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GEOCHEMICAL EVALUATION OF THE CITIES SERVICE NO. 1 RIDLEY A WELL, ROOSEVELT COUNTY, NEW MEXICO

4-2S-33E

By James E. Keal, Jr.
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Houston, Texas

March 28, 1983

ROBERTSON RESEARCH (U.S.) INC.

REPORT NO. 823/231

GEOCHEMICAL EVALUATION OF THE CITIES SERVICE #1 RIDLEY "A" WELL, ROOSEVELT COUNTY, NEW MEXICO

by
J. E. Keal

PROJECT NO. RRUS/823/T/231/2

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TABLE OF CONTENTS

INTRODUCTION

Cutting samples from the Cities Service #1, Ridley "A" test well, Roosevelt County, New Mexico were received and analyzed by Robertson Research (U.S.) Inc. in order to determine the source rock potential of the section penetrated. Most of the section penetrated by the well consisted of red beds and organic lean intervals, thereby making most intervals unsuitable for detailed geochemical analyses.

Preliminary data results were phoned to Cities Service Midland, on March 2, 1983.

DISCUSSION

Organic Richness

Thirty-three samples were analyzed for organic richness between 1,750 and 7,425 feet. All of these samples contained very low organic carbon richness (<0.5 weight percent) and are therefore rated as non-source rocks (Figure 1).

Organic Matter Type

Four samples analyzed by visual examination of the kerogen indicate that large amounts of amorphous kerogen plus exinite exist in relation to other maceral types (Figure 1). Often, high concentrations of these kerogen types are associated with oil-generating capability; however, the concentration of amorphous kerogen plus exinite is not a direct measurement of the amount of hydrogen that is present which actually

determines the oil-generating capability. These samples are found at 2,950; 3,950; 5,085; and 6,515 feet. All of the other samples analyzed visually contain terrestrial, dry gas-generating kerogen.

Kerogen typing by pyrolysis (Figure 3) suggests that the kerogen in most of the samples is hydrogen deficient and is predominantly gas-generating. The sample at 3,950 feet contains wet gas-generating kerogen.

Kerogen Maturity

Kerogen maturity can be determined by vitrinite reflectance (R_o) spore coloration index (SCI) and Rock-Eval pyrolysis (T-max). Zones of petroleum generation and destruction can be correlated using these three methods (Figure 5).

T-max is usually a reliable method for determining maturity in samples that contain reasonable amounts of organic matter. Because these samples are organic lean, the S_2 peaks, from which the T-max is measured (Appendix II), are of low amplitude making an accurate determination of T-max difficult.

Vitrinite reflectance (R_o) is the most accurate method for determining kerogen maturity and generally can be used when very little organic material is present in the samples. The generation zones shown in Figure 1 are established from the vitrinite reflectance profile shown in Figure 4. Data indicate that the section reaches the oil-generation window at approximately 3,000 feet and the dry gas preservation limit occurs at approximately 10,000 feet. Projection of the maturation profile to the surface shows that approximately 1,600 feet of overburden has been removed; however, this figure could be altered if more reflectance data were available from the upper part of section.

The SCI data at 6,515 and 6,935 feet agree well with the vitrinite data, but the shallower samples are more mature than would be expected when compared to the maturation trend established by vitrinite reflectance. These shallow samples probably contain oxidized and/or reworked organic material. This seems reasonable considering the amount of red bed intervals found in the section.

CONCLUSIONS

Cuttings samples from the Cities Service, #1 Ridley well are very lean in organic material and classified as nonsource rocks. Most of the organic material that is present is the terrestrial, gas-generating type. The depth range from the commencement of oil generation to the dry gas preservation limit is between 3,000 and 10,000 feet.

No potential for hydrocarbon generation exists in any part of the section analyzed; however, lateral facies changes may contain potential source beds.

RECOMMENDATIONS

We recommend that geochemical follow up studies be done on lateral wells and/or wells that penetrate a deeper part of the section in order to identify potential source beds that may exist.

#1 RIDLEY "A"

