New Mexico Bureau of Mines and Mineral Resources
Open-File Report No. OF-264

ORGANIC GEOCHEMICAL ANALYSES OF THE VIRGLE LANDRETH NO. 1 PANHANDLE, VIRGLE LANDRETH NO. 1 PANHANDLE A, AND SUN OIL CO. NO. 1 BINGHAM STATE WELLS, SOCORRO COUNTY, NEW MEXICO

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GeoChem Laboratories, Inc.
Houston, Texas

June, 1977

GEOCHEMICAL SERVICE REPORT

ORGANIC GEOCHEMICAL ANALYSES OF CUTTINGS SAMPLES

THREE (3) SOCORRO COUNTY WELLS, NEW MEXICO

VIRGLE Landreth #1 ~~Panhandle~~ 23-4S-6E
VIRGLE Landreth #1 Panhandle A 28-4S-6E
Sun #1 Bingham State 23-5S-5E

Prepared

for

Amerada-Hess Corporation - Tulsa, Oklahoma

June, 1977

1143-C BRITTMORE ROAD, HOUSTON, TEXAS 77043

INTRODUCTION

This report summarizes the results of organic geochemical analyses performed on a suite of thirty (30) small well cuttings samples from three (3) Socorro County wells, New Mexico. This work was initiated by the Amerada Hess Corporation, Tulsa, Oklahoma and involved cuttings samples supplied by Mr. Robert A. Bieberman from the sample library of the New Mexico Bureau of Mines and Mineral Resources. The geochemical work was authorized by Mr. Richard J. Wallace and was co-ordinated by Mr. John Wetzel.

The purpose of this study has been to ascertain as much as possible about the hydrocarbon source character (type, richness and degree of thermal maturity) of the sediments represented by this small suite of generally poor quality samples.

Analytical

A suite of thirty (30) well cuttings samples, comprised of ten (10) samples from each of the Landreth #1 Panhandle (Sec. 23, Twp. 4S, Rge. 6E), Landreth #1 Panhandle A (Sec. 29, Twp. 4S, Rge. 6E), and Sun #1 Bingham State (Sec. 23, Twp. 5S, Rge. 5E) wells, Socorro County, New Mexico, was shipped by mail to GeoChem's Houston laboratory by Mr. Robert A. Bieberman, New Mexico Bureau of Mines and Mineral Resources on April 5th, 1977.

On arrival at our laboratory, these samples were assigned the GeoChem Service Job No. 941 followed by a sample sequence number -001 through -030.

A GeoChem geologist examined the samples and hand-picked out,as best as possible considering the poor quality of some of the samples, representative uncaved litho samples for organic carbon screen analysis. The results of these analyses were transmitted to Amerada Hess, Tulsa on May 20, 1977. This data is reproduced in this report, for the sake of completeness, in Tables I, II and III.

On the basis of the low to very low total organic richness of the bulk of the samples analyzed, combined with the fact that sample quality is generally poor and sample size is small, GeoChem recommended a minimum program of detailed organic geochemical analyses. This program involved visual kerogen analysis of eleven (11) selected samples and C_{15}+ soxhlet extraction + deasphaltening, liquid chromatographic separation, gas-chromatographic analysis C_{15}+ paraffin-naphthene (P-N) hydrocarbon on one (1) composite cuttings sample 941-019/020 representing the well interval 2530'-2790' in the Landreth #1 Panhandle A well.

INSOL. ORGANIC MATTER

ORGANIC GEOCHEMICAL ANALYSES OF CUTTINGS SAMPLES

THREE (3) SOCORRO COUNTY WELLS, NEW MEXICO

SUMMARY

Organic geochemical analyses run on a suite of thirty (30) dry cuttings samples from three (3) Socorro County wells, New Mexico for Amerada Hess Corporation, Tulsa, Oklahoma, have indicated the following with respect to the hydrocarbon source characteristics of the sediments penetrated by these wells :

- The geothermal history of these sediments, as determined by kerogen color analysis, ranges from an immature Stage 1^+ to 2^- in shallow beds to a mature Stage 2 to 2^+ in deeper beds (on our 1 to 5 kerogen color alteration scale).

- The bulk of the fine-grained sediments encountered in these three wells are low to very low in organic richness.

- The majority of the samples analyzed comprise a very lean "Woody-Coaly" gas-prone organic facies.

- An "Amorphous" oil-prone organic facies is recognized in the deep portion of the two Landreth wells.

- At this well location this amorphous zone has experienced a suitable geothermal history for oil generation and preservation, but , because of its organic leanness, has not been a good oil source as evidenced by its low yields of $C_{15}+$ extract and associated $C_{15}+$ hydrocarbon.

We recommend Amerada Hess extend this pilot study over a broader geographical area to explore for a possible richer time-stratigraphic equivalent of the amorphous organic facies zone detected in this initial study.

Donald G. Van Delinder
GEOCHEM LABORATORIES, INC.

The C_{15}+ extraction and liquid chromatography results are presented in Tables IV-A, IV-B, and IV-C. The calculated data from the gas-chromatographic analysis of the C_{15} + P-N hydrocarbon fraction of the extract from this sample is recorded in Tables V-A, and V-B. The visual kerogen assessment worksheet is reproduced in Table VI. The gc chromatogram from the analysis of the sample and that of the analysis of our standard are reproduced in Figures I and II.

