

GEOCHEMICAL SERVICE REPORT

HYDROCARBON SOURCE ROCK EVALUATION STUDY

SUNRAY MID-CONTINENT OIL COMPANY

FEDERAL "M" NO. 1 WELL

SIERRA COUNTY, NEW MEXICO



Prepared

for

Pennzoil Company

Houston, Texas

CONFIDENTIAL
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SUMMARY

Organic geochemical analyses run on a suite of dried well cuttings samples from the Sunray Mid-Continent Oil Company Federal "M" No. 1 Well, located in Sierra County, New Mexico, have indicated that the gross well interval sampled, from 400+ feet to 9,765 feet (total depth), may be divided into two major geochemical zones, and four minor subzones:

Zone A (400+ feet to 3,610+ feet) is moderately prospective for minor accumulations of liquid hydrocarbons and associated gas, and moderately prospective for significant accumulations of natural and biogenic gas, with associated condensate. Of the two Subzones a₁ and a₂ making up Zone A, Subzone a₂ (2,500+ feet to 3,610+ feet) is more prospective for significant hydrocarbon accumulations than Subzone a₁.

Zone B (3,610+ feet to 9,765+ feet) is essentially unprospective for significant quantities of indigenous hydrocarbons, although the included sediments may have sourced minor quantities of thermally ometamorphosed natural gas.

The results of this study indicate that Pennzoil Company explorationists should concentrate their attention on the sediments within the interval herein defined as Subzone a₂, in the vicinity of the subject well, as being prospective for economic accumulations of petroleum hydrocarbons. In addition, potential reservoirs within the Zone A interval, which may be reasonably projected down-paleoslope into more marine facies, may be expected to be significantly more prospective for liquid hydrocarbon accumulations.


Chris P. Cunningham
GEOCHEM LABORATORIES, INC.

INTRODUCTION

This report summarizes the results of organic geochemical analyses which were run on a suite of dried well cuttings samples, from the Sunray Mid-Continent Oil Company Federal "M" No. 1 Well, located in Sierra County, New Mexico. The sample materials were provided to GeoChem Laboratories, Inc. by Pennzoil Company.

The purpose of this study has been to:

- Determine the hydrocarbon source quality (richness), source type (gas versus oil) and degree of thermal maturity of sediments penetrated by the subject Sunray No. 1 Well, within the interval from the surface to total depth (0 feet to 9,765 feet).
- Define the exploration significance of these data with regard to possible future drilling in the general vicinity of the subject well.

Analytical

Upon arrival at our Houston laboratory, all of the sample materials were collectively assigned the GeoChem Job No. 1018. Good samples of fine grained rock were then selected, at approximately 100 to 150 foot intervals, and each sample (4+ grams) thus obtained was examined for total organic carbon content. Each of the samples selected was assigned a sequential sample number -001 through -096; thus, a total of ninety-six (96) samples were subjected to this total organic carbon "screen" program. A brief lithologic description was also made of each sample. The results of the total organic carbon "screen" analytical program, the brief lithologic descriptions, the individual sample numbers and the sample depths are displayed in Table II-A.

After studying these total organic carbon and lithological data, and consulting with Mr. Hunt, a total of thirty-five (35) depth intervals were selected for a program of detailed organic geochemical analyses. In order to obtain sufficient rock material for these analyses, it was necessary to composite several samples together. The thirty-five (35) composited samples are identified by a sequential number followed by the post-script "D," i. e. 1018-005D, etc. (see Table II-B).

The following type and number of analyses were performed in this study:

<u>Sample Screen</u>	<u>No. of Analyses</u>
Hand-picking of uncaved lithologies and brief lithological description	96
Total organic carbon	96
 <u>Detailed Analyses</u>	
Hand-picking and compositing of 100+ gram samples	35
Detailed lithological description	35
Total organic carbon	35
C ₁₅₊ soxhlet extraction and deasphalting	35
Quantitative C ₁₅₊ liquid chromatographic separation	16
Qualitative C ₁₅₊ liquid chromatographic separation	19
gc C ₁₅₊ P-N hydrocarbon analysis	35
Visual kerogen assessment	35
Vitrinite reflectance measurement	17

A brief description of the various types of analyses performed in this study is presented in Appendix A for the benefit of the more interested reader.

Data Presentation

All analytical data, whether used in the ultimate interpretation of this report or not, are recorded in Tables I through VII. The data are also plotted in well profile form in Figure 1. The chromatographic traces obtained in the detailed analysis of the C₁₅₊ paraffin-naphthene (P-N) hydrocarbon fraction of the total extractable bitumen are reproduced in Figure 2. A comparison of the visual kerogen alteration data with the vitrinite reflectance measurements is presented in Figure 3. Histograms of the vitrinite reflectance data for all of the samples examined, showing the distribution of the measurements, are presented in Figure 4. A copy of the electrical log of the subject Sunray No. 1 Well was provided to GeoChem by Pennzoil Company. This log has been displayed, on scale, with Figure 1.

An additional set of all figures is appended in a pocket at the rear of this report in order to aid the reader in cross referencing the text with the well profile data illustrated.

General Information

Nine (9) copies of this report have been delivered to Mr. David Hunt of Pennzoil Company, at their Houston office. GeoChem has retained one (1) copy for future reference in telephone conversations with authorized Pennzoil Company personnel on specific details of this study.

All used and unused sample material, glass microscope kerogen slides, C₁₅₊ liquid chromatographic fractions, etc. will be returned to Pennzoil Company in the near future. We recommend that the isolated chromatographic fractions be saved for possible future use for C¹³/C¹² carbon isotope and/or high mass spectrometric analyses.

All data, interpretations, and other matters related to this well study are considered to be highly confidential and the sole proprietorship of Pennzoil Company.

RESULTS AND INTERPRETATIONS

Stratigraphy

Stratigraphic information, including the geological ages and formation names of the sediments penetrated by the Sunray Mid-Continent Oil Company Federal "M" No. 1 Well, was provided to GeoChem by Pennzoil Company. This information, including depths (Tops) at which the various units were encountered in the subject well, are presented in Table III. These data have been incorporated into Table I and Figure 1, for the convenience of Pennzoil Company explorationists.

Organic Geochemical Zonation

Based on the organic geochemical characteristics of the samples examined in this study, the stratigraphic section represented by the samples which were examined, from the Sunray Mid-Continent Oil Company Federal "M" No. 1 Well, located in Sierra County, New Mexico, over the gross well interval from the surface to 9,765 feet, may be divided into two major zones and four subzones.

	<u>Included Sample Nos.</u>	<u>Depth Interval</u>
Zone A	005-034	400 _± ' to 3,610 _± '
Subzone a ₁	005-024	400 _± ' to 2,500 _± '
Subzone a ₂	025-034	2,500 _± ' to 3,610 _± '
Zone B	038-096	3,610 _± ' to 9,765 _± '
Subzone b ₁	038-071	3,610 _± ' to 7,550 _± '
Subzone b ₂	075-096	7,550 _± ' to 9,765 _± '

Descriptions of each of the two major zones and the four subzones are provided in the following section. Each description contains information regarding the nature of key organic geochemical parameters, which define that particular zone or subzone.

Zone A (400_± feet to 3,610_± feet)

Total organic carbon values observed in the samples which represent Zone A range from 0.19% to 1.10% (poor to good), with an average of 0.62%. Total extractable C₁₅₊ bitumen content varied from 718 ppm to 1761 ppm (fair to good), averaging 1047 ppm.

The total C₁₅₊ hydrocarbon content varies from 101 ppm to 276 ppm (fair to good), with an overall average of 178 ppm. The Maturation Indices, as indicated by the visual kerogen examination of the sample material, varied from Stage 1+ to 2, indicating that the sediments are immature to moderately mature from the top to the bottom of the depth interval representing Zone A. All of the above listed data have been obtained from Table I. "Summary of Organic Geochemical Data." These data plus additional pertinent data are also displayed in Tables II-B, IV and VI.

Subzone a₁ (400+ feet to 2500+ feet)

The depth interval containing Subzone a₁ represents the very top of the subject well. (See Figure 1, Table I.) Observed total organic carbon values vary from 0.19% to 0.61% (poor to fair), averaging 0.40%. Total extractable C₁₅₊ bitumen contents range from 718 ppm to 989 ppm (fair), with an overall average of 801 ppm. The total C₁₅₊ hydrocarbon contents observed vary between 101 ppm and 242 ppm (fair to good), with an average of 153 ppm. The kerogen type is predominantly woody-herbaceous, with minor amounts of amorphous-sapropel material and some coaly material. The sediments represented by the samples included within this interval have experienced an immature to moderately immature geothermal history of Stage 1+ to 2-, as indicated by the visual kerogen assessment data.

Subzone a₂ (2500+ feet to 3610+ feet)

Total organic carbon values for the samples from the Subzone a₂ interval range from 0.48% to 1.10% (fair to good), averaging 0.84%. The total extractable C₁₅₊ bitumen content of these samples varied from 733 ppm to 1761 ppm (fair to good), with an overall average of 1293 ppm. The total C₁₅₊ hydrocarbon contents range from 119 ppm to 276 ppm (fair to good), averaging 202 ppm. The kerogen type observed is essentially the same as seen in Subzone a₁, predominantly woody-herbaceous with some amorphous-sapropel material and some coaly material. The visual kerogen data indicate a Maturation Index of Stage 2- to 2, which is moderately immature to moderately mature. It should be noted that this thermal maturity is at or immediately above the ideal value for the generation of thermally-derived hydrocarbons.

Zone B (3610+ feet to 9765+ feet)

Again referring to Table I and Figure 1, the total organic carbon values observed within the Zone B depth interval vary from 0.12% to 0.41% (poor), with an average of 0.22%.

The total extractable C₁₅₊ bitumen contents range from 320 ppm to 3420 ppm (poor to very good), with an average of 1133 ppm. The total C₁₅₊ hydrocarbon contents of the samples from Zone B were, with the exception of sample Nos. -043D and -053D, too small to be accurately measured by liquid chromatography. Values for these samples were estimated by subtracting the precipitated asphaltenes from the total extractable bitumen, and assuming 40% of the difference to be hydrocarbons. Samples so estimated are followed by the letter 'e' (see Table IV-B).

Subzone b₁ (3610+ feet to 7550+ feet)

Total organic carbon values observed for the samples contained in Subzone b₁ varied from 0.12% to 0.41% (poor), with an overall average of 0.24%. Total extractable C₁₅₊ bitumen contents varied from 320 ppm to 2163 ppm (poor to very good), with an average of 607 ppm. However, it should be pointed out that these values decrease dramatically if we delete sample No. -059D from our computations. (See Table I.) If this is done, the total C₁₅₊ bitumen contents vary from a low of 320 ppm to a high of only 733 ppm, poor to fair. The average drops from 607 ppm to 410 ppm. Total hydrocarbon content ranges from a low of 31e ppm to a high of 95 ppm (very poor to poor), with an average of 46e ppm. As mentioned in the discussion of Zone B, nine of the eleven samples contained within the Subzone b₁ interval were estimated. The kerogen type observed is predominantly woody-herbaceous, with minor amounts of coaly material and some amorphous-sapropel material. The thermal maturation index values vary from Stage 2- to 3-, indicating that the sediments are moderately immature to mature.

Subzone b₂ (7550+ feet to 9765+ feet)

Subzone b₂ is represented by samples containing total organic carbon contents ranging from 0.06% to 0.39% (poor to fair), with an overall average of 0.21%. Total extractable C₁₅₊ bitumen contents varied from 532 ppm to 3420 ppm (fair to very good), averaging 1660 ppm overall.

The total C₁₅₊ hydrocarbon contents vary from 28e ppm to 196e ppm (very poor to poor), with an average of 85e ppm. Please note, with reference to Table IV-B, that the four samples (sample Nos. -085D, -087D, -093D, and -096D) exhibiting the highest estimated values for total C₁₅₊ hydrocarbon were represented by small weights of rock extracted. (See Table IV-A.) This was due to a lack of available sample material, even after compositing all available samples within this interval. For this reason, it is the author's opinion that these four values are less reliable than the other values for this particular geochemical parameter.

If these four values are deleted from calculations, the C₁₅₊ hydrocarbon contents range from 28e ppm to 70e ppm (very poor to poor), and the average drops from 85e ppm to 46e ppm.

The kerogen type within Subzone b₂ is predominantly coaly, in contrast to the other three subzones. Minor amounts of herbaceous material, woody material, and some algal material are present. The Maturation Index values range from 2+ to 3+, mature to very mature.

Hydrocarbon Source Character of Sediments

The hydrocarbon source potential of the two (2) major zones and the four (4) subzones is contained in the following section. It should be pointed out that, in a study of this type, where C₁-C₇ light hydrocarbon data are not available, an accurate assessment of the gas source quality of the sediments is not possible. The author has, however, attempted to estimate the probable associated gas source quality on the basis of the kerogen type and the total organic carbon content of the samples.

Zone A (400+ feet to 3,610+ feet)

Based on all of the foregoing geochemical data, it is interpreted that Zone A, overall, is moderately prospective for minor accumulations of liquid hydrocarbons, with associated casing head gas. Based on the kerogen type, the thermal maturity, and the total organic carbon richness observed, Zone A is interpreted to be moderately prospective for significant quantities of natural gas and associated liquids (condensate).

Subzone a₁ (400+ feet to 2,500+ feet)

Based on the geochemical data which have been obtained by this study, the sediments representing Subzone a₁ are interpreted to be prospective for minor quantities of hydrocarbon liquids, and moderately prospective for significant quantities of biogenic gas.

Subzone a₂ (2,500+ feet to 3,610+ feet)

Based on all of the available geochemical data, sediments representing Subzone a₂ are interpreted to be moderately prospective for economic accumulations of petroleum liquids. It is also interpreted that these same sediments are prospective for significant quantities of natural gas and associated liquids (condensate).

Zone B (3,610+ feet to 9,765+ feet)

Based on all of the foregoing data, it is interpreted that sediments represented by the samples examined from within the interval defined as Zone B are interpreted to be essentially unprospective for even minor accumulation of indigenous hydrocarbon liquids. Zone B sediments may have generated minor quantities of thermally metamorphosed natural gas.

Subzone b₁ (3,610+ feet to 7,550+ feet)

Based on the available geochemical data, the sediments represented by the samples from the interval defined as Subzone b₁ are interpreted to be essentially unprospective for significant quantities of indigenous liquid hydrocarbons. The subject interval is moderately prospective for minor, probably non-economic, accumulations of natural gas.

Subzone b₂ (7,550+ feet to 9,765+ feet)

Based on all of the foregoing geochemical data, the stratigraphic interval represented by the samples from within Subzone b₂ is interpreted to be unprospective for significant quantities of indigenous liquid hydrocarbons. Sediments from Subzone b₂ may have sourced minor, probably non-economic, accumulations of natural gas.

Exploration Significance of Results

As a result of the integration of all the organic geochemical data which have been collected in this study, the following remarks may be made regarding the samples representing the subject well. For the convenience of the Pennzoil Company explorationists, reference will be made to specific formation names in addition to the geochemical zones which have been defined in this study. The major geochemical Zones A and B will not be discussed individually; rather, discussion will be concentrated solely on the four (4) Subzones a₁, a₂, b₁ and b₂.

Subzone a₁ (400+ feet to 2,500+ feet)

According to the stratigraphic information provided to GeoChem Laboratories, Inc. by Pennzoil Company (see Table III), Subzone a₁ is composed almost entirely of samples from the Mesa Verde Formation of Cretaceous age. The lithologic data (see Table II-B) indicate that this section is essentially a clastic sequence, with large amounts of sandstone present. Our palynologist, who provided the visual kerogen assessment data, believes that a substantial portion of the woody and herbaceous material seen in the

samples is reworked, rather than indigenous (see Appendix B for an analysis of the visual kerogen and vitrinite data). The Maturation Indices of Stage 1+ to 2- are just outside the range of values considered to be ideal for petroleum generation. The C₁₅₊ gas chromatograms (see Figure 2) are typical of a moderately immature to moderately mature sequence.

It is the author's view that this section would be much more prospective for liquid hydrocarbons if found with more amorphous-sapropel type kerogen, and a slightly higher thermal maturity of Stage 2 to 2+. The relatively high quantities of C₁₅₊ hydrocarbons present in the samples from this interval, and the quality of the gas chromatograms, are somewhat uncharacteristic of sediments having such moderate total organic carbon values and predominantly woody-herbaceous type kerogen. Thus, it is suggested that Pennzoil Company explorationists pursue this unit in a down-paleoslope direction, where the shales may be expected to contain more amorphous-sapropel material, and hopefully a higher total organic carbon content. Simultaneously, increasing depth may be expected to raise the Maturation Index to more desirable levels.

Subzone a₂ (2,500+ feet to 3,610+ feet)

According to the information provided to us by Pennzoil Company, Subzone a₂ contains four (4) samples from the Mancos Shale, one (1) from the Mesa Verde Formation, and one (1) from the Dakota Sandstone, (see Table I). The lithologic information (see Table II-B) indicate a clastic sequence composed of sandstone and shale. The total organic carbon values are better than in Subzone a₁, as are the C₁₅₊ hydrocarbon values. The gas chromatograms (see Figure 2) for the samples within this interval are of an excellent quality. The thermal maturity of Stage 2- to 2 is almost ideal for petroleum generation. The only drawback here is in the type of kerogen present in the samples, still predominantly woody-herbaceous.

Therefore, Pennzoil explorationists should attempt to find this unit in a slightly more marine environment, or in an area with less terrigenous sediment input. This may be expected to increase the proportion of amorphous-sapropel material, making the unit prospective for liquid hydrocarbons. While attention could be directed toward the equivalent of this unit down-paleoslope, it would be undesirable to increase the thermal maturity to more than a Stage 3-. Above this value, indigenous liquid hydrocarbons may be expected to begin to eometamorphose to gas.

Subzone b₁ (3,610+ feet to 7,550+ feet)

According to the information provided to us by Pennzoil Company, the stratigraphic interval that we have defined as Subzone b₁ contains the

San Andres Formation, the Glorieta Formation, the Yeso Formation, and the Abo Formation, all Permian in age. Also, included in Subzone b₁ are the Hueco Formation, the Cisco Formation and one (1) sample of the Canyon Formation, all of Pennsylvanian age. The lithological descriptions show this section to be composed primarily of carbonates, with minor amounts of sandstone and shale present overall. While the thermal maturity (Stage 2- to 3-) is very nearly ideal for petroleum generation, the data indicate that there simply is insufficient organic material for significant indigenous hydrocarbon generation. Thus, it is the author's opinion that Pennzoil Company explorationists should not consider any of these units to be potential source rocks, within the immediate vicinity of the subject well.