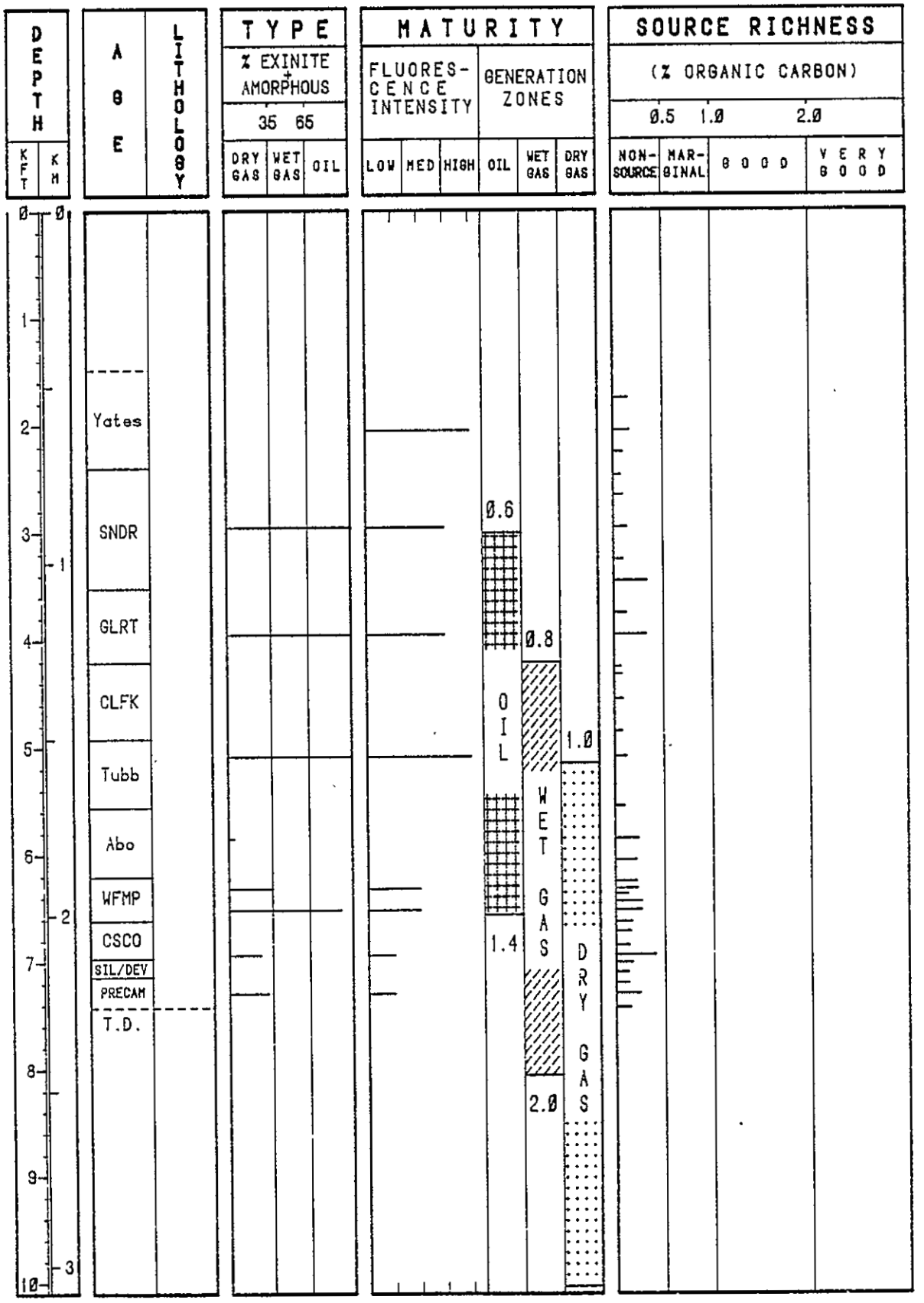


FIGURE 1: SUMMARY PLOTS SHOWING KEROGEN TYPES, MATURITY, AND SOURCE RICHNESS (SEE APPENDICES I AND III)

#1 RIDLEY "A"

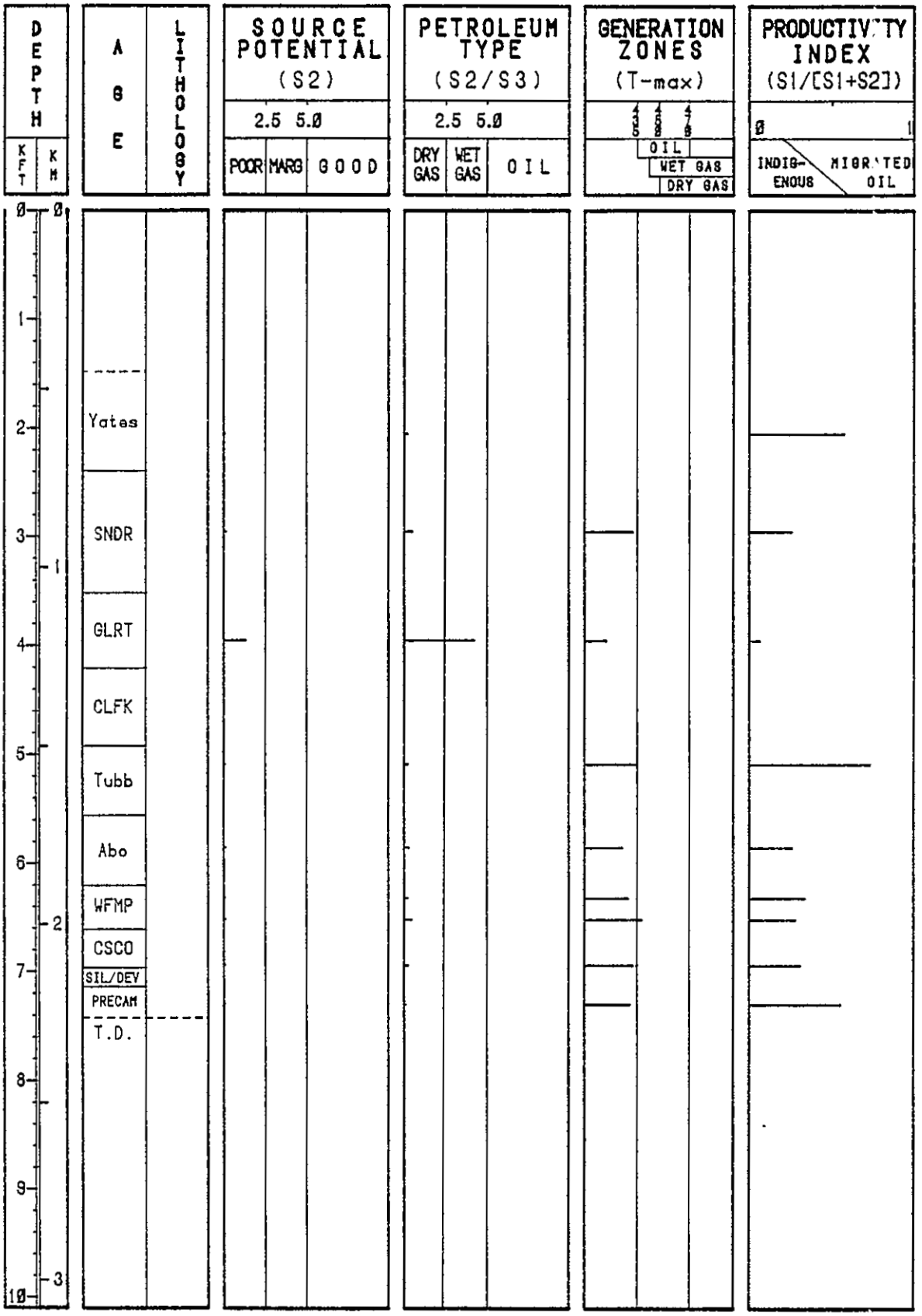


FIGURE 2: SUMMARY PLOTS OF ROCK-EVAL PYROLYSIS DATA (APPENDIX II)