A brief description of the various analyses performed in this study is presented in Appendix A located at the back of the report.

General Information

Four (4) copies of this report were mailed to Mr. Richard Wallace, Amerada Hess Corporation, Tulsa, Oklahoma on June 18, 1977. GeoChem retains copies of this report in their library for possible future reference in answering telephone enquiries from authorized Amerada Hess on specific details of this study.

All unused sample material has been returned to the library of the New Mexico Bureau of Mines and Mineral Resources as instructed by Mr. Bieberman in his letter of sample transmittal.

We will save the C_{15}+ chromat fractions unless the client indicates they wish to have this material sent to them.

All data, interpretations, and other matters related to this study are considered confidential and the sole proprietorship of the Amerada Hess Corporation.

RESULTS AND INTERPRETATIONS

A. Thermal Maturity of Sediments

The thermal maturity of the sediments encountered in the three (3) Socorro County wells of this study appears to range from an immature Stage 1^+ to 2^- to a moderately mature Stage 2 to 2^+ as indicated by kerogen color (Table VI) and shown in the well section of Figure III.

From an oil generation standpoint, only the deeper, more mature (Stage 2 to 2^+) sediments, as shown by the diagenetic diagram of Figure V, have experienced sufficient geothermal (time-temperature) history for oil generation.

B. Hydrocarbon Source Character of Sediments

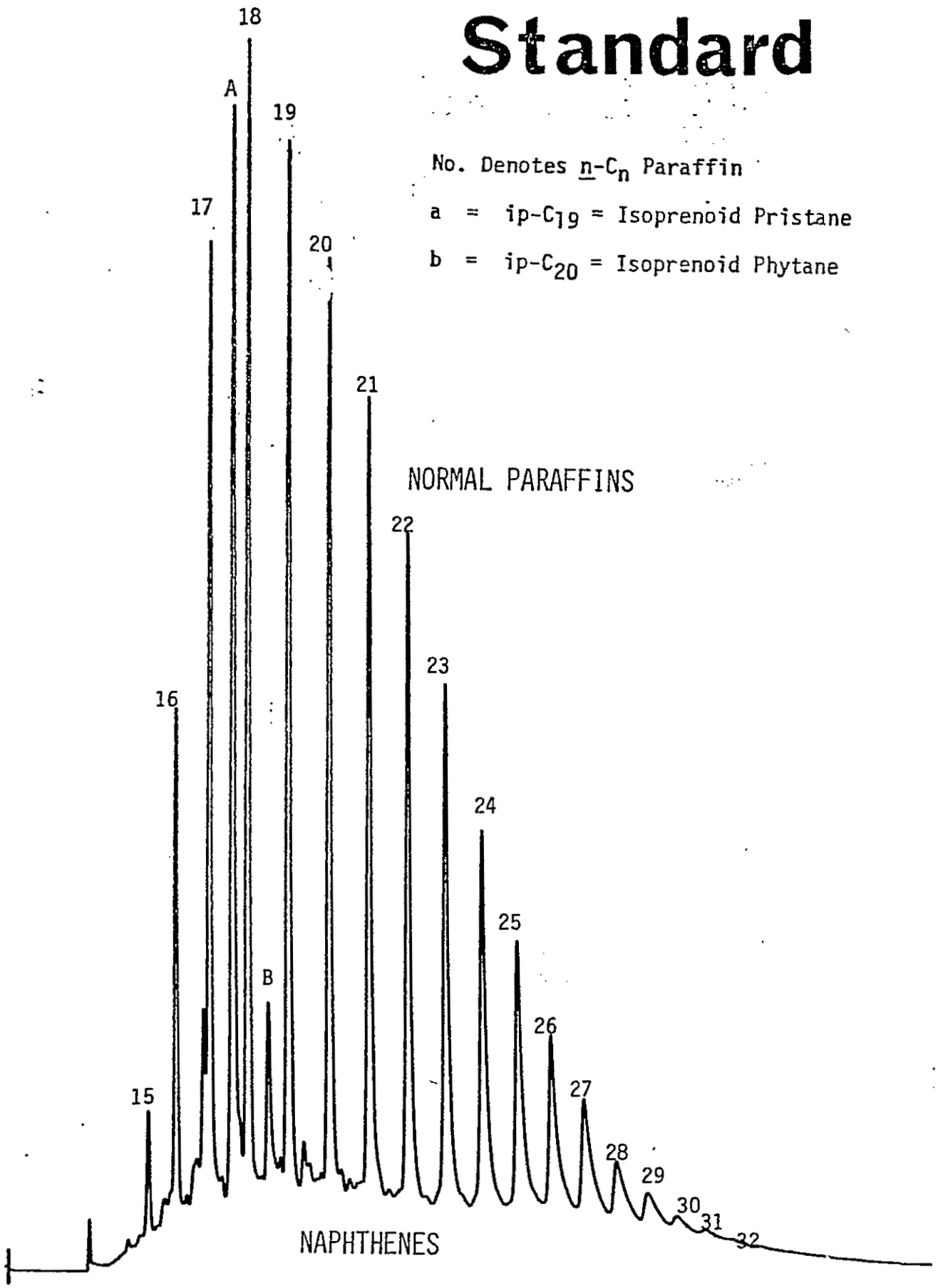
The fine-grained sediments analyzed in this study have a poor to very poor hydrocarbon source character. The bulk of the samples are lean to very lean in total organic matter content (Mean organic carbon content = 0.09% ; Range of Values - 0.01% to 0.36% maximum). The majority of the samples contain predominantly Woody-Coaly - 'gas-prone' kerogen type,but, as shown in Figure IV which illustrates the variations in kerogen type in the three wells, three (3) samples , 941-019/020; -027; & -028A, contain predominant Amorphous-Sapropel 'Oil-prone' type kerogen (Table VI).
The one (1) sample, 941-019/020 Composite, was subjected to C_{15}+ soxhlet extraction which yielded only modest amounts of C_{15}+ bitumen extract (357 ppm - Table IV) and associated C_{15}+ hydrocarbon (74 ppm - Table IV-B). This hydrocarbon has mature characteristics (as evidenced by the composition of the C_{15}+ P-N hydrocarbon revealed by the gc analysis - see gc chromatogram of Figure II) which match the thermal maturity indicated by kerogen color (Table VI).

