H	24.6	8.4
Middle Huron	2350-2543	1.53	0.49	2.10	H	12.0	6.7
Lower Huron	2543-2790	3.88	0.49	2.15	H	15.9	36.3

TABLE 10
Total Organic Carbon
for OH-6-4 Well

Mound Sample Number	Interval	Total Organic Carbon (wt %)
OH-6-4-001	Sunbury	0.57
OH-6-4-002		0.46
OH-6-4-003	Berea	0.34
OH-6-4-004		0.24
OH-6-4-005	Bedford	0.27
OH-6-4-006		0.16
OH-6-4-007		0.26
OH-6-4-008		0.19
OH-6-4-009		0.34
OH-6-4-010		0.22
OH-6-4-011		0.30
OH-6-4-012		0.61
OH-6-4-013		0.43
OH-6-4-014	Cleveland	8.69
OH-6-4-015		8.04
OH-6-4-016		3.56
OH-6-4-017		5.18
OH-6-4-018	Chagrin	0.46
OH-6-4-019		0.25
OH-6-4-020		0.20
OH-6-4-021		0.32
OH-6-4-022		0.31
OH-6-4-023		1.68
OH-6-4-024		0.24
OH-6-4-025		0.28
OH-6-4-026		0.46
OH-6-4-027		0.27
OH-6-4-028		0.30
OH-6-4-029		0.24
OH-6-4-030		1.38
OH-6-4-031		0.44
OH-6-4-032		0.28
OH-6-4-033		0.25
OH-6-4-034	Upper Huron	0.37
OH-6-4-035		2.10
OH-6-4-036		1.65
OH-6-4-037		2.45
OH-6-4-038		4.43
OH-6-4-039		0.69
OH-6-4-040		1.57

TABLE 10 (Continued)
Total Organic Carbon
for OH-6-4 Well

Mound Sample Number	Interval	Total Organic Carbon(wt %)
OH-6-4-041		2.15
OH-6-4-042		3.47
OH-6-4-043		0.64
OH-6-4-044	Upper Huron	3.32
OH-6-4-045		2.73
OH-6-4-046		2.09
OH-6-4-047		1.98
OH-6-4-048		2.61
OH-6-4-049		3.19
OH-6-4-050		0.50
OH-6-4-051		0.61
OH-6-4-052		1.72
OH-6-4-053		1.78
OH-6-4-054		0.74
OH-6-4-055		0.44
OH-6-4-056		0.96
OH-6-4-057	Middle Huron	1.43
OH-6-4-058		2.37
OH-6-4-059		1.48
OH-6-4-060		1.21
OH-6-4-061		2.60
OH-6-4-062		1.88
OH-6-4-063		0.44
OH-6-4-064		2.25
OH-6-4-065		0.54
OH-6-4-066		3.33
OH-6-4-067		3.41
OH-6-4-068		1.50
OH-6-4-069		1.19
OH-6-4-070		0.42
OH-6-4-071		9.53
OH-6-4-072		9.01
OH-6-4-073		1.15
OH-6-4-074	Lower Huron	5.81
OH-6-4-075'		5.61
OH-6-4-076		0.25
OH-6-4-077		5.56
OH-6-4-078		5.90
OH-6-4-079		1.12
OH-6-4-080		2.15
OH-6-4-081		5.57

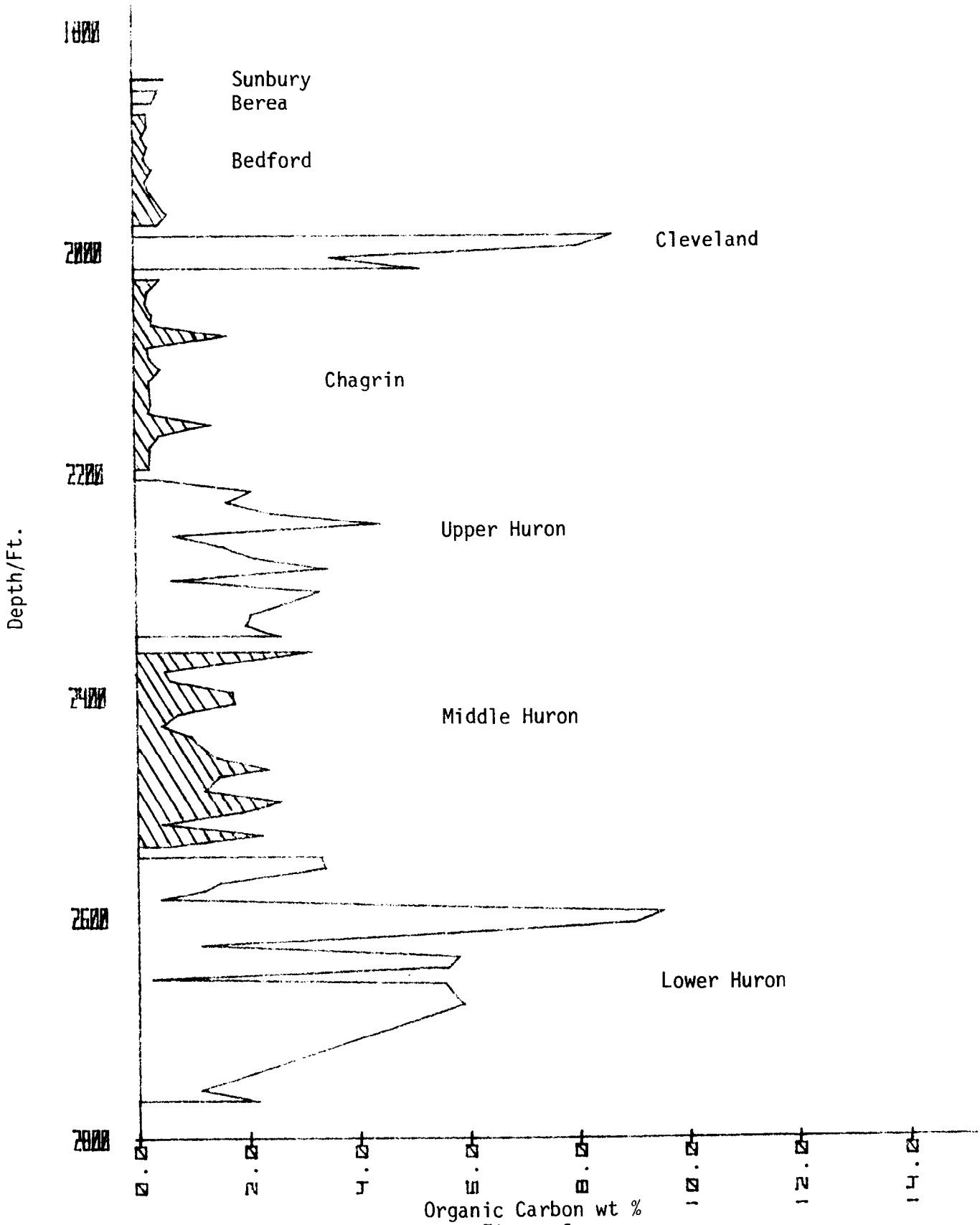

Figure 3
Organic Carbon vs. Depth for OH-6-4 Sample

TABLE 11
Vitrinite Reflectance Summary
for OH-6-4 Well

Mound Sample Number	Depth (feet)	Intervals	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-6-4-001	1844.8	Sunbury	(1)*	20	0.35	0.50	0.42
			(2)	27	0.57	1.99	0.97
OH-6-4-014	1976.72	Cleveland	(1)*	16	0.42	0.52	0.47
			(2)	8	0.56	0.69	0.62
			(3)	36	0.78	2.07	1.16
OH-6-4-017	2006.63	Chagrin	(1)*	20	0.30	0.53	0.46
			(2)	14	0.58	0.85	0.68
			(3)	26	0.88	2.10	1.27
OH-6-4-023	2066.63	"	(1)*	12	0.43	0.51	0.48
			(2)	17	0.57	0.81	0.66
			(3)	31	0.88	1.76	1.26
OH-6-4-030	2146.59	"	(1)*	9	0.42	0.59	0.50
			(2)	51	0.69	2.09	1.35
OH-6-4-038	2236.5	Upper Huron	(1)*	14	0.40	0.61	0.52
			(2)	46	0.64	2.16	1.30
OH-6-4-042	2276.72	"	(1)*	33	0.37	0.57	0.46
			(2)	8	0.64	0.80	0.75
			(3)	19	0.95	1.95	1.40
OH-6-4-044	2296.44	"	(1)*	18	0.39	0.57	0.47
			(2)	19	0.59	0.77	0.68
			(3)	23	0.83	2.28	1.28
OH-6-4-048	2336.63	"	(1)*	25	0.41	0.57	0.49
			(2)	35	0.60	2.23	1.18
OH-6-4-058	2456.41	Middle Huron	(1)*	36	0.39	0.60	0.50
			(2)	24	0.62	1.80	1.02

* Indigenous population

TABLE 11 (Continued)
Vitrinite Reflectance Summary

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-6-4-067	2516.32	Lower Huron	NO VITRINITE				
OH-6-4-068	2556.08	"	(1)*	5	0.42	0.61	0.51
			(2)	2	1.34	1.52	1.43
OH-6-4-071	2584.79	"	NO VITRINITE				
OH-6-4-077	2656.54	"	(1)*	2	0.44	0.48	0.46
			(2)	2	0.66	0.77	0.72
OH-6-4-080	2756.72	"	NO VITRINITE				

*Indigenous population

4. Visual Kerogen Assessment

Another primary factor in determining the oil and gas yield of source rocks, and closely related to the environment in which organic matter is deposited, is the type of organic matter deposited. Organic matter can be classified as amorphous, algal, herbaceous (spores, pollen, cuticles, and membrane debris), and woody-coaly material (composed of structured and inertinite material, respectively). Algal-amorphous organic material has the potential to yield significantly more oil and gas than woody-coaly material. Herbaceous material has an intermediate potential to produce hydrocarbons.[2,4]

Visual assessment of the kerogen in 81 OH-6-4 samples (Table 12) revealed that the kerogen was immature. The TAI was essentially constant with depth (2.1 to 2.2), except for an anomaly between 1956 ft. and 2036 ft. This section had a slightly lower TAI and possibly corresponds to structural changes. The color of the kerogen ranged from yellow orange to light brown (yellow to orange brown in the less mature region). In 80% of the samples, through the bottom of the Chagrin interval the primary source of kerogen was woody-coaly material (Table 13). Approximately 50% of the Upper Huron and approximately 70% of the Middle and Lower Huron samples had herbaceous derived organic material as the primary source of kerogen. Trace and secondary amounts of kerogen derived from algal-amorphous material were identified in an increasing number of samples below the Chagrin interval.

5. Lithology

A lithological description of the OH-6-4 samples is given in Table 14. All the samples were 100% shale and noncalcareous. The Berea and Bedford intervals at the top of the well and the Lower Huron interval at the bottom appear to be interbedded, alternating between medium to medium dark gray (N5 to N4) shales and brownish gray to black (5YR3 to 5YR2) shales. The Cleveland shale seem to be a homogeneously dark brownish gray shale (5YR3/1) corresponding to its high organic carbon content. The middle intervals, the Chagrin and Upper and Middle Huron intervals, are essentially medium gray to medium dark gray (N5 to N4). Tasmanites were visible in 60% of the Upper Huron samples.

E. OH-6-5 (Gallia County, Ohio

1. Stratigraphic Intervals

Table 15 identifies the stratigraphic zones of the OH-6-5 well.

TABLE 12

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH-6-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-6-4-001	1844'						2.1	
OH-6-4-002	1854'						2.1	
OH-6-4-003	1866'						2.1	
OH-6-4-004	1876'						2.1	
OH-6-4-005	1886'						2.1	
OH-6-4-006	1896'						2.1	
OH-6-4-007	1906'						2.2	
OH-6-4-008	1916'						2.2	
OH-6-4-009	1926'						2.2	
OH-6-4-010	1936'						2.2	
OH-6-4-011	1946'						2.2	
OH-6-4-012	1956'						1.9	
OH-6-4-013	1966'						1.9	
OH-6-4-014	1976'						1.9	
OH-6-4-015	1986'						1.9	
OH-6-4-016	1996'						1.9	
OH-6-4-017	2006'						2.0	
OH-6-4-018	2016'						2.0	
OH-6-4-019	2025'						2.0	
OH-6-4-020	2036'						2.0	

TABLE 12 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH-6-4 WELL

Mouna No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-6-4-021	2046'						2.1	
OH-6-4-022	2056'						2.1	
OH-6-4-023	2066'						2.1	
OH-6-4-024	2076'						2.1	
OH-6-4-025	2086'						2.1	
OH-6-4-026	2096'						2.1	
OH-6-4-027	2106'						2.1	
OH-6-4-028	2116'						2.1	
OH-6-4-029	2126'						2.1	
OH-6-4-030	2136'						2.1	
OH-6-4-031	2156'						2.1	
OH-6-4-032	2166'						2.1	
OH-6-4-033	2176'						2.1	
OH-6-4-034	2186'						2.1	
OH-6-4-035	2206'						2.1	
OH-6-4-036	2216'						2.1	
OH-6-4-037	2226'						2.1	
OH-6-4-038	2236'						2.1	
OH-6-4-039	2246'						2.1	
OH-6-4-040	2256'						2.1	

TABLE 12 (Continued)

OH-6-4 WELL

VISUAL KEROGEN ASSESSMENT WORKSHEET

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-6-4-041	2266'						2.1	
OH-6-4-042	2276'						2.1	
OH-6-4-043	2286'						2.1	
OH-6-4-044	2296'						2.1	
OH-6-4-045	2306'						2.1	
OH-6-4-046	2316'						2.1	
OH-6-4-047	2326'						2.1	
OH-6-4-048	2336'						2.1	
OH-6-4-049	2346'						2.1	
OH-6-4-050	2360'						2.1	
OH-6-4-051	2377'						2.1	
OH-6-4-052	2386'						2.1	
OH-6-4-053	2396'						2.1	
OH-6-4-054	2406'						2.1	
OH-6-4-055	2416'						2.1	
OH-6-4-056	2426'						2.1	
OH-6-4-057	2436'						2.1	
OH-6-4-058	2456'						2.1	
OH-6-4-059	2466'						2.1	
OH-6-4-060	2473'						2.1	

TABLE 12 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH-6-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-6-4-061	2486'						2.1	
OH-6-4-062	2496'						2.1	
OH-6-4-063	2506'						2.1	
OH-6-4-064	2516'						2.1	
OH-6-4-065	2526'						2.1	
OH-6-4-066	2536'						2.1	
OH-6-4-067	2546'						2.1	
OH-6-4-068	2556'						2.1	
OH-6-4-069	2569'						2.1	
OH-6-4-070	2576'						2.1	
OH-6-4-071	2584'						2.1	
OH-6-4-072	2596'						2.1	
OH-6-4-073	2606'						2.1	
OH-6-4-074	2626'						2.2	
OH-6-4-075	2636'						2.2	
OH-6-4-076	2646'						2.2	
OH-6-4-077	2650'						2.2	
OH-6-4-078	2660'						2.2	
OH-6-4-079	2675'						2.2	
OH-6-4-080	2755'						2.2	

TABLE 12 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH-6-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-6-4-08	2766'						pyrite; 2.2	

