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**New Mexico Bureau of Mines & Mineral Resources**  
Socorro, NM 87801

A DIVISION OF  
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

July 20, 1981

MEMO

TO: Frank E. Kottlowski, Director  
FROM: Sam Thompson III, Petroleum Geologist  
SUBJECT: Open-file report no. OF-149

As we discussed, the following report from GeoChem Laboratories, Inc is to be placed in the Bureau Open-File:

OF-149 Hydrocarbon source-rock evaluation study,  
Cockrell Corp. No. 1 Coyote State well,  
Grant County, New Mexico, by L. Paul Tybor,  
GeoChem Laboratories, Inc., 1981, 17p.  
(including 3p. text, 7 tables, 6 charts)

xc: Mike R. Smith, GeoChem  
Robert A. Bieberman, Subsurface Library  
Robert W. Kelley, Editor



GEOCHEMICAL ANALYSES  
SOURCE ROCK EVALUATION

CRUDE OIL—SOURCE ROCK CORRELATION

CRUDE OIL CHARACTERIZATION  
GEOCHEMICAL PROSPECTING

1143 - C BRITTMORE ROAD • HOUSTON, TEXAS 77043 • 713/467-7011

July 10, 1981

Mr. Sam Thompson III  
New Mexico Bureau of Mines &  
Mineral Resources  
Socorro, New Mexico 87801

Dear Mr. Thompson:

Enclosed please find the results of the organic geochemical analyses performed on thirty-seven (37) well cuttings samples from the Cockrell Corp. No. 1 Coyote State (1132-14) well, located in Grant County, New Mexico.

Upon Arrival at GeoChem the samples were logged in under GeoChem Job Number 2058, followed by the sample sequential number -001 to -037, and submitted to the following geochemical analytical program:

<u>Type of Analysis</u>	<u>Table</u>
Total organic carbon determination and brief lithological description.....	I
Pyrolysis.....	II
C <sub>15</sub> + soxhlet extraction, deasphalting, + liquid chromatographic separation.....	III
C <sub>15</sub> + paraffin-naphthene chromatography.....	IV; gas chromatograms
Visual kerogen assessment.....	V
Vitrinite reflectance analysis.....	VI; Histograms

## DISCUSSION OF THE RESULTS

### A. Thermal Maturity of Sediments

The Paleozoic sediments analyzed from this well range in thermal maturity from a moderately mature Maturation Index Stage 2 to 2+ at 2140+ feet, within the Mojado Formation, to a mature Maturation Index Stage 3- to 3 at 8380+ feet, within the Bliss Formation.

At these levels of thermal maturation, these Paleozoic rocks are considered to be within the oil window, wherein significant quantities of oil and associated gas could have been generated, provided these sediments contain sufficient quantities of oil-prone organic matter type.

Within this well interval there are zones which have been locally affected by the intrusions in this area of the basin. Where this has occurred the thermal maturity of the intruded sediments rapidly increases to severely altered levels. This is the case for sample 2052-021, where the interpreted indigenous vitrinite reflectance population is a severely altered 4.10% Ro (Table VI). These severely altered sediments could have generated dry gas. However, the severely altered nature of sediments, due to igneous intrusions, is normally a local event which does not greatly affect the regional maturation profile of sediments within a basin.

The overall mature maturation profile interpretation of the sediments from this well is based on the orange-brown to brown coloration of the kerogen isolated from these samples (Table V).

### B. Hydrocarbon Source Characterization of Sediments

The only stratigraphic unit, analyzed from this well, which has favorable hydrocarbon source characteristics is the Cretaceous Mojado formation. This formation is characterized as a moderately mature, poor oil, fair to good gas source. This rating pertains mainly to the lower half of this formation where fair to good amounts (Table I) of gas-prone organic matter (Table IV) were analyzed. The poor oil source character of this unit is indicated by the low amounts of C<sub>15+</sub> total bitumen (221 ppm avg.; Table III) and total hydrocarbon (119 ppm avg.; Table III). The very lean amounts of free hydrocarbon yield (S<sub>1</sub>; 0.13; Table II) and remaining hydrocarbon generating potential (S<sub>2</sub>; 0.33; Table II) also reflect the poor oil generating capability of these sediments.

Mr. Sam Thompson III

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July 10, 1981

The rest of the stratigraphic units penetrated by this well are organic-lean with poor hydrocarbon source characteristics.

Should you have any questions concerning the results of the analyses, or if we may be of further service, please feel free to contact me.

Sincerely,

A handwritten signature in cursive script, reading "Paul Tybor". The signature is written in dark ink and is positioned above a horizontal line.

Paul Tybor  
GEOCHEM LABORATORIES, INC.