Whereas at this locality the 'Amorphous' organic facies encountered in the Landreth #1 Panhandle and Landreth #1 Panhandle A wells is lean in total organic matter (0.19-0.36% total organic carbon - Tables II and III), it is conceivable that the total richness could improve away from this locality in this time-stratigraphic unit. At the study area locality, this facies unit has experienced a geothermal (time-temperature) history favorable for both the generation and preservation of oil, but has not experienced significant oil generation from an oil source standpoint because of its organic lean character.

RECOMMENDATIONS

We recommend that Amerada Hess extend this preliminary limited sample study to include a broader area in order to define whether or not the amorphous facies detected in this study becomes richer and an effective oil source. The distribution of this oil-source facies could be a very important control on oil accumulation in the general area.

FIGURE I


Standard
No. Denotes n-C_n Paraffin
a = ip-C_{19} = Isoprenoid Pristane
b = ip-C_{20} = Isoprenoid Phytane
NORMAL PARAFFINS
NAPHTHENES
15
16
17
18
A
19
B
20
21
22
23
24
25
26
27
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30
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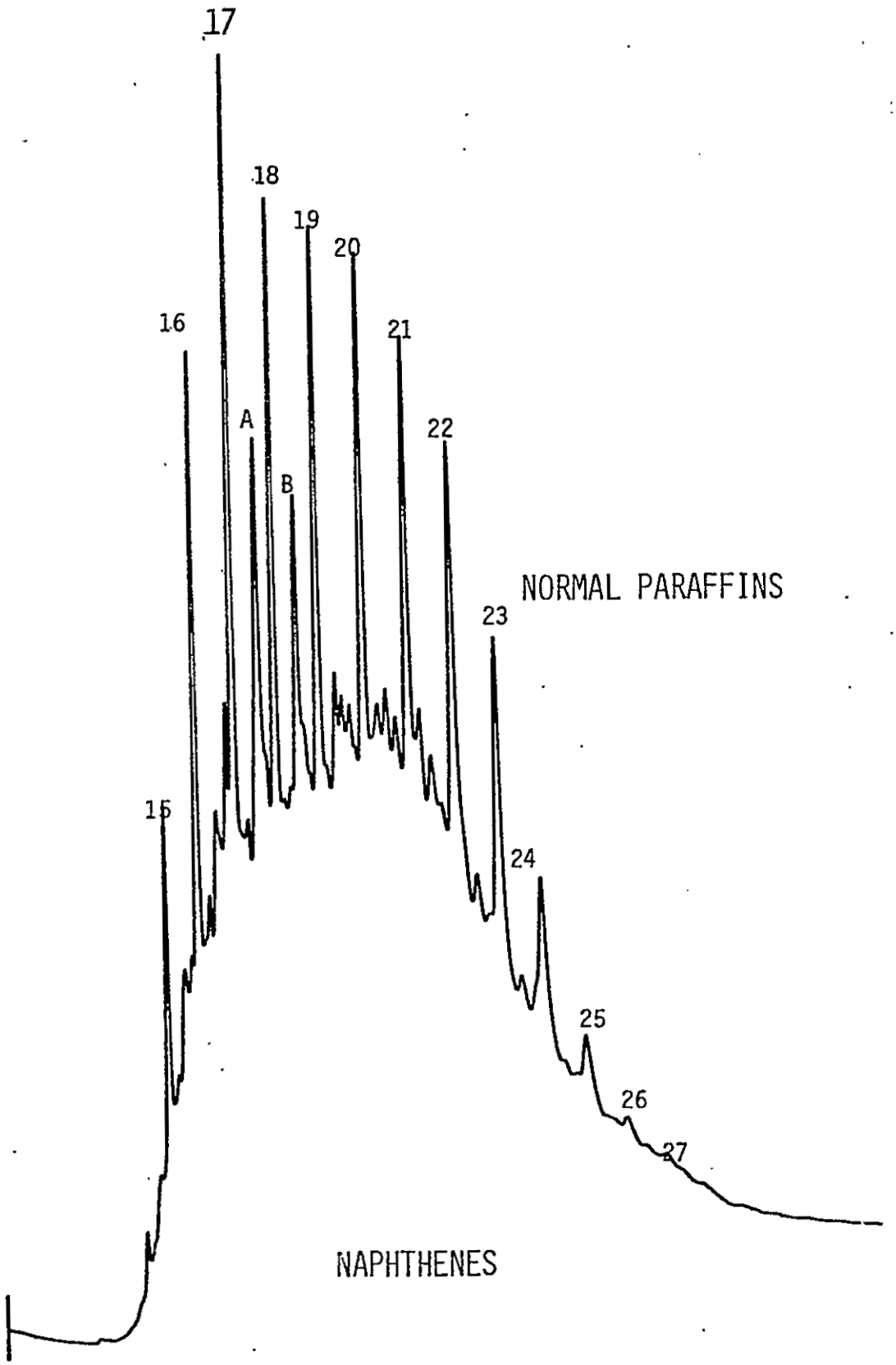
32

