OPEN FILE 5-96

EXPLORATION BRIEFS
&
TECHNICAL MEMORANDA

PT 1

PT 1

Ho 84.0172
c 3

205128 TROLEUM COMPANY
Petroleum Geochemistry Group

To: C. Titus
SPC Mid-Continent Region

December 17, 1984
PGW/121184/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No: 84-136
Classification: RESTRICTED

Subject: Maturity Assessment of the Vierson-Cochran 1-25 Weyerhaeuser Well, McCurtain County, Oklahoma -- Exploration Brief (PGW/EB211).

Thirty-six cuttings samples representing the 385-10000' interval of the Vierson-Cochran 1-25 Weyerhaeuser well were received for maturity assessment. This well penetrated 10000' of meta-sediments, all Devonian or older in age. A thrust fault (possibly the basal Ouachita Detachment) was believed to be at about 6990'. Due to the age and maturity of these sediments, bitumen and/or vitrinite reflectance was used to assess the maturity. Table 1 lists the maturity data.

The sediment thermal maturity profile (STAMP, Figure 1) for the 1-25 Weyerhaeuser well is a graphic representation of the detailed vitrinite (or vitrinite-like) reflectance analyses performed on the well section above the basal detachment fault at 6990' (the data point at 7100', however, was used as the lower most data value for the Outachita facies). Only twelve samples from a total of twenty-six yielded reflectance values for the Ouachita facies. A linear regression applied to this data set indicated a correlation coefficient of 0.97 (r^2=97%). The maturity gradient for this interval was 14.6 DOD units/km (4.45 DOD units/1000'). With this gradient HGT would have occurred at 18300' above the surface. Reflectance values ranged from 3.64% to 8.30% indicating all sediments were thermally spent. The gradient of the 1-25 Weyerhaeuser well compared favorably to the gradient of the Campbell 1-24 well (Cole, 1984). Since the gradients were similar, this would imply that no heating event occurred during the Broken Bow uplift, but maturation was due primarily to depth of burial (in this case, about 28000 to 30000' of burial).

Part 1
Page 1

An alternative interpretation was plotted in Figure 1. There is a possibility of a thrust fault at 4000 to 5000'. The two thrust sheets (dashed lines) had gradients of 18 to 23 DOD units/km. These gradients were much steeper than the gradient for the 1-24 Campbell well and would imply that a heating event had taken place, probably during the uplift of the Broken Bow area; therefore, less depth of burial was needed to attain these maturities (only about 18000 to 21000').

The sediments below the basal detachment fault consisted of highly variable R_o values with no maturity trend (thermally spent; values from 5.29 to 7.84% R_o). This was probably due to cavings and/or indigenous R_o values. The values and respective depths were:

Depth	R_o Value (%)
7500'	7.84
7800'	7.33
8100'	5.95
8400'	6.08
9000'	5.29
9300'	7.59

These values, however, are different enough from the sediments above the fault at 6990' to conclude that the fault is present and can be detected, at least in this case, by R_o determinations.

REFERENCES

Cole, G.A., March 1984, Source rock evaluation of the #1-24 Campbell well, Atoka County, Oklahoma: Technical Memorandum (PGW/TM156).

G. A. Cole

GAC:mlc

Enclosures: Table 1
Figure 1

cc: M. Killgore
H. G. Bassett
R. Drozd
Files (0) (2-5)

TABLE 1

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : MCCURTAIN
LOCATION : SEC25,T5SR23E
WELL/SITE : WEYERHAEUSER #1-25
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
385	WD6005	CTG			SH							
386	XD6005		MISS?	STAN?								
700	WD6006	CTG			SLTST							
985	WD6007	CTG			LST							
1300	WD6008	CTG			LST							
1600	WD6009	CTG			SLTST,CALC							
1900	WD6010	CTG			SH,CALC							
2200	WD6011	CTG			SH,CALC							
2500	WD6012	CTG			SH,CALC							
2800	WD6013	CTG			SH,CALC							
3100	WD6014	CTG			SH,CALC							
3400	WD6015	CTG			SH,CALC							
3700	WD6016	CTG			SH,CALC							
4000	WD6017	CTG			SH,CALC							
4300	WD6018	CTG			SH,CALC							
4600	WD6019	CTG			SH,CALC							
4900	WD6020	CTG			SH,CALC							
5200	WD6021	CTG			SH,CALC							
5500	WD6022	CTG			SH,CALC							
5800	WD6023	CTG			SH,CALC							
6100	WD6024	CTG			SH,CALC							
6400	WD6025	CTG			SH,CALC							
6700	WD6026	CTG			SH,CALC							
6800	WD6027	CTG			SH,CALC							
6900	WD6028	CTG			SH,CALC							
7000	WD6029	CTG			SH,CALC							
7100	WD6030	CTG			SH							
7200	WD6031	CTG			SLTST,CALC							
7500	WD6032	CTG			SH,CALC							
7800	WD6033	CTG			SH,CALC							
8100	WD6034	CTG			SH,CALC							
8400	WD6035	CTG			SH,CALC							
8700	WD6036	CTG			SH,CALC							
9000	WD6037	CTG			SH,CALC							
9300	WD6038	CTG			SH,CALC							
9700	WD6039	CTG			SH,CALC							
10000	WD6040	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
385												3.64			
386															
700															
985												4.36			
1300															
1600															
1900												4.88			
2200															
2500															
2800												5.47			
3100															
3400												6.16			
3700															
4000												6.05			
4300															
4600												6.39			
4900															
5200															
5500												6.57			
5800												7.01			
6100															
6400												7.21			
6700												7.49			
6800															
6900												6.84??			
7000															
7100												8.30			
7200															
7500												7.84			
7800															
8100															
8400															
8700															
9000															
9300															
9700															
10000															

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: C. Titus
SPC Mid-Continent Region
Dallas

September 10, 1985
PGG/090985/GC/2-5
PGG Job No.: 85-79

Attn: D. Bajak

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Geochemical Source Evaluation of Four Samples from the Ouachita Exploration #1 and #2 Caddo River Wells, Clark County, Arkansas - - Exploration Brief (PGG/EB315).

Four cuttings samples, two each from the Ouachita Exploration #1 Caddo River and #2 Caddo River wells, Clark County, Arkansas, were received for geochemical source evaluation. The wells were located in the SE/4, Sec.11-T15S-R23W. The samples were from unknown depths, but both wells were shallow with TD's about 1000'. All samples were Carboniferous in age and analyzed using PGG's standardized methods for whole-rock vitrinite reflectance, %TOC (Rock-Eval), and pyrolysis (Rock-Eval). Geochemical source evaluation data are listed in Table 1.

Results showed:

1) #1 Caddo River well (samples WE4651 and WE4652) - thermally spent with an average R_o of 2.34%; source richness was lean (TOC averaged 0.35%); no potential productivity (S2 averaged 0.05 kg/ton).

2) #2 Caddo River well (samples WE4653 and WE4654) - thermally spent with an average R_o of 2.39%; source richness was lean (TOC averaged 0.31%); no potential productivity (S2 averaged 0.04 kg/ton).

TABLE 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : CLARK
LOCATION : SEC11,T15SR23W
WELL/SITE : CADDO RIVER
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1	WE4651	CTG			SH			.48		0.00	.08	17
2	WE4652	CTG			SH			.22		0.00	.02	9
3	WE4653	CTG			SH			.36		0.00	.03	8
4	WE4654	CTG			SH			.26		0.00	.04	15

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1	0.00		0									2.34			
2	0.00		0									2.33			
3	0.00		0									2.51			
4	0.00		0									2.27			

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To:	C. Titus SPC Mid-Continent Region Dallas	June 20, 1985 PGG/061985/GC/2-5 PGG Job No.: 85-52
From:	Petroleum Geochemistry Group Warrensville	Classification: RESTRICTED

Subject: Source Rock Evaluation of Nineteen Samples from the Getty 1-20 Morris Well, Pushmataha County, Oklahoma -- Exploration Brief (PGG/EB280).

Nineteen (19) cuttings samples from the Getty 1-20 Morris well, Pushmataha County, Oklahoma, were received for source rock evaluation. The samples, from the 1260 to 11400' interval, were given PGG well numbers WE3573-WE3591. Samples were from the Pennsylvanian Jackfork Formation and Mississippian Stanley Group. The samples were analyzed using PGG's standardized methods for %TOC (Rock-Eval), pyrolysis (Rock-Eval), pyrolysis-gas chromatography (PGC), and whole-rock vitrinite reflectance. Source rock evaluation data are listed in Table 1.

The sediment thermal maturity profile (Figure 1) is a graphic representation of the detailed vitrinite reflectance analyses performed on all nineteen (19) samples. However, only ten (10) samples generated usable results. A linear regression applied to this data set indicated a correlation coefficient of 0.98 (r^2=96%). The maturity gradient for this well was 14.5 DOD units/km (4.43 DOD units/1000'). This data implied:

1. The surface R_o, as extrapolated by the regression analysis, was ~0.66%.

2. HGT (hydrocarbon generation threshold) would have occurred at approximately 1000' above the surface.

3. DGGT (dominant gas generation threshold) occurred at approximately 4000'.

4. All sediments below 10850' were thermally spent (R_o >2.0%).

5. The gradient for the Getty 1-20 Morris well was similar to those calculated for the Campbell 1-24, Weyerhaeuser 1-15, Weyerhaeuser 1-25, and Trotter-Dees 1-29 wells (Cole, 1985).

Petrographic analysis of the cuttings also indicated the presence of contaminants such as walnut shells, muds, and low R_o (<0.5%) lignite particles throughout the well. D. Bajak (Dallas, Ouachita Group) informed PGG that the Getty wellsite geologist said the well was air-drilled. The walnut shells, lignite, etc., indicated the use of drilling muds.

Source analyses indicated a moderate source richness for the Stanley and Jackfork sediments. %TOC averaged 0.65% for the well and ranged from 0.29 to 1.21%. Potential productivity, as measured by the S2 pyrolysis yield, was marginal with an average S2 of 0.92 kg/ton (ranged from 0.21-1.61 kg/ton). However, both the %TOC and S2 values would have been enriched by the contaminants/additives in the cuttings. The PGC result for sample number WE3587 (9560') shows the influence of the lignite/walnut shell contamination. The PGC result of 0.40 indicates a sample with a mixed oil/gas proneness. But, this sample also has an R_o of ~1.75-1.80%. A kerogen of this advanced maturity would have a very high PGC result (>1.0) and very little S2 yield (<1.0 kg/ton at best, given a TOC of 0.79%).

<u>REFERENCES</u>

Cole, G.A., 1985, Source evaluation of the Sohio Weyerhaeuser 1-15 well, Pushmataha County, Oklahoma: Technical Memorandum (PGG/TM195).

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

SOHIO

WELL : GETTY 1-20 MORRIS

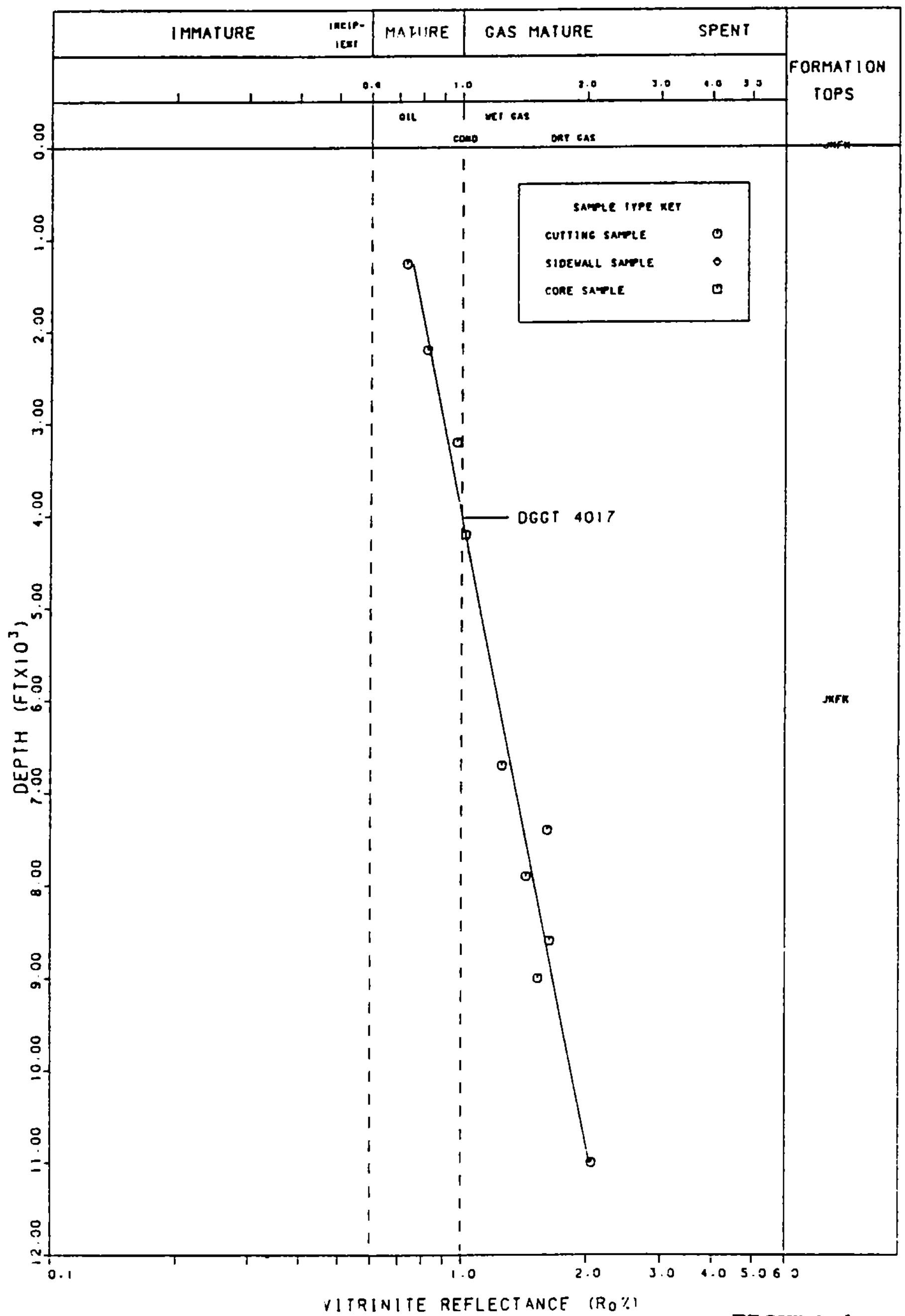


FIGURE 1

TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC20,T3SR17E
WELL/SITE : GETTY 1-20 MORRIS
API/OCS : 35-127-20013

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1260	WE3573	CTG			SH			.57		.66	1.53	268
1700	WE3574	CTG			SH			.67		.24	1.21	181
2200	WE3575	CTG			SH			.29		.16	.21	72
2700	WE3576	CTG			SH			.29		.26	.39	134
3200	WE3577	CTG			SH			.58		.63	.84	145
3750	WE3578	CTG			SH			.53		.80	.98	185
4200	WE3579	CTG			SH			1.21		.72	1.19	98
4800	WE3580	CTG			SH			.69		.50	.89	129
6150	WE3581	CTG			SH			.54		.68	.78	144
6700	WE3582	CTG			SH			.62		1.62	1.19	192
7400	WE3583	CTG			SH			.69		1.79	1.16	168
7900	WE3584	CTG			SH			.77		1.63	1.14	148
8600	WE3585	CTG			SH			.79		2.36	.82	104
9000	WE3586	CTG			SH			.74		1.39	.89	120
9560	WE3587	CTG			SH			.79		2.80	1.61	204
10000	WE3588	CTG			SH			.46		.88	.62	135
10500	WE3589	CTG			SH			.66		1.33	.58	88
11000	WE3590	CTG			SH			.77		1.44	1.00	130
11400	WE3591	CTG			SH			.59		.87	.48	81

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1260	.30		116									.73			
1700	.17		36												
2200	.43		55									.82			
2700	.40		90												
3200	.43		109									.97			
3750	.45		151												
4200	.38		60									1.02			
4800	.36		72												
6150	.47		126												
6700	.58		261									1.25			
7400	.61		259									1.61			
7900	.59		212									1.43			
8600	.74		299									1.63			
9000	.61		188									1.53			
9560	.63		354		.89	.25	.64	113	.40						
10000	.59		191												
10500	.70		202												
11000	.59		187									2.06			
11400	.64		147												

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: C. Titus
SPC Mid-Continent Region
Dallas

September 30, 1985
PGG/091085/GC/2-5
PGG Job No.: 85-75

Attn: D. Bajak

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Geochemical Source Evaluation of Selected Cuttings Samples from Sixteen Wells in Arkansas -- Exploration Brief (PGG/EB316).

A total of forty-four selected cuttings samples from sixteen wells in Arkansas were received for organic geochemical analyses. The objective of the sampling program was to assess the source rock potential and maturity of the Paleozoics below the Cretaceous cover in southern Arkansas.

All samples were analyzed for whole-rock vitrinite reflectance, % TOC (Rock-Eval), and pyrolysis (Rock-Eval). Source rock evaluation and well location data are located in Tables 1-16.

Source analyses showed:

1. Cretaceous sediments (5 samples) - immature with an average R_o of 0.41%; source richness was moderate with an average TOC of 0.86% (one sample contained very good source richness of 2.24% TOC); potential productivity was marginal with an average S2 yield of 0.58 kg/ton.

2. Paleozoic sediments undifferentiated (39 samples) - maturities ranged from peak oil generation (0.83% R_o) to thermally spent (4.58% R_o) depending upon location; source richness was moderate with an average TOC of 0.69% and ranged from 0.0 to 1.23%; potential productivity was poor with an average S2 yield of 0.21 kg/ton and ranged from 0.0 to 0.85 kg/ton.

Four of the thirty-nine Paleozoic sediments were identified as Jackfork Formation (Pennsylvanian age). The samples were from two wells in Sec.1 - T10S-R31W. The maturity in this section was between 0.99 to 1.32% R_o indicating potential for light oil to wet gas/condensate at shallow depths. Source richness was moderate with an average TOC of 0.78%, but potential productivity was poor (average S2 of 0.22 kg/ton).

G. A. Cole

G. A. Cole

GAC:mlc

Enclosures: Tables 1-16

cc: M. Killgore
H. G. Bassett
R. Drozd
Files (0) (2-5)

TABLE 1

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : HOT SPRINGS
LOCATION : SEC19,T4SR16W
WELL/SITE : #1 HENSON-CALHOUN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
700	WE4532	CTG			SH			.21		0.00	0.00	0
1000	WE4533	CTG			SH,CALC			.32		.04	.09	28
1375	WE4534	CTG			SH,CALC			.61		.02	.02	3

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
700			0									4.22			
1000	.31		12									3.97			
1375	.50		3									4.58			

TABLE 2

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : CLEVELAND
LOCATION : SEC32,T8SR11W
WELL/SITE : #1 OLIN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3550	WE4535	CTG	CRET		SH,CALC	38		2.24		.23	2.29	102
3750	WE4536	CTG			SH,CALC			.88		.11	.35	40

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3550	.09		10									.45			
3750	.24		12												

TABLE 3

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : CLEVELAND
LOCATION : SEC21,T10SR9W
WELL/SITE : #1 HOLDERFIELD
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3500	WE4537	CTG			SH,CALC			.86		.03	.20	23
4200	WE4538	CTG			SH,CALC			.79		.07	.21	27
4500	WE4539	CTG			SLTST			.69		.03	.07	10

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(U) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3500	.13		3												
4200	.25		9									.50 *			
4500	.30		4									2.73			

* Cretaceous Cavings

TABLE 4

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : HOT SPRINGS
LOCATION : SEC3,T6SR18W
WELL/SITE : #1 CABE BROS.
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
300	WE4540	CTG			SH			1.20		.03	.05	4

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
300	.38		2									1.95			

TABLE 5

S U M M A R Y   D A T A   F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : HEMPSTEAD
LOCATION : SEC27,T12SR26W
WELL/SITE : #1 DOUGLAS
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
11000	WE4541	CTG			SH			.36		.02	.02	6
11600	WE4542	CTG			SH,CALC			.92		0.00	.11	12
12200	WE4543	CTG			SH,CALC			.94		.06	.13	14
12500	WE4544	CTG			SH,CALC			.65		.04	.04	6
13100	WE4545	CTG			SH			1.23		.01	.09	7
13700	WE4546	CTG			SH			0.00		0.00	0.00	

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
11000	.50		6												
11600	0.00		0									1.68			
12200	.32		6									1.82			
12500	.50		6												
13100	.10		1									1.73			
13700												1.91			

TABLE 6

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : DALLAS
LOCATION : SEC11,T8SR15W
WELL/SITE : #1 INT'L PAPER
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2385	WE4547	CC			SH			.68		.01	.03	4
2400	WE4548	CC			SH			.68		.01	.85	125

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2385	.25		1									2.25			
2400	.01		1									2.04			

TABLE 7

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : GRANT
LOCATION : SEC35,T5SR13W
WELL/SITE : #1-35 INT'L PAPER
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2610	WE4549	CC			SH			.87		0.00	.02	2

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2610	0.00		0									2.39			

TABLE 8

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : GRANT
LOCATION : SEC30,T4SR11W
WELL/SITE : #1-30 INT'L PAPER
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2881	WE4550	CC			SH			.54		.10	.32	59
2886	WE4551	CC			SH			.43		.10	.56	130

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2881	.24		19									3.66			
2886	.15		23												

TABLE 9

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : HEMPSTEAD
LOCATION : SEC13,T10SR26W
WELL/SITE : TEXACO #1WEBB
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1350	WE4552	CTG			SH			.35		.03	.46	131
1600	WE4553	CTG			SH			.83		.02	.25	30
2030	WE4554	CTG			SH			.80		.04	.23	29

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1350	.06		9												
1600	.07		2									1.06			
2030	.15		5									.83			

TABLE 10

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : HEMPSTEAD
LOCATION : SEC16,T10SR25W
WELL/SITE : T.RAY #1HARRIS
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1800	WE4555	CTG			SH			.63		.40	.44	65
2300	WE4556	CTG			SH			.82		.43	.39	48
2800	WE4557	CTG			SH			.82		.32	.32	39
3300	WE4558	CTG			SH			.65		.15	.11	17
3800	WE4559	CTG			SH			.68		.36	.30	44
4220	WE4560	CTG			SH			.78		.30	.30	38

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1800	.48		59									1.00			
2300	.52		52												
2800	.50		39												
3300	.58		23												
3800	.55		53									1.23			
4220	.50		38									1.26			

TABLE 11

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : CLARK
LOCATION : SEC7,T11SR19W
WELL/SITE : ZICK #1GREEN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1210	WE4561	CTG			SH			.59		.26	.26	44

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1210	.50		44												

TABLE 12

PAGE . 1

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : CLARK
LOCATION : SEC35,T9SR18W
WELL/SITE : ROSS#1 OZAN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1620	WE4562	CTG			SH			.91		.09	.23	25
1790	WE4563	CTG			SH			.68		.02	.14	21

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1620	.28		10												
1790	.13		3									.47	*		

* Cretaceous Cavings

TABLE 13

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : SEVIER
LOCATION : SEC1,T10SR31W
WELL/SITE : DAVIS #1CAGE
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1000	WE4564	CTG	CRET		SH			.64		.50	.24	37
1660	WE4565	CTG	PENN	JKFK	SH			.84		.04	.19	23

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1000	.68		78									.38			
1660	.17		5									1.32			

TABLE 14

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : SEVIER
LOCATION : SEC1,T10SR31W
WELL/SITE : #1 81 NIX
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1500	WE4566	CTG	PENN	JKFK	SH			.40		.03	.12	30
1580	WE4567	CC	PENN	JKFK	SH			.85		.01	.25	29
1583	WE4568	CC	PENN	JKFK	SH			1.03		.09	.32	31

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1500	.20		7									1.02			
1580	.04		1									.99			
1583	.22		9									.99			

TABLE 15

PAGE . 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : LITTLE RIVER
LOCATION : SEC18,T12SR29W
WELL/SITE : #1 ADA MILLS
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2460	WE4569	CTG	CRET		SH			.38		.03	.08	21
2990	WE4570	CTG			SH			.33		.03	.09	27
3390	WE4571	CTG			SH			.39		.03	.09	23

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2460	.27		8									.38			
2990	.25		9									.75 *			
3390	.25		8												

* Cretaceous Cavings

TABLE 16

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : HOWARD
LOCATION : SEC28,T11SR27W
WELL/SITE : #1 STATE INS.
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1100	WE4572	CTG	CRET		SH			.50		.05	.09	18
1590	WE4573	CTG	CRET		SH			.55		.10	.20	36
2250	WE4574	CTG			SH			.69		.04	.15	22
2800	WE4575	CTG			SH			1.02		.10	.48	47

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1100	.36		10									.43			
1590	.33		18												
2250	.21		6									.84			
2800	.17		10									.91			

206002

2-5

EB 346

u086.0095
C-3

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: C. Titus
SPC Continental Region
Dallas

February 7, 1986
PGG/020786/GC/2-5
PGG Job No.: 86-09

51888

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Geochemical Evaluation of Two Cuttings Samples from Shallow Coreholes, Weyerhaeuser Acreage, Arkansas -- Exploration Brief (PGG/EB346).

Two (2) samples from shallow coreholes, Sevier County, Arkansas, were received for source rock evaluation. The samples were given PGG well numbers WE7878 and WE7879 and represent samples DQ 8-5 and DQ-27, respectively. The samples were analyzed using standardized PGG methods for % TOC (Rock-Eval), pyrolysis (Rock-Eval) and whole-rock vitrinite reflectance. The geochemical data for this series of samples are given in Table 1.

Both samples were from Section 31, T7S, R31W.

Despite mainly marginal organic carbon contents, a vitrinite reflectance measurement was possible on one sample. The R_o value was 1.86% indicating a dry gas maturity, only. Figure 1 illustrates the maturity scales used by PGG.

Geochemical source analyses indicated the sediments were source lean with poor potential productivities. TOC (%) and S2 yields were 0.42% and 0.14 kg/ton, respectively.

G. A. Cole

GAC:mlc

Enclosures: Figure 1
Table 1

cc: M. Howe
M. Killgore
T. Krancer
R. Drozd
D. McGuinness
Files (0) (2-5)

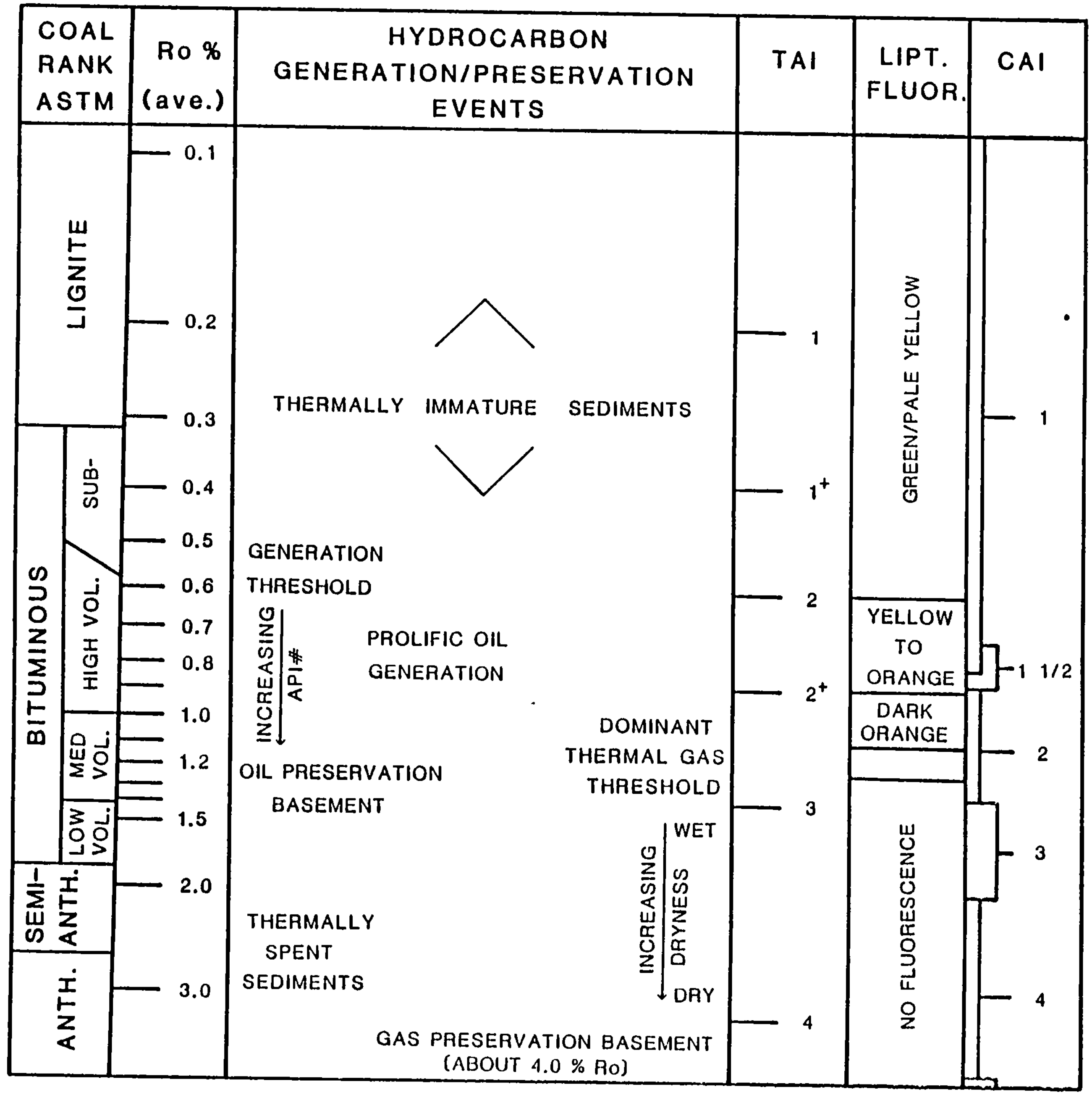

COAL RANK ASTM
Ro % (ave.)
HYDROCARBON GENERATION/PRESERVATION EVENTS
TAI
LIPT. FLUOR.
CAI
LIGNITE
BITUMINOUS
SUB-
HIGH VOL.
MED VOL.
LOW VOL.
SEMI-ANTH.
ANTH.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1.0
1.2
1.5
2.0
3.0
THERMALLY IMMATURE SEDIMENTS
GENERATION THRESHOLD
INCREASING API#
PROLIFIC OIL GENERATION
OIL PRESERVATION BASEMENT
DOMINANT THERMAL GAS THRESHOLD
WET
INCREASING DRYNESS
DRY
THERMALLY SPENT SEDIMENTS
GAS PRESERVATION BASEMENT (ABOUT 4.0 % Ro)
1
1+
2
2+
3
4
GREEN/PALE YELLOW
YELLOW TO ORANGE
DARK ORANGE
NO FLUORESCENCE
1
1 1/2
2
3
4

FIGURE 1

TABLE 1

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : SEVIER
LOCATION : SEC31,T7SR31W
WELL/SITE : JKFK SHOTPOINTS
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
60	WE7878	CTG	PENN	JKFK	SH,SLTY			.41		.01	.11	27
60	WE7879	CTG	PENN	JKFK	SH,SLTY			.42		.07	.16	38

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
60	.08		2												
60	.30		17									1.36			

STANDARD OIL PRODUCTION COMPANY

Petroleum Geochemistry Group

51905

To: D. McGuinness
Continental Division
Central Region
Dallas

March 31, 1986
PGG/033186/GC/2-5
PGG Job No.: 86-11

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Geochemical Evaluation of Eight Sediment Samples from Five SWEPI Wells, Pike County, Arkansas – Exploration Brief (PGG/EB353).

Eight samples from five shallow drill-holes, Weyerhaeuser Acreage, Pike County, Arkansas were received for source rock evaluation. The drill-holes were:

Hole #85-8	:	Section 1-T5S-R26W
Hole #85-9	:	Section 4-T5S-R26W
Hole #85-10	:	Section 5-T5S-R26W
Core #49	:	Section 4-T5S-R27W
Core #50	:	Section 5-T5S-R25W

The eight samples were given PGG well numbers WE8040 to WE8047. Each sample was analyzed using standardized PGG methods for %TOC (Rock-Eval), pyrolysis (Rock-Eval), and whole rock vitrinite reflectance. All samples were from the Devonian Arkansas Novaculite Formation. The geochemical data for this series of samples are given in Tables 1-5.

Geochemical source analyses indicated that the Arkansas Novaculite samples in this area were source lean with an average TOC of 0.02%; no potential productivity (as measured by S_2 pyrolysis) existed for these samples. Analyses from other areas of the Ouachita's, however, have shown good source richness and productivity for the Laminated Zone of the Arkansas Novaculite (see Titus and Cole, 1986). If samples could be obtained from the Laminated Zone, these sediments may be more definitive of the source rock potential in this area.

Vitrinite measurements were possible on only one sample (WE8044. Hole #85-10) due to the poor organic carbon contents. This sample had a R_o of 2.55% and is illustrated in Figure 1. This measurement is indicative of a thermally spent source rock.

REFERENCES:

Titus. C.A.O. and G.A. Cole. 1986. Source rock potential and sediment thermal maturity trends of the Ouachita facies of the Ouachita Overthrust. southeast Oklahoma: Continental Region Report 5130G.

G. A. Cole

GAC:mlc

Enclosures: Tables 1-5

Figure 1

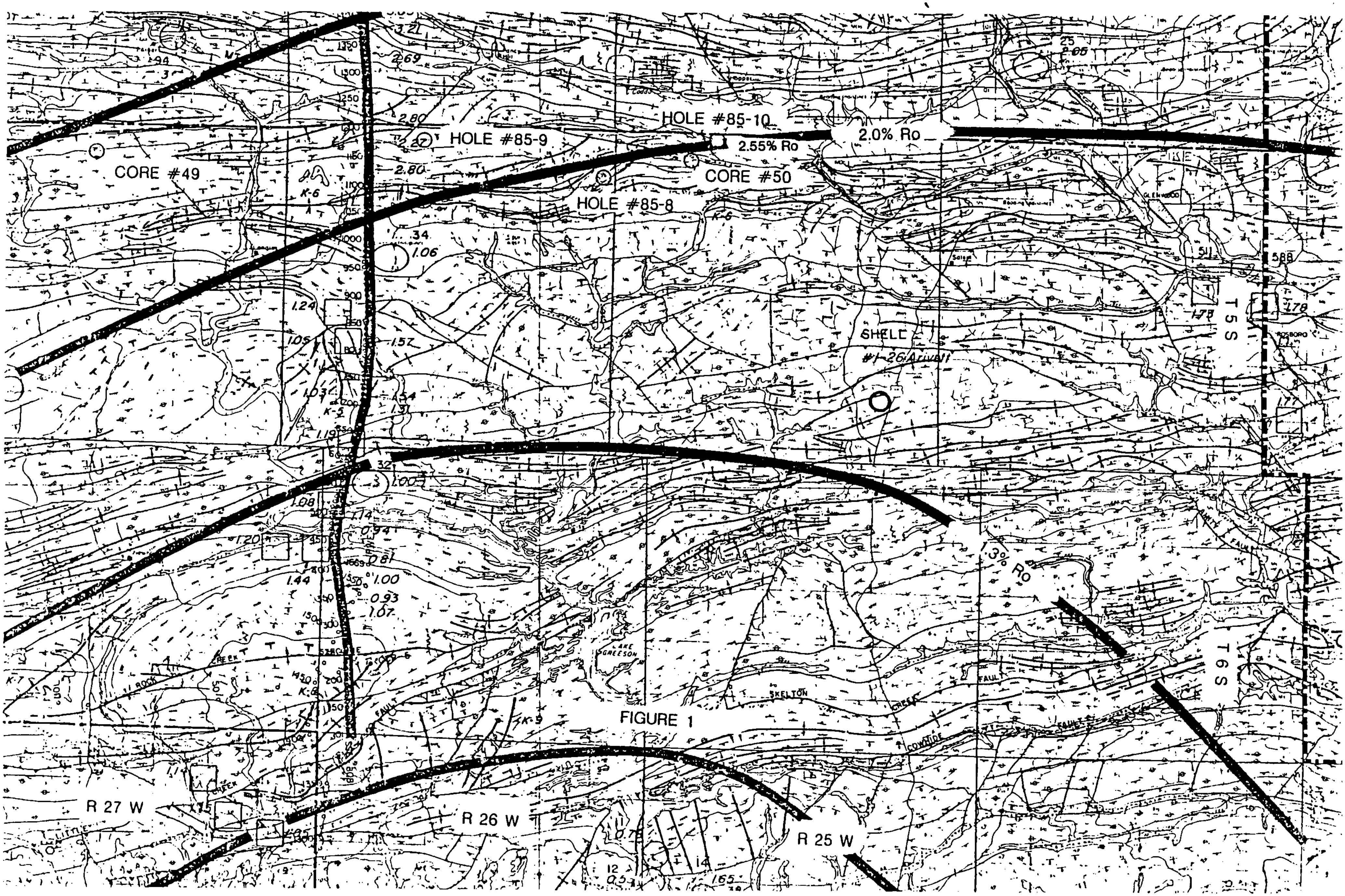
cc: M. Howe

A. Krancer

C. Titus

R. Drozd

Files (0) (2-5)



HOLE #85-10
2.0% Ro
2.55% Ro
HOLE #85-9
CORE #49
CORE #50
HOLE #85-8
SHELL
#1-26 Arivell
T5S
T6S
1.3% Ro
FIGURE 1
R 27 W
R 26 W
R 25 W

TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : PIKE
LOCATION : SEC1,T5SR26W
WELL/SITE : HOLE #85-8
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
280	WE8040	CTG	DEV	ARKN				.03		.05	0.00	0

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
280	1.00		167												

TABLE 2

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : PIKE
LOCATION : SEC4,T5SR26W
WELL/SITE : HOLE #85-9
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
100	WE8041	CTG	DEV	ARKN				.06		.22	.14	233
260	WE8042	CTG	DEV	ARKN				0.00		0.00	0.00	
280	WE8043	CTG	DEV	ARKN				0.00		.01	.03	

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
100	.61		367												
260															
280	.25														

TABLE 3

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : PIKE
LOCATION : SEC5.T5SR25W
WELL/SITE : HOLE #85-10
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
220	WE8044	CTG	DEV	ARKN				.12		.02	.08	67
280	WE8045	CTG	DEV	ARKN				.02		.01	.05	250

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
220	.20		17									2.55			
280	.17		50												

TABLE 4

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : PIKE
LOCATION : SEC4,T5SR27W
WELL/SITE : COU #49
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
294	WE8046	CC	DEV	ARKN				0.00		.01	.09	

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
294	.10														

TABLE 5

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY	:	US
STATE	:	AR
COUNTY/REGION/PROSPECT	:	PIKE
LOCATION	:	SEC5,T5SR25W
WELL/SITE	:	COU #50
API/OCS	:	-

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
296	WE8047	CC	DEV	ARKN				.01		.04	.10	1000

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
296	.29		400												

Petroleum Geochemistry Group

To: D. McGuiness
SOPC, Dallas

August 1, 1986

PGG/080186/GC/2-5

From: Petroleum Geochemistry Group
Freeport Center

Class.: Restricted

Subject: Kerogen types of the Ouachita Facies-- Exploration Brief(PGG/EB370)

At your request an attempt was made to determine the kerogen types for the Jackfork (Pennsylvanian) and Stanley (Mississippian) Formations in the Ouachita Overthrust. These two formations are part of the flysch deposits, commonly formed from submarine fan and turbidite complexes. This paper used the organic geochemical data from four sites: the Stringtown Quarry, 1-24 Campbell well, 1-15 Weyerhaeuser well, and 1-29 Trotter-Dees well.

