

OFFICE OF MINES
SOCORRO STATION
SOCORRO, N.M. 87801

NEW MEXICO HYDROCARBON SOURCE
ROCK EVALUATION PROJECT

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
SEC.1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
API NO. 30-053-20010
NORTHWEST AREA
GEOCHEM JOB NO. 3787

Prepared

for

PROGRAM PARTICIPANTS

by

Dr. Geoffrey S. Bayliss
and
Dr. Rudy R. Schwarzer

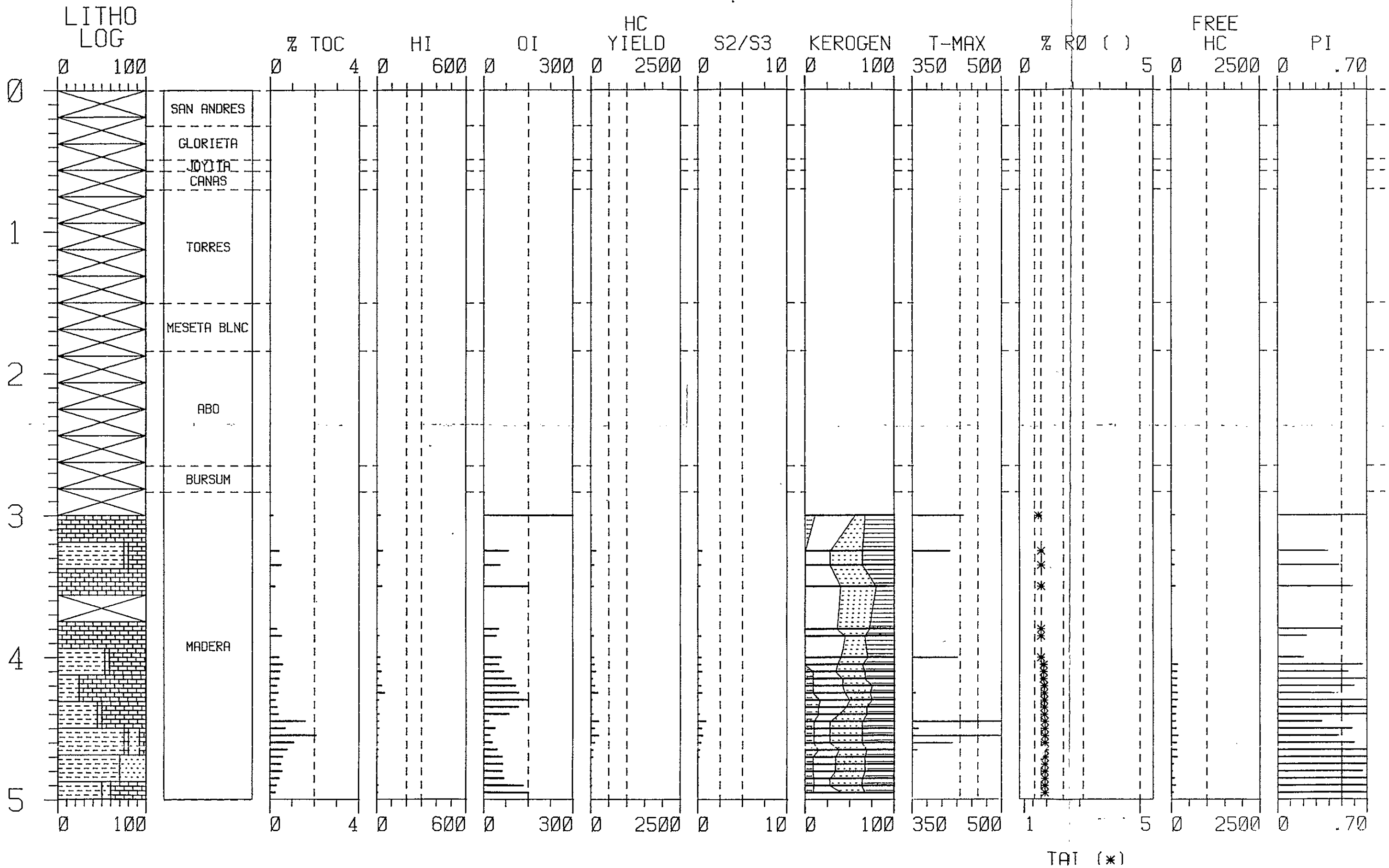
GEOCHEM LABORATORIES, INC.
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HOUSTON, TEXAS 77043
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CONFIDENTIAL
MARCH 1989

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

WELL NAME: JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 API NO.: 30-053-20010
 AREA: NORTHWEST
 LOCATION: SOCORRO COUNTY, NEW MEXICO SEC.1, T4S, R3E
 GEOCHEM JOB NO.: 3787
 TOTAL DEPTH: 4997 ft.
 INTERVAL SAMPLED: 3000-4996 ft.
 TOTAL NUMBER OF SAMPLES: 26

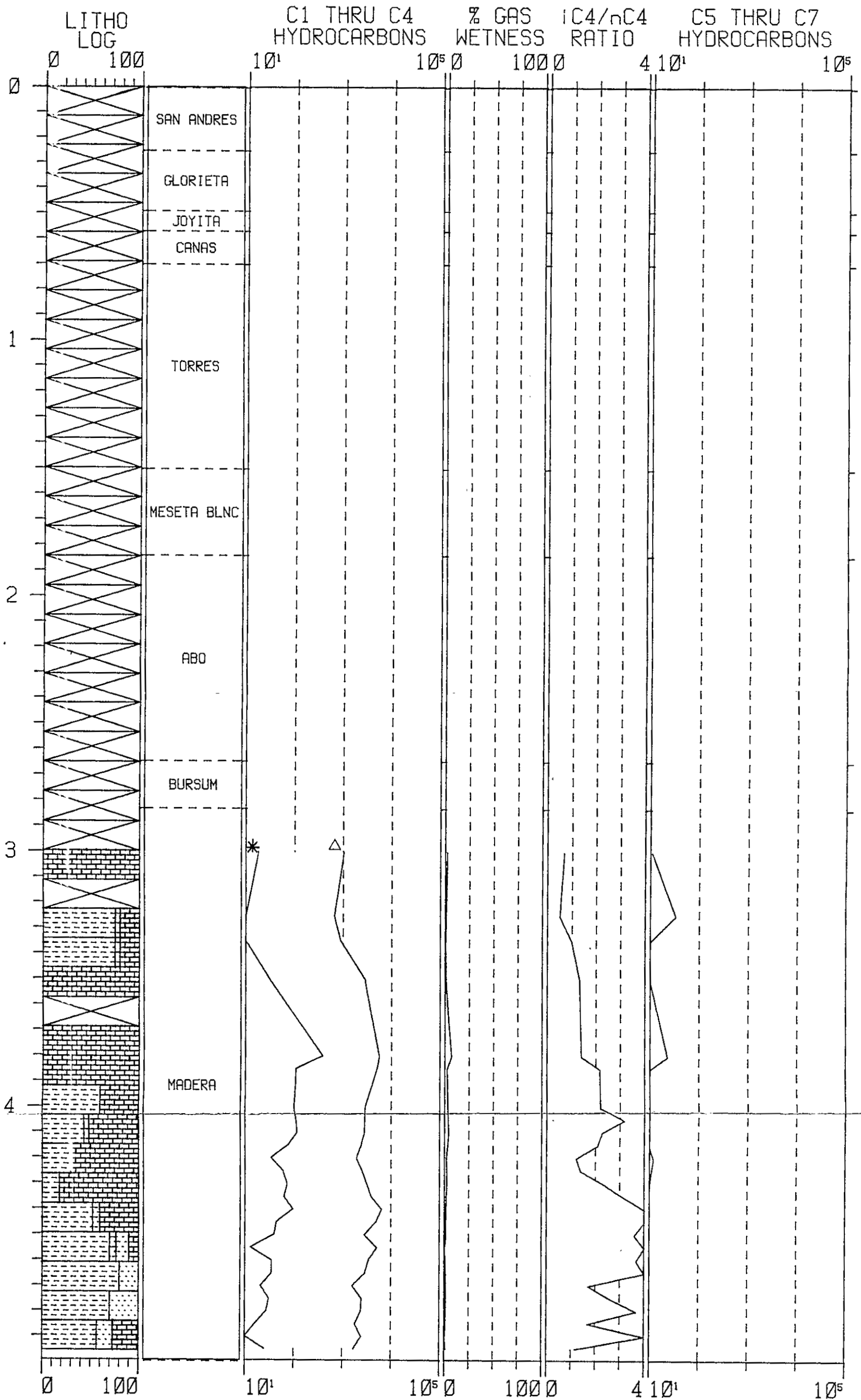
GEOCHEM SAMPLE NUMBER	SAMPLE DEPTH	STRATIGRAPHIC INTERVAL	ANALYSES					
			LITHO	TOC	ROCK-EVAL	KEROGEN	C1-C7	COMPUTER INTERPRE.
3787-001	3000-3050	Madera (Penn)	X	X	X	X	X	X
3787-002	3250-3300	Madera (Penn)	X	X	X	X	X	X
3787-003	3350-3400	Madera (Penn)	X	X	X	X	X	X
3787-004	3500-3550	Madera (Penn)	X	X	X	X	X	X
3787-005	3800-3850	Madera (Penn)	X	X	X	X	X	X
3787-006	3850-3900	Madera (Penn)	X	X	X	X	X	X
3787-007	4000-4050	Madera (Penn)	X	X	X	X	X	X
3787-008	4050-4100	Madera (Penn)	X	X	X	X	X	X
3787-009	4100-4150	Madera (Penn)	X	X	X	X	X	X
3787-010	4150-4200	Madera (Penn)	X	X	X	X	X	X
3787-011	4200-4250	Madera (Penn)	X	X	X	X	X	X
3787-012	4250-4300	Madera (Penn)	X	X	X	X	X	X
3787-013	4300-4350	Madera (Penn)	X	X	X	X	X	X
3787-014	4350-4400	Madera (Penn)	X	X	X	X	X	X
3787-015	4400-4500	Madera (Penn)	X	X	X	X	X	X
3787-016	4450-4500	Madera (Penn)	X	X	X	X	X	X
3787-017	4500-4550	Madera (Penn)	X	X	X	X	X	X
3787-018	4550-4600	Madera (Penn)	X	X	X	X	X	X
3787-019	4600-4650	Madera (Penn)	X	X	X	X	X	X
3787-020	4650-4700	Madera (Penn)	X	X	X	X	X	X
3787-021	4700-4750	Madera (Penn)	X	X	X	X	X	X
3787-022	4750-4800	Madera (Penn)	X	X	X	X	X	X
3787-023	4800-4850	Madera (Penn)	X	X	X	X	X	X
3787-024	4850-4900	Madera (Penn)	X	X	X	X	X	X
3787-025	4900-4950	Madera (Penn)	X	X	X	X	X	X
3787-026	4950-4996	Madera (Penn)	X	X	X	X	X	X