FIGURE II

941 - 019/020

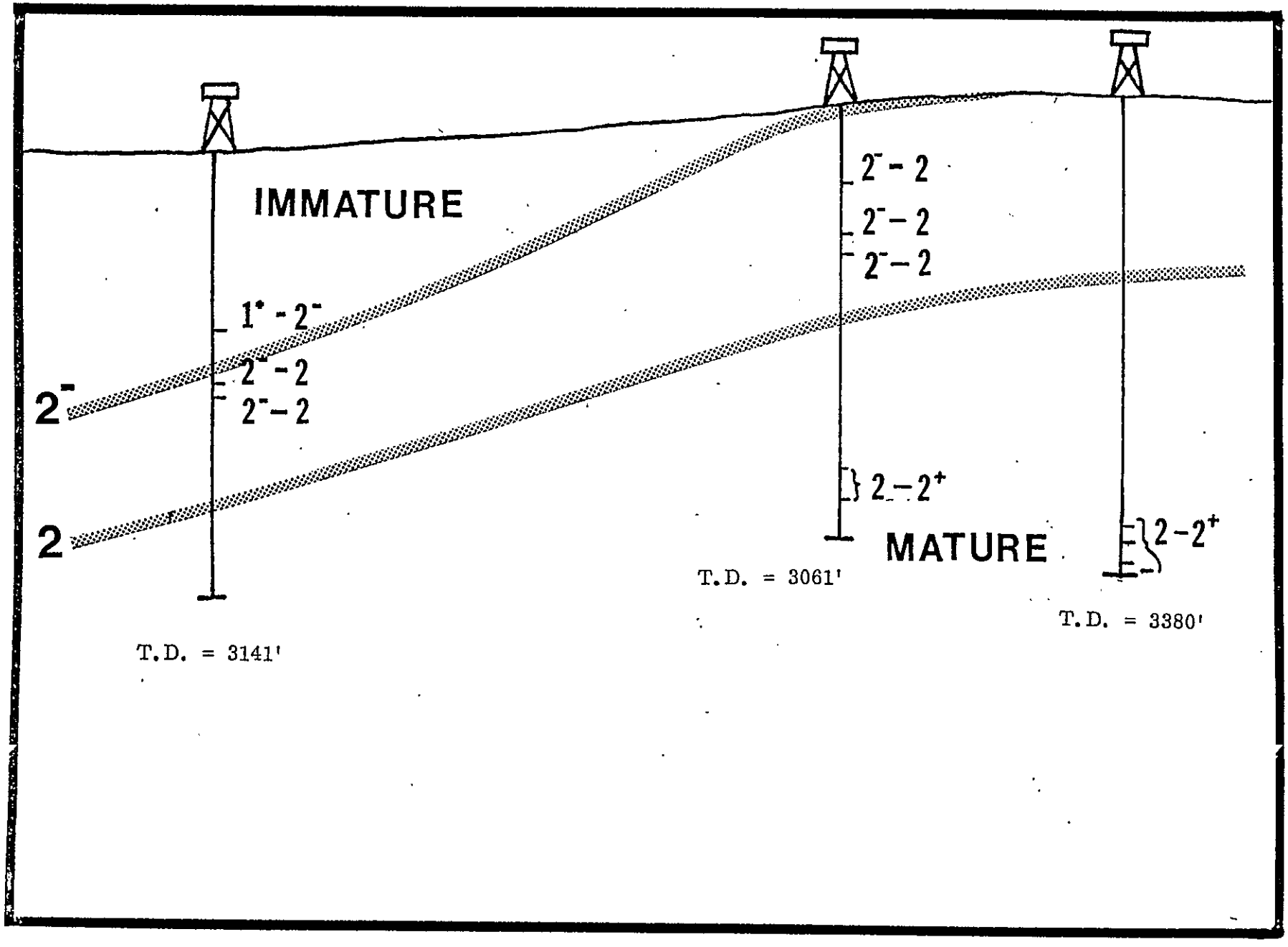


KEROGEN COLOR ALTERATION

SUN #1 BINGHAM STATE
23-5S-5E

LANDRETH #1 PANHANDLE A
20-4S-6E

LANDRETH #1 PANHANDLE
23-4S-6E