Traditionally, PGG uses an in-house technique for determining the hydrocarbon proneness of a sample. This technique is pyrolysis-gas chromatography (PGC) and is used to type the kerogen assemblage as being oil prone, mixed oil/gas prone, or gas prone. This method has been used quite successfully on the lower Paleozoic strata in the Ouachita Overthrust region. Of particular interest would be the dominant oil proneness of the Ordovician Polk Creek Shale, Bigfork Chert, and Womble Shale and the Devonian Arkansas Novaculite. Unfortunately, this technique requires an S_2 pyrolytic yield (from Rock-Eval pyrolysis) >1.0 kg/ton and a maturity <0.8% R_o. Mostly due to the S_2 restriction, the sediments belonging to the Jackfork and Stanley were unsuitable for PGC. The typical S_2 yield from these sediments is <1.0 kg/ton. Therefore, an attempt was undertaken to type the kerogens by using the hydrogen index (HI) and oxygen index (OI) values via a "van Krevelen" plot. HI (S_2/TOC) and OI (S_3/TOC) are calculated from the routine total organic carbon and Rock-Eval pyrolysis analytical data. The reliability is not exceptionally good due primarily to the influence of maturity and reworked materials during pyrolysis.

To determine the kerogen types, the following controls were used:

Formation	% R_o	% TOC	Result
Jackfork	<1.0	>0.5	**TYPE III**
Stanley	<1.0	>0.5	**TYPE III**
Ark. Novaculite	<0.8	>1.0	**TYPE II**
Polk Creek Shale	<0.8	>2.0	**TYPE I**
Bigfork Chert	<0.8	>1.0	**TYPE II**
Womble Shale	<0.8	>2.0	**TYPE I-II**

Figure 1, the van Krevelen diagram, shows that the flysch sediments are predominantly **TYPE III** kerogens and would generate mostly **gaseous hydrocarbons.** The lower Paleozoic sediments were **TYPE I and II** kerogens and would generate mostly **liquid hydrocarbons.**

It should be noted, however, that there are asphalt deposits and seeps within the Jackfork Formation. These seeps have different isotopic compositions than the oils derived from the lower Paleozoic section [(-25.7 vs. >-30.0 ppt, respectively) see Marsek, 1982 and Cole and others, 1984]. This could imply a localized source within the Jackfork that may be oil prone or mixed oil/gas prone. It is conceivable that occasional periods of passivity (long enough to deposit small amounts of marine shales) occurred between turbidite deposits; but, with the extent and thicknesses of flysch deposits, these marine shales would probably be very thin and extremely localized.

References

Cole, G., H. Halpern, and R. Sedivy, 1984, Geochemical characterization and comparison of two asphalt samples from the 1-24 Campbell well, Atoka County, Oklahoma: PGG/EB 144

Marsek, F., 1982, Pennsylvanian Jackfork Fm. Asphalts: PGG/TM 031

Tissot, B.P. and D.H. Welte, 1978, Petroleum Formation and Occurrence: Springer-Verlag, NY

G.A. Cole

cc: A. Krancer
M. Howe
R. Drozd
Files (0), (2-5)

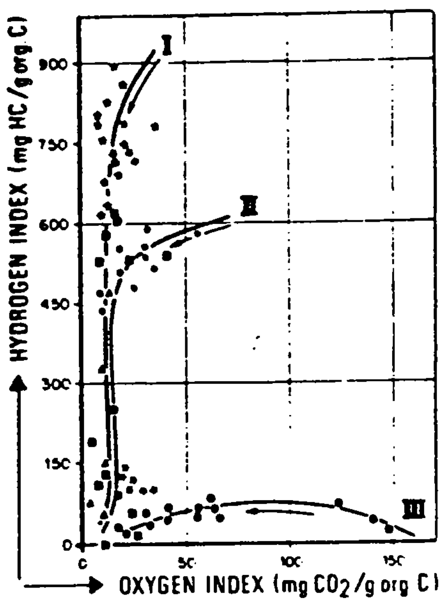
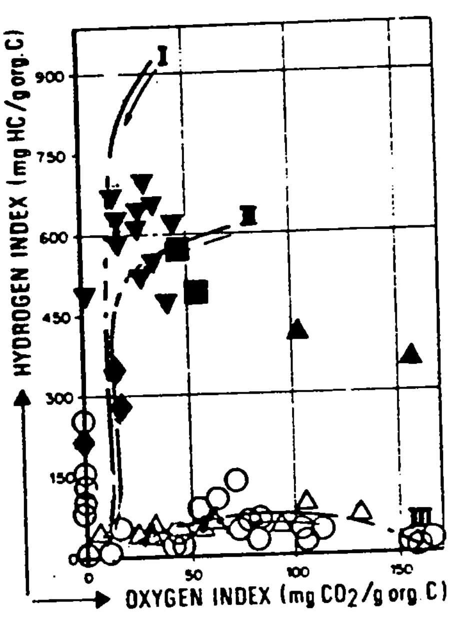


Fig. V.1.12. Classification of the source rock types by using hydrogen and oxygen indices. This diagram is readily comparable to the van Krevelen diagram plotted from elemental analysis of kerogen (Espitalié et al., 1977)

- Green River shales
- Lower Toarcian, Paris Basin
- Silurian-Devonian, Algeria, Libya
- Upper Cretaceous Douala Basin
- Others

HI versus OI using a "van Krevelen" type plot (from Tissot and Welte, 1978)



△ Jackfork

○ Stanley

◆ Arkansas Novaculite

▼ Polk Creek Shale

▲ Bigfork Chert

■ Womble Shale

FIGURE 1

THERMAL MATURITY ASSESSMENT OF THE WEYERHAEUSER 1-7 WELL LE FLORE COUNTY, OKLAHOMA

EXPLORATION BRIEF (PGG/EB388)

Author: G.A. Cole

STANDARD OIL PRODUCTION COMPANY
Petroleum Geochemistry Group

TO:	R. Jantzen Gulf Coast/COD Houston	DATE: June 10, 1987 FILE: PGG/061087/GC/2-8
FROM:	Petroleum Geochemistry Group Freeport Laboratory, Dallas	CLASS.: CONFIDENTIAL

Subject: Thermal Maturity Assessment of the Weyerhaeuser 1-7 Well, Le Flore County, Oklahoma--Exploration Brief (PGG/EB388).

Well cuttings samples from the 600-8000' interval (TD at 8000') from the Weyerhaeuser 1-7 well, Le Flore County, Oklahoma, were received for thermal maturity assessment via whole-rock vitrinite reflectance techniques. Samples were selected on a 300' basis. Data results are listed in Table 1 and graphically illustrated in Figure 1. No stratigraphic information was provided for this well site.

A total of 27 sample were selected for vitrinite reflectance analyses. From these 27 samples, 11 contained no measurable vitrinite and were reported as "NDP" (no determination possible). Sixteen samples yielded useable results and a linear regression was applied to this data set. The regression analysis indicated:

1.) The surface Ro was approximately 0.8% indicating that the surface rocks were within the oil window. The lower limit of the oil window for moderate API gravity oils (1.35% Ro) was at 5240'. Therefore, oils could be preserved to depths of 5240'. However, light oils can be preserved in rocks with Ro values as high as 1.50%, or to depths of about 6200'.

2.) The dominant gas generation threshold (DGGT; 1.00% Ro) occurred at 2170'. DGGT is where the kerogen begins generation of gaseous products. This is also where oils begin to thermally crack into lighter components.

3.) Thermally spent rocks (2.0% Ro) would have been penetrated at a depth of about 9265' if drilling had continued.

4.) The regression calculated a maturity gradient of 4.24 DOD units/1000' with a correlation coefficient of 94%. The gradient of the Weyerhaeuser 1-7 well correlates very well with gradients calculated from other wells in the Ouachita region. Gradients for other wells were: Shell 1-26 Arivett (Pike County, Arkansas)- 4.06 DOD units/1000', Campbell 1-24 well (Atoka County, Oklahoma)- 4.85 DOD units/1000', Getty 1-20 Morris well (Pushmataha County, Oklahoma)- 4.43 DOD units/1000', Trotter-Dees 1-29 well (Pushmataha County, Oklahoma)- 4.31 DOD units/1000', and the Weyerhaeuser 1-15 well (Pushmataha County, Oklahoma)- 4.43 DOD units/1000'.

5.) Typical surface Ro values without erosion are generally accepted as being 0.15-0.20%. Using a 0.20% Ro value for the surface, about 14300' of erosion has occurred at this site.

Conclusions:

The rocks penetrated by the Weyerhaeuser 1-7 well were oil mature (0.8% Ro at the surface) to wet gas mature at TD (about 1.7% Ro). If a source rock and reservoir rock were available, this site could have yielded liquid and/or gaseous hydrocarbons, depending upon depth.

Source rock analyses are pending, and will be reported at a later date.

G.A. Cole

encl: Table 1
Figure 1

cc: A. Krancer
J. Nania
M. Rahman
Exploration Briefs

Table 1

WEYERHAEUSER 1-7 VITRINITE DATA

DEPTH	AVE %Ro	# PTS	LOW	HIGH	Quality	REWORKED Ro
600	0.83	17	0.72	0.96	GOOD	
700	NDP	---	---	---		
1000	0.88	11	0.73	1.04	GOOD	
1300	0.92	11	0.78	1.04	GOOD	
1600	0.88	7	0.76	0.99	FAIR	
1900	NDP	---	---	---		1.31
2200	0.94	20	0.7	1.09	GOOD	
2500	NDP	---	---	---		1.59
2800	1.13	3	1.04	1.2	POOR	1.63
3000	1.16	4	0.99	1.32	POOR	1.62
3300	NDP	---	---	---		1.69
3600	NDP	---	---	---		1.61
3900	1.25	3	1.21	1.31	POOR	1.65
4200	1.21	3	1.17	1.27	POOR	
4500	1.38	3	1.21	1.48	POOR	2.02
4700	NDP	---	---	---		1.76
5000	NDP	---	---	---		1.86
5300	NDP	---	---	---		1.99
5600	1.37	12	1.05	1.54	GOOD	
5800	NDP	---	---	---		1.81
6100	1.5	4	1.37	1.66	POOR	2.04
6500	1.54	4	1.47	1.66	POOR	
6800	1.67	5	1.5	1.82	FAIR	1.8
7100	NDP	---	---	---		2.11
7300	1.49	4	1.37	1.65	POOR	1.97
7600	NDP	---	---	---		2
7900	1.66	5	1.47	1.89	FAIR	2

++++++++++++++++++++++++++++++++++++

WEYERHAEUSER 1-7

++++++++++++++++++++++++++++++++++++

Ro (%)	DEPTH (Feet)
0.20	-14311.
0.60	-3062.
0.85	504.
1.00	2168.
1.35	5241.
2.00	9265.

====================================

The slope of the best fit line is 4.24 DOD units/1000 ft.

The correlation coefficient is 0.97

WEYERHAEUSER 1-7

VITRINITE REFLECTANCE (% Ro)

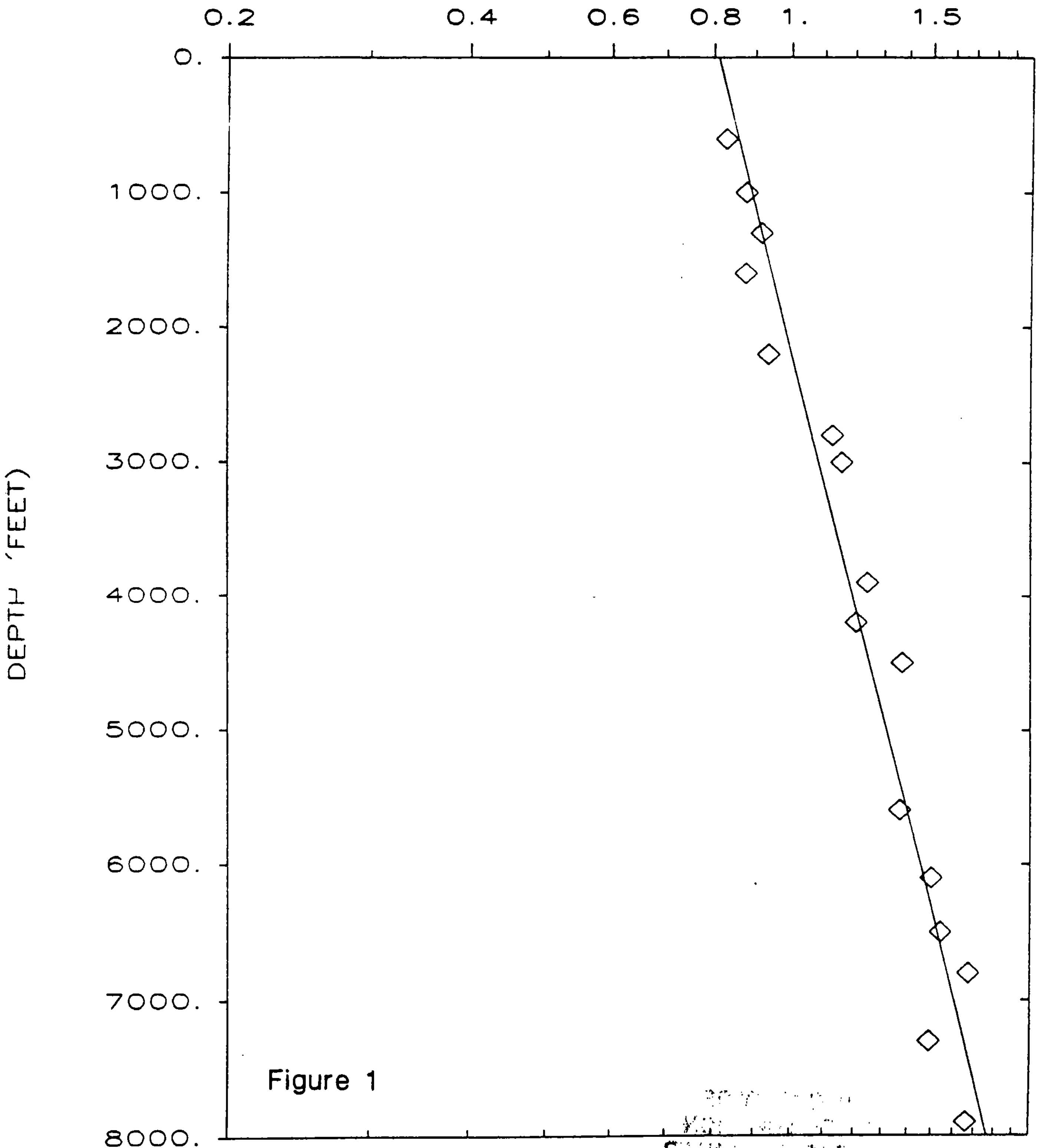


Figure 1

STANDARD OIL PRODUCTION

Petroleum Geochemistry Group

902999

STANDARD OIL PRODUCTION COMPANY

Petroleum Geochemistry Group

TO: R. Jantzen
Operations, Houston

DATE: July 15, 1987

FILE: PGG/071587/GC/2-6

FROM: Petroleum Geochemistry Group
Freeport Laboratory, Dallas

CLASS.: CONFIDENTIAL

SUBJECT: Contaminants used during the drilling of the Weyerhaeuser 1-22 well, McCurtain County, Oklahoma--Exploration Brief (PGG/EB393)

Cuttings samples and formation waters (with minor amounts of an unknown hydrocarbon) were submitted to the Petroleum Geochemistry Group for analysis using standard techniques for hydrocarbon characterization.

The cuttings samples were analyzed using routine organic petrographic methods. Results indicated that the marbles and phyllites penetrated at depths >14200' were contaminated with a lignite/coal rich additive (i.e. carbonox). The metamorphic cuttings samples, generally with Ro values > 8.0%, were greatly contaminated with lignite with an Ro value about 0.37%. Figure 1 illustrates the Ro plot for the 14200' sample.

The liquid hydrocarbon from the sample of formation waters was identified as a diesel contaminant. Identification was made htrough comparison with a diesel fuel and is shown in Figure 2. Figure 2 shows the whole oil chromatogram as determined on the TXGC (thermal extraction gas chromatograph) for the diesel fuel (upper chromatogram) and the contaminant from sample #1. Both chromatograms show the same general characteristics: only normal paraffins between C_{10} through C_{22} and pr/ph ratios about 1.5. Figure 3 overlays both the diesel fule and the contaminant chromatograms. (Note how well both samples compared.) The only apparent difference between the contaminant and the dielel are the greater amounts of C_{11} through C_{13} from the contaminant samples. This difference is probably due to the comparison to this particular diesel fuel; there are numerous grades of diesel fuel as well as rifinery runs available on the market and each has its own characteristics.

Figures 4, 5 and 6 illustrate the four samples [HCC222- bottle #1, 85 STKS; HCC223- bottle #2, 160 STKS; HCC224- bottle #3 268 STKS; HCC225- bottle #4, 400 STKS] of contaminants compared to one another. Samples HCC-222, 223, 224 and 225 were fully identical to each other, which further indicates that the samples were some type of diesel contamination If this was an oil which had lost its light ends due to the drilling process and the storage in the plastic bottles, there should have been some differences among the three samples since the above processes would have effected each separate sample at least somewhat differently.

G.A. COLE

encl: Figures 1-6

cc: M. Rahman
E. Werren
Exploration Briefs

SOHIO Reflectance

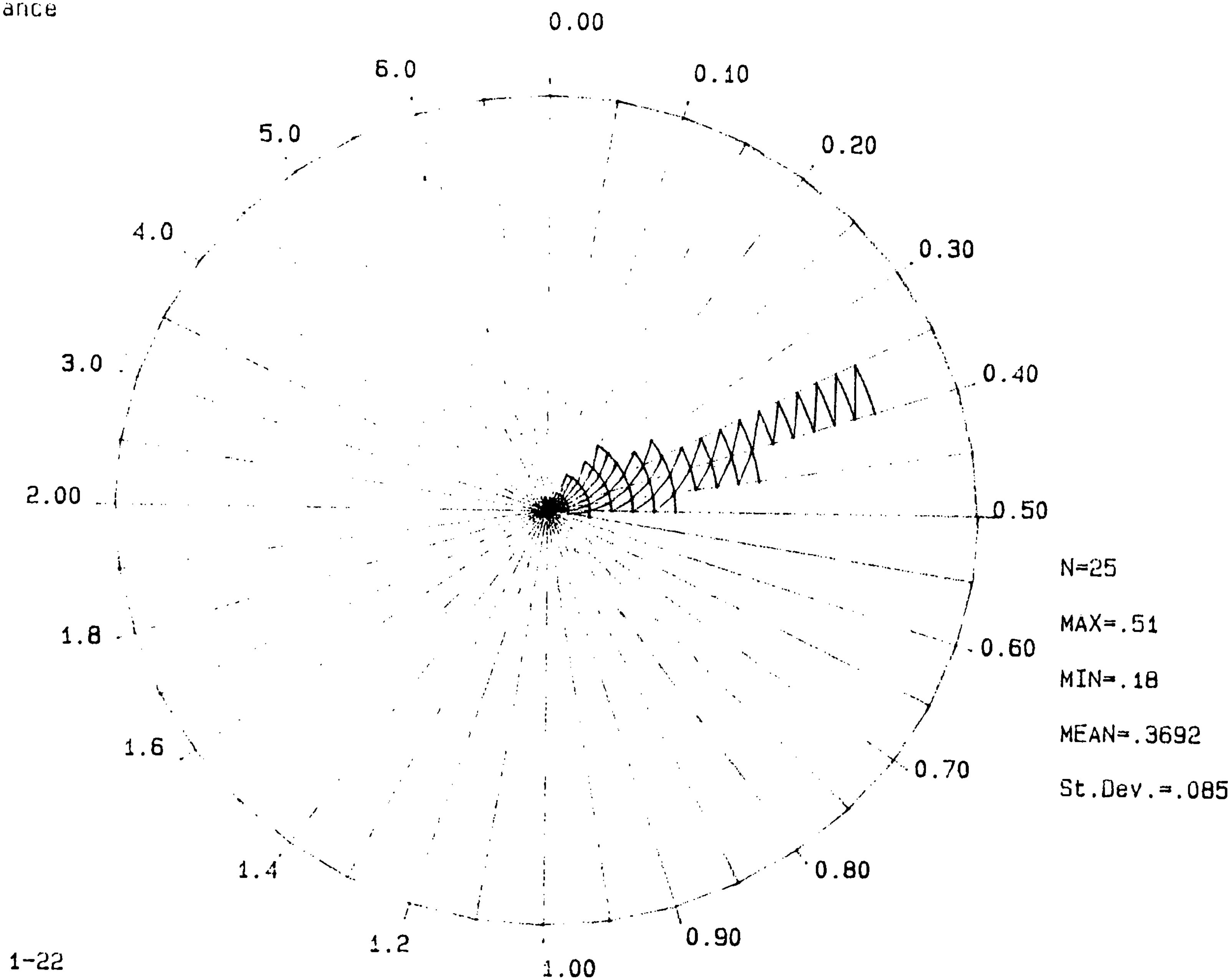


Figure 1:

14200' WEYER 1-22

MARBLE--BARREN--NDP//ADDITIVE (CONTAMINANT--LIGNO SULFINATE?) -LIGNITE RICH IN EXINITES

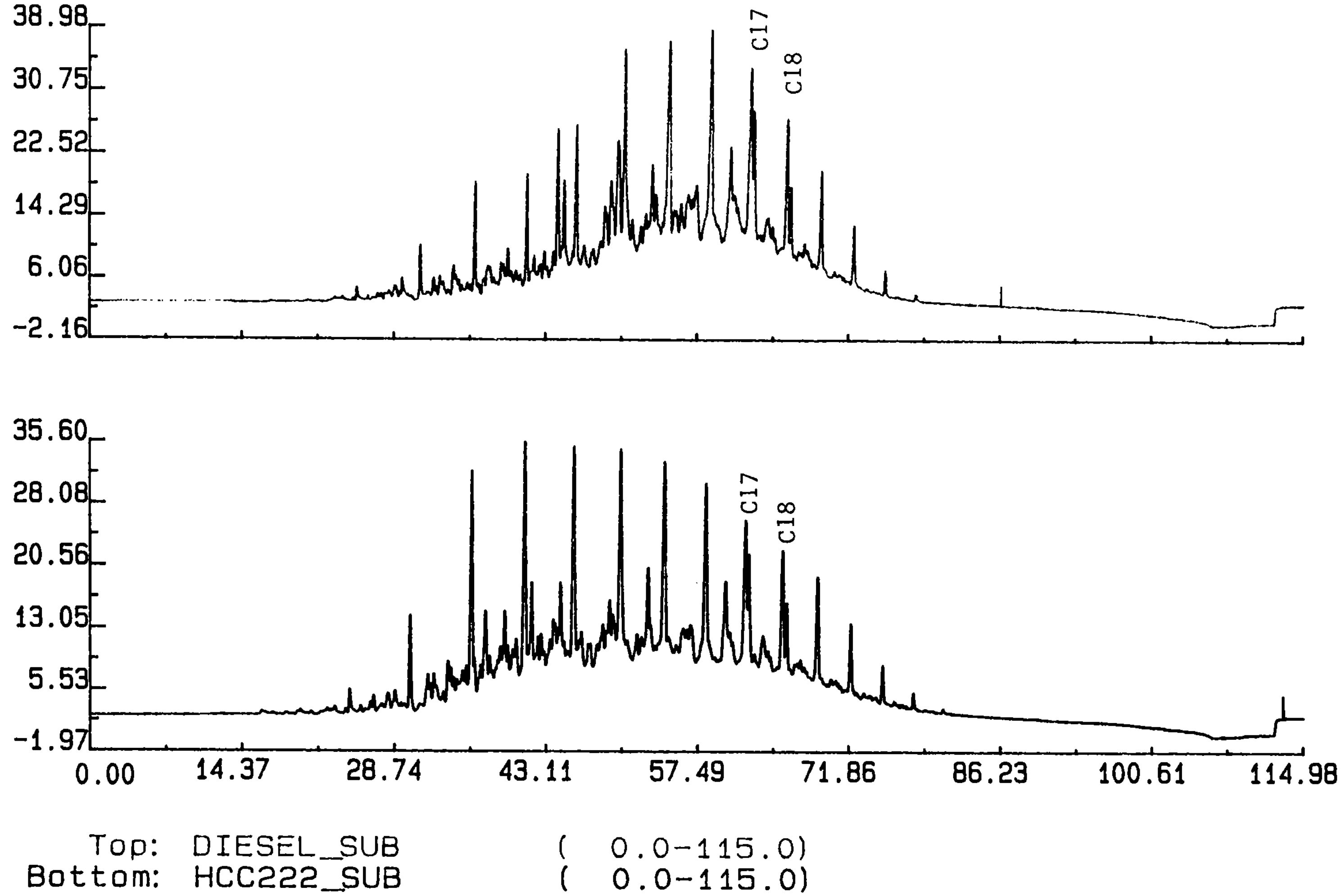
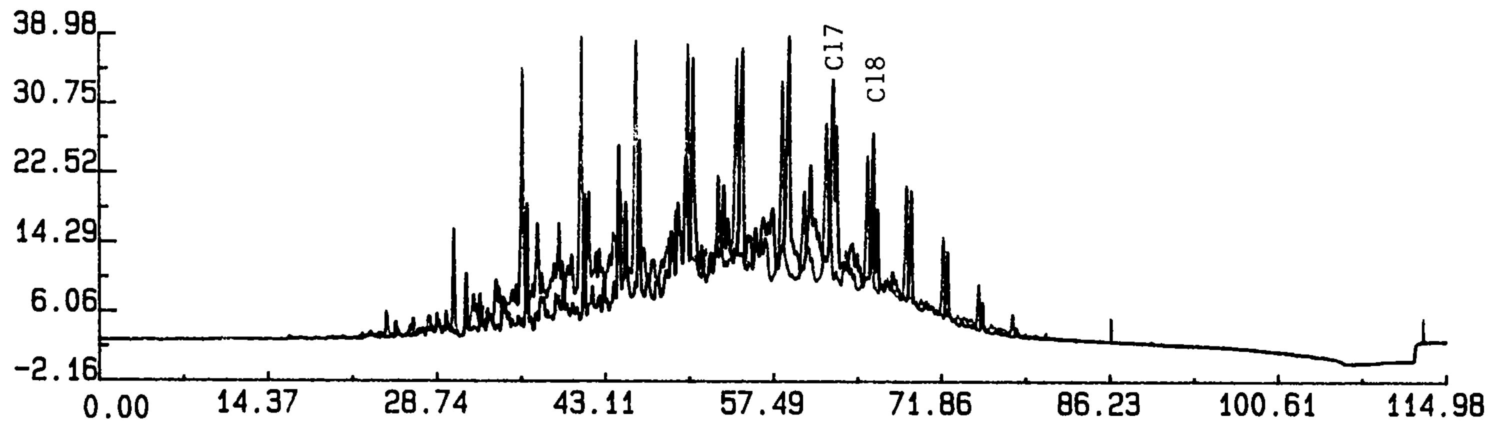

38.98
30.75
22.52
14.29
6.06
-2.16
C17
C18
35.60
28.08
20.56
13.05
5.53
-1.97
0.00
14.37
28.74
43.11
57.49
71.86
86.23
100.61
114.98
Top: DIESEL_SUB (0.0-115.0)
Bottom: HCC222_SUB (0.0-115.0)

Figure 2



Top: HCC222_SUB (0.0-115.0)
Bottom: DIESEL_SUB (0.0-115.0)

Figure 3

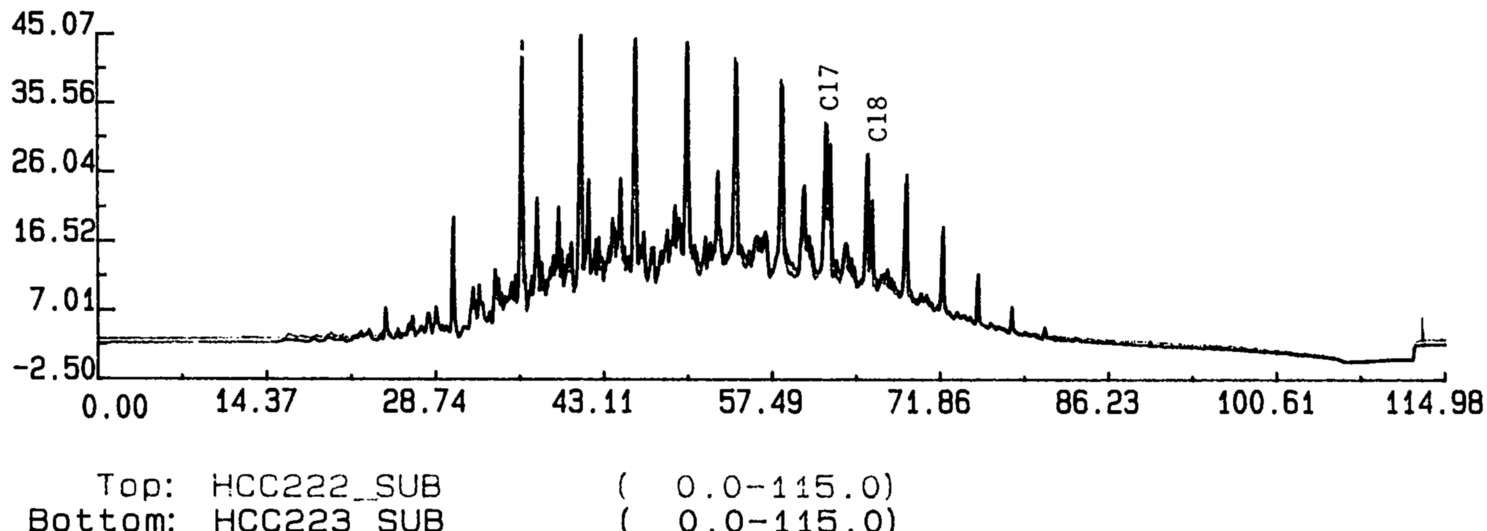

45.07
35.56
26.04
16.52
7.01
-2.50
0.00
14.37
28.74
43.11
57.49
71.86
86.23
100.61
114.98
C17
C18
Top: HCC222_SUB (0.0-115.0)
Bottom: HCC223_SUB (0.0-115.0)

Figure 4

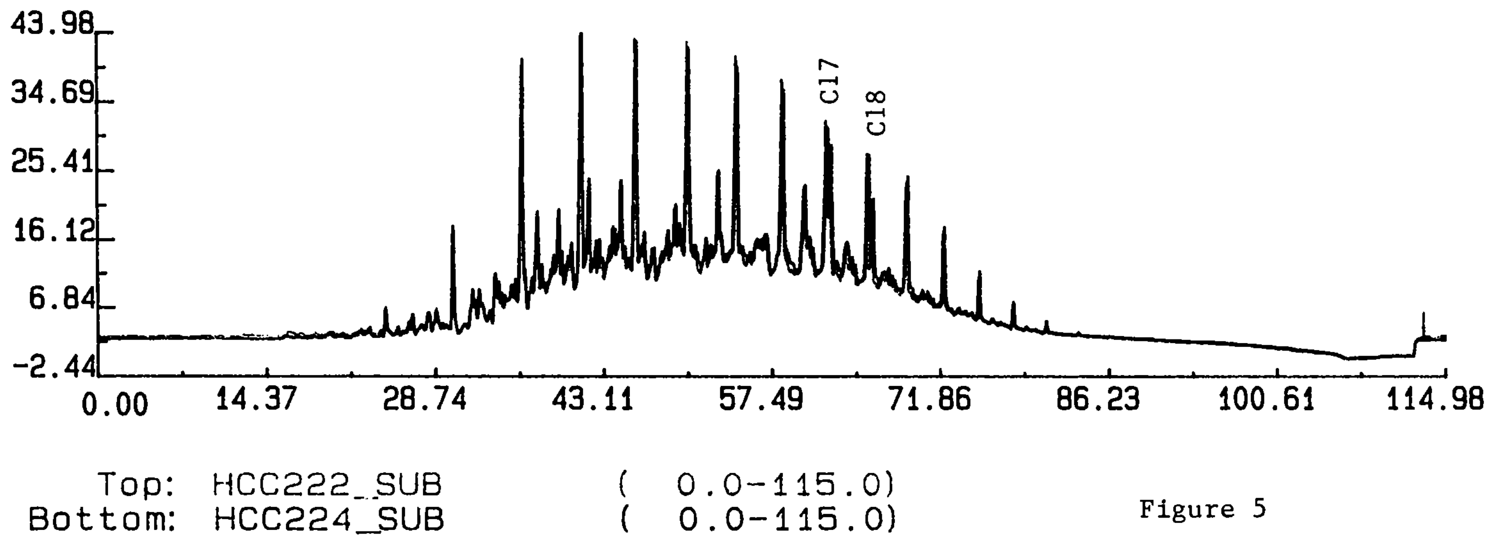

43.98
34.69
25.41
16.12
6.84
-2.44
0.00
14.37
28.74
43.11
57.49
71.86
86.23
100.61
114.98
C17
C18
Top: HCC222_SUB (0.0-115.0)
Bottom: HCC224_SUB (0.0-115.0)

Figure 5

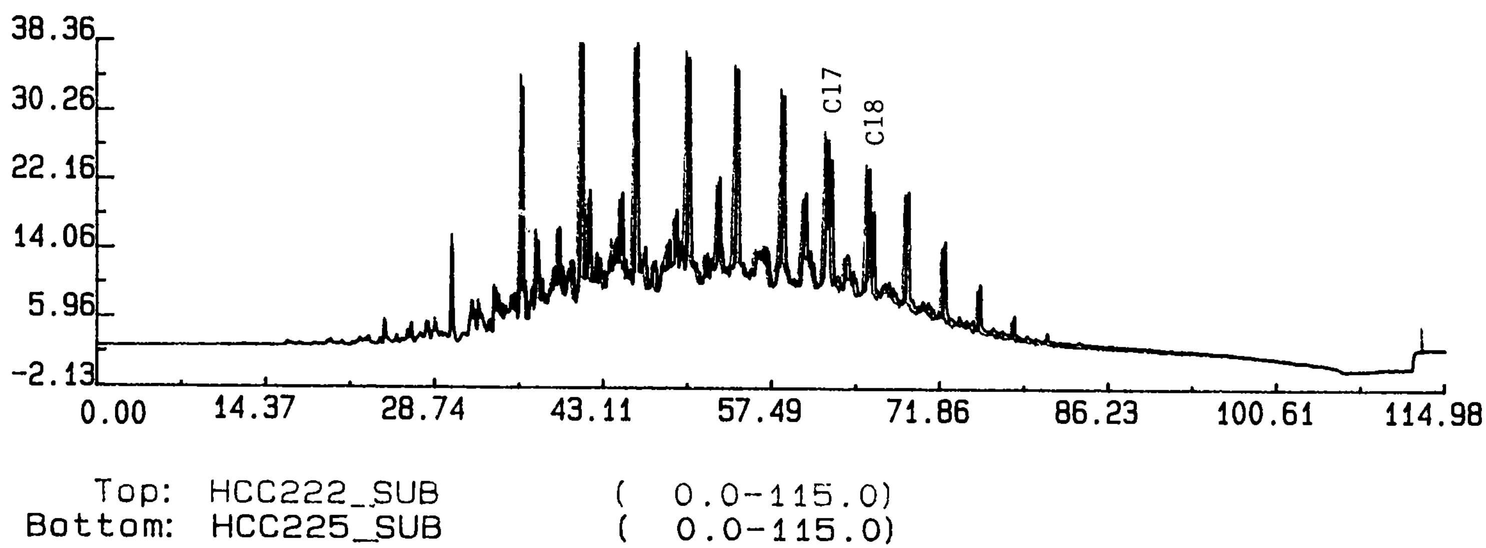

38.36
30.26
22.16
14.06
5.96
-2.13
0.00
14.37
28.74
43.11
57.49
71.86
86.23
100.61
114.98
C17
C18
Top: HCC222_SUB (0.0-115.0)
Bottom: HCC225_SUB (0.0-115.0)

Figure 6

STANDARD OIL PRODUCTION COMPANY
PETROLEUM GEOCHEMISTRY GROUP

To: R. Jantzen
COD, Houston

August 11, 1987

PGG/081187/GC/2-8

From: Petroleum Geochemistry Group
Freeport Lab, Dallas

Class.: CONFIDENTIAL

Subject: Final report Regarding Maturity Assessment for the 0-18900' Interval and Gas Analyses for the Weyerhaeuser 1-22 Well, McCurtain County, OK-- Exploration Brief (PGG/EB397)

Maturity determinations via vitrinite reflectance techniques were performed on sixty-one (61) samples from the 0-18900' interval from the Weyerhaeuser 1-22 well, McCurtain County, Oklahoma (located in Sec. 22, T 5 S, R24 E). The well prognosis indicate that the well should have spudded in the Ordovician Collier (surface formation) and penetrated older rocks. The decollement fault between the Ouachitan and Arbuckle rocks was projected to occur at the 11000 to 11500' depths. Since the rocks were Ordovician in age or older (depending upon depth), any Ro measurements would have been made on solid bitumens or pyrobitumens; vitrinite is a maceral which is formed from higher vascular plants (Late Silurian in age or younger). Therefore, for this report, we will refer to Ro as being measured from bitumens, not vitrinite.

The Ro results for the sixty-one (61) samples are listed in Table 1. Caution must be used in the interpretation of the data from Table 1. Ro measurements at this level of metamorphism are based on the knowledge and experience of the petrographer conducting the measurements. Identification of the bitumen or organic particle is based strictly on morphology which at this level of metamorphism can be mimicked by oxides and sulfides. This makes some of the measurements subject to error, especially the higher the measurement. The above samples are undoubtedly metamorphic in origin; the rocks themselves were slates, quartzites and marbles at the shallow depths and phyllites grading into schists at greater depths. The bitumen Ro values confirm this and suggest that the preservation of major amounts of dry gas (methane) is doubtful. This does not mean that dry gas is not present. In clastic sequences (low amounts of carbonates), the limit of dry gas preservation is not really understood. Dry gas may be preserved to 6-8% Ro. In carbonate sequences, however, dry gas is usually not preserved beyond an Ro of 4%. This is caused mainly by the thermal degradation of the carbonates and the subsequent dilution of any methane present. High concentrations of CO_2 are usually found in carbonate reservoirs beyond 4% Ro.

Caution must also be used in using the actual Ro measurements listed above. A characteristic of solid bitumens (and vitrinite) at these Ro levels is the anisotropy of the organic material. Each organic particle is anisotropic and consists of a maximum Ro, a minimum Ro, and a mean Ro. This anisotropism is extremely large at the 6% Ro range where it is not unusual to have a 2-4% Ro range per particle (i.e. a single bitumen particle may have a Ro_{max} of 7.8%, a Ro_{mean} of 6.1%, and a Ro_{min} of 4.9%). At extremely high Ro values (about >7-8%), previous PGG studies has shown almost total extinction (Ro_{min} about 0%) when measuring solid bitumens. Because of this anisotropism in the organic particles, it will be almost impossible to detect structural elements in the well section such as unconformities or thrust faults unless there is a major, confirmable change in Ro (we must be sure of the maximum Ro if a change occurs, and not just measuring a minimum or mean value).

Another problem encountered was the measurement of granular pyrobitumens which were in samples from the 11900 through 18900' depths. The most accurate measurements are taken from smooth surfaces where full reflectance from the particle occurs. However, granular bitumen is not a smooth surface and reflected light can scatter in various directions causing less light to reach the photometer. This causes lower than expected values. In particular, the samples from the 11900 and 12000' depths had measured values that were probably 10-20% too low. Therefore, instead of the 4.44 and 4.36% Ro values, these are probably about 4.8 to 5.25%. Most of the deeper samples contained at least a trace of smooth measureable organic particles, even though the major component was very fine, granular pyrobitumen, that could not be measured with any reliability in most instances.

Due to the problems asscociated with the measurement of organic materials at this level of metamorphism, no linear regression analysis was conducted since the results from a regression could be misleading.