ANDERSON #1 WISHBONE SUMMARY OF GEOCHEMICAL ANALYSES
 JOB NUMBER 3787

FIGURE 1

C1-C7 HYDROCARBONS







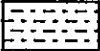

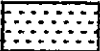



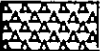







Δ PPM C1-C4 HYDROCARBONS
 * PPM C2-C4 HYDROCARBONS
 PPM VALUES EXPRESSED AS
 VOLUME OF GAS PER
 MILLION VOLUMES OF SED

PPM VALUES EXPRESSED AS
 VOLUMES OF GAS PER
 MILLION VOLUMES OF SED





LEGEND FOR SUMMARY DIAGRAM

<u>DEPTH:</u>	in feet
<u>LITHO LOG:</u>	see lithology symbols
<u>STRATIGRAPHY:</u>	by age
<u>% TOC:</u>	percent total organic carbon
<u>HI:</u>	Rock-Eval, Hydrocarbon Index = $100 S2(0/00 \text{ Wt})/TOC$
<u>OI:</u>	Rock-Eval, Oxygen Index = $100 S3(0/00 \text{ Wt})/TOC$
<u>HC YIELD:</u>	Rock-Eval, S2 peak (ppm)
<u>S2/S3:</u>	Rock-Eval, Ratio of S2 to S3 peak
<u>KEROGEN:</u>	see Kerogen symbols
<u>T-MAX:</u>	Rock-Eval, maximum temperature of S2 peak, in degrees Centigrade
<u>%RO (Δ):</u>	Vitrinite Reflectance (scale 0 to 5)
<u>TAI (*):</u>	Thermal Alteration Index (Scale 1 to 5)
<u>FREE HC:</u>	Rock-Eval, S1 peak (ppm)
<u>PI:</u>	Rock-Eval, Productivity Index = $S1/(S1+S2)$

LITHOLOGIES

	SHALE		SILICEOUS ROCKS
	MUDSTONE		EVAPORITES
	SILTSTONE		COAL
	SANDSTONE		IGNEOUS ROCKS
	CONGLOMERATE		VOLCANICS
	BRECCIA		METAMORPHIC ROCKS
	LIMESTONE		BASEMENT
	DOLOMITE		OTHER
	MARL		MISSING SECTION

KEROGEN TYPES

	AMORPHOUS
	HERBACEOUS
	WOODY
	INERTINITE

COMPUTERIZED GEOCHEMICAL SOURCE ROCK EVALUATION

INTERPRETATIVE CRITERIA

Simplified Flow Diagram

STEP I/DATA INPUT

1. Sample ID	1. Volatile hydrocarbon (S1)
2. Depth	2. Generated hydrocarbon (S2)
3. Lithology	3. Temperature (°C) of S2 peak (Tmax)
a. % Sandstone (Ss)	b. Total organic carbon (TOC)
b. % Siltstone (St)	c. Kerogen type
c. % Shale (Sh)	1. % Amorphous (Am)
d. % Carbonate (Cb)	2. % Herbaceous (H)
e. % Evaporite (E)	3. % Woody (W)
f. % Coal (C)	4. % Coaly (C)
g. % Other (Ot)	d. Thermal Maturity indicators
h. % Metamorphic (M)	1. Thermal alteration index (TAI)
4. Geochemical parameters	2. Vitrinite reflectance (%Ro)
a. Pyrolysis data	

Output

Formations
Table III
Samples:
Table VI
Fig. 1
Fig. 2



STEP II/LITHOLOGY CHECK

If the sample is uninterpretable because it contains coal, mud additives, or metamorphics, a statement is printed to that effect. If a significant portion of the sample is composed of "other" lithologies, the interpretation is referred to a footnote. If the sample is composed of 60% or more of either source rocks (shale and/or carbonate) or nonsource rocks (siltstones and/or sandstones) the sample is interpreted in Step III below.



STEP III/INTERPRETATION PROCEDURES

Interpretations are based on the following parameters:

- | | |
|-------------------------------|------------------------------|
| 1. Lithology | 4. Volatile hydrocarbon (S1) |
| 2. Thermal maturity using TAI | 5. Kerogen type |
| 3. Total organic carbon (TOC) | |

If a particular sample lacks only a TAI value, a TAI value is taken from a three term moving average curve (Figure 1). The descriptive terminology used relative to the parameter values is given below.

Output

Formations
Table I
Table II
Samples
Table IV
Table V

TABLE I
FORMATION INTERPRETATION

This table gives a formation by formation interpretation based on the following parameters:

- (1) Lithology
- (2) Thermal alteration index (TAI)
- (3) Total organic carbon (TOC)
- (4) Volatile hydrocarbon (S1)
- (5) Kerogen type

If a TAI value is lacking for an otherwise interpretable sample, a TAI value is taken from a three term moving average plot of all the TAI data for this well (see Figure 1).

The kerogen type oil/gas factor expressed as a percentage should be used as a modifier to the interpretation; i.e., a high oil factor will enhance the oil quality of the sample whereas correspondingly, a high gas factor will enhance the gas ratio of the sample and diminish the oil prospectiveness.

TABLE II
FORMATION SUMMARY INTERPRETATION

This table gives a formation by formation interpretation of each parameter used in Table I. The descriptive terminology used for each parameter is listed in the introduction.