Subzone b₂ (7,550+ feet to 9,765+ feet)

According to the information which was provided to us, Subzone b₂ contains samples from the Lower Strawn Formation, the Atoka Series, the Andresito Formation, the Fusselman Dolomite, the Montoya Formation, the Cable Canyon Formation, and the El Paso Formation, in age ranging from Pennsylvanian to Silurian, respectively, (see Table I). In general, all of these units have exceeded the Maturation values which are considered to be optimum for petroleum generation. Thus, any liquid hydrocarbons which may have been present can be expected to have been eometamorphosed to gas. Again, as in Subzone b₁, the organic content of these sediments is too low to be expected to produce significant quantities of liquid hydrocarbons.

In summary, the carbonate sequences representing the Paleozoic age sediments seen in the subject well are essentially unprospective for significant quantities of liquid hydrocarbons or natural gas, within the immediate vicinity of the subject well.

The clastic sequences seen in Zone A appear to be moderately prospective for gas, in-place, and may be significantly more prospective for liquid hydrocarbons if they can be found within a more marine depositional environment.

Table 1

Summary of Organic Geochemical Data

GEOLOGICAL AGE (PERIOD) Formation	GeoChem Sample Number	Depth Interval (feet)	Percent Organic Carbon	C ₁₅₊ Extraction		Visual Kerogen		Vitrinite Reflectance (% R ₀)	GEOCHEMICAL ZONATION Hydrocarbon Source Potential	
				C ₁₅₊ Extract (ppm)	C ₁₅₊ H. C. (ppm)	Type	Alteration (1-5 Scale)			
	1018-005D	400- 590	0.19	933	242	Am-W;H;-	1+ to 2-	-		
CRETACEOUS										
Mesa Verde	1018-010D	970-110	0.32	766	121	Am-W;H;-	1+ to 2-	1.03	The sediments representing Subzone a ₁ are interpreted to be prospective for <u>minor quantities of hydrocarbon liquids, and moderately prospective for significant quantities of biogenic gas.</u>	
	1018-012D	1170-1300	0.34	733	135	W;H;Am-C	1+ to 2-	-		
	1018-014D	1400-1500	0.43	989	151	W;-;H(Am)	1+ to 2-	0.97		
	1018-016D	1600-1700	0.40	718	138	W;-;H(Am)	1+ to 2-	-		
	1018-019D	1870-2000	0.43	646	101	W;H;Am	1+ to 2-	-		
	1018-021D	2060-2200	0.61	748	173	W;H;Am	1+ to 2-	1.17		
	1018-024D	2370-2500	0.53	878	166	W;H;Am	1+ to 2-	-		
	1018-025D	2500-2600	1.10	1513	214	W;H;Am-C	2-	1.09		
Mancos Shale	1018-026D	2600-2700	0.91	1319	178	W;H;Am-C	2- to 2	-	Sediments representing Subzone a ₂ are interpreted to be <u>moderately prospective for significant accumulations of petroleum liquids.</u> It is also interpreted that these same sediments are <u>prospective for significant quantities of natural gas and associated liquids (condensate).</u>	
	1018-029D	2840-2970	0.80	1488	119	H-W;-;-	2- to 2	1.41		
	1018-031D	3070-3190	0.85	1761	218	H;W;Am	2- to 2	-		
	1018-033D	3250-3400	0.93	945	276	W;-;H(C)	2- to 2	1.75		
Dakota Sandstone	1018-034D	3410-3520	0.48	733	209	W;H;Am(C)	2- to 2	-		
PERMIAN										
San Andres	1018-038D	3700-3850	0.36	320	37e	W;-;H(C)	2- to 2	-	The sediments represented by the samples from the interval defined as Subzone b ₁ are interpreted to be essentially <u>unprospective for significant quantities of indigenous liquid hydrocarbons.</u> The subject interval is <u>moderately prospective for minor, probably non-economic, accumulations of natural gas.</u>	
	1018-040D	4000-4200	0.23	340	34e	W;H;Am(C)	2- to 2	1.30		
Glorieta & Yeso	1018-043D	4230-4400	0.39	478	95	W;H;C	2 to 2+	1.48		
	1018-046D	4530-4700	0.28	389	36e	W;H-C;-	2 to 2+	1.55		
	1018-049D	4810-5100	0.13	733	38e	W;Am-H;C	2 to 2+	-		
Abo	1018-053D	5400-5600	0.14	571	76	W;H;Am	2 to 2+	1.28		
	1018-059D	5800-6100	0.17	2163	55e	Am-H-W;-;-	2 to 2+	-		
PENNSYLVANIAN										
Hueco	1018-061D	6110-6330	0.17	386	31e	W;-H(Am)	2+ to 3-	-		
Cisco	1018-065D	6600-6800	0.12	417	40e	W;H;Am	2+ to 3-	1.74		
	1018-068D	6970-7100	0.41	420	34e	W;-;H-C	2+ to 3-	-		
Canyon	1018-071D	7200-7400	0.27	456	35e	W;H-C;-	2+ to 3-	1.92		
	1018-075D	7700-7900	0.28	909	28e	W-C;H;-	2+ to 3-	-		
Lower Strawn	1018-077D	7900-8150	0.27	1333	70e	W-C;-;H	2+ to 3-	2.91		
Atoka Series	1018-081D	8300-8500	0.32	2697	58e	C;-;H-W	3- to 3	-	The stratigraphic interval represented by the samples from within Subzone b ₂ is interpreted to be <u>unprospective for significant quantities of indigenous liquid hydrocarbons.</u> Sediments from Subzone b ₂ may have sourced minor, probably non-economic, accumulations of natural gas.	
	1018-083	8500-8690	0.39	845	44e	C;-;H-W	3- to 3	3.20		
MISSISSIPPIAN										
Andresito	1018-085D	8680-8980	0.24	1430	84e	C;-;H	3- to 3	2.42		
DEVONIAN										
SILURIAN										
Fusselman	1018-087D	8960-9100	0.17	2767	196e	C;-;H-W	3- to 3	-		
Montoya	1018-090D	9100-9300	0.14	532	39e	C;-;H(Al)	3- to 3	2.21		
Cable Canyon	1018-092D	9300-9490	0.06	833	46e	H;-;C(Al)	3- to 3	1.37		
El Paso	1018-093D	9490-9600	0.17	1837	107e	C;-;H(Al)	3	-		
	1018-096D	9600-9765	0.09	3420	182e	C;Al;H	3 to 3+	-		

Table II-A

Screening Organic Carbon Analyses and Lithologic Descriptions

GeoChem Sample Number	Well Depth (Feet)	Percent Organic Carbon	Gross Litho Description
1018-001	100- 110	0.16	Siltstone, grayish red, argillaceous.
1018-002	200- 210	0.15	Siltstone, grayish red, argillaceous.
1018-003	300- 310	0.09	Siltstone, grayish red, argillaceous.
1018-004	400- 410	0.13	Siltstone, grayish red, argillaceous.
1018-005	500- 510	0.23; 0.18R	Claystone, grayish red, silty.
1018-006	600- 610	0.09	Claystone, grayish red, silty.
1018-007	700- 710	0.08	Shale, medium gray.
1018-008	800- 810	0.17	Shale, medium gray.
1018-009	900- 910	0.38	Shale, medium gray.
1018-010	1,000-1,010	0.49; 0.54R	Shale, medium gray.
1018-011	1,100-1,110	0.65	Shale, medium dark gray.
1018-012	1,200-1,210	0.65; 0.66R	Shale, medium dark gray.
1018-013	1,300-1,310	0.54	Shale, medium dark gray.
1018-014	1,400-1,410	1.02	Shale, medium dark gray.
1018-015	1,500-1,510	0.67	Shale, medium dark gray.
1018-016	1,600-1,610	0.86	Shale, medium dark gray.
1018-017	1,700-1,710	0.64; 0.59R	Shale, medium dark gray.
1018-018	1,800-1,810	0.40	Shale, medium dark gray.
1018-019	1,900-1,910	0.58	Shale, medium dark gray.
1018-020	2,000-2,010	0.81	Shale, medium dark gray.
1018-021	2,100-2,110	0.82	Shale, medium dark gray.
1018-022	2,200-2,210	0.64; 0.73R	Shale, medium dark gray.
1018-023	2,300-2,310	0.54	Shale, medium dark gray.
1018-024	2,400-2,410	0.99	Shale, medium dark gray.
1018-025	2,500-2,510	1.62	Shale, dark gray.
1018-026	2,600-2,610	2.13	Shale, medium dark gray.
1018-027	2,700-2,710	0.85; 0.80R	Shale, medium gray.
1018-028	2,800-2,810	0.81	Shale, medium gray.
1018-029	2,900-2,910	1.57	Shale, medium gray.
1018-030	3,000-3,010	0.87	Shale, medium gray.
1018-031	3,100-3,110	0.91	Shale, medium gray.
1018-032	3,220-3,230	0.67; 0.72R	Shale, medium gray.
1018-033	3,300-3,310	1.12	Shale, medium gray.
1018-034	3,400-3,410	0.79	Limestone, medium dark gray, argilla- ceous micrite.
1018-035	3,500-3,510	0.62	Medium gray shale.
1018-036	3,610-3,620	0.28	Limestone, medium gray.
1018-037	3,700-3,710	0.12	Limestone, medium gray.
1018-038	3,800-3,810	0.39	Limestone, medium dark gray, argilla- ceous micrite.

Table II-A (contd.)

Screening Organic Carbon Analyses and Lithologic Descriptions

GeoChem Sample Number	Well Depth (Feet)	Percent Organic Carbon	Gross Litho Description
1018-039	3,910-3,920	0.38	Limestone, medium dark gray, argilla- ceous micrite.
1018-040	4,000-4,010	1.14; 1.08R	Shale, medium dark gray.
1018-041	4,100-4,110	0.22	Limestone, medium dark gray argilla- ceous micrite.
1018-042	4,200-4,210	0.21	Limestone, medium dark gray argilla- ceous micrite.
1018-043	4,300-4,310	0.73	Dolomite, calcareous.
1018-044	4,400-4,410	0.34	Dolomite, calcareous.
1018-045	4,500-4,510	0.16; 0.14R	Dolomite, calcareous.
1018-046	4,600-4,610	0.60	Shale, medium gray.
1018-047	4,700-4,710	0.21	Limestone, medium gray argillaceous micrite.
1018-048	4,800-4,810	0.20	Shale, dolomite, medium dark gray.
1018-049	4,900-4,910	0.29	Medium gray dolomite.
1018-050	5,000-5,010	0.24; 0.28R	Medium gray dolomite.
1018-051	5,300-5,310	0.10	Grayish red shale.
1018-052	5,400-5,410	0.22	Dark red shale.
1018-053	5,500-5,510	0.28	Medium gray dolomite, calcareous.
1018-054	5,600-5,610	0.18	Medium dark red shale.
1018-055	5,700-5,710	0.13; 0.11R	Dark red shale.
1018-056	5,810-5,820	0.09	Dark red shale, dolomite.
1018-057	5,910-5,920	0.22	Dark red shale, dolomite.
1018-058	6,020-6,030	0.12	Dark red shale, calcareous.
1018-059	6,120-6,130	0.33	Medium dark gray limestone, slightly argillaceous.
1018-060	6,200-6,210	0.41; 0.35R	Medium dark gray limestone.
1018-061	6,300-6,310	0.26	Medium gray limestone.
1018-062	6,400-6,410	0.34	Medium gray limestone.
1018-063	6,500-6,510	0.24	Medium gray limestone with associated calcite.
1018-064	6,610-6,620	0.15	Medium gray limestone with associated calcite.
1018-065	6,700-6,710	0.27; 0.31R	Medium gray limestone with associated calcite.
1018-066	6,820-6,830	0.16	Medium gray limestone with associated calcite.
1018-067	6,900-6,910	0.24	Light to medium gray limestone, argil- laceous.
1018-068	7,000-7,010	0.23	Light to medium gray limestone, argil- laceous.

Table II-A (contd.)

Screening Organic Carbon Analyses and Lithologic Descriptions

GeoChem Sample Number	Well Depth (Feet)	Percent Organic Carbon	Gross Litho Description
1018-069	7,100-7,110	0.18	Medium gray limestone and associated calcite, slightly argillaceous.
1018-070	7,200-7,210	0.19; 0.14R	Light gray limestone, argillaceous.
1018-071	7,310-7,320	0.58	Medium dark gray limestone, argillaceous.
1018-072	7,400-7,410	0.47	Light to medium gray limestone, argillaceous.
1018-073	7,500-7,510	0.25	Light to medium gray limestone, argillaceous.
1018-074	7,600-7,610	0.22	Medium gray limestone, abundant calcite.
1018-075	7,700-7,710	0.33	Light to medium gray limestone and associated calcite, argillaceous limestone.
1018-076	7,800-7,810	0.37	Medium gray limestone and associated calcite.
1018-077	7,910-7,920	0.37	Medium gray limestone and associated calcite, argillaceous limestone.
1018-078	8,010-8,020	0.24	Medium gray limestone and associated calcite, argillaceous limestone.
1018-079	8,110-8,120	0.29; 0.25R	Medium gray limestone and associated calcite, argillaceous limestone.
1018-080	8,260-8,270	0.23	Medium gray limestone, argillaceous limestone and associated calcite.
1018-081	8,300-8,310	0.33	Medium gray limestone, argillaceous and associated calcite.
1018-082	8,400-8,410	0.23	Medium gray limestone, argillaceous and associated calcite, trace chert.
1018-083	8,500-8,510	0.55	Medium gray limestone, argillaceous limestone and associated calcite.
1018-084	8,610-8,620	0.17	Medium gray limestone, argillaceous limestone and associated calcite.
1018-085	8,700-8,710	0.67	Medium dark red and gray shale, grading into micrite, abundant chert.
1018-086	8,880-8,890	0.30	Medium dark gray limestone and dark gray shale, argillaceous silt.
1018-087	8,900-8,910	0.38	Medium gray limestone and dark gray shale, argillaceous, calcareous siltstone, trace chert.
1018-088	8,940-8,950	0.41	Medium dark gray to dark gray shale, trace limestone.
1018-089	9,010-9,020	0.22	Medium light gray dolomite, trace dark shale.

Table II-A (contd.)

Screening Organic Carbon Analyses and Lithologic Descriptions

GeoChem Sample Number	Well Depth (Feet)	Percent Organic Carbon	Gross Litho Description
1018-090	9,110-9,120	0.09	Medium light gray dolomite, trace black shale.
1018-091	9,200-9,210	0.06	Medium light gray dolomite, slightly calcareous, trace black limestone.
1018-092	9,310-9,320	0.02	Light gray to dark gray dolomite, trace black limestone
1018-093	9,400-9,410	0.03	Light gray dolomite, calcareous, trace black shale.
1018-094	9,520-9,530	0.01	Light gray dolomite.
1018-095	9,610-9,620	0.18	Medium gray dolomite.
1018-096	9,730-9,740	0.03	Medium gray limestone, trace light gray dolomite.

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-005D -A	590'	100% Sandstone, very slightly calcareous, very slightly argillaceous, slightly silty, very fine grain, subangular to angular, clear to frosted, oxidized, moderate hardness, good porosity, no show, grayish red to medium gray. Trace sparite. Trace coarse unconsolidated sand.	5R 4/2 to N5	0.19
1018-010D -A	1100'	90% Sandstone, very slightly calcareous, very slightly argillaceous, slightly silty, fine grain, subangular to angular, clear to frosted, moderate hardness, good porosity, no show, light olive gray.	5Y 6/1	0.32
-B		10% Shale, very slightly calcareous, very slightly silty, fissile, waxy, soft, no show, dark gray. Trace coarse unconsolidated sand.	N3	
1018-012D -A	1300'	60% Sandstone, very slightly calcareous, slightly argillaceous, slightly silty, very fine to medium grain, subrounded to subangular, clear to frosted, moderate hardness, good porosity, no show, light olive gray to yellowish gray.	5Y 6/1 to 5Y 8/1	0.34
-B		40% Shale, noncalcareous, slightly silty, blocky to fissile, moderate hardness, no show, medium gray to olive gray.	N5 to to 5Y 4/1	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-014D -A	1500'	60% Shale, noncalcareous, very slightly silty, fissile, moderate hardness, no show, medium gray to olive gray.	N5 to 5Y 4/1	0.43
-B		40% Sandstone, slightly calcareous, slightly argillaceous, slightly silty, very fine to medium grain, subrounded to subangular, clear to frosted, moderate hardness, good porosity, no show, light olive gray to yellowish gray.	5Y 6/1 to 5Y 8/1	
1018-016D -A	1700'	70% Shale, noncalcareous, very slightly silty, fissile, moderate hardness, waxy, no show, medium gray to olive gray.	N5 to 5Y 4/1	0.40
-B		30% Sandstone, slightly calcareous, slightly argillaceous, slightly silty, fine to medium grain, clear to frosted, moderate hardness, good porosity, no show, light olive gray.	5Y 6/1	
1018-019D -A	2000'	80% Shale, noncalcareous, slightly silty, moderate hardness, waxy, no show, medium dark gray to olive gray.	N4 to 5Y 4/1	0.43
-B		20% Sandstone, very slightly calcareous, slightly argillaceous, slightly silty, frosted, good porosity, no show, greenish gray.	5GY 6/1	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-021D -A	2200'	80% Shale, noncalcareous, slightly silty, moderate hardness, waxy, no show, medium dark gray to olive gray.	N4 to 5Y 4/1	0.61
-B		20% Sandstone, very slightly calcareous, slightly argillaceous, slightly silty, frosted, good porosity, no show, greenish gray.		
1018-024D -A	2500'	70% Sandstone, slightly calcareous, very slightly argillaceous, slightly silty, very fine to fine grain, subrounded, frosted, moderate hardness, good porosity, no show, light gray.	N7	0.53
-B		30% Shale, noncalcareous, very slightly silty, fissile, moderate hardness, no show, dark gray to medium gray.		
1018-025D -A	2600'	60% Sandstone, slightly calcareous, very slightly argillaceous, slightly silty, very fine to fine grain, subrounded, frosted, moderate hardness, good porosity, no show, light gray.	N7	1.10
-B		40% Shale, noncalcareous, very slightly silty, fissile, moderate hardness, no show, dark gray to medium gray.		
1018-026D -A	2700'	90% Shale, noncalcareous, silty, fissile, moderate hardness, no show, medium dark gray.	N4	0.91
-B		10% Sandstone, siliceous, slightly argillaceous, slightly silty, very fine grain, subrounded, frosted, moderately hard, good porosity, no show, light gray. Trace black carbonaceous shale.		