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Enclosures

SUMMARY TABLE I

AGE Stratigraphic Unit	Top (Feet)	Lithology	Organic Richness					Predominant Kerogen Type Visual Assessment	Thermal Maturity		T-Max (°C)	Hydrocarbon Source Potential	
			Organic Carbon (% of rock)	SI Free H.C.'s (mg/g)	C <sub>15</sub> <sup>+</sup> Total H.C. (ppm)	S2 Residual H.C. Yield (mg/g)	C <sub>15</sub> <sup>+</sup> Bitumen (ppm)		Kerogen Alteration (1-5 Scale)	Vitrinite Reflectance (%Ro)			
<u>CRETACEOUS</u>			<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>	<u>MEAN</u>		
Mojado	1790- 6400	Mudstone, olive gray; Shale, dark gray.	(23) 1.00	(5) 0.13	(2) 119	(5) 0.33	(2) 221	(10) W;H;-	(10) 2 to 2+	(1) 0.91	(1)* 4.10	(5) 426	Moderately mature, poor oil, fair to good gas source.
U-Bar	6400- 7100	Limestone, light brown to medium gray; Shale(? Mojado cavings).	(4) 0.26	(1) 0.01	(1) 28e	(1) 0.01	(1) 87	(2) W;H;Am	(2) 2 to 2+	n/a		(1) 497	Moderately mature, poor hydrocarbon source.
Hell-to-finish	7100- 7240	Varied lithology:(1) Shale, Limestone.0.36		n/a	n/a	n/a	n/a	(1) W;-;H	(1) 2	n/a		n/a	Moderately mature, poor hydrocarbon source.
<u>ORDOVICIAN</u>													
Montoya	7240- 7720	Dolomite, brown- ish gray.	(4) 0.03	n/a	n/a	n/a	n/a	(2) Am;-;-	(2) 2+ to 3-	n/a		n/a	Mature, poor hydrocarbon source.
El Paso	7720- 8360	Dolomite, brown- ish gray; Limestone, medium light gray0.05 to brownish gray.	(5) 0.05	n/a	n/a	n/a	n/a	(3) Am(A1);-;-	(3) 3- to 3	n/a		n/a	Mature, poor hydrocarbon source.

e-estimated

\* High reflectance due to local  
igneous intrusions.

Table I

SCREEN ANALYSIS SUMMARY

GeoChem Sample Number	Well Interval (Feet)	Brief Lithological Description	Total Organic Carbon (% of Rock)
2058-001	1950-1960	Mudstone, grayish olive.	0.21
2058-002	2140-2150	Composite: mudstone grayish olive and shale, brownish black.	1.34
2058-003	2330-2340	Mudstone, grayish olive.	0.34
2058-004	2480-2490	Composite: mudstone and shale.	0.38
2058-005	2560-2570	Mudstone, olive gray.	0.20; 0.21R
2058-006	2660-2670	Mudstone, olive gray.	0.23
2058-007	2990-3000	Mudstone, olive gray.	0.23
2058-008	3220-3230	Composite: mudstone and shale.	0.33
2058-009	3310-3320	Composite: mudstone and shale.	0.41
2058-010	3560-3570	Composite: mudstone and shale.	0.59
2058-011	3730-3740	Shale, medium gray to medium dark gray.	0.80
2058-012	3970-3980	Composite, mudstone and shale.	0.27
2058-013	4100-4110	Composite, mudstone and shale.	0.42
2058-014	4300-4310	Composite: mudstone and shale.	0.76
2058-015	4400-4410	Shale, medium dark gray.	0.71
2058-016	4490-4500	Shale, medium dark gray to dark gray.	0.74; 0.77R
2058-017	4730-4740	Composite: shale and mudstone.	0.62
2058-018	5080-5090	Shale, medium dark gray to dark gray.	0.66
2058-019	5160-5170	Shale, medium dark gray to dark gray.	1.17
2058-020	5250-5260	Composite: shale and mudstone.	0.72
2058-021	5620-5630	Shale, dark gray to grayish black.	9.98
2058-022	5800-5816	Shale, dark gray.	1.43
2058-023	6070-6080	Shale, medium dark gray to dark gray.	0.56

Table I

SCREEN ANALYSIS SUMMARY

GeoChem Sample Number	Well Interval (Feet)	Brief Lithological Description	Total Organic Carbon (% of Rock)
2058-024	6400-6410	Composite: shale and limestone.	0.46
2058-025	6490-6500	Composite: shale and limestone.	0.40
2058-026	6810-6820	Limestone, light brown.	0.05
2058-027	7080-7090	Limestone, medium gray.	0.14
2058-028	7120-7130	Composite, shale and quartz and limestone.	0.36
2058-029	7290-7300	Dolomite, brownish gray.	0.03
2058-030	7430-7440	Dolomite, brownish gray.	0.03; 0.03R
2058-031	7530-7540	Dolomite, brownish gray.	0.04
2058-032	7670-7680	Dolomite, brownish gray.	0.04
2058-033	7880-7890	Dolomite, brownish gray.	0.05
2058-034	7980-7990	Limestone, brownish gray.	0.05
2058-035	8130-8140	Dolomite, brownish gray.	0.07
2058-036	8220-8230	Limestone, medium light gray to brownish gray.	0.04
2058-037	8370-8380	Composite: limestone and dolomite.	0.02