TABLE III
FORMATION SUMMARY OF GEOCHEMICAL DATA

This table gives a formation by formation listing of the data used in the computerized interpretations. The information given for each formation is as follows:

- | | |
|-------------------------------------|--|
| (1) Sample number | (7) Total organic carbon (TOC %) |
| (2) Depth | (8) Kerogen composition (amorphous (Am), herbaceous (H), woody (W), and coaly (C)) |
| (3) Lithology | (9) Thermal alteration index (TAI) |
| (4) Volatile hydrocarbon (S1, ppm) | (10) Vitrinite reflectance (%R _c) |
| (5) Generated hydrocarbon (S2, ppm) | |
| (6) Maximum temperature of S2 peak | |

TABLE IV

SAMPLE INTERPRETATION

This table gives a sample by sample interpretation based on the following parameters:

- (1) Lithology
- (2) Thermal alteration index (TAI)
- (3) Total organic carbon (TOC)
- (4) Volatile hydrocarbon (S1)
- (5) Kerogen type

If a TAI value is lacking for an otherwise interpretable sample, a TAI value is taken from a three term moving average plot of all the TAI data for this well (see Figure 1).

The kerogen type oil/gas factor expressed as a percentage should be used as a modifier to the interpretation; i.e., a high oil factor will enhance the oil quality of the sample whereas correspondingly, a high gas factor will enhance the gas ratio of the sample and diminish the oil prospectiveness.

TABLE V

SAMPLE SUMMARY INTERPRETATION

This table gives a sample by sample interpretation of each parameter used in Table IV. This descriptive terminology used for each parameter is listed in the introduction.

TABLE VI

SAMPLE SUMMARY OF GEOCHEMICAL DATA

This table gives a sample by sample listing of the data used in the computerized interpretations. The information given for each formation is as follows:

- | | |
|-------------------------------------|--|
| (1) Sample number | (7) Total organic carbon (TOC %) |
| (2) Depth | (8) Kerogen composition (amorphous (Am), herbaceous (H), woody (W), and coaly (C)) |
| (3) Lithology | (9) Thermal alteration index (TAI) |
| (4) Volatile hydrocarbon (S1, ppm) | (10) Vitrinite reflectance (%Ro) |
| (5) Generated hydrocarbon (S2, ppm) | |
| (6) Maximum temperature of S2 peak | |

The TAI and %Ro values are plotted on Figures 1 and 2 respectively; values of TAI or %Ro indicated with an asterisk (*) are taken from the three term moving average plot of the respective parameter. Sample types are indicated by "blank" (cuttings), "C" (conventional core) and "S" (sidewall core). Casing points and the tops of all formations penetrated by the well are displayed on all tables with associated depths.

ABBREVIATIONS	USED IN TABLE
<p>Maturity Parameters: ----- TAI-Thermal Alteration Index, %R0 Vitrinite Reflectance, Tmax-Rock-Eval</p>	<p>Table 1,4</p>
<p>Thermal Maturity Ratings: ----- I-Immature, MI-Moderately Immature, MM-Moderately Mature, M-Mature, VM-Very Mature SA-Severely Altered, MT-Metamorphosed</p>	<p>Table 2,5</p>
<p>Kerogen Type: ----- Am-Amorphous/Sapropel, H-Herbaceous, W-Woody, C-Coaly/Inertinite (these abbreviations are used by GEOCHEM, the user specifies kerogen types in the LIMITS.DAT file under KERNAM and enters their abbreviations in this file)</p>	<p>Table 3,6c</p>
<p>Sample Type: ----- CT-Cuttings, C-Core, S-Sidewal Core, OC-Outcrop</p>	<p>Table 4,5,6a,b,c</p>
<p>Lithologies: ----- Sh-Shale, Md-Mudstone, St-Siltstone, Ss-Sandstone Cg-Conglomerate, Br-Breccia, Mr-Maral, Ls-Limestone Do-Dolomite, Si-Siliceous Rocks, Ev-Evaporites, C-Coal, Ig-Igneous Rocks, Vo-Volcanics, Mt-Metamorphics Bs-Basement, Ot-Other</p>	<p>Table 6a,b</p>
<p>NOTE 1: ----- The thermal maturity values and ratings presented in Tables 2 and 3 are based on running averages.</p>	<p>Table 2,3</p>
<p>NOTE 2: ----- A thermal maturity value or rating enclosed by brackets [] indicates that the value was taken from a running average of the parameter shown.</p>	<p>Table 4,5,6a</p>
<p>NOTE 3: ----- An asterisk (*) following the sample ID on Table 5 indicates a sample whose complete interpretation appears on Table 4.</p>	<p>Table 5</p>

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*
*           APPENDIX B.
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*           -----
*           LIMITS USED FOR INTERPRETATIONS
*           -----
*           FROM LIMITS.DAT FILE
*           -----
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THERMAL MATURITY PARAMETERS

TAI	Vitrinite	TMax	Thermal Maturity Rating
1.0 - 1.8	0.00 - 0.43	0 - 433	I Immature
1.8 - 2.2	0.43 - 0.56	433 - 437	MI Moderately Immature
2.2 - 2.6	0.56 - 0.81	437 - 441	MM Moderately Mature
2.6 - 3.6	0.81 - 1.63	441 - 451	M Mature
3.6 - 4.2	1.63 - 2.38	451 - 457	VM Very Mature
4.2 - 5.0	2.38 - 4.50	457 - 471	SA Severly Altered
5.0+	4.50+	471+	MT Metamorphosed

MATURITY HIERARCHY

TAI, STAI, %RO, S%RO, TMAX, STMAX

TOC RICHNESS

Shale	Rating	Carbonate	Rating
0.00 - 0.13	NONSOURCE	0.00 - 0.13	POOR
0.13 - 0.26	VERY POOR	0.13 - 0.26	FAIR
0.26 - 0.51	POOR	0.26 - 0.51	GOOD
0.51 - 1.01	FAIR	0.51 - 1.01	VERY GOOD
1.01 - 2.01	GOOD	1.01 - 2.01	EXCELLENT
2.01 - 4.01	VERY GOOD	2.01 - 4.01	EXCELLENT
4.01 - 8.01	EXCELLENT	4.01 - 8.01	EXCELLENT
8.01+	EXCELLENT	8.01+	EXCELLENT

S1 HYDROCARBON RICHNESS

S1 (mg/g)	Rating
0.000 - 0.201	VERY POOR
0.201 - 0.401	POOR
0.401 - 0.801	FAIR
0.801 - 1.601	GOOD
1.601 - 3.201	VERY GOOD
3.201+	EXCELLENT

LITHOLOGY LIMITS

<20.0% Other Lithology
 <10.0% Contamination
 <10.0% Coal
 >50.0% Major Lithology (Source or Nonsource)
 >50.0% Major Source Lithology for Interpretation

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*
*           APPENDIX B.
*
*           -----
*           LIMITS USED FOR INTERPRETATIONS
*           -----
*           FROM LIMITS.DAT FILE
*           -----
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KEROGEN TYPES SPECIFIED AND
OIL/GAS FACTOR COEFFICIENTS

Kerogen Types	Kerogen Names	Oil/Gas Coeff.
KER0	AMORPH	0.90
KER1	HERB	0.60
KER2	WOODY	0.30
KER3	INERT	0.10
KER4	NotDef	----
KER5	NotDef	----
KER6	NotDef	----
KER7	NotDef	----
KER8	NotDef	----
KER9	NotDef	----

PYROLYSIS GAS/OIL PRONE LIMITS

Hydrogen Index	S2-S3 Ratio	Rating
0.0 - 150.0	0.00 - 3.00	GAS
150.0 - 300.0	3.00 - 5.00	O/G
300.0+	5.00+	OIL

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE I: FORMATION INTERPRETATION

County/State: Socorro CO..NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Formation ID and litho	Depth (ft)	Thermal Maturity	Major Litho	Interpretation
	0	-----	Not Sampled	-----
	2830	-----	Madera (Penn.)	-----
02SH	2830- 4997	TAI	SHALE	MATURE VERY POOR TO POOR OIL SOURCE - FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
02CB	2830- 4997	TAI	CARB	MODERATELY MATURE POOR TO FAIR IMMATURE OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 41% GAS TYPE 59%

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE II: FORMATION SUMMARY INTERPRETATION

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Formation ID and litho	Depth (ft)	Major Litho	Thermal Maturity			TOC Richness	HC Richness	Prod Index	Oxy Index	Hyd Index	S2/S3 Ratio	Kerogen	
			TAI	%R0	Tmax							Oil	Gas
	0		Not Sampled										
	2830		Madera (Penn.)										
02SH	2830- 4997	SHALE	M		I	FAIR	VERY POOR	0.56	42	GAS	GAS	35	65
02CB	2830- 4997	CARB	MM		I	GOOD	VERY POOR	0.65	106	GAS	GAS	41	59