KEROGEN TYPE

SUN #1 BINGHAM STATE
23-5S-5E

LANDRETH #1 PANHANDLE A
28-4S-6E

LANDRETH #1 PANHANDLE
23-4S-6E

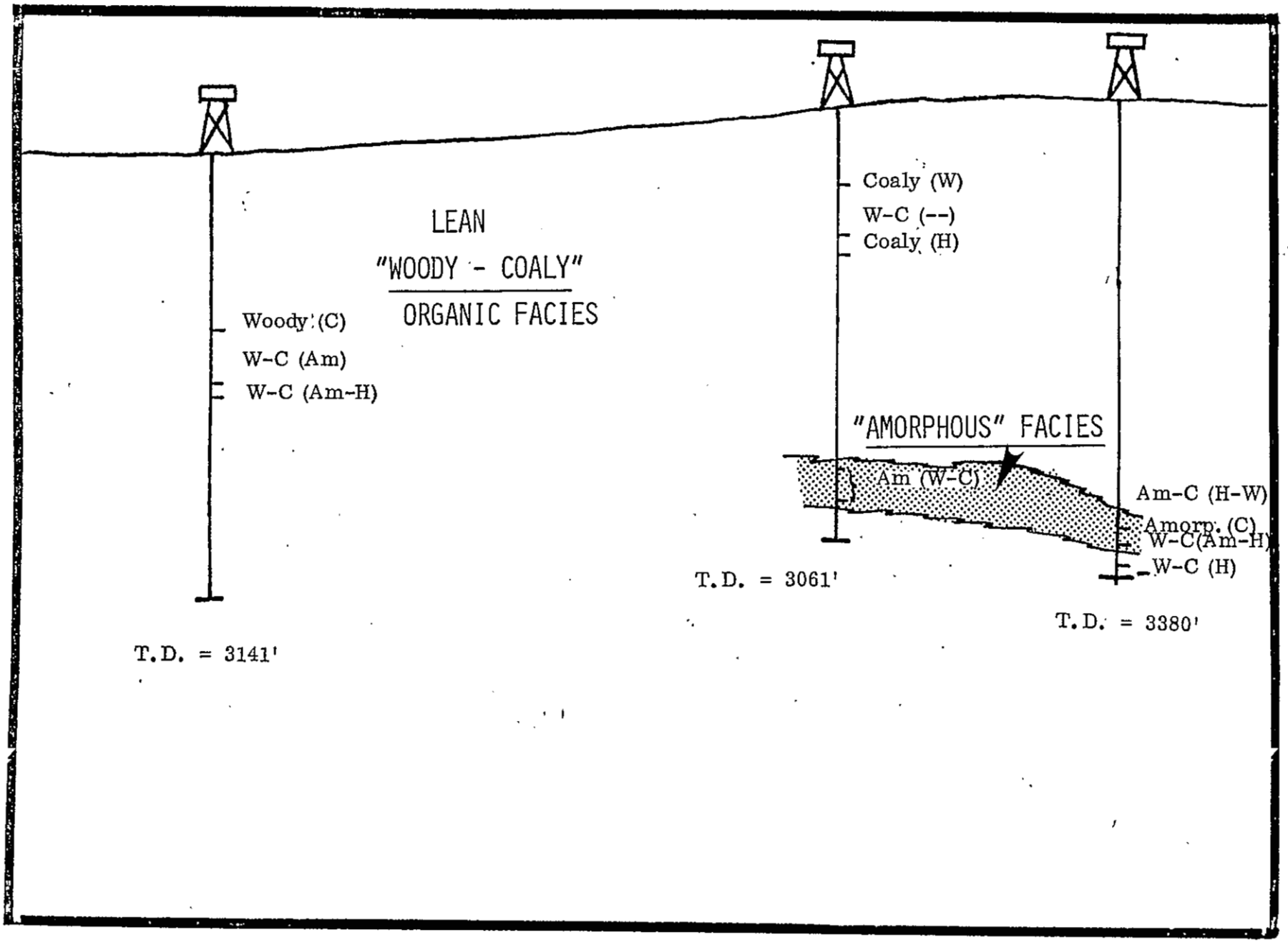
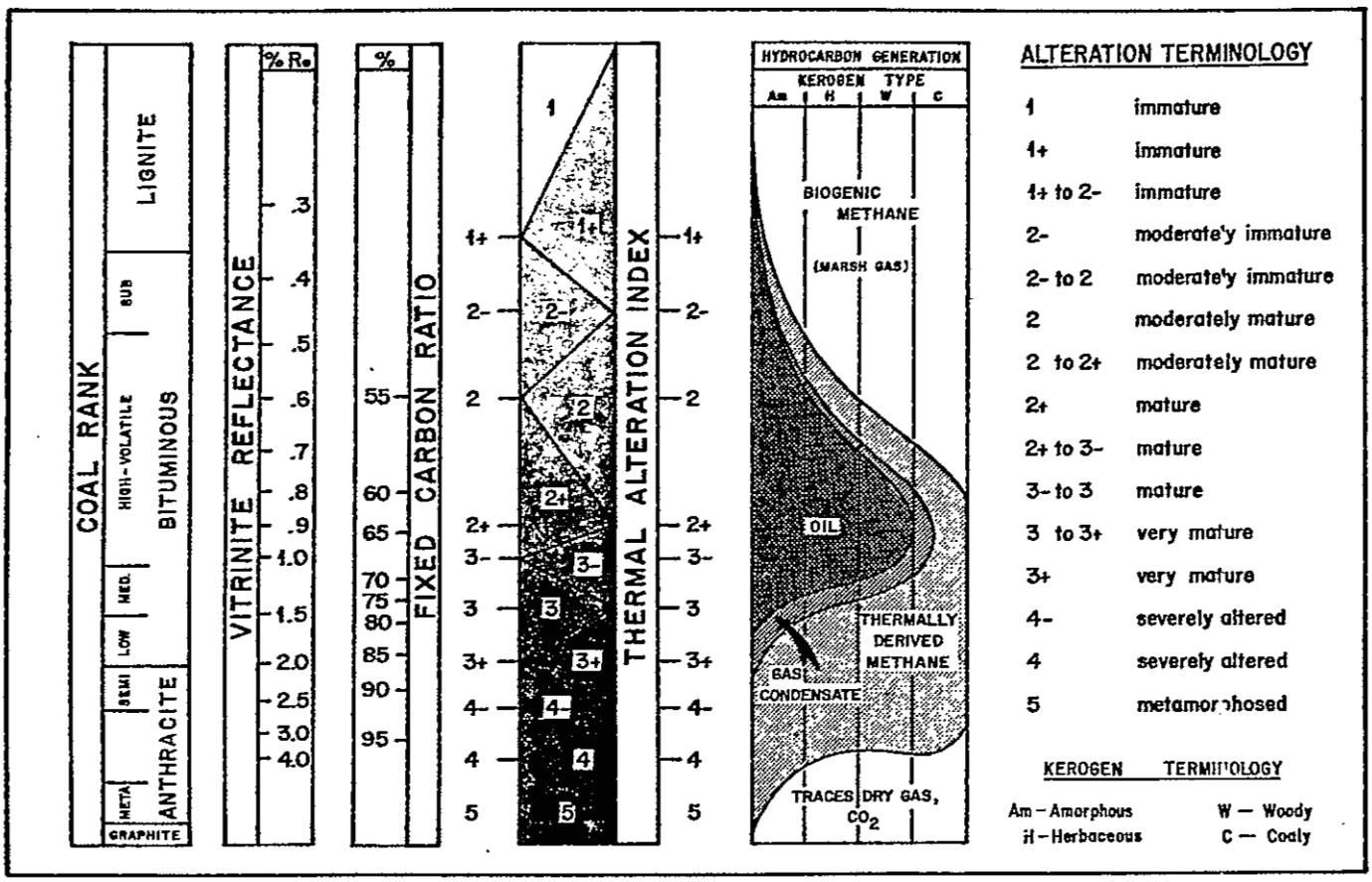