T.O.C. = Total organic carbon, wt. %  
S1 = Free hydrocarbons, mg HC/g of rock  
S2 = Residual hydrocarbon potential (mg HC/g of rock)  
S3 = CO2 produced from kerogen pyrolysis (mg CO2/g of rock)  
S1+S2 = Genetic hydrocarbon potential (mg HC/g of rock)  
Hydrogen Index = mg HC/g organic carbon  
Oxygen Index = mg CO2/g organic carbon  
S1/S1+S2 = Transformation ratio  
Tmax = Temperature Index, degrees C.

TABLE II  
RESULTS OF ROCK-EVAL PYROLYSIS

GeoChem Sample No.	Depth Interval ( )	T.O.C. (wt.%)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	S1+S2 (mg/g)	Hydrogen Index	Oxygen Index	S1/S1+S2	Tmax ( C )
2058-002	2140 - 2150	1.34	0.10	0.40	0.40	0.50	30	30	0.20	441
2058-011	3730 - 3740	0.80	0.10	1.00	0.14	1.10	125	18	0.09	430
2058-014	4300 - 4310	0.76	0.06	0.21	0.17	0.27	28	22	0.22	433
2058-019	5160 - 5170	1.17	0.21	0.02	0.10	0.23	2	9	0.91	436
2058-022	5800 - 5810	1.43	0.17	0.00	0.11	0.17	0	8	1.00	392
2058-024	6400 - 6410	0.46	0.01	0.01	0.09	0.02	2	20	0.50	497



Table III

Summary of C15+ Soxhlet Extraction, Deasphalting  
and Liquid Chromatography

A. Weights of Extracts and Chromatographic Fractions

GeoChem Sample Number	Well Interval	Weight of Rock Extd. (grams)	Total Extract (grams)	Precipitated Asphaltenes (grams)	N-C5 Soluble (grams)	Sulfur (grams)	Paraffins- Naphthenes (grams)	Aromatics (grams)	Eluted NSO'S (grams)	Noneluted NSO'S (grams)
2058-019	5100 -5230	100.0	0.0282	0.0059	0.0223	N.D.	0.0109	0.0067	0.0033	0.0014
2058-022	5650 -5900	100.0	0.0161	0.0059	0.0102	N.D.	0.0045	0.0018	0.0025	0.0014
2058-024	6340 -6430	100.0	0.0087	0.0030	0.0057	N.D.	N.D.	N.D.	N.D.	N.D.

B. Concentration of Extracted Materials in Rock

GeoChem Sample Number	Well Interval	Total Extract (ppm)	-----Hydrocarbons-----				-----Nonhydrocarbons-----			
			Paraffin- Naphthene (ppm)	Aromatic (ppm)	Total (ppm)	Sulfur (ppm)	Precipitd. Asphaltene (ppm)	Eluted NSO'S (ppm)	Noneluted NSO'S (ppm)	Total (ppm)
2058-019	5100 -5230	282	109	67	176	-	59	33	14	106
2058-022	5650 -5900	161	45	18	63	-	59	25	14	98
2058-024	6340 -6430	87	-	-	-	-	30	-	-	-

C. Composition of Extracts

GeoChem Sample Number	Well Interval	-----Hydrocarbons-----				-----Nonhydrocarbons-----					
		Paraffin- Naphthene %	Aromatic %	PN/Arom	Sulfur %	Eluted NSO'S %	Noneluted NSO'S %	Precipitd. Asphaltene %	Asph/NSO	HC'S %	HC/Non HC
2058-019	5100 -5230	38.7	23.8	1.63	-	11.7	5.0	20.9	1.26	62.4	1.66
2058-022	5650 -5900	28.0	11.2	2.50	-	15.5	8.7	36.6	1.51	39.1	0.64
2058-024	6340 -6430	-	-	-	-	-	-	34.5	-	-	-

Table IV-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
2058-019	5100 -5230	17.4	2.4	80.2	1.03	1.04	1.89
2058-022	5650 -5900	24.4	5.6	70.0	1.04	1.13	1.61
2058-024	6340 -6430	28.0	1.7	70.4	1.04	1.11	1.34