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE III: FORMATION SUMMARY OF GEOCHEMICAL DATA

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Madera (Penn.) (2830- 4997)

Sediment Facies	(No/Pct)	TOC	Pyrolysis Data (mg/g)				Maturity		Calculated Data					
			S1	S2	S3	Tmax	TAI	%R0	OI	HI	S2S3	Oil	Gas	
Shale Source	(15/ 60)													
AVG		0.72	0.12	0.09	0.30	352	2.7	----	42	12	0.29	35	64	
MIN		0.29	0.02	0.02	0.22	217	2.5	----						
MAX		2.08	0.19	0.21	0.40	535	2.8	----						
Carbonate Source	(10/ 40)													
AVG		0.31	0.11	0.06	0.34	308	2.6	----	106	19	0.18	40	59	
MIN		0.13	0.01	0.01	0.15	259	2.3	----						
MAX		0.51	0.17	0.19	0.52	436	2.7	----						
Siliceous Source	not present in this formation													
Evaporite Source	not present in this formation													
Sand/Silt Non-Source	not present in this formation													

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE IV: SAMPLE INTERPRETATION

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Thermal Maturity	Major Litho	Interpretation
	0	----- Not Sampled -----		
	2830	----- Madera (Penn.) -----		
3787-001 CT	3000- 3050	TAI	CARB	MODERATELY MATURE POOR IMMATURE OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 44% GAS TYPE 56%
3787-002 CT	3250- 3300	TAI	SHALE	MODERATELY MATURE POOR SOURCE FOR OIL/ASSOCIATED GAS OR BIOGENIC GAS KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 31% GAS TYPE 69%
3787-003 CT	3350- 3400	TAI	SHALE	MODERATELY MATURE POOR SOURCE FOR OIL/ASSOCIATED GAS OR BIOGENIC GAS KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 31% GAS TYPE 69%
3787-004 CT	3500- 3550	TAI	CARB	MODERATELY MATURE POOR IMMATURE OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 38% GAS TYPE 62%
3787-005 CT	3800- 3850	TAI	CARB	MODERATELY MATURE POOR TO FAIR IMMATURE OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-006 CT	3858- 3900	TAI	CARB	MODERATELY MATURE POOR TO FAIR IMMATURE OIL AND ASSOCIATED GAS SOURCE - FAIR BIOGENIC GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 36% GAS TYPE 64%
3787-007 CT	4000- 4050	TAI	SHALE	MODERATELY MATURE POOR SOURCE FOR OIL/ASSOCIATED GAS OR BIOGENIC GAS KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 36% GAS TYPE 64%
3787-008 CT	4050- 4100	TAI	SHALE	MATURE VERY POOR TO POOR OIL SOURCE - FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 34% GAS TYPE 66%
3787-009 CT	4100- 4150	TAI	SHALE	MATURE VERY POOR OIL SOURCE - POOR TO FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 37% GAS TYPE 63%
3787-010 CT	4150- 4200	TAI	CARB	MATURE POOR OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 39% GAS TYPE 61%
3787-011 CT	4200- 4250	TAI	CARB	MATURE POOR OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 40% GAS TYPE 60%
3787-012 CT	4250- 4300	TAI	CARB	MATURE POOR OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 42% GAS TYPE 58%

Well Name: Anderson #1 Wishbon
API Number: 30-053-20010
File Name: 3787
Lat/Long: NA

TABLE IV: SAMPLE INTERPRETATION

County/State: Socorro CO., NM
Location: Sec.1-4S-3E
Total Depth: 4997 FT
Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Thermal Maturity	Major Litho	Interpretation
-----------------------	------------	---------------------	----------------	----------------

	4997	+++++++	Total Depth	+++++++
--	------	---------	-------------	---------

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE IV: SAMPLE INTERPRETATION

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Thermal Maturity	Major Litho	Interpretation
3787-013	CT 4300- 4350	TAI	CARB	MATURE POOR OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 47% GAS TYPE 53%
3787-014	CT 4350- 4400	TAI	CARB	MATURE POOR OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 44% GAS TYPE 56%
3787-015	CT 4400- 4450	TAI	CARB	MATURE POOR OIL AND ASSOCIATED GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 42% GAS TYPE 58%
3787-016	CT 4450- 4500	TAI	SHALE	MATURE VERY POOR OIL SOURCE - GOOD GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-017	CT 4500- 4550	TAI	SHALE	MATURE VERY POOR TO POOR OIL SOURCE - FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-018	CT 4550- 4600	TAI	SHALE	MATURE VERY POOR OIL SOURCE - VERY GOOD GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-019	CT 4600- 4650	TAI	SHALE	MATURE VERY POOR OIL SOURCE - GOOD GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-020	CT 4650- 4700	TAI	SHALE	MATURE VERY POOR TO POOR OIL SOURCE - FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 42% GAS TYPE 58%
3787-021	CT 4700- 4750	TAI	SHALE	MATURE VERY POOR TO POOR OIL SOURCE - FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 37% GAS TYPE 63%
3787-022	CT 4750- 4800	TAI	SHALE	MATURE VERY POOR OIL SOURCE - POOR TO FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 37% GAS TYPE 63%
3787-023	CT 4800- 4850	TAI	SHALE	MATURE VERY POOR TO POOR OIL SOURCE - FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 37% GAS TYPE 63%
3787-024	CT 4850- 4900	TAI	SHALE	MATURE VERY POOR OIL SOURCE - POOR TO FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-025	CT 4900- 4950	TAI	SHALE	MATURE VERY POOR OIL SOURCE - POOR TO FAIR GAS SOURCE KEROGEN TYPE OIL/GAS FACTOR: OIL TYPE 35% GAS TYPE 65%
3787-026	CT 4950- 4996			MIXED SOURCE LITHOLOGIES

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE V: SAMPLE SUMMARY INTERPRETATION

County/State: Socorro CO., NM
 Location: Sec. 1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Major Litho	Thermal Maturity			TOC Richness	HC Richness	Prod Index	Oxy Index	Hyd Index	S2/S3 Ratio	Kerogen	
			TAI	%R0	Tmax							Oil	Gas
	0		Not Sampled										
	2830		Madera (Penn.)										
3787-001 * CT	3000- 3050	CARB	MM		MI	FAIR	VERY POOR	0.75	400	GAS	GAS	44	56
3787-002 * CT	3250- 3300	SHALE	MM		I	POOR	VERY POOR	0.39	82	GAS	GAS	31	69
3787-003 * CT	3350- 3400	SHALE	MM		I	POOR	VERY POOR	0.50	54	GAS	GAS	31	69
3787-004 * CT	3500- 3550	CARB	MM		I	FAIR	VERY POOR	0.59	150	GAS	GAS	38	62
3787-005 * CT	3800- 3850	CARB	MM		I	GOOD	VERY POOR	0.50	50	GAS	GAS	35	65
3787-006 * CT	3858- 3900	CARB	MM		I	VERY GOOD	VERY POOR	0.22	41	GAS	GAS	36	64
3787-007 * CT	4000- 4050	SHALE	MM		I	POOR	VERY POOR	0.20	58	GAS	GAS	36	64
3787-008 * CT	4050- 4100	SHALE	M		I	FAIR	VERY POOR	0.67	50	GAS	GAS	34	66
3787-009 * CT	4100- 4150	SHALE	M		I	POOR	VERY POOR	0.55	67	GAS	GAS	37	63
3787-010 * CT	4150- 4200	CARB	M		I	GOOD	VERY POOR	0.80	93	GAS	GAS	39	61
3787-011 * CT	4200- 4250	CARB	M		I	GOOD	VERY POOR	0.60	107	GAS	GAS	40	60
3787-012 * CT	4250- 4300	CARB	M		I	GOOD	VERY POOR	0.47	117	GAS	GAS	42	58
3787-013 * CT	4300- 4350	CARB	M		I	FAIR	VERY POOR	0.85	150	GAS	GAS	47	53
3787-014 * CT	4350- 4400	CARB	M		I	GOOD	VERY POOR	0.88	116	GAS	GAS	44	56
3787-015 * CT	4400- 4450	CARB	M		I	GOOD	VERY POOR	0.71	84	GAS	GAS	42	58
3787-016 * CT	4450- 4500	SHALE	M		MT	GOOD	VERY POOR	0.34	15	GAS	GAS	35	65
3787-017 * CT	4500- 4550	SHALE	M		I	FAIR	VERY POOR	0.58	37	GAS	GAS	35	65
3787-018 * CT	4550- 4600	SHALE	M		MT	VERY GOOD	VERY POOR	0.47	19	GAS	GAS	35	65
3787-019 * CT	4600- 4650	SHALE	M		I	GOOD	VERY POOR	0.60	27	GAS	GAS	35	65
3787-020 * CT	4650- 4700	SHALE	M		I	FAIR	VERY POOR	0.71	44	GAS	GAS	42	58
3787-021 * CT	4700- 4750	SHALE	M		I	FAIR	VERY POOR	0.77	61	GAS	GAS	37	63
3787-022 * CT	4750- 4800	SHALE	M		I	POOR	VERY POOR	0.75	63	GAS	GAS	37	63
3787-023 * CT	4800- 4850	SHALE	M		I	FAIR	VERY POOR	0.67	62	GAS	GAS	37	63