Interpretation:

The rocks from the Weyerhaeuser 1-22 well were metamorphic and should be considered thermally spent for hydrocarbon generation. The rocks were slates at the surface with Ro values about 4.4-5.0% which graded into phyllites and schists at greater depths. Ro values were greater than 8.0% at 9600-11800'. Between 11900' and 12000' the decollement fault separating the Ouachita rocks from the Arbuckle rocks was penetrated. This was indicated by the shift of the extremely metamorphosed Ouachita rocks with Ro values >8.0% and the lesser metamorphic (slate/phyllite) Arbuckle rocks with measured Ro values of 4.44 and 4.36% (should be corrected to 4.8-5.25% Ro due to the granular nature of the pyrobitumen). The maturity increased rapidly after the decollement fault was penetrated. Rocks at the bottom of the well, 14500' to 18900', had average Ro values of 8.0% or greater. Accurate measurments were hindered by the very fine granular nature of the pyrobitumens at these depths. Visually, the rocks from 16000' to TD had varying amounts of pyrobitumens (sometimes moderate to rich concentrations) indicating that at one time, these rocks had contained moderate amounts of oils. Consequently, the oils were bitumenized, then thermally baked, with the oils cracking to gases. Unfortunately, the end result at these levels of maturity, is the pyrobitumen end product and no commercial quantity of dry gas.

Gas Analyses:

Headspace gas analyses were performed on samples collected at approximately the 14200' depth of the Weyerhaeuser 1-22 well. These gases samples were dominated by non-hydrocarbon gases (nitrogen, oxygen, carbon dioxide) with hydrocarbon gases comprising a maximum of 5% of the sample. Analytical results for the gas samples are appended.

The hydrocarbon fraction of the samples were dominated by methane (C_1) which ranged from 94-98%. Ethane (C_2) was the next abundant hydrocarbon gas and only traces of C_3 through C_5 were observed. Since these rocks were metamorphic in nature, explaining the presence of C_{2+} components is somewhat difficult. If the gases are assumed to be in situ, we would not expect to see the C_{2+} components. However, during the drilling of this interval, the drillers added diesel fuel and Carbonox to the well. The very low concentrations of C_{2+} components,as well as some of the methane, were probably derived from the degradation of these additives during the drilling process.

G.A. Cole

encl: Table 1
Gas Appendix

cc: E. Werren
A. Krancer
M. Rahman
Exploration Briefs

TABLE 1

WEYERHAEUSER 1-22 WELL

DEPTH	Ave.Ro	MAX.	MIN.	# PTS	MATURITY
240	4.9	6.07	3.1	4	SPENT
420	4.41	5.67	3.06	6	SPENT
920	5.16	6.95	3.36	2	SPENT
1400	NDP	---	---		
1750	4.51	7.35	2.3	7	SPENT
2300	NDP	---	---		
2840	5.97	6.98	4.9	5	SPENT
3300	NDP	---	---		
3800	NDP	---	---		
4300	NDP	---	---		
4900	6.58	7.85	5.5	5	SPENT
5400	NDP	---	---		
6400	6.32	6.88	5.69	7	SPENT
6900	8.42	10.21	6.97	3	SPENT
7200	NDP	---	---		
7500	7.91	10.17	6.42	10	SPENT
7900	7.58	10.99	5.15	9	SPENT
8400	6.43	8.43	5.15	3	SPENT
8800	7.93	10.46	6.42	5	SPENT
9200	8.1	9.25	6.94	2	SPENT
9600	8.29	9.4	6.79	5	SPENT
10100	8.12	9.46	7.11	7	SPENT
10500	9.35	9.35	9.35	1	SPENT
10900	8.19	10.35	6.41	13	SPENT
11300	8.23	10.58	7.37	11	SPENT
11800	8.8	10.27	7.73	6	SPENT
11900	8.23	9.62	7.32	7	SPENT
11900	4.44	4.84	3.78	10	SPENT
12000	4.36	6.63	3.14	15	SPENT
12200	NDP	---	---		
12400	6.99	8.21	5.64	15	SPENT
12500	6.97	8.61	5.41	18	SPENT
12600	6.91	7.49	6.25	9	SPENT
12800	6.94	7.96	6.94	5	SPENT
13000	6.91	8.14	5.2	17	SPENT
13200	6.63	7.82	5.06	13	SPENT
13400	7.57	8.86	6.48	10	SPENT
13800	7.79	9.76	5.99	7	SPENT
14000	NDP	---	---		
14200	NDP	LIGNITE CONTAMINANTS -- 0.37% Ro			
14400	NDP	LIGNITE CONTAMINANTS -- 0.38% Ro			
14600	8.47	(1 POINT) LIGNITE CONTAMINANTS			
14800	NDP	---	---		
15000	8.67	11.09	7.35	7	SPENT
15200	7.75	8.04	7.32	4	SPENT
15400	8.29	10.35	6.00	4*	SPENT
15600	8.57	10.78	7.25	8*	SPENT
15800	9.09	9.67	8.38	4*	SPENT

TABLE 1

DEPTH	Ave. Ro	MAX.	MIN.	# PTS.	MATURITY
16000	7.91	8.99	6.82	2	SPENT
16200	NDP	---	---	--	
16400	8.26	9.99	6.53	2*	SPENT
16600	7.03	7.04	7.02	2*	SPENT
16800	NDP	---	---	--	
17000	8.34	8.58	7.99	3*	SPENT
17100	NDP	---	---	--	
17400	7.84	7.92	7.75	2	SPENT
17700	NDP	---	---	--	
18000	NDP	---	---	--	
18300	NDP	---	---	--	
18600	NDP	---	---	--	
18900	NDP	---	---	1 PARTICLE-	9.8% Ro

NDP--NO DETERMINATION POSSIBLE
* --LIGNITE CONTAMINANTS

WEYER 1-22 HEADSPACE GAS ANALYSIS

SAMPLE 18A

COMPONENT	BULK COMP. PPM	AIR-FREE COMP. PPM	%HC
METHANE	43213	43213	96.934
EHTANE	1337	1337	2.999
PROPANE	29	29	0.065
ISO-BUTANE	1	1	0.002
BUTANE	1	1	0.002
ISO-PENTANE	0	0	0.000
PENTANE	0	0	0.000
CARBON DIOXIDE	350	0	
OXYGEN	16900	0	
NITROGEN	404000	340963	

SAMPLE 18B

COMPONENT	BULK COMP, PPM	AIR-FREE COMP. PPM	%HC
METHANE	53396	53396	94.095
ETHANE	3283	3283	5.785
PROPANE	66	66	0.116
ISO-BUTANE	1	1	0.002
BUTANE	1	1	0.002
ISO-PENTANE	0	0	0.000
PENTANE	0	0	0.000
CARBON DIOXIDE	17950	17944	
OXYGEN	4100	0	
NITROGEN	501230	485937	

SAMPLE 18C

COMPONENT	BULK COMP. PPM	AIR-FREE COMP. PPM	%HC
METHANE	53310	53310	94.112
EHTANE	3265	3265	5.764
PROPANE	66	66	0.117
ISO-BUTANE	1	1	0.002
BUTANE	3	3	0.005
ISO-PENTANE	0	0	0.000
PENTANE	0	0	0.000
CARBON DIOXIDE	2280	2230	
OXYGEN	31410	0	
NITROGEN	183040	65881	

SAMPLE 19

COMPONENT	BULK COMP. PPM	AIR-FREE COMP. PPM	%HC
METHANE	47655	47655	96.034
EHTANE	1927	1927	3.883
PROPANE	39	39	0.079
ISO-BUTANE	1	1	0.002
BUTANE	1	1	0.002
ISO-PENTANE	0	0	0.000
PENTANE	0	0	0.000
CARBON DIOXIDE	12320	12223	
OXYGEN	61100	0	
NITROGEN	414000	186097	

SAMPLE DST CYLINDER

COMPONENT	BULK COMP. PPM	AIR-FREE COMP. PPM	%HC
METHANE	1504	1504	96.287
ETHANE	43	43	2.753
PROPANE	11	11	0.704
ISO-BUTANE	2	2	0.128
BUTANE	2	2	0.128
ISO-PENTANE	0	0	0.000
PENTANE	0	0	0.000
CARBON DIOXIDE	720	505	
OXYGEN	136000	0	
NITROGEN	41360	0	

SAMPLE CHAMBER

COMPONENT	BULK COMP. PPM	AIR-FREE COMP. PPM	%HC
METHANE	30607	30607	98.307
EHTANE	512	512	1.645
PROPANE	12	12	0.039
ISO-BUTANE	1	1	0.003
BUTANE	1	1	0.003
ISO-PENTANE	1	1	0.003
PENTANE	0	0	0.000
CARBON DIOXIDE	350	323	
OXYGEN	16900	0	
NITROGEN	404000	340963	

BELOW CIRC SUB

COMPONENT	BULK COMP. PPM	AIR-FREE COMP. PPM	%HC
METHANE	10163	10163	98.241
EHTANE	173	173	1.672
PROPANE	8	8	0.077
ISO-BUTANE	0	0	0.000
BUTANE	1	1	0.010
ISO-PENTANE	0	0	0.000
PENTANE	0	0	0.000
CARBON DIOXIDE	0	0	
OXYGEN	0	0	
NITROGEN	0	0	

SOURCE ROCK EVALUATION

FOR THE

WEYERHAEUSER 1-7 WELL

LE FLORE COUNTY, OKLAHOMA

EXPLORATION BRIEF (PGG/EB405)

Author: G.A. Cole

STANDARD OIL PRODUCTION COMPANY

Petroleum Geochemistry Group

TO: R. Jantzen
COD, Houston

DATE: October 6, 1987

FILE: PGG/100687/GC/2-8

FROM: Petroleum Geochemistry Group
Freeport Laboratory, Dallas

CLASS.: Restricted

SUBJECT: Source Rock Evaluation for the Weyerhaeuser 1-7 Well, Le Flore County, Oklahoma--Exploration Brief (PGG/EB405)

Cuttings samples from the Weyerhaeuser 1-7 well, Le Flore County, Oklahoma, were analyzed for their source quality. One-hundred foot composited cuttings samples were submitted for total organic carbon and Rock-Eval pyrolysis as per PGG standardized methods. Vitrinite reflectance results were reported on in PGG/EB 388.

Forty samples from a total of seventy-seven composited samples were analyzed (see attached table). Source quality results were dismal. Average TOC contents (determines the source richness) for the well averaged 0.27% and ranged from 0.04 to 0.88%. S_2 pyrolysis yields (determines the potential productivity) averaged 0.15 kg/ton and ranged from 0.00 to 0.43 kg/ton. Pyrolysis yields reflect true richness and potential only for samples that are immature to oil window mature, since the yields decrease with maturity. Generally, reliable results are obtained from samples with Ro results less than 1.0% (for rich samples with >3.0% TOC), and at 0.8% Ro for samples with moderate to good TOC. Only the uppermost interval (0-1000') of the well meets these criteria. From this interval, it was concluded that the well samples analyzed contained poor (lean) source richness with only negligible potential for gaseous hydrocarbons. The hydrogen index values (averaged 50) indicated that only gaseous hydrocarbons could be generated, and only in small amounts.

Even though no detailed stratigraphic information was provided by COD/Houston, these samples were believed to be representative of the Ouachita flysch rocks. If so, the sample results were very similar to those determined for the Ouachita Overthrust region. The flysch rocks are mostly source lean with no or little potential for generating hydrocarbons. The first known source rock usually penetrated by wells in this part of the Ouachita region is the Devonian Arkansas Novaculite, and then the Ordovician rocks deeper in the section (Polk Creek, Bigfork Chert, and Womble). Unfortunately, these rocks are usually overmature (Ro values > 2.0%) in this region due to the extremely deep burial.

References

Cole, G.A., 1987, Thermal maturity assessment of the Weyerhaeuser 1-7 well, Le flore County, Oklahoma: SOPC, Exploration Brief (PGG/EB388).

G.A. Cole

encl.: Source Rock Data Table

cc: M. Rahman
A. Krancer
Exploration Briefs

Weyerhaeuser 1-7 Source Rock Data Table

SAMPLE #	DEPTH	S1	S2	TOC	TMAX	TR	HI
WE9312	600	0.06	0.32	0.88	458	0.16	36
WE9313	700						
WE9314	800	0.13	0.13	0.31	449	0.50	41
WE9315	900						
WE9316	1000	0.05	0.23	0.10	374	0.18	
WE9317	1100						
WE9318	1200	0.06	0.20	0.15	409	0.23	
WE9319	1300						
WE9320	1400	0.12	0.26	0.10	397	0.32	
WE9321	1500						
WE9322	1600	0.02	0.10	0.14	331	0.17	
WE9323	1700						
WE9324	1800	0.08	0.43	0.10	469	0.16	
WE9325	1900						
WE9326	2000	0.07	0.25	0.26	351	0.22	96
WE9327	2100	0.03	0.12	0.34	357	0.21	35
WE9328	2200						
WE9329	2300						
WE9330	2400	0.07	0.26	0.45	412	0.21	62
WE9331	2500						
WE9332	2600	0.34	0.22	0.04	302	0.61	
WE9333	2700						
WE9334	2800	0.05	0.23	0.36	459	0.18	63
WE9335	2900						
WE9336	3000	0.10	0.36	0.45	448	0.22	80
WE9337	3100						
WE9338	3200	0.02	0.18	0.32	302	0.10	56
WE9339	3300						
WE9340	3400	0.07	0.30	0.41	373	0.19	73
WE9341	3500						
WE9342	3600	0.08	0.42	0.47	396	0.16	89
WE9343	3700	0.07	0.15	0.20	305	0.32	
WE9344	3800	0.02	0.15	0.36	351	0.12	41
WE9345	3900						
WE9346	4000	0.00	0.00	0.18	266		
WE9347	4100	0.00	0.00	0.07	276		
WE9348	4200						
WE9349	4300						
WE9350	4400	0.00	0.17	0.49	362	0.00	34
WE9351	4500						
WE9352	4600	0.05	0.22	0.44	3/8	0.19	50
WE9353	4700						
WE9354	4800	0.02	0.08	0.35	302	0.2	22
WE9355	4900						
WE9356	5000	0.04	0.12	0.07	302	0.25	
WE9357	5100						
WE9358	5200	0.00	0.00	0.25	305		
WE9359	5300						
WE9360	5400	0.05	0.10	0.33	357	0.36	30
WE9361	5500	0.03	0.19	0.36	394	0.14	52
WE9362	5600						
WE9363	5700						
WE9364	5800	0.00	0.00	0.25	275		
WE9365	5900						
WE9366	6000	0.00	0.02	0.4	305	0.00	5
WE9367	6100	0.00	0.06	0.36	305	16	
WE9368	6200						
WE9369	6300						
WE9370	6400	0.00	0.05	0.22	302	0.00	
WE9371	6500						
WE9372	6600	0.00	0.07	0.32	364	0.00	21
WE9373	6700						
WE9374	6800	0.02	0.13	0.32	331	0.14	40
WE9375	6900						
WE9376	7000	0.00	0.00	0.20	260		
WE9377	7100	0.00	0.00	0.15	256		
WE9378	7200						
WE9379	7300						
WE9380	7400	0.07	0.20	0.15	302	0.27	
WE9381	7500						
WE9382	7600	0.00	0.02	0.12	280	0.00	
WE9383	7700						
WE9384	7800	0.04	0.17	0.25	308	0.20	68
WE9385	7900	0.02	0.07	0.16	449	3.50	
WE9386	8000	0.05	0.05	0.07	354	0.50	
WE9387	8252						
WE9388	8270						
WE9389	8280						

SOURCE QUALITY EVALUATION
AND
THERMAL MATURITY ASSESSMENT
OF THE
STEWART 1-8 WELL
WEYERHAEUSER ACREAGE
HEMPSTEAD COUNTY, ARKANSAS
EXPLORATION BRIEF (PGG/EB413)

Author: G.A. Cole

STANDARD OIL PRODUCTION COMPANY

Petroleum Geochemistry Group

TO: A. Krancer
Exploration-Onshore, Houston

DATE: January 12, 1988

FILE: PGG/011288/GC/2-8

FROM: Petroleum Geochemistry Group
Freeport Laboratory, Dallas

CLASS.: CONFIDENTIAL

SUBJECT: Source Quality Evaluation and Thermal Maturity Assessment of the Stewart 1-8 Well, Weyerhaeuser Acreage, Hempstead County, Arkansas--Exploration Brief (PGG/EB413)

Well cuttings samples from the 0-8518' interval (TD at 8518') from the Stewart 1-8 well, Weyerhaeuser acreage, Hempstead County, Arkansas, were received for thermal maturity assessment vial whole-rock vitrinite reflectance techniques and for source quality determination (total organic carbon [TOC], Rock-Eval S_1 and S_2 pyrolytic yields). Samples were selected on a 500' basis. Data results are listed in Table 1 and the vitrinite reflectance profile is graphically illustrated in Figure 1. No detailed stratigraphic information was provided for this well site, but PGG was informed that the 0-1000' section was Cretaceous in age and the interval greater than 1000' belonged to the Ouachita flysch series.

A total of 25 samples were selected for vitrinite reflectance analyses. From these twenty-five (25) samples, seven (7) contained no measurable vitrinite and were reported as "NDP" (no determination possible). Two (2) samples (from 300' and 500') were from the Cretaceous rocks which indicated that this section was immature as shown by a R_o of 0.33% at 500'. Sixteen (16) samples from the Pennsylvanian age flysch rocks yielded useable results and a linear regression was applied to this data set . The regression analysis indicated:

1.) The surface R_o was approximately 0.3% indicating that the surface rocks of Cretaceous age were immature.

2.) The Cretaceous-Pennsylvanian unconformity occurred at approximately 1000'. The pennsylvanian rocks at this boundary had an R_o of about 1.0%. The dominant gas generation threshold (DGGT; 1.00% R_o) occurred at this point. DGGT is where the kerogen begins generation of gaseous products and where oils begin to thermally crack into lighter components. All Pennsylvanian age rocks in this well, therefore, are beyond the oil generation window of 0.6 to 1.0% R_o.

3.) The rocks between 1000' to 3440' (1.0 to 1.35% R_o) could reservoir oils, and the rocks between 3440 to about 5900' (1.35 to 1.75% R_o) could reservoir light oils and condensates, respectively. Only dry gas would be expected from 5900' to TD (R_o greater than 1.75%).

4.) Thermally spent rocks (>2.0% R_o) were penetrated from 6890' to TD. Only dry gas would be reservoired in these rocks.

5.) The regression calculated a maturity gradient of 4.94 DOD units/1000' with a correlation coefficient of 96%. The gradient of the Stewart 1-8 well correlated reasonably well with gradients calculated from other wells in the Ouachita region. However, this well had a slightly higher maturity gradient possibly indicating that this local area had a higher geothermal gradient in the past. Gradients for other wells were: Shell 1-26 Arivett (Pike County, Arkansas)- 4.06 DOD units/1000', Campbell 1-24 well (Atoka County, Oklahoma)- 4.85 DOD units/1000', Getty 1-20 Morris well (Pushmataha County, Oklahoma)- 4.43 DOD units/1000', Trotter-Dees 1-29 well (Pushmataha County, Oklahoma)- 4.31 DOD units/1000', the Weyerhaeuser 1-15 well (Pushmataha County, Oklahoma)- 4.43 DOD units/1000', and the Weyerhaeuser 1-7 well (Le Flore County, Oklahoma)- 4.24 DOD units/1000'.

6.) Typical surface R_o values without erosion are generally accepted as being 0.15-0.20%. Using a 0.20% R_o value for the surface, about 13340' of erosion has occurred at this site.

Source rock analyses for the Stewart 1-8 well indicated that the Pennsylvanian section penetrated had no source potential, whatsoever. The TOC contents averaged 0.33% (ranged from 0.17-0.62%); S_1 and S_2 pyrolytic yields averaged 0.03 and 0.14 kg/ton, respectively. All pyrolytic yields were considered negligible.

The Cretaceous section (0-1000') had poor source potential based on two sample results. TOC was less than 0.15% and pyrolytic yields were negligible.

CONCLUSIONS:

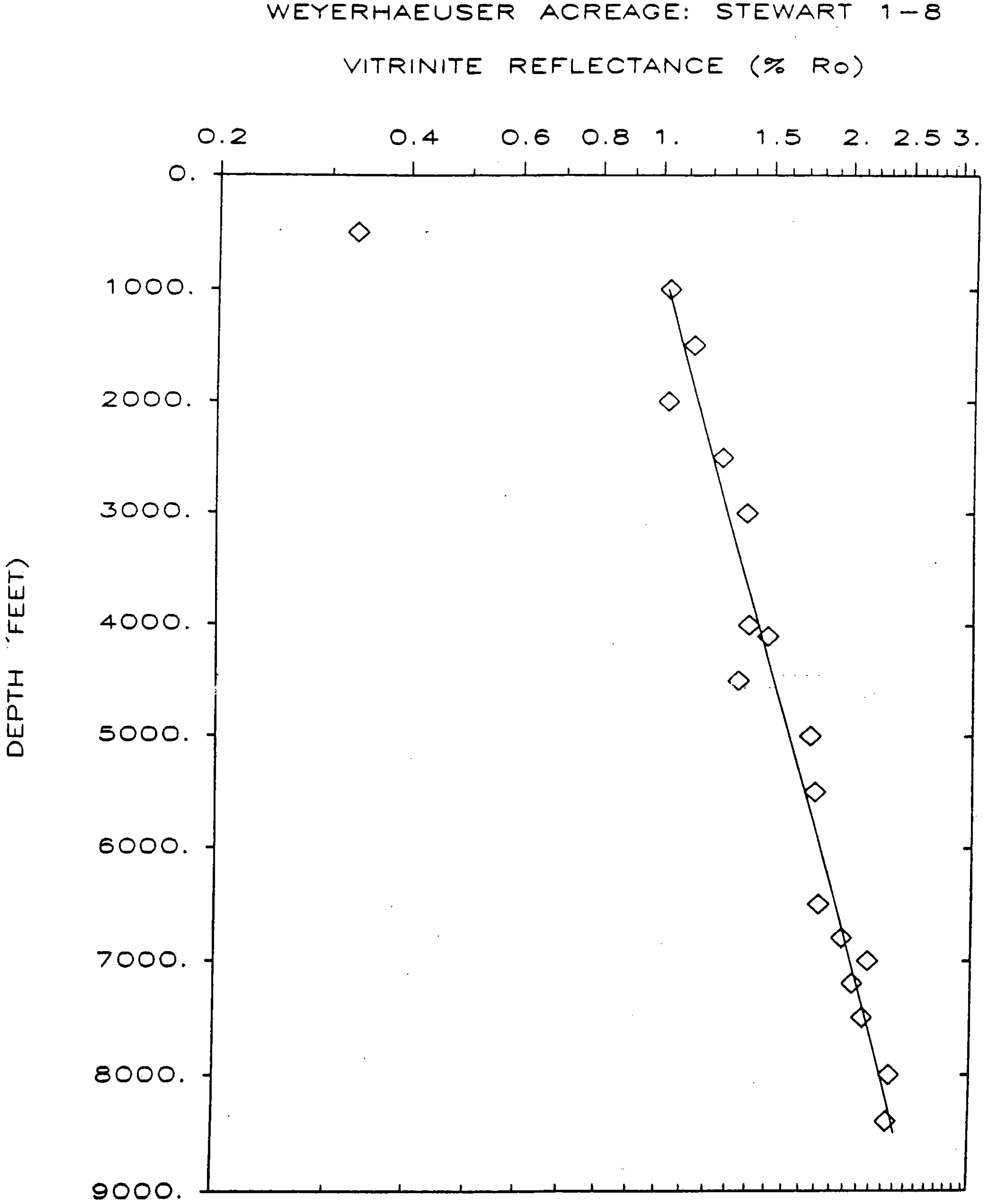
The Pennsylvanian age rocks penetrated by the Stewart 1-8 well were gas mature (1.0% R_o at the unconformity boundary) to thermally spent at TD (about 2.35% R_o). These rocks contained no source rocks capable of generating or reservoiring commercial quantities of hydrocarbons. If a source rock and reservoir rock were available, this site could have yielded liquid hydrocarbons (oils and /or condensates-wet gases) in the 0-5900' interval and gaseous hydrocarbons at depths greater than 5900'.

G.A. Cole

encl: Table 1
Figure 1

cc: T. Legg
R. Jantzen
M. Rahman
Exploration Briefs

FIGURE 1



STANDARD OIL PRODUCTION

Petroleum Geochemistry Group

TABLE

Sample #	Depth	Age	Form.	TOC	S1	S2	Ro	# Pts.
WE9750	0	CRET						
WE9751	100							
WE9752	200							
WE9753	300			0.00	0.00	0.00	NDP	---
WE9754	400							
WE9755	500			0.13	0.02	0.07	0.33	17
WE9756	600							
WE9757	700							
WE9758	800							
WE9759	900							
WE9760	1000	PENN	JKFK	0.43	0.02	0.20	1.03	11
WE9761	1100							
WE9762	1200							
WE9763	1300							
WE9764	1400							
WE9765	1500			0.62	0.14	0.60	1.13	5
WE9766	1600							
WE9767	1700							
WE9768	1800							
WE9769	1900							
WE9770	2000			0.35	0.00	0.04	1.03	3
WE9771	2100							
WE9772	2200							
WE9773	2300							
WE9774	2400							
WE9775	2500			0.28	0.02	0.12	1.26	12
WE9776	2600							
WE9777	2700							
WF0001	2800							
WF0002	2900							
WF0003	3000			0.27	0.05	0.12	1.38	8
WF0004	3100							
WF0005	3200							
WF0006	3300							
WF0007	3400							
WF0008	3500			0.26	0.02	0.04	NDP	---
WF0009	3600							
WF0010	3700							
WF0011	3800							
WF0012	3900							
WF0013	4000			0.21	0.02	0.09	1.39	6
WF0014	4100						1.49	4
WF0015	4200							
WF0016	4300						NDP	---
WF0017	4400							
WF0018	4500			0.17	0.02	0.07	1.34	7
WF0019	4600							
WF0020	4700						NDP	---
WF0021	4800							
WF0022	4900							
WF0023	5000			0.23	0.04	0.32	1.74	5
WF0024	5100							
WF0025	5200							
WF0026	5300						NDP	---
WF0027	5400							
WF0028	5500			0.25	0.04	0.14	1.77	4
WF0029	5600							
WF0030	5700							
WF0031	5800						NDP	---
WF0032	5900							
WF0033	6000			0.23	0.02	0.00	NDP	---
WF0034	6100							
WF0035	6200							
WF0036	6300							
WF0037	6400							
WF0038	6500			0.42	0.00	0.02	1.80	5
WF0039	6600							
WF0040	6700							
WF0041	6800						1.96	3
WF0042	6900							
WF0043	7000			0.39	0.00	0.09	2.16	12
WF0044	7100							
WF0045	7200						2.04	21
WF0046	7300							
WF0047	7400							
WF0048	7500			0.23	0.09	0.17	2.12	14
WF0089	7600							
WF0090	7700							
WF0091	7800							
WF0092	7900							
WF0093	8000			0.50	0.04	0.02	2.35	18
WF0094	8100							
WF0095	8200							
WF0096	8300							
WF0097	8400			0.37	0.02	0.14	2.33	11
WF0098	8500							
	TD-8518							

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: C.A.O. Titus
SPC Mid-Continent Division
Dallas, Texas

January 25, 1984

PGW/010384/HH/2-5

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Geochemical Evaluation of a Single Liquid Hydrocarbon Samples from the Texas Oil and Gas #1 Anson Well, Atoka County, Oklahoma -- Exploration Brief (PGW/EB104).

A single liquid hydrocarbon sample (PGW sample identification number HCB-416) was received by PGW. The sample was recovered from a drill depth of 7101-7119 ft., in the perforated Devonian Arkansas Novaculite. A geochemical characterization of the oil was performed as well as a comparison with hydrocarbons from the Taylor #1 well (HCB-006), the Stringtown Quarry (HCB-275), the #1 O'Steen (HCB-092), the #3 Victor (HCB-091), and the #1 Jones (HCB-092) wells.

Summary characteristics for the crude samples are given in Table 1. The Stringtown Quarry sample was extensively biodegraded thus precluding any n-alkane/isoprenoid data. Characteristics of the #1 Anson oil will be discussed first, followed by a comparison with the other hydrocarbons.

The Summary Hydrocarbon Data Sheet and the Summary Hydrocarbon Data Log for HCB-416 are given in Table 2 and Figure 1, respectively. Figure 2 gives the saturate C_{15+} gas chromatogram. The maximum at n-C_{17} on the gas chromatogram (Figure 2), the small quantities of pristane and phytane, the low sulfur content and values of the Thompson Paraffin Indices of I=1.75 and II=33.4 (see Table 3) indicate a highly mature petroleum sample. However, the presence of a naphthenic hump centered under ~n-C_{23} (Figure 2), the low API^o

(18.6°), the low distillate (B.P.<200°C) content (5.5%) and the presence of 3.1% asphaltenes argue that the sample is immature. The reason for this apprent contradiction may be that the oil represents a mixture, the majority of which is highly mature, to which a minor immature component has been added.

The mature component appears to be best represented by the #1 O'Steen (HCB-090), #3 Victor (HCB-091) and the #1 Jones (HCB-092) petroleums (Table 1). The Taylor #1 (HCB-006) and Stringtown Quarry (HCB-275) samples appear to be partially biodegraded and extensively biodegraded (respectively) members of this or a similar family. When the oils are plotted in carbon isotopic type-curve fashion (Figure 3), it appears that all samples except the #1 Anson are in close isotopic agreement. The #1 Anson petroleum is 0.3-0.5 ppt heavier than the others (except in the distillate fraction where it is >1 ppt heavier). This argues that the immature component alluded to previously is isotopically heavy; perhaps quite heavy because it is thought to be only a minor component. Also, it would appear that this fraction is an early bitumen-like material. This, when mixed in small quantities (< 20%) with a highly mature hydrocarbon like those at Victor, O'Steen and Jones could give rise to the Anson oil. This is corroborated by a comparison of the data in Table 1, namely the API°, % Asphaltenes, % Distillate, and $\delta^{13}C_{oil}$ values. This material could have been incorporated by extraction from less mature beds as the oil migrated to its present reservoir.

While the Anson hydrocarbon does show obvious correlation to the O'Steen, Victor and Jones oils, there are differences between these oils and the Taylor and Stringtown samples. These differences were not evident from the isotopic type-curves (Figure 3) or the ENVPLOT (Figure 4) where all the petroleums cluster reasonably close to the Marine source environment line. However, the difference is noticeable in some of the data in Table 1. Namely, high Pr/C_{17} and Ph/C_{18} ratios in Taylor (>0.8) and low values in Victor, Jones, O'Steen and Anson (<0.31). No values are recorded for Stringtown as it was heavily biodegraded with no n-alkanes and isoprenoids remaining. It should be pointed out that these differences may be due to Taylor and Stringtown being partially and extensively biodegraded (respectively), and perhaps early-mature. If the oils are all related, they can be plotted on an AIMAT oil maturity plot (Figure 5). The Taylor sample is seen to be least mature, the Victor most mature. The Anson oil may be pulled off the line by the minor immature component. It should be remembered, however, that this plot is only useful for comparison if the Taylor oil is of the same family as the others. The saturate C_{15+} gas chromatograms for all the hydrocarbons are shown in Figure 2 (Anson) and Figures 6-10 (O'Steen, Victor, Jones, Taylor and Stringtown, respectively). The mature O'Steen, Victor and Jones oils have previously been reported to be of the same family. (PGW/TM078 (1)). Their chromatograms (Figures 6-8) are not greatly different from the Anson (Figure 2) with the addition of the previously discussed mature component. However, the appearance of the Taylor (Figure 9) and Stringtown (Figure 10) chromatograms are different. A distinct bimodal hump exists in the naphthenic envelope. Along with the other reported differences between the two groups of oils, this may also be due to the effects of biodegradation and/or very immature Taylor and Stringtown samples.

In conclusion:

(1) The Anson oil appears to be related to the Victor, Jones and O'Steen hydrocarbons.

(2) The Anson oil contains a minor, isotopically heavy, early immature bitumen component.

(3) The Taylor and Stringtown hydrocarbons may be of a different family than the above oils, or more likely, differ from them because of biodegradation and/or maturity.

Summary hydrocarbon data sheets (Table 2 and Tables 4-8) and Summary hydrocarbon data logs (Figue 1 and Figures 11-15), are given for the Anson, O'Steen, Victor, Jones, Taylor and Stringtown, respectively.

REFERENCES

(1) Halpern, H., Marsek, F., Sedivy, R. 1982 Geochemical Characterization of Oils and Total Soluble Extracts Recovered from the #1 Jones, #1 O'Steen, and #3 Victor Wells, Isom Springs Field, Marshall County, Oklahoma.(PGW/TM078).

G. A. Cole

H. I. Halpern

R. A. Sedivy

GAC/HIH/RAS:mlc

Enclosures: Figures 1-15
Tables 1-8

cc: H. G. Bassett
R. Burwood
R. Drozd
E. Luttrell
PGW Files (0) (2-5)

Work By: S. Adams
R. Cavalier
H. Halpern
T. Morsefield
J. Reymander
R. Sedivy

TABLE 1

SUMMARY GEOCHEMICAL CHARACTERISTICS FOR THE HYDROCARBONS OF THIS STUDY

WELL/LOCATION	Taylor #1	#1 O'Steen	#3 Victor	#1 Jones	Stringtown Quarry	#1 Anson
HCB-	006	090	091	092	275	416
Depth (ft.)	2110	3356	4900	4000	0	7101
Formation	BGFK	ARKN	ARKN	ARKN	BGFK	ARKN
API^o	10^o	39.9^o	48.1^o	40.7^o	<0^o	18.6^o
% Sulfur	0.80	0.29	0.13	0.31	5.0	0.06
% Asphaltenes	12.0	0.66	0.38	0.44	52.2	3.1
% Distillate	0	22	42	19	0	6
CPI	1.07	1.04	1.16	1.08	-	1.07
Pr/Ph	1.11	1.59	1.62	1.56	-	1.51
Pr/C_{17}	0.86	0.30	0.22	0.31	-	0.30
Ph/C_{18}	0.81	0.28	0.20	0.29	-	0.20
*$\delta^{13}C_{oil}$(ppt)	-30.4	-30.3	-30.5	-30.4	-30.2	-29.8

*Standard is NBS-22 at -29.8 ppt.