Table IV-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
2058-019	5100 -5230	7.2	12.0	12.8	8.1	8.3	4.3	6.4	5.2	6.1	6.4	5.6	4.2	3.2	2.6	2.0	1.7	1.3	0.7	0.5	0.3	0.5	0.4	0.3
2058-022	5650 -5900	1.5	5.5	11.9	11.5	11.7	7.1	7.1	5.0	6.6	7.3	6.6	5.3	4.0	3.0	2.2	1.4	1.0	0.5	0.4	0.1	0.1	0.1	0.0
2058-024	6340 -6430	0.2	2.0	5.3	3.2	5.0	2.4	4.5	5.5	9.2	11.9	11.7	10.3	8.1	6.3	5.3	3.7	2.7	1.4	0.8	0.2	0.1	0.1	0.1

TABLE V  
VISUAL KEROGEN ASSESSMENT WORKSHEET

GEOCHEM No.	DEPTH	INDIGENOUS POPULATION (INTERPRETED)				GENERAL CHARACTERISTICS				CAVED AND/OR REWORKED POPULATION(S)				SUMMARY ORGANIC MATTER TYPE
		TYPE OF ORGANIC MATTER		MATURATION INDEX		COLOR OF ORGANIC MATTER	STATE OF ORGANIC MATTER	%	TYPE OF ORGANIC MATTER		MATURATION INDEX			
		1	2	3	4				5	6	7	8	9	
2058-002	2150													
2058-004	2490													
2058-009	3320													
2058-011	3740													
2058-014	4310													
2058-018	5090													
2058-019	5170													
2058-020	5260													
2058-022	5810													
2058-023	6080													
2058-024	6410													
2058-027	7090													
2058-028	7130													
2058-029	7300													
2058-031	7540													
2058-033	7890													
2058-035	8140													
2058-037	8380													

Table VI

## VITRINITE REFLECTANCE SUMMARY

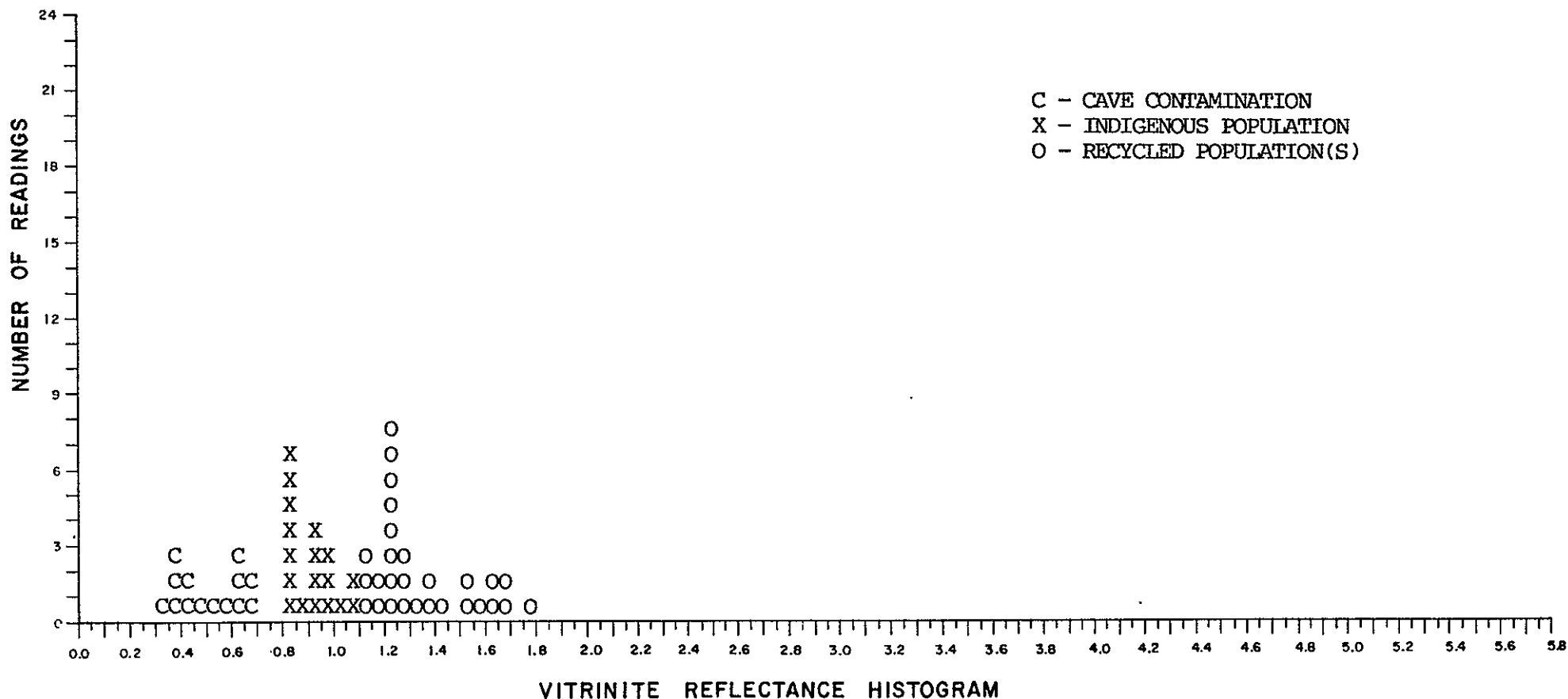
GEOCHEM SAMPLE NUMBER	DEPTH (feet)	TYPE OF SAMPLE	POPULATION	NUMBER OF READINGS	MINIMUM REFLECTANCE ( % Ro)	MAXIMUM REFLECTANCE ( % Ro)	MEAN REFLECTANCE ( % Ro)	STD. DEV. ( % Ro)	REMARKS
2058-011	3740	CTG	(1)	14	0.32	0.68	0.51	0.128	
			(2)	18	0.80	1.05	0.91	0.085	
			(3)	28	1.10	1.76	1.34	0.194	
2058-021	5630	CTG	(1)	4	0.96	1.71	1.36	0.360	
			(2)	54	3.49	4.81	4.10	0.317	
			(3)	2	5.45	5.46	5.46	-	