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-029D -A	2970'	70% Shale, noncalcareous, silty, fissile, moderately hard, no show, medium dark gray to light gray.	N4 to N7	0.80
-B		30% Sandstone, slightly calcareous, very slightly argillaceous, slightly silty, fine to medium grain, subangular, clear to frosted, moderate hardness, good porosity, no show, light gray. Trace black carbonaceous shale.		
1018-031D -A	3190'	100% Shale, very slightly calcareous, slightly silty, fissile to blocky, moderate hardness, no show, medium dark gray to medium gray. Trace sandstone. Trace sparite.	N4 to N5	0.85
1018-033D -A	3400'	90% Shale, calcareous, slightly silty, fissile to blocky, moderate hardness, no show, medium dark gray to medium gray.	N4 to N5	0.93
-B		10% Limestone, sparite grading into micrite, very slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, light gray. Trace sandstone. Trace calcite.		
1018-034D -A	3520'	50% Sandstone, siliceous, slightly argillaceous, slightly silty, very fine to medium grain, subangular to subrounded, clear to frosted, soft, excellent porosity, no show, very light gray.	N8	0.48
-B		50% Shale, slightly calcareous, silty, fissile, moderate hardness, no show, medium dark gray to medium gray. Trace sparite.		

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-038D -A	3850'	90% Limestone, limy grading into micrite, slightly argillaceous, slightly silty, very hard, fair porosity, no show, medium dark gray to very light gray.	N4 to N8	0.36
-B		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, very light gray. Trace calcite.	N8	
1018-040D -A	4200'	50% Limestone, micrite, argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray.	N4 to N5	0.23
-B		40% Sandstone, siliceous, slightly argillaceous, very fine to fine grain, subangular, frosted, oxidized, moderate hardness, good porosity, no show, pale red.	5R 6/2	
-C		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, light olive gray. Trace shale.	5Y 6/1	
1018-043D -A	4400'	60% Limestone, micrite, argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray.	N4 to N5	0.39
-B		30% Sandstone, siliceous, slightly argillaceous, very fine to fine grain, subangular, frosted, oxidized, moderate hardness, good porosity, no show, pale red.	5R 6/2	
-C		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, light olive gray. Trace anhydrite.	5Y 6/1	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-046D	4700'			0.28
-A		60% Limestone, micrite, argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray.	N4 to N5	
-B		30% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, light olive gray.	5Y 6/1	
-C		10% Sandstone, siliceous, slightly argillaceous, very fine to fine grain, subangular, frosted, oxidized, moderate hardness, good porosity, no show, pale red. Anhydrite associated.	5R 6/2	
1018-049D	5100'			0.13
-A		50% Sandstone, siliceous, slightly argillaceous, slightly silty, very fine to fine grain, subangular, frosted, oxidized, moderate hardness, good porosity, no show, pale red.	5R 6/2	
-B		40% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		10% Anhydrite, very light gray to white.	N8 to N9	
1018-053D	5600'			0.14
-A		80% Shale, slightly calcareous, silty, blocky to fissile, extremely hard, no show, grayish red.	5R 4/2	
-B		20% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-059D -A	6100'	90% Shale, slightly calcareous, silty, blocky to fissile, extremely hard, no show, grayish red.	5R 4/2	0.17
-B		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
1018-061D -A	6330'	50% Limestone, micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray.	N4 to N5	0.17
-B		30% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		20% Shale, slightly calcareous, silty, blocky to fissile, extremely hard, no show, grayish red.	5R 4/2	
1018-065D -A	6800'	70% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to light gray.	N4 to N7	0.12
-B		20% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		10% Shale, slightly calcareous, silty, blocky to fissile, very hard, no show, grayish red.	5Y 4/2	
1018-068D -A	7100'	80% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to light gray.	N4 to N7	0.41
-B		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		10% Shale, noncalcareous, slightly silty, moderately hard, no show, dark gray to grayish red. Trace anhydrite.	5Y 4/2	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-071D	7400'			0.27
-A		80% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to light gray.	N4 to N7	
-B		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		10% Shale, noncalcareous, slightly silty, moderately hard, no show, dark gray to grayish red. Trace anhydrite.	5Y 4/2	
1018-075D	7900'			0.28
-A		80% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to light gray.	N4 to N7	
-B		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		10% Shale, noncalcareous, slightly silty, moderately hard, no show, dark gray to grayish red. Trace anhydrite.	5Y 4/2	
1018-077D	8150'			0.27
-A		80% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to light gray.	N4 to N7	
-B		10% Dolomite, sucrosic, micro-crystalline, very hard, fair porosity, no show, medium gray.	N5	
-C		10% Shale, noncalcareous, slightly silty, moderately hard, no show, dark gray to grayish red. Trace anhydrite.	5Y 4/2	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-081D -A	8500'	100% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray. Trace dolomite. Trace black shale.	N4 to N5	0.32
1018-083D -A	8690'	80% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray.	N4 to N5	0.39
-B		20% Shale, calcareous, slightly silty, fissile, moderate hardness, no show, medium dark gray.	N4	
1018-085D -A	8980'	Varied lithology, includes shale, both red and dark gray, limestone, chert, and sandstone.		0.24
1018-087D -A	9100'	60% Dolomite, sucrosic, micro-crystalline, moderately hard, fair porosity, no show, very light gray.	N8	0.17
-B		30% Shale, calcareous, slightly silty, fissile, moderate hardness, no show, medium dark gray.	N4	
-C		10% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderate hardness, fair porosity, no show, medium dark gray to medium gray. Trace red shale.	N4 to N5	

Table II-B

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1018-090D -A	9300'	90% Dolomite, sucrosic, micro-crystalline, moderately hard, fair porosity, no show, very light gray.	N8	0.14
-B		10% Shale, calcareous, slightly silty, fissile, moderately hard, no show, medium dark gray. Trace micrite.	N4	
1018-092D -A	9490'	100% Dolomite, sucrosic, micro-crystalline, moderately hard, fair porosity, no show, very light gray. Trace micrite.	N8	0.06
1018-093D -A	9600'	100% Dolomite, sucrosic, micro-crystalline, moderately hard, fair porosity, no show, medium gray. Trace micrite.	N5	0.17
1018-096D -A	9765'	80% Limestone, sparite grading into micrite, slightly argillaceous, slightly silty, moderately hard, fair porosity, no show, medium dark gray.	N4	0.09
-B		20% Dolomite, sucrosic, micro-crystalline, moderately hard, fair porosity, no show, medium gray.	N5	

Table III

Stratigraphic Boundary InformationProvided by Pennzoil

Sunray Mid-Continent Oil Co.
 Federal "M" No. 1 Well
 Sierra County, New Mexico

<u>Age</u>	<u>Formation Name</u>	<u>Top</u>
Cretaceous	Mesa Verde Formation	954'
	Mancos Shale	2606'
	Dakota Sandstone	3416'
Permian	San Andres Formation	3605'
	Glorieta Formation	4300'
	Yeso Formation	4338'
	Igneous Sill (diorite)	5085' - 5180'
	Igneous Sill	5260' - 5270'
	Abo Formation	5260'
Pennsylvanian	Hueco Formation	6065'
	Cisco Formation	6573'
	Canyon Formation	7295'
	L. Strawn Formation	8038'
	Atoka Series	8401'
Mississippian	(Base Atoka Series)	8692'
	Andresito Formation	8800'
Devonian		8902'
Silurian	Fusselman Dolomite	9010'
	Montoya Formation	9083'
	Cable Canyon	9390'
	El Paso Formation	9425'
	T.D.	9765'

Table IV

Summary of C15+ Soxhlet Extraction, Deasphalting
and Liquid Chromatography

A. Weights of Extracts and Chromatographic Fractions

GeoChem Sample Number	Well Interval	Weight of Rock Extd. (grams)	Total Extract (grams)	Precipitated Asphaltenes (grams)	N-C5 Soluble (grams)	Sulfur (grams)	Paraffins- Naphthenes (grams)	Aromatics (grams)	Eluted NSO'S (grams)	Noneluted NSO'S (grams)
1018-005D	400- 590	85.0	0.0793	0.0501	0.0292	N.D.	0.0140	0.0066	0.0078	0.0008
1018-010D	970- 1100	85.0	0.0651	0.0460	0.0191	N.D.	0.0070	0.0033	0.0071	0.0017
1018-012D	1170- 1300	100.0	0.0733	0.0502	0.0231	N.D.	0.0087	0.0048	0.0078	0.0018
1018-014D	1400- 1500	80.0	0.0791	0.0563	0.0228	N.D.	0.0070	0.0051	0.0090	0.0017
1018-016D	1600- 1700	89.0	0.0639	0.0410	0.0229	N.D.	0.0079	0.0044	0.0092	0.0014
1018-019D	1870- 2000	85.0	0.0549	0.0381	0.0168	N.D.	0.0051	0.0035	0.0066	0.0016
1018-021D	2060- 2200	90.0	0.0673	0.0412	0.0261	N.D.	0.0100	0.0056	0.0082	0.0023
1018-024D	2370- 2500	100.0	0.0878	0.0574	0.0304	N.D.	0.0109	0.0057	0.0103	0.0035
1018-025D	2500- 2600	70.0	0.1059	0.0818	0.0241	N.D.	0.0086	0.0064	0.0084	0.0007
1018-026D	2600- 2700	69.0	0.0910	0.0698	0.0212	N.D.	0.0066	0.0057	0.0070	0.0019
1018-029D	2840- 2970	85.0	0.1265	0.1072	0.0193	N.D.	0.0060	0.0041	0.0071	0.0021
1018-031D	3070- 3190	80.0	0.1409	0.1179	0.0230	N.D.	0.0127	0.0047	0.0042	0.0014
1018-033D	3250- 3400	75.0	0.0709	0.0444	0.0265	N.D.	0.0155	0.0052	0.0039	0.0019
1018-034D	3410- 3520	93.0	0.0682	0.0414	0.0268	N.D.	0.0126	0.0068	0.0057	0.0017
1018-038D	3700- 3850	75.0	0.0240	0.0170	0.0070	N.D.	N.D.	N.D.	N.D.	N.D.
1018-040D	4000- 4200	78.0	0.0265	0.0199	0.0066	N.D.	N.D.	N.D.	N.D.	N.D.
1018-043D	4230- 4400	80.0	0.0382	0.0259	0.0123	N.D.	0.0049	0.0027	0.0034	0.0013
1018-046D	4530- 4700	80.0	0.0311	0.0239	0.0072	N.D.	N.D.	N.D.	N.D.	N.D.
1018-049D	4810- 5100	67.0	0.0491	0.0428	0.0063	N.D.	N.D.	N.D.	N.D.	N.D.
1018-053D	5400- 5600	79.0	0.0451	0.0350	0.0101	N.D.	0.0045	0.0015	0.0030	0.0011
1018-059D	5800- 6100	35.0	0.0757	0.0709	0.0048	N.D.	N.D.	N.D.	N.D.	N.D.
1018-061D	6110- 6330	70.0	0.0270	0.0216	0.0054	N.D.	N.D.	N.D.	N.D.	N.D.
1018-065D	6600- 6800	60.0	0.0250	0.0191	0.0059	N.D.	N.D.	N.D.	N.D.	N.D.
1018-068D	6970- 7100	85.0	0.0357	0.0286	0.0071	N.D.	N.D.	N.D.	N.D.	N.D.
1018-071D	7200- 7400	70.0	0.0319	0.0258	0.0061	N.D.	N.D.	N.D.	N.D.	N.D.
1018-075D	7700- 7900	100.0	0.0909	0.0838	0.0071	N.D.	N.D.	N.D.	N.D.	N.D.
1018-077D	7900- 8150	40.0	0.0533	0.0463	0.0070	N.D.	N.D.	N.D.	N.D.	N.D.
1018-081D	8300- 8500	30.0	0.0809	0.0766	0.0043	N.D.	N.D.	N.D.	N.D.	N.D.
1018-083D	8500- 8690	40.0	0.0338	0.0294	0.0044	N.D.	N.D.	N.D.	N.D.	N.D.
1018-085D	8680- 8980	20.0	0.0286	0.0244	0.0042	N.D.	N.D.	N.D.	N.D.	N.D.
1018-087D	8960- 9100	9.0	0.0249	0.0205	0.0044	N.D.	N.D.	N.D.	N.D.	N.D.
1018-090D	9100- 9300	65.0	0.0346	0.0283	0.0063	N.D.	N.D.	N.D.	N.D.	N.D.
1018-092D	9300- 9490	39.0	0.0325	0.0280	0.0045	N.D.	N.D.	N.D.	N.D.	N.D.
1018-093D	9490- 9600	13.5	0.0248	0.0212	0.0036	N.D.	N.D.	N.D.	N.D.	N.D.
1018-096D	9600- 9765	8.8	0.0301	0.0261	0.0040	N.D.	N.D.	N.D.	N.D.	N.D.

N.D. = No Data

Table IV (Continued)

B. Concentration of Extracted Materials in Rock

GeoChem Sample Number	Well Interval	Total Extract (ppm)	-----Hydrocarbons-----			Sulfur (ppm)	-----Nonhydrocarbons-----			Total (ppm)
			Paraffin- Naphthene (ppm)	Aromatic (ppm)	Total (ppm)		Preciptd. Asphaltene (ppm)	Eluted NSO'S (ppm)	Noneluted NSO'S (ppm)	
1018-005D	400- 590	933	165	78	242	-	589	92	9	691
1018-010D	970- 1100	766	82	39	121	-	541	84	20	645
1018-012D	1170- 1300	733	87	48	135	-	502	78	18	598
1018-014D	1400- 1500	989	88	64	151	-	704	113	21	838
1018-016D	1600- 1700	718	89	49	138	-	461	103	16	580
1018-019D	1870- 2000	646	60	41	101	-	448	78	19	545
1018-021D	2060- 2200	748	111	62	173	-	458	91	26	574
1018-024D	2370- 2500	878	109	57	166	-	574	103	35	712
1018-025D	2500- 2600	1513	123	91	214	-	1169	120	10	1299
1018-026D	2600- 2700	1319	96	83	178	-	1012	101	28	1141
1018-029D	2840- 2970	1488	71	48	119	-	1261	84	25	1369
1018-031D	3070- 3190	1761	159	59	218	-	1474	53	18	1544
1018-033D	3250- 3400	945	207	69	276	-	592	52	25	669
1018-034D	3410- 3520	733	135	73	209	-	445	61	18	525
1018-038D	3700- 3850	320	-	-	37e	-	227	-	-	-
1018-040D	4000- 4200	340	-	-	34e	-	255	-	-	-
1018-043D	4230- 4400	478	61	34	95	-	324	43	16	383
1018-046D	4530- 4700	389	-	-	36e	-	299	-	-	-
1018-049D	4810- 5100	733	-	-	38e	-	639	-	-	-
1018-053D	5400- 5600	571	57	19	76	-	443	38	14	495
1018-059D	5800- 6100	2163	-	-	55e	-	2026	-	-	-
1018-061D	6110- 6330	386	-	-	31e	-	309	-	-	-
1018-065D	6600- 6800	417	-	-	40e	-	318	-	-	-
1018-068D	6970- 7100	420	-	-	34e	-	336	-	-	-
1018-071D	7200- 7400	456	-	-	35e	-	369	-	-	-
1018-075D	7700- 7900	909	-	-	28e	-	838	-	-	-
1018-077D	7900- 8150	1333	-	-	70e	-	1158	-	-	-
1018-081D	8300- 8500	2697	-	-	58e	-	2553	-	-	-
1018-083D	8500- 8690	845	-	-	44e	-	735	-	-	-
1018-085D*	8680- 8980	1430	-	-	84e	-	1220	-	-	-
1018-087D*	8960- 9100	2767	-	-	196e	-	2278	-	-	-
1018-090D	9100- 9300	532	-	-	39e	-	435	-	-	-
1018-092D	9300- 9490	833	-	-	46e	-	718	-	-	-
1018-093D*	9490- 9600	1837	-	-	107e	-	1570	-	-	-
1018-096D*	9600- 9765	3420	-	-	182e	-	2966	-	-	-

* The weight of sample material extracted, shown in Tale IV-A, is less than or equal to 20.0g. (see text).

e = Estimated (see text).