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE V: SAMPLE SUMMARY INTERPRETATION

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Major Litho	Thermal Maturity			TOC Richness	HC Richness	Prod Index	Oxy Index	Hyd Index	S2/S3 Ratio	Kerogen	
			TAI	%R0	Tmax							Oil	Gas
3787-024 * CT	4850- 4900	SHALE	M		I	POOR	VERY POOR	0.80	67	GAS	GAS	35	65
3787-025 * CT	4900- 4950	SHALE	M		I	POOR	VERY POOR	0.79	134	GAS	GAS	35	65
3787-026 CT	4950- 4996	MIXED SOURCE LITHOLOGIES											
	4997	+++++++ Total Depth ++++++											

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE VI-A: SAMPLE SUMMARY OF GEOCHEMICAL DATA

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Lithology	TOC	Pyrolysis Data (mg/g)				Maturity		Kerogen		
				S1	S2	S3	Tmax	TAI	%R0	%Oil	%Gas	
	0	----- Not Sampled -----										
	2830	----- Madera (Penn.) -----										
3787-001	CT 3000- 3050	100Ls	0.13	0.09	0.03	0.52	436	2.3	----	44	55	
3787-002	CT 3250- 3300	75Sh 20Ls 5Md	0.39	0.09	0.14	0.32	413	2.5	----	31	68	
3787-003	CT 3350- 3400	75Sh 20Ls 5Md	0.50	0.08	0.08	0.27	274	2.5	----	31	68	
3787-004	CT 3500- 3550	100Ls	0.22	0.10	0.07	0.33	303	2.5	----	38	62	
3787-005	CT 3800- 3850	100Ls	0.30	0.01	0.01	0.15	262	2.5	----	35	64	
3787-006	CT 3858- 3900	100Ls	0.51	0.02	0.07	0.21	310	2.5	----	36	63	
3787-007	CT 4000- 4050	60Sh 40Ls	0.38	0.02	0.08	0.22	426	2.5	----	36	64	
3787-008	CT 4050- 4100	55Sh 40Ls 5Md	0.56	0.18	0.09	0.28	311	2.6	----	33	66	
3787-009	CT 4100- 4150	45Sh 45Ls 10Md	0.45	0.16	0.13	0.30	300	2.6	----	36	63	
3787-010	CT 4150- 4200	70Ls 30Sh	0.40	0.16	0.04	0.37	274	2.6	----	38	61	
3787-011	CT 4200- 4250	70Ls 30Sh	0.30	0.15	0.10	0.32	301	2.7	----	40	59	
3787-012	CT 4250- 4300	70Ls 30Sh	0.36	0.17	0.19	0.42	355	2.7	----	42	57	
3787-013	CT 4300- 4350	90Ls 5Sh 5Md	0.24	0.17	0.03	0.36	308	2.7	----	46	53	
3787-014	CT 4350- 4400	70Ls 30Sh	0.32	0.14	0.02	0.37	259	2.7	----	43	56	
3787-015	CT 4400- 4450	55Ls 35Sh 10Md	0.37	0.12	0.05	0.31	274	2.7	----	42	58	
3787-016	CT 4450- 4500	70Sh 25Ls 5Md	1.59	0.11	0.21	0.24	527	2.8	----	35	64	
3787-017	CT 4500- 4550	70Sh 20Ls 10Md	0.68	0.14	0.10	0.25	360	2.8	----	35	64	
3787-018	CT 4550- 4600	80Sh 10Ls 10Md	2.08	0.19	0.21	0.40	535	2.8	----	35	64	
3787-019	CT 4600- 4650	60Sh 40Ss	1.07	0.15	0.10	0.29	418	2.8	----	35	64	
3787-020	CT 4650- 4700	90Sh 10Ss	0.77	0.15	0.06	0.34	358	2.8	----	42	58	
3787-021	CT 4700- 4750	70Sh 30Ss	0.56	0.17	0.05	0.34	296	2.8	----	36	63	
3787-022	CT 4750- 4800	70Sh 30Ss	0.49	0.06	0.02	0.31	274	2.8	----	36	63	
3787-023	CT 4800- 4850	70Sh 30Ss	0.55	0.04	0.02	0.34	345	2.8	----	36	63	

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE VI-A: SAMPLE SUMMARY OF GEOCHEMICAL DATA

County/State: Socorro CO., NM
 Location: Sec.1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Lithology	TOC	Pyrolysis Data (mg/g)				Maturity		Kerogen	
				S1	S2	S3	Tmax	TAI	%R0	%Oil	%Gas
3787-024	CT 4850- 4900	70Sh 30Ss	0.42	0.08	0.02	0.28	240	2.8	----	35	64
3787-025	CT 4900- 4950	60Sh 40Ls	0.29	0.11	0.03	0.39	217	2.8	----	35	64
3787-026	CT 4950- 4996	40Sh 40Ls 20Ss	0.23	0.06	0.02	0.35	207	2.8	----	38	61
	4997	+++++++ Total Depth ++++++									

Well Name: Anderson #1 Wishbon
 API Number: 30-053-20010
 File Name: 3787
 Lat/Long: NA

TABLE VI-B: SAMPLE SUMMARY OF PYROLYSIS DATA

County/State: Socorro CO., NM
 Location: Sec. 1-4S-3E
 Total Depth: 4997 FT
 Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	Lithology	TOC	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	Tmax	Prod Index	Oxy Index	Hyd Index	S2/S3 Ratio
	0	----- Not Sampled -----									
	2830	----- Madera (Penn.) -----									
3787-001 CT	3000- 3050	100Ls	0.13	0.09	0.03	0.52	436	0.75	400	23	0.06
3787-002 CT	3250- 3300	75Sh 20Ls 5Md	0.39	0.09	0.14	0.32	413	0.39	82	35	0.44
3787-003 CT	3350- 3400	75Sh 20Ls 5Md	0.50	0.08	0.08	0.27	274	0.50	54	16	0.30
3787-004 CT	3500- 3550	100Ls	0.22	0.10	0.07	0.33	303	0.59	150	31	0.21
3787-005 CT	3800- 3850	100Ls	0.30	0.01	0.01	0.15	262	0.50	50	3	0.07
3787-006 CT	3858- 3900	100Ls	0.51	0.02	0.07	0.21	310	0.22	41	13	0.33
3787-007 CT	4000- 4050	60Sh 40Ls	0.38	0.02	0.08	0.22	426	0.20	57	21	0.36
3787-008 CT	4050- 4100	55Sh 40Ls 5Md	0.56	0.18	0.09	0.28	311	0.67	50	16	0.32
3787-009 CT	4100- 4150	45Sh 45Ls 10Md	0.45	0.16	0.13	0.30	300	0.55	66	28	0.43
3787-010 CT	4150- 4200	70Ls 30Sh	0.40	0.16	0.04	0.37	274	0.80	92	10	0.11
3787-011 CT	4200- 4250	70Ls 30Sh	0.30	0.15	0.10	0.32	301	0.60	106	33	0.31
3787-012 CT	4250- 4300	70Ls 30Sh	0.36	0.17	0.19	0.42	355	0.47	116	52	0.45
3787-013 CT	4300- 4350	90Ls 5Sh 5Md	0.24	0.17	0.03	0.36	308	0.85	150	12	0.08
3787-014 CT	4350- 4400	70Ls 30Sh	0.32	0.14	0.02	0.37	259	0.88	115	6	0.05
3787-015 CT	4400- 4450	55Ls 35Sh 10Md	0.37	0.12	0.05	0.31	274	0.71	83	13	0.16
3787-016 CT	4450- 4500	70Sh 25Ls 5Md	1.59	0.11	0.21	0.24	527	0.34	15	13	0.88
3787-017 CT	4500- 4550	70Sh 20Ls 10Md	0.68	0.14	0.10	0.25	360	0.58	36	14	0.40
3787-018 CT	4550- 4600	80Sh 10Ls 10Md	2.08	0.19	0.21	0.40	535	0.47	19	10	0.53
3787-019 CT	4600- 4650	60Sh 40Ss	1.07	0.15	0.10	0.29	418	0.60	27	9	0.34
3787-020 CT	4650- 4700	90Sh 10Ss	0.77	0.15	0.06	0.34	358	0.71	44	7	0.18
3787-021 CT	4700- 4750	70Sh 30Ss	0.56	0.17	0.05	0.34	296	0.77	60	8	0.15
3787-022 CT	4750- 4800	70Sh 30Ss	0.49	0.06	0.02	0.31	274	0.75	63	4	0.06
3787-023 CT	4800- 4850	70Sh 30Ss	0.55	0.04	0.02	0.34	345	0.67	61	3	0.06