#1 RIDLEY "A"

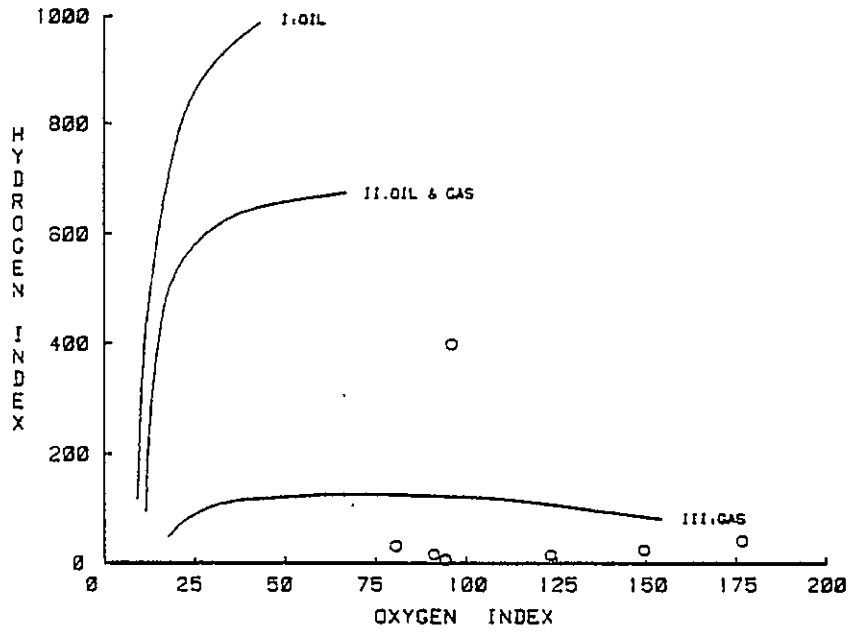
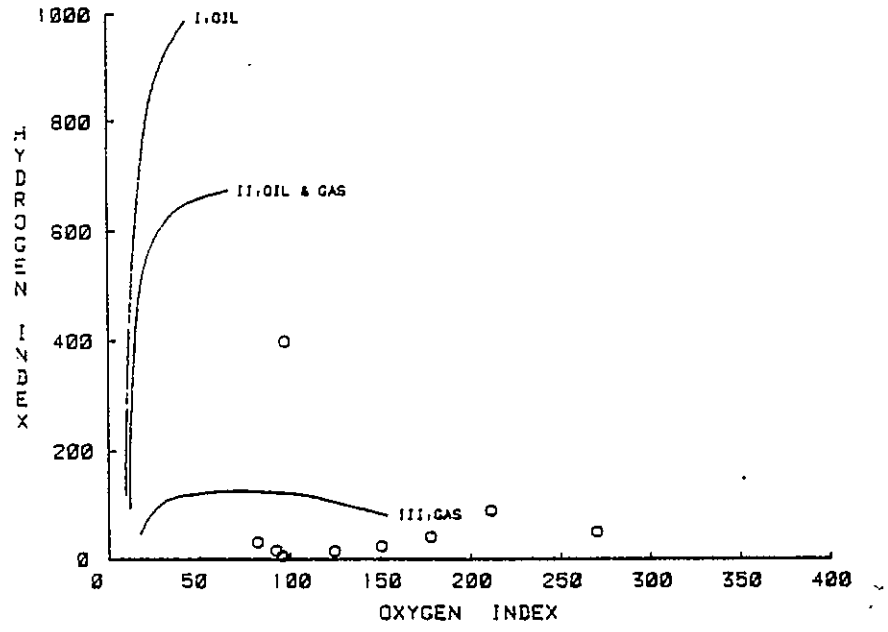


FIGURE 3: KEROGEN TYPE DETERMINATION FROM ROCK-EVAL PYROLYSIS DATA (APPENDIX II).

#1 RIDLEY "A"



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#1 RIDLEY "A"