TABLE 2

 14.31.10. 01/06/84

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#1 ANSON	SAMPLE ID:HCB416	FORMATION:ARKN
STATE :OK	LOCATION :SEC35,T2SR12E	TYPE:OIL	AGE/EPOCH:MS/DEV
COUNTY :ATOKA	API/OCS :35-005-20094	DEPTH(FT): 7101	
PGW JOB:83117	REPORT :	DATA BASE:PGW	

INSPECTION DATA		SIMULATED DISTILLATION %WT	DEG C	%WT	DEG C	N-ALKANE CONTENT	% WT SATURATES	PENTACYCLANE CONTENT NORMALISED DIST	
SPECIFIC GRAV. :	.943								
API GRAV. :	18.60								
SULFUR %WT:	.06								
NITROGEN %WT:		IBP	152			C10 :		H :	
WAX %WT:		2	184	52	395	C11 :		B :	
WAX MPT DEG C:		4	207	54	402	C12 :	.900	D :	
ASPHALTENE (1) %WT:	3.08	6	223	56	410	C13 :	1.240	G :	
NICKEL (PPM):		8	237	58	417	C14 :	1.680	N :	
VANADIUM (PPM):		10	249	60	425	C15 :	2.030	O :	
RESIDUE		12	261	62	433	C16 :	2.420	U :	
BPT>200C %WT:	95	14	271	64	441	C17 :	2.880	V :	
		16	278	66	449	C18 :	2.950	ALPHA :	
GEOCHEMICAL DATA		18	285	68	458	C19 :	2.850	BETA :	
		20	291	70	466	C20 :	2.500	GAMA :	
RESIDUE BPT>200C		22	299	72	475	C21 :	2.230	DELTA :	
TYPE ANALYSIS		24	305	74	483	C22 :	1.930	EPSILON :	
SATURATES %WT:	65.71	26	313	76	492	C23 :	1.660	ZETA :	
AROMATICS %WT:	18.60	28	319	78	501	C24 :	1.430		
POLARS %WT:	12.43	30	325	80	511	C25 :	1.310	STERANE	
ASPHALTENE(2)%WT:	3.24	32	331	82	521	C26 :	1.080	CONTENT	
N-ALKANE %WT:	30.66	34	337	84	531	C27 :	.760	NORMALISED DIST	
N-ALKANE CPI :	1.07	36	343	86		C28 :	.080		
ACYCLIC ISOPRENOID		38	349	88		C29 :	.400		
FARNESANE %WT:	.15	40	355	90		C30 :	.310	1 :	
ACYCLIC C16 %WT:	.48	42	361	92		C31 :		2 :	
ACYCLIC C18 %WT:	.54	44	368	94		C32 :		3 :	
PRISTANE %WT:	.87	46	374	96		C33 :		4 :	
PHYTANE %WT:	.58	48	381	98		C34 :		5 :	
PRISTANE/PHYTANE :	1.51	50	388	FBP		C35 :		6 :	
PRISTANE/N-C17 :	.30					C36 :		7 :	
PHYTANE/N-C18 :	.20							8 :	
NICKEL/VANADIUM :								9 :	
D-13 C(OIL) :	-29.83 %.							10 :	
D-13 C(DISTILLATE) :	-28.44 %.							11 :	
D-13 C(SATURATES) :	-30.10 %.							12 :	
D-13 C(AROMATICS) :	-29.68 %.							13 :	
D-13 C(POLARS) :	-29.52 %.							14 :	
D-13 C(ASPHALTENES) :	-29.59 %.							15 :	
D-13 C(RESINS) :	%.							16 :	
D-34 SULFUR :	%.							17 :	
D-2 DEUTERIUM :	%.							18 :	
D-15 NITROGEN :	%.							19 :	

TABLE 2 (cont'd)

S U M M A R Y H Y D R O C A R B O N D A T A S H E E T

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

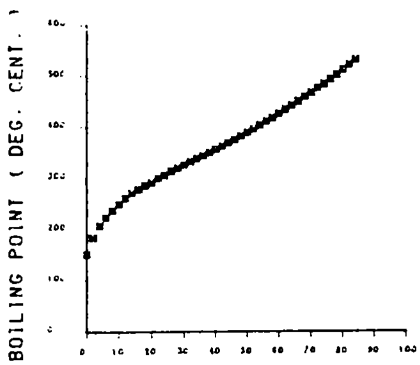
SAMPLE ID : HCB416 WELL/SITE : #1 ANSON

1	ISOBUTANE	.012
2	N-BUTANE	.073
3	ISOPENTANE	.158
4	N-PENTANE	.438
5	2,2-DIMETHYLBUTANE	.028
6	CYCLOPENTANE	.088
7	2,3-DIMETHYLBUTANE	.058
8	2-METHYLPENTANE	.401
9	3-METHYLPENTANE	.270
10	N-HEXANE	1.519
11	2,2-DIMETHYLPENTANE	.589
12	METHYLCYCLOPENTANE	.589
13	2,4-DIMETHYLPENTANE	.045
14	2,2,3-TRIMETHYLBUTANE	
15	BENZENE	1.123
16	CYCLOHEXANE	.037
17	2-METHYLHEXANE	.784
18	2,3-DIMETHYLPENTANE	.784
19	1,1-DIMETHYLCYCLOPENTANE	.110
20	3-METHYLHEXANE	.733
21	1-C-3-DIMETHYLCYCLOPENTANE	.207
22	1-T-3-DIMETHYLCYCLOPENTANE	.201
23	1-T-2-DIMETHYLCYCLOPENTANE	.459
24	2,2,4-TRIMETHYLPENTANE	
25	3-ETHYLPENTANE	
26	N-HEPTANE	3.805
27	2,2-DIMETHYLHEXANE	.034
28	METHYLCYCLOHEXANE	5.073
29	1,1,3-TRIMETHYLCYCLOPENTANE	.157
30	ETHYLCYCLOPENTANE	.294
31	2,5-DIMETHYLHEXANE	
32	2,4-DIMETHYLHEXANE	.233
33	2,2,3-TRIMETHYLPENTANE	.132
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.077
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	
36	2,3,4-TRIMETHYLPENTANE	.019
37	TOLUENE	2.376
38	3,3-DIMETHYLHEXANE	.252
39	2,3-DIMETHYLHEXANE	.302
40	2-METHYL-3-ETHYLPENTANE	1.855
41	2-METHYLHEPTANE	
42	4-METHYLHEPTANE	1.075
43	3,4-DIMETHYLHEXANE	
44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	.882
45	3-ETHYLHEXANE	.344
46	3-METHYLHEPTANE	
47	1-C-3-DIMETHYLCYCLOHEXANE	
48	3-METHYL-3-ETHYLPENTANE	
49	2,2,5-TRIMETHYLHEXANE	.214
50	1,1-DIMETHYLCYCLOHEXANE	
51	1-METHYL-C-2-ETHYLCYCLOPENTANE	.117
52	1-METHYL-C-3-ETHYLCYCLOPENTANE	.374
53	2,2,4-TRIMETHYLHEXANE	.104
54	1-T-2-DIMETHYLCYCLOHEXANE	.696
55	N-OCTANE	7.600
56	2,4,4-TRIMETHYLHEXANE	.116
57	2,3,3-TRIMETHYLHEXANE	.490
58	2,2-DIMETHYLHEPTANE	.076
59	2,3,5-TRIMETHYLHEXANE	
60	ETHYLCYCLOHEXANE	2.605
61	ETHYLBENZENE	.919
62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
63	M-XYLENE	4.654
64	P-XYLENE	.391
65	O-XYLENE	1.991
66	N-NONANE	8.011
67	ISOPROPYLBENZENE	.388
68	N-PROPYLBENZENE	.947
69	1-METHYL-3-ETHYLBENZENE	1.135
70	1-METHYL-4-ETHYLBENZENE	.607
71	1,3,5-TRIMETHYLBENZENE	.304
72	1-METHYL-2-ETHYLBENZENE	.631
73	N-DECANE	1.767
74	P-METHYLISOPROPYLBENZENE	.253
75	N-BUTYLBENZENE	.193
76	N-UNDECANE	.372

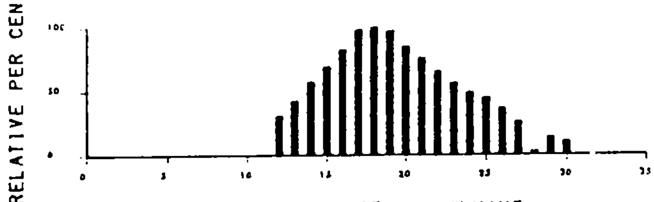
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

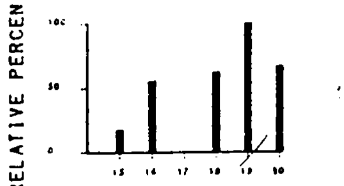
SIMULATED DISTILLATION



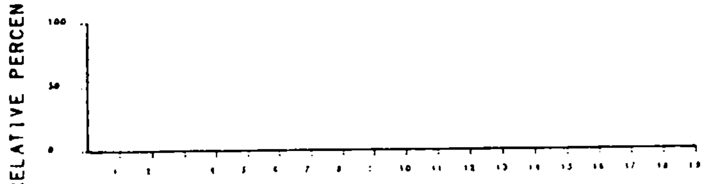
NORMAL ALKANE DISTRIBUTION



ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



PENTACYCLANE DISTRIBUTION

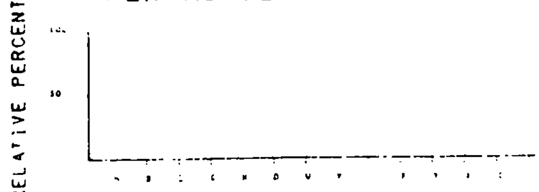
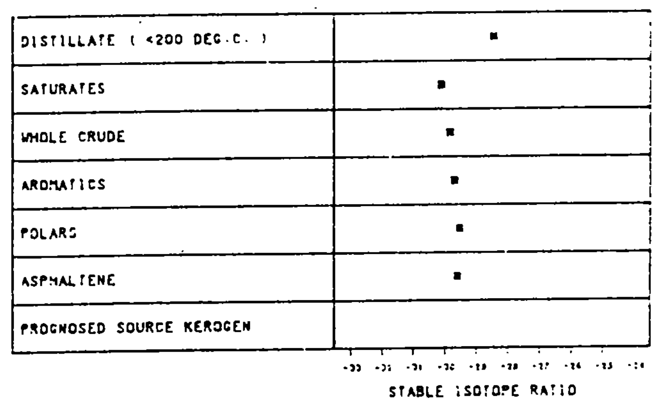


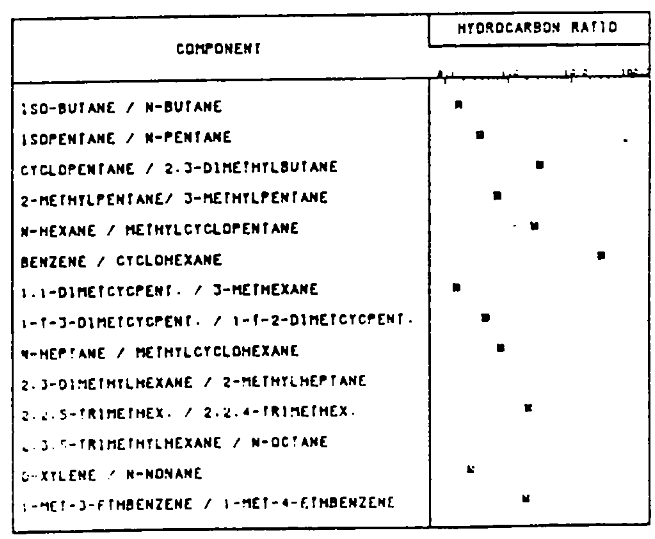
FIGURE 1. HYDROCARBON DATA

API GRAVITY	[illegible]	[illegible]
SPECIFIC GRAVITY	[illegible]	[illegible]
SULPHUR	% WT	[illegible]
WAX	% WT.	
WAX M. PT.	DEG. C	
ASPHALTENES	% WT	[illegible]
NICKEL	PPM	
VANADIUM	PPM	
NICKEL / VANADIUM RATIO		
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	[illegible]
AROMATICS	% WT.	[illegible]
POLARS	% WT.	[illegible]
N - ALKANE CPI		[illegible]
N - ALKANE % WT. OF SATURATES		30.66
PRISTANE / PHYTANE RATIO		[illegible]
PRISTANE / N - C17		0.30
PHYTANE / N - C18		[illegible]
CARBON ISOTOPE RATIO C13 %.		-29.83
SULPHUR ISOTOPE RATIO S34 %.		
DEUTERIUM ISOTOPE RATIO D2 %.		
NITROGEN ISOTOPE RATIO N15 %.		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE



COUNTRY [illegible]	SOHIO
STATE [illegible]	PETROLEUM GEOCHEMISTRY GROUP
COUNTY [illegible]	
LOCATION [illegible]	
WELL [illegible]	
DEPTH [illegible]	
SAMPLE TYPE [illegible]	
SAMPLE ID [illegible]	

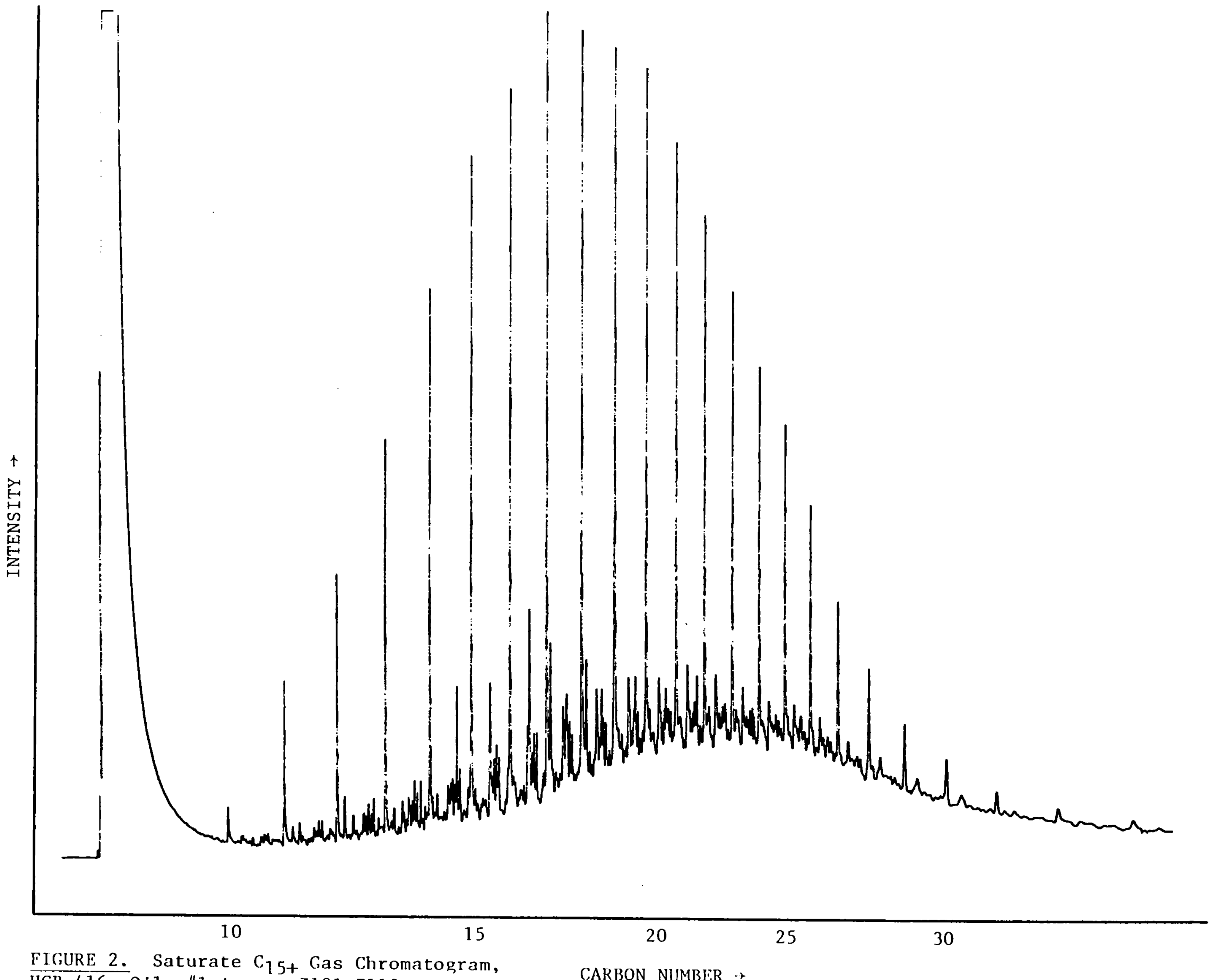


FIGURE 2. Saturate C_{15+} Gas Chromatogram, HCB-416, Oil, #1 Anson, 7101-7119 Ft., Arkansas Novaculite.

TABLE 3

Definitions of Thompson's Paraffin Indices.
The values for HCB-416 are I=1.75, II=33.4.

$$I = \frac{\text{2-methylhexane + 3-methylhexane}}{\Sigma\text{(3 dimethylcyclopentane isomers)}}$$

MATURITY ⟶

0.10 ⟶ 8.0

Or from Summary Hydrocarbon Data Sheet p.2:

$$I = \frac{\#17 + \#20}{\#21 + \#22 + \#23}$$

$$II = \frac{\underline{n}\text{-}C_7 \times 100}{\Sigma\text{(all compounds eluting between cyclohexane and methylcyclohexane except 2, 3-dimethylpentane, 2, 2, 4-trimethylpentane, 3-ethylpentane and 2, 2-dimethylhexane)}}$$

MATURITY ⟶

5 ⟶ 30

Or from Summary Hydrocarbon Data Sheet p.2:

$$II = \frac{\#26 \times 100}{(16 + 17 + 19 + 20 + 21 + 22 + 23 + 26 + 28)}$$

The numbers refer to the compounds listed on the Summary Hydrocarbon Data Sheet.

Reference:

Thompson, K.F.M., 1979, Light hydrocarbons in subsurface sediments: Geochimica et Cosmochimica Acta, V. 43, p. 657 - 672.

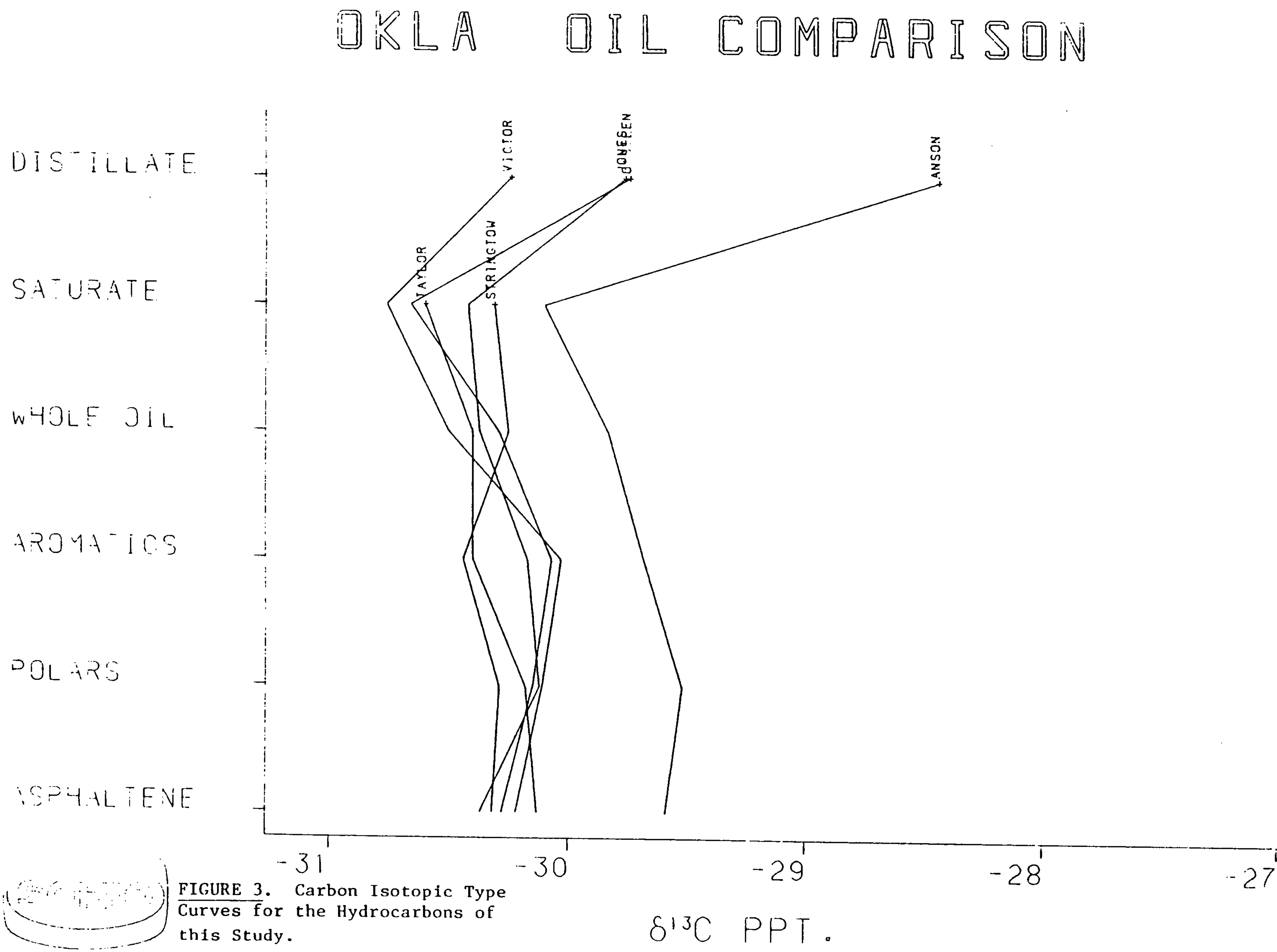


FIGURE 3. Carbon Isotopic Type Curves for the Hydrocarbons of this Study.

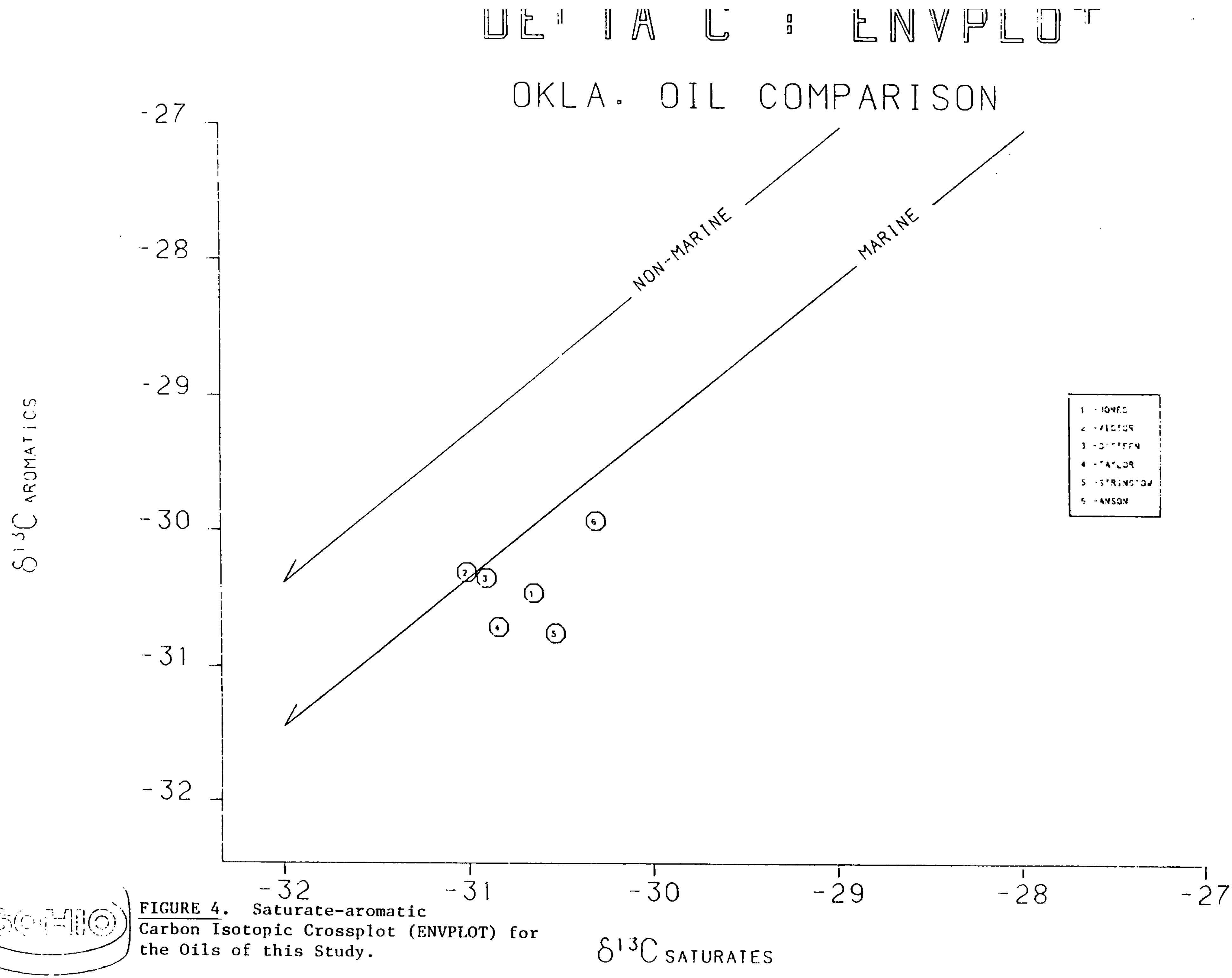


FIGURE 4. Saturate-aromatic Carbon Isotopic Crossplot (ENVPLOT) for the Oils of this Study.

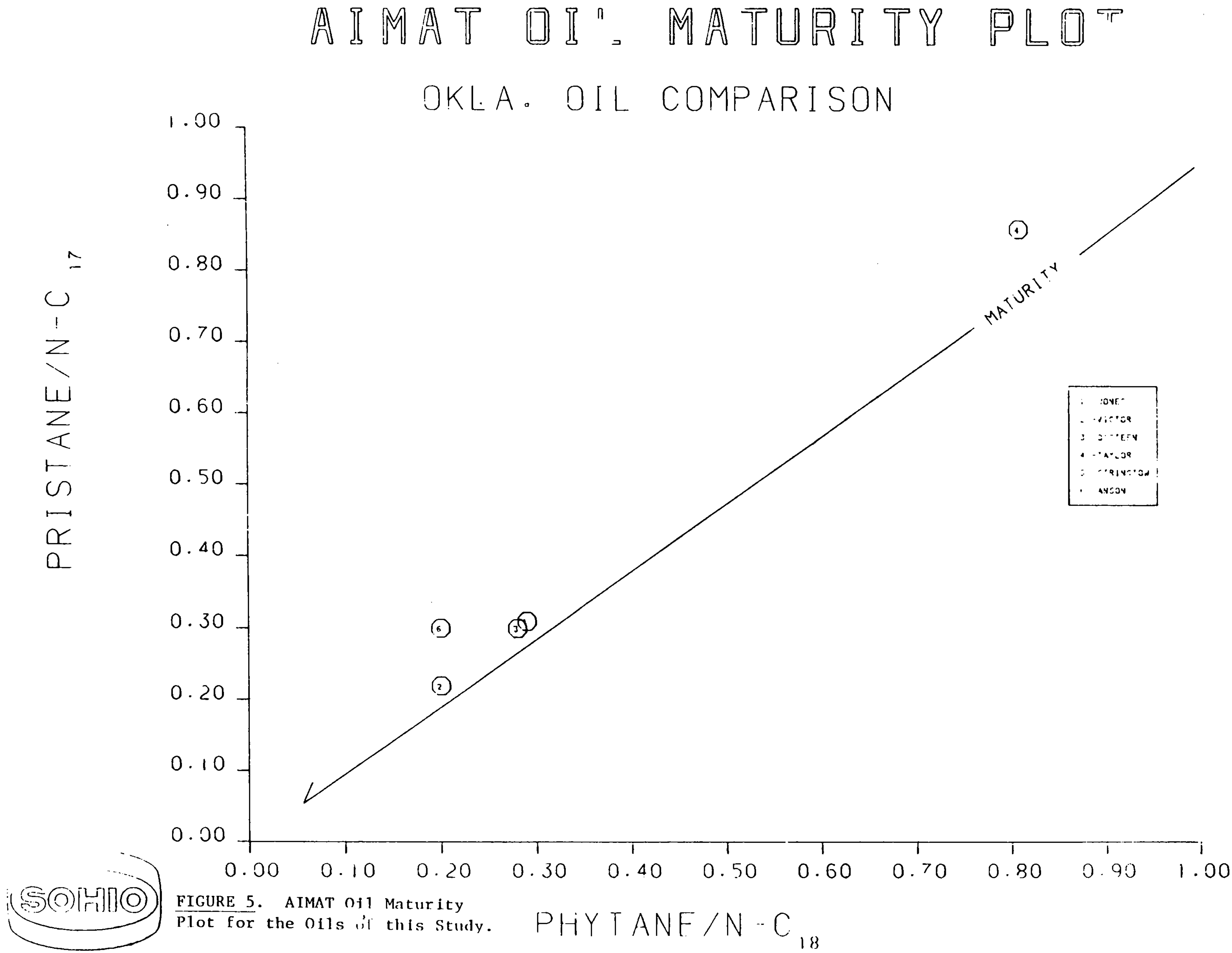


FIGURE 5. AIMAT Oil Maturity Plot for the Oils of this Study.

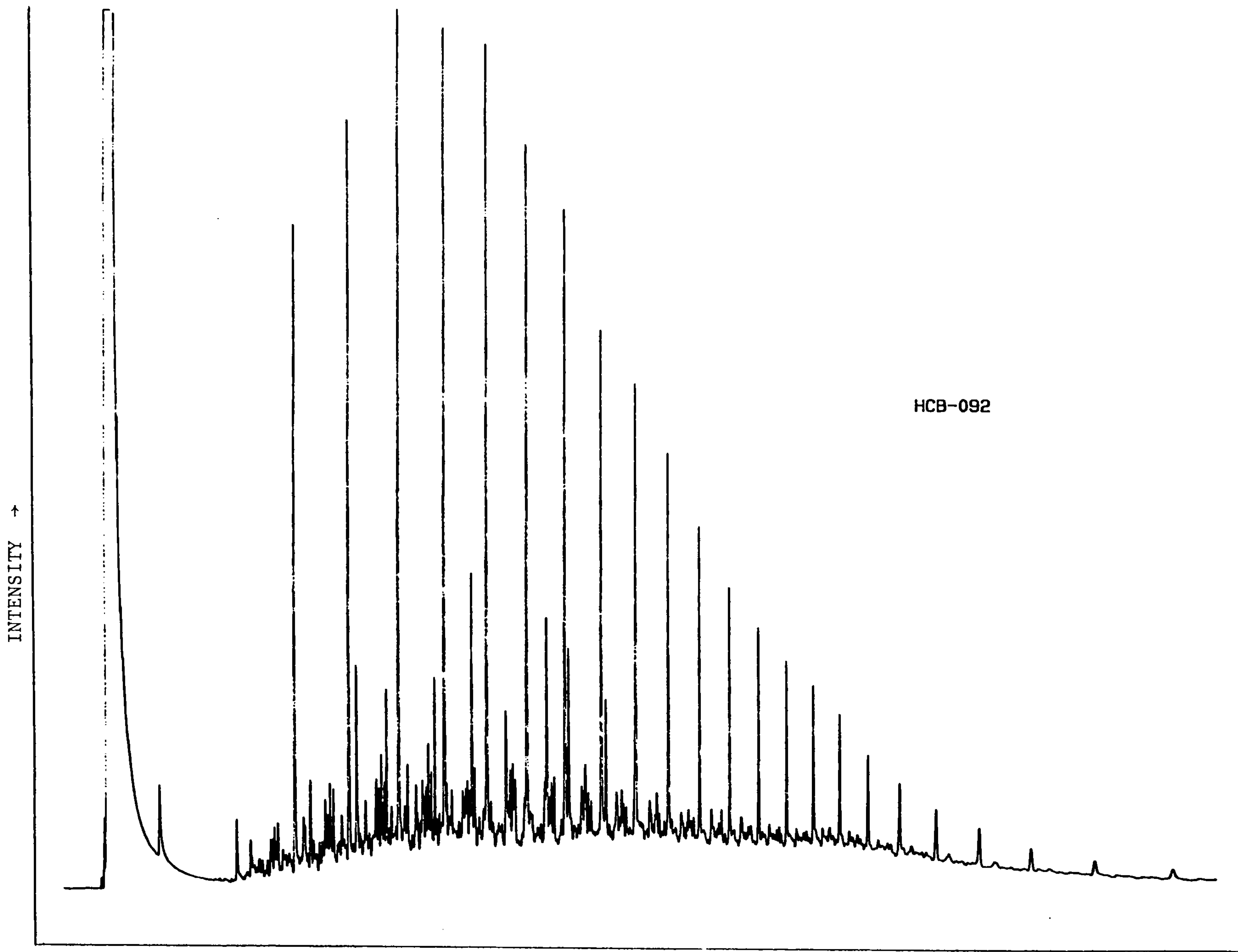


FIGURE 8. Saturate C_{15+} Gas Chromatogram of HCB-092, #1 Jones Well, Marshall Co., Oklahoma, 4000 ft., Arkansas Novaculite.

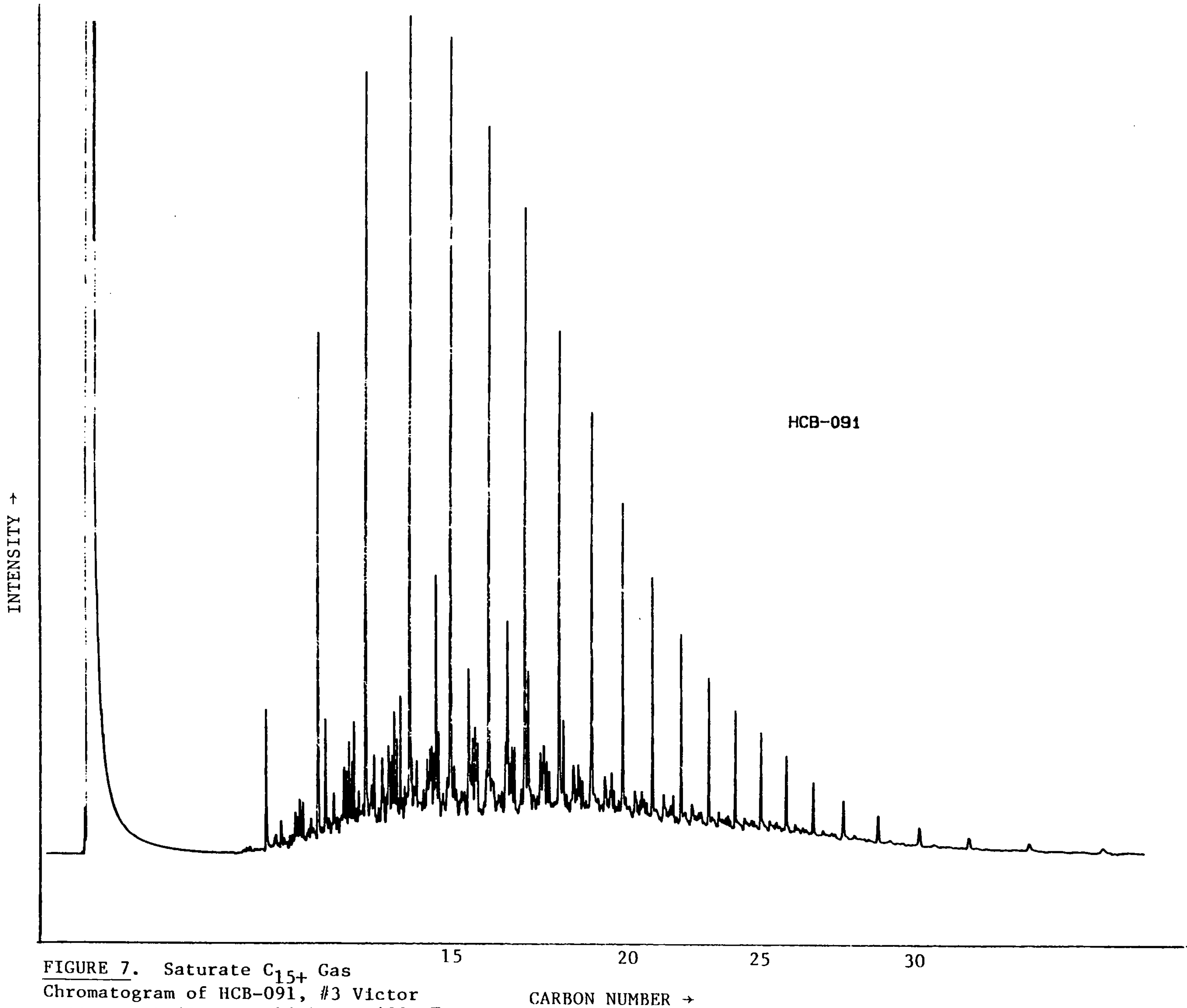


FIGURE 7. Saturate C_{15+} Gas Chromatogram of HCB-091, #3 Victor Well, Marshall Co., Oklahoma, 4900 Ft., Arkansas Novaculite.

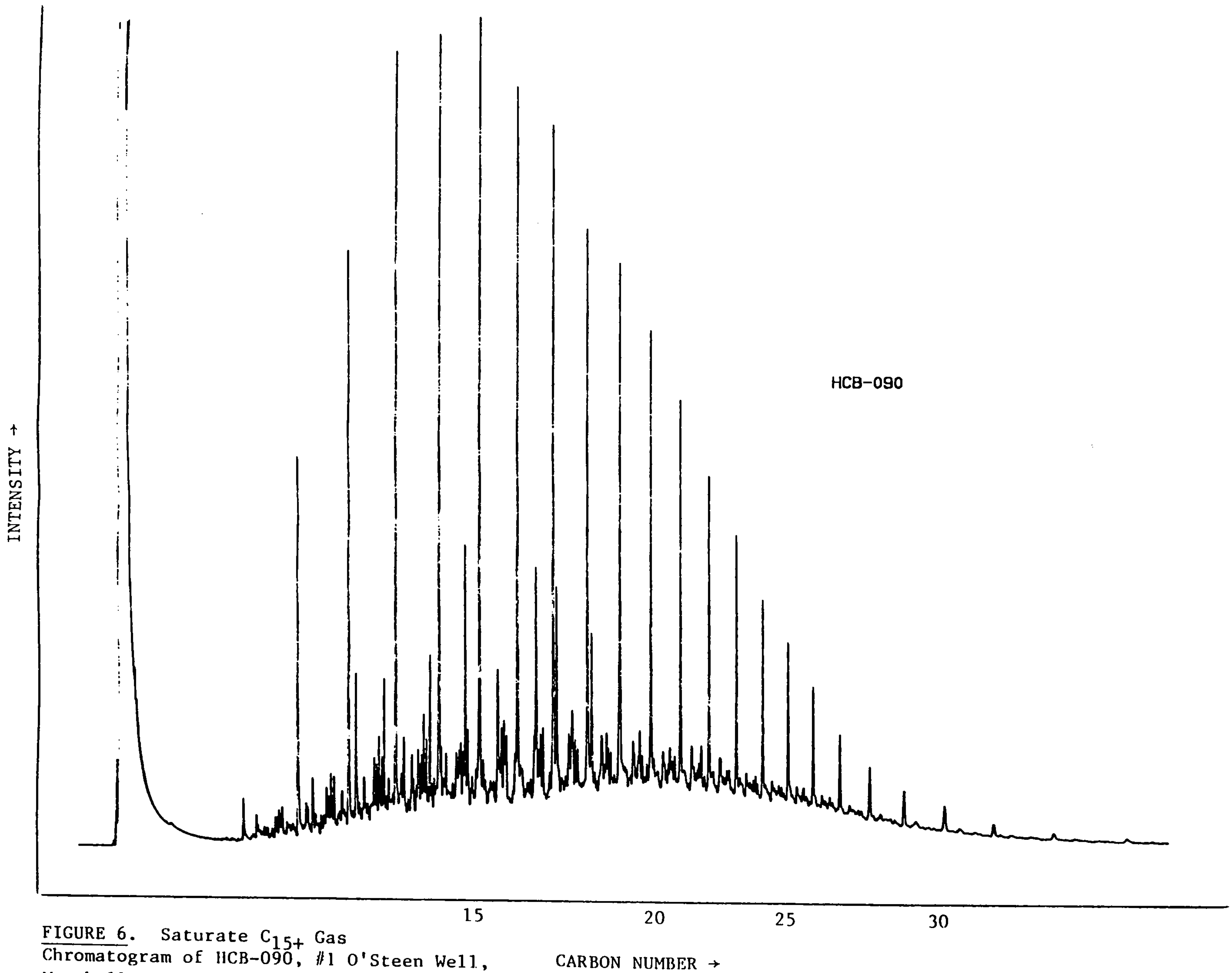


FIGURE 6. Saturate C_{15+} Gas Chromatogram of HCB-090, #1 O'Steen Well, Marshall Co., Oklahoma, 3356 ft., Arkansas Novaculite.

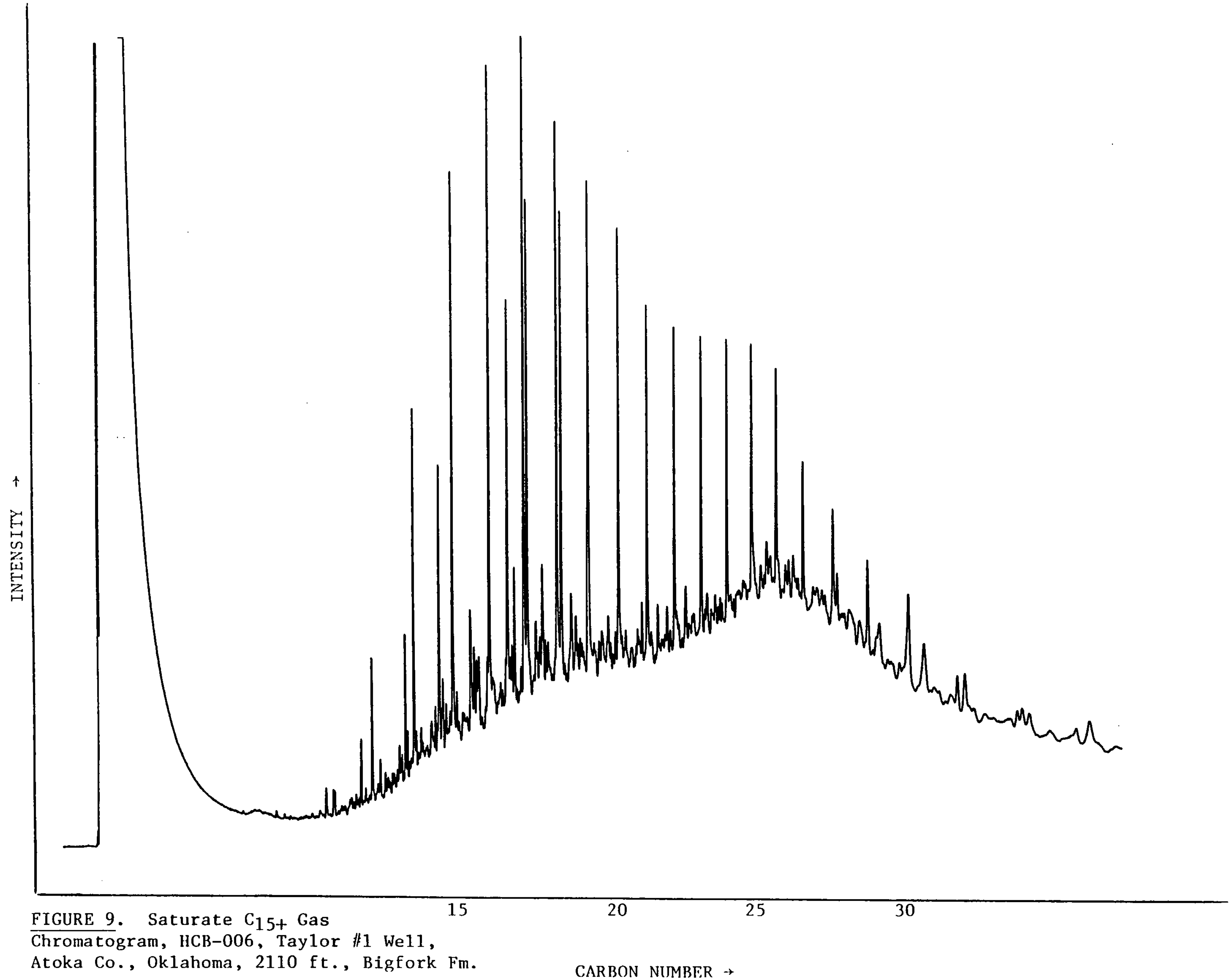


FIGURE 9. Saturate C_{15+} Gas Chromatogram, HCB-006, Taylor #1 Well, Atoka Co., Oklahoma, 2110 ft., Bigfork Fm.