FIGURE V

GEOTHERMAL DIAGENETIC CRITERIA

(GEOCHEM LABORATORIES, INC.)



ALTERATION TERMINOLOGY

1	immature
1+	immature
1+ to 2-	immature
2-	moderately immature
2- to 2	moderately immature
2	moderately mature
2 to 2+	moderately mature
2+	mature
2+ to 3-	mature
3- to 3	mature
3 to 3+	very mature
3+	very mature
4-	severely altered
4	severely altered
5	metamorphosed

KEROGEN TERMINOLOGY

Am – Amorphous
H – Herbaceous
W – Woody
C – Coaly

Table I

Sample Identification and Organic Carbon Analyses

GeoChem Sample Number	Amerada-Hess Sample Identification	Well Interval	Total Organic Carbon (% of Rock)
Sun #1 Bingham Well, Sec. 23, Twp. 5S, Rge. 5 E., Socorro County, New Mexico			
941-001	# 1	1120'-1140'	0.07
941-002	# 2	1140'-1160'	0.07
941-003	# 3	1240'-1270'	0.13
941-004	# 4	1615'-1650'	0.13
941-005	# 5	1690'-1720'	0.09; 0.10 R
941-006	# 6	2000'-2030'	0.07
941-007	# 7	2300'-2330'	0.01
941-008	# 8	2460'-2490'	0.11
941-009	# 9	2590'-2620'	0.10
941-010	#10	2630'-2660'	0.10; 0.11 R

Table II

Sample Identification and Organic Carbon Analyses

GeoChem Sample Number	Amerada-Hess Sample Identification	Well Interval	Total Organic Carbon (% of Rock)
Landreth #1 Panhandle A Well, Sec. 28-Twp. 4S, Rge 6E, Socorro County, New Mexico			
941-011	# 1	530'- 550'	0.23
941-012	# 2	900'- 930'	0.19
941-013	# 3	980'-1010'	0.22
941-014	# 4	1230'-1270'	0.05
941-015	# 5	1510'-1540'	0.06; 0.07 R
941-016	# 6	1680'-1720'	0.01
941-017	# 7	1780'-1820'	0.07
941-018	# 8	2070'-2110'	0.01
941-019	# 9	2530'-2570'	0.21
941-020	#10	2760'-2790'	0.35; 0.37 R