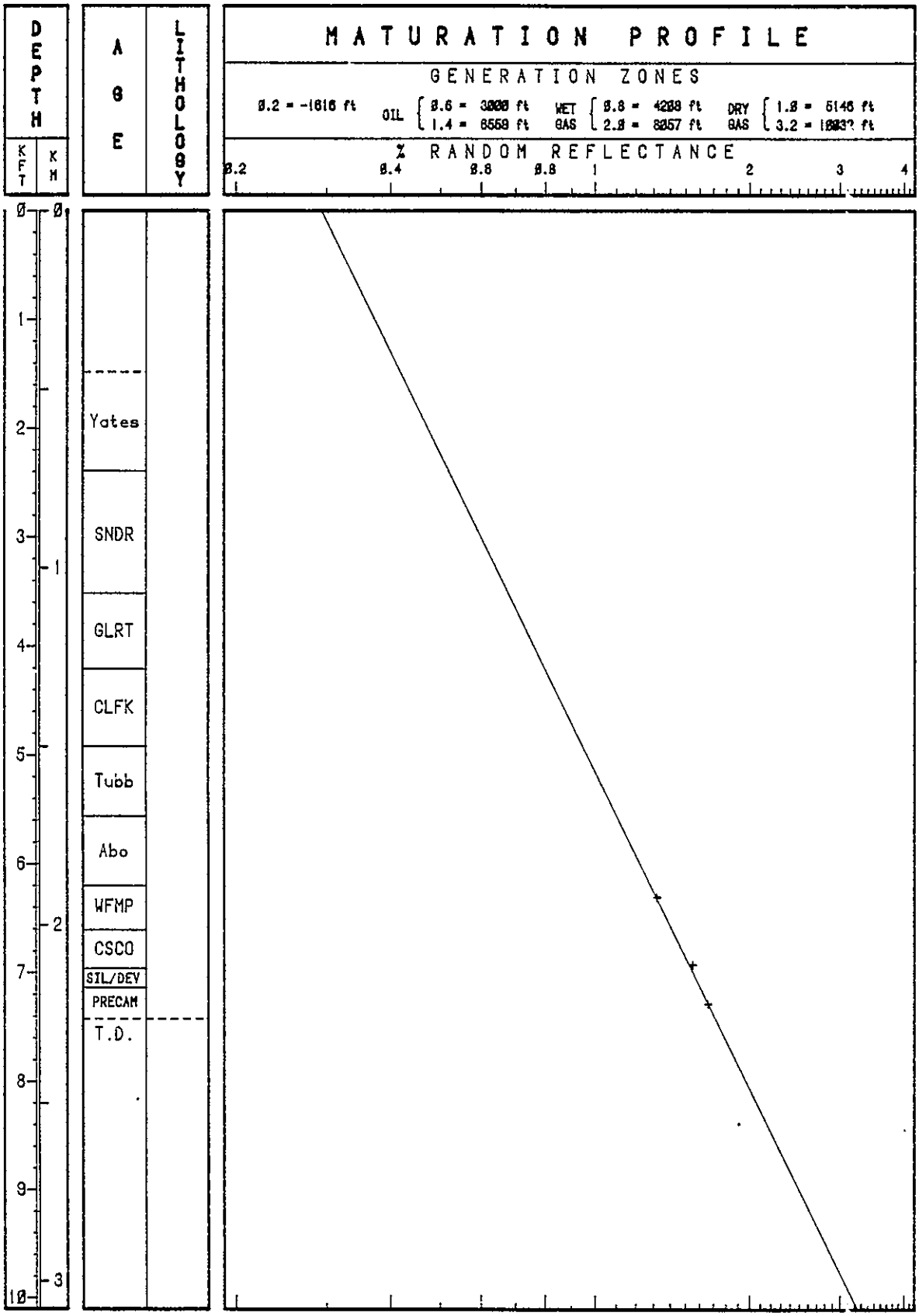


FIGURE 4: MATURATION PROFILE, BASED ON VITRINITE REFLECTANCE DATA (APPENDIX III)

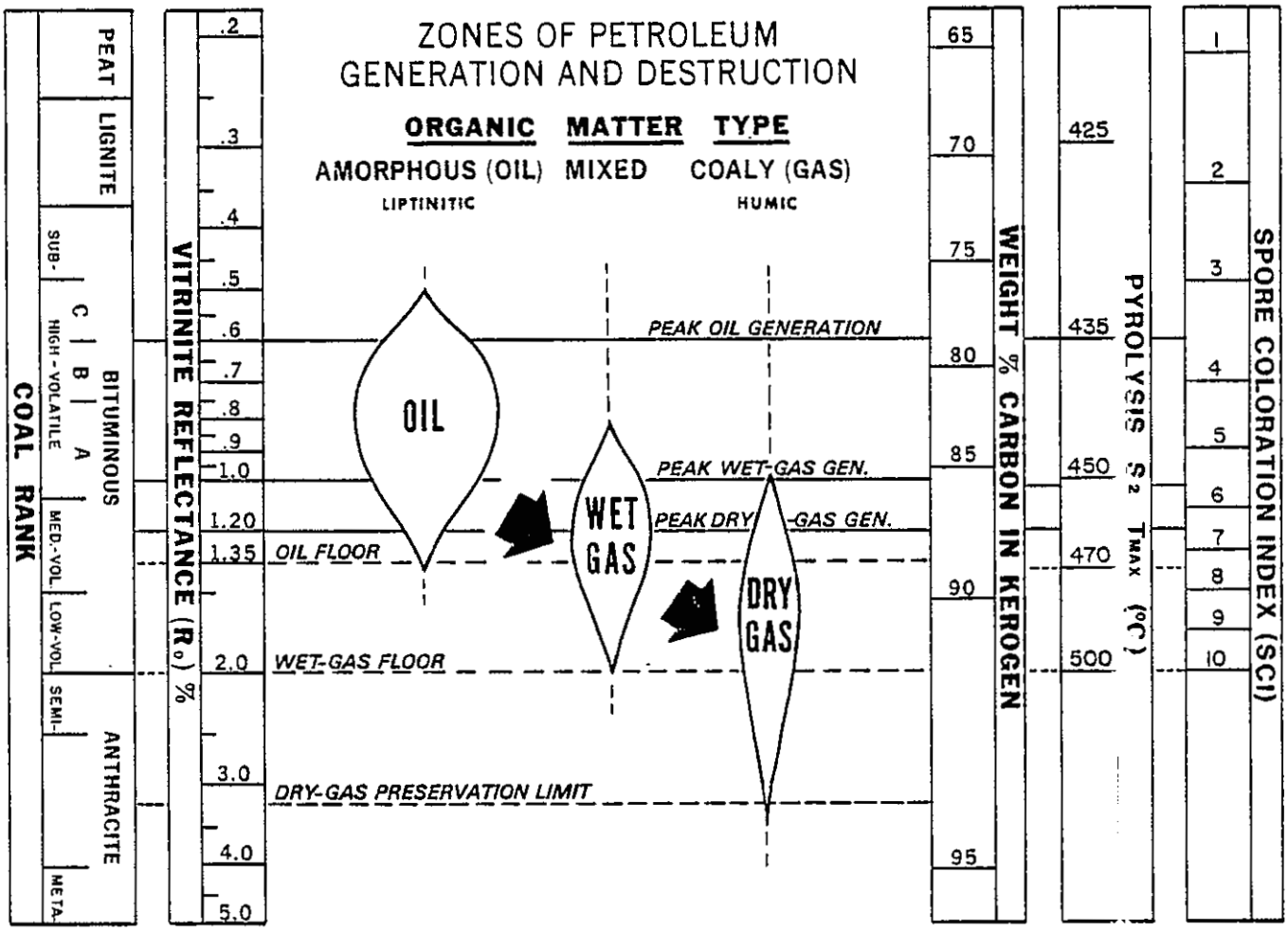


FIGURE 5: CORRELATION OF VARIOUS MATURATION INDICES AND ZONES OF PETROLEUM GENERATION AND DESTRUCTION.

