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GEOCHEMICAL SERVICE REPORT

HYDROCARBON SOURCE ROCK EVALUATION STUDY

PETROLEOS MEXICANOS NO. 1 CHINOS WELL

CHIHUAHUA, MEXICO

GeoChem Laboratories, Inc.

Prepared

for

Petroleos Mexicanos

Chihuahua, Mexico

CONFIDENTIAL
October, 1979

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SUMMARY

Organic geochemical analyses run on a suite of dried cuttings samples collected from the Pemex No. 1 Chinos Well, over the interval from Surface to 4,405± meters, indicate the following:

- Zone A (Surface to 2,850± meters) contains medium gray dolomites grading to grayish limestones interbedded with dark gray calcareous shales. These sediments have a very mature, grading with depth to severely altered, non-prospective oil, condensate and associated "wet" gas source character. Four (4) subzones within Zone A exhibit fair to very good "dry" methane gas source character.

- Zone B (2,850± meters to 4,405± meters) contains white to bluish gray dolomites grading to dolomitic shales and dark gray limestones. These sediments have a severely altered, non-prospective oil, condensate and associated "wet" gas source character. One (1) subzone within Zone B exhibits a good "dry" methane gas source character.

In order of priority, exploration plays and significant geological comments for the local area of the Pemex No. 1 Chinos Well are interpreted as follows (provided that reservoir traps are available):

1. Zone A (Surface to 2,850± meters)

   This section should be considered non-prospective for indigenously generated oil, condensate and associated "wet" gas. However, any available reservoir traps in juxtaposition to the four (4) subzone "dry" methane gas sources, should be considered prospective for fair to significant quantities of indigenously generated "dry" methane gas.

2. Zone B (2,850± meters to 4,405± meters)

   This section should be considered non-prospective for indigenously generated oil, condensate and associated "wet" gas. Any available reservoir traps associated with Subzone B_1, however, should be considered overall prospective for moderate quantities of "dry" methane gas.

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GEOCHEM LABORATORIES, INC.

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INTRODUCTION

This report summarizes the results of a detailed organic geochemical source rock evaluation study carried out on a suite of dried cuttings samples collected over the gross well interval from Surface to 4,405± meters from the Pemex No. 1 Chinos Well located in Chihuahua, Mexico. The purpose of this study has been to:

-- Investigate the richness, type (gas, condensate or oil), and state of thermal maturity of the fine-grained rocks which were penetrated from the surface to 4,405± meters by the Pemex No. 1 Chinos Well,

-- Characterize geochemical zones within the stratigraphic section of this well over the above mentioned interval and establish correlations between these zones and,

-- Define the exploration significance of this study with respect to future drilling in the local area of the Pemex No. 1 Chinos Well.

ANALYTICAL

Dry bagged cuttings samples were collected during the drilling of the Pemex No. 1 Chinos Well at five (5) meter intervals. Fifteen (15) boxes of samples were provided to GeoChem Laboratories, Inc. for analysis. Upon arrival at GeoChem all samples collected from the No. 1 Chinos Well were identified by the GeoChem Job No. 1276.

A suite of one hundred thirty-nine (139) hand-picked lithology samples representing 6± grams were analyzed for total organic carbon content. Utilizing these total organic carbon contents, and a brief lithologic description of each sample, fifty-one (51) samples were selected for visual kerogen examination as to kerogen type and maturation. It should be emphasized herein that the original total organic carbon content screen represented samples at approximately 30± meter intervals. The 6± gram samples were ground and split into two samples. One sample was analyzed for total organic carbon content, and the other sample was saved for possible future analyses as to kerogen visual assessment. Thus, all kerogen data represents the identical sample which was picked for total organic carbon content.

Utilizing the visual kerogen, total organic carbon content and brief lithologic description data, as well as the formation tops, eight (8) samples were selected for detailed C_{15+} extraction analyses. Eight (8) samples were also selected for vitrinite reflectance measurements.

All total organic carbon content data, lithologic descriptions, visual kerogen assessments as to type and maturation, C_{15+} extraction data and vitrinite reflectance measurements

are tabulated in table form in Tables I through VII, and are attached at the back of this report. In addition, a table (Table I) summarizing the hydrocarbon source character of the entire section penetrated by the Pemex No. 1 Chinos Well, is presented immediately after the text of this report. Values of the most important parameters, which define the hydrocarbon source character of the section of interest to Gas Producing Enterprises personnel are presented in Table I. In addition, the prospectiveness for reservoired hydrocarbons is also outlined in Table I for the various organic facies defined for this well.

A brief description of the standard analytical procedures used by GeoChem in this study is presented in Appendix A. All the analytical data obtained in this well study, whether used in the ultimate interpretation in this report or not are documented in the appropriate Tables I through VII in this report.

The results of the different geochemical analyses are presented in well profile format in Figures 1 and 2. A litho percentage log, compiled from our gross lithological examination of the samples composited for detailed analyses, is also reproduced on Figure 1. The formation tops have also been included on both Figures for reference by the reader. The gas chromatographic traces showing the molecular distribution of the C_{15+} paraffin-naphthene (P-N) hydrocarbons are reproduced in Figure 2 along with a well profile illustrating the location of the individual samples. The vitrinite reflectance histograms are presented as Figure 3, and a comparison of the visual kerogen maturation assessments and the vitrinite reflectance measurements is presented as Figure 4.

General Information

Two (2) copies of this report have been delivered to Gas Producing Enterprises, Inc., C and K Petroleum Company, Dr. Sam Thompson, III of the New Mexico Bureau of Mines and Mineral Resources, and three (3) copies to Petroleos Mexicanos. GeoChem retains one (1) copy for possible future reference in telephone conversations with authorized personnel of the above mentioned group on specific details of this well study.

All remaining used and unused, picked and unpicked cuttings materials will be returned to the New Mexico Bureau of Mines and Mineral Resources in the near future. The C_{15+} liquid chromatographic fractions and a set of glass microscope slides of the kerogen concentrate analyzed in this study are available on request at GeoChem for examination.

The data, interpretations, sample materials, and all other matters pertaining to this well study have been treated in a highly confidential manner and are considered propriety to the above mentioned group.

RESULTS AND INTERPRETATIONS

A. Formation Tops

Various formation tops were provided to GeoChem by the New Mexico Bureau of Mines and Resources. These include the following:

Concha Surface	Surface
Scherrer	82 meters
Epitaph	86 meters
Colina	396 meters
Earp	842 meters
Horquilla	1,034 meters
Pennsylvanian	1,170 meters
Paradise	1,925 meters
Escabrosa	2,134 meters
Percha	2,671 meters
Canutillo	2,853 meters
Montoya	3,425 meters
El Paso	4,150 meters
Bliss	4,349 meters
Pre Cambrian	4,381 meters

B. Organic Geochemical Zonation

The stratigraphic section which was evaluated by GeoChem in the Pemex No. 1 Chinos Well has been subdivided into two (2) major zones based primarily on the organic geochemical richness (both total organic carbon and total extracted hydrocarbon) and on the organic matter kerogen type variations for cuttings samples collected over the interval from surface to 4,405± meters. The geochemical zonation, which is independent of the formation tops, is as follows:

Zone A	Surface to 2,850± meters
Zone B	2,850± meters to 4,405± meters

Zone A (Surface to 2,850± meters)

Zone A is made up primarily of medium gray dolomites grading to grayish limestones interbedded with dark gray calcareous shales. The Zone A Sediments, overall, have fair organic carbon contents, with subzones of shales and carbonaceous limestones that have good to excellent organic carbon contents. These subzones are identified as follows:

Subzone A_1 . . . . . Lower Earp, Upper Horquilla
930± meters to 1085± meters

Subzone A_2 . . . . . Upper Pennsylvanian
1240± meters to 1335± meters

Subzone A_3 . . . . . Paradise, Upper Escabrosa
1930± meters to 2175± meters

Subzone A_4 . . . . . Lower Percha
2770± meters to 2835± meters

It is from these subzones that samples for C_{15+} soxhlet extraction were chosen. Unfortunately these composited samples contain very poor C_{15+} total bitumen contents and poor C_{15+} total hydrocarbon contents. Thus, overall, this section represents a non-source section for the generation of any type of liquid hydrocarbons. It should be stressed that the good to excellent organic carbon contents for Subzones A_1, A_2, A_3 and A_4 within Zone A represent a predominance of the gas-prone kerogen, herbaceous, woody and coaly type material. This herbaceous, woody and coaly type of kerogen will most probably yield a "dry" methane gas under high thermal diagenetic conditions. Therefore the four (4) subzones are interpreted as follows:

Subzone A_1

The lower Earp and upper Horquilla section contained in Zone A represents a section that is identified as having an overall good "dry" methane gas source character.