Table IV (Continued)

C. Composition of Extracts

GeoChem Sample Number	Well Interval	-----Hydrocarbons-----				-----Nonhydrocarbons-----					
		Paraffin- Naphthene %	Aromatic %	PN/Arom	Sulfur %	Eluted NSO'S %	Noneluted NSO'S %	Precipitd. Asphaltene %	Asph/NSO	HC'S %	HC/Non HC
1018-005D	400- 590	17.7	8.3	2.12	-	9.8	1.0	63.2	5.83	26.0	0.35
1018-010D	970- 1100	10.8	5.1	2.12	-	10.9	2.6	70.7	5.23	15.8	0.19
1018-012D	1170- 1300	11.9	6.5	1.81	-	10.6	2.5	68.5	5.23	18.4	0.23
1018-014D	1400- 1500	8.8	6.4	1.37	-	11.4	2.1	71.2	5.26	15.3	0.18
1018-016D	1600- 1700	12.4	6.9	1.80	-	14.4	2.2	64.2	3.87	19.2	0.24
1018-019D	1870- 2000	9.3	6.4	1.46	-	12.0	2.9	69.4	4.65	15.7	0.19
1018-021D	2060- 2200	14.9	8.3	1.79	-	12.2	3.4	61.2	3.92	23.2	0.30
1018-024D	2370- 2500	12.4	6.5	1.91	-	11.7	4.0	65.4	4.16	18.9	0.23
1018-025D	2500- 2600	8.1	6.0	1.34	-	7.9	0.7	77.2	8.99	14.2	0.17
1018-026D	2600- 2700	7.3	6.3	1.16	-	7.7	2.1	76.7	7.84	13.5	0.16
1018-029D	2840- 2970	4.7	3.2	1.46	-	5.6	1.7	84.7	11.65	8.0	0.09
1018-031D	3070- 3190	9.0	3.3	2.70	-	3.0	1.0	83.7	21.05	12.3	0.14
1018-033D	3250- 3400	21.9	7.3	2.98	-	5.5	2.7	62.6	7.66	29.2	0.41
1018-034D	3410- 3520	18.5	10.0	1.85	-	8.4	2.5	60.7	5.59	28.4	0.40
1018-038D	3700- 3850	-	-	-	-	-	-	70.8	-	-	-
1018-040D	4000- 4200	-	-	-	-	-	-	75.1	-	-	-
1018-043D	4230- 4400	12.8	7.1	1.81	-	8.9	3.4	67.8	5.51	19.9	0.25
1018-046D	4530- 4700	-	-	-	-	-	-	76.8	-	-	-
1018-049D	4810- 5100	-	-	-	-	-	-	87.2	-	-	-
1018-053D	5400- 5600	10.0	3.3	3.00	-	6.7	2.4	77.6	8.54	13.3	0.15
1018-059D	5800- 6100	-	-	-	-	-	-	93.7	-	-	-
1018-061D	6110- 6330	-	-	-	-	-	-	80.0	-	-	-
1018-065D	6600- 6800	-	-	-	-	-	-	76.4	-	-	-
1018-068D	6970- 7100	-	-	-	-	-	-	80.1	-	-	-
1018-071D	7200- 7400	-	-	-	-	-	-	80.9	-	-	-
1018-075D	7700- 7900	-	-	-	-	-	-	92.2	-	-	-
1018-077D	7900- 8150	-	-	-	-	-	-	86.9	-	-	-
1018-081D	8300- 8500	-	-	-	-	-	-	94.7	-	-	-
1018-083D	8500- 8690	-	-	-	-	-	-	87.0	-	-	-
1018-085D	8680- 8980	-	-	-	-	-	-	85.3	-	-	-
1018-087D	8960- 9100	-	-	-	-	-	-	82.3	-	-	-
1018-090D	9100- 9300	-	-	-	-	-	-	81.8	-	-	-
1018-092D	9300- 9490	-	-	-	-	-	-	86.2	-	-	-
1018-093D	9490- 9600	-	-	-	-	-	-	85.5	-	-	-
1018-096D	9600- 9765	-	-	-	-	-	-	86.7	-	-	-

Table V-A

Saturate Hydrocarbon Analyses

Summary of Paraffin-Naphthene Distribution

GeoChem Sample Number	Well Interval	% Paraffin	% Isoprenoid	% Naphthene	C-P Index A	C-P Index B	ipl9/ip20
1018-005D	400- 590	6.4	0.7	92.8	1.15	-	0.71
1018-010D	970- 1100	18.5	2.8	78.6	1.13	1.31	1.02
1018-012D	1170- 1300	17.3	2.8	79.9	1.23	-	0.74
1018-014D	1400- 1500	18.3	2.6	79.0	1.20	-	1.07
1018-016D	1600- 1700	21.7	3.1	75.2	1.15	-	1.04
1018-019D	1870- 2000	17.2	2.9	79.9	1.22	-	0.84
1018-021D	2060- 2200	16.2	2.6	81.3	1.15	-	1.25
1018-024D	2370- 2500	23.7	1.9	74.4	1.07	1.19	1.02
1018-025D	2500- 2600	21.3	2.6	76.1	1.07	1.19	1.42
1018-026D	2600- 2700	22.0	3.4	74.6	1.10	-	1.23
1018-029D	2840- 2970	17.8	2.4	79.8	1.08	1.25	0.70
1018-031D	3070- 3190	18.7	3.0	78.4	1.24	-	1.20
1018-033D	3250- 3400	22.8	3.7	73.4	1.07	-	1.44
1018-034D	3410- 3520	14.3	2.4	83.3	1.15	-	0.91
1018-038D	3700- 3850	17.7	2.5	79.9	1.13	-	0.82
1018-040D	4000- 4200	13.6	1.4	85.0	1.17	-	0.77
1018-043D	4230- 4400	16.1	1.7	82.2	1.20	-	0.84
1018-046D	4530- 4700	16.3	1.7	82.0	1.16	-	0.69
1018-049D	4810- 5100	11.4	1.0	87.6	1.15	-	0.51
1018-053D	5400- 5600	13.5	1.4	85.1	1.13	-	0.63
1018-059D	5800- 6100	11.3	0.8	87.9	1.08	-	0.39
1018-061D	6110- 6330	11.4	0.9	87.7	1.14	-	0.55
1018-065D	6600- 6800	13.1	0.3	86.6	1.10	1.36	0.24
1018-068D	6970- 7100	12.7	1.7	85.6	1.08	-	0.50
1018-071D	7200- 7400	11.2	0.7	88.1	1.10	-	0.21
1018-075D	7700- 7900	12.8	1.2	86.0	1.12	-	0.49
1018-077D	7900- 8150	9.3	0.5	90.2	1.11	1.44	0.52
1018-081D	8300- 8500	13.5	0.6	85.9	1.11	1.45	0.25
1018-083D	8500- 8690	14.5	0.7	84.9	1.10	1.41	0.27
1018-085D	8680- 8980	11.6	0.3	88.1	1.10	1.31	0.27
1018-087D	8960- 9100	10.9	0.1	89.0	1.10	1.40	0.80
1018-090D	9100- 9300	11.7	0.4	87.9	1.12	1.38	0.44
1018-092D	9300- 9490	7.1	0.1	92.8	1.08	-	0.40
1018-093D	9490- 9600	5.7	0.2	94.1	1.13	-	0.44
1018-096D	9600- 9765	7.5	0.1	92.4	1.12	-	1.50

Table V-B

Saturate Hydrocarbon Analyses

Normalized Paraffin Distribution

GeoChem Sample Number	Well Interval	% nC15	% nC16	% nC17	% ipl9	% nC18	% ip20	% nC19	% nC20	% nC21	% nC22	% nC23	% nC24	% nC25	% nC26	% nC27	% nC28	% nC29	% nC30	% nC31	% nC32	% nC33	% nC34	% nC35
1018-005D	400- 590	1.0	1.6	4.9	4.1	10.0	5.8	14.5	13.4	11.6	9.2	7.5	4.4	4.1	2.7	2.0	1.0	1.0	0.6	0.7	0.0	0.0	0.0	0.0
1018-010D	970- 1100	0.3	2.9	8.8	6.7	14.5	6.6	16.9	13.1	9.3	6.6	4.8	2.9	2.2	1.3	1.2	0.6	0.6	0.3	0.2	0.1	0.0	0.0	0.0
1018-012D	1170- 1300	0.5	3.3	9.8	6.0	15.6	8.1	18.2	15.2	10.4	6.3	3.6	1.5	0.9	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
1018-014D	1400- 1500	0.4	3.5	9.3	6.5	14.7	6.1	18.4	15.3	10.2	6.3	4.0	1.9	1.3	0.7	0.5	0.3	0.3	0.1	0.1	0.0	0.0	0.0	0.0
1018-016D	1600- 1700	0.5	2.9	8.2	6.3	14.4	6.1	19.0	15.7	10.1	6.4	3.9	2.0	1.5	1.0	0.7	0.5	0.4	0.2	0.1	0.0	0.0	0.0	0.0
1018-019D	1870- 2000	0.2	3.2	10.5	6.6	15.9	7.9	17.1	13.7	9.7	6.4	4.3	1.8	1.2	0.5	0.4	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
1018-021D	2060- 2200	1.4	6.4	12.4	7.6	13.8	6.1	15.0	10.8	8.2	6.2	4.7	2.6	2.0	1.1	0.8	0.3	0.3	0.2	0.1	0.0	0.0	0.0	0.0
1018-024D	2370- 2500	0.2	1.6	5.3	3.8	9.6	3.7	13.2	12.8	11.6	10.1	8.4	6.1	4.7	3.1	2.4	1.4	1.0	0.4	0.3	0.1	0.0	0.0	0.0
1018-025D	2500- 2600	1.5	5.9	11.2	6.4	13.6	4.5	14.2	11.5	8.8	7.1	5.3	3.4	2.6	1.6	1.0	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.0
1018-026D	2600- 2700	0.6	5.1	11.4	7.4	14.2	6.0	15.6	12.1	8.6	6.2	4.5	3.0	2.1	1.2	0.9	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0
1018-029D	2840- 2970	0.2	2.4	8.5	4.8	14.1	6.9	15.5	12.5	9.6	7.9	6.1	4.0	3.0	1.7	1.3	0.6	0.3	0.2	0.1	0.1	0.0	0.0	0.0
1018-031D	3070- 3190	0.5	5.5	13.1	7.5	14.8	6.2	13.6	10.6	10.5	6.4	4.8	3.0	1.7	0.9	0.5	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
1018-033D	3250- 3400	5.5	10.8	14.1	8.3	12.9	5.8	11.6	9.1	6.9	5.5	4.1	2.5	1.4	0.7	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
1018-034D	3410- 3520	0.7	4.1	10.1	6.9	14.0	7.6	16.0	13.2	9.7	6.9	5.1	2.7	1.5	0.6	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
1018-038D	3700- 3850	0.4	2.2	8.7	5.5	15.2	6.7	18.3	13.9	10.3	7.5	5.3	2.9	1.5	0.6	0.4	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0
1018-040D	4000- 4200	0.3	2.1	8.1	4.1	13.0	5.3	16.6	14.4	12.1	9.5	7.2	3.5	2.0	0.6	0.5	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.0
1018-043D	4230- 4400	0.5	2.7	8.1	4.3	14.2	5.1	18.5	15.4	11.5	8.0	5.8	2.8	1.6	0.5	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
1018-046D	4530- 4700	0.4	1.9	8.5	3.8	14.8	5.6	17.7	13.8	11.4	8.8	6.7	3.3	1.7	0.7	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
1018-049D	4810- 5100	0.2	0.9	5.7	2.8	12.1	5.6	17.7	14.9	12.6	10.4	8.4	4.2	2.3	0.9	0.6	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0
1018-053D	5400- 5600	0.3	1.1	5.7	3.7	11.9	5.8	17.0	15.3	13.0	10.3	7.5	4.1	2.3	0.8	0.4	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0
1018-059D	5800- 6100	0.7	0.7	3.7	2.0	10.1	5.0	15.3	15.8	15.1	13.5	8.9	4.6	2.1	1.0	0.7	0.3	0.3	0.2	0.2	0.0	0.0	0.0	0.0
1018-061D	6110- 6330	0.3	0.7	4.5	2.6	9.4	4.7	14.2	14.8	15.4	13.7	9.6	4.6	2.6	1.0	0.9	0.4	0.3	0.1	0.1	0.0	0.0	0.0	0.0
1018-065D	6600- 6800	0.4	0.4	1.2	0.5	5.8	2.1	11.4	13.0	14.8	15.9	13.5	8.0	5.1	2.6	2.3	1.2	1.0	0.5	0.4	0.1	0.0	0.0	0.0
1018-068D	6970- 7100	0.2	1.3	9.1	4.0	16.2	8.1	18.1	13.9	10.5	8.3	5.3	2.8	1.1	0.5	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
1018-071D	7200- 7400	0.2	0.3	3.0	1.0	10.7	4.9	17.3	15.0	14.2	12.9	9.8	5.2	2.8	1.0	0.7	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0
1018-075D	7700- 7900	0.2	1.2	7.1	2.7	13.0	5.5	16.7	14.0	12.5	10.8	7.6	3.9	2.3	0.9	0.6	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0
1018-077D	7900- 8150	1.4	1.4	3.8	1.7	8.4	3.2	13.0	13.2	13.6	13.3	10.8	6.2	4.5	2.2	1.3	0.6	0.7	0.3	0.4	0.1	0.0	0.0	0.0
1018-081D	8300- 8500	0.4	0.5	2.8	0.9	8.6	3.5	14.8	15.3	15.2	14.0	10.4	5.6	3.3	1.5	1.3	0.6	0.6	0.3	0.4	0.1	0.0	0.0	0.0
1018-083D	8500- 8690	0.3	0.3	3.3	1.0	9.7	3.5	14.7	13.6	13.4	13.5	11.4	6.4	3.7	1.6	1.5	0.8	0.7	0.3	0.3	0.1	0.0	0.0	0.0
1018-085D	8680- 8980	0.5	0.5	1.3	0.5	5.1	1.8	10.6	12.6	14.9	15.9	13.4	8.0	5.1	2.8	2.5	1.5	1.5	0.7	0.5	0.2	0.0	0.0	0.0
1018-087D	8960- 9100	0.4	1.1	1.3	0.5	3.6	0.6	8.8	12.1	14.2	16.0	14.6	9.1	6.3	3.3	2.7	1.5	1.9	0.8	0.9	0.3	0.1	0.0	0.0
1018-090D	9100- 9300	0.7	0.6	1.9	1.0	6.2	2.3	12.0	14.7	16.5	16.3	13.2	6.8	3.5	1.4	1.2	0.6	0.4	0.3	0.3	0.1	0.0	0.0	0.0
1018-092D	9300- 9490	0.9	0.9	1.5	0.6	5.8	1.5	12.2	14.0	16.6	18.4	15.2	7.6	3.2	0.9	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
1018-093D	9490- 9600	0.7	0.9	1.7	0.9	3.9	2.0	9.3	11.5	14.5	16.9	16.3	10.0	6.3	2.0	1.3	0.4	0.9	0.2	0.4	0.0	0.0	0.0	0.0
1018-096D	9600- 9765	0.4	0.8	1.2	0.6	2.2	0.4	5.7	9.5	13.9	18.8	19.0	10.9	6.7	3.4	2.8	1.2	1.4	0.4	0.6	0.0	0.0	0.0	0.0

TABLE VI
VISUAL KEROGEN ASSESSMENT WORKSHEET

GEOCHEM No.	DEPTH	TYPE OF ORGANIC MATTER		COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	MATURATION INDEX	DEPOSITIONAL ENVIRONMENT	REMARKS																																																																																															
		RECOGNIZABLE ALGAE	AMORPHOUS SAMPSON	YELLOW	BLACK	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
1018-005D	590'							Am-W;H;-	V.L.O.M.																																																																																														
1018-010D	1100'							Am-W;H;-	V.L.O.M.																																																																																														
1018-012D	1300'							W;H;Am-C																																																																																															
1018-014D	1500'							W;-;H(Am)																																																																																															
1018-016D	1700'							W;-;H(Am)																																																																																															
1018-019D	2000'							W;H;Am																																																																																															
1018-021D	2200'							W;H;Am																																																																																															
1018-024D	2500'							W;H;Am																																																																																															
1018-025C	2600'							W;H;Am-C																																																																																															
1018-026D	2700'							W;H*;Am-C																																																																																															
1018-029D	2970'							H-W;-;-																																																																																															
1018-031D	3190'							H*;W;Am																																																																																															
1018-033D	3400'							W;-;H(C)																																																																																															
1018-034D	3520'							W;H*;Am-C																																																																																															
1018-038D	3850'							W;-;H(C)																																																																																															
1018-040D	4200'							W;H;Am(C)																																																																																															
1018-043D	4400'							W;H;C																																																																																															
1018-046D	4700'							W;H-C;-																																																																																															
1018-049D	5100'							W;Am-H;C																																																																																															
1018-053D	5600'							W;H;Am																																																																																															
1018-059D	6100'							Am-H-W;-;-	V.L.O.M.																																																																																														
1018-061D	6330'							W;-;H(Am)																																																																																															
1018-065D	6800'							W;H;Am																																																																																															
1018-068D	7100'							W;-;H-C																																																																																															
1018-071D	7400'							W;H-C;-																																																																																															
1018-075D	7900'							W-C;H;-																																																																																															
1018-077D	8150'							W-C;-;H																																																																																															
1018-081D	8500'							C;-;H*-W																																																																																															
1018-083D	8690'							C;-;H*-W																																																																																															
1018-085D	8980'							C;-;H*																																																																																															
1018-087D	9100'							C;-;H*-W																																																																																															
1018-090D	9300'							C;-;H*(Al)	C-H* may be caved, identifiable Silurian debris rare																																																																																														
1018-092D	9490'							H*;-;C(Al)	"																																																																																														
1018-093D	9600'							C;-;H*(Al)	"																																																																																														
1018-096D	9765'							C;Al;H*	"																																																																																														

Table VII
Vitrinite Reflectance Summary

GeoChem Sample Number	Depth (feet)	Number of Readings	Minimum Reflectance (% Ro)	Maximum Reflectance (% Ro)	Average Reflectance (% Ro)
1018-010D	970-1100	40	.36	1.41	1.03
1018-014D	1400-1500	42	.38	1.62	.97
1018-021D	2060-2200	40	.81	1.90	1.17
1018-025D	2500-2600	44	.76	1.80	1.09
1018-029D	2840-2970	38	.86	1.99	1.41
1018-033D	3250-3400	40	.79	2.46	1.75
1018-040D	4000-4200	40	.70	2.06	1.30
1018-043D	4230-4400	40	.44	2.09	1.48
1018-046D	4530-4700	41	.66	2.18	1.55
1018-053D	5400-5600	40	.37	1.99	1.28
1018-065D	6600-6800	29	.50	2.58	1.74
1018-071D	7200-7400	17	.52	2.59	1.92
1018-077D	7900-8150	42	1.05	3.52	2.91
1018-083D	8500-8690	26	1.34	3.54	3.20
1018-085D	8680-8900	37	1.27	3.53	2.42
1018-090D	9100-9300	17	1.21	3.58	2.21
1018-092D	9300-9490	43	.59	2.10	1.37

APPENDIX A

Brief Description of Organic Geochemical analyses Carried Out by GeoChem

C₁-C₇ Hydrocarbon

The C₁-C₇ hydrocarbon content and composition of sediments reflects source type, source quality and thermal maturity.

The C₁-C₇ hydrocarbon content of well cuttings is determined by analyzing both a sample of the cuttings and the air space at the top of the can. The results of the two analyses are summed to give an inventory of the C₁-C₇ hydrocarbon content of the well cuttings prior to any losses from the cuttings during the lapsed time period between collection at the wellsite and laboratory analysis.

The air space C₁-C₇ hydrocarbon analysis involves taking a measured volume of the air space gas out of the can with a syringe and injecting same into a gas chromatograph. GeoChem uses a Varian Aerograph Model 1400 instrument equipped with a Porapac Q column. The gas sample is taken through the column by a carrier gas and before reaching the detector is separated into its various C₁ (methane), C₂ (ethane), C₃ (propane), iC₄ (isobutane), nC₄ (normal butane), and C₅, C₆, C₇ hydrocarbon components.