GEOCHEM NO. 2058-011 TYPE OF SAMPLE: CTG DEPTH/SAMPLE NO. 3740

CLIENT'S NAME NEW MEXICO BUREAU OF MINES WELL NAME COCKRELL #1 COYOTE STATE

(NO. OF READINGS = 60) 0.32 0.35 0.37 0.38 0.42 0.43 0.48 0.53 0.59 0.62 0.63 0.64 0.65 0.68  
 0.80 0.81 0.81 0.81 0.83 0.83 0.84 0.85 0.90 0.93 0.93 0.94 0.96 0.97 0.98 1.00 1.05 1.05  
 1.10 1.11 1.11 1.16 1.16 1.20 1.20 1.20 1.21 1.22 1.23 1.24 1.24 1.25 1.25 1.28 1.32 1.39  
 1.39 1.43 1.50 1.53 1.57 1.60 1.62 1.65 1.66 1.76

POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD. DEV. (%)	REMARKS
(1)	14	0.32	0.68	0.51	0.128	
(2)	18	0.80	1.05	0.91	0.085	
(3)	28	1.10	1.76	1.34	0.194	

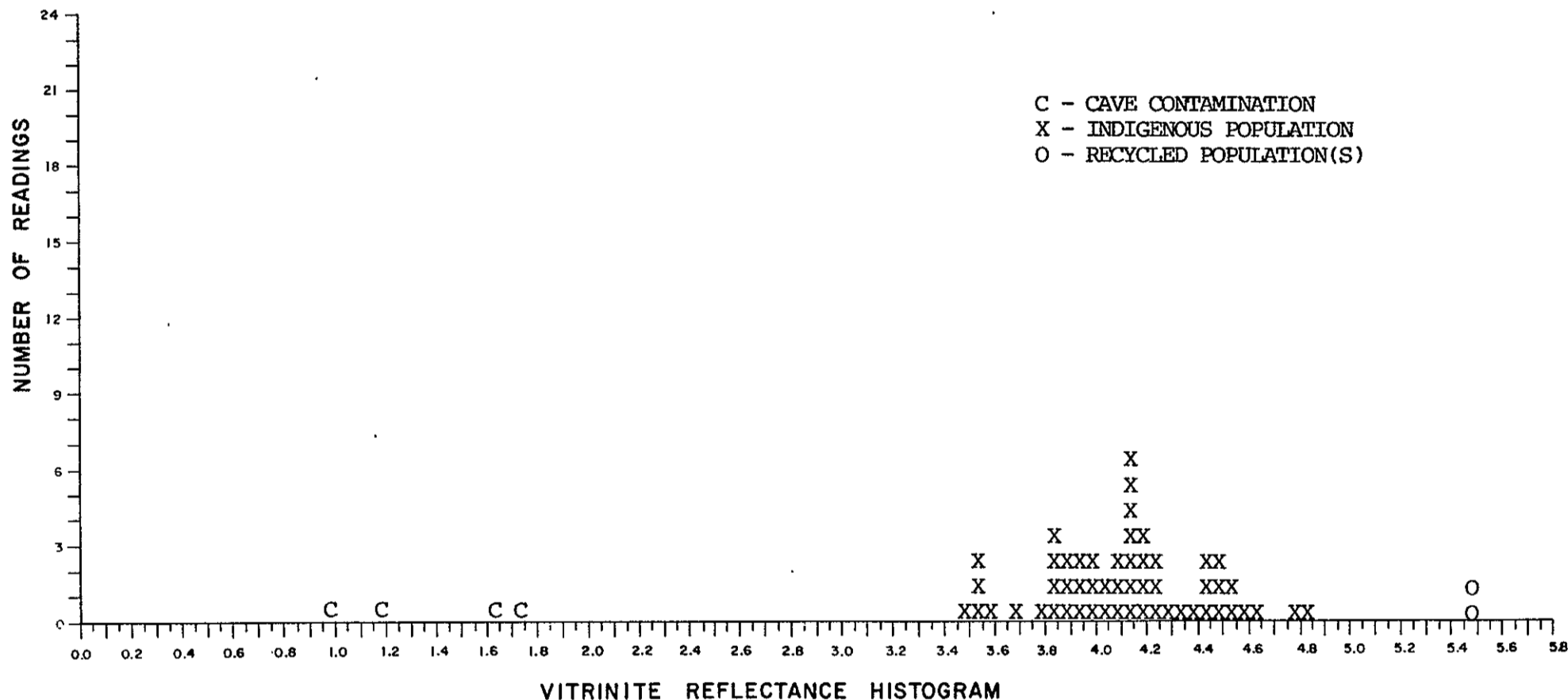


GEOCHEM NO. 2058-021 TYPE OF SAMPLE: CTG DEPTH/SAMPLE NO. 5630

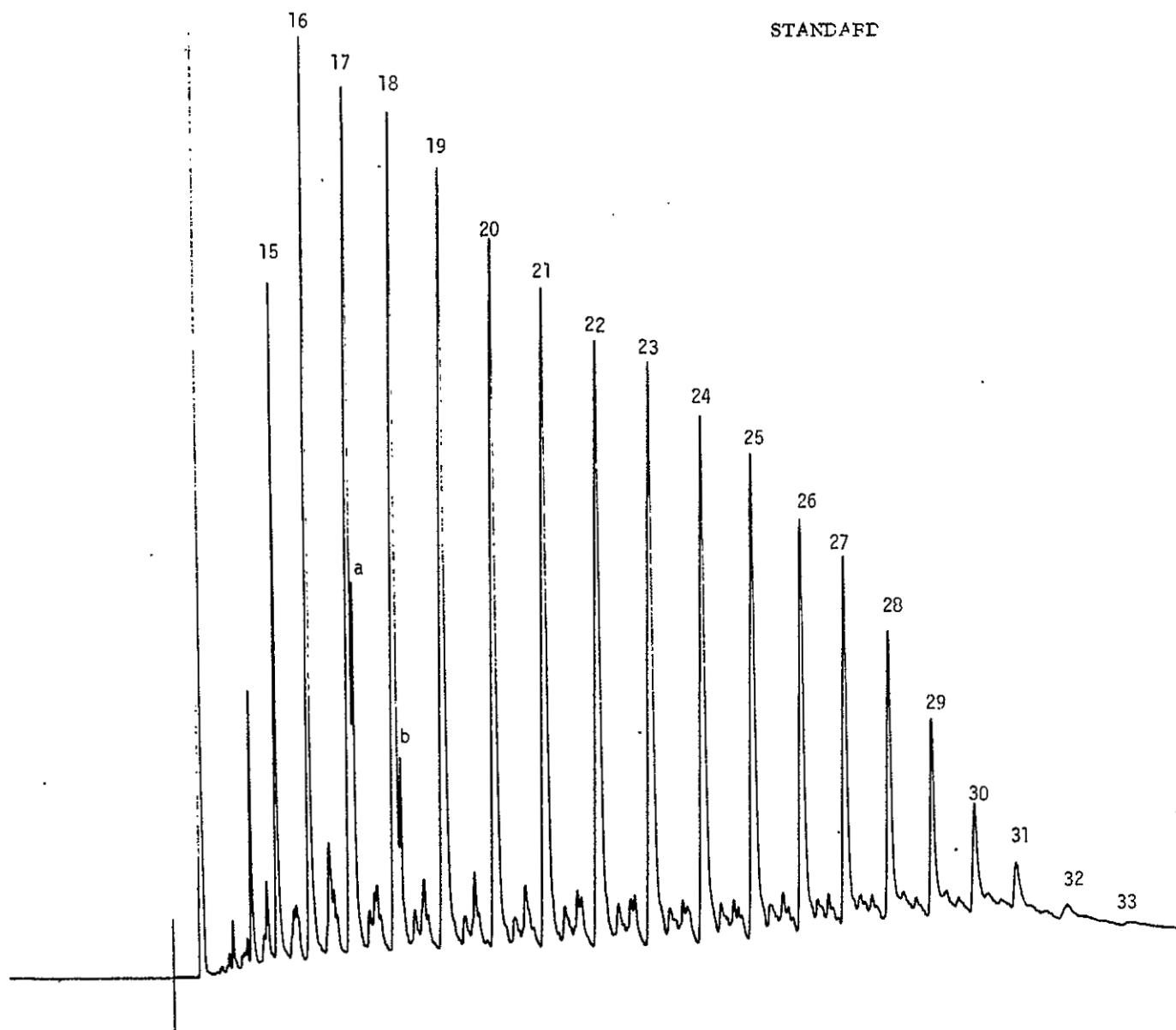
CLIENT'S NAME NEW MEXICO BUREAU OF MINES WELL NAME COCKRELL #1 COYOTE STATE

(NO. OF READINGS = 60) 0.96 1.15 1.61 1.71 3.49 3.50 3.52 3.54 3.58 3.68 3.77 3.80 3.80 3.81  