APPENDIX I

TOTAL ORGANIC CARBON DATA

Total organic carbon is determined by pulverizing the sample, treating a carefully weighed portion with warm hydrochloric acid to remove carbonate minerals, and analysing the residue for carbon content with a Leco carbon analyser. It is generally accepted that samples with less than about 0.5 percent TOC cannot yield sufficient petroleum to form commercial deposits and are therefore considered nonsources; samples with between 0.5 and 1.0 TOC are rated as marginal in source quality; and samples with more than 1.0 TOC are considered to be good in source quality.

TOTAL ORGANIC CARBON DATA

#1 RIDLEY "A"

DEPTH (Feet)	TOC (%)	DEPTH (Feet)	TOC (%)
1750	0.14	5850	0.23
2050	0.16	6050	0.21
2250	0.09	6250	0.21
2465	0.07	6315	0.22
2650	0.09	6365	0.12
2950	0.13	6435	0.26
3250	0.09	6515	0.26
3450	0.33	6625	0.16
3750	0.12	6715	0.15
3950	0.32	6845	0.13
4250	0.06	6935	0.40
4320	0.07	7005	0.16
4550	0.08	7095	0.12
4850	0.07	7195	0.12
5085	0.11	7295	0.24
5350	0.00	7425	0.14
5550	0.09		

APPENDIX II

ROCK-EVAL PYROLYSIS DATA

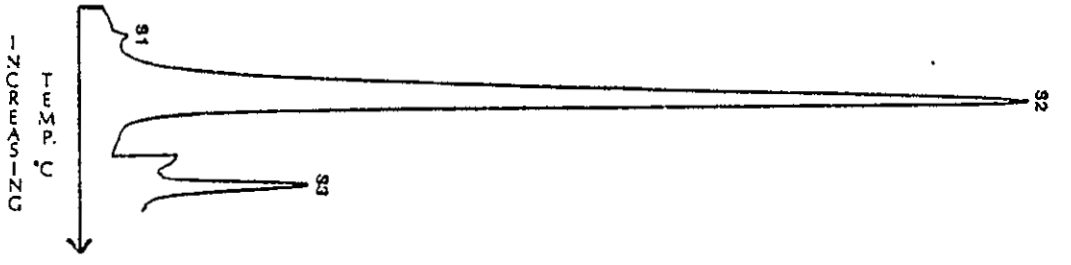
Rock-Eval data are expressed as mg/g of rock and include four basic parameters: 1) S_1 represents the quantity of free hydrocarbons present in the rock and is roughly analogous to the solvent extractable portion of the organic matter; 2) S_2 represents the quantity of hydrocarbons released by the kerogen in the sample during pyrolysis; 3) S_3 is related to the amount of oxygen present in the kerogen; and 4) T-max is the temperature at which the maximum rate of generation (of the S_2 peak) occurs and can be used as an estimate of thermal maturity.

In addition, the ratio S_2/S_3 provides a general indication of kerogen quality (type) and reveals whether oil or gas is likely to be generated. The ratio $S_1/(S_1+S_2)$, or the productivity index, is an indication of the relative amount of free hydrocarbons (in place or migrated) present in the sample. Hydrogen and oxygen index values are expressed as mg of hydrocarbons (S_2 peak) or carbon dioxide (S_3 peak) per gram of organic carbon. When plotted against each other on a van Krevelen-type diagram, information on kerogen type and maturity can be obtained.

Key for data interpretation:

Source Potential - values of S2	<2.5	: poor
	2.5-5.0	: marginal
	>5.0	: good
Petroleum Type - values of S2/S3	<2.5	: dry gas
	2.5-5.0	: wet gas
	>5.0	: oil
Generation Zones - values of T-max (°C)	<435	: immature
	435-470	: oil
	450 +	: gas

Productivity Index - high values of S1/(S1+S2) indicate migrated hydrocarbons.



ROCK-EVAL PYROLYSIS RAW DATA

#1 RIDLEY "A"

DEPTH (FEET)	S1	S2	S3	S2/S3	S1/(S1+S2)	T-MAX
2050	0.037	0.027	0.197	0.139	0.571	-
2950	0.041	0.120	0.273	0.440	0.255	432
3950	0.083	1.284	0.306	4.193	0.061	414
5085	0.161	0.059	0.295	0.198	0.734	433
5850	0.035	0.100	0.405	0.247	0.258	425
6315	0.029	0.059	0.327	0.179	0.334	429
6515	0.034	0.088	0.208	0.421	0.279	438
6935	0.032	0.072	0.362	0.199	0.307	432
7295	0.023	0.019	0.225	0.083	0.552	430

HYDROGEN AND OXYGEN INDICES FROM ROCK-EVAL PYROLYSIS DATA, WITH TOC DATA

#1 RIDLEY "A"

DEPTH (FEET)	HYDROGEN INDEX (mg HC/g TOC)	OXYGEN INDEX (mg CO2/g TOC)	TOC (%)
2050	17	123	0.16
2950	92	210	0.13
3950	401	96	0.32
5085	53	268	0.11
5850	43	176	0.23
6315	27	149	0.22
6515	34	80	0.26
6935	18	91	0.40
7295	8	94	0.24

APPENDIX III

REFLECTED LIGHT MICROSCOPY DATA

A sample of ground rock is treated successively with hydrochloric and hydrofluoric acids to concentrate the kerogen, freeze-dried, mounted in an epoxy plug, and polished. Kerogen type is identified with the aid of blue light fluorescence.

The visual kerogen analysis data table contains visual percentage estimates of each principle kerogen type and kerogen background fluorescence data. This data is also displayed on the histograms with relative amounts of solid bitumen and coked material.