No Visible Kerogen

Table III

Sample Identification and Organic Carbon Analyses

GeoChem Sample Number	Amerada-Hess Sample Identification	Well Interval	Total Organic Carbon (% of Rock)
Landreth #1 Panhandle, Sec. 23, Twp. 4S, Rge 6E, Socorro County, New Mexico			
941-021	# 1	1120'-1160'	0.13
941-022	# 2	1220'-1260'	0.08
941-023	# 3	1390'-1430'	0.04
941-024	# 4	1570'-1610'	0.10
941-025	# 5	1820'-1850'	0.05; 0.06 R
941-026	# 6	1960'-1990'	0.11
941-027	# 7	3020'-3070'	0.29
941-028	# 8	3090'-3130'	0.19
941-029	# 9	3280'-3310'	0.34
941-030	#10	3340'-3380'	0.19; 0.20 R

Table IV

Summary of C15+ Soxhlet Extraction, Deasphaltening 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)
941-019 /020	2530'-2790'	100.0	0.0357	0.0256	0.0101	N.D.	0.0049	0.0025	0.0027	0.0000

B. Concentration of Extracted Materials in Rock

			Hydrocarbons				Nonhydrocarbons			
GeoChem Sample Number	Well Interval	Total Extract (ppm)	Paraffin-Naphthene (ppm)	Aromatic (ppm)	Total (ppm)	Sulfur (ppm)	Preciptd. Asphaltene (ppm)	Eluted NSO'S (ppm)	Noneluted NSO'S (ppm)	Total (ppm)
941-019 /020	2530'-2790'	357	49	25	74	-	256	27	0	283

C. Composition of Extracts

		Hydrocarbons				Nonhydrocarbons					
GeoChem Sample Number	Well Interval	Paraffin-Naphthene %	Aromatic %	PN/Arom	Sulfur %	Eluted NSO'S %	Noneluted NSO'S %	Precipitd. Asphaltene %	Asph/NSO	HC'S %	HC/Non HC
941-019 /020	2530'-2790'	13.7	7.0	1.96	-	7.6	0.0	71.7	9.48	20.7	0.26

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	ip19/ip20
941-019 /020	2530'-2790'	15.1	2.2	82.7	1.08	-	1.33

Table V-B

Saturate Hydrocarbon Analyses

Normalized Paraffin Distribution

GeoChem Sample Number	Well Interval	%nC15	%nC16	%nC17	%ip19	%nC18	%ip20	%nC19	%nC20	%nC21	%nC22	%nC23	%nC24	%nC25	%nC26	%nC27	%nC28	%nC29	%nC30	%nC31	%nC32	%nC33	%nC34	%nC35
941-019 /020	2530'-2790'	5.6	10.9	14.6	7.2	11.0	5.4	10.2	9.1	8.2	7.7	5.9	2.8	0.9	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Visual Kerogen Assessment Worksheet

Sun No. 1 Bingham

TYPE OF ORGANIC MATTER | COLOR OF ORGANIC MATTER | STATE OF ORGANIC MATTER | MATURATION INDEX | DEPOSITIONAL ENVIRONMENT

\+ 2 or more maturation populations

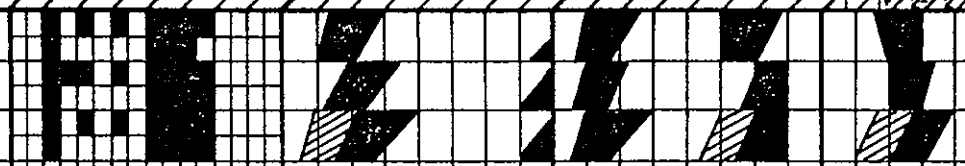
~2% to 20%

20% to 45%

45% to 80%

80% +

RECOGNIZABLE ALGAE
AMORPHOUS-SAPROPEL
SPORES-POLLEN
CUTICLE-MEMBRANOUS DEBRIS
WOODY-STRUCTURED DEBRIS
COAL DEBRIS
PYROBITUMEN
NONRECOGNIZABLE DEBRIS
GREENISH LIGHT YELLOW
YELLOW ORANGE
ORANGE BROWN
LIGHT BROWN
DARK BROWN
BLACK
PARTICLE SIZE
FINELY DISSEMINATED
FINE
MEDIUM
COARSE
PRESERVATION
EXCELLENT
GOOD
FAIR
POOR
UNALTERED
SLIGHTLY ALTERED
MODERATELY ALTERED
STRONGLY ALTERED
SEVERELY ALTERED
METAMORPHOSED
OFFSHORE MARINE
NEARSHORE MARINE
RESTRICTED NEARSHORE-MARSH
LACUSTRINE
CONTINENTAL
1 1+ 2- 2 2+ 3- 3 3+ 4- 4 5
REMARKS



GeoChem No.	Depth	Remarks
941-003	1270'	W; C; Am-H
-004A	1650'	W-C; Am; H *
-005	1720'	W-C; Am-H; -