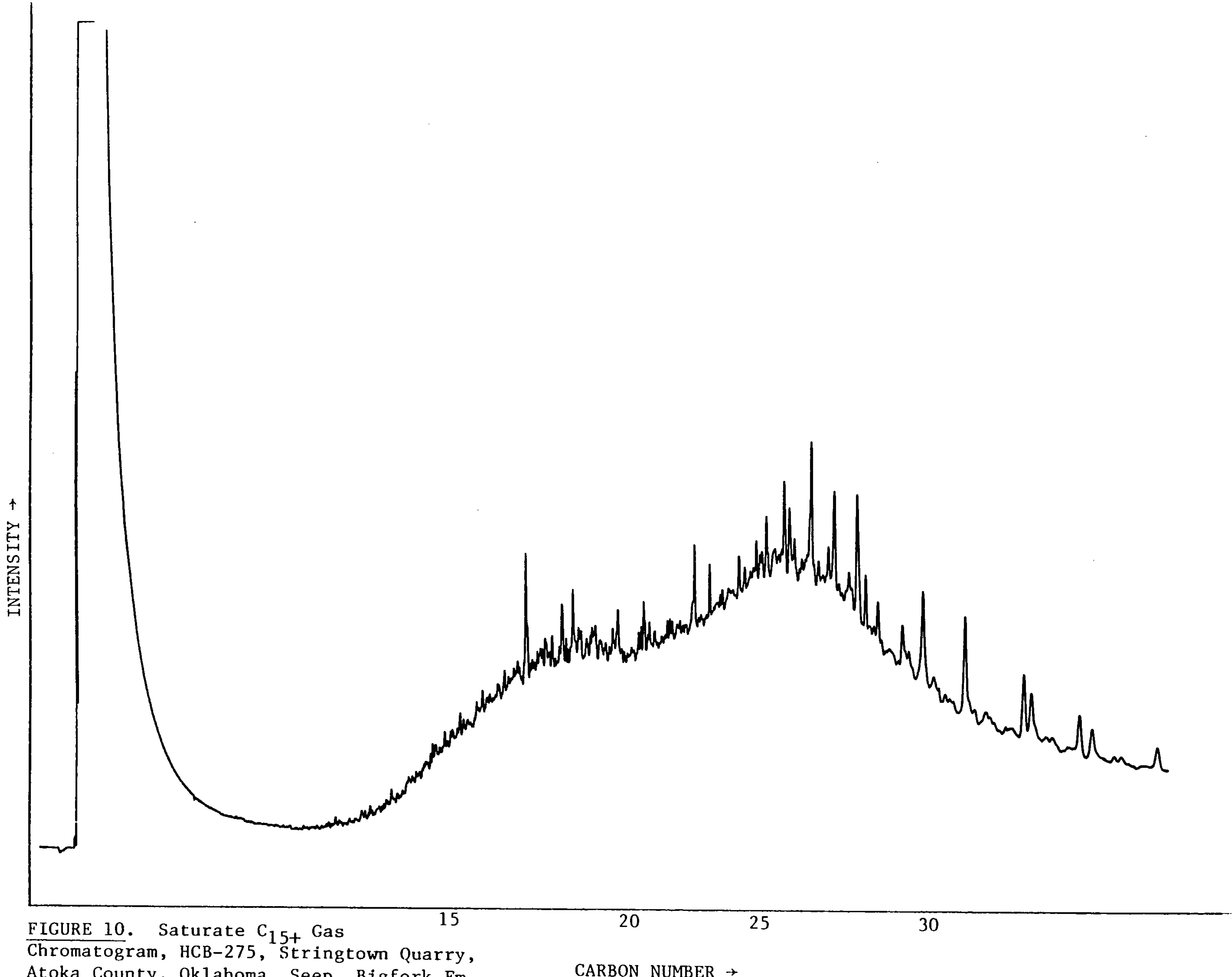


FIGURE 10. Saturate C_{15+} Gas Chromatogram, HCB-275, Stringtown Quarry, Atoka County, Oklahoma, Seep, Bigfork Fm.

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#1 O'STEEN	SAMPLE ID:HCB090 FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:OIL AGE/EPOCH:MS/DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 3356
PGW JOB:8158	REPORT :	DATA BASE:PGW

INSPECTION DATA

SPECIFIC GRAV.	:	.830
API GRAV.	:	39.90
SULFUR	%WT:	.29
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	.66
NICKEL	(PPM):	9
VANADIUM	(PPM):	20
RESIDUE BPT>200C	%WT:	78

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	71.10	
AROMATICS	%WT:	15.00	
POLARS	%WT:	13.00	
ASPHALTENE(2)	%WT:	.85	
N-ALKANE	%WT:	30.10	
N-ALKANE CPI	:	1.04	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.60	
ACYCLIC C16	%WT:	1.30	
ACYCLIC C18	%WT:	1.30	
PRISTANE	%WT:	.80	
PHYTANE	%WT:	.50	
PRISTANE/PHYTANE	:	1.59	
PRISTANE/N-C17	:	.30	
PHYTANE/N-C18	:	.28	
NICKEL/VANADIUM	:	.45	
D-13 C(OIL)	:	-30.29	%.
D-13 C(DISTILLATE)	:	-29.74	%.
D-13 C(SATURATES)	:	-30.66	%.
D-13 C(AROMATICS)	:	-30.07	%.
D-13 C(POLARS)	:	-30.15	%.
D-13 C(ASPHALTENES)	:	-30.28	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:	17.20	%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2	56	52	310
4	74	54	319
6	92	56	329
8	100	58	341
10	115	60	352
12	123	62	364
14	133	64	375
16	144	66	387
18	152	68	400
20	163	70	413
22	171	72	427
24	180	74	442
26	191	76	458
28	199	78	475
30	209	80	495
32	216	82	518
34	227	84	
36	235	86	
38	245	88	
40	251	90	
42	262	92	
44	270	94	
46	280	96	
48	290	98	
50	300	FBP	

N-ALKANE CONTENT

	% WT SATURATES
C10 :	
C11 :	
C12 :	3.800
C13 :	4.200
C14 :	4.200
C15 :	4.100
C16 :	3.300
C17 :	2.700
C18 :	1.800
C19 :	1.600
C20 :	1.100
C21 :	.800
C22 :	.700
C23 :	.600
C24 :	.400
C25 :	.400
C26 :	.300
C27 :	
C28 :	
C29 :	
C30 :	
C31 :	
C32 :	
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT

	NORMALISED DIST
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT

	NORMALISED DIST
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

TABLE 4 (cont.)

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB090 WELL/SITE : #1 O'STEEN

1	ISOBUTANE	
2	N-BUTANE	
3	ISOPENTANE	.042
4	N-PENTANE	.157
5	2,2-DIMETHYLBUTANE	
6	CYCLOPENTANE	.065
7	2,3-DIMETHYLBUTANE	.069
8	2-METHYLPENTANE	.535
9	3-METHYLPENTANE	.450
10	N-HEXANE	1.935
11	2,2-DIMETHYLPENTANE	.925
12	METHYLCYCLOPENTANE	
13	2,4-DIMETHYLPENTANE	.111
14	2,2,3-TRIMETHYLBUTANE	
15	BENZENE	
16	CYCLOHEXANE	1.623
17	2-METHYLHEXANE	1.718
18	2,3-DIMETHYLPENTANE	
19	1,1-DIMETHYLCYCLOPENTANE	.212
20	3-METHYLHEXANE	1.684
21	1-C-3-DIMETHYLCYCLOPENTANE	.433
22	1-T-3-DIMETHYLCYCLOPENTANE	.408
23	1-T-2-DIMETHYLCYCLOPENTANE	.902
24	2,2,4-TRIMETHYLPENTANE	
25	3-ETHYLPENTANE	
26	N-HEPTANE	5.646
27	2,2-DIMETHYLHEXANE	.098
28	METHYLCYCLOHEXANE	6.269
29	1,1,3-TRIMETHYLCYCLOPENTANE	.340
30	ETHYLCYCLOPENTANE	.385
31	2,5-DIMETHYLHEXANE	.254
32	2,4-DIMETHYLHEXANE	.370
33	2,2,3-TRIMETHYLPENTANE	
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.433
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	.503
36	2,3,4-TRIMETHYLPENTANE	
37	TOLUENE	.770
38	3,3-DIMETHYLHEXANE	.156

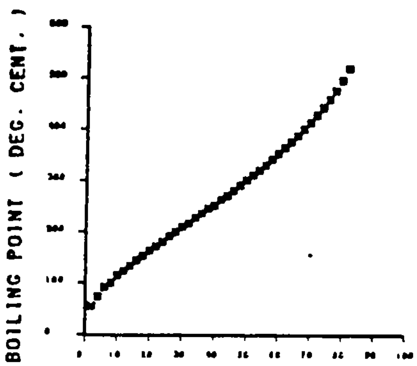
39	2,3-DIMETHYLHEXANE	.532
40	2-METHYL-3-ETHYLPENTANE	
41	2-METHYLHEPTANE	2.699
42	4-METHYLHEPTANE	
43	3,4-DIMETHYLHEXANE	
44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	
45	3-ETHYLHEXANE	1.240
46	3-METHYLHEPTANE	4.654
47	1-C-3-DIMETHYLCYCLOHEXANE	
48	3-METHYL-3-ETHYLPENTANE	1.064
49	2,2,5-TRIMETHYLHEXANE	.220
50	1,1-DIMETHYLCYCLOHEXANE	.430
51	1-METHYL-C-2-ETHYLCYCLOPENTANE	
52	1-METHYL-C-3-ETHYLCYCLOPENTANE	
53	2,2,4-TRIMETHYLHEXANE	
54	1-T-2-DIMETHYLCYCLOHEXANE	1.319
55	N-OCTANE	7.765
56	2,4,4-TRIMETHYLHEXANE	
57	2,3,3-TRIMETHYLHEXANE	.679
58	2,2-DIMETHYLHEPTANE	.119
59	2,3,5-TRIMETHYLHEXANE	.126
60	ETHYLCYCLOHEXANE	2.441
61	ETHYLBENZENE	.425
62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
63	M-XYLENE	2.001
64	P-XYLENE	.626
65	O-XYLENE	.876
66	N-NONANE	9.429
67	ISOPROPYLBENZENE	.149
68	N-PROPYLBENZENE	.396
69	1-METHYL-3-ETHYLBENZENE	.926
70	1-METHYL-4-ETHYLBENZENE	.376
71	1,3,5-TRIMETHYLBENZENE	.731
72	1-METHYL-2-ETHYLBENZENE	1.220
73	N-DECANE	3.409
74	P-METHYLISOPROPYLBENZENE	.146
75	N-BUTYLBENZENE	
76	N-UNDECANE	.436

SUMMARY HYDROCARBON DATA LOG

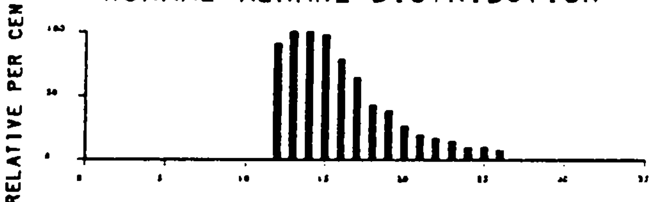
FIGURE 11

PETROLEUM TYPE

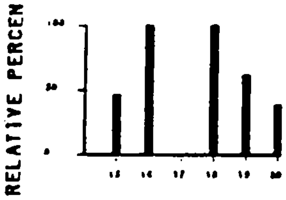
SIMULATED DISTILLATION



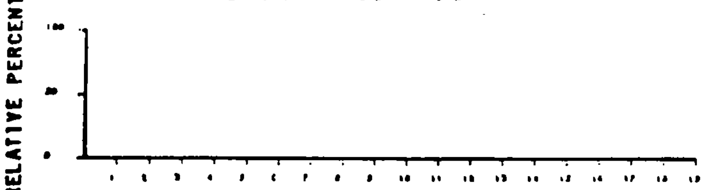
NORMAL ALKANE DISTRIBUTION



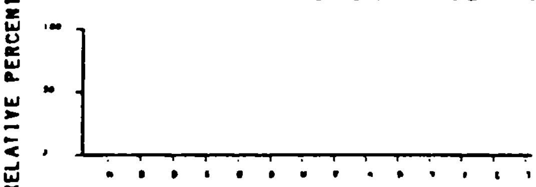
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



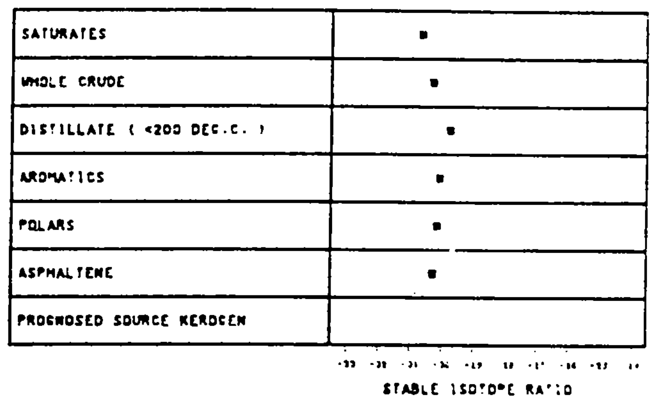
PENTACYCLANE DISTRIBUTION



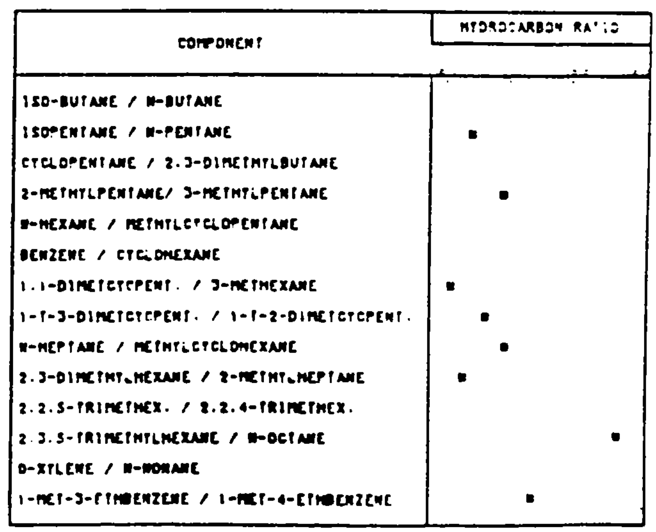
HYDROCARBON DATA

API GRAVITY	60 DEG. F.	39.90
SPECIFIC GRAVITY	60 DEG. F.	0.83
SULPHUR	% WT.	0.29
WAX	% WT.	
WAX M. PT.	DEG. C.	
ASPHALTENES	% WT.	0.66
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.45
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	71.10
AROMATICS	% WT.	15.00
POLARS	% WT.	13.00
N - ALKANE CPI		1.04
N - ALKANE	% WT.	30.10
PRISTANE / PHYTANE RATIO		1.59
PRISTANE / N - C17		0.30
PHYTANE / N - C18		0.28
CARBON ISOTOPE RATIO C13 %.		-30.29
SULPHUR ISOTOPE RATIO S34 %.		17.20
DEUTERIUM ISOTOPE RATIO D2 %.		
NITROGEN ISOTOPE RATIO N15 %.		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE



COUNTRY: US
STATE OK
COUNTY MARSHALL
LOCATION [illegible]
WELL [illegible]
DEPTH [illegible]
SAMPLE TYPE OIL

PETROLEUM GEOCHEMISTRY GROUP

TABLE 5

09.22.46. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US
STATE :OK
COUNTY :MARSHALL
PGW JOB:8157

WELL/SITE:#3 VICTOR
LOCATION :SEC2,T8SR5E
API/OCS :-
REPORT :

SAMPLE ID:HC8091 FORMATION:ARKN
TYPE:OIL AGE/EPOCH:MS/DEV
DEPTH(FT): 4900
DATA BASE:PGW

INSPECTION DATA

SPECIFIC GRAV.	:	.787
API GRAV.	:	48.10
SULFUR	%WT:	.13
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	.38
NICKEL	(PPM):	4
VANADIUM	(PPM):	12
RESIDUE BPT>200C	%WT:	58

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	79.00	
AROMATICS	%WT:	12.40	
POLARS	%WT:	7.80	
ASPHALTENE(2)	%WT:	.66	
N-ALKANE	%WT:	29.07	
N-ALKANE CPI	:	1.16	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.52	
ACYCLIC C16	%WT:	1.24	
ACYCLIC C18	%WT:	1.00	
PRISTANE	%WT:	.55	
PHYTANE	%WT:	.34	
PRISTANE/PHYTANE	:	1.62	
PRISTANE/N-C17	:	.22	
PHYTANE/N-C18	:	.20	
NICKEL/VANADIUM	:	.33	
D-13 C(OIL)	:	-30.50	Z.
D-13 C(DISTILLATE)	:	-30.24	Z.
D-13 C(SATURATES)	:	-30.76	Z.
D-13 C(AROMATICS)	:	-30.03	Z.
D-13 C(POLARS)	:	-30.11	Z.
D-13 C(ASPHALTENES)	:	-30.22	Z.
D-13 C(RESINS)	:		Z.
D-34 SULFUR	:		Z.
D-2 DEUTERIUM	:		Z.
D-15 NITROGEN	:		Z.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP	83		
2	96	52	290
4	106	54	300
6	117	56	311
8	124	58	321
10	133	60	331
12	141	62	343
14	148	64	357
16	154	66	371
18	162	68	387
20	168	70	406
22	173	72	430
24	182	74	461
26	190	76	519
28	195	78	
30	204	80	
32	210	82	
34	216	84	
36	226	86	
38	233	88	
40	241	90	
42	248	92	
44	255	94	
46	264	96	
48	272	98	
50	281	FBP	

N-ALKANE CONTENT % WT SATURATES

C10	:	
C11	:	
C12	:	4.400
C13	:	4.920
C14	:	4.280
C15	:	4.040
C16	:	2.970
C17	:	2.530
C18	:	1.680
C19	:	1.420
C20	:	.950
C21	:	.640
C22	:	.470
C23	:	.350
C24	:	.250
C25	:	.170
C26	:	
C27	:	
C28	:	
C29	:	
C30	:	
C31	:	
C32	:	
C33	:	
C34	:	
C35	:	
C36	:	

PENTACYCLANE CONTENT NORMALISED DIST

H	:	
B	:	
D	:	
G	:	
N	:	
O	:	
U	:	
V	:	
ALPHA	:	
BETA	:	
GAMA	:	
DELTA	:	
EPSILON	:	
ZETA	:	

STERANE CONTENT NORMALISED DIST

1	:	
2	:	
3	:	
4	:	
5	:	
6	:	
7	:	
8	:	
9	:	
10	:	
11	:	
12	:	
13	:	
14	:	
15	:	
16	:	
17	:	
18	:	
19	:	

TABLE 5 (cont.)

09.22.46. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB091 WELL/SITE : #3 VICTOR

1	ISOBUTANE	.276
2	N-BUTANE	1.745
3	ISOPENTANE	2.185
4	N-PENTANE	3.824
5	2,2-DIMETHYLBUTANE	.214
6	CYCLOPENTANE	.249
7	2,3-DIMETHYLBUTANE	.352
8	2-METHYLPENTANE	2.324
9	3-METHYLPENTANE	1.586
10	N-HEXANE	5.414
11	2,2-DIMETHYLPENTANE	1.590
12	METHYLCYCLOPENTANE	
13	2,4-DIMETHYLPENTANE	.238
14	2,2,3-TRIMETHYLBUTANE	.041
15	BENZENE	
16	CYCLOHEXANE	2.124
17	2-METHYLHEXANE	2.462
18	2,3-DIMETHYLPENTANE	
19	1,1-DIMETHYLCYCLOPENTANE	.241
20	3-METHYLHEXANE	2.181
21	1-C-3-DIMETHYLCYCLOPENTANE	.413
22	1-T-3-DIMETHYLCYCLOPENTANE	.376
23	1-T-2-DIMETHYLCYCLOPENTANE	
24	2,2,4-TRIMETHYLPENTANE	
25	3-ETHYLPENTANE	.791
26	N-HEPTANE	6.246
27	2,2-DIMETHYLHEXANE	.121
28	METHYLCYCLOHEXANE	5.843
29	1,1,3-TRIMETHYLCYCLOPENTANE	.263
30	ETHYLCYCLOPENTANE	.226
31	2,5-DIMETHYLHEXANE	.258
32	2,4-DIMETHYLHEXANE	.372
33	2,2,3-TRIMETHYLPENTANE	
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.293
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	.264
36	2,3,4-TRIMETHYLPENTANE	
37	TOLUENE	.552
38	3,3-DIMETHYLHEXANE	.161
39	2,3-DIMETHYLHEXANE	.385
40	2-METHYL-3-ETHYLPENTANE	
41	2-METHYLHEPTANE	2.110
42	4-METHYLHEPTANE	
43	3,4-DIMETHYLHEXANE	
44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	
45	3-ETHYLHEXANE	.983
46	3-METHYLHEPTANE	1.973
47	1-C-3-DIMETHYLCYCLOHEXANE	
48	3-METHYL-3-ETHYLPENTANE	.872
49	2,2,5-TRIMETHYLHEXANE	.120
50	1,1-DIMETHYLCYCLOHEXANE	.331
51	1-METHYL-C-2-ETHYLCYCLOPENTANE	
52	1-METHYL-C-3-ETHYLCYCLOPENTANE	.111
53	2,2,4-TRIMETHYLHEXANE	
54	1-T-2-DIMETHYLCYCLOHEXANE	.895
55	N-OCTANE	5.976
56	2,4,4-TRIMETHYLHEXANE	
57	2,3,3-TRIMETHYLHEXANE	.483
58	2,2-DIMETHYLHEPTANE	.096
59	2,3,5-TRIMETHYLHEXANE	
60	ETHYLCYCLOHEXANE	1.637
61	ETHYLBENZENE	.212
62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
63	M-XYLENE	1.278
64	P-XYLENE	.339
65	O-XYLENE	.503
66	N-NONANE	6.544
67	ISOPROPYLBENZENE	.133
68	N-PROPYLBENZENE	.208
69	1-METHYL-3-ETHYLBENZENE	.334
70	1-METHYL-4-ETHYLBENZENE	
71	1,3,5-TRIMETHYLBENZENE	.601
72	1-METHYL-2-ETHYLBENZENE	1.001
73	N-DECANE	4.730
74	P-METHYLISOPROPYLBENZENE	.152
75	N-BUTYLBENZENE	.325
76	N-UNDECANE	1.209

SUMMARY HYDROCARBON DATA LOG

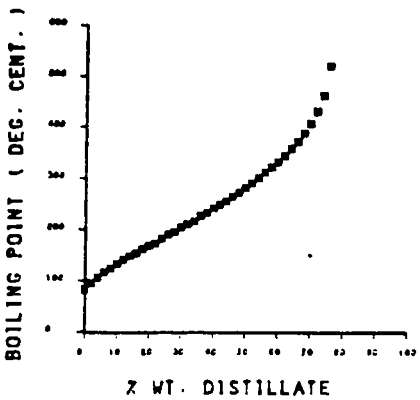
PETROLEUM TYPE

<u>FIGURE 12</u>

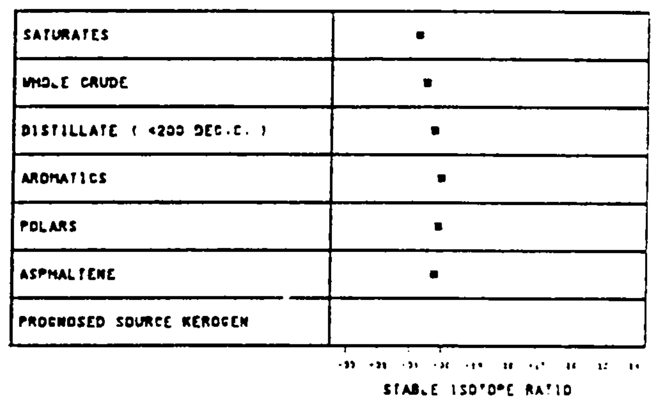
HYDROCARBON DATA

API GRAVITY	60 DEG. F.	48.10
SPECIFIC GRAVITY	60 DEG. F.	0.79
SULPHUR	% WT.	0.13
WAX	% WT.	
WAX M. PT.	DEG. F.	
ASPHALTENES	% WT.	0.38
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.00
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	79.00
AROMATICS	% WT.	12.40
POLARS	% WT.	7.80
N - ALKANE CPI		1.16
N - ALKANE	% WT.	29.0?
PRISTANE / PHYTANE RATIO		1.02
PRISTANE / N - C17		0.22
PHYTANE / N - C18		0.20
CARBON ISOTOPE RATIO C13 %.		-30.50
SULPHUR ISOTOPE RATIO S34 %.		
DEUTERIUM ISOTOPE RATIO D2 %.		
NITROGEN ISOTOPE RATIO N15 %.		

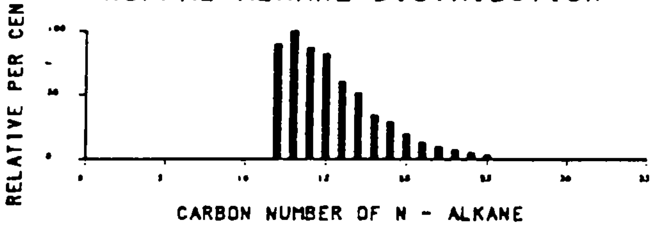
SIMULATED DISTILLATION



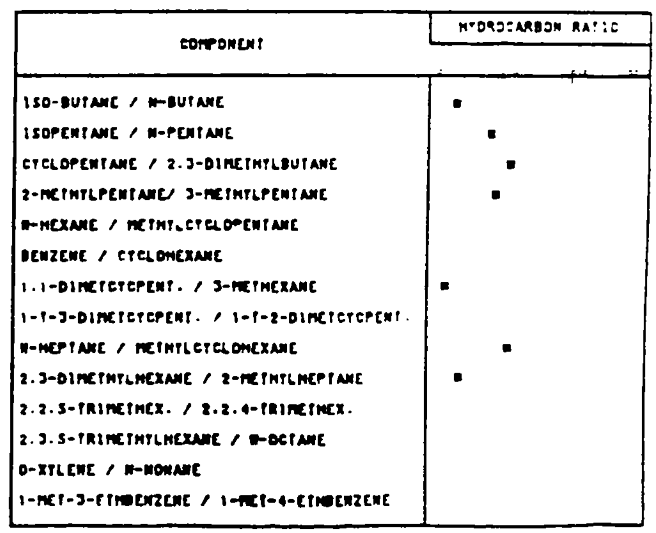
STABLE CARBON ISOTOPE PROFILE



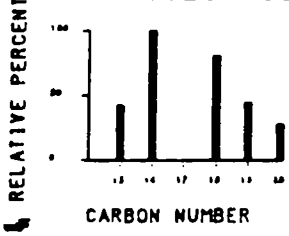
NORMAL ALKANE DISTRIBUTION



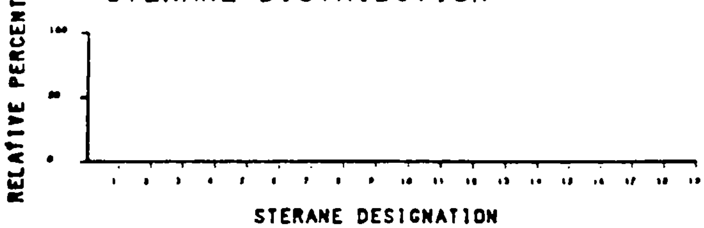
LIGHT HYDROCARBON PROFILE



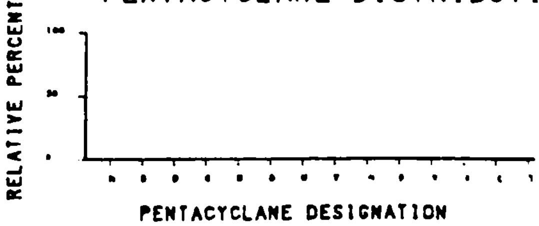
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



PENTACYCLANE DISTRIBUTION



COUNTRY US
STATE [illegible]
COUNTY MARSHALL
LOCATION [illegible]
WELL [illegible] VICTOR
DEPTH [illegible]
SAMPLE TYPE OIL
SAMPLE ID [illegible]
DATA BASE [illegible]

PETROLEUM GEOCHEMISTRY GROUP [illegible]

TABLE 6

 09.30.33. 09/03/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#1 JONES	SAMPLE ID:HCB092 FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:OIL AGE/EPOCH:MS/DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 4000
PGW JOB:8158	REPORT :	DATA BASE:PGW

INSPECTION DATA

SPECIFIC GRAV.	:	.822
API GRAV.	:	40.70
SULFUR	%WT:	.31
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	.44
NICKEL	(PPM):	10
VANADIUM	(PPM):	25
RESIDUE BPT>200C	%WT:	81

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	70.30	
AROMATICS	%WT:	14.00	
POLARS	%WT:	15.20	
ASPHALTENE(2)	%WT:	.54	
N-ALKANE	%WT:	32.90	
N-ALKANE CPI	:	1.08	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.74	
ACYCLIC C16	%WT:	1.50	
ACYCLIC C18	%WT:	.97	
PRISTANE	%WT:	.98	
PHYTANE	%WT:	.63	
PRISTANE/PHYTANE	:	1.56	
PRISTANE/N-C17	:	.31	
PHYTANE/N-C18	:	.29	
NICKEL/VANADIUM	:	.40	
D-13 C(OIL)	:	-30.37	%.
D-13 C(DISTILLATE)	:	-29.76	%.
D-13 C(SATURATES)	:	-30.42	%.
D-13 C(AROMATICS)	:	-30.17	%.
D-13 C(POLARS)	:	-30.12	%.
D-13 C(ASPHALTENES)	:	-30.37	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:	18.80	%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP	85		
2	98	52	343
4	116	54	354
6	127	56	366
8	140	58	378
10	148	60	390
12	159	62	403
14	168	64	417
16	175	66	431
18	186	68	446
20	194	70	464
22	204	72	483
24	211	74	505
26	222	76	533
28	231	78	
30	240	80	
32	248	82	
34	256	84	
36	265	86	
38	274	88	
40	283	90	
42	294	92	
44	303	94	
46	313	96	
48	323	98	
50	333	FBP	

N-ALKANE CONTENT

	% WT SATURATES
C10 :	
C11 :	
C12 :	3.110
C13 :	4.320
C14 :	4.610
C15 :	4.710
C16 :	3.920
C17 :	3.210
C18 :	2.200
C19 :	1.960
C20 :	1.300
C21 :	.980
C22 :	.790
C23 :	.640
C24 :	.490
C25 :	.380
C26 :	.290
C27 :	
C28 :	
C29 :	
C30 :	
C31 :	
C32 :	
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT

	NORMALISED DIST
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT

	NORMALISED DIST
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

TABLE 6 (cont.)

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB092 WELL/SITE : #1 JONES

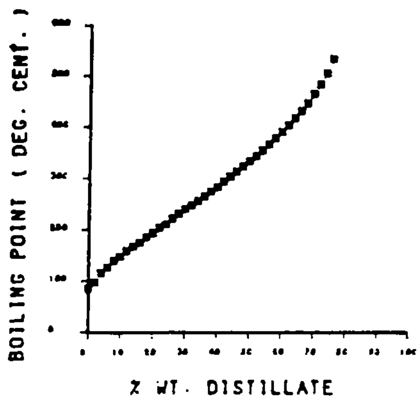
1	ISOBUTANE	.256	39	2,3-DIMETHYLHEXANE	.280
2	N-BUTANE	1.571	40	2-METHYL-3-ETHYLPENTANE	
3	ISOPENTANE	1.647	41	2-METHYLHEPTANE	1.867
4	N-PENTANE	2.670	42	4-METHYLHEPTANE	
5	2,2-DIMETHYLBUTANE	.117	43	3,4-DIMETHYLHEXANE	
6	CYCLOPENTANE	.212	44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	
7	2,3-DIMETHYLBUTANE	.196	45	3-ETHYLHEXANE	.821
8	2-METHYLPENTANE	1.353	46	3-METHYLHEPTANE	3.211
9	3-METHYLPENTANE	.893	47	1-C-3-DIMETHYLCYCLOHEXANE	
10	N-HEXANE	2.872	48	3-METHYL-3-ETHYLPENTANE	.724
11	2,2-DIMETHYLPENTANE	1.006	49	2,2,5-TRIMETHYLHEXANE	.156
12	METHYLCYCLOPENTANE		50	1,1-DIMETHYLCYCLOHEXANE	.286
13	2,4-DIMETHYLPENTANE	.107	51	1-METHYL-C-2-ETHYLCYCLOPENTANE	.110
14	2,2,3-TRIMETHYLBUTANE		52	1-METHYL-C-3-ETHYLCYCLOPENTANE	.274
15	BENZENE		53	2,2,4-TRIMETHYLHEXANE	
16	CYCLOHEXANE	1.241	54	1-T-2-DIMETHYLCYCLOHEXANE	.943
17	2-METHYLHEXANE	1.182	55	N-OCTANE	6.423
18	2,3-DIMETHYLPENTANE		56	2,4,4-TRIMETHYLHEXANE	
19	1,1-DIMETHYLCYCLOPENTANE	.140	57	2,3,3-TRIMETHYLHEXANE	.654
20	3-METHYLHEXANE	1.085	58	2,2-DIMETHYLHEPTANE	.109
21	1-C-3-DIMETHYLCYCLOPENTANE	.274	59	2,3,5-TRIMETHYLHEXANE	
22	1-T-3-DIMETHYLCYCLOPENTANE	.248	60	ETHYLCYCLOHEXANE	2.125
23	1-T-2-DIMETHYLCYCLOPENTANE	.539	61	ETHYLBENZENE	.379
24	2,2,4-TRIMETHYLPENTANE		62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
25	3-ETHYLPENTANE		63	M-XYLENE	1.855
26	N-HEPTANE	3.306	64	P-XYLENE	.617
27	2,2-DIMETHYLHEXANE	.053	65	O-XYLENE	1.235
28	METHYLCYCLOHEXANE	3.348	66	N-NONANE	9.552
29	1,1,3-TRIMETHYLCYCLOPENTANE	.189	67	ISOPROPYLBENZENE	.146
30	ETHYLCYCLOPENTANE	.211	68	N-PROPYLBENZENE	.426
31	2,5-DIMETHYLHEXANE	.152	69	1-METHYL-3-ETHYLBENZENE	1.005
32	2,4-DIMETHYLHEXANE	.217	70	1-METHYL-4-ETHYLBENZENE	.404
33	2,2,3-TRIMETHYLPENTANE		71	1,3,5-TRIMETHYLBENZENE	.850
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.235	72	1-METHYL-2-ETHYLBENZENE	1.464
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	.289	73	N-DECANE	4.879
36	2,3,4-TRIMETHYLPENTANE		74	P-METHYLISOPROPYLBENZENE	.212
37	TOLUENE	.401	75	N-BUTYLBENZENE	.334
38	3,3-DIMETHYLHEXANE	.084	76	N-UNDECANE	.717

SUMMARY HYDROCARBON DATA LOG

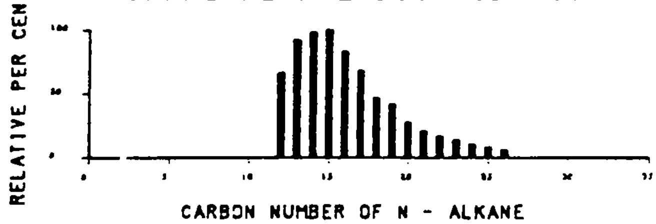
FIGURE 13

PETROLEUM TYPE

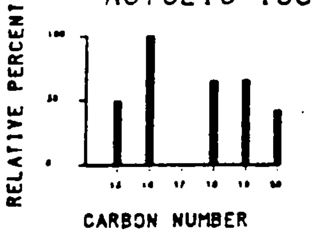
SIMULATED DISTILLATION



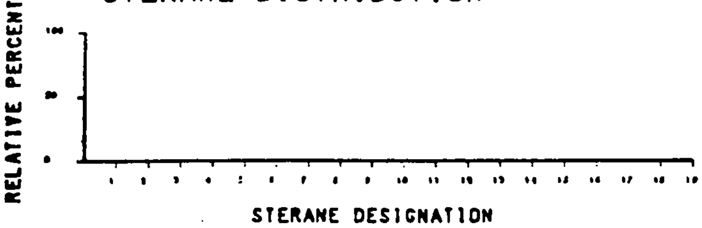
NORMAL ALKANE DISTRIBUTION



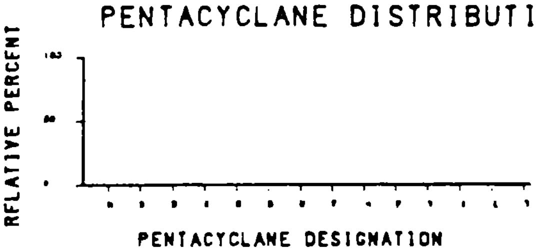
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



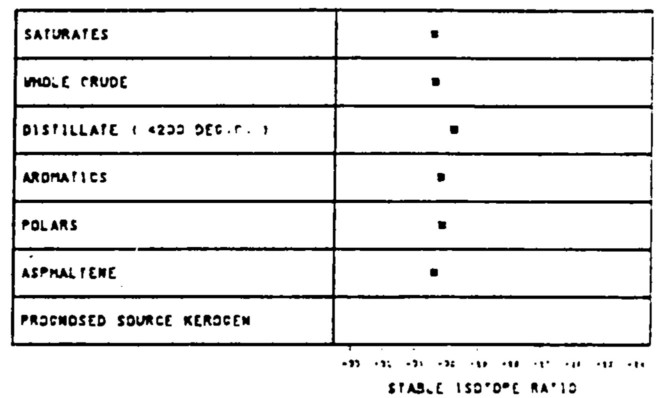
PENTACYCLANE DISTRIBUTION



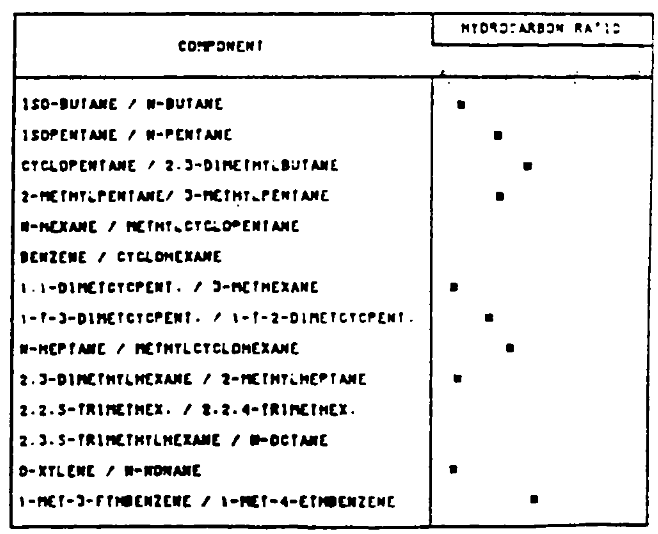
HYDROCARBON DATA

API GRAVITY	60 DEG. F.	40.70
SPECIFIC GRAVITY	60 DEG. F.	0.82
SULPHUR	% WT.	0.31
WAX	% WT.	
WAX M. PT.	DEG. C.	
ASPHALTENES	% WT.	0.44
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.40
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	70.30
AROMATICS	% WT.	14.00
POLARS	% WT.	15.20
N - ALKANE CPI		1.08
N - ALKANE	% WT.	32.90
PRISTANE / PHYTANE RATIO		1.56
PRISTANE / N - C17		0.3[illegible]
PHYTANE / N - C18		0.29
CARBON ISOTOPE RATIO C13 ‰		-30.37
SULPHUR ISOTOPE RATIO S34 ‰		18.80
DEUTERIUM ISOTOPE RATIO D2 ‰		
NITROGEN ISOTOPE RATIO N15 ‰		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE



COUNTRY: US
STATE OH
COUNTY MARSHALL
LOCATION [illegible]
WELL #1 JONES
DEPTH 400.
SAMPLE TYPE OIL
SAMPLE ID [illegible]