 3.83 3.85 3.86 3.87 3.92 3.93 3.94 3.95 3.96 3.99 4.03 4.04 4.06 4.06 4.07 4.11 4.11 4.11  
 4.13 4.13 4.14 4.14 4.15 4.18 4.19 4.19 4.21 4.23 4.23 4.28 4.34 4.36 4.42 4.42 4.44 4.45  
 4.45 4.46 4.51 4.53 4.59 4.64 4.75 4.81 5.45 5.46

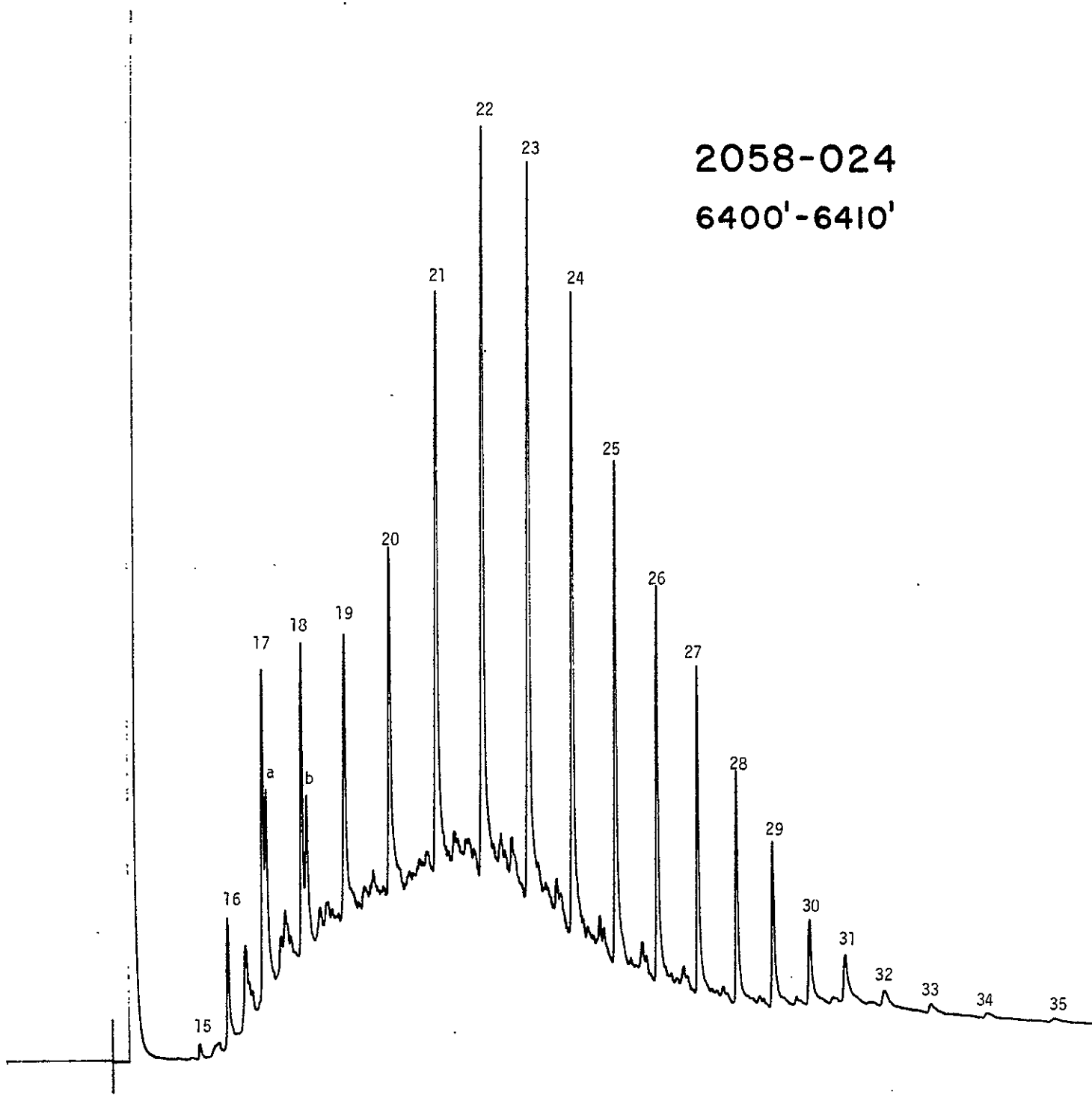
POPULATION	NO. OF READINGS	MIN. Ro (%)	MAX. Ro (%)	MEAN Ro (%)	STD. DEV. (%)	REMARKS
(1)	4	0.96	1.71	1.36	0.360	
(2)	54	3.49	4.81	4.10	0.317	
(3)	2	5.45	5.46	5.46	-	