Well Name: Anderson #1 Wishbon
API Number: 30-053-20010
File Name: 3787
Lat/Long: NA

TABLE VI-C: SAMPLE SUMMARY OF KEROGEN DATA

County/State: Socorro CO.,NM
Location: Sec.1-4S-3E
Total Depth: 4997 FT
Remark: NM SOURCE RK STUDY

Sample ID and type	Depth (ft)	AMORPH	HERB	WOODY	INERT	NotDef	NotDef	NotDef	NotDef	NotDef	NotDef	%Oil	%Gas
3787-024	CT 4850- 4900	10	18	36	36	---	---	---	---	---	---	35	64
3787-025	CT 4900- 4950	10	18	36	36	---	---	---	---	---	---	35	64
3787-026	CT 4950- 4996	8	33	26	33	---	---	---	---	---	---	38	61
	4997	+++++++ Total Depth ++++++											

FIGURE 1

THERMAL MATURITY PROFILE

USING THE THERMAL ALTERATION INDEX (TAI)

This figure displays a thermal maturity profile for the well using the thermal alteration index (TAI). The raw data plot displays the TAI values of individual samples plotted versus depth (150 foot intervals). Within a particular interval an "A" indicates one TAI values and a "B" indicates two TAI determinations of the same value, etc. The "AVG" gives the average TAI value for that interval.

The three term moving average plot displays a TAI profile smoothed by a three term moving average. The "AVG" gives the average for the particular interval. When a sample lacks a TAI value for interpretation, a TAI value is taken from this smoothed curve for that sample depth.

The descriptive terminology used to define thermal maturity, the associated hydrocarbon type, and the numerical values of TAI corresponding to this terminology is given below.

<u>TAI Value</u>	<u>Descriptive Terminology</u>	<u>TAI Value</u>	<u>Associated Hydrocarbon Type</u>
1.0 - 1.7	Immature (I)	1.3 - 1.5	Biogenic Gas
1.8 - 2.1	Moderately Immature (MI)	1.5 - 2.2	Biogenic Gas and Immature Oil
2.2 - 2.5	Moderately Mature (MM)	2.2 - 2.5	Immature Heavy Oil
2.6 - 3.5	Mature (M)	2.5 - 3.2	Mature Oil
3.6 - 4.1	Very Mature (VM)	3.2 - 3.4	Mature Oil, Condensate and Wet Gas
4.2 - 4.9	Severely Altered (SA)	≥ 3.8	Petrogenic Methane Gas
≥ 5.0	Metamorphosed		

Tops are shown by a dashed line (---) and the names are indicated along the right hand margin. The exact depth of the tops are given in the Introduction. Total well depth is indicated and labeled with appropriate depth.

TABLE I

RESULTS OF TOTAL ORGANIC CARBON

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC.1 T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	TOTAL ORGANIC CARBON (% of Rock)
3787-001	3000-3050	0.13
3787-002	3250-3300	0.39
3787-003	3350-3400	0.50
3787-004	3500-3550	0.22/0.22
3787-005	3800-3850	0.30
3787-006	3850-3900	0.51
3787-007	4000-4050	0.38
3787-008	4050-4100	0.56
3787-009	4100-4150	0.45
3787-010	4150-4200	0.40
3787-011	4200-4250	0.30
3787-012	4250-4300	0.36/0.35
3787-013	4300-4350	0.24
3787-014	4350-4400	0.32
3787-015	4400-4450	0.37
3787-016	4450-4500	1.59
3787-017	4500-4550	0.68
3787-018	4550-4600	2.08
3787-019	4600-4650	1.07
3787-020	4650-4700	0.77/C.76
3787-021	4700-4750	0.56
3787-022	4750-4800	0.49
3787-023	4800-4850	0.55
3787-024	4850-4900	0.42
3787-025	4900-4950	0.29
3787-026	4950-4996	0.23

TABLE I-B
C1 - C7 HYDROCARBON ANALYSES OF CUTTINGS GAS

GEOCHEM ID	BEG. DEPTH	END DEPTH	METHANE	ETHANE	PROPANE	ISOBUTANE	N-BUTANE	C5-C7
=====	=====	=====	=====	=====	=====	=====	=====	=====
3787-001	3000	3050	991.4	11.8	3.4	1.2	1.8	10.3
3787-002	3250	3300	640.1	2.8	0.9	0.2	0.3	31.9
3787-003	3350	3400	874.7	2.8	0.6	0.2	0.1	2.8
3787-004	3500	3550	2745.2	21.2	6.0	2.1	1.5	3.6
3787-005	3800	3850	5184.8	229.7	104.1	30.4	20.8	22.4
3787-006	3850	3900	4804.2	77.5	23.6	5.1	2.3	1.2
3787-007	4000	4050	2736.1	41.3	52.0	4.5	2.0	2.6
3787-008	4050	4100	2678.4	39.2	68.5	3.6	1.1	0.7
3787-009	4100	4150	2646.9	73.7	30.5	8.7	3.8	6.0
3787-010	4150	4200	2280.7	45.9	21.6	5.3	2.5	4.0
3787-011	4200	4250	1878.7	20.7	9.4	2.3	1.8	11.3
3787-012	4250	4300	2460.9	36.4	16.0	4.3	3.0	10.6
3787-013	4300	4350	3022.5	44.2	21.5	5.2	2.2	3.8
3787-014	4350	4400	3803.3	40.2	16.9	4.5	1.4	1.5
3787-015	4400	4450	6192.9	69.0	17.4	7.3	1.8	2.5
3787-016	4450	4500	4762.5	35.9	6.1	1.7	0.4	0.2
3787-017	4500	4550	2754.4	28.3	8.2	1.9	0.6	2.5
3787-018	4550	4600	5012.8	6.1	5.8	0.8	0.2	0.6
3787-019	4600	4650	3315.1	26.8	6.4	1.2	0.4	2.7
3787-020	4650	4700	2791.8	24.5	8.4	1.3	0.3	3.3
3787-021	4700	4750	1556.8	13.4	5.6	1.2	0.7	6.1
3787-022	4750	4800	2413.0	20.6	8.6	1.4	0.5	2.8
3787-023	4800	4850	2299.7	16.9	8.3	1.2	0.4	0.8
3787-024	4850	4900	1754.1	8.9	5.8	0.6	0.3	0.6
3787-025	4900	4950	2402.6	7.4	2.0	0.4	0.1	1.1
3787-026	4950	4996	1631.7	16.6	5.4	1.4	1.2	6.4

TABLE II-B
C1 - C7 HYDROCARBON ANALYSES OF CUTTINGS GAS
(CALCULATED VALUES)