The histograms show measured reflectance values of all vitrinite present and on all material with the visual appearance of vitrinite. Shaded values (marked with *) are those used to calculate the interpreted vitrinite reflectance maturities. Unshaded values are interpreted to be oxidized vitrinite, recycled vitrinite, or possibly misidentified material such as solid bitumen, pseudo-vitrinite, or semifusinite. When samples analysed contain no vitrinite, nonindigenous vitrinite or have an insufficient number of readings to allow a reliable maturity determination to be made, then the mean value for that sample is shown as N. D. (Not Determined). Alternate maturity calculations are possible on a few samples. The histograms are identified by a Robertson Research sequence number (RRUS No.) and depth or other notation.

ABBREVIATIONS USED IN VISUAL KEROGEN ANALYSIS DATA SHEET AND HISTOGRAMS

Am	:	Amorphous Kerogen
Ex	:	Exinite
Vit	:	Vitrinite
Inert	:	Inertinite
R_o	:	Vitrinite Reflectance Mean in Immersion Oil
Bkg Fl	:	Background Fluorescence

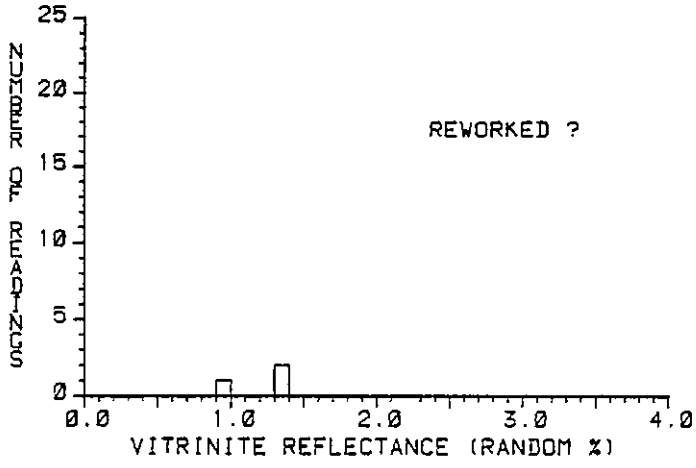
VISUAL KEROGEN ANALYSIS - REFLECTED LIGHT

#1 RIDLEY "A"

Project No. : RRUS/823/T/231/02

SAMPLE IDENTIFICATION		REFLECT.	KEROGEN CHARACTERISTICS					TOC
RRUS	DEPTH (Feet)	Ro %	Am%	Ex%	Vit%	Inert%	Fluor	%
2	2050	1.23	0	0	40	60	V Hi	0.16
6	2950	0.00	80	20	0	tr	High	0.13
10	3950	0.00	99	tr	0	0	High	0.32
15	5085	0.00	99	tr	0	tr	V Hi	0.11
18	5850	0.00	--	--	--	--	----	0.23
21	6315	1.32	30	5	40?	25	Med	0.22
24	6515	0.64	60	30	5	5	Med	0.26
28	6935	1.55	20	5	60	15	Low	0.40
32	7295	1.66	30	tr	35	35	Low	0.24

#1 RIDLEY "A"



REWORKED ?

RRUS No. : 2

DEPTH : 2050.0 Ft
: 624.8 M

MEAN : N.D.

HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

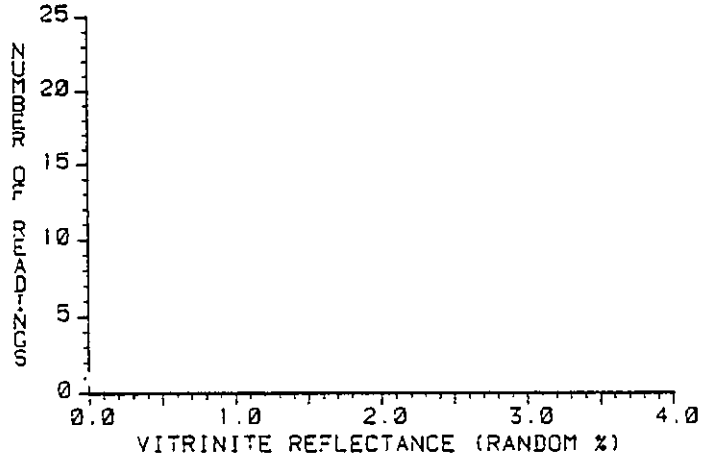
ORDERED REFLECTANCE VALUES:

0.92
1.37
1.39

KEROGEN DESCRIPTION

Amorphous	:	0 %
Exinite	:	0 %
Vitrinite	:	40 %
Inertinite	:	60 %
Back Fluor	:	V High
Bitumen	:	None
Coke	:	None

#1 RIDLEY "A"



RRUS No. : 6

DEPTH : 2950.0 Ft
: 899.2 M

MEAN : N.D.

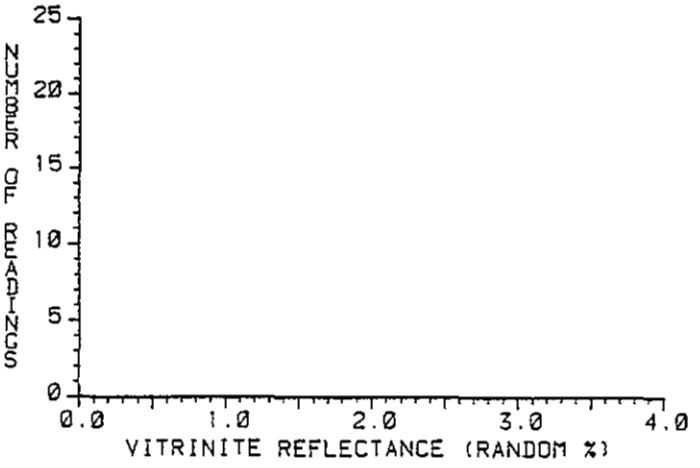
HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

ORDERED REFLECTANCE VALUES:

KEROGEN DESCRIPTION

Amorphous	:	80 %
Exinite	:	20 %
Vitrinite	:	0 %
Inertinite	:	tr %
Back Fluor	:	High
Bitumen	:	None
Coke	:	tr

#1 RIDLEY "A"



RRUS No. : 10

DEPTH : 3950.0 Ft
: 1204.0 M

MEAN : N.D.