This particular analysis gives a complete separation of the C₁-C₄ gas-range hydrocarbons and a partial separation of the C₅-C₇ gasoline-range hydrocarbons. (A detailed C₄-C₇ analysis, to be discussed later, involving a capillary column, effects a complete separation of this molecular range into its several individual molecular species.)

The electrical response of the various hydrocarbons as they reach the detector is recorded on a paper strip chart as a peak. This response is simultaneously fed to an integrator which computes the area of each peak. The concentration of C₁-C₇ hydrocarbons in the air space, expressed as volumes of gas per million volumes of cuttings, is determined by a calculation involving the volume of cuttings, volume of air space in the can, volume of sample injected, volume of standard gas sample used in the calibration, calibration factor for C₁, C₂, C₃, etc. determined by gc analysis of a standard gas sample, and the gc peak response.

The C₁-C₇ hydrocarbon content of the cuttings is determined by degasification of a measured volume of cuttings (in a medium of a measured volume of water) in a closed blender, sampling of the air space at the top of the blender, and injection of a measured volume of gas into the gas chromatograph.

The C₁-C₇ hydrocarbon data from the air space and cuttings gas analyses are summed to give a "restored" C₁-C₇ hydrocarbon content of the cuttings.

Sample Washing and Hand-Picking of Uncaved Lithology Samples

The cuttings samples are washed to remove all drilling mud from the cuttings. Care is taken in the washing procedure not to remove any soft clays, claystones, etc. and any loose fine sand and silt. The washed cuttings are usually kept under water cover until picked, to prevent loss of any gasoline-range hydrocarbons. Using the C₁-C₇ hydrocarbon data profile and the electrical well log supplied to us and our visual examination of the cuttings material under the binocular microscope, we carefully hand-pick and describe a suite of uncaved lithologies representative of the various stratigraphic zones penetrated by the well. The lithological data is used to compile a gross litho percentage log which is shown on all Figures. The 2-4 gram picked lithology samples are stored under water in small glass vials in those instances where we wish to run detailed C₄-C₇ hydrocarbon analyses. This sample set is used not only for the C₄-C₇ hydrocarbon analysis, but also for the visual kerogen and total organic carbon analyses. All remaining cuttings material is dried and packaged in labelled plastic bags for possible C₁₅₊ soxhlet extraction and/or eventual return to the client. Sample material from this study will be retained at GeoChem until advised of disposition.

Detailed C₄-C₇ Hydrocarbon

The C₄-C₇ gasoline-range hydrocarbon content of sediments reflects source quality, thermal maturation and organic facies. Compositional data can be used in crude oil-parent rock correlation work.

The C₄-C₇ hydrocarbon content and detailed molecular composition of hydrocarbon, in hand-picked lithologies, is determined by a gc analysis of the light hydrocarbon extracted from 1-2 gram cuttings samples macerated in a microblender. A measured volume of sample is placed in a sealed microblender along with a measured volume of hot water. The rock sample is pulverized by the blades of the blender. A sample of the liberated light hydrocarbons which collect in the air space at the top of the blender is injected into our Varian Aerograph 1400 gc unit which is equipped with a capillary column. Data recording, computations, etc. are comparable to those used for the C₁-C₇ analysis discussed previously in this report. Hydrocarbon concentration is expressed as volume gas per million volumes of cuttings.

Organic Carbon

The total organic carbon content of a rock is a measure of its total organic richness. This data is used, in conjunction with visual kerogen and C₁-C₄, C₄-C₇ and C₁₅₊ hydrocarbon content of a rock, to indicate the hydrocarbon source quality of rocks.

The procedure for determining the total organic carbon content of a rock involves drying the sample, grinding to a powder, weighing out 0.2729 gram sample into a crucible, acidizing with hot and cold hydrochloric acid to remove calcium and magnesium carbonate, and carbon analysis by combustion in a Leco carbon analyzer.

We run several blank crucibles, standards (iron rings of known carbon content) and duplicate rock samples in this analysis at no additional charge to the client for purposes of data quality control.

C₁₅₊ Soxhlet Extraction, Deasphalting and Chromatographic Separation

The amount and composition of the organic matter which can be solvent-extracted from a rock reflects source quality and source type. C¹³/C¹² carbon isotopic, high mass spectrometric and gc analyses of the paraffin-naphthene and aromatic hydrocarbon fractions of the soluble extract gives data which is used in crude oil-parent rock correlations. This analysis involves grinding of a dry rock sample to a powder and removal of the soluble organic matter by soxhlet extraction using a co-distilled toluene-methanol azeotrope solvent. Where the amount of available sample material permits, we like to use at least 100 grams of rock for this analysis.

The extracted bitumen is separated into an asphaltene (ASPH) and a pentane soluble fraction by normal pentane precipitation. The pentane soluble components are separated into a C₁₅₊ paraffin-naphthene (P-N) hydrocarbon, C₁₅₊ aromatic hydrocarbon (AROM) and C₁₅₊ nitrogen-sulfur-oxygen containing fraction (NSO) by adsorption chromatography on a silica gel-alumina column using pentane, toluene and toluene-methanol azeotrope eluants.

APPENDIX B

As indicated in the text, the visual kerogen data suggests that much of the woody-herbaceous material that is present in the kerogen from the samples examined has been reworked. The vitrinite reflectance data which has been obtained may be used to test this conclusion.

Vitrinite is an organic material, resulting from the biochemical decomposition and coalification of plant debris. In as much as vitrinite is the dominant organic constituent of coal, and its reflectance increases with increased metamorphism of the coal, it has been used for years as a tool to estimate the geothermal history of a particular coal body. Vitrinite is present in virtually all kerogen, and therefore can be used to estimate the thermal maturity of the containing sediments.

The vitrinite found in kerogen is composed primarily of woody and herbaceous material. If the woody and herbaceous material seen in the samples is reworked, it would be expected that the vitrinite reflectance data, which preferentially select woody-herbaceous material, would show significantly higher Maturation Index values than those derived from the visual kerogen assessments. If a great deal of reworking of sediments has taken place, it would be expected that a fairly wide range of vitrinite reflectance values would be seen, resulting from the multiple cycles of sedimentation, lithification and erosion that would take place under such circumstances.

Examination of Figure 3 shows almost exactly this situation. In sixteen (16) of the seventeen (17) samples examined for both visual kerogen and vitrinite reflectance, just such a picture emerges. While these data alone, without supporting geological and paleontological information, do not guarantee the validity of the proposed model, the presence of at least one obvious unconformity (between the Cretaceous and Permian periods) inferred from Table III, makes the suggested concept appear to be quite reasonable.

GC Analysis of C₁₅₊ Paraffin-Naphthene (P-N) Hydrocarbons

The content and molecular composition of the heavy C₁₅₊ paraffin-naphthene (P-N) hydrocarbons of rocks, as determined by gc analysis, reflects source quality, source type and degree of thermal maturation.

In this analysis, we subject a very small fraction of the total amount of the P-N fraction extracted from a rock sample to gc analysis. The gas chromatograph is a Varian Aerograph Model 1400 equipped with a solid rod injection system and a eutectic column.

The calculated C. P. I. (carbon preference index) values for the normal paraffin data is defined as the mean of two ratios which are determined by dividing the sum of concentrations of odd-carbon numbered n-paraffins by the sum of even-carbon numbered n-paraffins. The C. P. Indices A and B were obtained by the formulas:

$$C. P. Index A = \frac{C_{21}+C_{23}+C_{25}+C_{27}}{C_{22}+C_{24}+C_{26}+C_{28}} + \frac{C_{21}+C_{23}+C_{25}+C_{27}}{C_{20}+C_{22}+C_{24}+C_{26}} \quad C. P. Index B = \frac{C_{25}+C_{27}+C_{29}+C_{31}}{C_{26}+C_{28}+C_{30}+C_{32}} + \frac{C_{25}+C_{27}+C_{29}+C_{31}}{C_{24}+C_{26}+C_{28}+C_{30}}$$

Visual Kerogen

A visual study of kerogen, the insoluble organic matter in rocks, can indicate the relative abundance, size, and state of preservation of the various recognizable kerogen types and thereby indicate the hydrocarbon source character of a rock. The color of the kerogen can be used to indicate the state of thermal maturity of the sediments (i.e. their time-temperature history). Thermal maturation plays an important role in the generation of hydrocarbons from organic matter, and also affects the composition of reservoir hydrocarbons.

Our procedure for visual kerogen slide preparation involves isolation of the organic matter of a rock by removal of the rock material with hydrochloric and hydrofluoric acid treatment and heavy liquid separation. This procedure is comparable to that used by the palynologist except it does not include an oxidation stage. (The oxidation treatment is deleted from our procedure because it removes a great deal of kerogen and blanches any remaining kerogen to an extent whereby it is useless for our kerogen color observations.) The kerogen residue is mounted on a glass slide and is examined visually under a high power microscope.

Vitrinite Reflectance

Measurement of the reflectivity of vitrinite particles (%R₀) present in the kerogen isolated from sedimentary rocks provides a method of determining the state of maturation, and the diagenetic (time-temperature) history of the organic matter present in the sediments.

The kerogen, obtained from a 25 gram aliquot of crushed rock by the acid procedure previously discussed, is dried and embedded in a Bioplastic plug. The surface of the plug is polished using 0.05 micron alumina and the reflectivity determined under oil using a Ziess high resolution microscope. A minimum of 40 values are required to adequately determine the Maturation Rank.

Fluorescence Spectrophotometric Analysis

Fluorescence spectrophotometry can be used to characterize and fingerprint crude oils, establish crude oil-source rock relationships, and to measure the hydrocarbon source potential of fine-grained sediments.

A one (1) microliter aliquot of either (i) a crude oil or (ii) the solvent extractable rock bitumen, is passed through an alumina/silica gel micro column and the C₁₀₊ aromatic hydrocarbons isolated. The aromatic hydrocarbon is diluted and the emission and excitation spectra determined at 240 nm and 420 nm using a Perkin-Elmer Model 512 Double Beam Fluorescence Spectrophotometer.

GEOHERMAL DIAGENETIC CRITERIA

(GEOCHEM LABORATORIES, INC.)

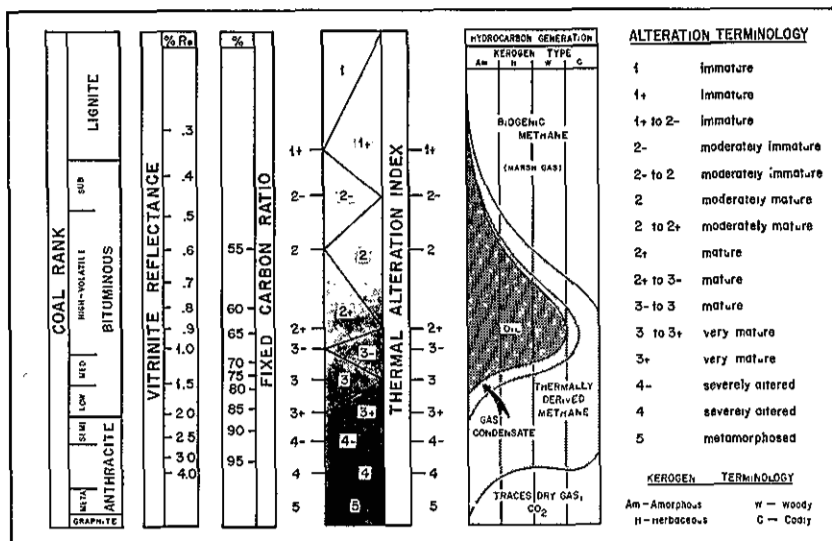


FIGURE 1

SUNRAY MID-CONTINENT OIL CO.
FEDERAL "M" NO.1 WELL
SIERRA COUNTY, NEW MEXICO

SUMMARY OF ORGANIC ANALYSES
SOURCE CHARACTER

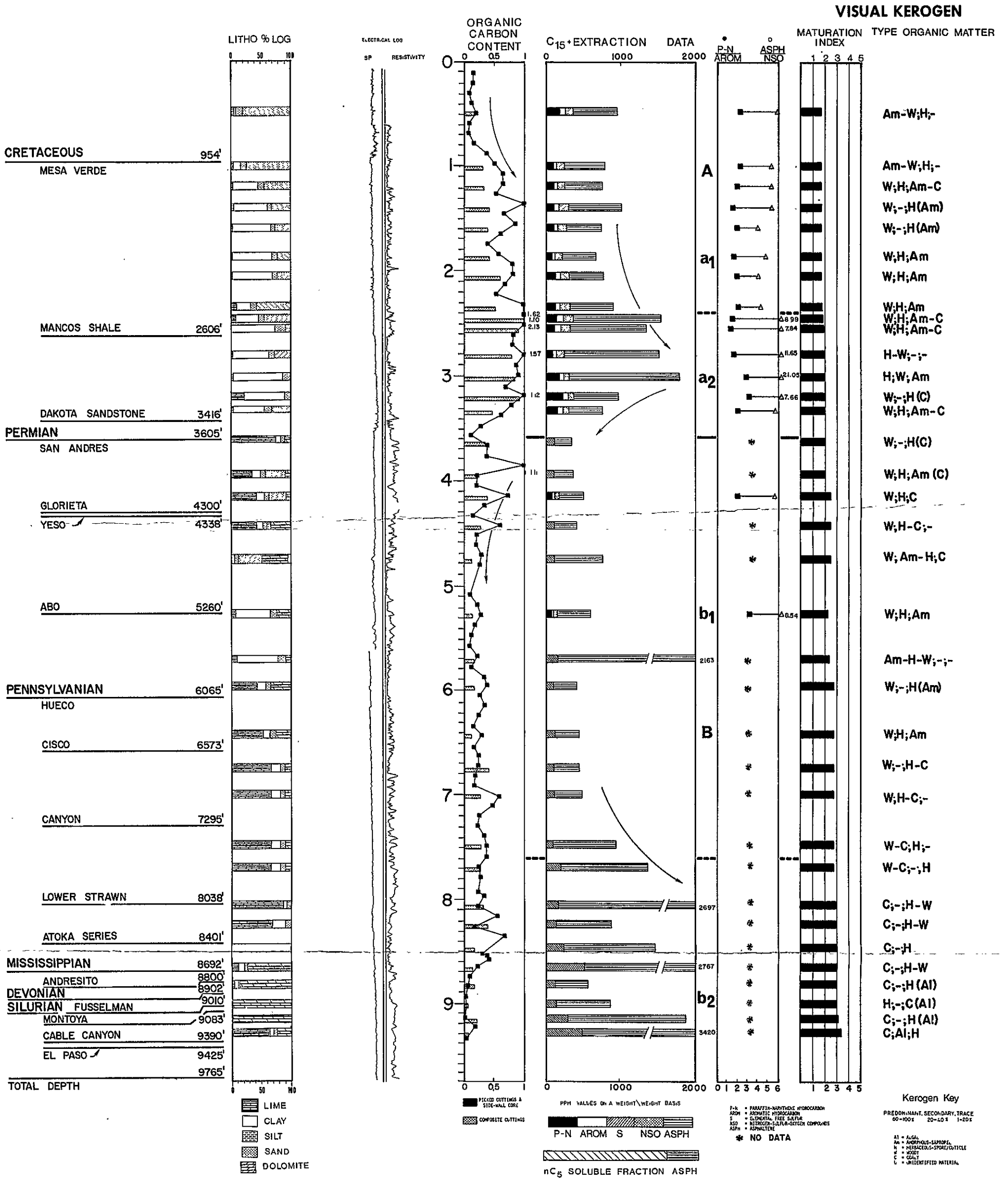


FIGURE 2
 C_{15}^+ GAS CHROMATOGRAMS

SUNRAY MID-CONTINENT OIL CO.
 FEDERAL "M" NO. 1 WELL
 SIERRA COUNTY, NEW MEXICO

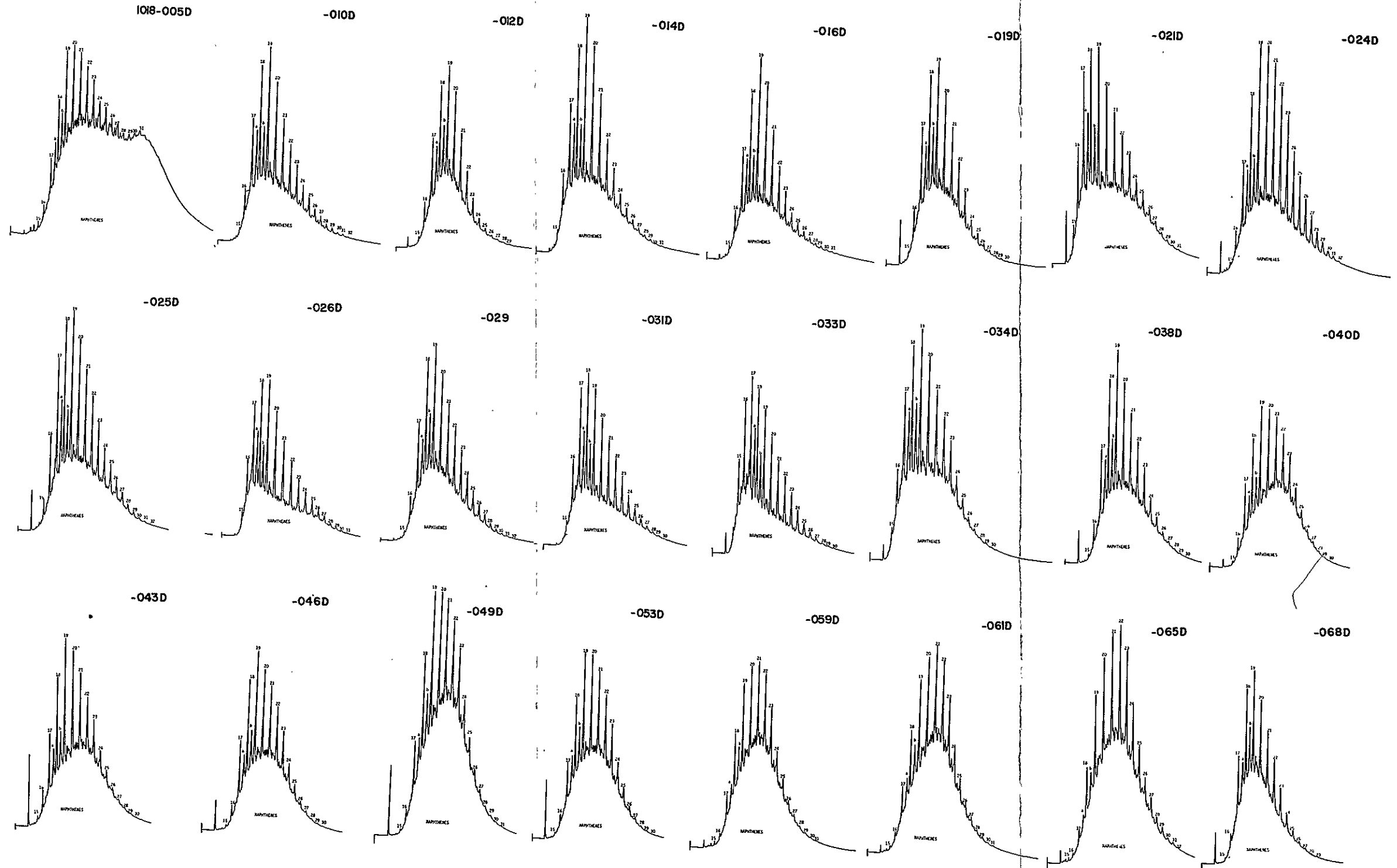
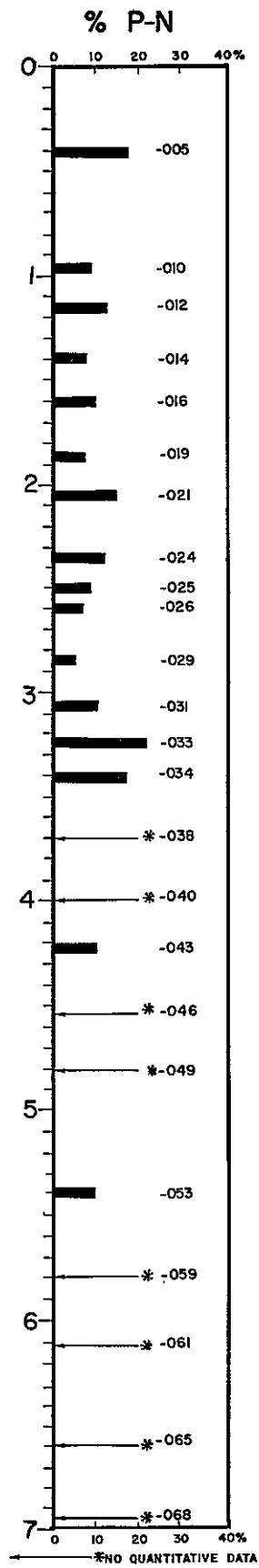