GEOCHEM ID	BEG. DEPTH	END DEPTH	C1-C4	C2-C4	IC4/NC4	%WETNESS
=====	=====	=====	=====	=====	=====	=====
3787-001	3000	3050	1009.5	18.2	0.7	1.8
3787-002	3250	3300	644.2	4.1	0.7	0.6
3787-003	3350	3400	878.5	3.8	1.2	0.4
3787-004	3500	3550	2776.0	30.8	1.4	1.1
3787-005	3800	3850	5569.9	385.0	1.5	6.9
3787-006	3850	3900	4912.8	108.6	2.2	2.2
3787-007	4000	4050	2835.8	99.7	2.3	3.5
3787-008	4050	4100	2790.9	112.4	3.2	4.0
3787-009	4100	4150	2763.5	116.6	2.3	4.2
3787-010	4150	4200	2355.9	75.2	2.1	3.2
3787-011	4200	4250	1912.8	34.2	1.3	1.8
3787-012	4250	4300	2520.6	59.7	1.4	2.4
3787-013	4300	4350	3095.7	73.2	2.4	2.4
3787-014	4350	4400	3866.3	63.0	3.2	1.6
3787-015	4400	4450	6288.4	95.4	4.1	1.5
3787-016	4450	4500	4806.6	44.1	4.1	0.9
3787-017	4500	4550	2793.4	39.0	3.4	1.4
3787-018	4550	4600	5025.7	12.9	4.1	0.3
3787-019	4600	4650	3349.8	34.7	3.5	1.0
3787-020	4650	4700	2826.2	34.5	4.2	1.2
3787-021	4700	4750	1577.7	20.9	1.7	1.3
3787-022	4750	4800	2444.1	31.1	2.8	1.3
3787-023	4800	4850	2326.3	26.7	3.3	1.2
3787-024	4850	4900	1769.6	15.6	2.0	0.9
3787-025	4900	4950	2412.6	10.0	2.9	0.4
3787-026	4950	4996	1656.3	24.6	1.2	1.5

TABLE II

LITHOLOGICAL DESCRIPTIONS AND ORGANIC CARBON ANALYSES

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC.1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	LITHO DESCRIPTION	GSA NO.	ORGANIC CARBON (wt.%)
3787-001 -A	3000-3050	100% Limestone, fine crystalline, light to medium gray.	N7 to N5	0.13
3787-002 -A	3250-3300	75% Shale, noncalcareous, medium dark gray.	N4	0.39
-B		20% Limestone, fine crystalline, light gray.	N7	
-C		5% Mudstone, moderate reddish brown.	10R-4/6	
3787-003 -A	3350-3400	75% Shale, noncalcareous, medium dark gray.	N4	0.50
-B		20% Limestone, fine crystalline, light gray.	N7	
-C		5% Mudstone, moderate reddish brown.	10R-4/6	
3787-004 -A	3500-3550	100% Limestone, fine crystalline, light to medium gray.	N7 to N5	0.22/0.22
3787-005 -A	3800-3850	100% Limestone, clayey, fine crystalline, medium dark gray.	N4	0.30
3787-006 -A	3850-3900	100% Limestone, clayey, fine crystalline, dark gray.	N3	0.51

TABLE II (continued)

LITHOLOGICAL DESCRIPTIONS AND ORGANIC CARBON ANALYSES

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC.1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	LITHO DESCRIPTION	GSA NO.	ORGANIC CARBON (wt.%)
3787-007	4000-4050			0.38
-A		60% Shale, slightly calcareous, grayish black.	N2	
-B		40% Limestone, fine crystalline, medium gray.	N5	
3787-008	4050-4100			0.56
-A		55% Shale, slightly calcareous, grayish black.	N2	
-B		40% Limestone, fine crystalline, medium gray.	N5	
-C		5% Mudstone, moderate reddish brown.	10R-4/6	
3787-009	4100-4150			0.45
-A		45% Shale, slightly calcareous, grayish black.	N2	
-B		45% Limestone, fine crystalline, medium gray.	N5	
-C		10% Mudstone, moderate reddish brown.	10R-4/6	
3787-010	4150-4200			0.40
-A		70% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-B		30% Shale, slightly calcareous, grayish black. Trace of red mudstone.	N2	
3787-011	4200-4250			0.30
-A		70% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-B		30% Shale, slightly calcareous, grayish black. Trace of red mudstone.	N2	

TABLE II (continued)

LITHOLOGICAL DESCRIPTIONS AND ORGANIC CARBON ANALYSES

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC.1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	LITHO DESCRIPTION	GSA NO.	ORGANIC CARBON (wt.%)
3787-013	4300-4350			0.24
-A		90% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-B		5% Shale, grayish black.	N2	
-C		5% Mudstone, moderately reddish brown.	10R-4/6	
3787-014	4300-4400			0.32
-A		70% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-B		30% Shale, slightly calcareous, grayish black.	N2	
3787-015	4400-4450			0.37
-A		55% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-B		35% Shale, grayish black.	N2	
-C		10% Mudstone, moderately reddish brown.	10R-4/6	
3787-016	4450-4500			1.59
-A		70% Shale, slightly calcareous, grayish black.	N2	
-B		25% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-C		5% Mudstone, moderately reddish brown.	10R-4/6	
3787-017	4500-4550			0.68
-A		70% Shale, slightly calcareous, grayish black.	N2	
-B		20% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-C		10% Mudstone, moderately reddish brown.	10R-4/6	

TABLE II (continued)

LITHOLOGICAL DESCRIPTIONS AND ORGANIC CARBON ANALYSES

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC.1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	LITHO DESCRIPTION	GSA NO.	ORGANIC CARBON (wt.%)
3787-018	4550-4600			2.08
-A		80% Shale, slightly calcareous, grayish black.	N2	
-B		10% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-C		10% Mudstone, moderately reddish brown.	10R-4/6	
3787-019	4600-4650			1.07
-A		60% Shale, noncalcareous, grayish black.	N2	
-B		40% Sandstone, calcareous, fine grained, clear to white. Trace red mudstone.	N9	
3787-020	4650-4700			0.77/0.76
-A		90% Shale, noncalcareous, grayish black.	N2	
-B		10% Sandstone, calcareous, fine grained, clear to white.	N9	
3787-021	4700-4750			0.56
-A		70% Shale, noncalcareous, grayish black.	N2	
-B		30% Sandstone, calcareous, fine grained, clear to white.	N9	
3787-022	4750-4800			0.49
-A		70% Shale, noncalcareous, grayish black.	N2	
-B		30% Sandstone, calcareous, fine grained, clear to white.	N9	

TABLE II (continued)

LITHOLOGICAL DESCRIPTIONS AND ORGANIC CARBON ANALYSES

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC.1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	LITHO DESCRIPTION	GSA NO.	ORGANIC CARBON (wt.%)
3787-023	4800-4850			0.55
-A		70% Shale, noncalcareous, grayish black.	N2	
-B		30% Sandstone, calcareous, fine grained, clear to white.	N9	
3787-024	4850-4900			0.42
-A		70% Shale, noncalcareous, grayish black.	N2	
-B		30% Sandstone, calcareous, fine grained, clear to white.	N9	
3787-025	4900-4950			0.29
-A		60% Shale, noncalcareous, grayish black.	N2	
-B		40% Limestone, fine crystalline, light to medium gray. Trace sandstone.	N7 to N5	
3787-026	4950-4996			0.23
-A		40% Shale, noncalcareous, grayish black.	N2	
-B		40% Limestone, fine crystalline, light to medium gray.	N7 to N5	
-C		20% Sandstone, calcareous, fine grained, clear to white.	N9	