PETROLEUM
GEOCHEMISTRY
GROUP
[illegible]

TABLE 7

10.07.36. 01/06/84

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:TAYLOR#1	SAMPLE ID:HCB006 FORMATION:BGFK
STATE :OK	LOCATION :SEC15,T3SR11E	TYPE:PRO AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :35-A00520087	DEPTH(FT): 2110
PGW JOB:8003	REPORT :	DATA BASE:GEOCHEM/PGW

INSPECTION DATA			SIMULATED DISTILLATION				N-ALKANE CONTENT		PENTACYCLANE CONTENT
			%WT	DEG C	%WT	DEG C	% WT SATURATES		NORMALISED DIST
SPECIFIC GRAV.	:	1.000							
API GRAV.	:	10.00	---	-----	---	-----			
SULFUR	%WT:	.80							
NITROGEN	%WT:		IBP	257			C10 :		H :
WAX	%WT:		2	287	52		C11 :		B :
WAX MPT	DEG C:		4	305	54		C12 :	.150	D :
ASPHALTENE (1)	%WT:	12.00	6	320	56		C13 :	.700	G :
NICKEL	(PPM):	42	8	336	58		C14 :	1.600	N :
VANADIUM	(PPM):	180	10	352	60		C15 :	2.870	O :
RESIDUE			12	368	62		C16 :	3.340	U :
BPT>200C	%WT:	100	14	384	64		C17 :	3.700	V :
---------------------------			16	399	66		C18 :	3.550	ALPHA :
GEOCHEMICAL DATA			18	414	68		C19 :	3.520	BETA :
---------------------------			20	427	70		C20 :	2.550	GAMA :
RESIDUE BPT>200C			22	440	72		C21 :	2.300	DELTA :
TYPE ANALYSIS			24	452	74		C22 :	1.760	EPSILON :
SATURATES	%WT:	31.40	26	463	76		C23 :	1.800	ZETA :
AROMATICS	%WT:	22.80	28	474	78		C24 :	1.420	---------------
POLARS	%WT:	33.80	30	486	80		C25 :	2.160	STERANE
ASPHALTENE(2)	%WT:	12.00	32	498	82		C26 :	1.590	CONTENT
N-ALKANE	%WT:	38.23	34	510	84		C27 :	1.090	NORMALISED DIST
N-ALKANE CPI	:	1.07	36	522	86		C28 :	1.080	---------------
ACYCLIC ISOPRENOID			38	532	88		C29 :	.900	
FARNESANE	%WT:	.65	40	541	90		C30 :	1.470	1 :
ACYCLIC C16	%WT:	1.48	42		92		C31 :	.480	2 :
ACYCLIC C18	%WT:	2.37	44		94		C32 :	.190	3 :
PRISTANE	%WT:	3.18	46		96		C33 :		4 :
PHYTANE	%WT:	2.86	48		98		C34 :		5 :
PRISTANE/PHYTANE	:	1.11	50		FBP		C35 :		6 :
PRISTANE/N-C17	:	.86					C36 :		7 :
PHYTANE/N-C18	:	.81							8 :
NICKEL/VANADIUM	:	.23							9 :
D-13 C(OIL)	:	-30.40 %.							10 :
D-13 C(DISTILLATE)	:	%.							11 :
D-13 C(SATURATES)	:	-30.60 %.							12 :
D-13 C(AROMATICS)	:	-30.40 %.							13 :
D-13 C(POLARS)	:	-30.18 %.							14 :
D-13 C(ASPHALTENES)	:	-30.13 %.							15 :
D-13 C(RESINS)	:	%.							16 :
D-34 SULFUR	:	%.							17 :
D-2 DEUTERIUM	:	%.							18 :
D-15 NITROGEN	:	%.							19 :

TABLE 7 (cont'd)

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB006 WELL/SITE : TAYLOR#1

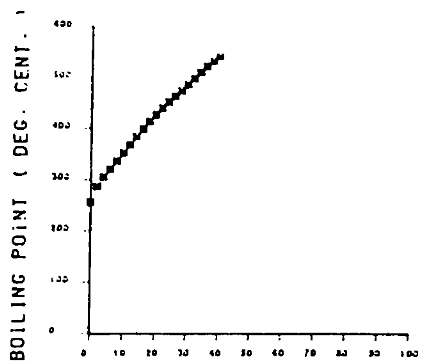
1	ISOBUTANE	:
2	N-BUTANE	:
3	ISOPENTANE	:
4	N-PENTANE	:
5	2,2-DIMETHYLBUTANE	:
6	CYCLOPENTANE	:
7	2,3-DIMETHYLBUTANE	:
8	2-METHYLPENTANE	:
9	3-METHYLPENTANE	:
10	N-HEXANE	:
11	2,2-DIMETHYLPENTANE	:
12	METHYLCYCLOPENTANE	:
13	2,4-DIMETHYLPENTANE	:
14	2,2,3-TRIMETHYLBUTANE	:
15	BENZENE	:
16	CYCLOHEXANE	:
17	2-METHYLHEXANE	:
18	2,3-DIMETHYLPENTANE	:
19	1,1-DIMETHYLCYCLOPENTANE	:
20	3-METHYLHEXANE	:
21	1-C-3-DIMETHYLCYCLOPENTANE	:
22	1-T-3-DIMETHYLCYCLOPENTANE	:
23	1-T-2-DIMETHYLCYCLOPENTANE	:
24	2,2,4-TRIMETHYLPENTANE	:
25	3-ETHYLPENTANE	:
26	N-HEPTANE	:
27	2,2-DIMETHYLHEXANE	:
28	METHYLCYCLOHEXANE	:
29	1,1,3-TRIMETHYLCYCLOPENTANE	:
30	ETHYLCYCLOPENTANE	:
31	2,5-DIMETHYLHEXANE	:
32	2,4-DIMETHYLHEXANE	:
33	2,2,3-TRIMETHYLPENTANE	:
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	:
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	:
36	2,3,4-TRIMETHYLPENTANE	:
37	TOLUENE	:
38	3,3-DIMETHYLHEXANE	:
39	2,3-DIMETHYLHEXANE	:
40	2-METHYL-3-ETHYLPENTANE	:
41	2-METHYLHEPTANE	:
42	4-METHYLHEPTANE	:
43	3,4-DIMETHYLHEXANE	:
44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	:
45	3-ETHYLHEXANE	:
46	3-METHYLHEPTANE	:
47	1-C-3-DIMETHYLCYCLOHEXANE	:
48	3-METHYL-3-ETHYLPENTANE	:
49	2,2,5-TRIMETHYLHEXANE	:
50	1,1-DIMETHYLCYCLOHEXANE	:
51	1-METHYL-C-2-ETHYLCYCLOPENTANE	:
52	1-METHYL-C-3-ETHYLCYCLOPENTANE	:
53	2,2,4-TRIMETHYLHEXANE	:
54	1-T-2-DIMETHYLCYCLOHEXANE	:
55	N-OCTANE	:
56	2,4,4-TRIMETHYLHEXANE	:
57	2,3,3-TRIMETHYLHEXANE	:
58	2,2-DIMETHYLHEPTANE	:
59	2,3,5-TRIMETHYLHEXANE	:
60	ETHYLCYCLOHEXANE	:
61	ETHYLBENZENE	:
62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	:
63	M-XYLENE	:
64	P-XYLENE	:
65	O-XYLENE	:
66	N-NONANE	:
67	ISOPROPYLBENZENE	:
68	N-PROPYLBENZENE	:
69	1-METHYL-3-ETHYLBENZENE	:
70	1-METHYL-4-ETHYLBENZENE	:
71	1,3,5-TRIMETHYLBENZENE	:
72	1-METHYL-2-ETHYLBENZENE	:
73	N-DECANE	:
74	P-METHYLISOPROPYLBENZENE	:
75	N-BUTYLBENZENE	:
76	N-UNDECANE	:

SUMMARY HYDROCARBON DATA LOG

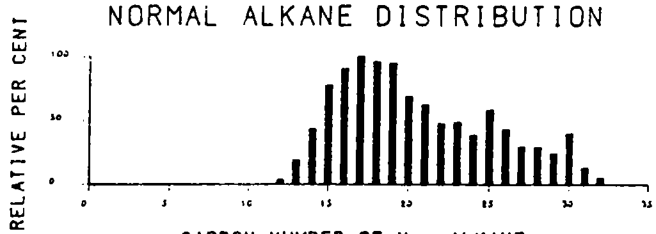
FIGURE 14

PETROLEUM TYPE

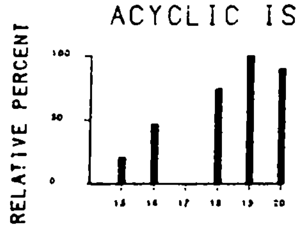
SIMULATED DISTILLATION



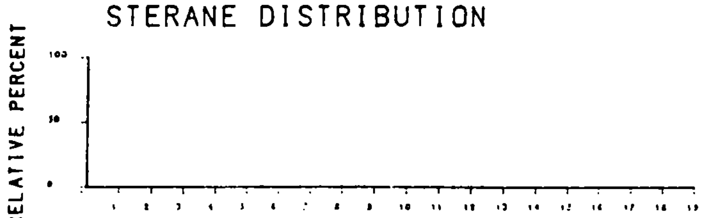
NORMAL ALKANE DISTRIBUTION



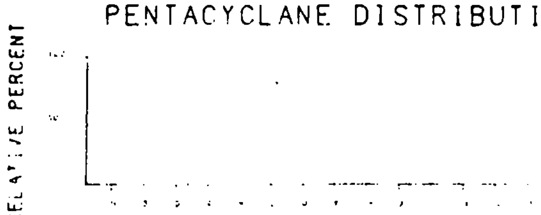
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



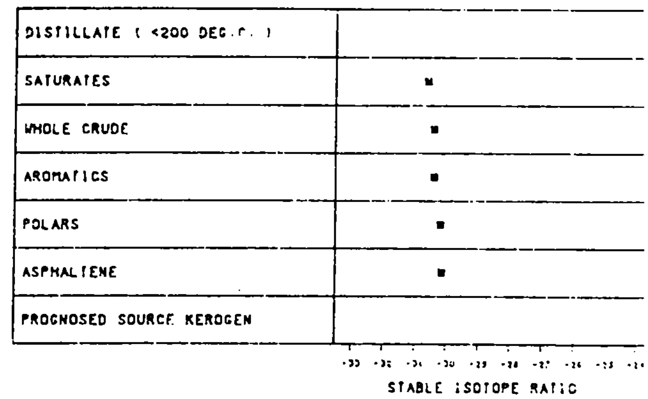
PENTACYCLANE DISTRIBUTION



HYDROCARBON DATA

API GRAVITY	[illegible]	[illegible]
SPECIFIC GRAVITY	[illegible]	[illegible]
SULPHUR	% WT	[illegible]
WAX	% WT	
WAX M. PT.	DEG	
ASPHALTENES	% WT	[illegible]
NICKEL	PPM	[illegible]
VANADIUM	PPM	[illegible]
NICKEL / VANADIUM RATIO		[illegible]
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	[illegible]
AROMATICS	% WT.	[illegible]
POLARS	% WT.	[illegible]
N - ALKANE CPI		[illegible]
N - ALKANE % WT. OF SATURATES		[illegible]
PRISTANE / PHYTANE RATIO		[illegible]
PRISTANE / N - C17		[illegible]
PHYTANE / N - C18		[illegible]
CARBON ISOTOPE RATIO C13 ‰		[illegible]
SULPHUR ISOTOPE RATIO S34 ‰		
DEUTERIUM ISOTOPE RATIO D2 ‰		
NITROGEN ISOTOPE RATIO N15 ‰		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE

COMPONENT	HYDROCARBON RATIO
ISO-BUTANE / N-BUTANE	
ISOPENTANE / N-PENTANE	
CYCLOPENTANE / 2.3-DIMETHYLBUTANE	
2-METHYLPENTANE/ 3-METHYLPENTANE	
N-HEXANE / METHYLCYCLOPENTANE	
BENZENE / CYCLOHEXANE	
1.1-DIMETCYCPENT. / 3-METHEXANE	
1-T-3-DIMETCYCPENT. / 1-T-2-DIMETCYCPENT.	
N-HEPTANE / METHYLCYCLOHEXANE	
2.3-DIMETHYLHEXANE / 2-METHYLHEPTANE	
2.2.5-TRIMETHEX. / 2.2.4-TRIMETHEX.	
2.3.5-TRIMETHYLHEXANE / N-OCTANE	
O-XYLENE / N-NONANE	
1-MET-3-ETHBENZENE / 1-MET-4-ETHBENZENE	

COUNTRY [illegible]	
STATE [illegible]	
COUNTY [illegible]	
LOCATION [illegible]	
WELL [illegible]	
DEPTH [illegible]	
SAMPLE TYPE [illegible]	
SAMPLE ID [illegible]	
DATA BASE ORIGIN [illegible]	

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:STRINGTOWN QUARRY	SAMPLE ID:HCB275	FORMATION:BGFK
STATE :OK	LOCATION :SEC16,T1SR12E	TYPE:TSE	AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :-	DEPTH(FT):	
PGW JOB:82102	REPORT :	DATA BASE:GEOCHEM/PGW	

INSPECTION DATA

SPECIFIC GRAV.	:	1.250
API GRAV.	:	
SULFUR	%WT:	4.98
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	52.18
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE		
BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	6.63	
AROMATICS	%WT:	11.84	
POLARS	%WT:	29.35	
ASPHALTENE(2)	%WT:	52.18	
N-ALKANE	%WT:	0.00	
N-ALKANE CPI	:		
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	0.00	
ACYCLIC C16	%WT:	0.00	
ACYCLIC C18	%WT:	0.00	
PRISTANE	%WT:	0.00	
PHYTANE	%WT:	0.00	
PRISTANE/PHYTANE	:		
PRISTANE/N-C17	:		
PHYTANE/N-C18	:		
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-30.25	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-30.31	%.
D-13 C(AROMATICS)	:	-30.44	%.
D-13 C(POLARS)	:	-30.29	%.
D-13 C(ASPHALTENES)	:	-30.32	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
2[illegible]		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT % WT SATURATES

C10	0.000
C11	0.000
C12	0.000
C13	0.000
C14	0.000
C15	0.000
C16	0.000
C17	0.000
C18	0.000
C19	0.000
C20	0.000
C21	0.000
C22	0.000
C23	0.000
C24	0.000
C25	0.000
C26	0.000
C27	0.000
C28	0.000
C29	0.000
C30	0.000
C31	0.000
C32	0.000
C33	0.000
C34	0.000
C35	0.000
C36	0.000

PENTACYCLANE CONTENT NORMALISED DIST

H	:
B	:
D	:
G	:
N	:
O	:
U	:
V	:
ALPHA	:
BETA	:
GAMA	:
DELTA	:
EPSILON	:
ZETA	:

STERANE CONTENT NORMALISED DIST

1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:
16	:
17	:
18	:
19	:

TABLE 8 (cont'd)

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB275 WELL/SITE : STRINGTOWN QUARRY

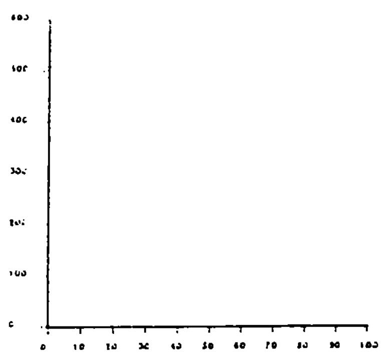
1	ISOBUTANE	:
2	N-BUTANE	:
3	ISOPENTANE	:
4	N-PENTANE	:
5	2,2-DIMETHYLBUTANE	:
6	CYCLOPENTANE	:
7	2,3-DIMETHYLBUTANE	:
8	2-METHYLPENTANE	:
9	3-METHYLPENTANE	:
10	N-HEXANE	:
11	2,2-DIMETHYLPENTANE	:
12	METHYLCYCLOPENTANE	:
13	2,4-DIMETHYLPENTANE	:
14	2,2,3-TRIMETHYLBUTANE	:
15	BENZENE	:
16	CYCLOHEXANE	:
17	2-METHYLHEXANE	:
18	2,3-DIMETHYLPENTANE	:
19	1,1-DIMETHYLCYCLOPENTANE	:
20	3-METHYLHEXANE	:
21	1-C-3-DIMETHYLCYCLOPENTANE	:
22	1-T-3-DIMETHYLCYCLOPENTANE	:
23	1-T-2-DIMETHYLCYCLOPENTANE	:
24	2,2,4-TRIMETHYLPENTANE	:
25	3-ETHYLPENTANE	:
26	N-HEPTANE	:
27	2,2-DIMETHYLHEXANE	:
28	METHYLCYCLOHEXANE	:
29	1,1,3-TRIMETHYLCYCLOPENTANE	:
30	ETHYLCYCLOPENTANE	:
31	2,5-DIMETHYLHEXANE	:
32	2,4-DIMETHYLHEXANE	:
33	2,2,3-TRIMETHYLPENTANE	:
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	:
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	:
36	2,3,4-TRIMETHYLPENTANE	:
37	TOLUENE	:
38	3,3-DIMETHYLHEXANE	:
39	2,3-DIMETHYLHEXANE	:
40	2-METHYL-3-ETHYLPENTANE	:
41	2-METHYLHEPTANE	:
42	4-METHYLHEPTANE	:
43	3,4-DIMETHYLHEXANE	:
44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	:
45	3-ETHYLHEXANE	:
46	3-METHYLHEPTANE	:
47	1-C-3-DIMETHYLCYCLOHEXANE	:
48	3-METHYL-3-ETHYLPENTANE	:
49	2,2,5-TRIMETHYLHEXANE	:
50	1,1-DIMETHYLCYCLOHEXANE	:
51	1-METHYL-C-2-ETHYLCYCLOPENTANE	:
52	1-METHYL-C-3-ETHYLCYCLOPENTANE	:
53	2,2,4-TRIMETHYLHEXANE	:
54	1-T-2-DIMETHYLCYCLOHEXANE	:
55	N-OCTANE	:
56	2,4,4-TRIMETHYLHEXANE	:
57	2,3,3-TRIMETHYLHEXANE	:
58	2,2-DIMETHYLHEPTANE	:
59	2,3,5-TRIMETHYLHEXANE	:
60	ETHYLCYCLOHEXANE	:
61	ETHYLBENZENE	:
62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	:
63	M-XYLENE	:
64	P-XYLENE	:
65	O-XYLENE	:
66	N-NONANE	:
67	ISOPROPYLBENZENE	:
68	N-PROPYLBENZENE	:
69	1-METHYL-3-ETHYLBENZENE	:
70	1-METHYL-4-ETHYLBENZENE	:
71	1,3,5-TRIMETHYLBENZENE	:
72	1-METHYL-2-ETHYLBENZENE	:
73	N-DECANE	:
74	P-METHYLISOPROPYLBENZENE	:
75	N-BUTYLBENZENE	:
76	N-UNDECANE	:

SUMMARY HYDROCARBON DATA LOG

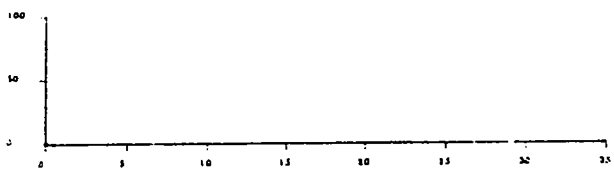
FIGURE 15

PETROLEUM TYPE

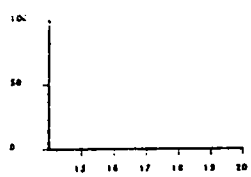
SIMULATED DISTILLATION



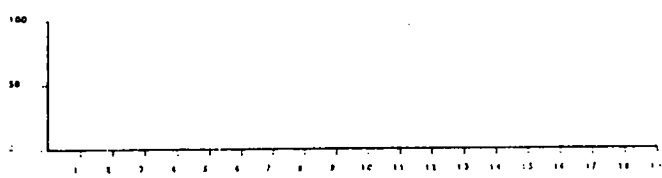
NORMAL ALKANE DISTRIBUTION



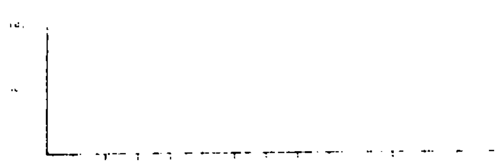
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



PENTACYCLANE DISTRIBUTION



HYDROCARBON DATA

API GRAVITY	[illegible]	
SPECIFIC GRAVITY	[illegible]	[illegible]
SULPHUR	% WT.	[illegible]
WAX	% WT.	
WAX M. PT	DEG. [illegible]	
ASPHALTENES	% WT.	[illegible]
NICKEL	PPM	
VANADIUM	PPM	
NICKEL / VANADIUM RATIO		
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	6.[illegible]
AROMATICS	% WT.	11.84
POLARS	% WT.	29.[illegible]
N - ALKANE CPI		
N - ALKANE % WT. OF SATURATES		0.00
PRISTANE / PHYTANE RATIO		
PRISTANE / N - C17		
PHYTANE / N - C18		
CARBON ISOTOPE RATIO C13 ‰		-30.25
SULPHUR ISOTOPE RATIO S34 ‰		
DEUTERIUM ISOTOPE RATIO D2 ‰		
NITROGEN ISOTOPE RATIO N15 ‰		

STABLE CARBON ISOTOPE PROFILE

DISTILLATE (<200 DEG.C.)	
SATURATES	■
WHOLE CRUDE	■
AROMATICS	■
POLARS	■
ASPHALTENE	■
PROGNOSED SOURCE KEROGEN	

-33 -32 -31 -30 -29 -28 -27 -26 -25 -24

STABLE ISOTOPE RATIO

LIGHT HYDROCARBON PROFILE

COMPONENT	HYDROCARBON RATIO
ISO-BUTANE / N-BUTANE	
ISOPENTANE / N-PENTANE	
CYCLOPENTANE / 2.3-DIMETHYLBUTANE	
2-METHYLPENTANE/ 3-METHYLPENTANE	
N-HEXANE / METHYLCYCLOPENTANE	
BENZENE / CYCLOHEXANE	
1.1-DIMETCYCPENT. / 3-METHEXANE	
1-T-3-DIMETCYCPENT. / 1-T-2-DIMETCYCPENT.	
N-HEPTANE / METHYLCYCLOHEXANE	
2.3-DIMETHYLHEXANE / 2-METHYLHEPTANE	
2.2.5-TRIMETHEX. / 2.2.4-TRIMETHEX.	
2.3.4-TRIMETHYLHEXANE / N-OCTANE	
O XYLENE / N-NONANE	
1-MET-3-ETHBENZENE / 1-MET-4-ETHBENZENE	

COUNTRY US
STATE [illegible]
COUNTY [illegible]
LOCATION [illegible]
WELL [illegible]
DEPTH
SAMPLE TYPE [illegible]
SAMPLE ID [illegible]

SOHIO

PGW/EB123
H. G. Bassett

903051

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

H084.0257
c.3

To: E. Luttrell
SPC Mid-Continent Region
Dallas

April 18, 1984

PGW/040384/GC/2-5

52514

Attn: D. May

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Source Rock Evaluation of Thirty Samples From a Measured Section of the Polk Creek Shale (Ordovician Age) Within the Stringtown Quarry, Atoka County, Oklahoma -- Exploration Brief (PGW/EB123).

Thirty samples from a measured section of the Polk Creek Shale within the Stringtown Quarry (South End), Atoka County, Oklahoma were received for source rock evaluation. The samples were given PGW Field Survey numbers FSE001 to FSE030 and represent the total Polk Creek section from the Bigfork contact (Lower; 0') to the Missouri Mountain contact (Upper; 58'). The section was sampled by collecting 2' composite samples. All samples were analyzed using standardized PGW methods for % TOC (bitumen free), pyrolysis (Rock-Eval), and PGC (pyrolysis gas chromatography). The data for these samples are given in Table 1.

Maturity of the Stringtown Quarry sediments was previously reported on by PGW (1). The maturity of the Polk Creek Shale as determined by bitumen R_o and qualitative fluorescence was incipiently mature to oil mature. Source evaluation of the Polk Creek sediment showed that the 58' Polk Creek section had excellent source richness (TOC averaged 5.42% and ranged from 1.09 to 15.13%); excellent potential productivity (S2 averaged 33.99 kg/ton and ranged from 5.88 to 103.6 kg/ton); and the kerogen assemblages were dominantly oil prone as determined by PGC (the average GOGI value was 0.235 and ranged from 0.19 to 0.30). The 2' sample from the Polk Creek/Missouri Mountain contact had a lean TOC (0.31%) and no potential productivity (0 kg/ton S2). Figure 1 illustrates the source rock evaluation parameters as compared to the gamma log. No definite conclusions could be drawn from this comparison, but some of the high K (potassium) peaks did appear to correlate with high TOC values (i.e. peaks at 26', 28', 34', 48', and 56'). Also note, though, there were no correlations with the high TOC values found at 2', 14', 16', and 30'.

CONCLUSIONS

1) The 58' Polk Creek Shale section located in the Stringtown Quarry, Atoka County, Oklahoma is an incipiently mature, organic rich section with excellent potential productivity and dominant oil prone kerogen assemblages. Based upon this section, this formation therefore, appears to be an excellent oil source rock for the Ouachita Overthrust Belt.

2) It is recommended that Polk Creek samples should be collected from other Ouachita locations (both Arkansas and Oklahoma such as the Potato Hills region) for detailed source rock analysis to determine the extent and continuation of the source richness.

3) Two samples (FSD 998 and FSD 999) were collected from the north end of the quarry. The two samples were from 2' and 4' above the Bigfork/Polk Creek contact, respectively. Source analyses showed that these two samples had excellent source richness, excellent potential productivity and dominantly oil prone kerogen assemblages. These samples compared quite well with the same intervals from the south end of the quarry.

REFERENCE

1. Cole, G. A. 1983 Source Rock and Maturity Evaluation of Sixteen Samples From a Measured Section Within the Stringtown Quarry, Atoka County, Oklahoma -- Exploration Brief (PGW/EB081).

G. A. Cole

GAC:mlc

Enclosures: Table 1
Figure 1

cc: C. Titus
H. G. Bassett
R. Burwood
R. Drozd
Files (0) (2-5)

Work by: R. Lukco
C. Hodges
D. Noffsinger

Figure 1: Comparison of source quality data and gamma log response for the Polk Creek Shale, Stringtown Quarry, Atoka County, Oklahoma.

STRINGTOWN QUARRY

REMARKS:
ATOKA CO., OKLA - 16 - 1S - 12E

CURVE NUMBER	LEFT MARGIN LIMIT	RIGHT MARGIN LIMIT	TRACK NUMBER	CURVE MODIFIER	LINE TYPE	NAME	TOOL	UNITS
1.0	0.	200.	10.	LIN	DSOL	GR		GAPI
1.0	200.	400.	10.	LIN	DLDA	GR		GAPI
1.0	400.	600.	10.	LIN	DSDA	GR		GAPI
2.0	0.	10.	40.	LIN	DDOT	THOR		CPS
3.0	0.	10.	40.	LIN	DSOL	URAN		CPS
4.0.	0.	10.	40.	LIN	DLDA	K		CPS

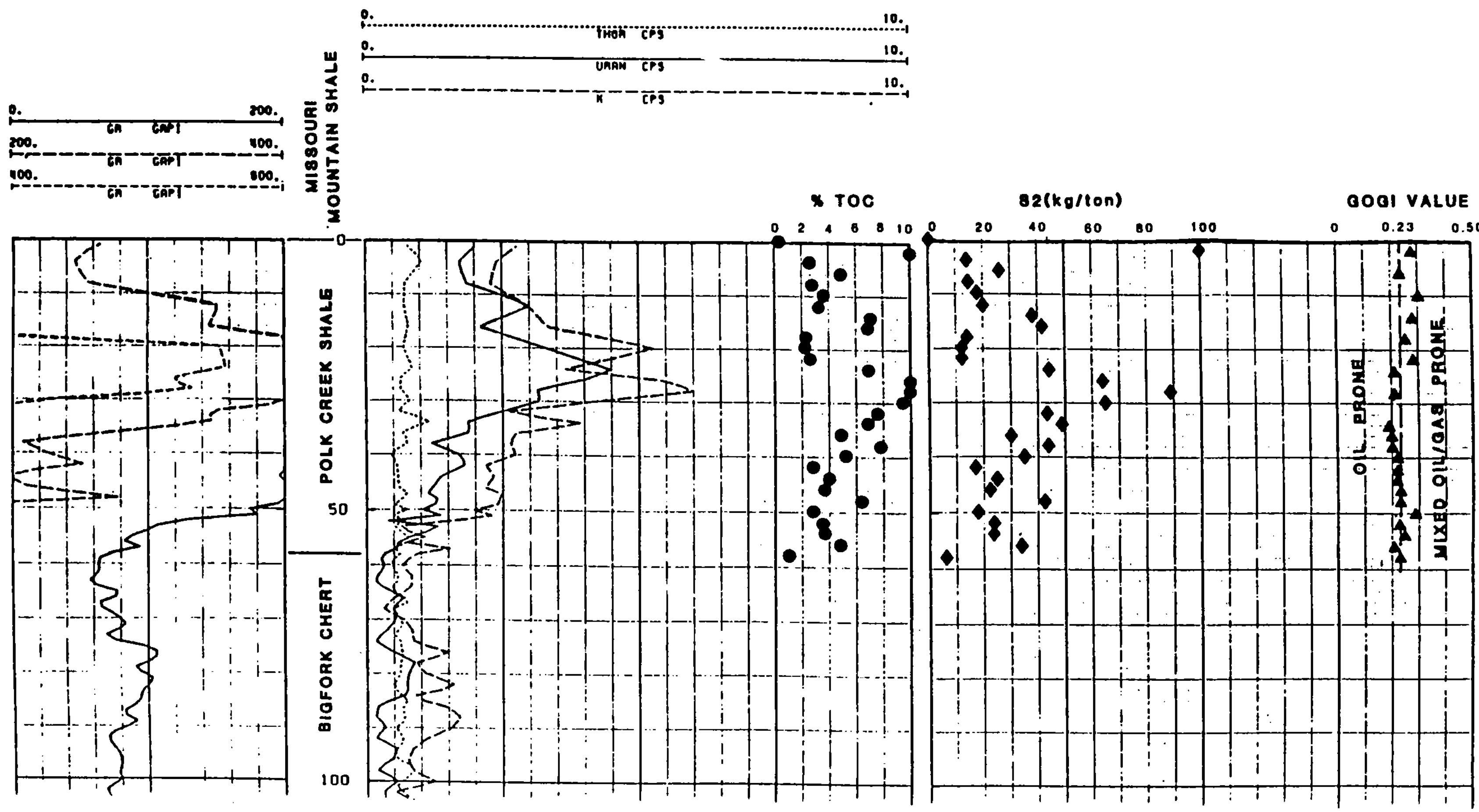


TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : ATOKA
LOCATION : SEC16,T1SR12E
WELL/SITE : STRINGTOWN(POLK CR)
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
*0	FSD998	OC	ORD	POLK	SH	4		7.85	6.41	5.06	55.78	711
*0	FSD999	OC	ORD	POLK	SH	1		6.45	4.29	3.11	39.26	609
(a) 0	FSE001	OC	ORD	POLK	SH	3		1.09	2.53	.34	5.88	539
2	FSE002	OC	ORD	POLK	SH	3		4.67	2.77	1.88	31.62	677
4	FSE003	OC	ORD	POLK	SH	2		3.83	1.96	1.37	23.65	617
6	FSE004	OC	ORD	POLK	SH	7		3.71	1.66	1.12	23.28	627
8	FSE005	OC	ORD	POLK	SH	8		2.73	1.03	.79	17.69	648
10	FSE006	OC	ORD	POLK	SH	2		6.33	2.46	1.73	41.86	661
12	FSE007	OC	ORD	POLK	SH,CALC	21		3.77	1.38	1.06	21.66	575
14	FSE008	OC	ORD	POLK	SH	1		3.95	2.08	.86	24.85	629
16	FSE009	OC	ORD	POLK	SH	1		2.88	.97	.51	16.56	575
18	FSE010	OC	ORD	POLK	SH	3		5.32	1.91	1.90	35.36	665

(a) BIGFORK/POLK CREEK CONTACT

* sampled from the north end of the quarry

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0	.08	82	64	1	30.40	5.88	24.52	387	.24						
0	.07	67	48	1	25.39	4.75	20.64	394	.23						
0	.05	232	31	7	4.77	.89	3.88	438	.23						
2	.06	59	40	1	22.06	3.83	18.23	472	.21						
4	.05	51	36	1	17.18	3.44	13.74	449	.25						
6	.05	45	30	1	18.11	3.39	14.72	488	.23						
8	.04	38	29	1	14.22	3.20	11.02	521	.29						
10	.04	39	27	1	29.55	5.53	24.02	467	.23						
12	.05	37	28	1	17.47	3.27	14.20	463	.23						
14	.03	53	22	2	18.90	3.41	15.49	478	.22						
16	.03	34	18	2	13.43	2.42	11.01	466	.22						
18	.05	36	36	1	26.27	4.74	21.53	494	.22						

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
20	FSE011	OC	ORD	POLK	SH	3		6.91	2.12	1.96	43.55	630
22	FSE012	OC	ORD	POLK	SH	9		4.84	1.42	1.36	30.45	629
24	FSE013	OC	ORD	POLK	SH	5		6.80	1.99	2.05	49.06	721
26	FSE014	OC	ORD	POLK	SH	2		7.60	1.46	2.20	43.31	570
28	FSE015	OC	ORD	POLK	SH	2		9.63	2.54	2.44	64.88	674
30	FSE016	OC	ORD	POLK	SH	2		12.85	2.68	3.38	89.17	694
32	FSE017	OC	ORD	POLK	SH	3		10.38	2.06	2.58	64.07	617
34	FSE018	OC	ORD	POLK	SH	2		6.90	1.52	1.88	43.92	637
36	FSE019	OC	ORD	POLK	SH	1		2.42	.49	.38	12.33	510
38	FSE020	OC	ORD	POLK	SH	5		2.19	.88	.26	11.87	542
40	FSE021	OC	ORD	POLK	SH,CALC	11		2.28	3.09	.75	14.14	620
42	FSE022	OC	ORD	POLK	SH	2		6.86	1.48	2.25	41.18	600
44	FSE023	OC	ORD	POLK	SH	3		7.00	1.80	1.55	37.94	542
46	FSE024	OC	ORD	POLK	SH	1		3.32	.82	.68	19.98	602
48	FSE025	OC	ORD	POLK	SH	4		3.66	1.18	.66	18.62	509
50	FSE026	OC	ORD	POLK	SH	1		2.68	.58	.33	15.06	562
52	FSE027	OC	ORD	POLK	SH	2		4.89	1.10	.61	25.98	531

WELL/SITE :STRINGTOWN(POLK CR)

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
20	.04	31	28	1	30.77	5.13	25.64	445	.20						
22	.04	29	28	1	22.36	3.73	18.63	462	.20						
24	.04	29	30	1	31.78	5.07	26.71	467	.19						
26	.05	19	29	1											
28	.04	26	25	1											
30	.04	21	26	1	55.90	9.70	46.20	435	.21						
32	.04	20	25	1											
34	.04	22	27	1	31.74	5.51	26.23	460	.21						
36	.03	20	16	1	10.39	2.27	8.12	429	.28						
38	.02	40	12	3											
40	.05	136	33	4	11.34	2.27	9.07	497	.25						
42	.05	22	33	1											
44	.04	26	22	1	28.11	5.98	22.13	402	.27						
46	.03	25	20	1											
48	.03	32	18	2	14.23	3.28	10.95	389	.30						
50	.02	22	12	2											
52	.02	22	12	2	20.29	3.79	16.50	415	.23						

WELL/SITE :STRINGTOWN(POLK CR)

	DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
	54	FSE028	OC	ORD	POLK SH		1		2.53	.60	.28	14.31	566
	56	FSE029	OC	ORD	POLK SH		2		15.13	4.66	5.71	103.60	685
(b)	58	FSE030	OC	SIL	MONT SH		3		.31		0.00	0.00	0

(b) POLK CREEK/MISSOURI MOUNTAIN CONTACT

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
54	.02	24	11	2											
56	.05	31	38	1	63.77	13.56	50.21	421	.27						
58			0												

Oklahoma Geological Survey
Open-File Report 5-96

SOURCE ROCK POTENTIAL AND SEDIMENT THERMAL MATURITY TRENDS IN THE OUACHITA OVERTHRUST OF SOUTHEAST OKLAHOMA AND SOUTHWEST ARKANSAS

REPORT: GE (CD) 01

by

CHARLES A.O. TITUS
SPC Continental Division, Dallas

and

GARY A. COLE
SPC Petroleum Geochemistry Group, Warrensville

Modified Version of Report

March, 1986
5130G

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: E. Luttrell
SPC Mid-Continent Region
Dallas

May 23, 1984

PGW/050884/GC/2-5

Attn: C. Titus

Classification: RESTRICTED

From: Petroleum Geochemistry Group
Warrensville

Subject: Geochemical Characterization and Comparison of Two Asphalt Samples from the #1-24 Campbell Well, Atoka County, Oklahoma -- Exploration Brief (PGW/EB144).

Two asphalt samples, recovered from 1020-40' (Mississippian Stanley Group) and 3011' (Ordovician Polk Creek Shale) in the #1-24 Campbell well, were characterized using standardized PGW methods. The asphalts were then compared to Taylor #1/Stringtown Quarry asphalts and to kerogen pyrolyzate carbon isotopic data for #1-24 Campbell well cuttings samples and outcrop samples from Stringtown Quarry. The source potential (predominantly oil prone) of the Ordovician Polk Creek Shale and Bigfork Chert Formations was previously documented in two reports, PGW/EB081 (1) and PGW/EB 123 (2). The source potential of the #1-24 Campbell well was reported in PGW/TM156 (3). A comparison of asphalts from the Stringtown Quarry and Taylor #1 well was reported in PGW/TM109 (4).

1) ASPHALTS/OILS

Sample locations, PGW sample designations, summary hydrocarbon data sheets and logs, and the saturate fraction C_{12+} gas chromatograms are included as Tables 1-3 and Figures 1-6 for the Polk Creek Shale asphalt (HCB-463, Campbell well), the Bigfork Chert asphalt (HCB-275, Stringtown Quarry) and the Taylor #1 asphalt (HCB-006), respectively. No data sheets were available for the Stanley asphalt from the Campbell well since this sample had a 100% asphaltene content.

Results of the hydrocarbon geochemical analysis showed:

a) The Campbell well (Polk Creek) sample, HCB-463, contained a similar proportion of asphaltenes as the Taylor #1 asphalt HCB-006 (12.2 vs. 12.0%), but a significantly lower asphaltene content than the Bigfork Chert sample (Stringtown Quarry, HCB-275, 52.2%). Comparison of the quantities of saturate and aromatic fractions of the 3 samples showed a wide scatter and no apparent correlation.

b) Saturate gas chromatograms (Figures 2, 4, and 6) revealed a complete series of n-alkanes, from n-C_{13} to n-C_{30+} for HCB-006 (Figure 6). HCB-275 (Figure 4) contained few peaks and no identifiable n-alkanes, which is indicative of biodegradation. The high asphaltene content (52%) as well as the chromatographic character of HCB-275 were indicative of severe weathering/biodegradation. Similarities in the bimodal naphthenic distributions of HCB-006 and HCB-275 suggested that these two asphalts were generically related; it is possible that HCB-463 is also similar, but the bimodality is masked by the extremely large "hump" at n-C_{25}. HCB-463 has an unusual chromatogram. It has a pronounced naphthenic hump centered at n-C_{25}. This is indicative of biodegradation and/or waterwashing; n-alkanes are present in the range n-C_{15} to n-C_{27}, however, after which there is an abrupt n-alkane concentration decrease. Biodegradation/waterwashing would remove light compounds preferentially leaving a heavier n-alkane residue and a pronounded naphthenic hump. It may be that the "hump" represents the residuum of a pre-existing altered oil, whereas the n-alkanes present are derived from a later contribution of fresher, more recently migrated petroleum.

c) Stable carbon isotopic data, depicted in Figure 7, confirmed that the hydrocarbons are related. The isotopic profiles were, generally, in close agreement. Overall, however, the Campbell (Polk Creek) asphalt appeared to be slightly isotopically lighter than the Taylor #1 and Stringtown Quarry asphalts, but still within the range of acceptable correlation.