FIGURE 2 (CONTINUED)
C₁₅+ GAS CHROMATOGRAMS

SUNRAY MID-CONTINENT OIL CO.
 FEDERAL "M" NO.1 WELL
 SIERRA COUNTY, NEW MEXICO

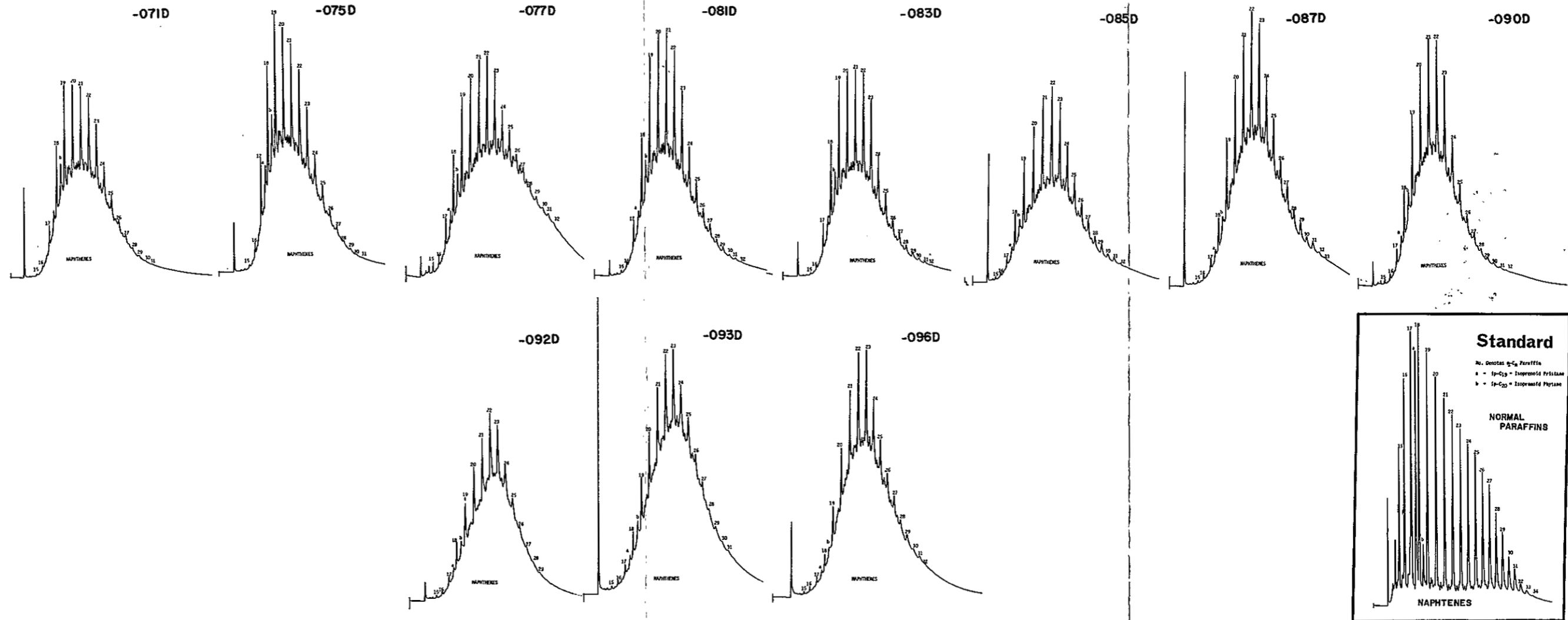
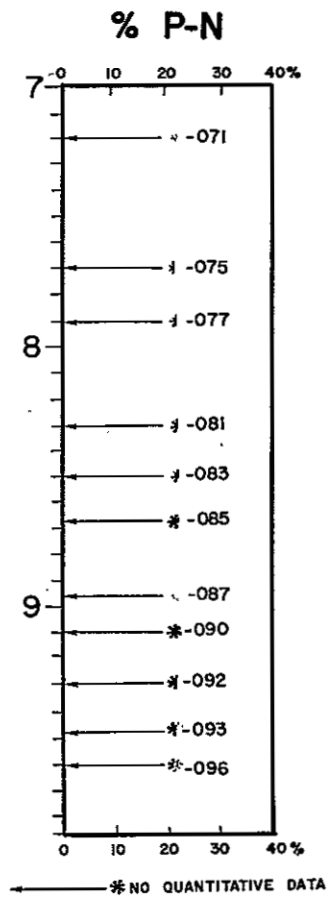


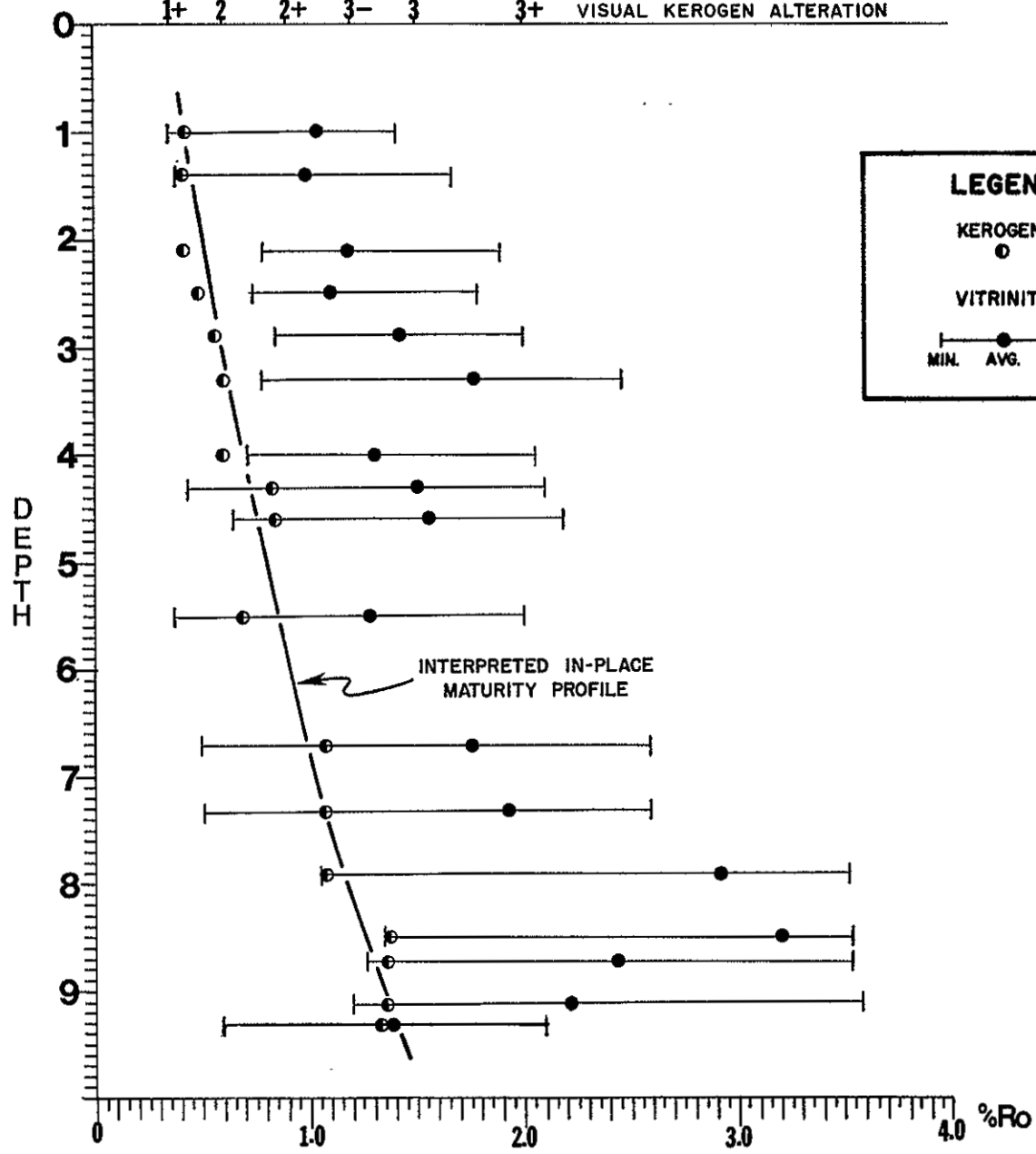
FIGURE 3

SUMMARY OF VITRINITE REFLECTANCE AND VISUAL KEROGEN ALTERATION RESULTS

GEOCHEM
SAMPLE
NUMBER

BIOGENIC GAS	IMMATURE OIL	OIL	WET GAS-CONDENSATE	GAS
1+	2	2+	3- 3	3+ VISUAL KEROGEN ALTERATION

1018-010
-014
-021
-025
-029
-033
-040
-043
-046
-053
-065
-071
-077
-083
-085
-090
-092



LEGEND

KEROGEN
○

VITRINITE
●

MIN. AVG. MAX.

FIGURE 4 VITRINITE REFLECTANCE HISTOGRAMS

SUNRAY MID-CENTRINT OIL CO. FEDERAL "M" NO.1 WELL SIERRA COUNTY, NEW MEXICO

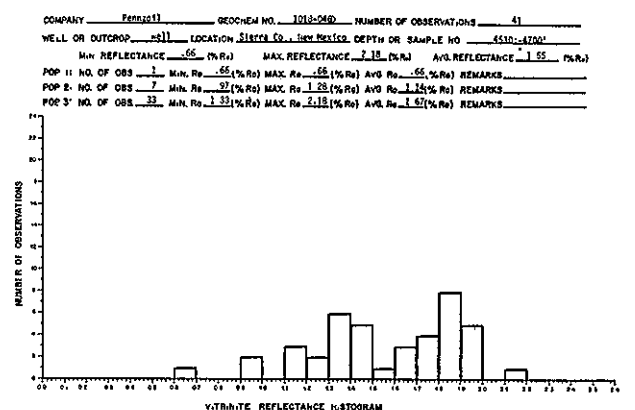
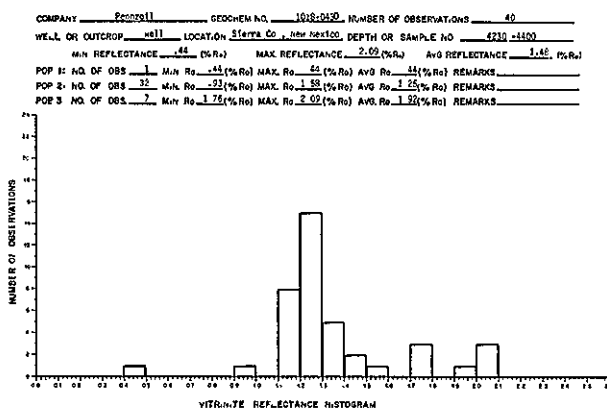
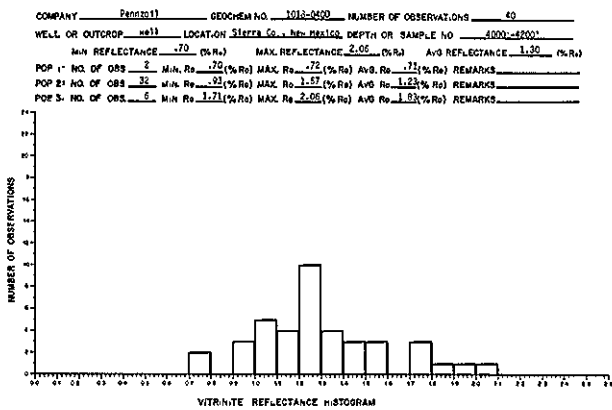
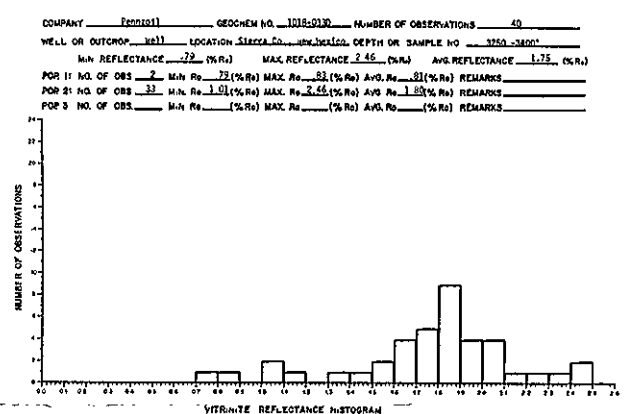
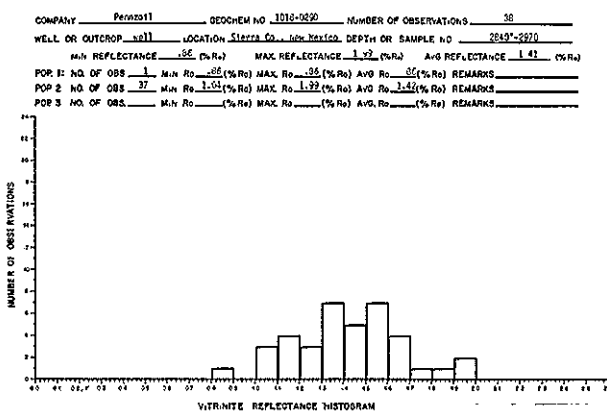
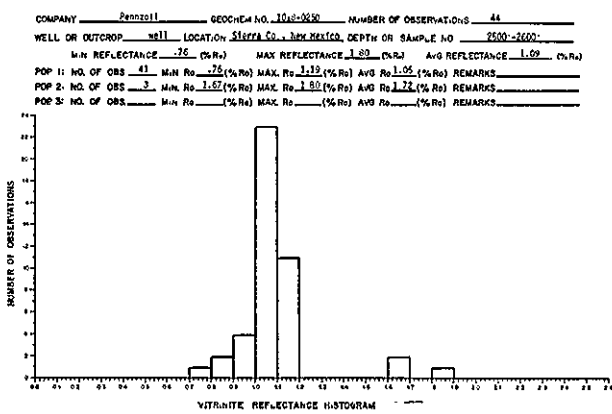
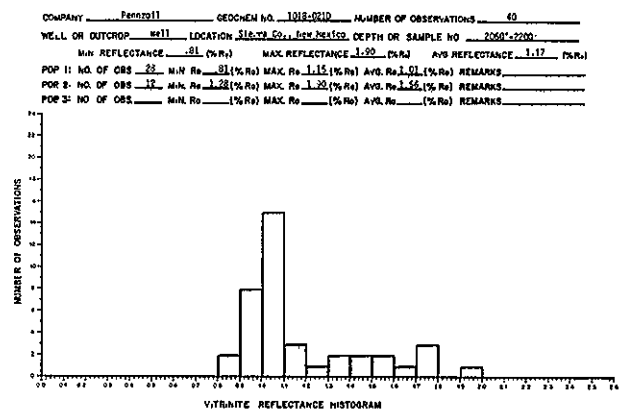
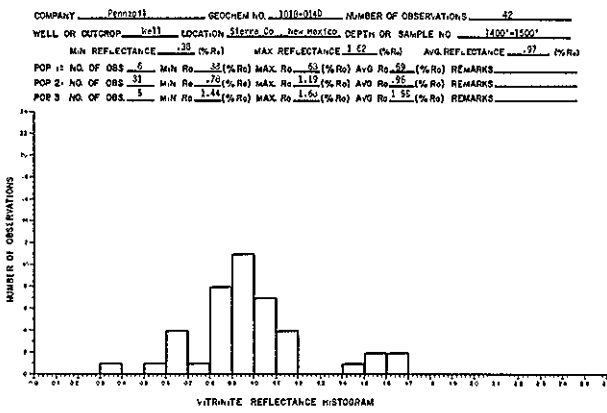
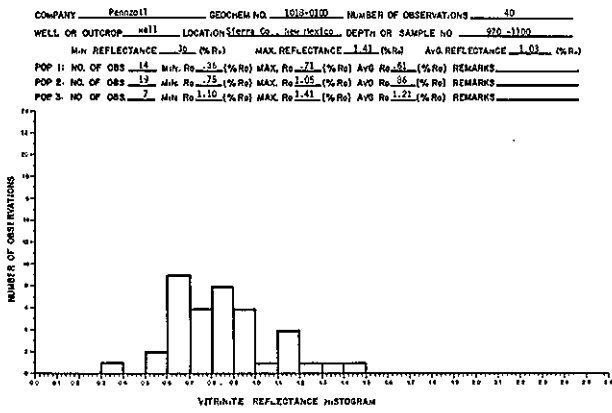