TABLE 13
Kerogen Visual Assessment; Components of Kerogen
for OH-6-4

Mound Sample Number		Predominant	Secondary	Trace
OH-6-4-001	Sunbury	H	W-C	A-A
OH-6-4-002		H	A-A	W-C
OH-6-4-003	Berea	W-C	H	-
OH-6-4-004		W-C	H	-
OH-6-4-005		W-C	H	-
OH-6-4-006		W-C	H	-
OH-6-4-007		W-C	H	-
OH-6-4-008		W-C	H	-
OH-6-4-009		W-C	H	-
OH-6-4-010	Bedford	W-C	H	-
OH-6-4-011		W-C	H	-
OH-6-4-012		W-C+H	-	-
OH-6-4-013		W-C	H	-
OH-6-4-014		H	W-C	A-A
OH-6-4-015		H	W-C	A-A
OH-6-4-016	Cleveland	W-C	H	A-A
OH-6-4-017		W-C	H	A-A
OH-6-4-018		W-C	H	-
OH-6-4-019		W-C	H	-
OH-6-4-020		W-C	H	-
OH-6-4-021		H	W-C	-
OH-6-4-022		W-C	H	-
OH-6-4-023		H+W-C	A-A	-
OH-6-4-024		W-C	H	-
OH-6-4-025	Chagrin	W-C	H	-
OH-6-4-026		W-C	H	-
OH-6-4-027		W-C	H	-
OH-6-4-028		W-C	H	-
OH-6-4-029		W-C	H	-
OH-6-4-030		W-C	H	A-A
OH-6-4-031		W-C	H	-
OH-6-4-032		W-C	H	-
OH-6-4-033		W-C	H	-
OH-6-4-034		W-C	H	-
OH-6-4-035		H	W-C	A-A
OH-6-4-036		H	W-C	A-A
OH-6-4-037		H	W-C	A-A
OH-6-4-038		H	A-A	-
OH-6-4-039	Upper Huron	W-C	H	-
OH-6-4-040		W-C	H	A-A
OH-6-4-041		W-C	H	A-A
OH-6-4-042		H	W-C	A-A
OH-6-4-043		W-C	H	-
OH-6-4-044		H	W-C	A-A
OH-6-4-045		H	W-C+A-A	-

TABLE 13(Continued)
Kerogen Visual Assessment; Components of Kerogen
for OH-6-4

Mound Sample Number		Predominant	Secondary	Trace
OH-6-4-046	Upper Huron	W-C	H	A-A
OH-6-4-047		W-C	H	A-A
OH-6-4-048		H	W-C	A-A
OH-6-4-049		H	W-C	A-A
OH-6-4-050	Middle Huron	W-C	H	-
OH-6-4-051		W-C	H	-
OH-6-4-052		W-C	H	-
OH-6-4-053		H	W-C	A-A
OH-6-4-054		H	W-C	A-A
OH-6-4-055		W-C	H	-
OH-6-4-056		H	W-C	A-A
OH-6-4-057		H	W-C	A-A
OH-6-4-058		H	A-A	W-C
OH-6-4-059		H	W-C	A-A
OH-6-4-060		H	W-C	A-A
OH-6-4-061		H	W-C	A-A
OH-6-4-062		H	W-C	A-A
OH-6-4-063		W-C	H	-
OH-6-4-064		H	W-C+A-A	-
OH-6-4-065		W-C	H	-
OH-6-4-066		H	W-C+A-A	-
OH-6-4-067		H	W-C+A-A	-
OH-6-4-068	Lower Huron	H	W-C	A-A
OH-6-4-069		H	W-C+A-A	-
OH-6-4-070		W-C	H	-
OH-6-4-071		H	A-A	-
OH-6-4-072		H	A-A	W-C
OH-6-4-073		W-C	H	A-A
OH-6-4-074		H	A-A	W-C
OH-6-4-075		H	W-C+A-A	-
OH-6-4-076		W-C	H	-
OH-6-4-077		H	W-C	A-A
OH-6-4-078		H	A-A	W-C
OH-6-4-079		W-C	H	-
OH-6-4-080		H	W-C+A-A	-
OH-6-4-081		H	A-A	W-C

TABLE 14
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-001	Sunbury	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-002	Berea	100% Siltstone, noncalcareous, lithified, massive very hard, light olive gray.	5Y 6/1
OH-6-4-003		100% Shale, noncalcareous, slightly anhydritic, slightly siliceous, massive, moderately hard to hard, medium dark gray.	N4
OH-6-4-004	Bedford	100% Shale, noncalcareous, slightly anhydritic, massive, moderately hard, medium dark gray.	N4
OH-6-4-005	"	100% Shale, noncalcareous, slightly anhydritic, very slightly carbonaceous, massive to tabular, moderately hard, medium dark gray.	N4
OH-6-4-006	"	100% Shale, noncalcareous, very slightly anhydritic, massive to tabular, moderately hard, grayish brown.	5YR3/2
OH-6-4-007	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular moderately hard, grayish brown.	5YR3/2
OH-6-4-008	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-009	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, brownish gray.	5YR3/2
OH-6-4-010	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, dusky brown.	5YR4/1
OH-6-4-011	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, dusky brown.	5YR2/2

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-012	Bedford	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-013	"	100% Shale, noncalcareous, anhydritic, siliceous in part, tabular, moderately hard to hard, medium to medium dark gray.	N5 to N4
OH-6-4-014	Cleveland	100% Shale, noncalcareous, slightly micromicaceous, very slightly carbonaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-015	"	100% Shale, noncalcareous, slightly micromicaceous, slightly carbonaceous, siliceous in part, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-016	"	100% Shale, noncalcareous, slightly micromicaceous, very slightly carbonaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-017	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly carbonaceous, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-018	Chagrin	100% Shale, noncalcareous, anhydritic, siliceous in part, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-019	"	100% Shale, noncalcareous, anhydritic, siliceous in part, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-020	"	100% Shale, noncalcareous, anhydritic, siliceous in part, tabular, moderately hard, medium to medium dark gray.	N5 to N4

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-021	Chagrin	100% Shale, noncalcareous, anhydritic, siliceous in part, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-022	"	100% Shale, noncalcareous, slightly anhydritic, tabular, medium hard, medium dark gray.	N4
OH-6-4-023	"	100 % Shale, noncalcareous, anhydritic, conchoidal to tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-024	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-025	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5
OH-6-4-026	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5
OH-6-4-027	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5
OH-6-4-028	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5
OH-6-4-029	"	100% Shale, noncalcareous, slightly anhydritic, slightly siliceous, tabular, moderately hard, medium gray.	N5
OH-6-4-030	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-031	Chagrin	100% Shale, noncalcareous, slightly anhydritic, siliceous, tabular, moderately hard to hard, medium light gray to medium gray.	N6 to N5
OH-6-4-032	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-033	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-034	Upper Huron	100% Shale, noncalcareous, anhydritic in part, micromicaceous in part, siliceous in part, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-035	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, siliceous in part, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-036	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-037	"	100% Shale, noncalcareous, very slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-038	"	100% Shale, noncalcareous, very slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-039	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-040	"	100% Shale, noncalcareous, anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-041	Upper Huron	100% Shale, noncalcareous, anhydritic, Tasmanites visible tabular, moderately hard, medium dark gray.	N4
OH-6-4-042	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-043	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-044	"	100% Shale, noncalcareous, very slightly anhydritic, few Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-045	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-046	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-047	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-6-4-048	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-049	Miidle Huron	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, medium dark gray.	N4
OH-6-4-050	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, medium dark gray.	N4

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-051	Middle Huron	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-052	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-053	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-054	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-055	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-056	"	100% Shale, noncalcareous, slightly anhydritic, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-057	"	100% Shale, noncalcareous, slightly anhydritic, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-058	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-059	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-060	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-061	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-062	Middle Huron	100% Shale, noncalcareous, slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, medium dark gray.	N4
OH-6-4-063	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-064	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-065	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-6-4-066	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-6-4-067	Lower Huron	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-068	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-069	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5
OH-6-4-070	"	100% Shale, noncalcareous, slightly anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-6-4-071	"	100% Shale, noncalcareous, slightly carbonaceous, very slightly micromicaceous, tabular, moderately hard, brownish black.	5YR2/1
OH-6-4-072	"	100% Shale, noncalcareous, very slightly carbonaceous, very slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1

TABLE 14(Continued)
Gross Lithological Description
for OH-6-4

Mound Sample Number	Interval	Gross Lithological Description	GSA Color Code
OH-6-4-073	Lower Huron	100% Shale, noncalcareous, slightly anhydritic, slightly micromicaceous, tabular, moderately hard, medium dark gray.	N4
OH-6-4-074	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-075	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-076	"	100% Shale, noncalcareous, anhydritic, massive to tabular, moderately hard, medium light gray.	N6
OH-6-4-077	"	100% Shale, noncalcareous, very slightly anhydritic, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-6-4-078	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-079	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium light to medium gray.	N6 to N5
OH-6-4-080	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-6-4-081	"	100% Shale, noncalcareous, very slightly anhydritic, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1

TABLE 15
Stratigraphic Intervals and Geochemical data for OH-6-5

Stratigraphic Interval	Depths (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Bedford	1555-1678	1.94		2.00	H+W-C	2.8	12.4
Cleveland	1678-1714	6.59	0.49	2.10	W-C	12.0	44.1
Upper Huron	1900-2034	1.94	0.48	2.10	W-C	11.9	5.6
Lower Huron	2206-2446	0.49	0.49	2.10	H	23.2	65.0
Upper Olentangy	2446-2582	0.62	-	2.10	H	4.1	2.9

2. Kerogen Elemental Composition

Two samples from the OH-6-5 well were analyzed for their kerogen composition - one sample from the Cleveland interval and one from the Lower Huron (Table 3). The H/C and O/C ratios were 1.14, 0.19, and 1.18, 0125, respectively. The plot of O/C vs. H/C for these samples indicates in Figure 2 that the kerogen is immature and was deposited in an intermediate environment.

3. Vitrinite Reflectance

Vitrinite reflectance measurements were completed on these two samples and two additional samples from the Upper Huron and the Upper Olentangy intervals (Table 16). No vitrinite was detected for the Olentangy sample, and the R_o values for the others ranged between 0.48 and 0.49, indicating that the shales are immature.

F. Ill-5 (Wayne County, Illinois)

1. Vitrinite Reflectance

A summary of the vitrinite reflectance measurements for 5 samples from the Ill-5 well is presented in Table 17. The range of R_o values was between 0.54 and 0.60, implying that all the samples were moderately immature.

G. OH-7 (Trumbull County, Ohio)

1. Stratigraphic Intervals

The stratigraphic intervals for the OH-7 well are identified in Table 18 along with average values for data accumulated for various intervals.

2. Organic Carbon Content

The total organic carbon content was determined for 121 samples from the OH-7 well (Table 19). The Rhinestreet interval had a high TOC average of 6.76 wt %, but this was biased upward by sample OH-7-108 which had a TOC value of 27.18 wt %. The Huron and the Chagrin-Huron had a combined average of 2.20 wt % and the Marcellus had an average of 3.25 wt %. The overall average TOC for the entire well was 2.01 wt % and a plot of TOC vs. depth is presented in Figure 4.

3. Vitrinite Relflectance

Measurements of the vitrinite reflectance were completed on 24 samples from the OH-7 well. The increase in thermal maturation down the well can be observed in Table 20. The average R_o

TABLE 16
Vitrinite Reflectance Summary
for OH-6-5

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-6-5-003	1682	Cleveland	(1)*	17	0.36	0.56	0.49
			(2)	9	0.60	0.73	0.67
			(3)	17	0.80	1.15	1.02
			(4)	1.30	2.10	1.61	
OH-6-5-009	1962	Upper Huron	(1)*	16	0.38	0.59	0.48
			(2)	8	0.65	0.80	0.73
			(3)	36	0.87	2.12	1.35
OH-6-5-013	2442	Lower Huron	(1)*	29	0.36	0.59	0.49
			(2)	12	0.61	0.75	0.69
			(3)	6	0.85	1.13	0.97
OH-6-5-016	2472	Upper Olentangy	NO VITRINITE				

*Indigenous population

TABLE 17
Vitrinite Reflectance Summary

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
Ill-5-001	5045.76	Hannibal-Saverton	(1)*	19	0.43	0.64	0.56
			(2)	41	0.74	2.29	1.40
Ill-5-005	5085.67	Grassy Creek	(1)*	22	0.42	0.65	0.54
			(2)	22	0.68	1.57	0.94
Ill-5-013	5160.55	Grassy Creek	(1)*	25	0.46	0.65	0.57
			(2)	23	0.67	1.51	0.81
Ill-5-019	5222.46	Selmier	(1)*	27	0.45	0.64	0.55
			(2)	19	0.66	0.80	0.71
			(3)	14	0.81	1.91	1.38
Ill-5-024	5271.55	Blocher	(1)*	14	0.51	0.67	0.60
			(2)	21	0.70	1.30	0.87
			(3)	25	1.63	2.46	1.96

*Indigenous population

TABLE 18
Stratigraphic Intervals and Geochemical data for OH-7

Stratigraphic Interval	Depths* (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Chagrin	1502-1551	0.73	0.50	1.76	H	7.0	2.6
Chagrin-Huron Intertongued	1551-1721	2.26	0.53	1.86	H	12.1	9.2
Huron	1721-2151	2.14	0.55	1.92	H	19.4	23.7
Hanover	2151-2281	0.42	0.66	2.15	W-C	6.5	1.2
Pipe Creek	2281-2292	0.28				2.4	0.6
Angola	2291-2481	0.66	0.61	2.30	H	5.2	4.5
Rhinestreet	2481-2581	6.76	0.58	2.30	H	15.8	40.9
Mahantango	2581-2651	1.21	0.64	2.30	W-C	11.9	16.4
Marcellus	2651-2701	3.15	0.62	2.30	H	32.6	37.8

*Approximate

TABLE 19
Total Organic Carbon

Mound Sample Number	Interval	Total Organic Carbon (wt %)
OH-7-001	Chagrin	2.42
OH-7-002		0.28
OH-7-003		0.41
OH-7-004		0.37
OH-7-005		0.18
OH-7-006	Chagrin-Huron Intertongued	1.38
OH-7-007		0.61
OH-7-008		3.92
OH-7-009		4.53
OH-7-010		0.29
OH-7-011		0.30
OH-7-012		1.34
OH-7-013		0.89
OH-7-014		3.15
OH-7-015		5.73
OH-7-016		0.76
OH-7-017		0.29
OH-7-018		7.30
OH-7-019		3.01
OH-7-020		0.70
OH-7-021		3.63
OH-7-022		0.39
OH-7-023		2.48
OH-7-024	Huron	2.63
OH-7-025		1.38
OH-7-026		4.00
OH-7-027		3.39
OH-7-028		0.20
OH-7-029		3.85
OH-7-030		0.22
OH-7-031		0.16
OH-7-032		3.22
OH-7-033		0.28
OH-7-034		3.08
OH-7-035		2.13
OH-7-036		3.60
OH-7-037		3.24
OH-7-038		3.20
OH-7-039		2.43
OH-7-040		1.85
OH-7-041		0.33
OH-7-042		0.56
OH-7-043		0.19
OH-7-044		4.74
OH-7-045		1.41