Subzone A_2

The upper Pennsylvanian section contained in Zone A represents a section that is identified as having a good "dry" methane gas source character.

Subzone A_3

The Paradise and upper Escalrosa section contained in Zone A represents a section that is identified as having a fair to good "dry" methane gas source character.

Subzone A_4

The lower Percha section contained in Zone A represents a section that is identified as having a very good "dry" methane gas source character.

Zone B (2,850± meters to 4,405± meters)

Zone B is made up primarily of white to bluish gray dolomites grading to dolomitic shales and dark gray limestones. The Zone B Sediments, overall, have fair organic carbon contents, with one subzone of limestone and shale that has good to very good organic carbon contents. This subzone is identified as follows:

Subzone B_1 . . . . . Upper and Middle El Paso
4220± meters to 4320± meters

The samples selected for C_{15+} soxhlet extraction exhibited fair C_{15+} total bitumen contents and fair to good C_{15+} total hydrocarbon contents. The predominant kerogen type within these samples is the oil-precursor amorphous-sapropel type kerogen. Unfortunately, the advanced degree of thermal maturity (Stage 4- to 4) identifies this section as a non-source section for the generation of any type of liquid hydrocarbons. It should be emphasized that the good to very good organic carbon contents in Subzone B_1 within Zone B identifies this section as having a good "dry" methane gas source character.

C. Thermal Maturity of Sediments

The thermal maturity of the Zone A and Zone B Sediments is defined in this report primarily on the kerogen coloration, vitrinite reflectance measurements and on the composition of the C_{15+} P-N (paraffin-naphthene) hydrocarbon contained in the various samples. Important aspects of these geochemical criteria are as follows:

i) Kerogen Color - The dark brown to black coloration of the kerogen, as seen under a binocular microscope through transmitted light (Table VI and Figure 1), indicates a narrow range in thermal maturity of the sediments from surface to 4405± meters. The kerogen isolated from the samples throughout this interval are rated at Stages 3+ to 4. These stages are defined as being very mature to severely altered. At these stages of thermal maturation any type of kerogen material present within this section has passed beyond the "oil generating window" (see appendix A. Geothermal Diagenetic Criteria chart). Any producible liquid hydrocarbons from this section have already been generated and converted to "dry" methane gas. This section is, however, prospective for this end product - the thermally derived "dry" methane gas.

ii) Vitrinite Reflectance Measurements - The vitrinite particles and associated kerogen types processed from the drill cuttings were analyzed under a high resolution microscope to measure the reflectivity of the vitrinite particles. The measurements, expressed as %Ro, are in agreement with the visual kerogen assessments (Figure 4, Figure 5 and Table

VII). Vitrinite reflectance measurements in excess of 2.0 indicate a very mature to severely altered sample. The mean reflectance for samples in both Zone A and Zone B were in excess of 4.0 (4.73 and 5.78 respectively). An interpretation of these results defines the Zone A and B section penetrated by the Pemex No. 1 Chinos Well as being non-sources for the generation of any liquid hydrocarbon, but prospective for thermally derived "dry" methane gas.

iii) Composition of C_{15+} P-N (Paraffin-Naphthene) Hydrocarbon

A skewed molecular distribution of the normal paraffins and naphthenes toward a lower molecular weight range in the C_{15+} paraffin-naphthene gas chromatograms suggests maturity. The reader is referred to the various gas chromatograms depicted in Figure 2. A mature appearance is seen for the chromatograms by a skewedness toward the lefthand side (lower molecular weight range C_{15+} paraffin-naphthene hydrocarbons).

As noted in the drilling log, diesel was added to the mud system during the drilling of the Pemex No. 1 Chinos Well. The addition of diesel has had little, if any, effect on the results of the examination of the composition of the C_{15+} P-N hydrocarbon as evidenced by the poor C_{15+} total hydrocarbon content and the lack of visual evidence in the gas chromatographic traces of the paraffin-naphthene hydrocarbon character.

D. Hydrocarbon Source Character of Sediments

Zone A (Surface to 2,850± meters)

The Zone A Sediments are rated as having a very mature to severely altered, non-source character for the generation of oil, condensate and associated "wet" gas. The non-source quality assigned to these sediments is based primarily on the very poor C_{15+} total hydrocarbon contents and the extreme diagenetic (time-temperature) history experienced by this section as evidenced by the visual kerogen and vitrinite reflectance data. The predominance of the gas-prone kerogen (herbaceous, woody and coaly type material), the good to excellent organic carbon contents of the four (4) subzones present within Zone A and the intense geothermal history of this section does identify these subzones as having a fair to very good "dry" methane gas source character.

It is interpreted that any available reservoir traps within the Zone A section in the local area of the Pemex No. 1 Chinos Well should be considered non-prospective for indigenously generated oil, condensate and associated "wet" gas.

Zone B (2,850+ meters to 4,405+ meters)

The Zone B Sediments are rated as having a severely altered, non-source character for the generation of oil, condensate and associated "wet" gas. The non-source quality assigned to these sediments is based primarily on the extreme diagenetic (time-temperature) history experienced by this section as evidenced by the visual kerogen and vitrinite reflectance data. Although the Zone B Sediments have fair C_{15+} total bitumen contents and fair to good C_{15+} total hydrocarbon contents, the high degree of thermal maturity (Maturation Index of Stage 4- to 4) precludes the occurrence of any liquid hydrocarbons. The good to very good organic carbon contents of Subzone B_1 present within Zone B, and the intense geothermal history of this section, does identify this subzone as having a good "dry" methane gas source character. Any available reservoir traps associated with Subzone B_1 should be considered prospective for moderate quantities of "dry" methane gas.

E. Exploration Significance of This Hydrocarbon Source Rock Evaluation Study

The examination of the richness, type (oil, condensate or gas) and state of thermal maturity of the hydrocarbon source rocks penetrated by the Pemex No. 1 Chinos Well in Chihuahua, Mexico, shows that the stratigraphic interval from Surface to 4,405+ meters contains two zones with a rather unique degree of exploration potential for indigenously generated hydrocarbons. In order of priority, exploration plays and significant geological points are interpreted as follows:

Locally:

1. Zone A (Surface to 2,850+ meters)

   The dark gray to grayish black shales and black carbonaceous limestone making up the four (4) subzones present within Zone A have a fair to very good "dry" methane gas source character. Any available reservoir traps found juxtaposition to these subzones should be considered prospective for fair to significant quantities of "dry" methane gas.

2. Zone B (2,850+ meters to 4,405+ meters)

   The dark gray to black shales and limestones making up the Subzone B_1 present within Zone B has a good "dry" methane gas source character. Any available reservoir traps found associated with this Subzone B_1 should be considered prospective for moderate quantities of "dry" methane gas.

Semi-regionally:
(Laterally removed
from the Pemex
No. 1 Chinos Well)

It has been mentioned that the predominant kerogen type encountered in Zone B Sediments is primarily the oil-precursor amorphous-sapropel type kerogen. The oil, condensate and associated "wet" gas source character of this section could be enhanced if this section were encountered in a laterally removed, less thermally mature regime. Such a position would provide placing these sediments within the oil-generating range as shown on the Geothermal Diagenetic Criteria chart (Appendix A), thus significantly increasing the oil, condensate and associated "wet" gas generating quality of these sediments.

TABLE I

SUMMARY OF HYDROCARBON SOURCE FACIES

Petroleos Mexicanos No. 1 Chinos Well, Chihuahua, Mexico

Organic Facies	Well Depth Interval (meters)	Lithology	Organic Carbon (% of rock)	Visual Kerogen Type	Visual Kerogen Alteration (Considered in place)	Vitrinite Reflectance $\%R_o$	C_{15+} Extraction Data (ppm) Total	P-N	AROM	Total HC's	Hydrocarbon Source Character at Present Level of Thermal Maturity	Prospectiveness*
A	Surface	Medium gray dolomites grading to grayish limestones interbedded with dark gray calcareous shales.	0.04	Woody-Coaly predominates	3+ to 4	3.90	116	18	20	38	Very mature to severely altered, non-source rocks for the generation of oil, condensate and associated "wet" gas source character. Four (4) subzones within Zone A exhibit fair to very good "dry" methane gas source character.	Non-prospective for indigenously generated oil, condensate and associated "wet" gas. Four (4) subzones within Zone A prospective for fair to significant quantities of indigenously generated "dry" methane gas.
			to			to	to	to	to	to		
			3.83	W-C;H*;Am		5.77	270	63	40	94		
	2850+		0.47 Mean	Secondary amounts of degraded herbaceous		4.73 Mean	204 Mean	38 Mean	27 Mean	65 Mean		
B	2850+	White to bluish gray dolomites grading to dolomitic shales and dark gray limestones.	0.05	Amorphous-sapropel predominates	4- to 4	5.18	442	77	82	159	Severely altered, non-source rocks for the generation of oil, condensate and associated "wet" gas source character. One (1) subzone within Zone B exhibits a good "dry" methane gas source character.	Non-prospective for indigenously generated oil, condensate and associated "wet" gas. One (1) subzone within Zone B prospective for moderate quantities of indigenously generated "dry" methane gas.
			to			to	to	to	to	to		
			1.43	Am;H*;C		7.15	628	174	84	258		
	4405+		0.34 Mean	Secondary amounts of degraded herbaceous		5.78 Mean	535 Mean	125 Mean	83 Mean	208 Mean		

*Provided that reservoir traps are available.