STANDARD



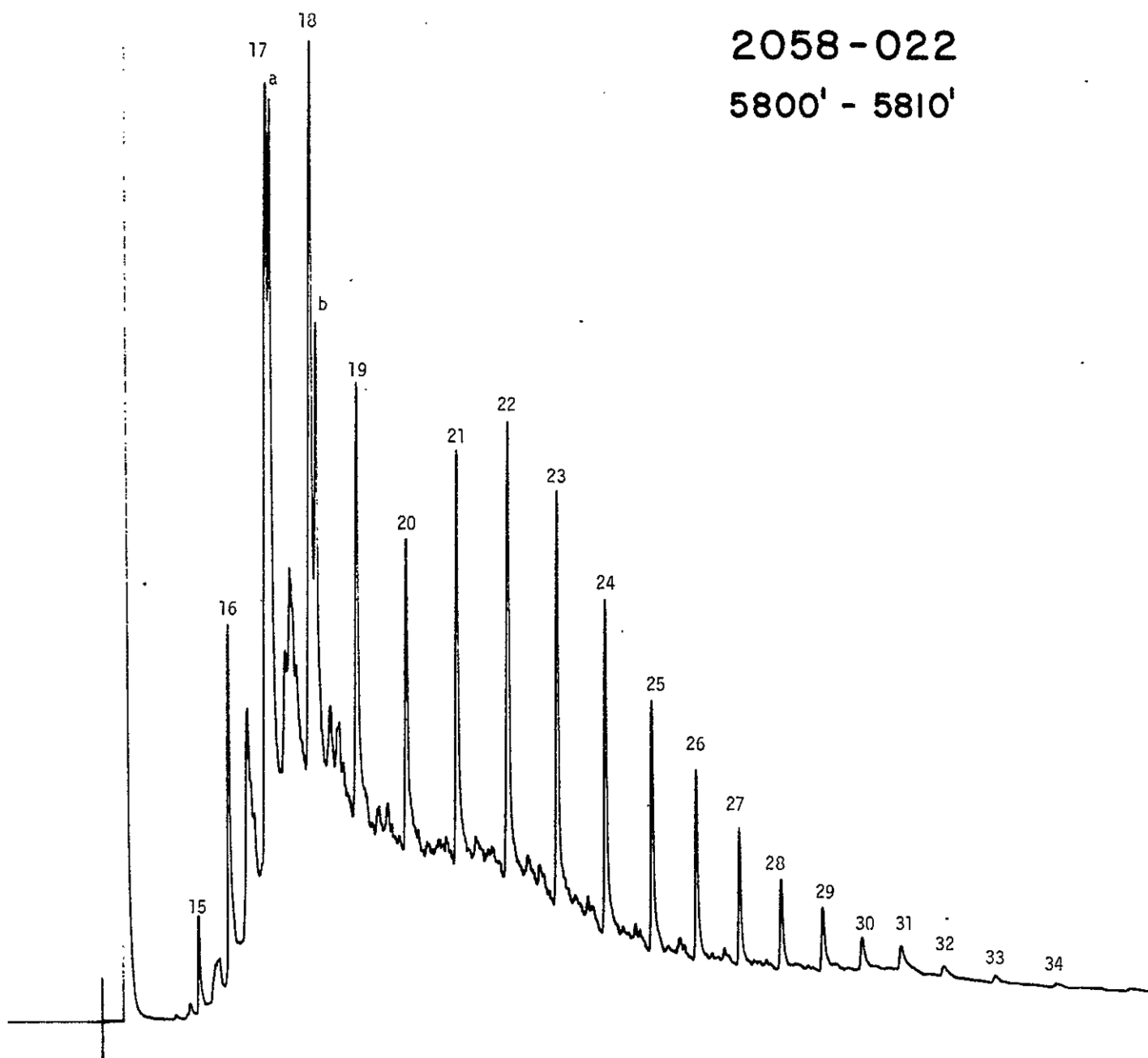
2058-024  
6400'-6410'





2058-022

5800' - 5810'



2058-019

5160'-5170'