TABLE 19 (Continued)
Total Organic Carbon

Mound Sample Number	Interval	Total Organic Carbon(wt %)
OH-7-046	Huron	1.78
OH-7-047		2.46
OH-7-048		2.54
OH-7-049		2.18
OH-7-050		2.42
OH-7-051		2.33
OH-7-052		0.38
OH-7-053		0.32
OH-7-054		1.82
OH-7-055		1.27
OH-7-056		0.87
OH-7-057		0.59
OH-7-058		3.38
OH-7-059		3.09
OH-7-060		2.85
OH-7-061		0.15
OH-7-062		2.24
OH-7-063		2.10
OH-7-064		5.11
OH-7-065		4.70
OH-7-066		5.29
OH-7-067		0.34
OH-7-068	Hanover	0.13
OH-7-069		0.75
OH-7-070		0.50
OH-7-071		0.14
OH-7-072		0.66
OH-7-073		0.32
OH-7-074		0.17
OH-7-075		0.22
OH-7-076		0.17
OH-7-077		0.44
OH-7-078		1.34
OH-7-079	Pipe Creek	0.19
OH-7-080		0.28
OH-7-081	Angola	0.14
OH-7-082		0.16
OH-7-083		0.13
OH-7-084		0.12
OH-7-085		0.13
OH-7-086		0.09
OH-7-087		0.10
OH-7-088		0.11
OH-7-089		2.76
OH-7-090		0.84

TABLE 19 (Continued)
Total Organic Carbon

Mound Sample Number	Interval	Total Organic Carbon(wt %)
OH-7-091	Angola	0.45
OH-7-092		0.18
OH-7-093		0.18
OH-7-094		0.21
OH-7-095		0.96
OH-7-096		1.59
OH-7-097		3.21
OH-7-098		0.78
OH-7-099		0.46
OH-7-100	Rhinestreet	3.72
OH-7-101		2.19
OH-7-102		3.58
OH-7-103		7.85
OH-7-104		6.12
OH-7-105		2.14
OH-7-106		5.02
OH-7-107		7.31
OH-7-108		27.18
OH-7-109		2.52
OH-7-110	Mahantango	5.40
OH-7-111		0.42
OH-7-112		0.57
OH-7-113		0.68
OH-7-114		0.56
OH-7-115		0.60
OH-7-116		0.50
OH-7-117		0.96
OH-7-118	Marcellus	2.12
OH-7-119		3.22
OH-7-120		2.34
OH-7-121		4.93

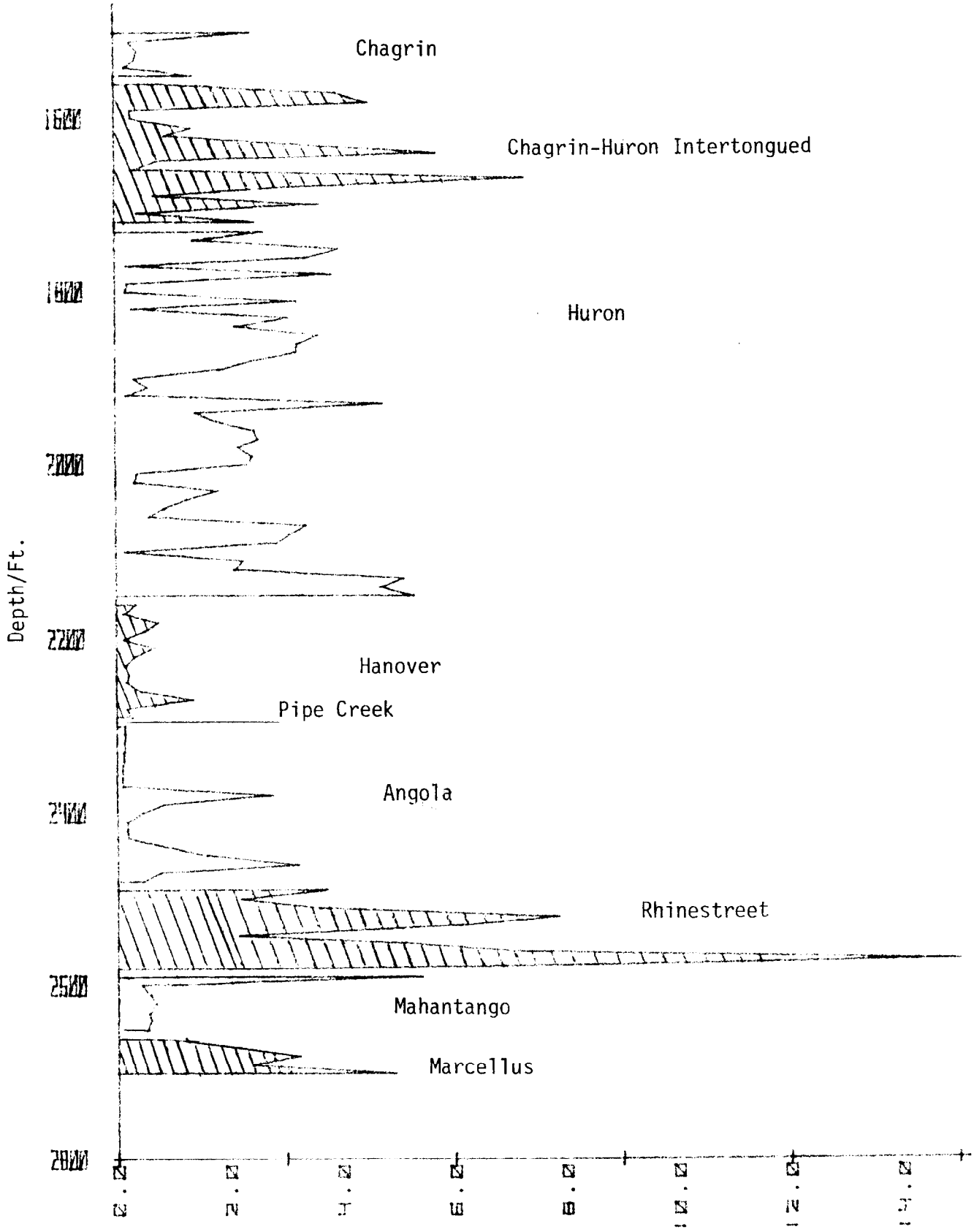

Figure 4

Organic Carbon vs. Depth for OH-7 Samples

TABLE 20
Vitrinite Reflectance Summary
for OH-7 Well

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-7-001	1502.69	Chagrin	(1)*	41	0.39	0.60	0.50
			(2)	19	0.67	2.20	1.22
OH-7-005	1542.66	"	(1)*	17	0.44	0.55	0.50
			(2)	17	0.58	0.71	0.65
			(3)	26	0.86	2.18	1.45
OH-7-009	1582.55	Chagrin-Huron Intertongued	(1)*	49	0.38	0.63	0.55
			(2)	11	0.67	1.26	0.93
OH-7-019	1681.82	"	(1)*	21	0.38	0.63	0.51
			(2)	39	0.67	2.22	1.21
OH-7-024	1732.65	Huron	(1)*	36	0.41	0.61	0.54
			(2)	18	0.62	0.76	0.67
			(3)	6	1.10	1.78	1.37
OH-7-030	1791.57	"	(1)*	1	0.49	0.40	0.49
			(2)	17	0.60	0.76	0.68
			(3)	42	0.80	2.04	1.21
OH-7-034	1831.55	"	(1)*	20	0.43	0.58	0.51
			(2)	34	0.60	0.83	0.71
			(3)	6	0.88	1.47	1.13
OH-7-040	1891.42		(1)*	29	0.44	0.63	0.57
			(2)	23	0.64	0.73	0.68
			(3)	8	0.77	1.09	0.85
OH-7-044	1931.62		(1)*	33	0.39	0.65	0.54
			(2)	9	0.70	0.88	0.75
			(3)	2	1.50	1.51	1.51

*Indigenous population

TABLE 20(Continued)
Vitrinite Reflectance Summary
for OH-7 Well

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-7-048	1971.71	Huron	(1)*	23	0.47	0.64	0.59
			(2)	14	0.66	0.72	0.69
			(3)	23	0.79	1.76	1.13
OH-7-053	2071.76	"	(1)*	4	0.48	0.68	0.57
			(2)	56	0.76	2.12	1.32
OH-7-058	2071.76	"	(1)*	8	0.47	0.56	0.52
			(2)	32	0.60	0.77	0.68
			(3)	20	0.80	1.43	1.08
OH-7-065	2141.83	"	(1)*	18	0.55	0.67	0.61
			(2)	16	0.69	0.93	0.78
			(3)	5	1.05	1.59	1.31
OH-7-069	2181.84	Hanover	(1)*	8	0.52	0.67	0.59
			(2)	38	0.70	0.95	0.84
			(3)	14	0.98	1.84	1.23
OH-7-073	2221.67	"	(1)*	15	0.57	0.76	0.69
			(2)	45	0.78	1.85	1.27
OH-7-078	2271.86	"	(1)*	16	0.57	0.77	0.69
			(2)	21	0.84	1.02	0.91
			(3)	23	1.15	1.89	1.36
OH-7-089	2381.68	Angola	(1)*	17	0.48	0.68	0.59
			(2)	40	0.70	0.90	0.78
			(3)	3	1.36	1.63	1.53

*Indigenous population

TABLE 20(Continued)
Vitrinite Reflectance Summary
for OH-7 Well

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-7-095	2442.47	Angola	(1)*	18	0.53	0.70	0.64
			(2)	32	0.72	0.95	0.80
			(3)	10	1.11	1.82	1.40
OH-7-100	2491.90	"	(1)*	20	0.49	0.68	0.59
			(2)	4	0.72	0.84	0.75
OH-7-104	2531.55	Rhinestreet	(1)*	16	0.51	0.64	0.58
			(2)	24	0.66	0.80	0.73
			(3)	20	0.85	1.66	1.08
OH-7-110	2591.85	Mahantango	(1)*	17	0.49	0.70	0.63
			(2)	15	0.77	1.24	0.96
OH-7-114	2631.81	"	(1)*	6	0.59	0.68	0.65
			(2)	28	0.78	1.15	1.01
			(3)	26	1.18	1.98	1.56
OH-7-119	2681.89	Marcellus	(1)*	23	0.50	0.70	0.61
			(2)	13	0.73	0.87	0.78
			(3)	24	0.95	2.20	1.40
OH-7-121	2701.52	Marcellus	(1)*	6	0.55	0.72	0.63
			(2)	4	0.81	0.93	0.85
			(3)	2	1.27	1.80	1.54

*Indigenous population

values range from 0.50 in the Chagrin to 0.64 in the Mahantango. This implies that the shale ranges in maturity from moderately immature to moderately mature.

4. Visual Kerogen Assessment

This moderate increase in maturity was also observed by visual assessment of the samples' kerogen. The TAI ranged from 1.76 in the Chagrin to 2.3 in the Marcellus. Table 21 indicates that the source of kerogen and the depositional environment changed occasionally. The Marcellus and the Rhinestreet appear to have been deposited in an intermediate to marine type environment (near shore?) with herbaceous material being the predominant source of kerogen and algal-amorphous being a secondary source (Table 22). In between the two, the Mahantango interval has terrestially derived woody-coaly material as the predominant source of kerogen. Kerogen in the Angola and Hanover was derived alternately between herbaceous and woody-coaly, or a mixture of the two. Their low TOC content and the source material suggests these intervals would not be good source rocks for hydrocarbon production. The Huron and Chagrin-Huron are basically from an intermediate type environment with herbaceous material as the predominant component.

5. Lithology

The lithological description for the OH-7 samples was completed (Table 23). All samples were 100% shale. Most of the shale was medium light to medium dark gray (N6 to N4) with occasional zones of brownish gray shale (5YR3/1). The Rhinestreet did have about a 20 ft. zone of brownish-black shale (5YR2/1). Tasmanites were visible throughout the Huron interval and in a few of the other samples.

H. PA-4 (Indiana County, Pennsylvania)

1. Stratigraphic Intervals

The stratigraphic intervals are described in Table 24. The average values for data from various intervals are also included.

2. Organic Carbon Content

Ninety-one samples from the PA-4 well were analyzed for organic carbon content (Table 25). The average TOC for the well was 0.98 wt %. The Middle Olentangy interval had the highest TOC with 1.08 wt %. Figure 5 is a plot of organic carbon vs. depth.

OH - 7 Well

TABLE 21
VISUAL KEROGEN ASSESSMENT WORKSHEET

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-001	1502'				1.70			H;W-C;-
OH-7-002	1512'				1.70			H;W;C
OH-7-003	1522'				1.80			H;W-C;-
OH-7-004	1532'				1.80			H;W-C;-
OH-7-005	1542'				1.80			H;W-C;-
OH-7-006	1551'				1.80			H*;Am;W-C
OH-7-007	1561'				1.80			H;W;C
OH-7-008	1571'				1.80			H*;Am;W-C
OH-7-009	1582'				1.80			Am-H*;-;W-C
OH-7-010	1591'				1.80			H;-;W-C
OH-7-011	1601'				1.80		vlom	H-C;-;Am**
OH-7-012	1612'				1.80			H;W-C;-
OH-7-013	1621'				1.90			H;W-C;Am
OH-7-014	1631'				1.90			H*;Am;W-C
OH-7-015	1641'				1.90			H;W-C;Am
OH-7-016	1651'				1.90			H;-;W-C
OH-7-017	1661'				1.90			H;W-C;-
OH-7-018	1671'				1.90			H;W;C(Am)
OH-7-019	1681'				1.90			H;W;C
OH-7-020	1691'				1.90			H;W-C;Am

OH - 7 Well

TABLE 21(Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

Mound No.	DEPTH	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-021	1701'	1.90	H*;Am;W-C
OH-7-022	1711'	1.90	H;W-C;Am
OH-7-023	1721'	1.90	H;Am;W-C
OH-7-024	1732'	1.90	H;Am;W-C
OH-7-025	1741'	1.90	H;W-C;Am
OH-7-026	1751'	1.90	H;Am;W-C
OH-7-027	1762'	1.90	H;Am;W-C
OH-7-028	1771'	1.90	H-C;W;-
OH-7-029	1781'	1.90	H;-;Am
OH-7-030	1791'	1.90	H-C;W;-
OH-7-031	1801'	1.90	W;H-C;-
OH-7-032	1812'	1.90	H;Am;W-C
OH-7-033	1821'	1.90	H;W-C;-
OH-7-034	1831'	1.90	H*;Am;W-C
OH-7-035	1841'	1.90	H*;Am-W;C
OH-7-036	1851'	1.90	H*;Am;W
OH-7-037	1861'	1.90	H*;Am;W
OH-7-038	1871'	1.90	H*;Am;W-C
OH-7-039	1881'	1.90	H*;Am;W-C
OH-7-040	1891'	1.90	Am-H*;-;W

TABLE 21(Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH - 7 Well

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-041	1901'				1.90			H;W-C;-
OH-7-042	1911'				1.90			H;W-C;-
OH-7-043	1921'				1.90			H;W-C;-
OH-7-044	1931'				1.90			H*;Am;W
OH-7-045	1941'				1.90			H;Am;W-C
OH-7-046	1951'				1.90			Am-H*;-;W
OH-7-047	1961'				1.90			Am-H*;-;W
OH-7-048	1971'				1.90			Am-H*;-;W-C
OH-7-049	1981'				1.90			Am-H*;-;
OH-7-050	1991'				1.90			H*;Am;W-C
OH-7-051	2001'				1.90			Am-H*;-;W-C
OH-7-052	2011'				1.90			H;W-C;-
OH-7-053	2021'				1.90			H;C;W
OH-7-054	2031'				1.90			H*;Am;W(C)
OH-7-055	2041'				1.90			Am-H*;-;W
OH-7-056	2051'				1.90			H;W-C;-
OH-7-057	2061'				1.90	vlom		H-C;W;-
OH-7-058	2071'				1.90			H*;Am;W-C
OH-7-059	2081'				1.90			H;Am;W-C
OH-7-060	2091'				1.90			H*;Am;W