FIGURE 1
PEMAX NO. 1 CHINOS WELL
CHIHUAHUA, MEXICO

SUMMARY OF ORGANIC ANALYSES

SOURCE CHARACTER

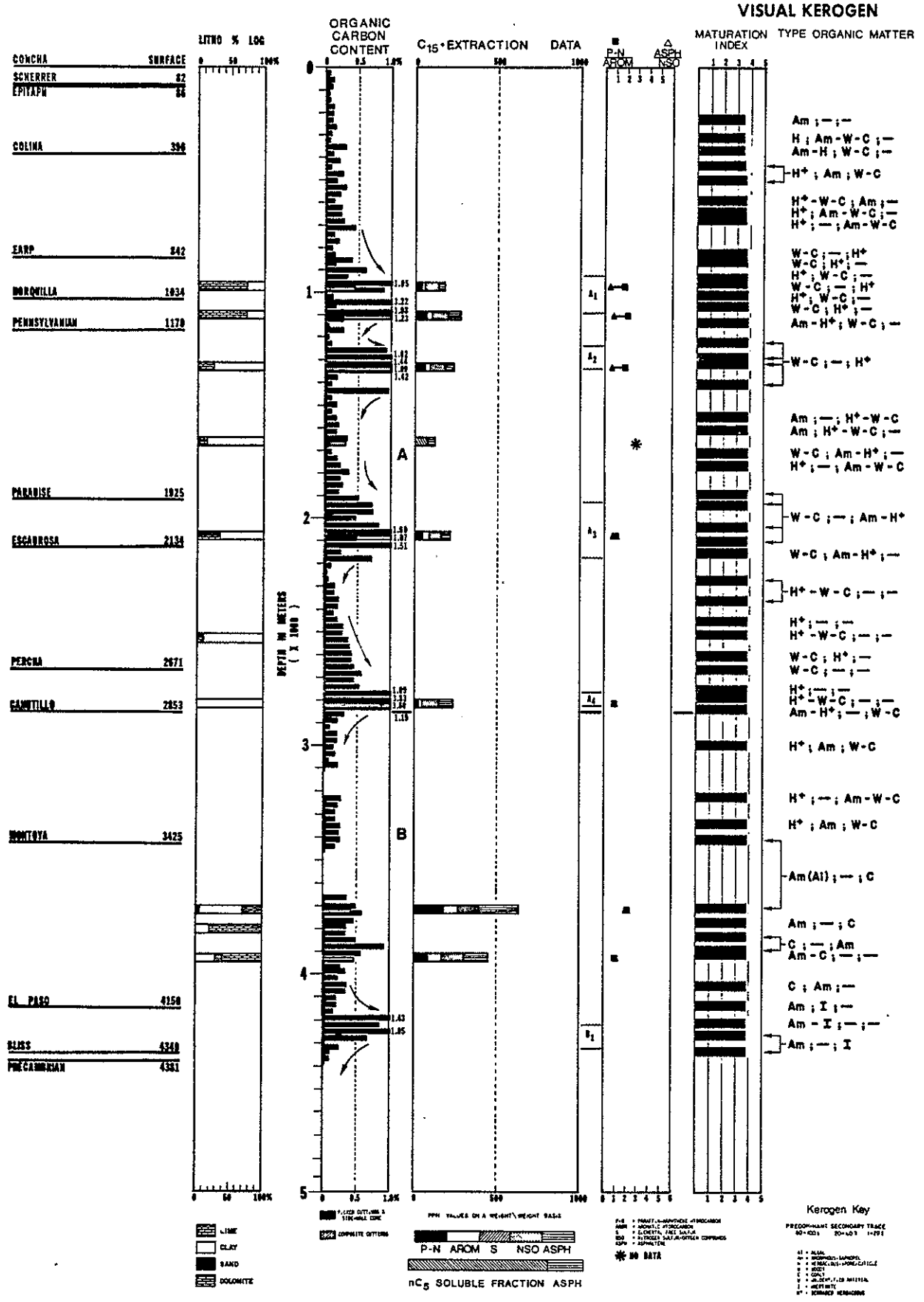


FIGURE 2
PEMEX NO. 1 CHINOS WELL
CHIHUAHUA, MEXICO
C_{15}+ GAS CHROMATOGRAMS

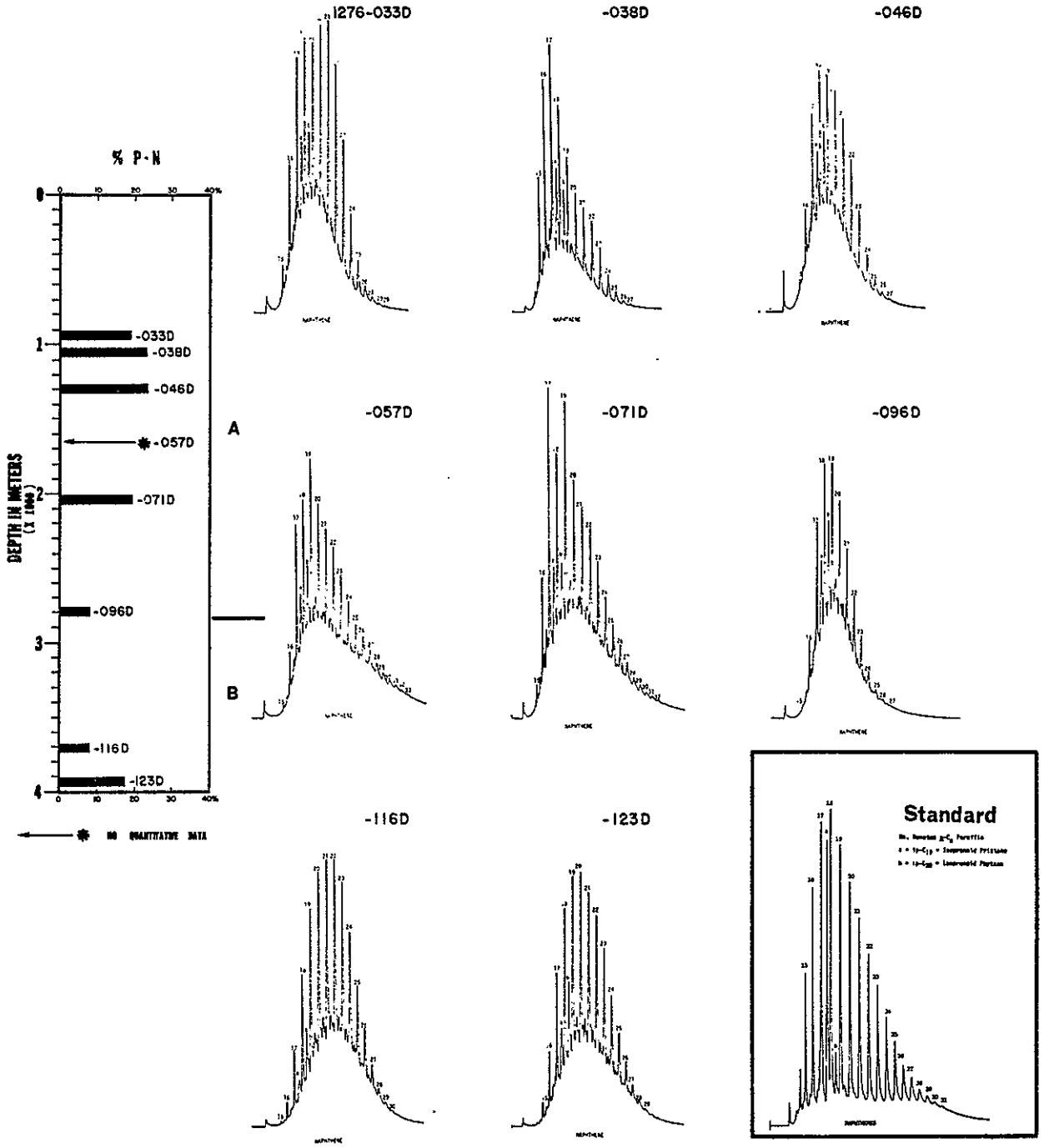


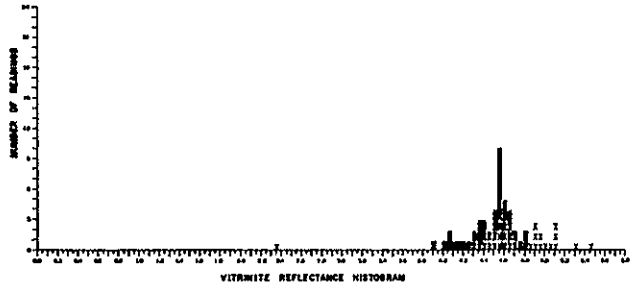
FIGURE 3
VITRINITE REFLECTANCE HISTOGRAMS

GEOCHEM NO. 1276-0330 TYPE OF SAMPLE: CTGS DEPTH/SAMPLE NO. 945

CLIENT'S NAME BORDER EXPL. WELL NAME #1 LOS CHINOS

(NO. OF READINGS = 60) 2.36 3.90 4.01 4.07 4.09 4.11 4.19 4.21 4.27 4.31 4.34 4.35 4.35 4.35
4.43 4.43 4.44 4.45 4.46 4.50 4.52 4.52 4.54 4.55 4.55 4.55 4.56 4.57 4.57 4.58 4.58 4.59
4.59 4.60 4.60 4.61 4.61 4.64 4.65 4.65 4.66 4.68 4.72 4.74 4.75 4.80 4.80 4.85 4.90 4.92
4.93 4.97 4.99 5.02 5.07 5.10 5.12 5.13 5.33 5.48

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD DEV (%)	REMARKS
(1)	1	2.36	2.36	2.36	-	
(2)	46	3.90	4.80	4.48	0.212	
(3)	13	4.85	5.48	5.06	0.178	

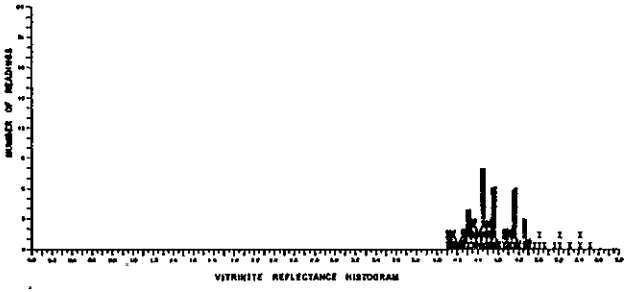


GEOCHEM NO. 1276-380 TYPE OF SAMPLE: CTGS DEPTH/SAMPLE NO. 1075

CLIENT'S NAME BORDER EXPL. WELL NAME #1 LOS CHINOS

(NO. OF READINGS = 60) 4.11 4.11 4.16 4.18 4.23 4.26 4.29 4.30 4.33 4.34 4.34 4.38 4.39 4.39
4.41 4.43 4.45 4.45 4.45 4.46 4.48 4.48 4.49 4.49 4.50 4.52 4.53 4.55 4.55 4.57 4.57 4.58
4.59 4.62 4.66 4.67 4.71 4.74 4.75 4.76 4.76 4.77 4.78 4.79 4.82 4.88 4.89 4.89 4.94 4.98
5.02 5.04 5.06 5.18 5.23 5.24 5.32 5.40 5.43 5.51

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD DEV (%)	REMARKS
(1)	49	4.11	4.94	4.53	0.215	
(2)	11	4.98	5.51	5.22	0.181	

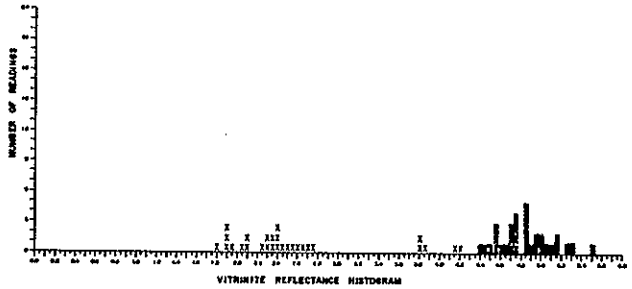


GEOCHEM NO. 1276-0480 TYPE OF SAMPLE: CTGS DEPTH/SAMPLE NO. 1305