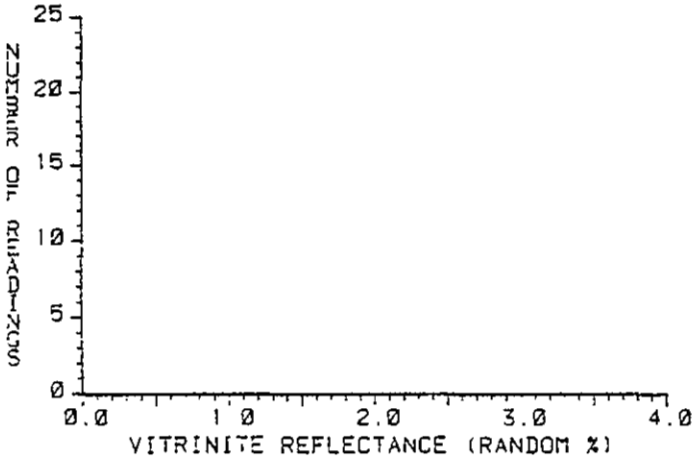
HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

ORDERED REFLECTANCE VALUES:

KEROGEN DESCRIPTION

Amorphous	:	99 %
Exinite	:	tr %
Vitrinite	:	0 %
Inertinite	:	0 %
Back Fluor	:	High
Bitumen	:	High
Coke	:	None

#1 RIDLEY "A"



RRUS No. : 15

DEPTH : 5085.0 Ft
: 1549.9 M

MEAN : N.D.

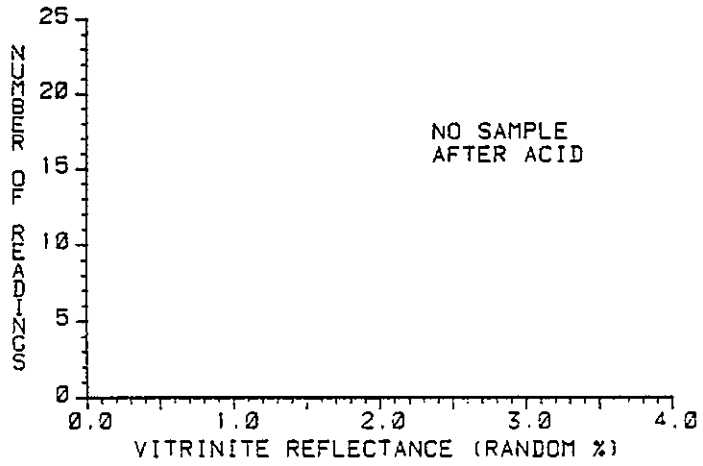
HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

ORDERED REFLECTANCE VALUES:

KEROGEN DESCRIPTION

Amorphous	:	99 %
Exinite	:	tr %
Vitrinite	:	0 %
Inertinite	:	tr %
Back Fluor	:	V High
Bitumen	:	Med
Coke	:	None

#1 RIDLEY "A"



NO SAMPLE
AFTER ACID

RRUS No. : 18

DEPTH : 5850.0 Ft
: 1783.1 M

MEAN : N.D.

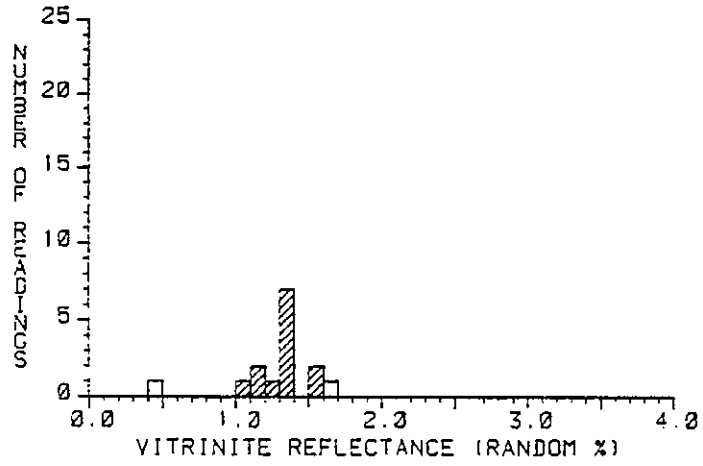
HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

ORDERED REFLECTANCE VALUES:

KEROGEN DESCRIPTION

Amorphous	: ?	2 %
Exinite	: ?	2 %
Vitrinite	: ?	2 %
Inertinite	: ?	2 %
Back Fluor	: ?Med	
Bitumen	: ?Small	
Coke	: ?Small	

#1 RIDLEY "A"



RRUS No. : 21

DEPTH : 6315.0 Ft
: 1924.8 M

* = Ro MATURITY

VALUES : 13

MEAN : 1.32
STD DEV : 0.15
MEDIAN : 1.33
MODE : 1.35

HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

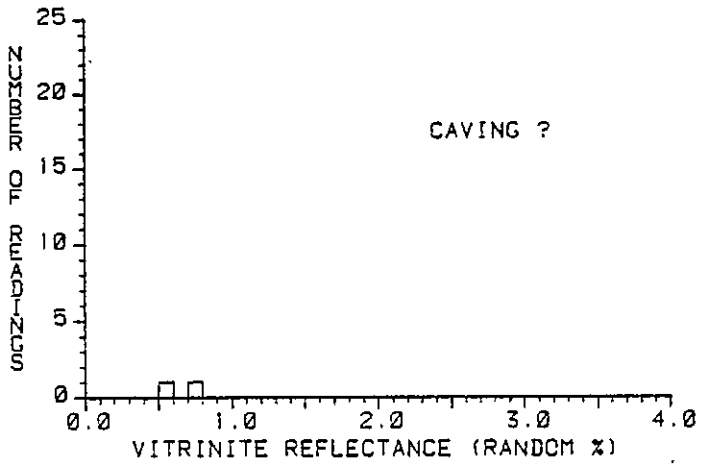
ORDERED REFLECTANCE VALUES:

0.49	*1.38
*1.06	*1.38
*1.14	*1.57
*1.17	*1.59
*1.21	1.62
*1.30	
*1.30	
*1.33	
*1.34	
*1.35	

KEROGEN DESCRIPTION

Amorphous	:	30 %
Exinite	:	5 %
Vitrinite	: ?	40 %
Inertinite	:	25 %
Back Fluor	:	Med
Bitumen	:	Med
Coke	:	tr

#1 RIDLEY "A"



CAVING ?