OH - 7 Well

TABLE 21(Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

Mound No.	DEPTH	TYPE OF ORGANIC MATTER: RECOGNIZABLE ALGAE	AMORPHOUS - SAPROPEL	HELIC AMORPHOUS	PROTEA-POLLEN	PROTOZOA	CUTICLE	WOODY - HERBACEOUS DEBRIS	COALY - STRUCTURED DEBRIS	PYROBITUMEN	NONFLUORESCENT DEBRIS	OPAQUE DEBRIS	COLOR OF ORGANIC MATTER: YELLOW	YELLOW ORANGE	ORANGE BROWN	LIGHT BROWN	DARK BROWN	BLACK	STATE OF ORGANIC MATTER: PARTICLE SIZE: FINELY DISSEMINATED	FINE	MEDIUM	COARSE	PRESERVATION: EXCELLENT	GOOD	FAIR	POOR	UNALTERED	SLIGHTLY ALTERED	MODERATELY ALTERED	STRONGLY ALTERED	MATURATION INDEX: SEVERELY ALTERED	HYPERMETAMORPHOSED	DEPOSITIONAL ENVIRONMENT: OFFSHORE MARINE	NEARSHORE MARINE	RESTRICTED MARINE	LACUSTRINE	DELTA-SHORE MARSH	CONTINENTAL	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-061	2101'																																							2.00	H-C;W;-
OH-7-062	211'																																							2.00	H;-;Am-W
OH-7-063	2121'																																							2.00	H;-;W-C
OH-7-064	2131'																																							2.00	H*;Am;W-C
OH-7-065	2141'																																							2.00	H*;Am;W-C
OH-7-066	2151'																																							2.00	H*;Am;W-C
OH-7-067	2161'																																							2.10	H;W-C;-
OH-7-068	2171'																																							2.10 vlom	H-C;-;-
OH-7-069	2181'																																							2.10	H;W;C
OH-7-070	2191'																																							2.10 vlom	H;W;-
OH-7-071	2201'																																							2.10	H;W;C
OH-7-072	2211'																																							2.10	H;-;W
OH-7-073	2221'																																							2.10	W-C;H;-
OH-7-074	2231'																																							2.10	W;H-C;-
OH-7-075	2241'																																							2.20	W-C;H;-
OH-7-076	2251'																																							2.20	W-C;-;H
OH-7-077	2261'																																							2.20	H;W-C;-
OH-7-078	2271'																																							2.20	H;W-C;-
OH-7-079	2281'																																							2.30	W-C;H;-
OH-7-080	2291'																																							2.30	W-C;H;-

TABLE 21(Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH - 7 Well

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-081	2301'						2.30 vlom; barren	H-C;-;-
OH-7-082	2311'						2.30 vlom; barren	H-C;-;-
OH-7-083	2321'						2.30 vlom; barren	H-C;-;-
OH-7-084	2331'						2.30 vlom; barren	H-C;-;-
OH-7-085	2341'						2.30 vlom; barren	H;C;-
OH-7-086	2351'						2.30 vlom; barren	H-C;-;-
OH-7-087	2361'						2.30 vlom; barren	H-C;-;-
OH-7-088	2371'						2.30 vlom; barren	H-C;-;-
OH-7-089	2381'						2.30	H*;Am;W-C
OH-7-090	2391'						2.30 vlom; barren	H-C;-;-
OH-7-091	2401'						2.30 vlom; barren	H;C;-
OH-7-092	2411'						2.30 vlom; barren	H-C;-;-
OH-7-093	2421'						2.30 vlom; barren	H-C;-;-
OH-7-094	2431'						2.30 vlom; barren	H-C;-;-
OH-7-095	2442'						2.30	H*;Am;W-C
OH-7-096	2451'						2.30	H*;Am;-
OH-7-097	2462'						2.30	H*;Am-W;C
OH-7-098	2471'						2.30 vlom	H;C;-
OH-7-099	2481'						2.30	H-W;C;-
OH-7-100	2491'						2.30 vlom	H*;Am;W

TABLE 21(Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH - 7 Well

Mound No.	DEPTH	TYPE OF ORGANIC MATTER: RECOGNIZABLE ALGAE	AMORPHOUS-SAPROPEL	RELIC AMORPHOUS	SPORES-POLLEN	PEDERIDO	CUTICLE	WOODY HERBACEOUS DEBRIS	COAL-NATIVE DEBRIS	PYROBITUMEN	BORDERLAND	COLOR OF ORGANIC MATTER: GREENISH LIGHT YELLOW	YELLOW	YELLOW ORANGE	ORANGE BROWN	LIGHT BROWN	DARK BROWN	BLACK	PARTICLE SIZE: FINELY DISSEMINATED	FINE	MEDIUM	COARSE	PRESERVATION: EXCELLENT	GOOD	FAIR	POOR	STATE OF ORGANIC MATTER: UNALTERED	SLIGHTLY ALTERED	MODERATELY ALTERED	STRONGLY ALTERED	MATURATION INDEX: 1	1.5	2	2.5	3	3.5	4	4.5	5	DEPOSITIONAL ENVIRONMENT: SEVERELY ALTERED	MEIMOREMOTED	OFFSHORE	NEARSHORE	RESTRICTED	LACUSTRINE	CONTINENTAL	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-101	2501'																																															2.30	H*;Am;W-C
OH-7-102	2511'																																															2.30	H*;Am;W-C
OH-7-103	2521'																																															2.30	Am-H*;-;W-C
OH-7-104	2531'																																															2.30	Am-H*;-;W
OH-7-105	2543'																																															2.30	H*;Am;W-C
OH-7-106	2551'																																															2.30	Am-H*;W;C
OH-7-107	2561'																																															2.30	H*;Am;W(C)
OH-7-108	2572'																																															2.30	H*;Am;W
OH-7-109	2581'																																															2.30	H*;Am-W;-
OH-7-110	2591'																																															2.30	H*;Am;W(C)
OH-7-111	2600'																																															2.30	H-C;W;-
OH-7-112	2611'																																															2.30	H;C;W
OH-7-113	2621'																																															2.30	H;W-C;-
OH-7-114	2631'																																															2.30	H;C;W
OH-7-115	2641'																																															2.30 vlom	H-C;W;-
OH-7-116	2651'																																															2.30	H;W-C;Am
OH-7-117	2660'																																															2.30	H*;W-C;Am
OH-7-118	2671'																																															2.30	H*;Am;W(C)
OH-7-119	2681'																																															2.30	H*;Am;W-C
OH-7-120	2691'																																															2.30	H*;Am;W

TABLE 21(Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

OH - 7 Well

Mound No.	DEPTH	TYPE OF ORGANIC MATTER: RECOGNIZABLE LEAF / AMORPHOUS-GRANULAR / MELTED AMORPHOUS / SPORIFIC-PALLID / SPORIFIC-DARK / CUTICLE / WOODY-FIBROUS / COAL-LIGNITE-TYPE WOOD / PEAT-LIGNITE-TYPE WOOD / ROOTLETS-RHIZOMES / CYLINDRIC LEAF / YELLOW / ORANGE / DRAB BROWN / LIGHT BROWN / DARK BROWN / BLACK	COLOR OF ORGANIC MATTER: FINELY DISSEMINATED / FINE / MEDIUM / COARSE	STATE OF ORGANIC MATTER: PARTICLE SIZE / PRESERVATION: EXCELLENT / GOOD / FAIR / POOR / UNALTERED / SLIGHTLY ALTERED / MODERATELY ALTERED / STRONGLY ALTERED / SEVERELY ALTERED	MATURATION INDEX: METAMORPHOSED / OFFSHORE MARINE / NEARSHORE MARINE / RESTRICTED MARINE / LAGOONAL / NEARSHORE MARSH / CONTINENTAL	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
OH-7-121	2701'						2.30	Am-H*;-;W

TABLE 22
Kerogen Visual Assessment; Componets of Kerogen
for OH-7 Well

Mound Sample Number		Predominant	Secondary	Trace
OH-7-001		H	W-C	-
OH-7-002		H	W	C
OH-7-003	Chagrin	H	W-C	-
OH-7-004		H	W-C	-
OH-7-005		H	W-C	-
OH-7-006		H	Am	W-C
OH-7-007		H	W	C
OH-7-008		H	Am	W-C
OH-7-009		Am-H	-	W-C
OH-7-010		H	-	W-C
OH-7-011		H-C	-	Am
OH-7-012		H	W-C	-
OH-7-013		H	W-C	Am
OH-7-014	Chagrin-Huron	H	Am	W-C
OH-7-015	Intertongued	H	W-C	Am
OH-7-016		H	-	W-C
OH-7-017		H	W-C	-
OH-7-018		H	W	C(Am)
OH-7-019		H	W	C
OH-7-020		H	W-C	Am
OH-7-021		H	Am	W-C
OH-7-022		H	W-C	Am
OH-7-023		H	Am	W-C
OH-7-024		H	Am	W-C
OH-7-025		H	W-C	Am
OH-7-026		H	Am	W-C
OH-7-027		H	Am	W-C
OH-7-028		H-C	W	-
OH-7-029		H	-	Am
OH-7-030		H-C	W	-
OH-7-031		W	H-C	-
OH-7-032		H	Am	W-C
OH-7-033		H	W-C	-
OH-7-034		H	Am	W-C
OH-7-035		H	Am-W	C
OH-7-036		H	Am	W
OH-7-037	Huron	H	Am	W
OH-7-038		H	Am	W-C
OH-7-039		H	Am	W-C
OH-7-040		Am-H	-	W
OH-7-041		H	W-C	-
OH-7-042		H	W-C	-
OH-7-043		H	W-C	-
OH-7-044		H	Am	W
OH-7-045		H	Am	W-C

TABLE 22 (Continued)
Kerogen Visual Assessment; Components of Kerogen
for OH-7 Well

Mound Sample Number		Predominant	Secondary	Trace
OH-7-046		Am-H	-	W
OH-7-047		Am-H	-	W
OH-7-048		Am-H	-	W-C
OH-7-049		Am-H	-	-
OH-7-050		H	Am	W-C
OH-7-051	Huron	Am-H	-	W-C
OH-7-052		H	W-C	-
OH-7-053		H	C	W
OH-7-054		H	Am	W(C)
OH-7-055		Am-H	-	W
OH-7-056		H	W-C	-
OH-7-057		H-C	W	-
OH-7-058		H	Am	W-C
OH-7-059		H	Am	W-C
OH-7-060		H	Am	W
OH-7-061		H-C	W	-
OH-7-062		H	-	Am-W
OH-7-063		H	-	W-C
OH-7-064		H	Am	W-C
OH-7-065		H	Am	W-C
OH-7-066		H	Am	W-C
OH-7-067		H	W-C	-
OH-7-068		H-C	-	-
OH-7-069		H	W	C
OH-7-070		H	W	-
OH-7-071		H	W	C
OH-7-072		H	-	W
OH-7-073	Hanover	W-C	H	-
OH-7-074		W	H-C	-
OH-7-075		W-C	H	-
OH-7-076		W-C	-	H
OH-7-077		H	W-C	-
OH-7-078		H	W-C	-
OH-7-079		W-C	H	-
OH-7-080	Pipecreek	W-C	H	-
OH-7-081		H-C	-	-
OH-7-082		H-C	-	-
OH-7-083		H-C	-	-
OH-7-084		H-C	-	-
OH-7-085	Angola	H	C	-
OH-7-086		H-C	-	-
OH-7-087		H-C	-	-
OH-7-088		H-C	-	-
OH-7-089		H	Am	W-C
OH-7-090		H-C	-	-

TABLE 22 (Continued)
Kerogen Visual Assessment; Components of Kerogen
for OH-7 Well

Mound Sample Number		Predominant	Secondary	Trace
OH-7-091		H	C	-
OH-7-092		H-C	-	-
OH-7-093		H-C	-	-
OH-7-094		H-C	-	-
OH-7-095	Angola	H	Am	W-C
OH-7-096		H	Am	-
OH-7-097		H	Am-W	C
OH-7-098		H	C	-
OH-7-099		H-W	C	-
OH-7-100		H	Am	W
OH-7-101		H	Am	W-C
OH-7-102		H	Am	W-C
OH-7-103	Rhinestreet	Am-H	-	W-C
OH-7-104		Am-H	-	W
OH-7-105		H	Am	W-C
OH-7-106		Am-H	W	C
OH-7-107		H	Am	W(C)
OH-7-108		H	Am	W
OH-7-109		H	Am-W	-
OH-7-110		H	Am	W(C)
OH-7-111		H-C	W	-
OH-7-112		H	C	W
OH-7-113	Mahantango	H	W-C	-
OH-7-114		H	C	W
OH-7-115		H-C	W	-
OH-7-116		H	W-C	Am
OH-7-117		H	W-C	Am
OH-7-118		H	Am	W(C)
OH-7-119	Marcellus	H	Am	W-C
OH-7-120		H	Am	W
OH-7-121		Am-H	-	W

TABLE 23
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-001	Chagrin	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-002	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-003	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-004	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-005	"	100% Shale, noncalcareous, anhydritic, siliceous in part, tabular, moderately hard, medium gray to medium dark gray.	N5 to N4
OH-7-006	Chagrin-Huron Intertongued	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-007	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-008	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly carbonaceous, tabular, moderately hard, dark olive gray.	5Y3/1
OH-7-009	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-010	"	100% Shale, noncalcareous, siliceous in part, slightly anhydritic, tabular to massive, moderately hard to hard, medium light gray to medium dark gray.	N6 to N4

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-011	Chagrin-Huron Intertongued	100% Shale, noncalcareous, extremely siliceous, tabular to massive, hard, medium light gray.	N6
OH-7-012	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-013	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-014	"	100% Shale, noncalcareous, very slightly micromicaceous, very slightly carbonaceous, tabular, moderately hard, brownish black.	5YR2/1
OH-7-015	"	100% Shale, noncalcareous, anhydritic, few Tasmanites visiable, tabular, moderately hard, medium to medium dark gray.	N5 to N4
OH-7-016	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-017	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-018	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-019	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-020	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-021	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-022	Chagrin-Huron Intertongued	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-023	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-024	Huron	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-025	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-026	"	100% Shale, noncalcareous, slightly anhydritic, slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-027	"	100% Shale, noncalcareous, slightly anhydritic, slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-028	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-029	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-030	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-031	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-032	"	100% Shale, noncalcareous, abundant Tasmanites, tabular, moderately hard, brownish black.	5YR2/1

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-033	Huron	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-034	"	100% Shale, noncalcareous, very slightly anhydritic, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-035	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-036	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, medium dark gray.	N4
OH-7-037	"	100% Shale, noncalcareous, slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-038	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-039	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-040	"	100% Shale, noncalcareous, anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-041	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-042	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-043	"	100% Shale, slightly calcareous, anhydritic, tabular, moderately hard, medium gray.	N5

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-044	Huron	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, abundant Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-045	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-046	"	100%, noncalcareous, very slightly anhydritic, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-047	"	100% Shale, noncalcareous, very slightly anhydritic. very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-048	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-049	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, brownish gray.	5YR4/1
OH-7-050	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-051	"	100% Shale, noncalcareous, slightly anhydritic, tabular, hard, dark brownish gray.	5YR3/1
OH-7-052	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-053	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-054	Huron	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-055	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-056	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-057	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-058	"	100% Shale, noncalcareous, slightly micromicaceous, very slightly anhydritic, very slightly carbonaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-059	"	100% Shale, noncalcareous, slightly micromicaceous, very slightly anhydritic, very slightly carbonaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-060	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4
OH-7-061	"	100% Shale, noncalcareous, anhydritic, tabular to massive, moderately hard, medium gray.	N5
OH-7-062	"	100% Shale, noncalcareous, anhydritic, abundant Tasmanites, tabular, moderately hard, medium dark gray.	N4
OH-7-063	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, medium dark gray.	N4

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-064	Huron	100% Shale, noncalcareous, slightly carbonaceous, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, olive black.	5Y2/1
OH-7-065	"	100% Shale, noncalcareous, slightly carbonaceous, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, olive black.	5Y2/1
OH-7-066	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, medium dark gray.	N4
OH-7-067	"	100% Shale, noncalcareous, anhydritic, massive to tabular, moderately hard, medium gray.	N5
OH-7-068	Hanover	100% Shale, slightly calcareous, slightly anhydritic, tabular to massive, moderately hard, medium dark gray.	N4
OH-7-069	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-070	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-071	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-072	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5
OH-7-073	"	100% Shale, noncalcareous, anhydritic, tabular to conchoidal, moderately hard, medium gray.	N5

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-074	Hanover	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-075	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-076	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-077	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-078	"	100% Shale, noncalcareous, very slightly anhydritic, coal lens, tabular, moderately hard, medium dark gray.	N4
OH-7-079	"	100% Shale, noncalcareous, anhydritic tabular, moderately hard, medium gray.	N5
OH-7-080	Pipe Creek	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-081	Angola	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-082	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-083	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-084	"	100% Shale, very slightly calcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-085	"	100% Shale, very slightly calcareous, anhydritic, tabular, moderately hard, medium dark gray.	