CLIENT'S NAME BORDER EXPL. WELL NAME #1 LOS CHINOS

(NO. OF READINGS = 60) 1.83 1.90 1.93 1.94 1.95 2.07 2.13 2.14 2.25 2.31 2.33 2.38 2.39 2.40
2.42 2.43 2.45 2.51 2.57 2.62 2.69 2.73 2.75 3.00 3.04 3.06 4.17 4.24 4.42 4.46 4.54 4.56
4.56 4.58 4.62 4.65 4.71 4.74 4.74 4.75 4.77 4.78 4.86 4.86 4.88 4.89 4.89 4.92 4.95
4.97 5.01 5.04 5.05 5.12 5.15 5.18 5.25 5.30 5.54

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD DEV (%)	REMARKS
(1)	8	1.83	2.14	1.98	0.113	
(2)	15	2.25	2.75	2.48	0.155	
(3)	5	3.00	4.24	3.98	0.206	
(4)	32	4.42	5.54	4.86	0.259	

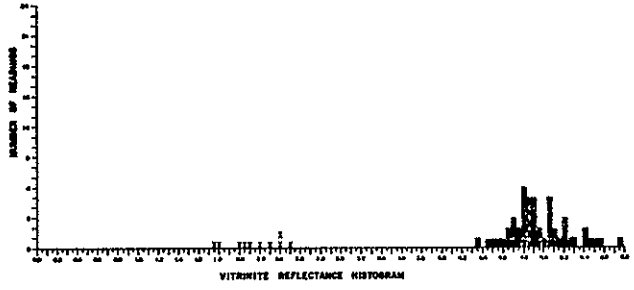


GEOCHEM NO. 1276-071 TYPE OF SAMPLE: CTGS DEPTH/SAMPLE NO. 2055

CLIENT'S NAME BORDER EXPL. WELL NAME #1 LOS CHINOS

(NO. OF READINGS = 60) 1.77 1.82 2.04 2.05 2.11 2.23 2.33 2.40 2.40 2.50 4.39 4.47 4.50 4.55
4.64 4.67 4.69 4.70 4.71 4.73 4.79 4.79 4.81 4.82 4.82 4.83 4.84 4.84 4.85 4.86 4.87 4.88
4.88 4.90 4.91 4.92 4.93 4.93 4.95 4.98 5.04 5.07 5.07 5.08 5.08 5.08 5.12 5.14 5.16 5.20
5.23 5.23 5.25 5.33 5.42 5.44 5.47 5.53 5.57 5.77

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD DEV (%)	REMARKS
(1)	10	1.77	2.50	2.17	0.250	
(2)	50	4.39	5.77	4.97	0.294	

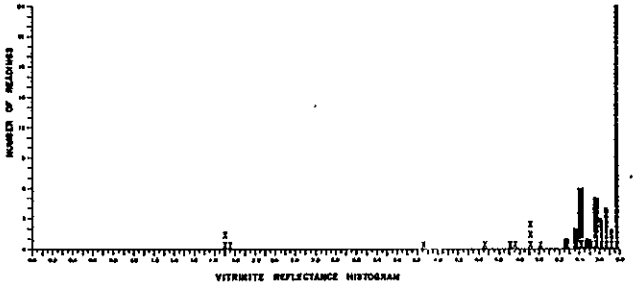


GEOCHEM NO. 1276-178 TYPE OF SAMPLE: CTGS DEPTH/SAMPLE NO. 3790

CLIENT'S NAME BORDER EXPL. WELL NAME #1 LOS CHINOS

(NO. OF READINGS = 60) 1.90 1.94 1.96 3.88 4.45 4.74 4.77 4.93 4.93 4.94 5.02 5.27 5.38 5.39
5.41 5.41 5.47 5.43 5.43 5.44 5.46 5.54 5.56 5.56 5.57 5.57 5.58 5.60 5.62 5.62 5.65 5.67
5.69 5.69 5.70 5.72 5.75 5.75 5.75 5.91 5.83 5.84 5.85 5.90 5.81 5.93 5.91 5.94 5.96 5.97
5.98 6.01 6.01 6.08 6.12 6.15 6.46 6.72 6.76 7.15