FIGURE 4 (CONTINUED)
VITRINITE REFLECTANCE HISTOGRAMS

SUNRAY MID-CENTINENT OIL CO.
FEDERAL "M" NO.1 WELL
SIERRA COUNTY, NEW MEXICO

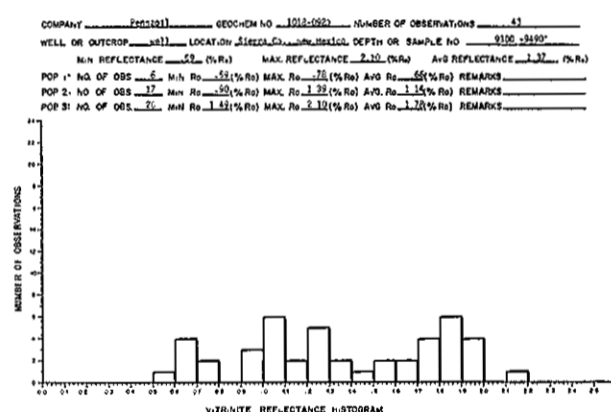
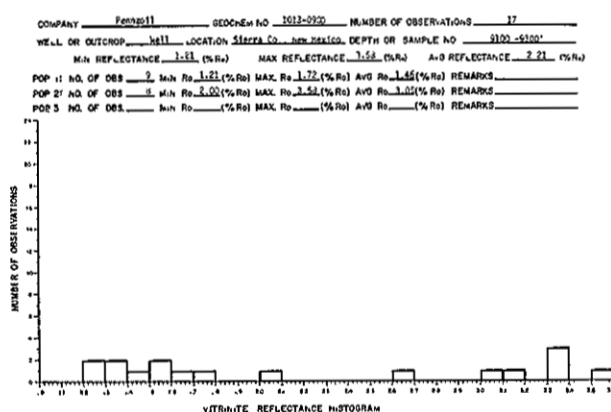
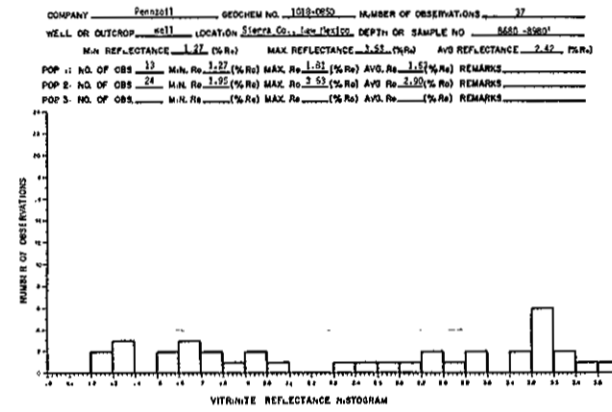
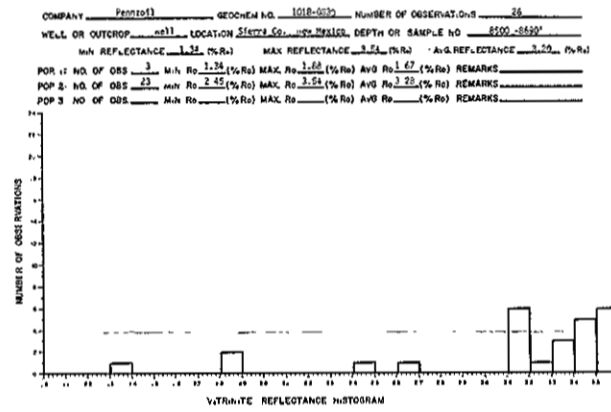
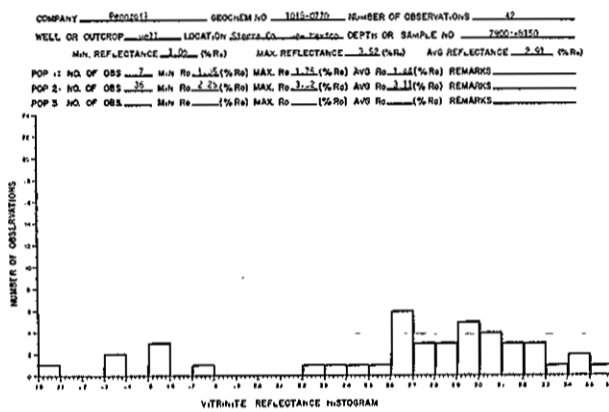
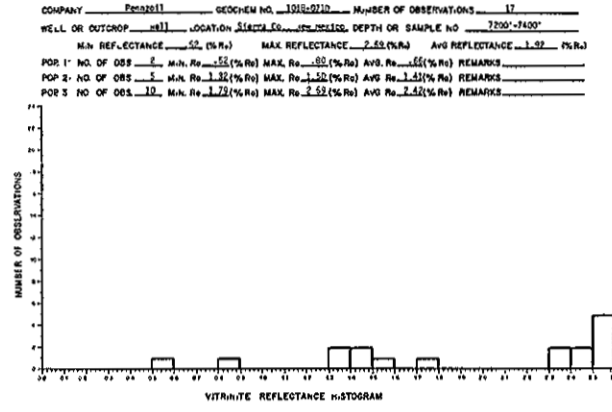
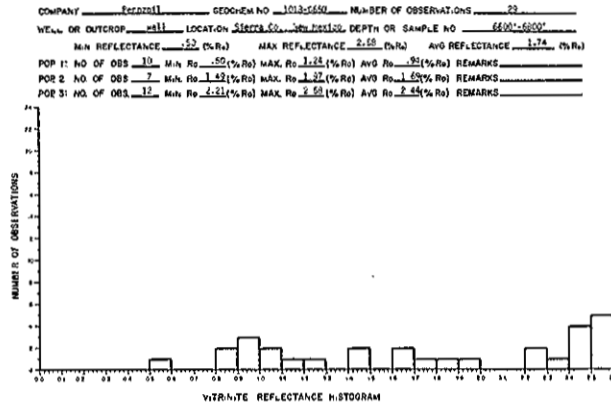
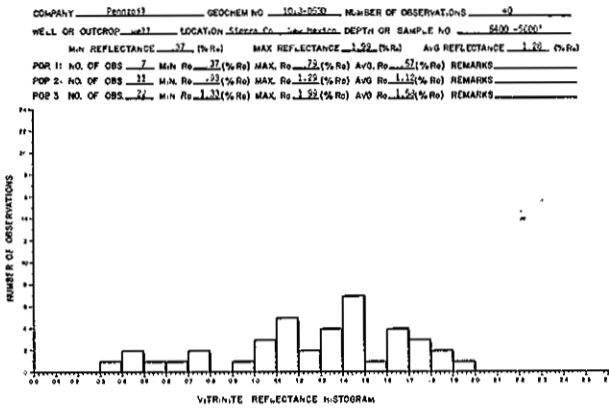


FIGURE 4 (CONTINUED)
VITRINITE REFLECTANCE HISTOGRAMS

SUNRAY MID-CENTINENT OIL CO.
FEDERAL "M" NO.1 WELL
SIERRA COUNTY, NEW MEXICO

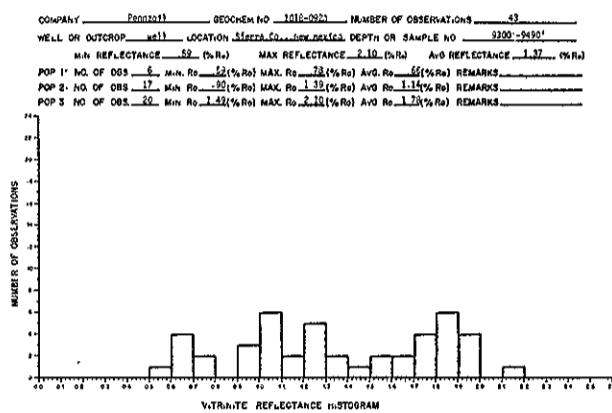
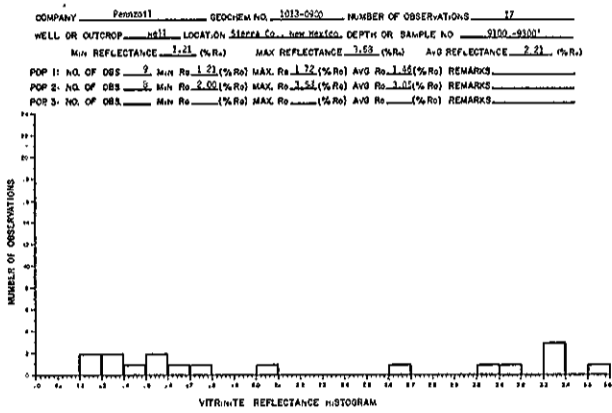
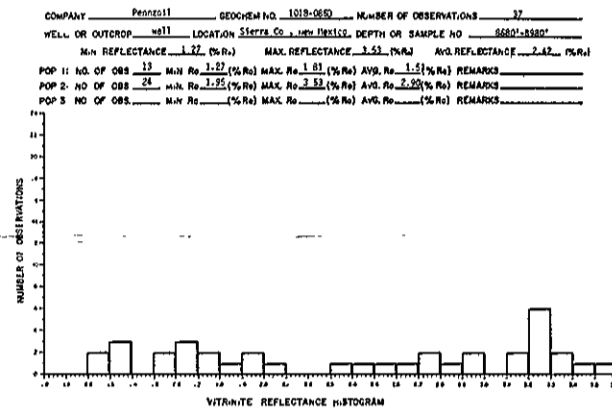
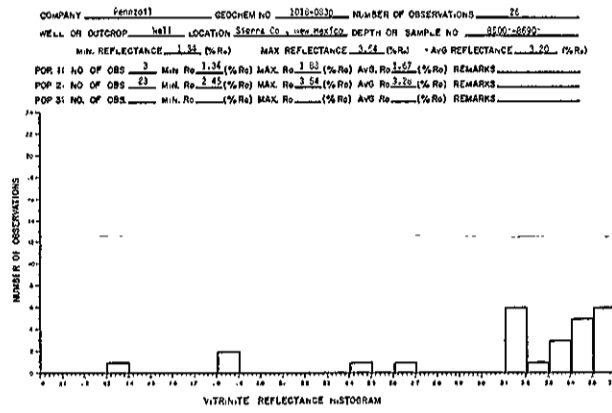
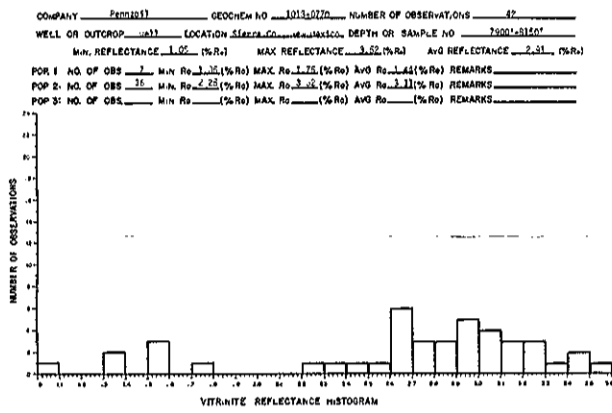
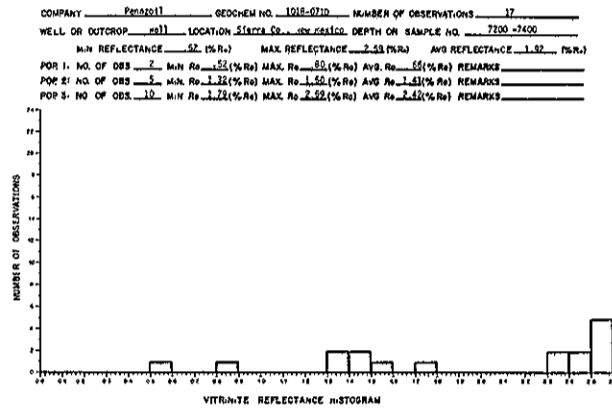
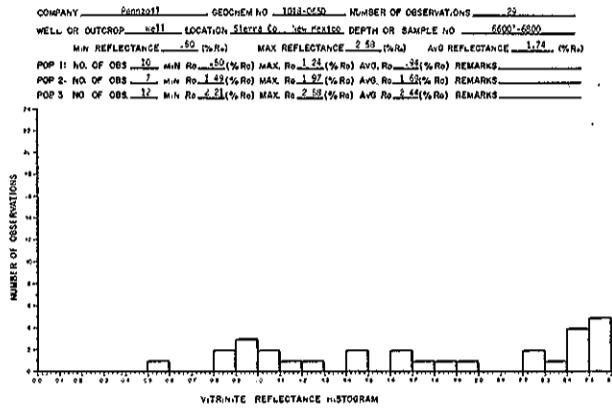
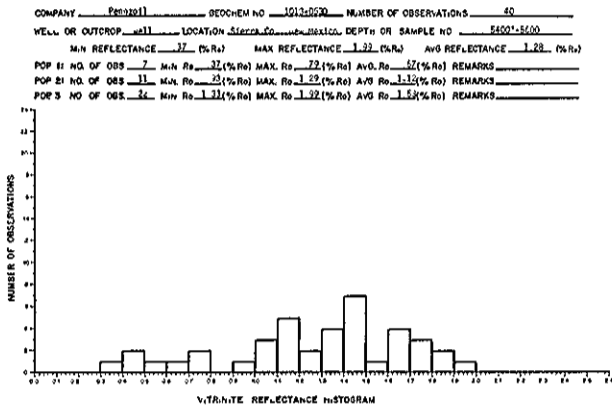


FIGURE 4 VITRINITE REFLECTANCE HISTOGRAMS

SUNRAY MID-CONTINENT OIL CO. FEDERAL "M" NO.1 WELL SIERRA COUNTY, NEW MEXICO

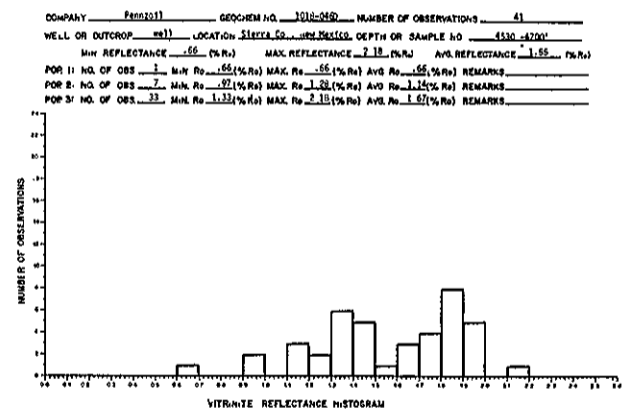
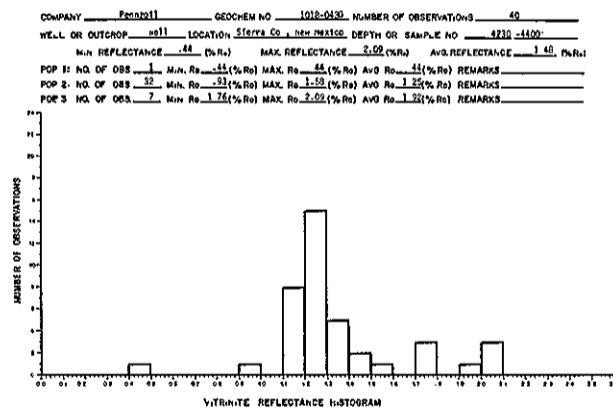
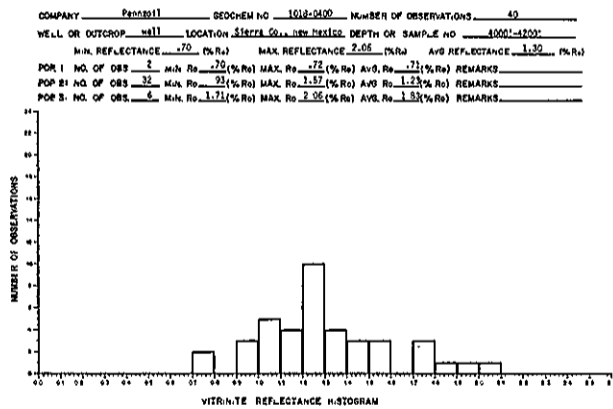
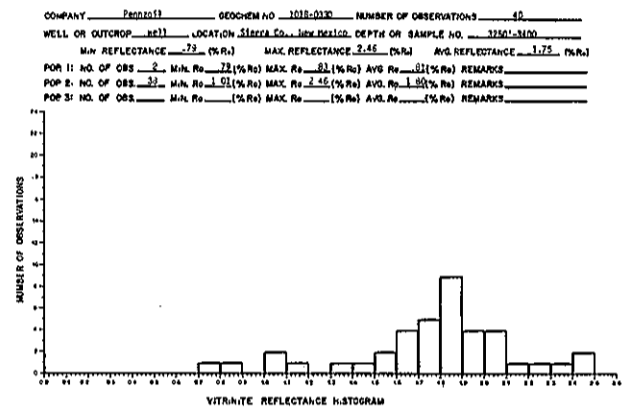
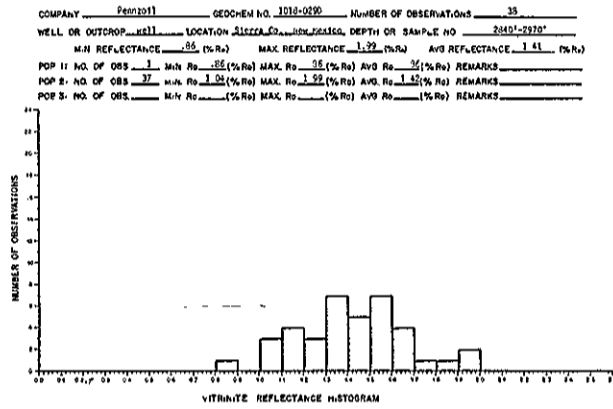
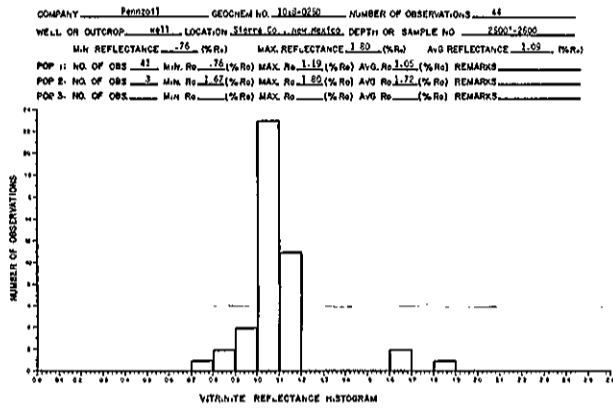
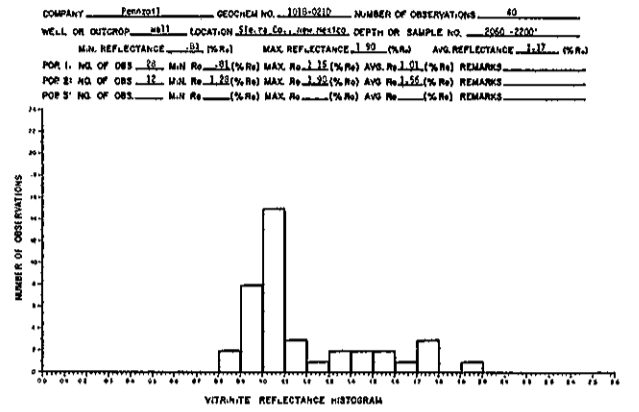
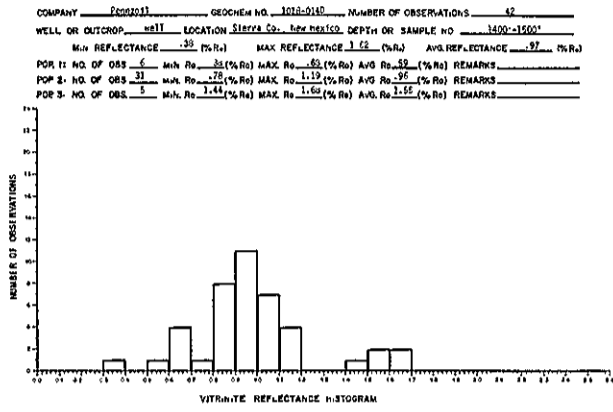
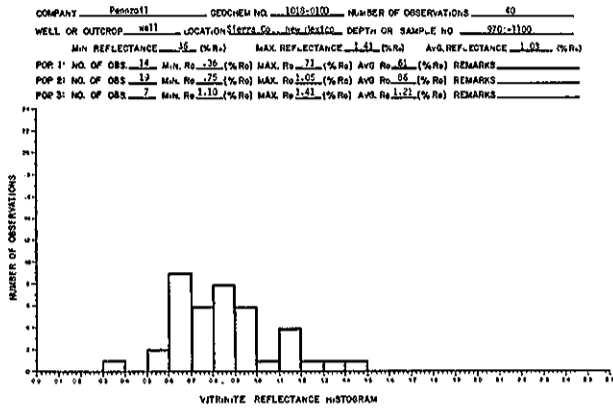