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-086	Angola	100% Shale, very slightly calcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-087	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-088	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-089	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-090	"	100% Shale, noncalcareous, anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-091	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-092	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-093	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-094	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium gray.	N5
OH-7-095	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-096	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-097	Angola	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-098	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-099	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-100	Rhinestreet	100% Shale, noncalcareous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-101	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-102	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard medium dark gray.	N4
OH-7-103	"	100% Shale, noncalcareous, very slightly micromicaceous, tabular, moderately hard, dark brownish black.	5YR3/1
OH-7-104	"	100% Shale, noncalcareous, very slightly micromicaceous, Tasmanites visible, tabular, moderately hard, brownish black.	5YR2/1
OH-7-105	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, brownish black.	5YR2/1
OH-7-106	"	100% Shale, noncalcareous, slightly micromicaceous, tabular, moderately hare, brownish black.	5YR2/1
OH-7-107	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-108	Rhinestreet	100% Shale, noncalcareous, slightly carbonaceous, very slightly micromicaceous, tabular, moderately hard, brownish black.	5YR2/1
OH-7-109	"	100% Shale, noncalcareous, slightly anhydritic, tabular to massive, moderately hard, medium dark gray.	N4
OH-7-110	Mahantango	100% Shale, noncalcareous, tabular, moderately hard, brownish black.	5YR2/1
OH-7-111	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-7-112	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-7-113	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-7-114	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-7-115	"	100% Shale, very slightly calcareous, slightly anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-7-116	"	100% Shale, calcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
OH-7-117	"	100% Shale, very slightly calcareous, anhydritic, tabular to conchoidal, moderately hard, medium dark gray.	N4
OH-7-118	Marcellus	100% Shale, very slightly calcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 23(Continued)
Gross Lithological Description
for OH-7

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
OH-7-119	Marcellus	100% Shale, noncalcareous, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-120	"	100% Shale, noncalcareous, slightly anhydritic, Tasmanites visible, tabular, moderately hard, dark brownish gray.	5YR3/1
OH-7-121	"	100% Shale, noncalcareous, tabular, moderately hard, brownish black.	5YR2/1

TABLE 24
Stratigraphic Intervals and Geochemical data for PA-4

Stratigraphic Interval	Depths* (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Sonyea	7100-7340	0.86		3.60	W-C	11.3	1.6
Genesee	7340-7569	1.33		3.60	W-C	12.3	3.7
Tully L.S.	7569-7620	0.64		3.60	W-C	12.1	2.1
Mahantango	7620-7671	0.80		3.60	W-C	8.3	1.3
Marcellus	7671-8003	0.87		3.60	W-C	9.2	1.9

*Approximate

TABLE 25
Total Organic Carbon
for PA-4

Mound Sample Number	Interval	Total Organic Carbon(wt %)
PA-4-001		0.25
PA-4-002		0.20
PA-4-003		0.21
PA-4-004		0.27
PA-4-005		0.31
PA-4-006		0.29
PA-4-007		0.19
PA-4-008		0.25
PA-4-009		0.36
PA-4-010		0.21
PA-4-011		0.30
PA-4-012		0.27
PA-4-013		0.35
PA-4-014		0.35
PA-4-015		0.35
PA-4-016		0.56
PA-4-017		0.99
PA-4-018		2.19
PA-4-019	Sonyea	2.80
PA-4-020		1.77
PA-4-021		1.84
PA-4-022		3.44
PA-4-023		1.79
PA-4-024		1.26
PA-4-025		0.75
PA-4-026		2.24
PA-4-027	Genesee	2.57
PA-4-028		0.58
PA-4-029		1.03
PA-4-030		0.92
PA-4-031		0.40
PA-4-032		0.63
PA-4-033		0.61
PA-4-034		0.64
PA-4-035		0.32
PA-4-036		0.55
PA-4-037		0.88
PA-4-038		0.60
PA-4-039		1.05
PA-4-040		1.06
PA-4-041		1.44
PA-4-042		1.72
PA-4-043		1.31
PA-4-044		1.28
PA-4-045		1.47

TABLE 25 (Continued)
Total Organic Carbon
for PA-4

Mound Sample Number	Interval	Total Organic Carbon (wt %)
PA-4-046	Genesee	2.16
PA-4-047		5.60
PA-4-048		1.65
PA-4-049	Tully L.S.	0.43
PA-4-050		1.44
PA-4-051		0.43
PA-4-052		0.25
PA-4-053	Mahantango	1.21
PA-4-054		0.93
PA-4-055		0.78
PA-4-056		0.84
PA-4-057		0.88
PA-4-058	Marcellus	0.63
PA-4-059		0.52
PA-4-060		0.48
PA-4-061		0.49
PA-4-062		0.37
PA-4-063		0.37
PA-4-064		0.42
PA-4-065		0.44
PA-4-066		0.44
PA-4-067		0.42
PA-4-068		0.47
PA-4-069		0.32
PA-4-070		0.31
PA-4-071		0.33
PA-4-072		0.35
PA-4-073		0.41
PA-4-074		0.39
PA-4-075		0.36
PA-4-076		0.26
PA-4-077		0.26
PA-4-078		0.30
PA-4-079		0.99
PA-4-080		0.97
PA-4-081		0.86
PA-4-082		0.72
PA-4-083		1.37
PA-4-084		1.67
PA-4-085		1.71
PA-4-086		3.09
PA-4-087		2.71
PA-4-088		2.98
PA-4-089		2.95
PA-4-090		0.44
PA-4-091		0.70

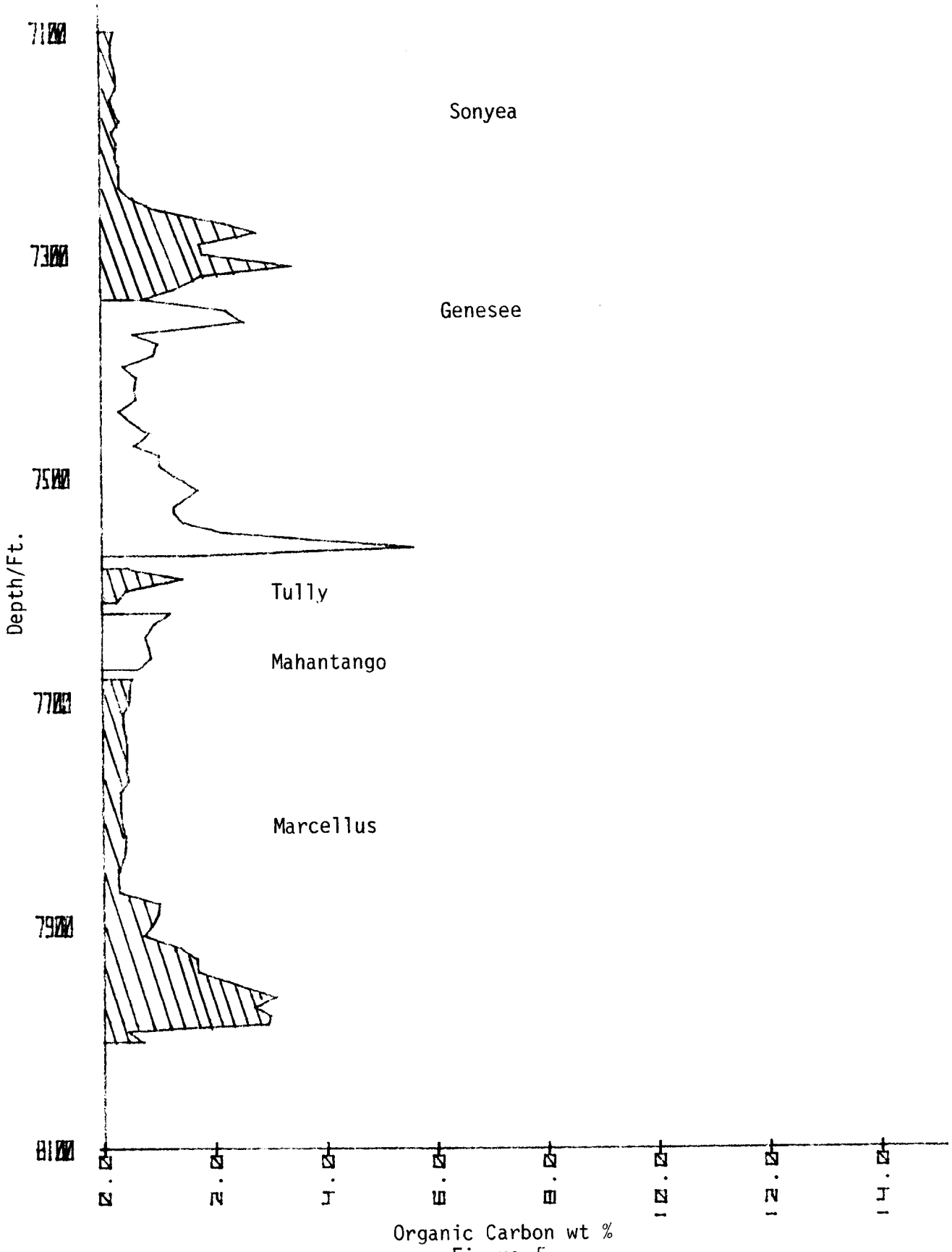

Figure 5
Organic Carbon vs. Depth for PA-4 Samples

3. Visual Kerogen Assessment

The visual kerogen assessment of the samples revealed that all the samples were very mature (TAI = 3.6; Table 26). The kerogen was dark brown to black and was derived from woody-coaly material except in two locations (7471-7489 ft. and 7930-7994 ft.) where amorphous material was the predominant source (Table 27). The low amount of organic material, the high degree of maturation, and the source material suggest that much of this well's potential for hydrocarbon generation has already been produced, probably in the form of gaseous hydrocarbons. The gas contents were low, (the amount of residual and total gas released was small) and the percentage of methane in the gas was high, all implying that much of the gas has been converted to methane and has migrated away from the source rock.

4. Lithology

Lithological descriptions of the PA-4 samples were completed (Table 28). All samples are 100% shale, noncalcareous, and either medium dark gray or dark gray (N4 or N3).

I. MI-1 (Ostego County, Michigan)

1. Organic Carbon Content

The total organic carbon content was determined for six MI-1 samples (Table 29). The average TOC was 7.01 wt %, ranging from 15.76 wt % to 1.83 wt %. Figure 6 is a plot of organic carbon vs. depth.

2. Visual Kerogen Assessment

Visual Kerogen Assessment of the MI-1 well was completed (Table 30). The shale was immature. The TAI ranged from 1+ to 2- and the color from yellow to orange brown. The predominant source of kerogen in all samples was herbaceous material (Table 31). Algal-amorphous material was a secondary source. Almost no woody-coaly derived kerogen was found. This would indicate that this shale with its very high organic carbon content has a high potential for oil generation.

3. Vitrinite Reflectance

One sample from MI-1 was analyzed for vitrinite reflectance (Table 32). Its R_0 value of 0.47 indicates the sample was moderately immature.

PA-4 WELL

TABLE 26
VISUAL KEROGEN ASSESSMENT WORKSHEET

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
PA-4-001	7100						3.6	
PA-4-002	7110						3.6	
PA-4-003	7120						3.6	
PA-4-004	7131						3.6	
PA-4-005	7140						3.6	
PA-4-006	7150						3.6	
PA-4-007	7160						3.6	
PA-4-008	7170						3.6	
PA-4-009	7180						3.6	
PA-4-010	7190						3.6	
PA-4-011	7200						3.6	
PA-4-012	7212						3.6	
PA-4-013	7221						3.6	
PA-4-014	7230						3.6	
PA-4-015	7240						3.6	
PA-4-016	7250						3.6	
PA-4-017	7260						3.6	
PA-4-018	7272						3.6	
PA-4-019	7280						3.6	
PA-4-020	7290						3.6	

TABLE 26 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

PA-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
PA-4-021	7300						3.6	
PA-4-022	7310						3.6	
PA-4-023	7319						3.6	
PA-4-024	7332						3.6	
PA-4-025	7340						3.6	
PA-4-026	7350						3.6	
PA-4-027	7360						3.6	
PA-4-028	7371						3.6	
PA-4-029	7380						3.6	
PA-4-030	7391						3.6	
PA-4-031	7400						3.6	
PA-4-032	7410						3.6	
PA-4-033	7420						3.6	
PA-4-034	7430						3.6	
PA-4-035	7440						3.6	
PA-4-036	7450						3.6	
PA-4-037	7460						3.6	
PA-4-038	7471						3.6	
PA-4-039	7480						3.6	
PA-4-040	7489						3.6	

TABLE 26 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

PA-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
PA-4-041	7502						3.6	
PA-4-042	7511						3.6	
PA-4-043	7525						3.6	
PA-4-044	7530						3.6	
PA-4-045	7540						3.6	
PA-4-046	7549						3.6	
PA-4-047	7562						3.6	
PA-4-048	7569						Vlom. 3.6	
PA-4-049	7580						3.6	
PA-4-050	7590						3.6	
PA-4-051	7600						3.6	
PA-4-052	7610						3.6	
PA-4-053	7620						3.6	
PA-4-054	7630						3.6	
PA-4-055	7640						3.6	
PA-4-056	7651						3.6	
PA-4-057	7660						3.6	
PA-4-058	7671						3.6	
PA-4-059	7680						3.6	
PA-4-060	7690						3.6	

TABLE 26 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

PA-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
PA-4-061	7700						3.6	
PA-4-062	7710						3.6	
PA-4-063	7720						3.6	
PA-4-064	7730						3.6	
PA-4-065	7738						3.6	
PA-4-066	7750						3.6	
PA-4-067	7760						3.6	
PA-4-068	7770						3.6	
PA-4-069	7780						3.6	
PA-4-070	7790						3.6	
PA-4-071	7799						3.6	
PA-4-072	7810						3.6	
PA-4-073	7820						3.6	
PA-4-074	7830						3.6	
PA-4-075	7840						3.6	
PA-4-076	7850						3.6	
PA-4-077	7860						3.6	
PA-4-078	7870						VLOM 3.6	
PA-4-079	7880						3.6	
PA-4-080	7890						3.6	