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD DEV (%)	REMARKS
(1)	3	1.90	1.96	1.93	0.031	
(2)	8	3.88	5.02	4.71	0.379	
(3)	49	5.27	7.15	5.79	0.374	



GEOCHEM NO. 1276-1230 TYPE OF SAMPLE: CTGS DEPTH/SAMPLE NO. 3935

CLIENT'S NAME BORDER EXPL. WELL NAME #1 LOS CHINOS

(NO. OF READINGS = 7) 3.29 3.84 4.16 4.56 5.18 5.26 5.52

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD DEV (%)	REMARKS
(1)	1	3.29	3.29	3.29	-	
(2)	3	3.84	4.56	4.19	0.361	
(3)	3	5.18	5.52	5.32	0.178	

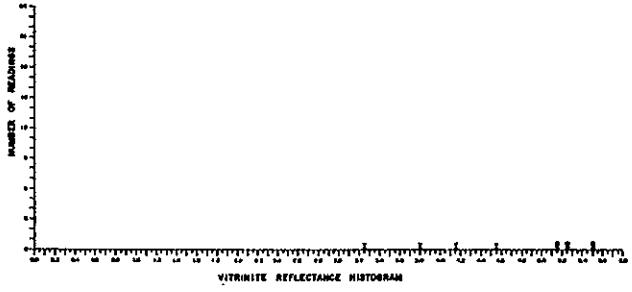


TABLE I-A

SCREEN ANALYSIS SUMMARY

GeoChem Sample Number	Depth Interval (Meters)	Brief Lithological Description	Organic Carbon (% of Rock)
1276-001	0-5	Dolomite, limestone and quartzose.	0.05
1276-002	30-35	Dolomite, crystalline, moderate blue green.	0.11
1276-003	60-65	Dolomite, crystalline, greenish gray.	0.09
1276-004	90-95	Dolomite, crystalline, medium blue green.	0.04
1276-005	120-125	Dolomite, crystalline, moderate blue green.	0.05
1276-006	150-155	Dolomite, crystalline, medium blue green.	0.11
1276-007	180-185	Dolomite, crystalline, medium blue green.	0.10
1276-008	210-215	Dolomite, crystalline, medium gray.	0.09
1276-009	240-245	Dolomite, crystalline, medium gray.	0.14
1276-010	270-275	Dolomite, crystalline, medium to dark gray.	0.06; 0.08R
1276-011	300-305	Dolomite, crystalline, medium to dark gray.	0.05
1276-012	330-335	Dolomite, dark gray.	0.29
1276-013	360-365	Dolomite, dark gray.	0.10
1276-014	390-395	Dolomite, dark gray.	0.20
1276-015	420-425	Limestone, dark bluish gray.	0.07
1276-016	450-455	Limestone, dark gray.	0.25
1276-017	480-485	Limestone, dark gray.	0.16
1276-018	510-515	Limestone, dark gray.	0.30
1276-019	540-545	Limestone, grayish black.	0.21
1276-020	570-575	Limestone, grayish black to dark gray.	0.12
1276-021	600-605	Limestone, dark gray to grayish black.	0.20; 0.26R
1276-022	630-635	Limestone, dark gray.	0.23
1276-023	660-665	Limestone, sparite, dark gray.	0.27
1276-024	690-695	Limestone, dark gray.	0.44
1276-025	720-725	Limestone, light to dark gray.	0.12
1276-026	750-755	Composite: dolomite, limestone and shale.	0.19
1276-027	780-785	Limestone, dark bluish gray.	0.09
1276-028	810-815	Limestone, medium to dark gray.	0.13
1276-029	835-840	Limestone, sparite, dark gray.	0.39
1276-030	850-855	Limestone, light to dark gray and shale, noncalcareous, dark gray.	0.14
1276-031	880-885	Shale, very slightly calcareous, grayish black, and limestone, dark gray.	0.60
1276-032	910-915	Limestone, bluish gray.	0.32; 0.34R
1276-033	940-945	Limestone, carbonaceous, black.	3.22
1276-034	970-975	Limestone, carbonaceous, dark gray to black.	0.88
1276-035	1000-1005	Limestone, micrite, dark bluish gray.	0.10
1276-036	1025-1030	Limestone, micrite, dark bluish gray and shale, dark gray.	1.05
1276-037	1040-1045	Limestone, micrite, dark gray and shale, noncalcareous, black.	0.15
1276-038	1070-1075	Limestone, micrite, dark gray and shale, calcareous, grayish black.	1.08
1276-039	1100-1105	Limestone, micrite, dark gray and shale, noncalcareous, grayish black.	0.26
1276-040	1130-1135	Limestone, micrite, dark bluish gray.	0.04
1276-041	1150-1155	Limestone, micrite, dark bluish gray and shale, calcareous, grayish black.	0.26
1276-042	1180-1185	Limestone, micrite, dark gray, and shale, slightly calcareous, grayish black.	0.04
1276-043	1210-1215	Limestone, micrite, medium dark gray.	0.10; 0.06R
1276-044	1240-1245	Shale, slightly calcareous, dark gray.	0.92
1276-045	1270-1275	Shale, slightly calcareous, dark gray.	1.02
1276-046	1300-1305	Shale, slightly calcareous, dark gray.	1.44
1276-047	1330-1335	Shale, slightly calcareous, dark gray.	1.42
1276-048	1360-1365	Limestone and shale, medium gray.	0.17
1276-049	1390-1395	Limestone, micrite, bluish gray, trace of shale.	0.08
1276-050	1420-1425	Shale, slightly calcareous, dark gray.	0.95
1276-051	1450-1455	Limestone, micrite, bluish gray, trace shale.	0.08
1276-052	1480-1485	Composite: limestone and shale, dark gray.	0.16
1276-053	1510-1515	Limestone, micrite, bluish gray and shale, calcareous, dark gray.	0.08
1276-054	1540-1545	Limestone, micrite, bluish gray, trace of shale.	0.16
1276-055	1570-1575	Limestone, micrite, bluish gray to dark gray.	0.19
1276-056	1600-1605	Limestone, micrite, bluish gray to dark gray.	0.16
1276-057	1630-1635	Shale, calcareous, dark gray and limestone, dark gray.	0.32
1276-058	1660-1665	Limestone, micrite, light to medium dark gray.	0.04
1276-059	1690-1695	Limestone, intramicrite, dark gray.	0.08
1276-060	1720-1725	Limestone, light to medium dark gray.	0.14; 0.20R
1276-061	1750-1755	Limestone, micrite, dark gray.	0.22
1276-062	1780-1785	Shale, limy, dark gray.	0.35
1276-063	1810-1815	Shale, limy, dark gray.	0.22
1276-064	1840-1845	Composite: limestone, medium gray and shale, limy, dark gray.	0.26
1276-065	1870-1875	Composite: limestone, medium gray and shale, limy, dark gray.	0.20
1276-066	1900-1905	Composite: shale, limy, carbonaceous, black, and limestone, dark gray.	0.50
1276-067	1930-1935	Composite: shale, limy, carbonaceous, black, and limestone, dark gray.	0.71
1276-068	1960-1965	Shale, limy, dark gray.	0.72
1276-069	1990-1995	Shale, limy, dark gray.	0.47
1276-070	2020-2025	Shale, limy, dark gray.	0.87
1276-071	2050-2055	Shale, calcareous, dark grey to grey-ish black.	1.60; 1.63R
1276-072	2080-2085	Composite: shale, limestone and dolomite.	0.47
1276-073	2110-2115	Shale, calcareous, dark gray to grayish black.	1.51
1276-074	2140-2145	Shale, calcareous, dark gray	0.23