The isotopic results clearly demonstrated a generic relationship between the three asphalts; it is probable that these materials represented residues derived from one and the same precursor oil.

d) Figure 8 illustrates the relative maturity of the asphalts (for HCB-006 and HCB-463) via the AIMAT plot. Results showed the Campbell sample to be somewhat more mature than the Taylor.

e) Figure 9 illustrates the probable source organic environments from which the oils were derived. This "ENVPLOT" clearly illustrates that the three asphalts were derived from marine kerogens.

2) SEDIMENTS CHARACTERIZATION AND SOURCE-OIL CORRELATION

One core sample and three cuttings samples from the #1-24 Campbell well and four Stringtown Quarry samples (all Ordovician Age) were selected for kerogen-kerogen pyrolyzate carbon isotopic characterization. Source quality analyses indicated good to exellent source richness, good to excellent potential productivity, and oil-prone kerogen assemblages. Organic petrography techniques indicated incipiently mature to threshold (oil) mature status. Table 4 lists pertinent source quality and location data for the eight sediment samples.

Generally, whole kerogen isotopic values varied by less than 1.0 ppt for the sediments examined, indicating only minor variations in organic facies between formations at the two sites (#1-24 Campbell well and the Stringtown Quarry). Δ_k values ($\Delta_k = \delta^{13}C_{kpy} - \delta^{13}C_k$) were negative (except for WC-9410 which was +0.18 ppt) and small in absolute magnitude (0.30 to 0.48 ppt), consistent with a predominantly marine kerogen assemblage as would be expected with Ordovocian Age sediments.

The #1-24 Campbell asphalt whole oil $\delta^{13}C$ value varied by 0.06-0.51 ppt from the kerogen pyrolyzate compositions. A differential of $< \pm 1$ ppt is considered an acceptable oil-potential source match with $\leq \pm 0.5$ ppt considered excellent. Therefore, the Polk Creek Shale, Bigfork Chert, and Womble Shale are all potential source matches for the asphalt sample from the 3011' depth in the #1-24 Campbell well. Composite carbon isotopic profiles comparing all sediment pyrolyzate data against the three asphalts are illustrated in Figure 10 (Polk Creek Shale), Figure 11 (Bigfork Chert), and Figure 12 (Womble Shale).

The asphalt sample from 1020-1040' in the #1-24 Campbell well was 100% asphalt, having an isotopic value of -30.29 ppt. This value is similar to that of the asphalt from 3011' and thus also matches the possible sources.

3. CONCLUSIONS

Kerogen pyrolyzate data was insufficient alone to distinguish which of the three Ordovician formations was the source provenance of the asphalts under study. From stratigraphic proximity considerations the Polk Creek Formation would appear to be the favored candidate.

Notwithstanding, all three asphalts appear to show a common provenance. Both the Taylor #1 and Campbell #1-24 recovered products had characteristics of heavy, early generation products, whilst the Stringtown asphalt appeared to be a biodegraded/ atmospheric weathered residuum of the same.

REFERENCES

(1)	Cole, G.	1984	Source Rock and Maturity Evaluation of Sixteen Samples from a Measured Section Within the Stringtown Quarry, Atoka County, OK. - Exploration Brief (PGW/EB081).
(2)	Cole, G.	1984	Source Rock Evaluation of Thirty Samples from a Measured Section of the Polk Creek Shale (Ord. Age) Within the Stringtown Quarry, Atoka County, OK. - Exploration Brief (PGW/EB123).
(3)	Cole, G.	1984	Source Rock Potential Evaluation of the #1-24 Campbell Well, Atoka County, OK. - Technical Memorandum (PGW/TM156).
(4)	Cole, G. and Sedivy, R.	1983	Geochemical Characterization and Comparison of Two Asphalt Samples from the Bigfork Chert, Atoka County, OK. - Technical Memorandum (PGW/TM109).

G. A. Cole

H. I. Halpern

R. A. Sedivy

GAC/HIH/RAS:mlc

Enclosures: Tables 1-4
Figures 1-12

cc: T. Legg
D. May
H. G. Bassett
R. Burwood
R. Drozd
Files (0) (2-5)

Work by: S. Adams
R. Cavalier
L. Monnens
T. Morsefield
R. Sedivy
E. Tausch

13.22.18. 04/23/84

TABLE 1

SUMMARY HYDROCARBON DATA SHEET

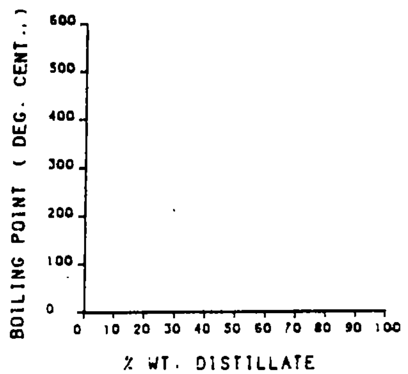
COUNTRY:US	WELL/SITE:#1-24 CAMPBELL	SAMPLE ID:HCB463 FORMATION:POLK
STATE :OK	LOCATION :SEC24,T3SR11E	TYPE:ASP AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :35-005-20138	DEPTH(FT): 3011
PGW-JOB:83150	REPORT :	DATA BASE:PGW

INSPECTION DATA		SIMULATED DISTILLATION %WT	DEG C	%WT	DEG C	N-ALKANE CONTENT % WT SATURATES		PENTACYCLANE CONTENT NORMALISED DIST	
SPECIFIC GRAV. :									
API GRAV. :									
SULFUR %WT:									
NITROGEN %WT:		IBP				C10 :		H :	
WAX %WT:		2		52		C11 :		B :	
WAX MPT DEG C:		4		54		C12 :		D :	
ASPHALTENE (1) %WT:	12.17	6		56		C13 :		G :	
NICKEL (PPM):		8		58		C14 :	.060	N :	
VANADIUM (PPM):		10		60		C15 :	.220	O :	
RESIDUE		12		62		C16 :	.440	U :	
BPT>200C %WT:	100	14		64		C17 :	.640	V :	
		16		66		C18 :	.750	ALPHA :	
GEOCHEMICAL DATA		18		68		C19 :	.870	BETA :	
		20		70		C20 :	1.020	GAMA :	
RESIDUE BPT>200C		22		72		C21 :	1.180	DELTA :	
TYPE ANALYSIS		24		74		C22 :	.900	EPSILON :	
SATURATES %WT:	15.65	26		76		C23 :	.800	ZETA :	
AROMATICS %WT:	28.21	28		78		C24 :	.840		
POLARS %WT:	43.97	30		80		C25 :	.730	STERANE CONTENT	
ASPHALTENE(2)%WT:	12.17	32		82		C26 :	.650		
N-ALKANE %WT:	10.20	34		84		C27 :	.450	NORMALISED DIST	
N-ALKANE CPI :	.95	36		86		C28 :	.250		
ACYCLIC ISOPRENOID		38		88		C29 :	.070		
FARNESANE %WT:	.04	40		90		C30 :	.210	1 :	
ACYCLIC C16 %WT:	.09	42		92		C31 :		2 :	
ACYCLIC C18 %WT:	.27	44		94		C32 :	.120	3 :	
PRISTANE %WT:	.50	46		96		C33 :		4 :	
PHYTANE %WT:	.44	48		98		C34 :		5 :	
PRISTANE/PHYTANE :	1.13	50		FBP		C35 :		6 :	
PRISTANE/N-C17 :	.77					C36 :		7 :	
PHYTANE/N-C18 :	.59							8 :	
NICKEL/VANADIUM :								9 :	
D-13 C(OIL) :	-30.68 %.							10 :	
D-13 C(DISTILLATE) :	%.							11 :	
D-13 C(SATURATES) :	-30.50 %.							12 :	
D-13 C(AROMATICS) :	-30.66 %.							13 :	
D-13 C(POLARS) :	-30.66 %.							14 :	
D-13 C(ASPHALTENES) :	-30.64 %.							15 :	
D-13 C(RESINS) :	%.							16 :	
D-34 SULFUR :	%.							17 :	
D-2 DEUTERIUM :	%.							18 :	
D-15 NITROGEN :	%.							19 :	

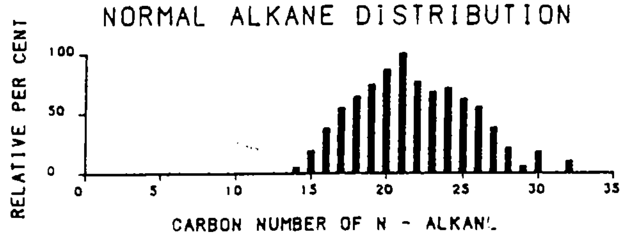
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

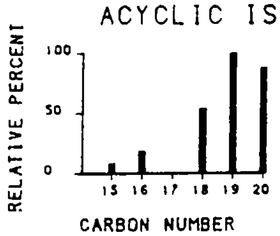
SIMULATED DISTILLATION



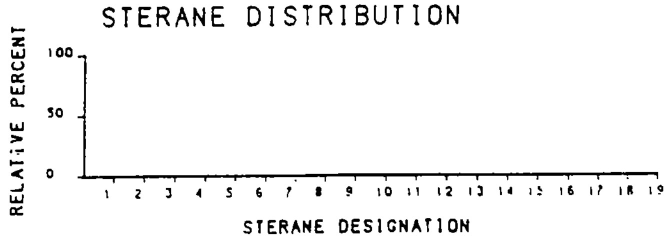
NORMAL ALKANE DISTRIBUTION



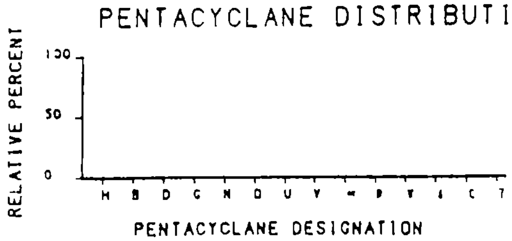
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



PENTACYCLANE DISTRIBUTION



HYDROCARBON DATA

API GRAVITY	60 DEG. F.	
SPECIFIC GRAVITY	60 DEG. F.	
SULPHUR	% WT.	
WAX	% WT.	
WAX M. PT.	DEG. C.	
ASPHALTENES	% WT.	12.17
NICKEL	PPM	
VANADIUM	PPM	
NICKEL / VANADIUM RATIO		
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	15.65
AROMATICS	% WT.	28.21
POLARS	% WT.	43.97
N - ALKANE CPI		0.95
N - ALKANE % WT. OF SATURATES		10.20
PRISTANE / PHYTANE RATIO		1.13
PRISTANE / N - C17		0.77
PHYTANE / N - C18		0.59
CARBON ISOTOPE RATIO C13 ‰		-30.68
SULPHUR ISOTOPE RATIO S34 ‰		
DEUTERIUM ISOTOPE RATIO D2 ‰		
NITROGEN ISOTOPE RATIO N15 ‰		

STABLE CARBON ISOTOPE PROFILE

DISTILLATE (<200 DEG.C.)	
SATURATES	■
WHOLE CRUDE	■
AROMATICS	■
POLARS	■
ASPHALTENE	■
PROGNOSED SOURCE KEROGEN	

-33 -32 -31 -30 -29 -28 -27 -26 -25 -24

STABLE ISOTOPE RATIO

LIGHT HYDROCARBON PROFILE

COMPONENT	HYDROCARBON RATIO
ISO-BUTANE / N-BUTANE	
ISOPENTANE / N-PENTANE	
CYCLOPENTANE / 2.3-DIMETHYLBUTANE	
2-METHYLPENTANE/ 3-METHYLPENTANE	
N-HEXANE / METHYLCYCLOPENTANE	
BENZENE / CYCLOHEXANE	
1.1-DIMETCYCPENT. / 3-METHEXANE	
1-T-3-DIMETCYCPENT. / 1-T-2-DIMETCYCPENT.	
N-HEPTANE / METHYLCYCLOHEXANE	
2.3-DIMETHYLHEXANE / 2-METHYLHEPTANE	
2.2.5-TRIMETHEX. / 2.2.4-TRIMETHEX.	
2.3.5-TRIMETHYLHEXANE / N-OCTANE	
O-XYLENE / N-NONANE	
1-MET-3-ETHBENZENE / 1-MET-4-ETHBENZENE	

COUNTRY US	SOHIO
STATE OR	
COUNTY ATORA	
LOCATION SEC24.[illegible]	
WELL #1-24 CAMPBELL	
DEPTH 3011	PETROLEUM GEOCHEMISTRY GROUP
SAMPLE TYPE ASP	WARRENSVILLE
SAMPLE ID MC844[illegible]	[illegible]
DATA BASE ORIGIN PGW	[illegible]

FIGURE 1

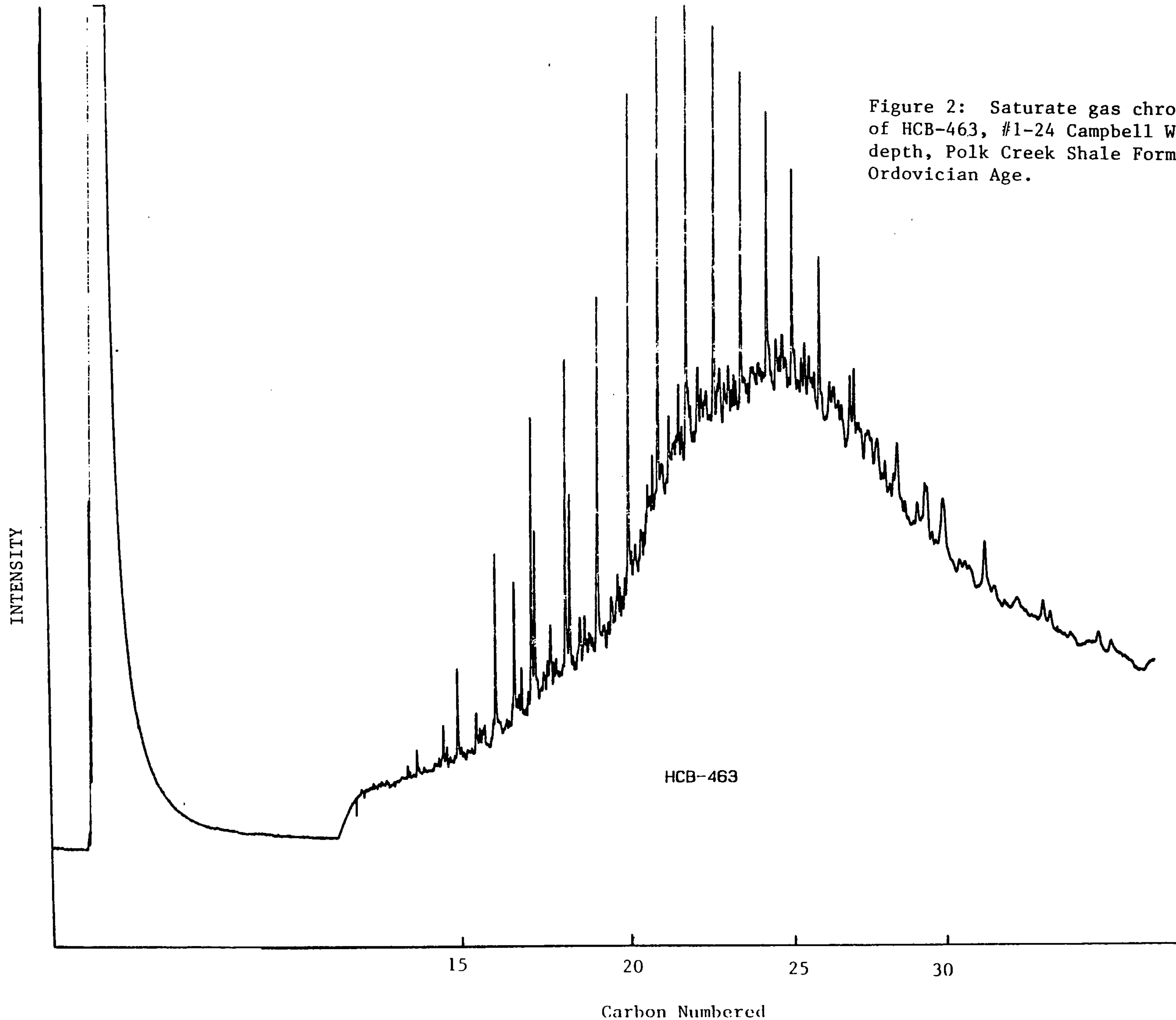


Figure 2: Saturate gas chromatogram of HCB-463, #1-24 Campbell Well, 3011' depth, Polk Creek Shale Formation, Ordovician Age.

TABLE 2

S U M M A R Y H Y D R O C A R B O N D A T A S H E E T

COUNTRY:US	WELL/SITE:STRINGTOWN QUARRY	SAMPLE ID:HCB275 FORMATION:BGFK
STATE :OK	LOCATION :SEC16,T1SR12E	TYPE:TSE AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :-	DEPTH(FT):
PGW-JOB:82102	REPORT :	DATA BASE:GEOCHEM/PGW

INSPECTION DATA

SPECIFIC GRAV.	:	1.250
API GRAV.	:	
SULFUR	%WT:	4.98
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	52.18
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE		
BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C		
TYPE ANALYSIS		
SATURATES	%WT:	6.63
AROMATICS	%WT:	11.84
POLARS	%WT:	29.35
ASPHALTENE(2)	%WT:	52.18
N-ALKANE	%WT:	0.00
N-ALKANE CPI	:	
ACYCLIC ISOPRENOID		
FARNESANE	%WT:	0.00
ACYCLIC C16	%WT:	0.00
ACYCLIC C18	%WT:	0.00
PRISTANE	%WT:	0.00
PHYTANE	%WT:	0.00
PRISTANE/PHYTANE	:	
PRISTANE/N-C17	:	
PHYTANE/N-C18	:	
NICKEL/VANADIUM	:	
D-13 C(OIL)	:-30.25	%.
D-13 C(DISTILLATE)	:	%.
D-13 C(SATURATES)	:-30.31	%.
D-13 C(AROMATICS)	:-30.44	%.
D-13 C(POLARS)	:-30.29	%.
D-13 C(ASPHALTENES)	:-30.32	%.
D-13 C(RESINS)	:	%.
D-34 SULFUR	:	%.
D-2 DEUTERIUM	:	%.
D-15 NITROGEN	:	%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

% WT SATURATES	
C10 :	0.000
C11 :	0.000
C12 :	0.000
C13 :	0.000
C14 :	0.000
C15 :	0.000
C16 :	0.000
C17 :	0.000
C18 :	0.000
C19 :	0.000
C20 :	0.000
C21 :	0.000
C22 :	0.000
C23 :	0.000
C24 :	0.000
C25 :	0.000
C26 :	0.000
C27 :	0.000
C28 :	0.000
C29 :	0.000
C30 :	0.000
C31 :	0.000
C32 :	0.000
C33 :	0.000
C34 :	0.000
C35 :	0.000
C36 :	0.000

PENTACYCLANE CONTENT

NORMALISED DIST	
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

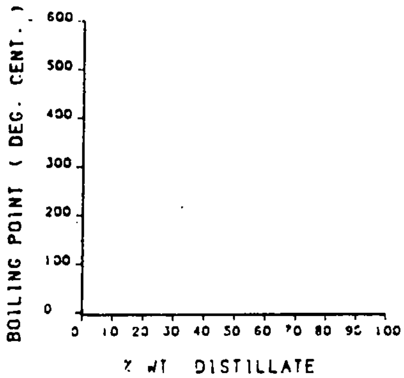
STERANE CONTENT

NORMALISED DIST	
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

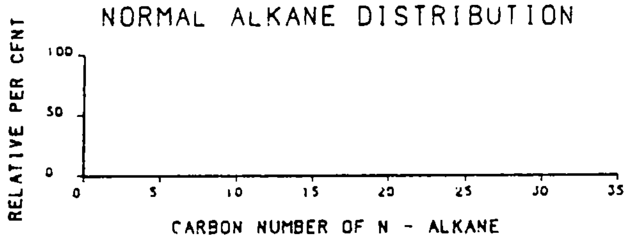
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

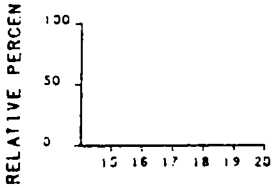
SIMULATED DISTILLATION



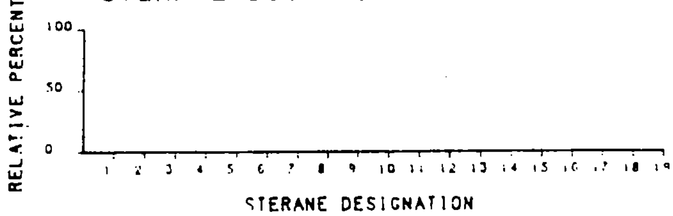
NORMAL ALKANE DISTRIBUTION



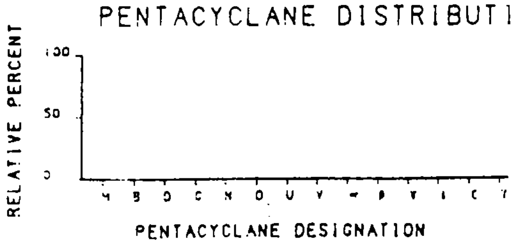
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



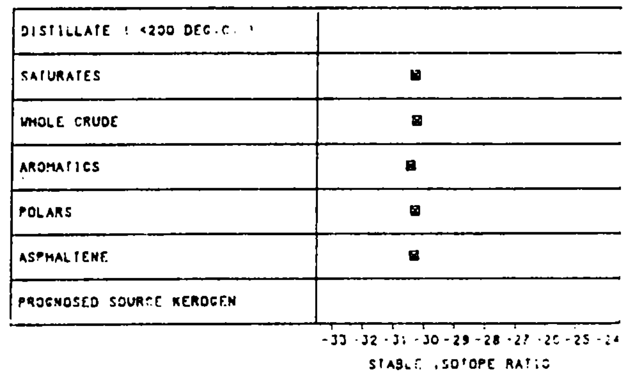
PENTACYCLANE DISTRIBUTION



HYDROCARBON DATA

API GRAVITY	60 DEG F.	
SPECIFIC GRAVITY	60 DEG F.	1.25
SULPHUR	% WT.	4.98
WAX	% WT.	
WAX M. PT.	DEG. C	
ASPHALTENES	% WT	52.18
NICKEL	PPM	
VANADIUM	PPM	
NICKEL / VANADIUM RATIO		
NITROGEN	% WT	
TYPE ANALYSIS		
SATURATES	% WT.	6.63
AROMATICS	% WT	11.84
POLARS	% WT.	29.35
N - ALKANE CPI		
N - ALKANE % WT. OF SATURATES		0.00
PRISTANE / PHYTANE RATIO		
PRISTANE / N - C17		
PHYTANE / N - C18		
CARBON ISOTOPE RATIO C13 %		-30.15
SULPHUR ISOTOPE RATIO S34 %		
DEUTERIUM ISOTOPE RATIO D2 %		
NITROGEN ISOTOPE RATIO N15 %		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE

COMPONENT	HYDROCARBON RATIO
ISO-BUTANE / N-BUTANE	
ISOPENTANE / N-PENTANE	
CYCLOPENTANE / 2,3-DIMETHYLBUTANE	
2-METHYLPENTANE/ 3-METHYLPENTANE	
N-HEXANE / METHYLCYCLOPENTANE	
BENZENE / CYCLOHEXANE	
1,1 DIMETCYCPENT. / 3-METHEXANE	
1-T-3-DIMETCYCPENT. / 1-T-2-DIMETCYCPENT.	
N-HEPTANE / METHYLCYCLOHEXANE	
2,3-DIMETHYLHEXANE / 2-METHYLHEPTANE	
2,2,5-TRIMETHEX. / 2,2,4-TRIMETHEX.	
2,3,5-TRIMETHYLHEXANE / N-OCTANE	
O-XYLENE / N-NONANE	
1-MET-3-ETHBENZENE / 1-MET-4-ETHBENZENE	

COUNTRY US STATE OK COUNTY ATOKA LOCATION SEC16 T1S R11E WELL STRINGTOWN QUARRY DEPTH SAMPLE TYPE TST SAMPLE ID HCB.[illegible] DATA BASE ORIGIN GEOCHEM/PGW	SOHIO PETROLEUM GEOCHEMISTRY GROUP WARRENSVILLE DATE APPROVAL

FIGURE 3

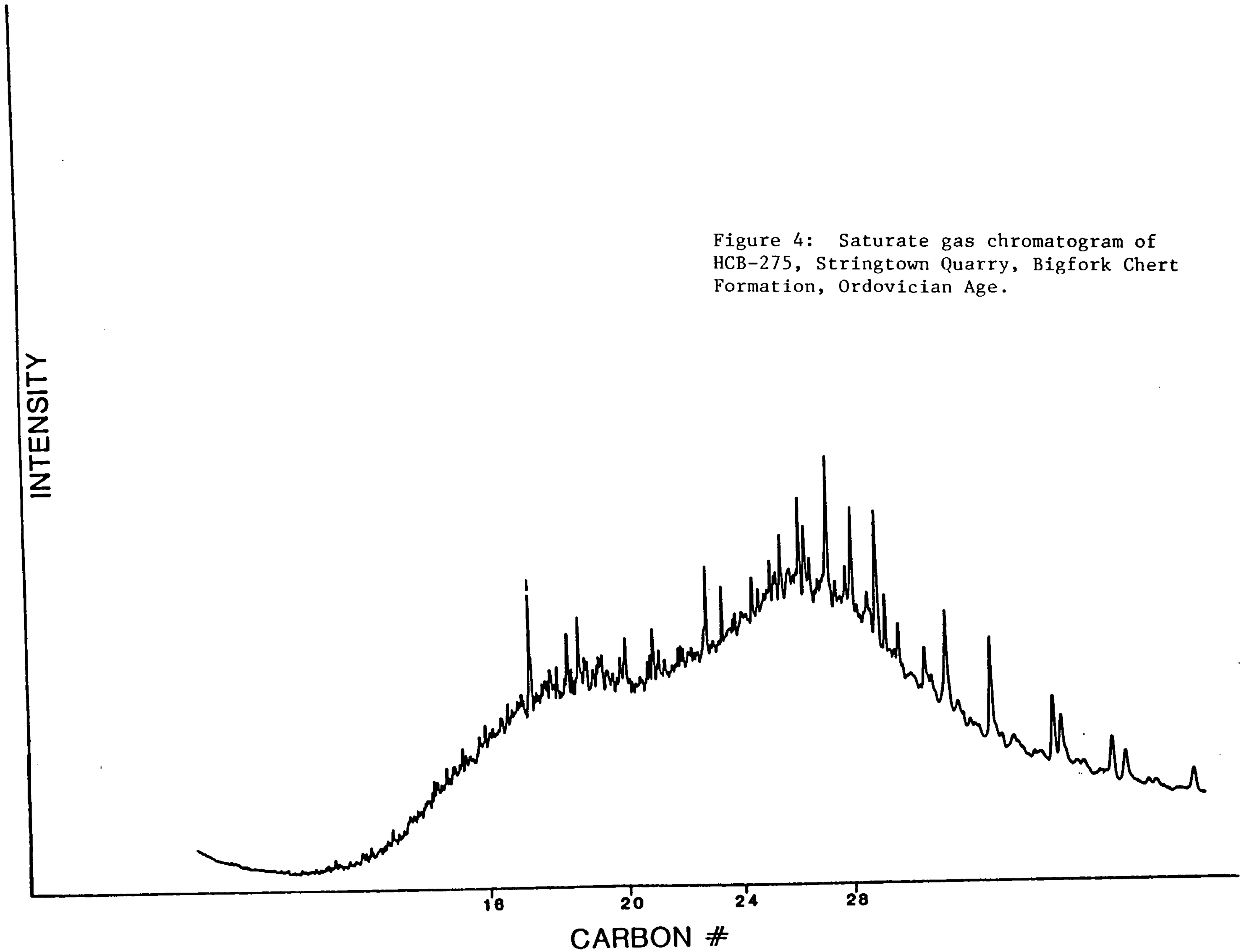


Figure 4: Saturate gas chromatogram of HCB-275, Stringtown Quarry, Bigfork Chert Formation, Ordovician Age.

TABLE 3
SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:TAYLOR#1	SAMPLE ID:HCB006 FORMATION:BGFK
STATE :OK	LOCATION :SEC15,T3SR11E	TYPE:PRO AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :35-A00520087	DEPTH(FT): 2110
PGW JOB:8003	REPORT :	DATA BASE:GEOCHEM/PGW

INSPECTION DATA

SPECIFIC GRAV.	:	1.000
API GRAV.	:	10.00
SULFUR	%WT:	.80
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	12.00
NICKEL	(PPM):	42
VANADIUM	(PPM):	180
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	31.40	
AROMATICS	%WT:	22.80	
POLARS	%WT:	33.80	
ASPHALTENE(2)	%WT:	12.00	
N-ALKANE	%WT:	38.23	
N-ALKANE CPI	:	1.07	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.65	
ACYCLIC C16	%WT:	1.48	
ACYCLIC C18	%WT:	2.37	
PRISTANE	%WT:	3.18	
PHYTANE	%WT:	2.86	
PRISTANE/PHYTANE	:	1.11	
PRISTANE/N-C17	:	.86	
PHYTANE/N-C18	:	.81	
NICKEL/VANADIUM	:	.23	
D-13 C(OIL)	:	-30.40	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-30.60	%.
D-13 C(AROMATICS)	:	-30.40	%.
D-13 C(POLARS)	:	-30.18	%.
D-13 C(ASPHALTENES)	:	-30.13	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP	257		
2	287	52	
4	305	54	
6	320	56	
8	336	58	
10	352	60	
12	368	62	
14	384	64	
16	399	66	
18	414	68	
20	427	70	
22	440	72	
24	452	74	
26	463	76	
28	474	78	
30	486	80	
32	498	82	
34	510	84	
36	522	86	
38	532	88	
40	541	90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

% WT SATURATES	
C10 :	
C11 :	
C12 :	.150
C13 :	.700
C14 :	1.600
C15 :	2.870
C16 :	3.340
C17 :	3.700
C18 :	3.550
C19 :	3.520
C20 :	2.550
C21 :	2.300
C22 :	1.760
C23 :	1.800
C24 :	1.420
C25 :	2.160
C26 :	1.590
C27 :	1.090
C28 :	1.080
C29 :	.900
C30 :	1.470
C31 :	.480
C32 :	.190
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT

NORMALISED DIST	
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT

NORMALISED DIST	
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

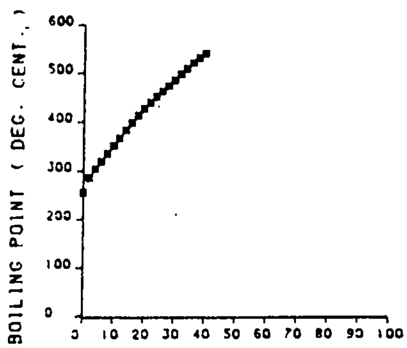
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

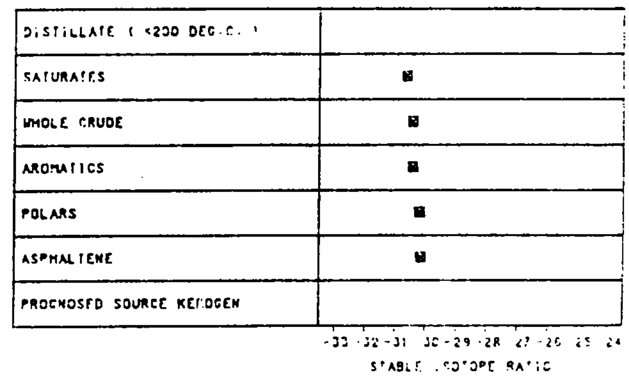
HYDROCARBON DATA

API GRAVITY	60 DEG F.	10.00
SPECIFIC GRAVITY	60 DEG F.	1.00
SULPHUR	% WT.	0.80
WAX	% WT.	
WAX M. PT.	DEG. F	
ASPHALTENES	% WT	12.00
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.23
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	31.40
AROMATICS	% WT.	22.80
POLARS	% WT.	33.80
N - ALKANE CPI		1.07
N - ALKANE % WT. OF SATURATES		38.[illegible]
PRISTANE / PHYTANE RATIO		1.[illegible]
PRISTANE / N - C17		0.86
PHYTANE / N - C18		0.8[illegible]
CARBON ISOTOPE RATIO C13 %		-30.40
SULPHUR ISOTOPE RATIO S34 %		
DEUTERIUM ISOTOPE RATIO D2 %		
NITROGEN ISOTOPE RATIO N15 %		

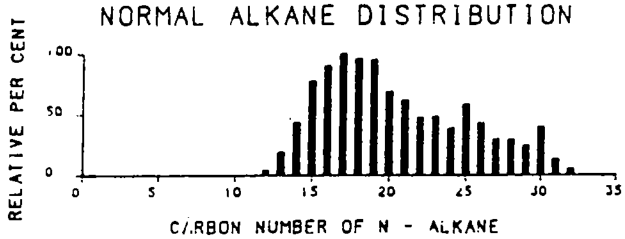
SIMULATED DISTILLATION



STABLE CARBON ISOTOPE PROFILE



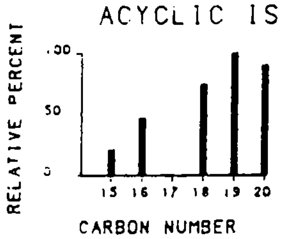
NORMAL ALKANE DISTRIBUTION



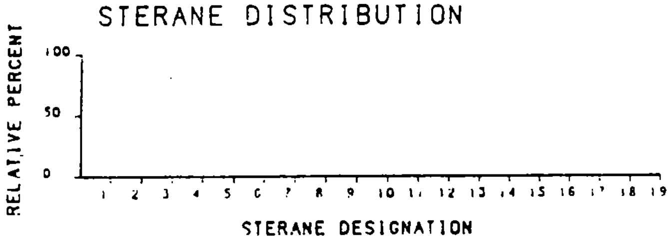
LIGHT HYDROCARBON PROFILE

COMPONENT	HYDROCARBON RATIO
ISO-BUTANE / N-BUTANE	
ISOPENTANE / N-PENTANE	
CYCLOPENTANE / 2,3-DIMETHYLBUTANE	
2-METHYLPENTANE/ 3-METHYLPENTANE	
N-HEXANE / METHYLCYCLOPENTANE	
BENZENE / CYCLOHEXANE	
1,1-DIMETCYCPENT. / 3-METHEXANE	
1-T-3-DIMETCYCPENT. / 1-T-2-DIMETCYCPENT.	
N-HEPTANE / METHYLCYCLOHEXANE	
2,3-DIMETHYLHEXANE / 2-METHYLHEPTANE	
2,2,5-TRIMETHEX. / 2,2,4-TRIMETHEX.	
2,3,5-TRIMETHYLHEXANE / N-OCTANE	
O-XYLENE / N-NONANE	
1-MET-3-ETHBENZENE / 1-MET-4-ETHBENZENE	

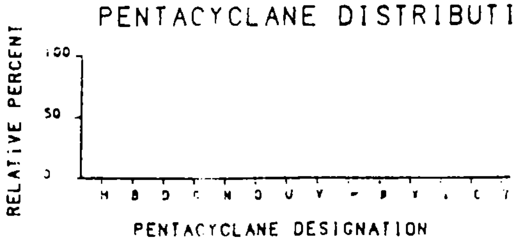
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



PENTACYCLANE DISTRIBUTION



COUNTRY US
STATE OR
COUNTY ATORA
LOCATION SEC15.T35R11E
WELL TAYLOR#1
DEPTH 3110
SAMPLE TYPE PRO
SAMPLE ID HC8004
DATA BASE ORIGIN GEOCHEM[illegible]

SOHIO
PETROLEUM GEOCHEMISTRY GROUP
[illegible]

FIGURE 5

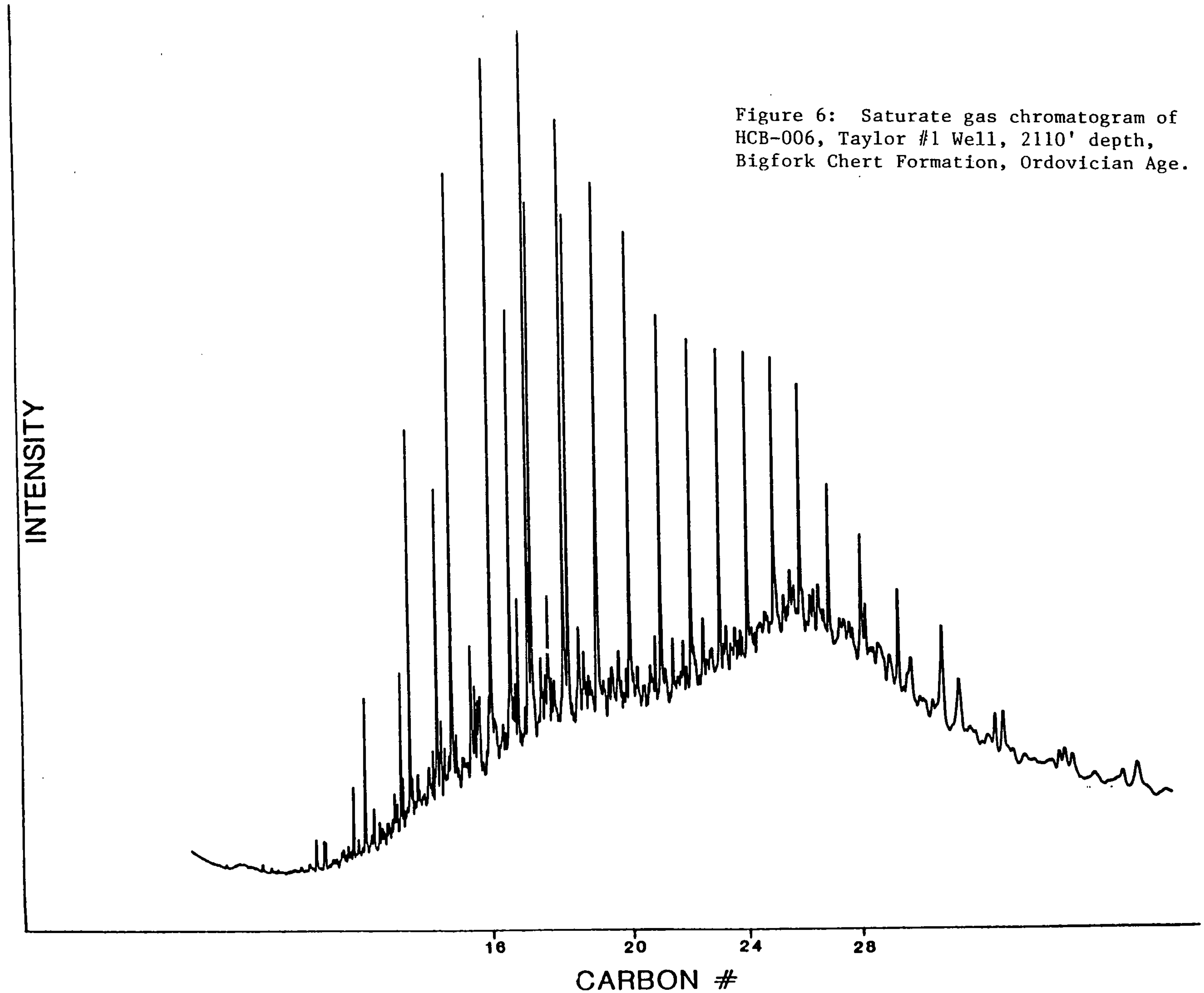
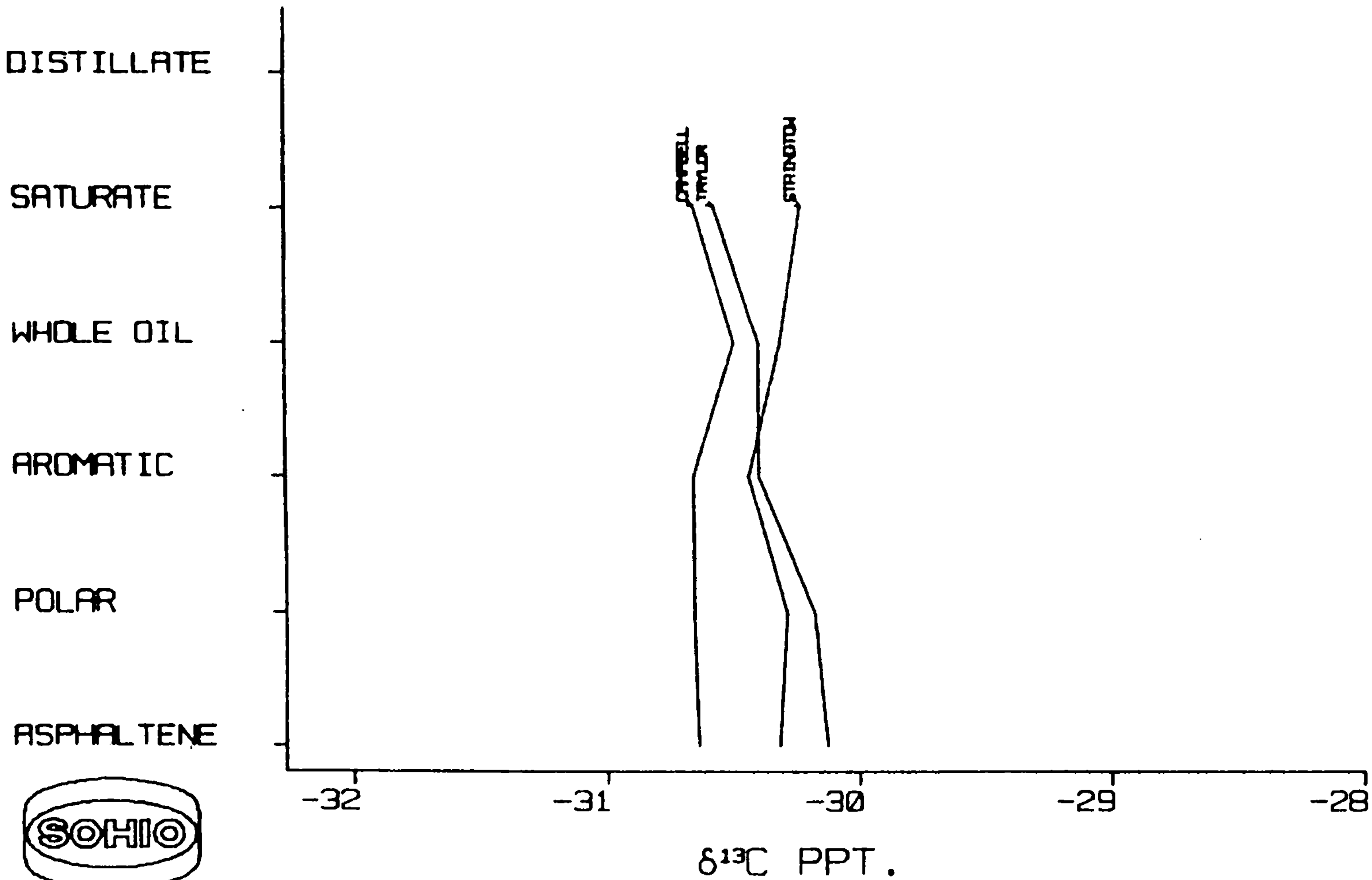


Figure 6: Saturate gas chromatogram of HCB-006, Taylor #1 Well, 2110' depth, Bigfork Chert Formation, Ordovician Age.