TABLE 26 (Continued)

VISUAL KEROGEN ASSESSMENT WORKSHEET

PA-4 WELL

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS	SUMMARY ORGANIC MATTER TYPE
PA-4-081	7900						3.6	
PA-4-082	7909						3.6	
PA-4-083	7920						3.6	
PA-4-084	7930						3.6	
PA-4-085	7942						Vlom; 3.6	
PA-4-086	7964						Vlom; 3.6	
PA-4-087	7973						3.6	
PA-4-088	7980						3.6	
PA-4-089	7988						3.6	
PA-4-090	7994						3.6	
PA-4-091	8003						Vlom; 3.6	

TABLE 27
Kerogen Visual Assessment; Components of Kerogen
for PA-4 Well

Mound Sample Number		Predominant	Secondary	Trace
PA-4-001		W-C	-	H
PA-4-002		W-C	-	H
PA-4-003		W-C	-	H
PA-4-004		W-C	-	H
PA-4-005		W-C	-	H
PA-4-006		W-C	-	H
PA-4-007		W-C	-	H
PA-4-008		W-C	-	H
PA-4-009		W-C	-	H
PA-4-010		W-C	-	H
PA-4-011		W-C	-	H
PA-4-012		W-C	-	H
PA-4-013		W-C	-	H
PA-4-014		W-C	-	H
PA-4-015		W-C	-	H
PA-4-016	Sonyea	W-C	-	Am
PA-4-017		W-C	-	H
PA-4-018		W-C	-	H
PA-4-019		W-C	-	H
PA-4-020		W-C	-	H
PA-4-021		W-C	-	H+Am
PA-4-022		W-C	-	H+Am
PA-4-023		W-C	-	Am
PA-4-024		W-C	-	H
PA-4-025		W-C	-	H
PA-4-026		W-C	-	Am+H
PA-4-027		W-C	-	H
PA-4-028		W-C	-	H
PA-4-029		W-C	-	H+Am
PA-4-030	Genesee	W-C	-	H
PA-4-031		W-C	-	H
PA-4-032		W-C	-	H
PA-4-033		W-C	-	H
PA-4-034		W-C	-	H
PA-4-035		W-C	-	H
PA-4-036		W-C	-	H
PA-4-037		W-C		H
PA-4-038		W-C	H	Am
PA-4-039		W-C	H	Am
PA-4-040		W-C	H	Am
PA-4-041		W-C	H	Am
PA-4-042		W-C	H	-
PA-4-043		W-C	H	-
PA-4-044		W-C	H	-
PA-4-045		W-C	H	-

TABLE 27 (Continued)
Kerogen Visual Assessment; Components of Kerogen
for PA-4 Well

Mound Sample Number		Predominant	Secondary	Trace
PA-4-046	Genesee	W-C	H	Am
PA-4-047		W-C	H	Am
PA-4-048		W-C	H	-
PA-4-049		W-C	H	-
PA-4-050	Tully	W-C	H	-
PA-4-051		W-C	H	-
PA-4-052		W-C	H	Am
PA-4-053		W-C	H	-
PA-4-054	Mahantango	W-C	H	-
PA-4-055		W-C	H	-
PA-4-056		W-C	H	-
PA-4-057		W-C	H	-
PA-4-058		W-C	H	-
PA-4-059		W-C	H	-
PA-4-060		W-C	H	-
PA-4-061		W-C	H	-
PA-4-062		W-C	H	-
PA-4-063		W-C	H	-
PA-4-064		W-C	H	-
PA-4-065		W-C	H	-
PA-4-066		W-C	H	-
PA-4-067		W-C	H	-
PA-4-068		W-C	H	-
PA-4-069		W-C	H	-
PA-4-070		W-C	H	-
PA-4-071		W-C	H	-
PA-4-072		W-C	H	-
PA-4-073	Marcellus	W-C	H	-
PA-4-074		W-C	H	-
PA-4-075		W-C	H	-
PA-4-076		W-C	H	-
PA-4-077		W-C	H	-
PA-4-078		W-C	H	-
PA-4-079		W-C	H	-
PA-4-080		W-C	H	-
PA-4-081		W-C	H	-
PA-4-082		W-C	H	-
PA-4-083		W-C	H	Am
PA-4-084		Am	H	W-C
PA-4-085		Am	H	W-C
PA-4-086		Am	H	W-C
PA-4-087		Am	H	W-C
PA-4-088		Am	H	W-C
PA-4-089		Am	H	W-C
PA-4-090		Am	H	W-C
PA-4-091		W-C	H	-

TABLE 28
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-001	Sonyea	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-002	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-003	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-004	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-005	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-006	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-007	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-008	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-009	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-010	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-011	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-012	Sonyea	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-013	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-014	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-015	"	100% Shale, noncalcareous, slightly anhdyritic, tabular, moderately hard, medium dark gray.	N4
PA-4-016	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-017	"	100% Shale, noncalcareous, siliceous in part, tabular, moderately hard, dark gray.	N3
PA-4-018	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-019	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-020	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-021	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-022	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-023	Sonyea	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-024	"	100% Shale, noncalcareous, slightly anhydritic, tabular to papery, moderately hard, medium dark gray.	N4
PA-4-025	"	100% Shale, noncalcareous, very slightly carbonaceous, tabular to papery, moderately hard, dark gray.	N3
PA-4-026	Genesee	100% Shale, noncalcareous, very slightly carbonaceous, tabular to papery, moderately hard, dark gray.	N3
PA-4-027	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-028	"	100% Shale, noncalcareous, very slightly micromicaceous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-029	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-030	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-031	"	100% Shale, noncalcareous, tabular, moderately hard, dark gray.	N3
PA-4-032	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark gray.	N3
PA-4-033	"	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark gray.	N3

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-034	Genesee	100% Shale, noncalcareous, very slightly anhydritic, very slightly micromicaceous, tabular, moderately hard, dark gray.	N3
PA-4-035	"	100% Shale, noncalcareous, slightly anhydritic, tabular to massive, moderately hard, medium dark gray.	N4
PA-4-036	"	100% Shale, noncalcareous, slightly anhydritic, tabular to massive, moderately hard, medium dark gray.	N4
PA-4-037	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-038	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-039	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-040	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-041	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-042	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-043	"	100% Shale, very slightly calcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-044	"	100% Shale, very slightly calcareous, tabular to papery, moderately hard, dark gray.	N3

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-045	Genesee	100% Shale, very slightly calcareous, tabular to papery, moderately hard, dark gray	N3
PA-4-046	"	100% Shale, very slightly calcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-047	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-048	"	100% Shale, very slightly calcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-049	Tully	100% Shale, very calcareous, slightly anhydritic, massive to tabular, hard, medium dark gray.	N4
PA-4-050	"	100% Shale, slightly calcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-051	"	100% Shale, calcareous, slightly anhydritic, massive to tabular, moderately hard, medium dark gray.	N4
PA-4-052	"	100% Shale, very calcareous, slightly anhydritic, massive to tabular, moderately hard to hard, medium dark gray.	N4
PA-4-053	Mahantango	100% Shale, noncalcareous, tabular to papery, moderately hard, medium dark gray.	N4
PA-4-054	"	100% Shale, noncalcareous, tabular to papery, moderately hard, medium dark gray.	N4
PA-4-055	"	100% Shale, noncalcareous, tabular to papery, moderately hard, medium dark gray.	N4

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-056	Mahantango	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-057	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-058	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-059	Marcellus	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-060	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-061	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-062	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-063	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-064	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-065	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-066	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-067	Marcellus	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-068	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-069	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-070	"	100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-071	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-072	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-073	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-074	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-075	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-076	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-077	"	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-078	Marcellus	100% Shale, noncalcareous, slightly anhydritic, tabular, moderately hard, medium dark gray.	N4
PA-4-079	"	100% Shale, noncalcareous, tabular, moderately hard, medium dark gray.	N4
PA-4-080	"	100% Shale, noncalcareous, tabular, moderately hard, medium dark gray.	N4
PA-4-081	"	100% Shale, noncalcareous, tabular, moderately hard, medium dark gray.	N4
PA-4-082	"	100% Shale, noncalcareous, tabular, moderately hard, medium dark gray.	N4
PA-4-083	"	100% Shale, noncalcareous, tabular, moderately hard, dark gray.	N3
PA-4-084	"	100% Shale, noncalcareous, tabular, moderately hard, dark gray.	N3
PA-4-085	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-086	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-087	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-088	"	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3

TABLE 28(Continued)
Gross Lithological Description
for PA-4

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
PA-4-089	Marcellus	100% Shale, noncalcareous, tabular to papery, moderately hard, dark gray.	N3
PA-4-090	"	100% Shale, noncalcareous, slightly anhydritic, vertical calcite vein, tabular, moderately hard, medium dark gray.	N4
PA-4-091	"	100% Shale, noncalcareous, slightly anhydritic, vertical calcite vein, tabular, moderately hard, medium dark gray.	N4

TABLE 29
Total Organic Carbon

Mound Sample Number	Total Organic Carbon (wt %)
MI-1-001	6.38
MI-1-002	2.72
MI-1-003	13.07
MI-1-004	15.76
MI-1-005	2.28
MI-1-006	1.83

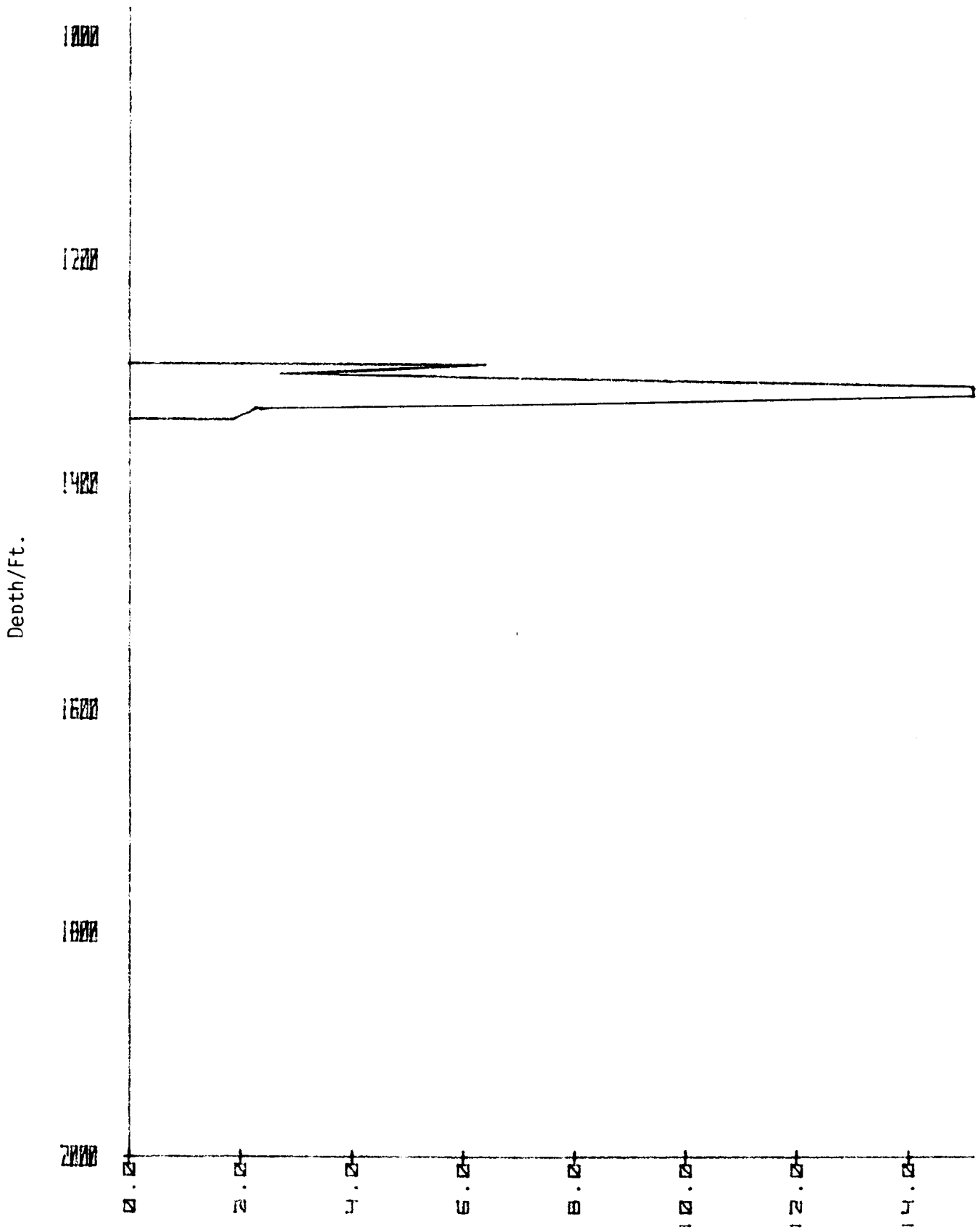

Figure 6

Organic Carbon vs. Depth for MI-1 Samples

TABLE 30

VISUAL KEROGEN ASSESSMENT WORKSHEET

MI-1 Well

Mound No.	DEPTH	TYPE OF ORGANIC MATTER	COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT / REMARKS	SUMMARY ORGANIC MATTER TYPE
MI-1-001	1293'					pyrite 1.8	
MI-1-002	1302'					1.8	
MI-1-003	1311'					1.8	
MI-1-004	1321'					1.8	
MI-1-005	1332'					1.8	
MI-1-006	1342'					1.8	

Column sub-headings — Type of organic matter: Recognizable algae; Amorphous - sapropel; Relic amorphous; Spores - pollen; Degraded herbaceous debris; Cuticle - membranous debris; Woody - structured debris; Coaly - inertinite debris; Pyrobitumen; Nonrecognizable debris. Color of organic matter: Greenish light yellow; Yellow; Yellow orange; Orange; Light brown; Brown; Dark brown; Black. State of organic matter: Particle size (Finely disseminated; Fine; Medium; Coarse); Preservation (Excellent; Good; Fair; Poor). Maturation index: Unaltered; Slightly altered; Moderately altered; Strongly altered; Severely altered; Metamorphosed. Depositional environment: Offshore marine; Nearshore marine; Restricted nearshore - marsh; Lacustrine; Continental.

TABLE 31
Kerogen Visual Assessment; Components of Kerogen
for MI-1

Mound Sample Number	Predominant	Secondary	Trace
MI-1-001	H	A-A	-
MI-1-002	H	A-A	-
MI-1-003	H	A-A	-
MI-1-004	H	A-A	-
MI-1-005	H	A-A	
MI-1-006	H	A-A	-

TABLE 32
Vitrinite Reflectance Summary
for MI-1 Sample

Mound Sample Number	Depth (feet)	Type of Sample	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
MI-1-003	1311.75	CORE	(1)*	30	0.36	0.54	0.47
			(2)	29	0.56	0.83	0.66
			(3)	1	1.50	1.50	1.50

*Indigenous population

4. Lithology

A lithological description of the MI-1 samples is given in Table 33. All were 100% shale. Samples MI-1-4 and MI-1-5 were medium dark gray (N5 to N4), and the balance were brownish gray (5YR4/1 to 5YR3/1).

J. OH-5 (Lorain County, Ohio)

1. Stratigraphic Intervals

Table 34 includes the stratigraphic intervals of the OH-5 well and geochemical data arranged by interval.

2. Vitrinite Reflectance

Vitrinite reflectance measurements were completed on 17 samples from OH-5 (Table 35). The maturity of the shale increases slightly down the well from moderately immature (R_0 = 0.55) in the Chagrin to moderately mature (R_0 = 0.66) in the Upper Olentangy.