FIGURE 4

SUMMATION OF VITRINITE REFLECTANCE AND VISUAL KEROGEN ALTERATION RESULTS

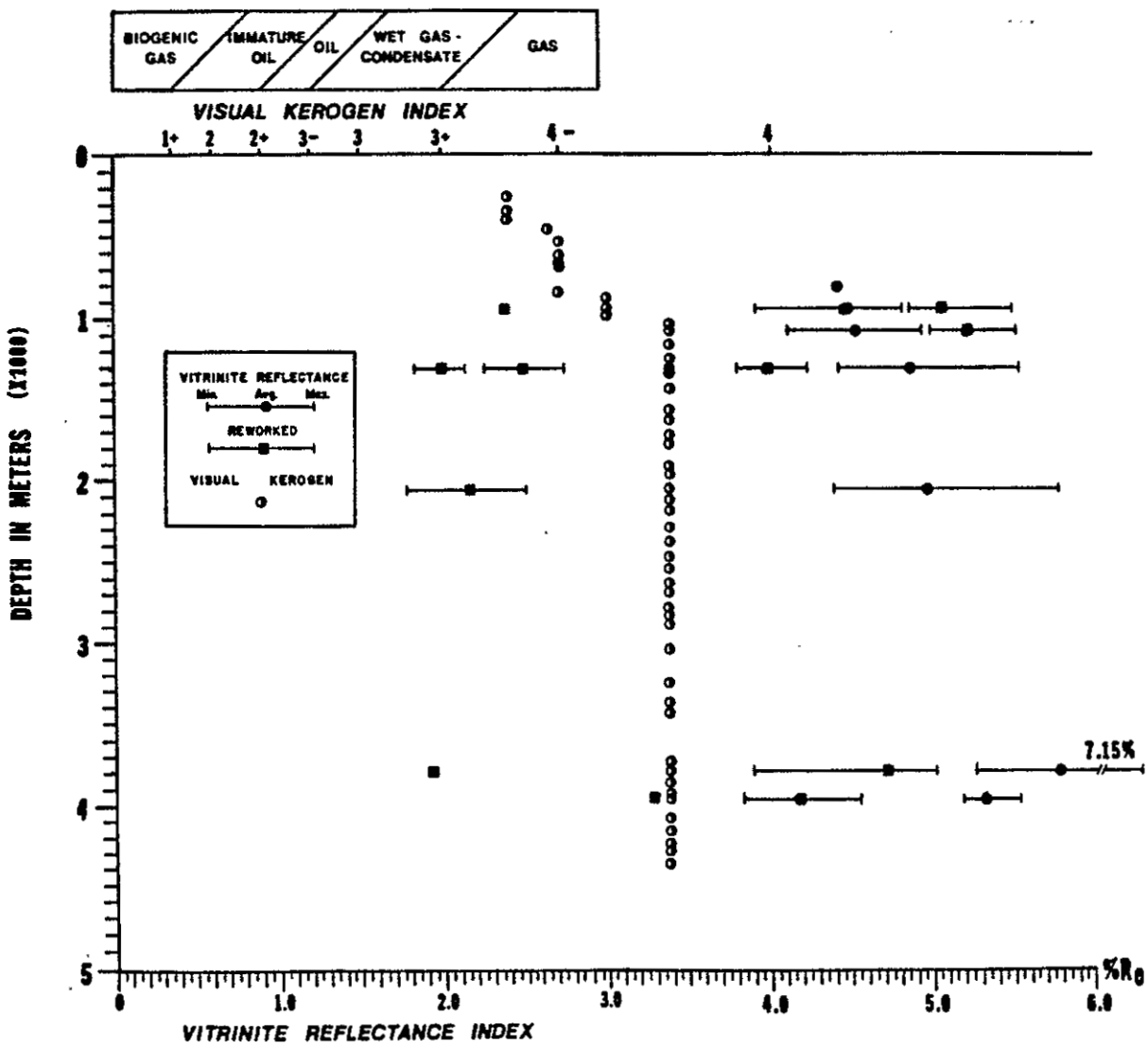


TABLE I-A (CONT.)

SCREEN ANALYSIS SUMMARY

GeoChem Sample Number	Depth Interval (Meters)	Brief Lithological Description	Organic Carbon (% of Rock)
1276-075	2170-2175	Shale, very calcareous, bluish gray to dark bluish gray.	0.70
1276-076	2200-2205	Limestone, micrite, white to light bluish gray.	0.08
1276-077	2260-2265	Limestone and shale, light to dark bluish gray.	0.04
1276-079	2290-2295	Shale, very calcareous, bluish green-gray.	0.14
1276-080	2320-2325	Shale, very calcareous, dark gray and limestone, light gray.	0.13
1276-081	2350-2355	Shale, limy, dark gray.	0.20
1276-082	2380-2385	Shale, limy, dark gray.	0.17; 0.20R
1276-083	2410-2415	Limestone and shale, medium gray.	0.12
1276-084	2440-2445	Shale, very calcareous, dark gray.	0.18
1276-085	2470-2475	Shale, limy, dark gray.	0.27
1276-086	2500-2505	Shale, calcareous, dark gray.	0.26
1276-087	2530-2535	Shale, calcareous, medium dark gray.	0.35
1276-088	2560-2565	Shale, calcareous, medium dark gray.	0.38
1276-089	2590-2595	Shale, calcareous, medium dark gray.	0.41
1276-090	2620-2625	Shale, limy, dark bluish gray.	0.40
1276-091	2650-2655	Shale, calcareous, dark gray.	0.44
1276-092	2680-2685	Shale, slightly calcareous, dark gray.	0.55
1276-093	2710-2715	Shale, noncalcareous, dark gray to greenish black.	0.41; 0.47R
1276-094	2740-2745	Shale, noncalcareous, dark gray to greenish black.	0.52
1276-095	2770-2775	Shale, noncalcareous, black.	1.09
1276-096	2800-2805	Shale, noncalcareous, black.	3.83
1276-097	2833-2835	Shale, noncalcareous, black.	1.19
1276-098	2863-2865	Dolomite, bluish gray and shale, non-calcareous, black.	0.29
1276-099	2890-2895	Dolomite, bluish gray and shale, non-calcareous, black.	0.19
1276-100	2920-2925	Dolomite, white to bluish gray.	0.07
1276-101	2950-2955	Dolomite, white to bluish gray.	0.18
1276-102	2980-2985	Dolomite, white to bluish white and shale, black.	0.18
1276-103	3010-3015	Dolomite, white to bluish gray.	0.13
1276-104	3040-3045	Dolomite, white to bluish gray.	0.15
1276-105	3070-3075	Dolomite, bluish gray.	0.05
1276-106	3090-3095	Dolomite, white to bluish gray.	0.19
1276-107	3240	Dolomite, bluish gray.	0.24
1276-108	3270	Dolomite, bluish gray.	0.19
1276-109	3300	Dolomite, bluish gray.	0.15
1276-110	3330-3335	Dolomite, light bluish gray to white.	0.16; 0.14R
1276-111	3360-3365	Dolomite, medium bluish gray.	0.23
1276-112	3390-3395	Dolomite, medium bluish gray.	0.21
1276-113	3420-3425	Dolomite, medium bluish gray.	0.23
1276-114	3450-3455	Shale, dolomitic, medium bluish gray.	0.15
1276-115	3680-3685	Shale, dolomitic, medium bluish gray.	0.33
1276-116	3720-3725	Shale, dolomitic, medium bluish gray.	0.47
1276-117	3750-3755	Shale, dolomitic, bluish gray to black.	0.56
1276-118	3785-3790	Shale, slightly calcareous, dark gray.	0.44
1276-119	3810-3815	Dolomite, dark grey, calcite fracture fillings.	0.33
1276-120	3840-3845	Dolomite, dark gray and quartzose, clear.	0.33
1276-121	3870-3875	Composite: dolomite, shale, quartzose and sand.	0.43; 0.52R
1276-122	3900-3905	Dolomite, medium bluish gray and shale, black	0.90
1276-123	3930-3935	Shale, noncalcareous, dark gray to black.	0.55
1276-124	3960-3965	Composite: shale, quartzose and dolomite.	0.43
1276-125	3990-3995	Sandstone, white and shale, non-calcareous, black.	0.24
1276-126	4010-4015	Sandstone, white and shale, non-calcareous, black.	0.32
1276-127	4040-4045	Limestone, dark gray and shale, slightly calcareous, dark gray.	0.21
1276-128	4070-4075	Limestone, dark gray and shale, dark gray.	0.34
1276-129	4100-4105	Limestone, dark gray.	0.32
1276-130	4130-4135	Limestone, dark gray and shale, very slightly calcareous, dark gray.	0.18
1276-131	4160-4165	Limestone, dark gray.	0.18
1276-132	4190-4195	Limestone, and shale, dark gray.	0.11; 0.16R
1276-133	4220-4224	Limestone, shale and quartzite.	1.43
1276-134	4250-4254	Limestone and shale, gray to black.	0.84
1276-135	4280-4284	Limestone and shale, gray to black; trace of quartzite.	1.05
1276-136	4310-4314	Limestone, shale and quartzite.	0.65
1276-137	4350-4355	Limestone, shale and quartzite.	0.22
1276-138	4370-4375	Dolomite, white.	0.08
1276-139	4400-4405	Dolomite, quartzite, chlorite, and pyrite.	0.07