RRUS No. : 24

DEPTH : 6515.0 Ft
: 1985.8 M

MEAN : N.D.

HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

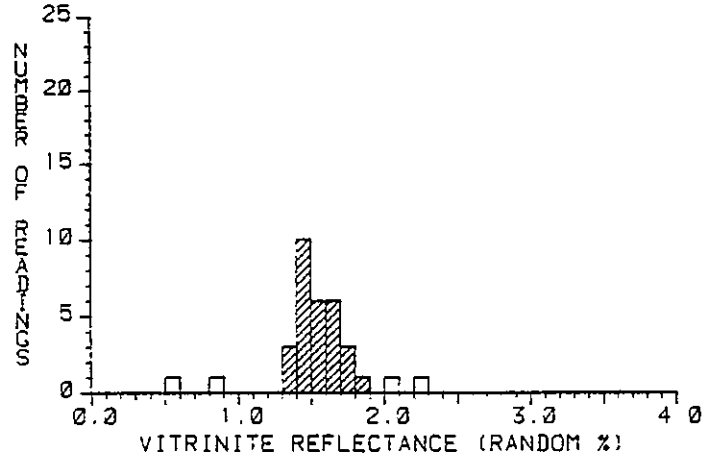
ORDERED REFLECTANCE VALUES:

0.54
0.75

KEROGEN DESCRIPTION

Amorphous	:	60 %
Exinite	:	30 %
Vitrinite	:	5 %
Inertinite	:	5 %
Back Fluor	:	Med
Bitumen	:	Med
Coke	:	None

#1 RIDLEY "A"



RRUS No. : 28

DEPTH : 6935.0 Ft
: 2113.8 M

* = Ro MATURITY

# VALUES	:	29
MEAN	:	1.55
STD DEV	:	0.14
MEDIAN	:	1.54
MODE	:	1.45

HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

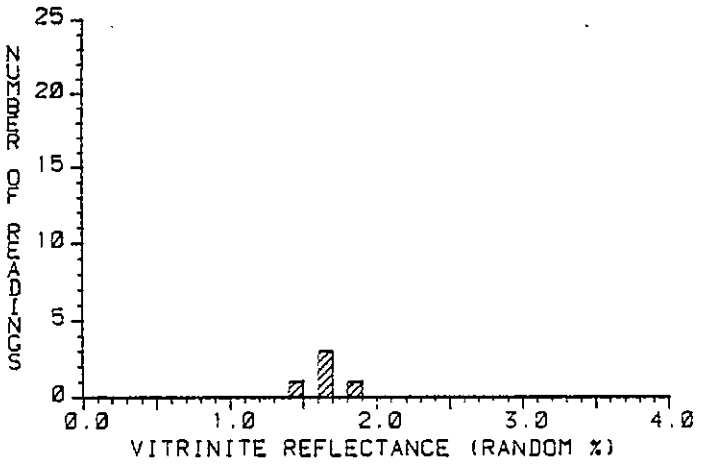
ORDERED REFLECTANCE VALUES:

0.52	*1.45	*1.59	*1.87
0.81	*1.47	*1.60	2.05
*1.31	*1.47	*1.63	2.24
*1.31	*1.48	*1.64	
*1.38	*1.49	*1.65	
*1.40	*1.50	*1.67	
*1.41	*1.54	*1.69	
*1.42	*1.55	*1.75	
*1.43	*1.58	*1.78	
*1.43	*1.58	*1.79	

KEROGEN DESCRIPTION

Amorphous	:	20 %
Exinite	:	5 %
Vitrinite	:	60 %
Inertinite	:	15 %
Back Fluor	:	Low
Bitumen	:	Small
Coke	:	None

#1 RIDLEY "A"



RRUS No. : 32

DEPTH : 7295.0 Ft
: 2223.5 M

* = Ro MATURITY

VALUES : 5

MEAN : 1.66
STD DEV : 0.14
MEDIAN : 1.66
MODE : 1.65

HISTOGRAM:
Range: 0- 4%
Increment: 0.10%

ORDERED REFLECTANCE VALUES:

*1.43
*1.64
*1.66
*1.67
*1.88

KEROGEN DESCRIPTION

Amorphous	:	30 %
Exinite	:	tr %
Vitrinite	:	35 %
Inertinite	:	35 %
Back Fluor	:	Low
Bitumen	:	None
Coke	:	tr

APPENDIX IV

TRANSMITTED LIGHT MICROSCOPY DATA

Transmitted light slides are prepared with standard palynological techniques and SCI values on all spores and pollen present are recorded on a 1-10 scale. The basis for the SCI color scale is hue, not intensity. A brief description of the colors for each of the ten SCI units is as follows:

SCI COLOR SCALE

1. straw to pale yellow
2. yellow
3. yellow/orange
4. golden
5. amber
6. reddish brown/chocolate
7. neutral brown
8. blackish brown
9. black
10. glossy black/graphitized

CITIES #1 RIDLEY

TRANSMITTED LIGHT VISUAL KEROGEN ANALYSIS

RRUS NO.	DEPTH	SCI RANGE
6	2,950	5-6
10	3,950	5-7
24	6,515	5-7
28	6,935	5-6