III. SORPTION TESTING

Sorption properties were determined for eight (8) samples. Test samples were selected from the Huron, Upper, Middle, and Lower Olentangy stratigraphic intervals from the OH-4, PA-3, OH-5, and OH-6-4 wells.

The cumulative volume of desorbed gas from each sample is given in Tables 36 and 37. These data are plotted as a function of time in Figures 7 to 10. Although two (2) OH-5 and two (2) OH-6-4 samples are shown in Table 37 as being completed; the termination of the experiment shortened the time interval thus preventing total desorption of the samples. The cumulative gas volume and data plotted as a function of time, is for a thirty minute period.

Samples from the Huron interval show a rapid gas release. These two (2) pressure core barrel samples (PA-3-9 and PA-3-11) desorbed > 90% of the methane within thirty minutes of test initiation. The Upper and Middle Olentangy intervals produced an intermediate release rate; while the Lower Olentangy samples (PA-3-170 and OH-4-202) displayed relatively slow desorption properties.

A summation of all sorption results is given in Table 41.

TABLE 33
Gross Lithological Description
for MI-I

Mound Sample Number	Well Interval	Gross Lithological Description	GSA Color Code
MI-1-001		100% Shale, noncalcareous, very slightly micromicaceous, very slightly carbonaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
MI-1-002		100% Shale, noncalcareous, very slightly micromicaceous, very slightly carbonaceous, tabular, moderately hard, dark brownish gray.	5YR3/1
MI-1-003		100% Shale, noncalcareous, very slightly anhydritic, tabular, moderately hard, dark brownish gray.	5YR3/1
MI-1-004		100% Shale, slightly calcareous in part, anhydritic to non-anhydritic, mottled, tabular, moderately hard, medium light gray or medium dark gray.	N6 or N4
MI-1-005		100% Shale, slightly calcareous, anhydritic, tabular, moderately hard, medium to medium dark gray.	N5 to N4
MI-1-006		100% Shale, slightly calcareous, anhydritic, tabular to massive, moderately hard, brownish gray.	5YR4/1

TABLE 34
Stratigraphic Intervals and Geochemical data for OH-5

Stratigraphic Interval	Depths* (Feet)	Organic Carbon (wt %)	Ro	TAI	Organic Source	Gas Content MCF/A·F Free	Gas Content MCF/A·F Core
Cleveland	405-420	3.16		2.10	H	12.9	6.8
Chagrin	420-725	1.49		2.10	W-C	8.9	3.1
Upper Huron	725-805	4.38		2.10	H	38.7	14.9
Middle Huron	805-896	5.37		2.10	H	42.8	23.5
Lower Huron	896-1076	7.94		2.10	H	41.8	38.9
Upper Olentangy	1076-1276	0.99		2.10	W-C	13.3	6.8

*Approximate

TABLE 35
Vitrinite Reflectance Summary
for OH-5 Well

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-5-001	405.6	Cleveland	(1)*	29	0.34	0.52	0.45
			(2)	11	0.56	0.70	0.63
			(3)	20	0.76	1.42	1.04
OH-5-007	463.84	Chagrin	(1)*	17	0.42	0.51	0.47
			(2)	15	0.55	0.80	0.70
			(3)	28	0.91	1.63	1.23
OH-5-015	545.86	"	(1)*	12	0.37	0.53	0.44
			(2)	21	0.57	0.81	0.69
			(3)	23	0.91	1.35	1.10
			(4)	4	1.62	1.76	1.72
OH-5-020	596.68	"	(1)*	11	0.38	0.55	0.48
			(2)	16	0.61	0.91	0.77
			(3)	33	0.97	1.84	1.37
OH-5-024	636.69	"	NO VITRINITE				
OH-5-029	686	"	(1)*	25	0.38	0.60	0.50
			(2)	21	0.72	1.29	0.95
			(3)	14	1.47	2.08	1.78
OH-5-034	735.65	Upper Huron	(1)*	22	0.40	0.55	0.49
			(2)	20	0.59	0.88	0.72
			(3)	9	0.94	1.24	1.09
			(4)	9	1.38	1.70	1.52
OH-5-040	795.63	"	(1)*	34	0.40	0.60	0.51
			(2)	18	0.63	0.93	0.77
			(3)	8	1.00	1.82	1.41

*Indigenous population

TABLE 35 (Continued)
Vitrinite Reflectance Summary
for OH-5 Well

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-4-045	845.45	Middle Huron	(1)*	14	0.40	0.61	0.51
			(2)	8	0.66	0.88	0.75
			(3)	12	0.98	1.84	1.30
OH-5-050	896.71	"	(1)*	8	0.45	0.60	0.54
			(2)	7	0.70	0.95	0.84
			(3)	16	1.09	2.28	1.51
OH-5-055	946.87	Lower Huron	(1)*	23	0.41	0.65	0.52
			(2)	1	1.30	1.30	1.30
OH-5-060	996.46	"	(1)*	37	0.40	0.60	0.52
			(2)	22	0.62	0.87	0.70
			(3)	1	1.21	1.21	1.21
OH-5-066	1056.78	"	(1)*	36	0.45	0.65	0.57
			(2)	14	0.68	0.89	0.77
			(3)	10	1.10	1.51	1.33
OH-5-071	1105.77	Upper Olentangy	(1)*	2	0.46	0.55	0.51
			(2)	3	1.12	1.90	1.52
OH-5-076	1156.82	"	(1)*	31	0.46	0.64	0.55
			(2)	22	0.66	0.91	0.75
			(3)	6	1.06	1.33	1.21
			(4)	1	1.83	1.83	1.83
OH-5-078	1176.56	"	(1)*	56	0.48	0.68	0.59
			(2)	4	0.74	0.85	0.78
OH-5-085	1246.75	"	(1)*	52	0.46	0.75	0.60
			(2)	8	1.07	2.11	1.48

*Indigenous population

TABLE 35 (Continued)
Vitrinite Reflectance Summary
for OH-5 Well

Mound Sample Number	Depth (feet)	Interval	Population	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Mean Reflectance (% Ro)
OH-5-088	1276.55	Upper Olentangy	(1)*	38	0.47	0.66	0.56
			(2)	16	0.69	0.94	0.78
			(3)	3	1.12	1.49	1.27

*Indigenous population

*Indigenous population

Table 36
Sorption Time and Volume Data For Samples Listed
Volume (cm^3/g)

Time ($Min^{\frac{1}{2}}$)	PA-3-09	PA-3-11	PA-3-90	PA-3-117
1.23	0.143	0.151	0.071	0.04
1.73	0.187	0.233	0.103	0.05
2.12	0.193	0.246	-	-
2.45	0.200	0.252	0.116	0.052
2.92	0.206	0.257	0.132	0.055
3.16	-	0.258	-	0.056
3.54	0.209	0.260	0.144	0.059
3.74	0.210	0.261	0.151	0.060
4.00	0.211	0.262	-	0.062
4.58	0.214	0.263	0.203	0.064
4.96	0.215	0.263	0.208	0.067
5.20	0.216	0.264	-	-
5.48	0.217	0.264	0.223	0.070
6.33	0.218	0.265	0.241	0.074
7.01	-	0.265	0.256	0.077
7.75	-	-	0.268	0.080
9.49	-	0.266	0.297	0.087
10.95	0.223	0.266	0.313	0.093
14.66	0.225	-	-	0.105
16.58	0.226	0.268	0.404	0.111
18.30	-	0.295	-	-
37.62	0.224	0.292	0.478	0.196
40.68	0.224	0.291	-	0.201
65.56	0.223	0.291	-	-
75.45	0.223	0.291	0.520	0.244
83.04	0.222	-	0.520	0.245
90.25	-	-	0.521	0.249
101.12	0.221	0.290	0.520	0.248
109.84	0.221	0.291	0.521	0.246
Pressure (psi)	168	168+	331	432

Table 36
Sorption Time and Volume Data for Test Samples Listed
Volume (cm^3/g)

Time ($Min^{\frac{1}{2}}$)	PA-3-137	PA-3-170	OH-4-131	OH-4-202
1.23	0.050	0.040	0.073	0.043
1.73	0.054	0.044	0.090	-
2.12	0.062	0.046	-	-
2.92	0.071	0.050	0.110	0.050
3.54	0.080	0.052	0.124	0.052
4.00	0.086	0.054	0.133	0.053
5.20	0.101	0.057	0.155	0.056
6.33	0.110	0.061	0.177	0.057
7.01	0.119	0.063	0.189	0.058
7.75	0.125	0.065	0.199	0.061
9.49	-	0.070	0.273	0.065
10.95	0.176	-	0.293	0.067
14.49	-	-	0.341	0.072
18.97	-	-	0.395	0.081
37.45	0.331	0.114	0.591	0.094
41.68	0.346	0.119	0.653	0.098
56.63	-	0.122	0.741	0.108
66.61	-	0.127	0.775	0.114
76.47	0.419	0.130	0.879	0.118
82.28	0.421	0.129	-	0.121
93.59	0.420	0.127	-	0.123
100.38	0.419	0.128	0.930	0.125
109.11			0.934	-
110.76			0.942	-
116.69			0.951	0.131
117.08			0.952	0.132
118.12			0.954	0.128
Pressure (psi)	454	545	480	599

Table 37
Sorption Time and Volume Data for Test Samples Listed
Volume (cm^3/g)

Time ($Min^{\frac{1}{2}}$)	OH-5-36	OH-5-59	OH-6-4-36	OH-6-4-58
1.5	0.542	0.071	0.182	0.091
6.5	0.751	0.111	0.461	0.143
12.5	0.986	0.122	0.542	0.180
16.0	1.063	0.128	0.613	0.193
20.5	1.127	0.135	0.644	0.251
25.0	1.193	0.140	0.668	0.260
27.5	1.206	0.141	0.675	0.269
28.5	1.223	0.149	0.681	0.278
30.0	1.238	0.152	0.685	0.279
Pressure (psi)	--	--	975	1081

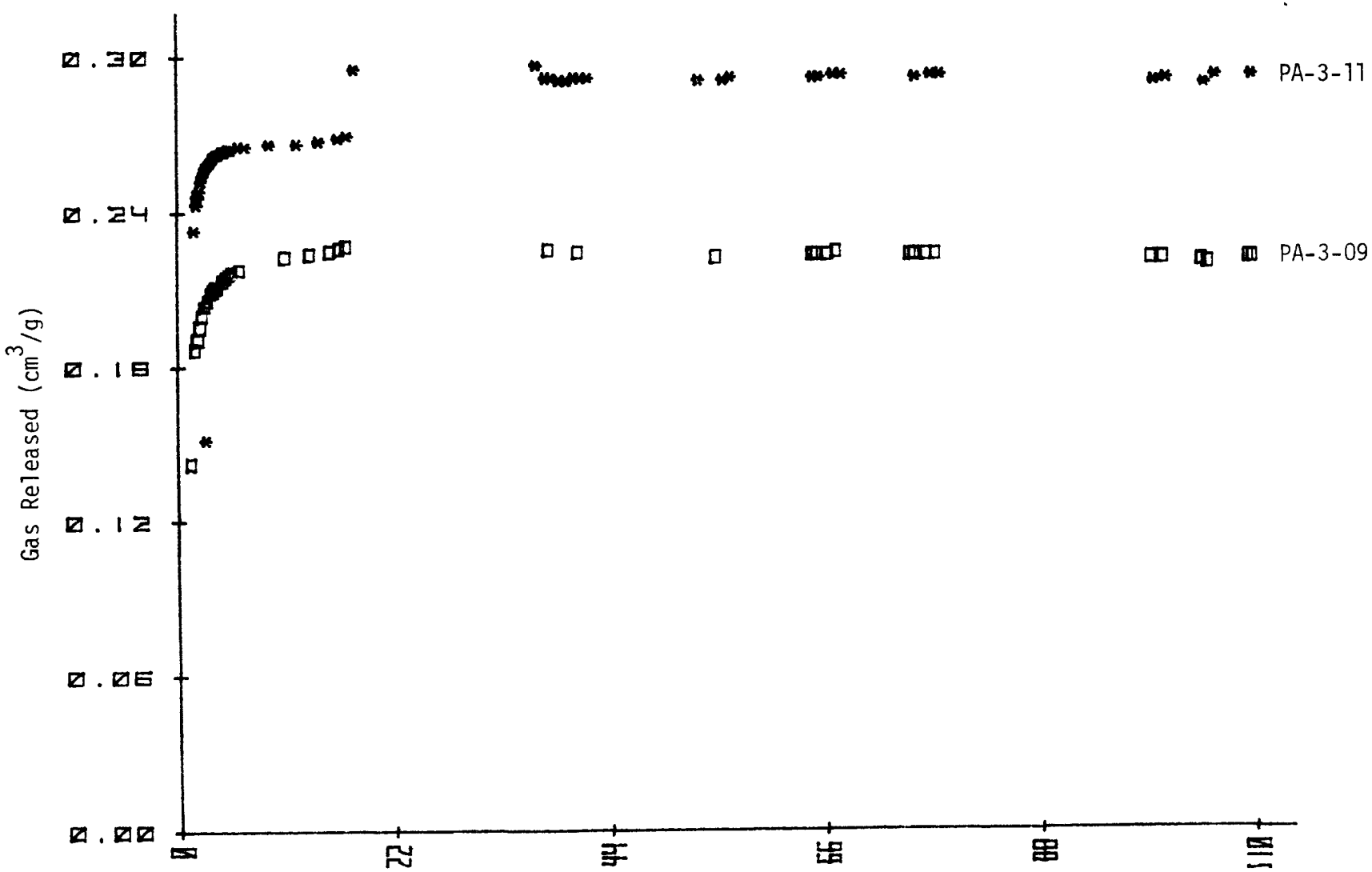

Figure 7

The Concentration of Gas Desorbed as a Function of Time.