* Very little organic matter on slide

Visual Kerogen Assessment Worksheet

Landreth No. 1 Panhandle A

TYPE OF ORGANIC MATTER | COLOR OF ORGANIC MATTER | STATE OF ORGANIC MATTER | MATURATION INDEX | DEPOSITIONAL ENVIRONMENT

+ 2 or more maturation populations

~2% to 20%

20% to 45%

45% to 80%

80% +

RECOGNIZABLE ALGAE
AMORPHOUS-SAPROPEL
SPORES-POLLEN
CUTICLE-MEMBRANOUS DEBRIS
WOODY-STRUCTURED DEBRIS
COAL DEBRIS
PYROBITUMEN
NONRECOGNIZABLE DEBRIS
GREENISH LIGHT YELLOW
YELLOW
YELLOW ORANGE
ORANGE BROWN
LIGHT BROWN
BROWN
DARK BROWN
BLACK
PARTICLE SIZE
FINELY DISSEMINATED
FINE
MEDIUM
COARSE
PRESERVATION
EXCELLENT
GOOD
FAIR
POOR
UNALTERED
SLIGHTLY ALTERED
MODERATELY ALTERED
STRONGLY ALTERED
SEVERELY ALTERED
METAMORPHOSED
OFFSHORE MARINE
NEARSHORE MARINE
RESTRICTED NEARSHORE - MARSH
LACUSTRINE
CONTINENTAL

1 1+ 2- 2 2+ 3- 3 3+ 4- 4 5

	GeoChem No.	Depth	REMARKS
	941-011A	550'	C; W; H (Am) (+) *
	-012	930'	W-C; - ; Am-H *
+	-013	1010'	C; H; Am-W
+	-019/20	2570'	Am; W-C; H (-)

(-) Degraded herbaceous debris in sample (+) Mineral charcoal in sample

* Very little organic matter on slide Sample 13 may contain some metamorphosed organic debris.

Visual Kerogen Assessment Worksheet

Landreth No. 1 Panhandle

TYPE OF ORGANIC MATTER | COLOR OF ORGANIC MATTER | STATE OF ORGANIC MATTER | MATURATION INDEX | DEPOSITIONAL ENVIRONMENT

+ 2 or more maturation populations

~2% to 20%

20% to 45%

45% to 80%

80% +

RECOGNIZABLE ALGAE
AMORPHOUS-SAPROPEL
SPORES-POLLEN
CUTICLE-MEMBRANOUS DEBRIS
WOODY-STRUCTURED DEBRIS
COAL DEBRIS
PYROBITUMEN
NONRECOGNIZABLE DEBRIS
GREENISH LIGHT YELLOW
YELLOW
YELLOW ORANGE
ORANGE BROWN
LIGHT BROWN
BROWN
DARK BROWN
BLACK
PARTICLE SIZE
FINELY DISSEMINATED
FINE
MEDIUM
COARSE
PRESERVATION
EXCELLENT
GOOD
FAIR
POOR
UNALTERED
SLIGHTLY ALTERED
MODERATELY ALTERED
STRONGLY ALTERED
SEVERELY ALTERED
METAMORPHOSED
OFFSHORE MARINE
NEARSHORE MARINE
RESTRICTED NEARSHORE-MARSH
LACUSTRINE
CONTINENTAL

1 1+ 2- 2 2+ 3- 3 3+ 4- 4 5

GeoChem No.	Depth	REMARKS
+ 941-027	3070'	Am-C; H-W; - (-)
-028A	3130'	Am; C; H-W (-)
+ -029	3310'	W-C; Am-H; - (-)
-030	3380'	W-C; H; Am (-)

(-) Degraded herbaceous debris in sample.

APPENDIX A

Brief Description of Organic Geochemical Analyses Carried Out by GeoChem

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 C_1-C_4, C_4-C_7 and C_{15}+ 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.

C_{15}+ Soxhlet Extraction, Deasphaltening 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. C^{13}/C^{12} 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 benzene-methanol 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 C_{15}+ paraffin-naphthene (P-N) hydrocarbon, C_{15}+ aromatic hydrocarbon (AROM) and C_{15}+ nitrogen-sulfur-oxygen containing fraction (NSO) by adsorption chromatography on a silica gel-alumina column.

GC Analysis of C_{15}+ Paraffin-Naphthene (P-N) Hydrocarbons

The content and molecular composition of the heavy C_{15}+ 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:

$$\text{C. P. Index A} = \frac{\dfrac{C_{21}+C_{23}+C_{25}+C_{27}}{C_{22}+C_{24}+C_{26}+C_{28}} + \dfrac{C_{21}+C_{23}+C_{25}+C_{27}}{C_{20}+C_{22}+C_{24}+C_{26}}}{2}$$

$$\text{C. P. Index B} = \frac{\dfrac{C_{25}+C_{27}+C_{29}+C_{31}}{C_{26}+C_{28}+C_{30}+C_{32}} + \dfrac{C_{25}+C_{27}+C_{29}+C_{31}}{C_{24}+C_{26}+C_{28}+C_{30}}}{2}$$

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 reservoired 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.