Table II

Organic Carbon Analyses and Gross Lithological Description

GeoChem Sample Number	Well Interval Meters	Gross Lithological Description	GSA Color Code	Total Organic Carbon (% of Rock)
1276-033D	930-965			0.44
-A		70% Limestone, micrite, chunky, blocky, moderately hard to hard, dark gray.	N3	
-B		30% Shale, calcareous, chunky, moderately hard, dark gray.	N3	
1276-038D	1070-1085			1.23
-A		70% Limestone, micrite, chunky, blocky, moderately hard, dark gray.	N3	
-B		30% Shale, calcareous, chunky, moderately hard, dark gray.	N3	
1276-046D	1300-1315			1.09
-A		80% Shale, slightly calcareous, chunky, moderately hard to hard, dark gray.	N3	
-B		20% Limestone, micrite, chunky, moderately hard to hard, dark gray.	N3	
1276-057D	1630-1645			0.30
-A		90% Shale, calcareous, chunky, platy, moderately hard to hard, dark gray.	N3	
-B		10% Limestone, micrite, chunky, moderately hard, medium dark gray.	N4	
1276-071D	2050-2070			1.07
-A		70% Shale, calcareous, chunky, splintery, platy, moderately hard, grayish black.	N2	
-B		30% Limestone, micrite, chunky, moderately hard, dark gray.	N3	
1276-087D	2530-2535			
-A		100% Shale, calcareous, chunky, splintery, platy, moderately hard, dark gray.	N3	
1276-096D	2800-2815			3.60
-A		100% Shale, noncalcareous, carbonaceous, chunky, splintery, platy, moderately hard, grayish black.	N2	
-B		Trace quartzite.		
1276-116D	3720-3735			0.39; 0.41
-A		70% Shale, very slightly calcareous, chunky, platy, moderately hard, dark gray.	N3	
-B		30% Dolomite, massive, chunky, moderately hard to hard, dark gray. This sample is slightly contaminated.	N3	
1276-118D	3785-3790			
-A		80% Dolomite, massive, chunky, moderately hard to hard, dark gray to white.	N3 to N9	
-B		20% Shale, noncalcareous, chunky, moderately hard, dark gray. This sample is slightly contaminated.	N3	
1276-123D	3930-3955			1.23
-A		60% Dolomite, massive, chunky, moderately hard to hard, dark gray to white.	N3 to N9	
-B		30% Shale, slightly calcareous, chunky, moderately hard, dark gray.	N3	
-C		10% Orthoquartzite, slightly dolomitic, chunky, moderately hard, very light gray. This sample is slightly contaminated.	N8	

*This sample is contaminated by walnut shells, mica and metal filings.

TABLE III

SUMMARY OF ORGANIC CARBON AND VISUAL KEROGEN ANALYSIS

GEOCHEM SAMPLE NUMBER	WELL DEPTH (METERS)	PERCENT ORGANIC CARBON	VISUAL KEROGEN	
			ORGANIC MATTER TYPE	ALTERATION (1 - 5 Scale)
1276-033D	930- 965	0.44	H*;W-C;-	4- to 4
1276-038D	1070-1085	1.23	W-C;H*;-	4- to 4
1276-046D	1300-1315	1.09	W-C;-;H*	4- to 4
1276-057D	1630-1645	0.30	Am;H*-W-C;-	4- to 4
1276-071D	2050-2070	1.07	W-C;-;Am-H*	4- to 4
1276-096D	2800-2815	3.60	H*-W-C;-;-	4- to 4
1276-116D	3720-3735	0.39; 0.41R	Am(Al);-;C	4- to 4
1276-123D	3930-3955	0.45	Am-C;-;-	4- to 4

R = Repeat Analysis

Kerogen Key

Predominant: Secondary: Trace

60 - 100% 20 - 40% 1 - 20%

Al = Algal
Am = Amorphous-Sapropel
H = Herbaceous-Spore/Cuticle
H* = Degraded Herbaceous
W = Woody
C = Coaly
U = Unidentified Material

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)
1276-033D	930- 965	100.0	0.0174	0.0039	0.0135	N.D.	0.0033	0.0019	0.0071	0.0012
1276-038D	1070- 1085	100.0	0.0270	0.0077	0.0193	N.D.	0.0063	0.0031	0.0070	0.0029
1276-046D	1300- 1315	100.0	0.0229	0.0056	0.0173	N.D.	0.0054	0.0030	0.0083	0.0006
1276-057D	1630- 1645	100.0	0.0116	0.0047	0.0069	N.D.	N.D.	N.D.	N.D.	N.D.
1276-071D	2050- 2070	100.0	0.0209	0.0054	0.0155	N.D.	0.0041	0.0040	0.0058	0.0016
1276-096D	2800- 2815	100.0	0.0226	0.0087	0.0139	N.D.	0.0018	0.0020	0.0078	0.0023
1276-116D	3720- 3735	100.0	0.0628	0.0244	0.0384	N.D.	0.0174	0.0084	0.0123	0.0003
1276-123D	3930- 3955	91.8	0.0406	0.0133	0.0273	N.D.	0.0071	0.0075	0.0111	0.0016

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)
1276-033D	930- 965	174	33	19	52	-	39	71	12	122
1276-038D	1070- 1085	270	63	31	94	-	77	70	29	176
1276-046D	1300- 1315	229	54	30	84	-	56	83	6	145
1276-057D	1630- 1645	116	-	-	-	-	47	-	-	-
1276-071D	2050- 2070	209	41	40	81	-	54	58	16	128
1276-096D	2800- 2815	226	18	20	38	-	87	78	23	188
1276-116D	3720- 3735	628	174	84	258	-	244	123	3	370
1276-123D	3930- 3955	442	77	82	159	-	145	121	17	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
1276-033D	930- 965	19.0	10.9	1.74	-	40.8	6.9	22.4	0.47	29.9	0.43
1276-038D	1070- 1085	23.3	11.5	2.03	-	25.9	10.7	28.5	0.78	34.8	0.53
1276-046D	1300- 1315	23.6	13.1	1.80	-	36.2	2.6	24.5	0.63	36.7	0.58
1276-057D	1630- 1645	-	-	-	-	-	-	40.5	-	-	-
1276-071D	2050- 2070	19.6	19.1	1.03	-	27.8	7.7	25.8	0.73	38.8	0.63
1276-096D	2800- 2815	8.0	8.8	0.90	-	34.5	10.2	38.5	0.86	16.8	0.20
1276-116D	3720- 3735	27.7	13.4	2.07	-	19.6	0.5	38.9	1.94	41.1	0.70
1276-123D	3930- 3955	17.5	18.5	0.95	-	27.3	3.9	32.8	1.05	36.0	0.56

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
1276-033D	930- 965	30.5	2.9	66.6	1.09	-	1.02
1276-038D	1070- 1085	32.3	4.7	62.9	-	-	1.34
1276-046D	1300- 1315	21.1	3.3	75.7	-	-	0.84
1276-057D	1630- 1645	18.1	2.1	79.8	1.02	1.13	0.84
1276-071D	2050- 2070	26.5	2.4	71.0	1.02	1.12	1.09
1276-096D	2800- 2815	20.1	4.3	75.6	-	-	0.84
1276-116D	3720- 3735	27.7	1.2	71.1	1.03	-	0.48
1276-123D	3930- 3955	30.3	3.0	66.7	1.03	-	0.66

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
1276-033D	930- 965	1.8	6.5	10.2	4.4	10.4	4.3	10.0	11.5	13.2	11.9	8.1	4.5	1.9	0.8	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1276-038D	1070- 1085	9.1	15.4	17.1	7.3	12.7	5.5	8.5	6.1	5.7	5.5	3.8	2.1	0.9	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1276-046D	1300- 1315	0.9	4.6	10.4	6.1	13.4	7.3	13.0	12.1	11.6	9.5	6.3	3.1	1.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1276-057D	1630- 1645	0.3	3.3	12.1	4.8	12.0	5.7	15.0	10.5	8.7	8.0	6.1	4.2	3.2	2.2	1.4	0.9	0.7	0.3	0.3	0.2	0.1	0.0	0.0
1276-071D	2050- 2070	1.3	6.8	17.6	4.4	11.7	4.0	15.0	8.9	7.4	6.9	5.4	3.6	2.6	1.8	1.0	0.6	0.4	0.3	0.3	0.1	0.0	0.0	0.0
1276-096D	2800- 2815	0.4	4.9	12.7	8.1	16.5	9.6	15.0	11.7	8.2	6.2	4.0	1.7	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1276-116D	3720- 3735	0.2	1.2	4.2	1.4	8.4	2.9	12.0	13.0	12.6	12.8	11.4	8.6	5.5	3.3	1.6	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0
1276-123D	3930- 3955	1.2	4.1	7.9	3.5	11.5	5.4	12.9	12.3	10.4	9.9	8.3	5.8	3.4	2.0	0.9	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0