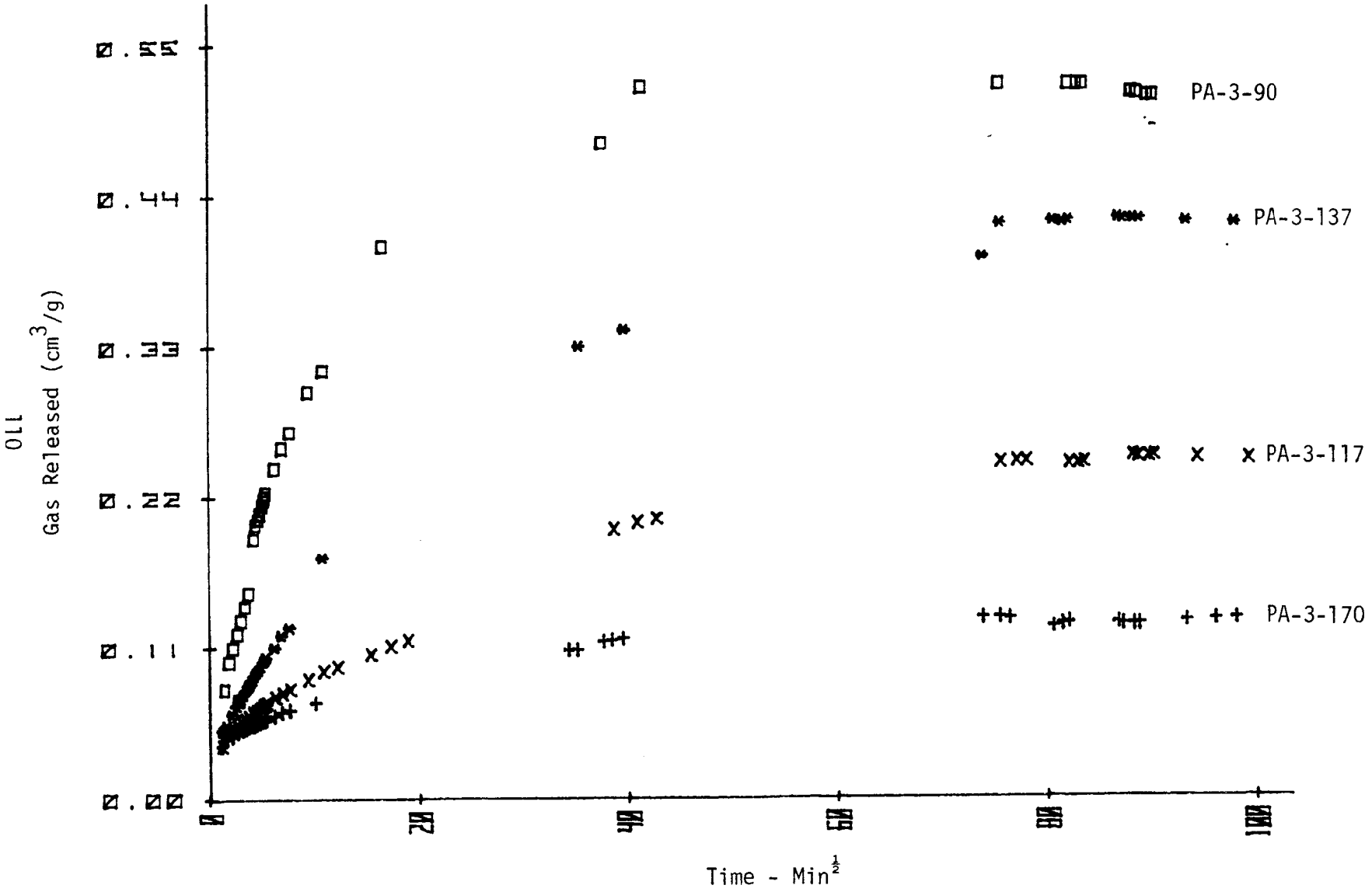

Figure 8

The Concentration of Gas Desorbed as a Function of Time.

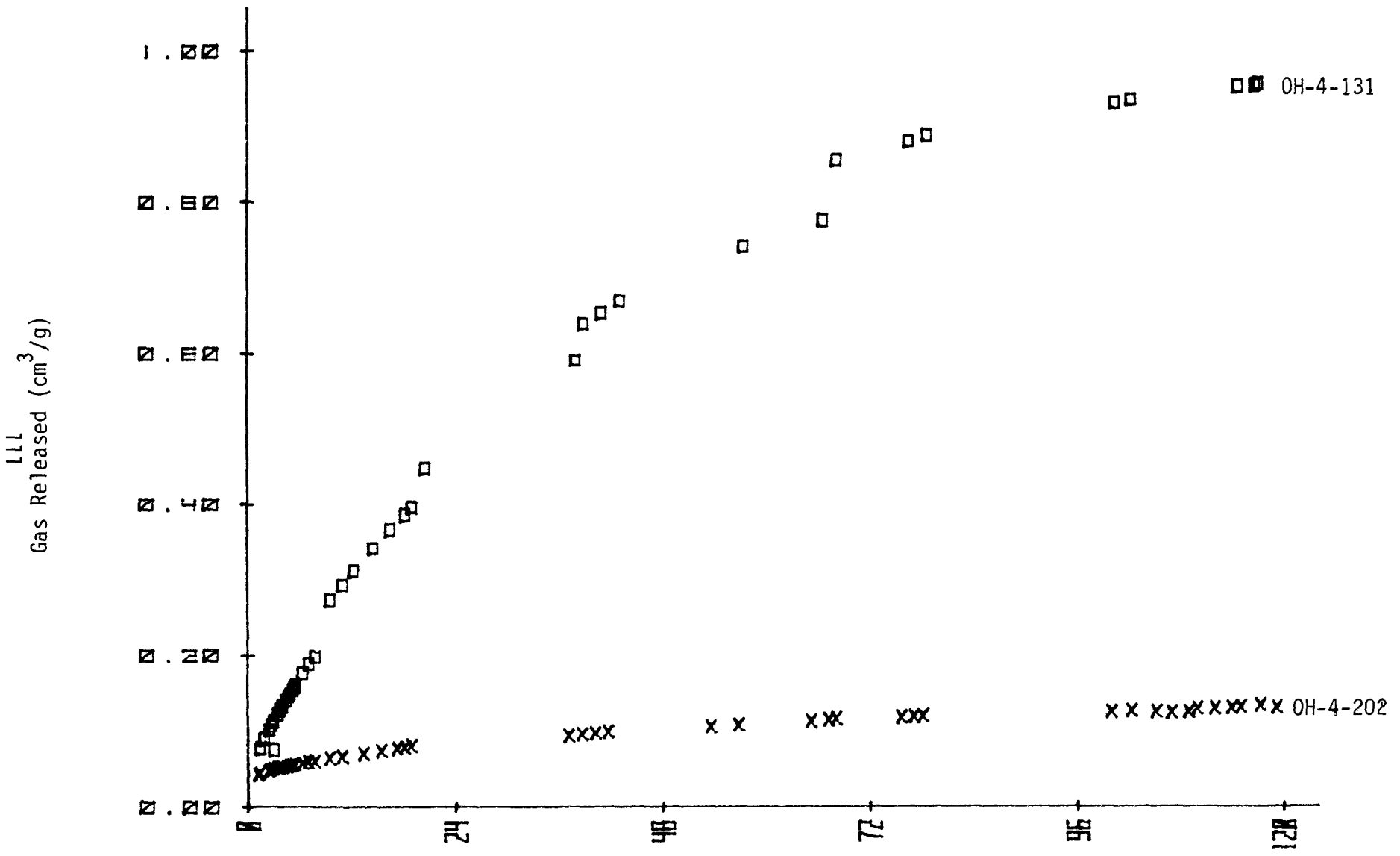

Figure 9

The Concentration of Gas Desorbed as a Function of Time.

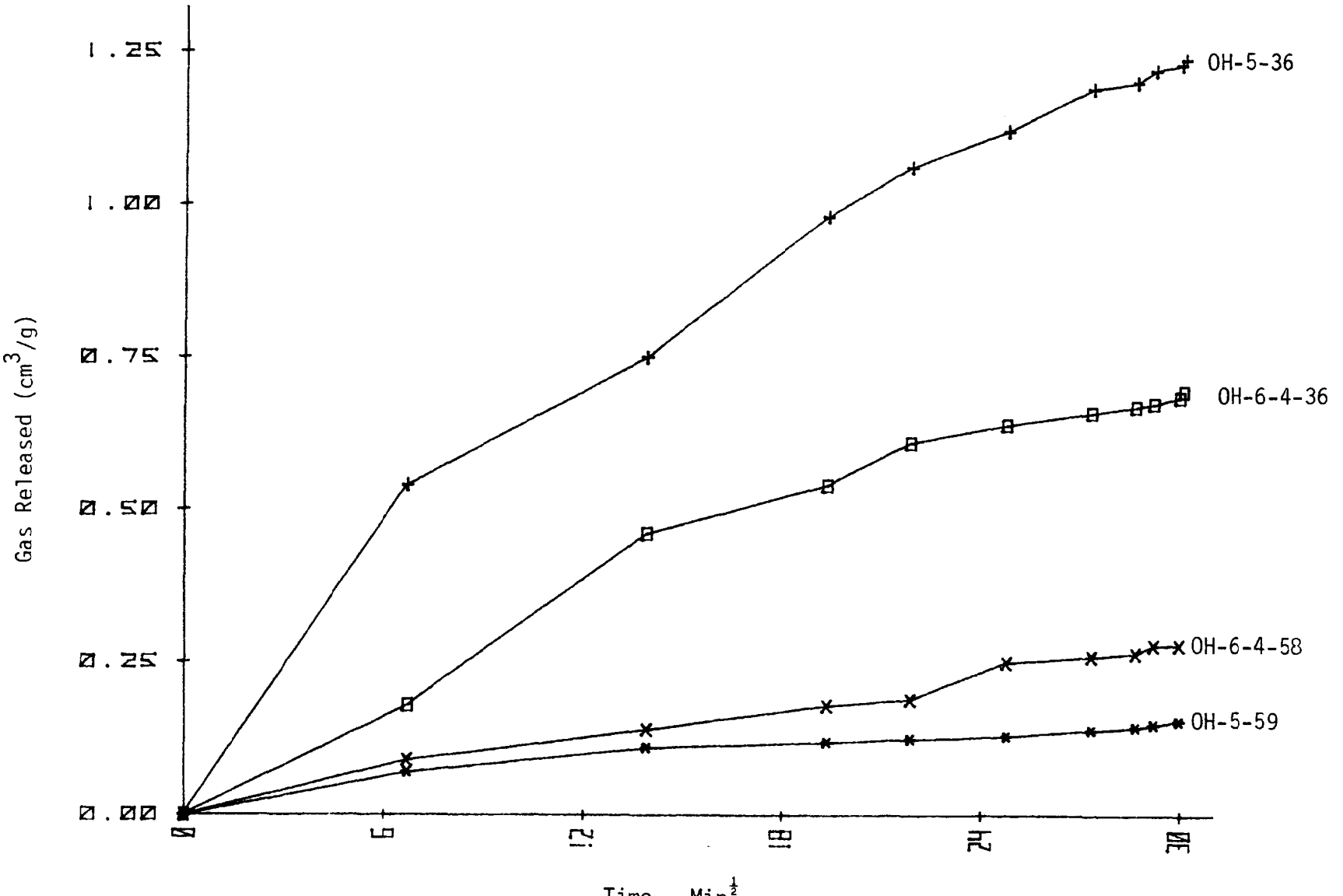

Figure 10

The Concentration of Gas Desorbed as a Function of Time.

Table 38
Summary Results for all Desorption Samples:
Test Pressure and Gas Release

Sample	Pressure and cm^3/g	Depth	Stratigraphic Zone
OH-3-5	301/0.26	684'	Chagrin
	400/0.42		
	800/0.67		
	1200/0.95		
OH-3-15	386/1.50	878'	Huron
	400/1.60		
	800/2.53		
	1200/3.18		
OH-3-19	400/1.19	944'	Huron
	415/1.31		
	800/2.02		
	1200/2.60		
OH-3-29	400/0.68	1150'	Upper Olentangy
	506/0.85		
	800/1.10		
	1200/1.17		
OH-6-4-36	975/	2216'	Upper Huron
OH-6-4-58	1081/	2456'	Middle Huron
OH-4-15	200/0.57	549'	Huron
	400/0.96		
	800/1.81		
	1200/1.84		

Table 38 (Continued)
Summary Results for all Desorption Samples:
Test Pressure and Gas Release

Sample	Pressure and cm^3/g	Depth	Stratigraphic Zone
OH-4-43	200/0.65	748'	Huron
	400/1.10		
	800/1.83		
	1200/2.82		
OH-4-103	400/1.10	953'	Java Fm., Pipe Creek
	419/1.06		
	1200/2.38		
OH-4-126	400/1.25	1076'	Angola
	473/1.52		
	1200/2.40		
OH-4-131	480/0.97	1091'	Angola
OH-4-134	400/1.24	1098'	Angola
	483/1.42		
	1200/2.62		
OH-4-164	200/0.15	1171'	Rhinestreet
	400/0.27		
	800/0.53		
	1200/0.64		

Table 38(Continued)
Summary Results for all Desorption Samples:
Test Pressure and Gas Release

Sample	Pressure and cm^3/g	Depth	Stratigraphic Zone
OH-4-199	200/0.18	1351'	Marcellus
	400/0.30		
	800/0.41		
	1200/0.64		
OH-4-202	599/0.13	1361'	Marcellus
OH-4-207	400/0.04	1373'	Marcellus
	604/0.07		
	1200/0.13		
PA-3-9	168/0.23	382'	Huron
PA-3-11	168+/0.30	384'	Huron
PA-3-90	331/0.52	752'	Pipe Creek
PA-3-117	432/0.25	982'	Rhinestreet
PA-3-137	454/0.42	1032'	Rhinestreet
PA-3-170	545/0.13	1238'	Marcellus

APPENDIX

Table A-1
Mean Organic Carbon Content for
Devonian Shales

Appalachian Data

Well	Mean Organic Carbon Content (wt %)
PA-2	1.74
VA-1	1.96
KY-2	2.04
R-109	1.35
OH-1	1.86
WV-5	1.30
WV-6	1.85
WV-7	1.64
NY-1	0.56
KY-4	2.91
OH-3	2.23
PA-1	1.43
PA-3	2.12
OH-4	2.23
OH-6-1	2.90
OH-6-2	3.97
OH-6-3	5.45
OH-6-4	1.92
OH-6-5	3.03
OH-5	3.41
OH-7	2.01
PA-4	0.98

Illinois Basin Data	Mean Organic Carbon Content (wt %)
I-1	6.77
I-2	0.88
I-3	1.39
O-1	8.75
P-1	4.73
IND-2	7.56
Ill-4	1.95
Ill-5	5.77
MI-1	7.01

Table A-2
Maturation Results for Illinois and
Appalachian Basin Shales

Appalachian Basin

Well	Predominant TAI	Mean Ro
VA-1	2+	1.02
KY-2	1+ to 3	0.52
WV-5	2- to 2+	0.64
WV-6	3+	2.19
KY-4	1+ to 2	0.57
R-109	2	0.58
PA-2	3 to 3+	2.48
OH-1	1+ to 2	0.71
OH-3	2	0.56
WV-7	3	1.58
NY-1	2- to 3	1.29
PA-1	3	1.12
OH-4	1 to 2	0.45**
PA-3	1+ to 2	0.45**
OH-6-1	2- to 2	0.51
OH-6-2	2- to 2	0.44
OH-6-3	2- to 2	0.42
OH-6-4	2- to 2	0.48
OH-6-5	2- to 2	0.37
OH-5	2- to 2	
OH-7	2- to 2	0.58
PA-4	3+	

Illinois Basin

Well	Predominant TAI	Mean Ro
O-1	2-	0.45
P-1*	2-	0.63
I-1	1+ to 2-	0.45
I-3	2 to 2+	0.46
I-2	1+	0.40
IND-2	1+	0.48
Ill-4	3 to 3+	1.44
Ill-5	2 to 2+	0.56
MI-1	1+ to 2-	0.47

*Core exposed for several weeks before canning.

V. REFERENCES

1. Zielinski, R. E., and Moteff, J. D., "Physical and Chemical Characterization of Devonian Shale," MLM-ML-80-68-0002, Quarterly Status Report (April 1 - June 30, 1980), Monsanto Research Corp., Mound Facility, Miamisburg, Ohio.

2. Tissot, B., Durand, B., Espitolie, J., and Combaz, A., "Influence of Nature and Diagenesis of Organic Matter in Formation of Petroleum," American Association of Petroleum Geologists Bulletin, 58, 1974, pp. 499-506.

3. Castano, J. R., and Sparks, D. E., "Interpretation of Vitrinite Reflectance Measurements in Sedimentary Rocks and Determination of Burial History Using Vitrinite Reflectance and Authigenic Materials," Geol. Soc. America, Special Paper 153, 1974, pp. 31-51.

4. Dow., W. G., "Kerogen Studies and Geological Interpretations," J. Geochem Expl., 7, 1977, pp. 79-99.

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