TABLE III

SUMMARY OF ORGANIC CARBON AND VISUAL KEROGEN DATA

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
SEC. 1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	TOTAL ORGANIC CARBON	ORGANIC MATTER TYPE	VISUAL ABUNDANCE NORMALIZED PERCENT					ALTERATION STAGE	THERMAL ALTERATION INDEX
				Al	Am	H	W	I		
3787-001	3000-3050	0.13	H;I;Am-W	0	11	44	11	34	2 to 2+	2.3
3787-002	3250-3300	0.39	W-I;H;-	0	0	38	36	36	2 to 2+	2.5
3787-003	3350-3400	0.50	W-I;H;-	0	0	28	36	36	2 to 2+	2.5
3787-004	3500-3550	0.22/0.22	H-W;I:-	0	0	40	40	20	2 to 2+	2.5
3787-005	3800-3850	0.30	H-W;I:-	0	0	36	36	28	2 to 2+	2.5
3787-006	3850-3900	0.51	H;I;W	0	0	44	22	34	2 to 2+	2.5
3787-007	4000-4050	0.38	H;W-I:-	0	0	40	30	30	2 to 2+	2.5
3787-008	4050-4100	0.56	H-I;W:-	0	0	36	28	36	2+	2.6
3787-009	4100-4150	0.45	W-I;H;Am	0	8	26	33	33	2+	2.6
3787-010	4150-4200	0.40	H-I;W;Am	0	8	33	26	33	2+	2.6
3787-011	4200-4250	0.30	H-W;I;Am	0	8	33	33	26	2+ to 3-	2.7
3787-012	4250-4300	0.36/0.35	H;W-I;Am	0	10	36	27	27	2+ to 3-	2.7
3787-013	4300-4350	0.24	H;W-I;Am	0	17	33	25	25	2+ to 3-	2.7
3787-014	4350-4400	0.32	H-I;W;Am	0	15	30	25	30	2+ to 3-	2.7
3787-015	4400-4450	0.37	W-I;H;Am	0	15	25	30	30	2+ to 3-	2.7
3787-016	4450-4500	1.59	W-I;H;Am	0	10	18	36	36	2+ to 3-	2.8
3787-017	4500-4550	0.68	W-I;H;Am	0	10	18	36	36	2+ to 3-	2.8
3787-018	4550-4600	2.08	W-I;H;Am	0	10	18	36	36	2+ to 3-	2.8
3787-019	4600-4650	1.07	W-I;H;Am	0	10	18	36	36	2+ to 3-	2.8
3787-020	4650-4700	0.77/0.76	W-I;H;Am	0	15	25	30	30	2+ to 3-	2.8

LEGEND:

KEROGEN KEY

Predominant; Secondary; Trace
60-100% 20-40% 0-20%

Al = Algal
Am = Amorphous-Sapropel
Am* = Relic Amorphous-Sapropel
H = Herbaceous-Spore/Pollen
H* = Degraded Herbaceous
W = Woody-Structured
U = Unidentified Material
I = Inertinite
C = Coaly

TABLE III (continued)

SUMMARY OF ORGANIC CARBON AND VISUAL KEROGEN DATA

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC. 1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (feet)	TOTAL ORGANIC CARBON	ORGANIC MATTER TYPE	VISUAL ABUNDANCE NORMALIZED PERCENT					ALTERATION STAGE	THERMAL ALTERATION INDEX
				Al	Am	H	W	I		
3787-021	4700-4750	0.56	W-I;H;Am	0	8	26	33	33	2+ to 3-	2.8
3787-022	4750-4800	0.49	W-I;H;Am	0	8	26	33	33	2+ to 3-	2.8
3787-023	4800-4850	0.55	W-I;H;Am	0	8	26	33	33	2+ to 3-	2.8
3787-024	4850-4900	0.42	W-I;H;Am	0	10	18	36	36	2+ to 3-	2.8
3787-025	4900-4950	0.29	W-I;H;Am	0	10	18	36	36	2+ to 3-	2.8
3787-026	4950-4996	0.23	H-I;W;Am	0	8	33	26	33	2+ to 3-	2.8

LEGEND:

KEROGEN KEY

Predominant;	Secondary;	Trace
60-100%	20-40%	0-20%

Al = Algal
 Am = Amorphous-Sapropel
 Am* = Relic Amorphous-Sapropel
 H = Herbaceous-Spore/Pollen
 H* = Degraded Herbaceous
 W = Woody-Structured
 U = Unidentified Material
 I = Inertinite
 C = Coaly

TABLE IV

RESULTS OF ROCK-EVAL PYROLYSIS ANALYSIS

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL.
 SEC. 1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (Feet)	TMAX (c)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	PI	PC*	T.O.C. (wt.%)	HYDROGEN INDEX	OXYGEN INDEX
3787-001	3000-3050	436	0.09	0.03	0.52	0.75	0.01	0.13	23	400
3787-002	3250-3300	413	0.09	0.14	0.32	0.41	0.01	0.39	35	82
3787-003	3350-3400	274	0.08	0.08	0.27	0.50	0.01	0.50	16	54
3787-004	3500-3550	303	0.10	0.07	0.33	0.62	0.01	0.22	31	150
3787-005	3800-3850	262	0.01	0.01	0.15	0.50	0.00	0.30	3	50
3787-006	3850-3900	310	0.02	0.07	0.21	0.25	0.00	0.51	13	41
3787-007	4000-4050	426	0.02	0.08	0.22	0.20	0.00	0.38	21	57
3787-008	4050-4100	311	0.18	0.09	0.28	0.69	0.02	0.56	16	50
3787-009	4100-4150	300	0.16	0.13	0.30	0.57	0.02	0.45	28	66
3787-010	4150-4200	274	0.16	0.04	0.37	0.80	0.01	0.40	10	92
3787-011	4200-4250	301	0.15	0.10	0.32	0.62	0.02	0.30	33	106
3787-012	4250-4300	355	0.17	0.19	0.42	0.47	0.03	0.36	52	116
3787-013	4300-4350	308	0.17	0.03	0.36	0.85	0.01	0.24	12	150
3787-014	4350-4400	259	0.14	0.02	0.37	0.87	0.01	0.32	6	115
3787-015	4400-4450	274	0.12	0.05	0.31	0.75	0.01	0.37	13	83
3787-016	4450-4500	527	0.11	0.21	0.24	0.34	0.02	1.59	13	15
3787-017	4500-4550	360	0.14	0.10	0.25	0.58	0.02	0.68	14	36
3787-018	4550-4600	535	0.19	0.21	0.40	0.47	0.03	2.08	10	19
3787-019	4600-4650	418	0.15	0.10	0.29	0.62	0.02	1.07	9	27
3787-020	4650-4700	358	0.15	0.06	0.34	0.75	0.01	0.77	7	44

T.O.C. = Total organic carbon, wt.%

S1 = Free hydrocarbons, mg HC/g of rock

S2 = Residual hydrocarbon potential
(mg HC/g or rock)S3 = CO₂ produced from kerogen pyrolysis
(mg CO₂/g of rock)

PC* = 0.083 (S1 + S2)

Hydrogen
Index = mg HC/g organic carbon

Oxygen

Index = mg CO₂/g organic carbon

PI = S1/S1 + S2

TMAX = Temperature Index, degrees C.

TABLE IV (continued)

RESULTS OF ROCK-EVAL PYROLYSIS ANALYSIS

NEW MEXICO HYDROCARBON SOURCE ROCK EVALUATION

JAMES K. ANDERSON, INC. NO.1 WISHBONE FEDERAL
 SEC. 1, T4S, R3E, SOCORRO COUNTY, NEW MEXICO
 API #30-053-20010

GEOCHEM SAMPLE NUMBER	DEPTH INTERVAL (Feet)	TMAX (c)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	PI	PC*	T.O.C. (wt.%)	HYDROGEN INDEX	OXYGEN INDEX
3787-021	4700-4750	296	0.17	0.05	0.34	0.77	0.01	0.56	8	60
3787-022	4750-4800	274	0.06	0.02	0.31	0.75	0.00	0.49	4	63
3787-023	4800-4850	345	0.04	0.02	0.34	0.67	0.00	0.55	3	61
3787-024	4850-4900	240	0.08	0.02	0.28	0.80	0.00	0.42	4	66
3787-025	4900-4950	217	0.11	0.03	0.39	0.79	0.01	0.29	10	134
3787-026	4950-4996	207	0.06	0.02	0.35	0.75	0.00	0.23	8	152

T.O.C. = Total organic carbon, wt.%

S1 = Free hydrocarbons, mg HC/g of rock

S2 = Residual hydrocarbon potential
(mg HC/g or rock)S3 = CO₂ produced from kerogen pyrolysis
(mg CO₂/g of rock)

PC* = 0.083 (S1 + S2)

Hydrogen
Index = mg HC/g organic carbon

Oxygen

Index = mg CO₂/g organic carbon

PI = S1/S1 + S2

TMAX = Temperature Index, degrees C.

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.

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:

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

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

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 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 bleaches 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 (1) a crude oil or (2) 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.

GEOTHERMAL DIAGENETIC CRITERIA

(GEOCHEM LABORATORIES, INC.)