FIGURE 3

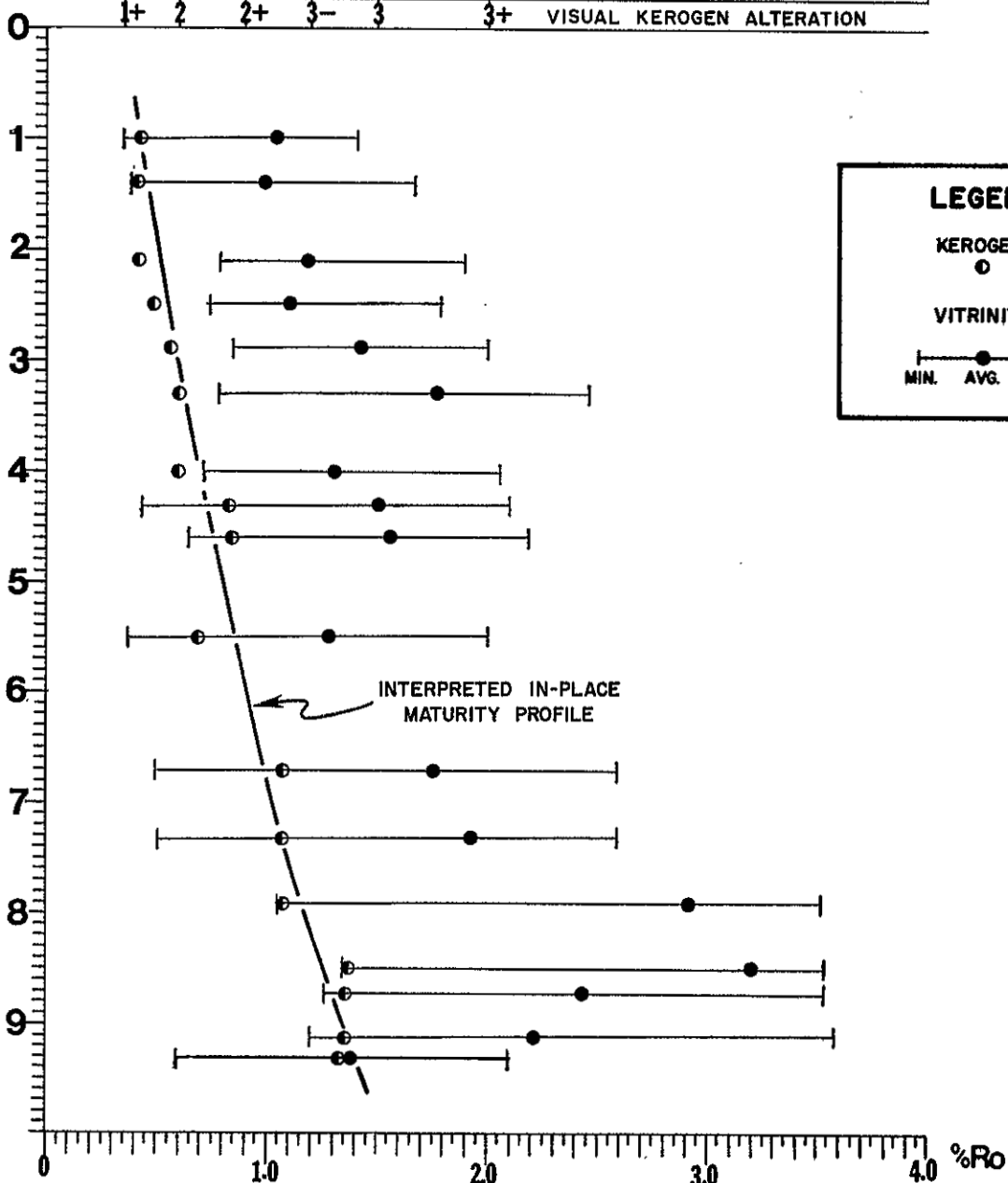
SUMMARY OF VITRINITE REFLECTANCE AND VISUAL KEROGEN ALTERATION RESULTS

GEOCHEM
SAMPLE
NUMBER

BIOGENIC GAS	IMMATURE OIL	OIL	WET GAS-CONDENSATE	GAS
1+	2	2+	3- 3	3+
VISUAL KEROGEN ALTERATION				

1018-010
-014
-021
-025
-029
-033
-040
-043
-046
-053
-065
-071
-077
-083
-085
-090
-092

DEPTH



LEGEND

KEROGEN
○

VITRINITE
●

—●—
MIN. AVG. MAX.

FIGURE 2 (CONTINUED)
C₁₅+ GAS CHROMATOGRAMS

SUNRAY MID-CONTINENT OIL CO.
 FEDERAL "M" NO.1 WELL
 SIERRA COUNTY, NEW MEXICO

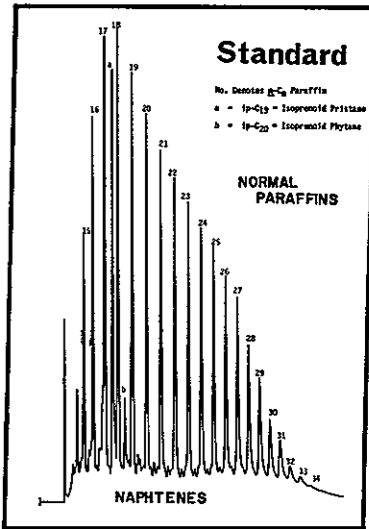
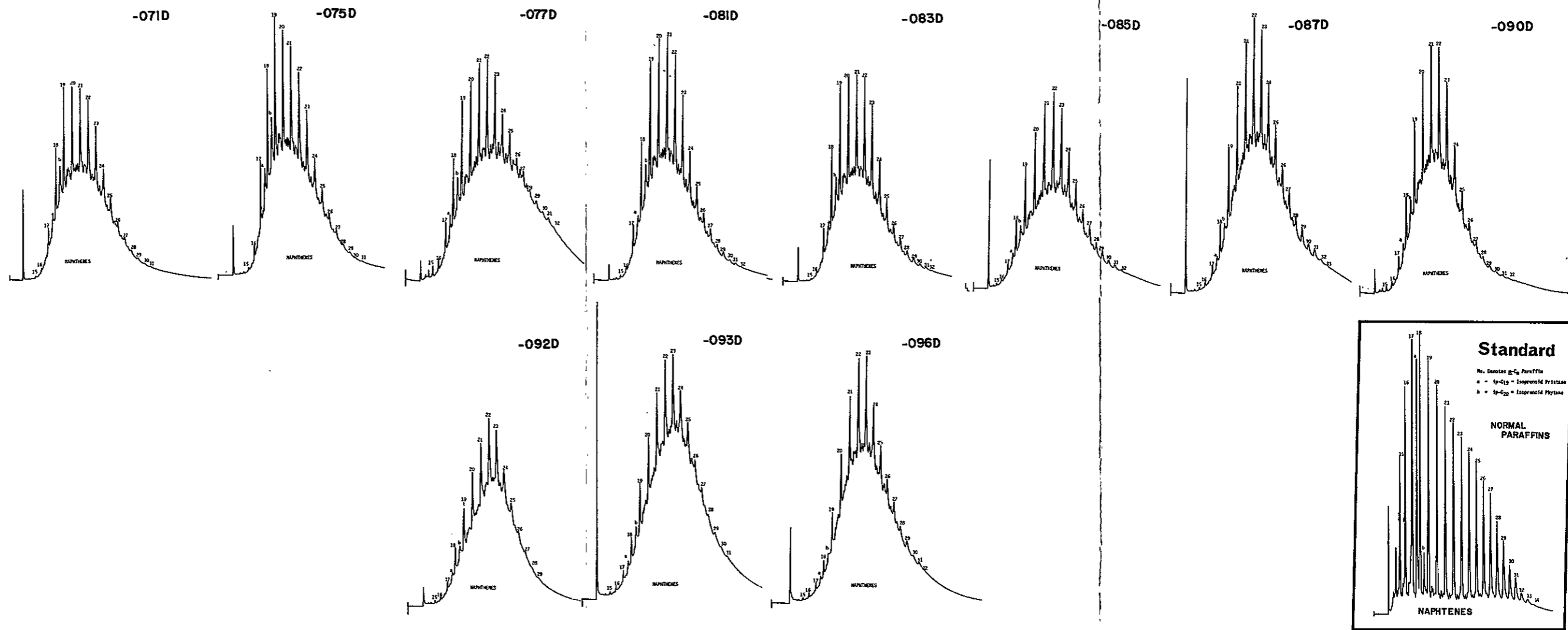
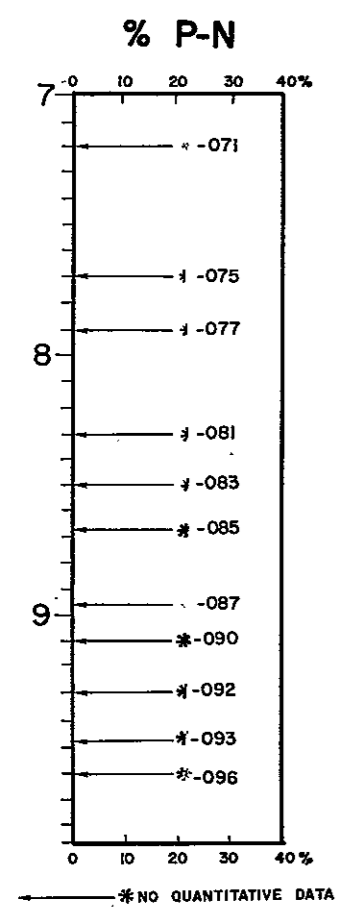


FIGURE 2
C₁₅⁺ GAS CHROMATOGRAMS

SUNRAY MID-CONTINENT OIL CO.
 FEDERAL "M" NO. 1 WELL
 SIERRA COUNTY, NEW MEXICO

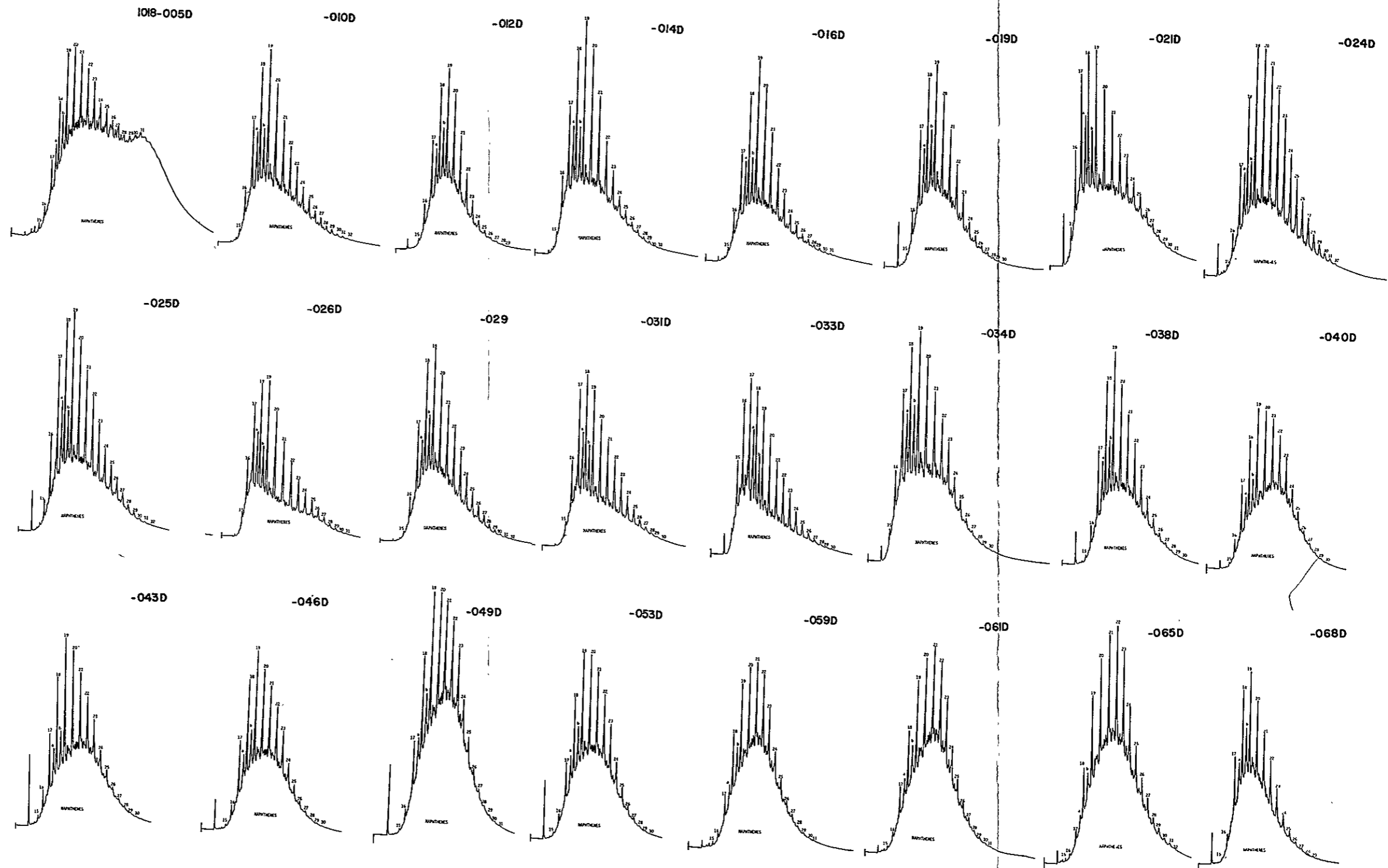
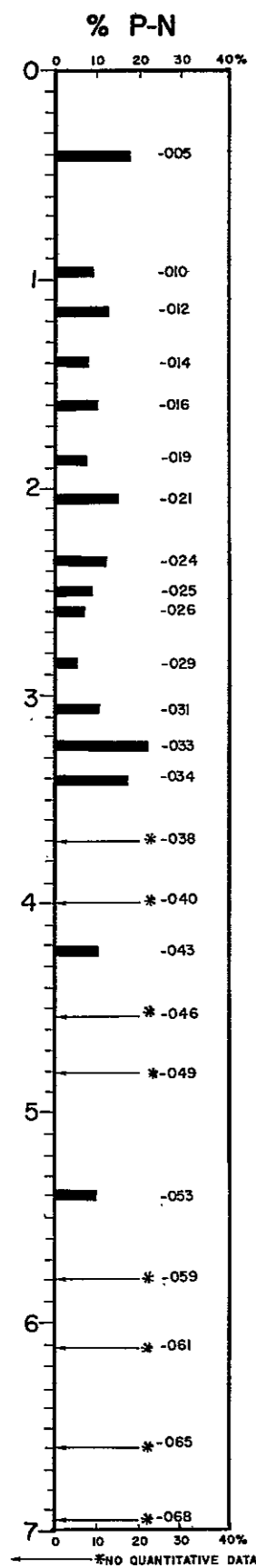


FIGURE 1

SUNRAY MID-CONTINENT OIL CO.
FEDERAL "M" NO.1 WELL
SIERRA COUNTY, NEW MEXICO

SUMMARY OF ORGANIC ANALYSES

SOURCE CHARACTER

VISUAL KEROGEN