TABLE VI

VISUAL KEROGEN ASSESSMENT WORKSHEET

Pemex No. 1 Chinos Well

Chihoahoa, Mexico

GEOCHEM No	DEPTH	INDIGENOUS POPULATION (INTERPRETED) TYPE OF ORGANIC MATTER / MATURATION INDEX / REMARKS	GENERAL CHARACTERISTICS COLOR OF ORGANIC MATTER / STATE OF ORGANIC MATTER / %	CAVED AND/OR REWORKED POPULATION(S) TYPE OF ORGANIC MATTER / MATURATION INDEX / REMARKS	SUMMARY ORGANIC MATTER TYPE
1276-009	245 m	Am;-;-			Am;-;-
1276-012	335 m	H;Am-W-C;-			H;Am-W-C;-
1276-014	395 m	Am-H;W-C;-			Am-H;W-C;-
1276-016	455 m	H*;Am;W-C			H*;Am;W-C
1276-018	515 m	H*;Am;W-C			H*;Am;W-C
1276-021	605 m	H*-W-C;Am;-			H*-W-C;Am;-
1276-023	665 m	H*;Am-W-C;-			H*;Am-W-C;-
1276-024	695 m	H*;-;Am-W-C			H*;-;Am-W-C
1276-029	840 m	W-C;-;H*			W-C;-;H*
1276-031	885 m	W-C;H*;-			W-C;H*;-
1276-033	945 m	H*;W-C;-			H*;W-C;-
1276-034	975 m	W-C;-;H*			W-C;-;H*
1276-036	1030 m	H*;W-C;-			H*;W-C;-
1276-038	1075 m	W-C;H*;-			W-C;H*;-
1276-041	1155 m	Am-H*;W-C;-			Am-H*;W-C;-
1276-044	1245 m	W-C;-;H*			W-C;-;H*
1276-046	1305 m	W-C;-;H*			W-C;-;H*
1276-047	1335 m	W-C;-;H*			W-C;-;H*
1276-050	1425 m	W-C;-;H*			W-C;-;H*
1276-055	1575 m	Am;-;H*-W-C			Am;-;H*-W-C
1276-057	1635 m	Am;H*-W-C;-			Am;H*-W-C;-
1276-060	1725 m	W-C;Am-H*;-			W-C;Am-H*;-
1276-062	1785 m	H*;-;Am-W-C			H*;-;Am-W-C
1276-066	1905 m	W-C;-;Am-H*			W-C;-;Am-H*
1276-068	1965 m	W-C;-;Am-H*			W-C;-;Am-H*
1276-071	2055 m	W-C;-;Am-H*			W-C;-;Am-H*
1276-073	2115 m	W-C;-;Am-H*			W-C;-;Am-H*
1276-075	2174 m	W-C;Am-H*;-			W-C;Am-H*;-
1276-079	2295 m	H*-W-C;-;-			H*-W-C;-;- VLOM
1276-082	2385 m	H*-W-C;-;-			H*-W-C;-;- VLOM
1276-085	2475 m	H*;-;-			H*;-;- VLOM
1276-087	2535 m	H*-W-C;-;-			H*-W-C;-;- VLOM
1276-090	2625 m	W-C;H*;-		W;H;-	W-C;H*;- VLOM
1276-092	2685 m	W-C;-;-			W-C;-;- VLOM
1276-095	2775 m	H*;-;-			H*;-;- VLOM
1276-096	2805 m	H*-W-C;-;-			H*-W-C;-;-
1276-098	2865 m	Am-H*;-;W-C			Am-H*;-;W-C
1276-103	3015 m	H*;Am;W-C			H*;Am;W-C
1276-107	3240 m	H*;-;Am-W-C		W;H;-	H*;-;Am-W-C
1276-111	3365 m	H*;Am;W-C			H*;Am;W-C
1276-113	3425 m	Am(Al);-;C			Am(Al);-;C
1276-116	3725 m	Am(Al);-;C		W;-;-	Am(Al);-;C
1276-118	3790 m	Am;-;C			Am;-;C VLOM
1276-120	3845 m	C;-;Am			C;-;Am VLOM
1276-122	3905 m	C;-;Am			C;-;Am VLOM
1276-123	3935 m	Am-C;-;-			Am-C;-;- VLOM
1276-128	4075 m	C;Am;-			C;Am;- VLOM
1276-131	4165 m	Am;I;-		W;H;-	Am;I;- VLOM
1276-133	4224 m	Am-I;-;-		H-W;-;-	Am-I;-;- VLOM
1276-135	4284 m	Am;-;I		H-W;-;-	Am;-;I VLOM
1276-137	4355 m	Am;-;I		H-W;-;-	Am;-;I

TABLE VII

VITRINITE REFLECTANCE SUMMARY

GEOCHEM SAMPLE NUMBER	DEPTH (meters)	TYPE OF SAMPLE	POPULATION	NUMBER OF READINGS	MINIMUM REFLECTANCE (% Ro)	MAXIMUM REFLECTANCE (% Ro)	MEAN REFLECTANCE (% Ro)	STD. DEV. (% Ro)	REMARKS
1276-033D	945	CTGS	(1)	1	2.36	2.36	2.36	-	
			(2)	46	3.90	4.80	4.48	0.212	
			(3)	13	4.85	5.48	5.06	0.178	
1276-38D	1075	CTGS	(1)	49	4.11	4.94	4.53	0.215	
			(2)	11	4.98	5.51	5.22	0.181	
1276-046D	1305	CTGS	(1)	8	1.83	2.14	1.99	0.113	
			(2)	15	2.25	2.75	2.48	0.155	
			(3)	5	3.80	4.24	3.98	0.206	
			(4)	32	4.42	5.54	4.86	0.259	
1276-071D	2055	CTGS	(1)	10	1.77	2.50	2.17	0.250	
			(2)	50	4.39	5.77	4.97	0.294	
11276-087D	2535	CTGS	NO VITRINITE						
1276-096	2805	CTGS	NO VITRINITE						
1276-118	3790	CTGS	(1)	3	1.90	1.96	1.93	0.031	
			(2)	8	3.88	5.02	4.71	0.379	
			(3)	49	5.27	7.15	5.79	0.374	
1276-123D	3935	CTGS	(1)	1	3.29	3.29	3.29	-	
			(2)	3	3.84	4.56	4.19	0.361	
			(3)	3	5.18	5.52	5.32	0.178	

C_1-C_7 Hydrocarbon

The C_1-C_7 hydrocarbon content and composition of sediments reflects source type, source quality and thermal maturity.

The C_1-C_7 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 C_1-C_7 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 C_1-C_7 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 Porapec Q column. The gas sample is taken through the column by a carrier gas and before reaching the detector is separated into its various C_1 (methane), C_2 (ethane), C_3 (propane), iC_4 (isobutane), nC_4 (normal butane), and C_5, C_6, C_7 hydrocarbon components.

This particular analysis gives a complete separation of the C_1-C_4 gas-range hydrocarbons and a partial separation of the C_5-C_7 gasoline-range hydrocarbons. (A detailed C_4-C_7 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 C_1-C_7 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 C_1, C_2, C_3, etc. determined by gc analysis of a standard gas sample, and the gc peak response.

The C_1-C_7 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 C_1-C_7 hydrocarbon data from the air space and cuttings gas analyses are summed to give a "restored" C_1-C_7 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 C_1-C_7 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 C_4-C_7 hydrocarbon analyses. This sample set is used not only for the C_4-C_7 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 C_{15+} soxhlet extraction and/or eventual return to the client. Sample material from this study will be retained at GeoChem until advised of disposition.

Detailed C_4-C_7 Hydrocarbon

The C_4-C_7 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 C_4-C_7 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 C_1-C_7 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 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 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 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 using pentane, toluene and toluene-methanol azeotrope eluants.

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:

$$\text{C.P. Index A} = \frac{\frac{C_{21}+C_{23}+C_{25}+C_{27}}{C_{22}+C_{24}+C_{26}+C_{28}} + \frac{C_{21}+C_{23}+C_{25}+C_{27}}{C_{20}+C_{22}+C_{24}+C_{26}}}{2} \qquad \text{C.P. Index B} = \frac{\frac{C_{25}+C_{27}+C_{29}+C_{31}}{C_{26}+C_{28}+C_{30}+C_{32}} + \frac{C_{25}+C_{27}+C_{29}+C_{31}}{C_{24}+C_{26}+C_{28}+C_{30}}}{2}$$

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.

Vitrinite Reflectance

Measurement of the reflectivity of vitrinite particles (%R_o) 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 C_{10+} 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.

GEOTHERMAL DIAGENETIC CRITERIA

(GEOCHEM LABORATORIES, INC)