CAMPBELL/TAYLOR OILS



SOHIO

FIGURE 7

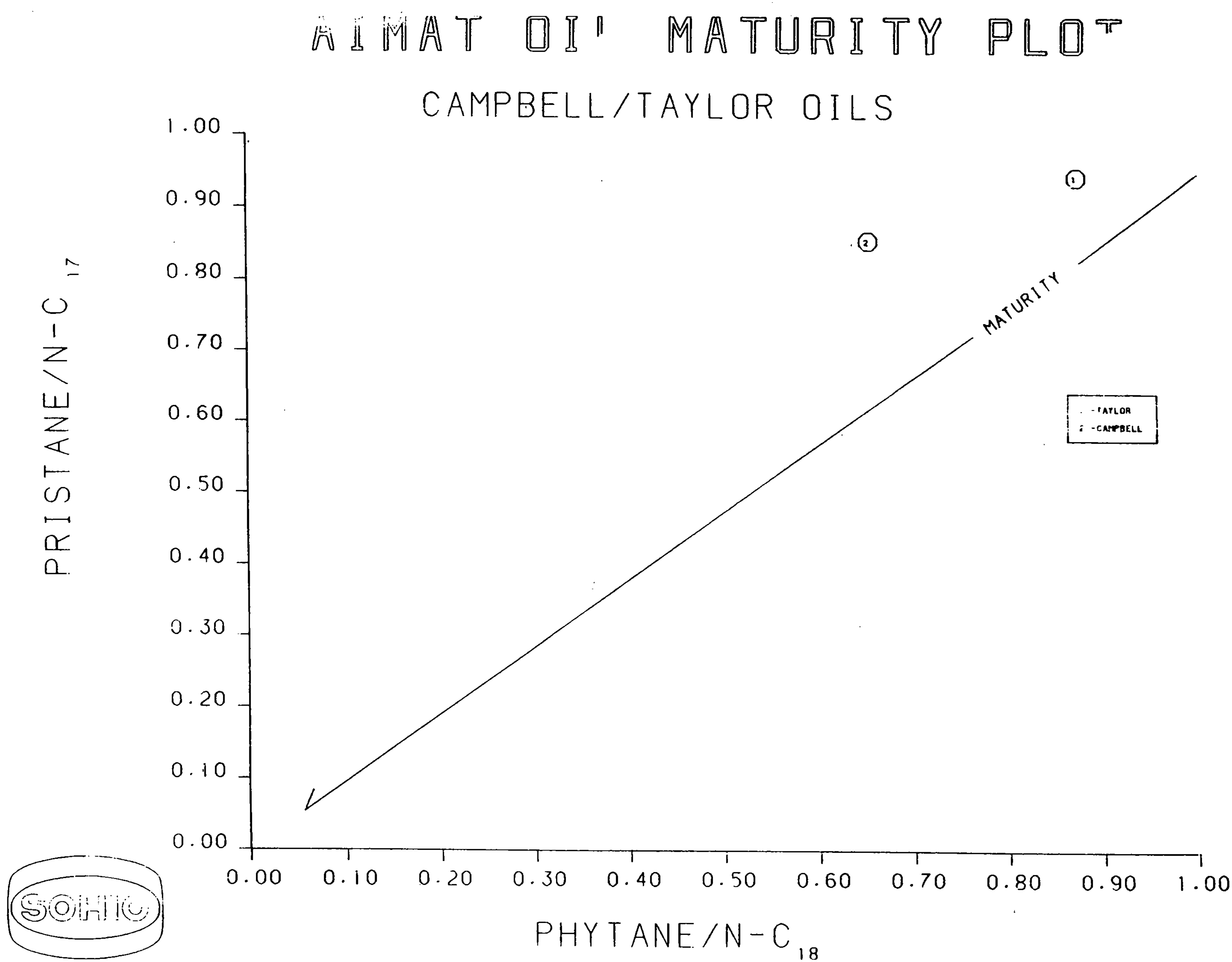

AIMAT OI' MATURITY PLOT
CAMPBELL/TAYLOR OILS
PRISTANE/N-C 17
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
PHYTANE/N-C 18
MATURITY
-TAYLOR
-CAMPBELL
SOHIO

FIGURE 8

DELTA C : ENVPLOT

CAMPBELL/TAYLOR OILS

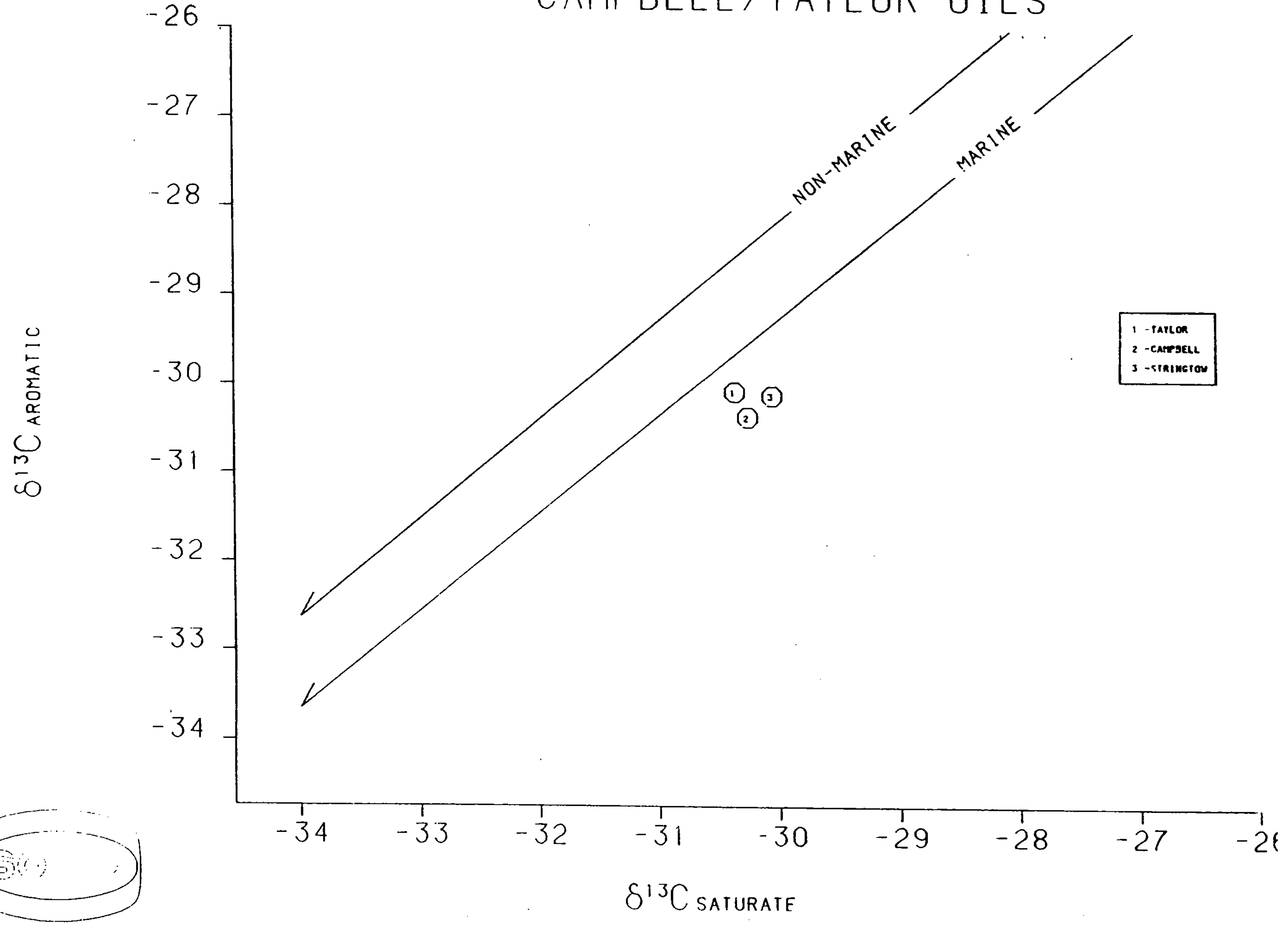


FIGURE 9

TABLE 4

SOURCE QUALITY AND KEROGEN PYROLYZATE DATA SUMMARY

PGW #	FM.	Equivalent Ro* (%)	TOC (%)	GOGI	K2 (Kg/Ton)	$\delta^{13}C_k$	$\delta^{13}C_{kpy}$	$\delta^{13}C_{ksp}$	Δ_k	Depth(ft)
Stringtown Quarry Outcrops										
FSC-366	Polk Creek	0.63	9.14	0.24	38.1	-30.35	-30.80	-29.76	-0.45	
FSC-367	"	0.56	10.5	0.22	45.2	-30.42	-30.74	-29.82	-0.32	
FSC-377	BGFK		4.69	0.20	17.8	-30.14	-30.49	-29.72	-0.35	
FSC-378	"		1.15	0.22	4.95	-30.22	**---	---	---	
Campbell #1-24 Well										
WC-7464	Polk Creek	0.59	5.03	0.34	20.9	-30.56	-30.88	-30.12	-0.32	3011
WC-9384	BGFK		1.05	0.29	2.99	-30.71	-31.19	-30.20	-0.48	3100
WC-9410	Womble	0.54	2.62	0.22	10.13	-30.18	-30.00	-29.68	+0.18	3880
WC-9412	Womble		3.82	0.20	14.61	-30.92	-31.22	-30.38	-0.30	3940

*Measured on bitumen (solid) or vitrinite-like material

**Not Enough

HYDROCARBON-KEROGEN/KEROGEN PYROLYZATE COMPOSITE PROFILE

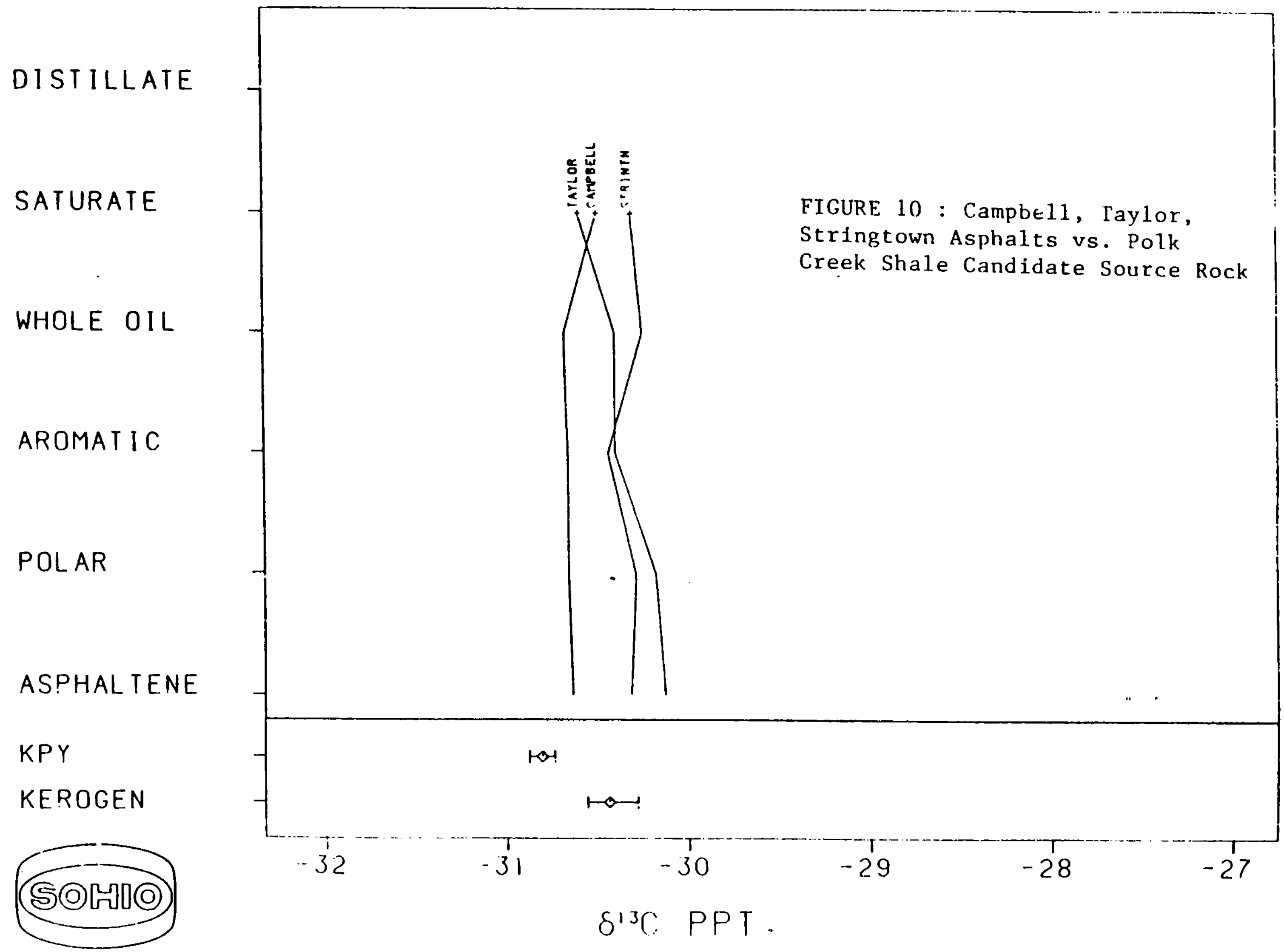


FIGURE 10 : Campbell, Taylor, Stringtown Asphalts vs. Polk Creek Shale Candidate Source Rock

HYDROCARBON-KEROGEN/KEROGEN PYROLYZATE COMPOSITE PROFILE

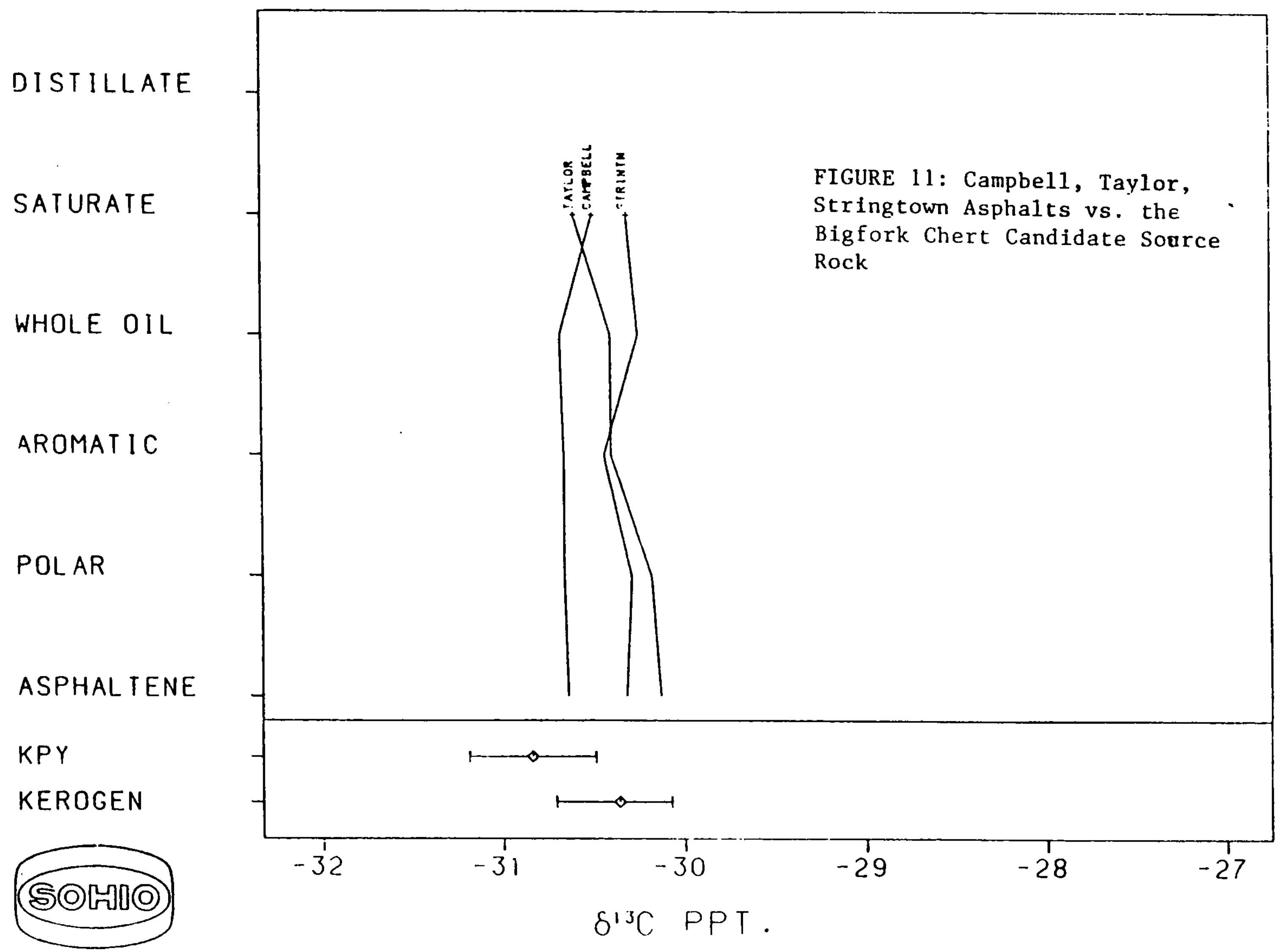


FIGURE 11: Campbell, Taylor, Stringtown Asphalts vs. the Bigfork Chert Candidate Source Rock

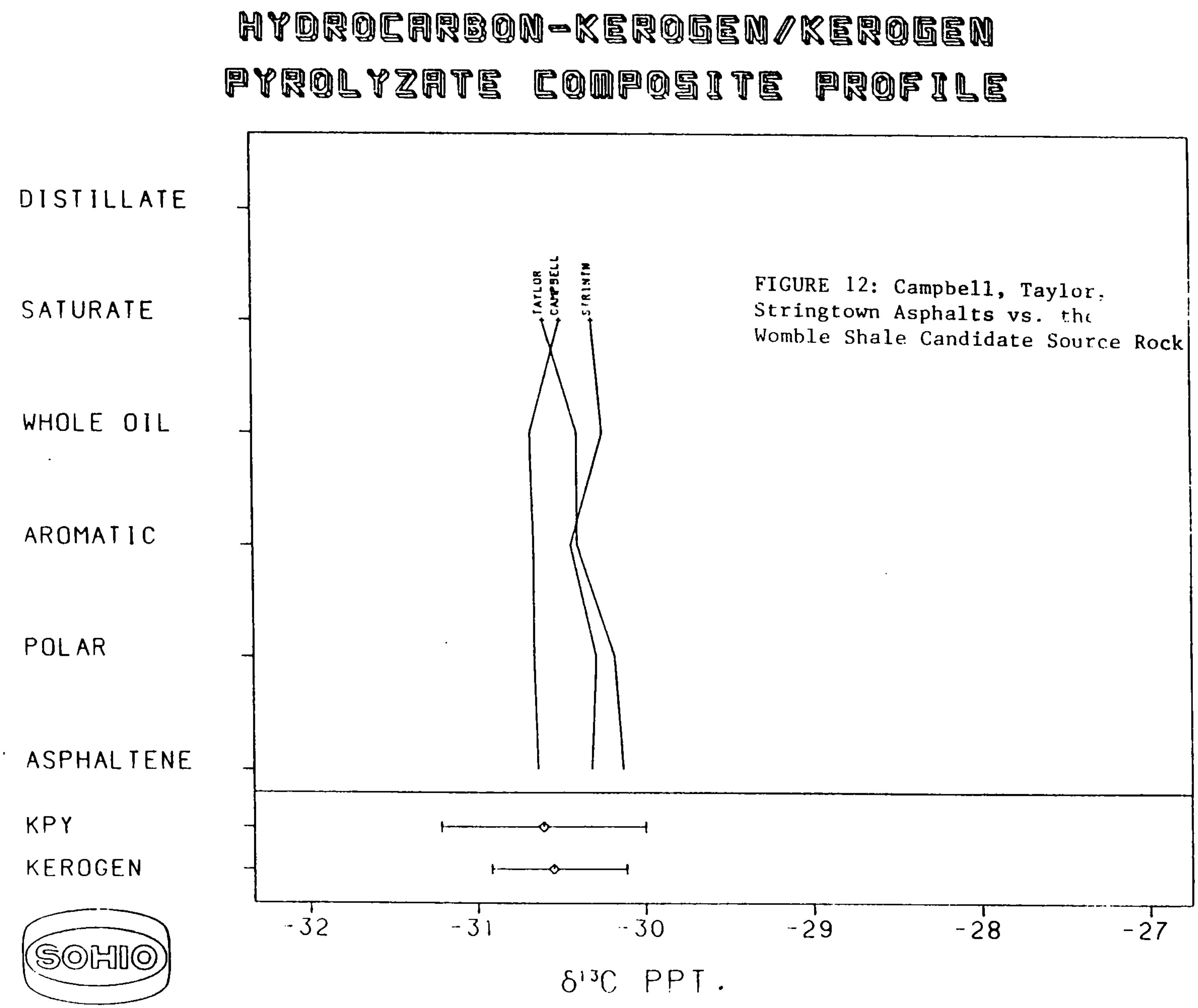


FIGURE 12: Campbell, Taylor, Stringtown Asphalts vs. the Womble Shale Candidate Source Rock

R. Burwood

IO PETROLEUM COMPANY
Petroleum Geochemistry Group

61140

To: Eric Luttrell
SPC Mid-Continent
Dallas

June 13, 1984

PGW/060684/RS/2-5

Attn: Doris Bajak

From: Petroleum Geochemistr Group
Warrensville

Classification: RESTRICTED

Subject: Characterization of Natural Gas Samples from the #1-29 Trotter-Dees Well, Pushmataha County, Oklahoma -- Exploration Brief (PGW/EB150).

Thirteen natural gas samples were received by PGW during April, 1984 from the #1-29 Trotter-Dees well, S29-TIN-R18E Pushmataha County, Oklahoma. The samples, collected in vacutainers, record several prominent gas shows encountered in the Mississippian Stanley Formation over the depth interval 6,249 ft. to 6,484 ft.

Sample depths, mud logging "hot-wire" units, and results of gas chromatographic compositional analyses are shown in Table 1. The data are presented on an "air-free" basis; all samples contained $\geq$50% air by volume. All of the gases were somewhat "wet", ranging from approximately 5-11 mol.% C_{2+} components. These compositions are typical for oil or oil source rock associated, thermogenic gases of low to moderate (gas) maturity. Vitrinite reflectance (preliminary) measurements now in progress suggest an R_o = 1.2-1.3% (Dominant Gas Generation status for sediments within this depth interval, consistent with a possible in-situ origin for these gases.

Replicate samples obtained at two depths, 6376 ft. and 6435 ft., provide an indication of the reproducibility of the sampling/analysis procedures. Results of the three analyses at 6376 ft. were in very close agreement, varying at maximum by 0.4% for the major constituents. Values for the duplicate 6435 ft. samples varied by up to 2.2% for both methane and ethane, and 0.5% for propane.

Inspection of the data in Table 1 reveals a poorly defined trend toward slightly reduced C_{2+} component abundances in samples collected at lower production levels (as indicated by "hot-wire" detector response). As discussed in a previous report (1), both contamination and sample size may contribute to a slight apparent enhancement in the methane concentration of small samples. Consideration of the mud log for this well section (Figure 1), however, indicates a possible correlation between increased methane concentration and the proportion of shale in sediments at an equivalent depth. This relationship suggests that the higher methane concentrations observed may be a result of preferential diffusion of methane, relative to C_{2+} components, out of the "tighter" shaly intervals. The individual results from 6376 ft. and the interval 6376-86 ft. would seem to support this observation, as the section from ≅ 6380 to 6386 ft. contains considerably less shale than the overlying 6376-6380 ft. interval. If this interpretation is valid, a fairly shaly origin for the more prominent show at ≅ 6393 ft. is implied. More detailed lithologic data are required to further substantiate these ideas.

CONCLUSIONS

The natural gas samples received from the #1-29 Trotter-Dees well were thermogenic in origin and somewhat "wet" (~5-11% C_{2+} components).

Interpretation of the gas characterization data showed:

1. The gases higher in methane content (i.e. 6376' and 6393') were probably sourced locally from more shaly intervals where preferential diffusion of methane occurred.

2. The major gas show at 6435-6438' was sourced locally from an interval where preferential diffusion did not occur, as evidenced by the higher C_{2+} component abundances.

REFERENCE:

Cole, G. and Sedivy, R. 1984 Characterization of Vacutainer Natural Gas Samples from the Haley 1-30 Well, Loving County, Texas -- Exploration Brief (PGW/EB151).

G. Cole

R. Sedivy

GC/RS:mc

Enclosures: Table 1
Figure 1

cc: H. G. Bassett
R. Burwood
R. Drozd
PGW Files (0) (2-5)

Work by: R. Cavalier

TABLE 1

GAS CHROMATOGRAPHIC RESULTS FOR SAMPLES
FROM THE #1-29 TROTTER-DEES WELL

AIR-FREE COMPOSITION,[+] MOL%

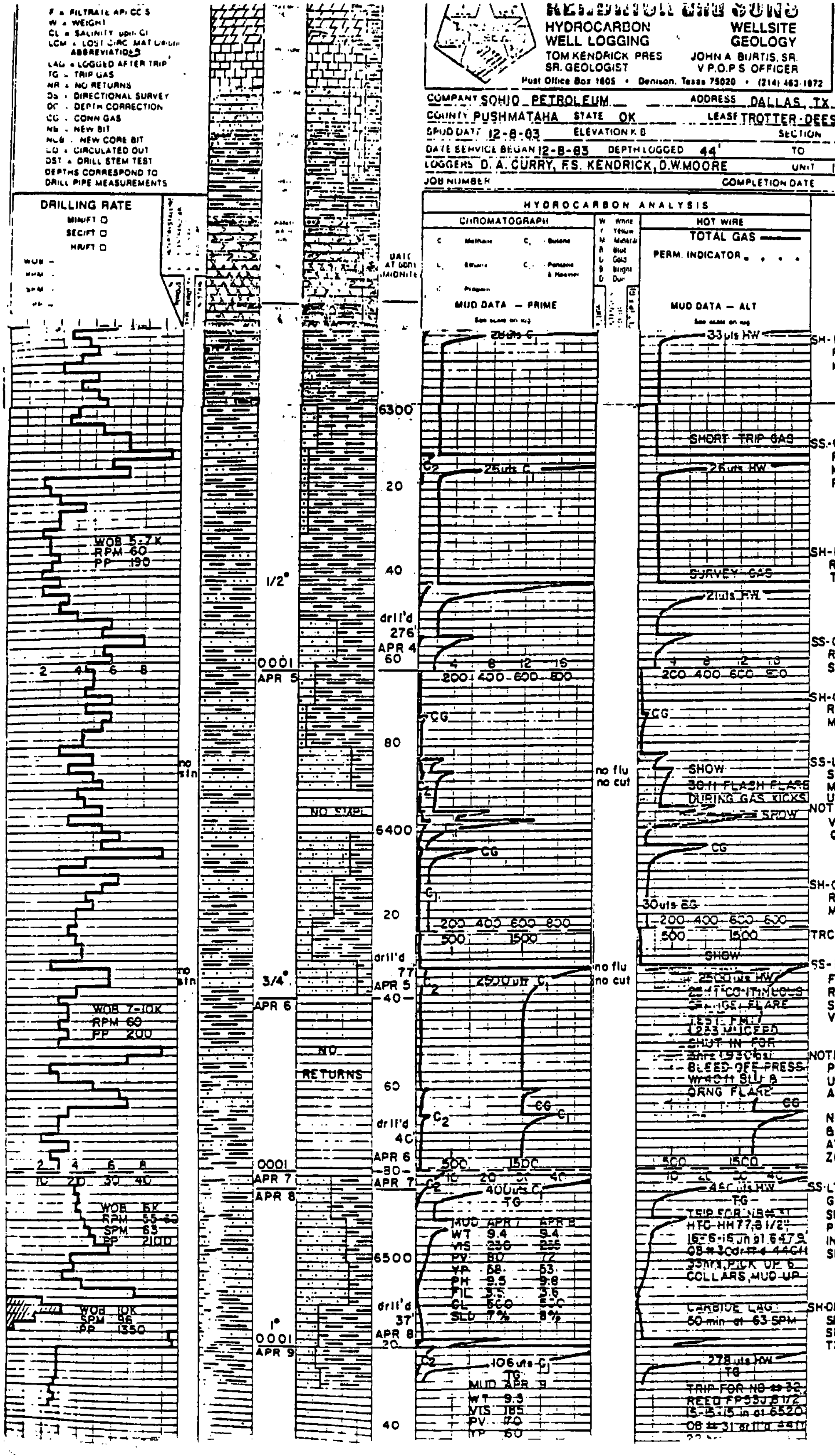
Depth, Ft.	H.W. Units	C_1	C_2	C_3	iC_4	nC_4	iC_5	nC_5	GWI*
6249	5	94.2	4.0	1.4	0.22	-	-	0.22	0.94
6280	40	93.6	4.3	1.7	0.19	-	0.05	0.11	0.94
6376()	150	94.7	3.5	1.5	0.15	-	0.05	0.07	0.95
6376(2)	150	94.3	3.8	1.6	0.15	-	0.05	0.07	0.94
6376(3)	150	94.6	3.5	1.6	0.15	-	0.05	0.07	0.95
6376-86	450	90.4	6.3	2.5	0.22	0.47	0.08	0.07	0.90
6393	700	93.5	4.2	1.7	0.16	0.31	0.06	0.05	0.94
6432	158	92.3	4.8	2.0	0.19	0.47	0.12	0.13	0.92
6435(1)	2250	91.2	5.6	2.4	0.21	0.46	0.08	0.06	0.91
6435(2)	2250	89.0	7.12	2.9	0.26	0.54	0.11	0.08	0.89
6432-38	2250	90.6	6.1	2.4	0.22	0.45	0.09	0.07	0.91
6438	2250	91.0	5.8	2.4	0.21	0.46	0.08	0.07	0.91
6484	1750	93.0	4.5	1.9	0.16	0.36	0.07	0.06	0.93

[+]All samples contained $\geq$50% "air" by volume.

*Gas Wetness Index = $C_1/(C_1 \rightarrow C_5)$.

FIGURE 1

Mud Log from Stanley Fm., Trotter-Dees 1-29 Well.



PGW/EB157
H. G. Bassett

903257

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: Dann May
SPC Mid-Continent Region
Dallas

July 6, 1984

PGW/070584/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Subject: Additional Source Analyses from the 2770 to 3190' Interval, #1-24 Campbell Well, Atoka County, Oklahoma - Exploration Brief (PGW/EB157).

Eight additional samples were analyzed for source quality from the 2770 to 3190' interval, #1-24 Campbell Well, Atoka County, Oklahoma. Samples were analyzed for % TOC (bitumen-free) and Rock-Eval pyrolysis according to PGW standardized methods. Other data was previously reported on in PGW/TM156 [1]. Table 1 lists the total source quality data base for the #1-24 Campbell well.

The following eight samples were requested to detail the source quality of the interval surrounding and including the Polk Creek Shale:

				Rock-Eval Pyrolysis (kg/ton)	
	Sample#	Depth	% TOC	S1	S2
	WC 9353	2770	0.36	0.09	0.41
	WC 9355	2830	0.58	0.18	1.05
	WC 9377	2890	1.04	0.40	3.00
Polk Creek Shale	WC 9379	2950	1.66	0.67	7.33
Polk Creek Shale	WC 9381	3010	1.90	0.98	8.89
	WC 9383	3070	0.70	0.39	2.83
	WC 9385	3130	0.71	0.41	1.85
	WC 9387	3190	1.65	0.83	6.83

From the new data and using the data from PGW/TM 156, the 150' interval from 2890 to 3040' had good to excellent source richness (% TOC ranged from 1.04 to 5.03%); good to excellent potential productivity (S2 ranged from 3:00 to 27.61 kg/ton); and the GOGI values indicated that the kerogen assemblages were dominant oil/minor gas prone. This interval was also incipiently mature as measured by bitumen R_o and qualitative fluorescence [1].

References

1. Cole, G.A. March 1984 Source Evaluation of the #1-24 Campbell Well, Atoka County, Oklahoma: PGW Technical Memorandum (PGW/TM 156).

G. A. Cole

GAC:mlc

Enclosure: Table 1

cc: H. G. Bassett
E. Luttrell
C. Titus
R. Drozd
Files (0) (2-5)

Work by: R. Lukco
C. Hodges

TABLE 1

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : ATOKA
LOCATION : SEC24,T3SR11E
WELL/SITE : #1-24 CAMPBELL
API/OCS : 35-005-20138

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
150	WC9269	CTG			SH,CALC							
290	XC9269		MISS	STAN	FORM.TOP							
300	WC9270	CTG			SH,CALC	16		.46		.04	.10	22
310	WC9271	CTG			SH,CALC							
360	WC9272	CTG			SH,CALC	15		.48		.03	.10	21
370	WC9273	CTG			SH,CALC							
400	WC9274	CTG			SH,CALC	15		.46		.12	.17	37
430	WC9275	CTG			SH,CALC							
460	WC9276	CTG			SH,CALC	16		.45		.07	.07	16
490	WC9277	CTG			SH,CALC							
520	WC9278	CTG			SH,CALC	15		.46		.12	.12	26
550	WC9279	CTG			SH,CALC							
580	WC9280	CTG			SH,CALC	14		.56		.23	.23	41
610	WC9281	CTG			SH,CALC							
640	WC9282	CTG			SH,CALC	14		.52		.12	.22	42
670	WC9283	CTG			SH,CALC							
700	WC9284	CTG			SH,CALC	14		.58		.13	.40	69
730	WC9285	CTG			SH,CALC							
760	WC9286	CTG			SH,CALC	15		.43		.09	.17	40
790	WC9287	CTG			SH,CALC							
820	WC9288	CTG			SH,CALC	15		.35		.05	.08	23
850	WC9289	CTG			SH,CALC							
880	WC9290	CTG			SH,CALC							
910	WC9291	CTG			SH,CALC							
940	WC9292	CTG			SH,CALC	15		.40		.07	.10	25
970	WC9293	CTG			SH,CALC							
1000	WC9294	CTG			SH,CALC	14		.43		.09	.12	28
1030	WC9295	CTG			SH,CALC							
1060	WC9296	CTG			SH,CALC	12		.47		.07	.28	60
1090	WC9297	CTG			SH,CALC							
1120	WC9298	CTG			SH,CALC	13		.53		.13	.29	55
1150	WC9299	CTG			SH,CALC							
1180	WC9300	CTG			SH,CALC	14		.57		.10	.31	54
1210	WC9301	CTG			SH,CALC							
1240	WC9302	CTG			SH,CALC	14		.68		.13	.33	49
1270	WC9303	CTG			SH,CALC							
1300	WC9304	CTG			SH,CALC	14		.59		.15	.17	29

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
150															
290															
300	.29		9												
310															
360	.23		6												
370															
400	.41		26												
430												.41			
460	.50		16												
490															
520	.50		26												
550															
580	.50		41												
610															
640	.35		23												
670															
700	.25		22									.39			
730															
760	.35		21												
790															
820	.38		14												
850												.43			
880															
910															
940	.41		17												
970															
1000	.43		21												
1030												.43			
1060	.20		15												
1090															
1120	.31		25												
1150															
1180	.24		18												
1210															
1240	.28		19												
1270															
1300	.47		25												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1330	WC9305	CTG			SH,CALC							
1360	WC9306	CTG			SH,CALC	14		.59		.15	.44	75
1390	WC9307	CTG			SH,CALC							
1420	WC9308	CTG			SH,CALC	14		.69		.17	.38	55
1450	WC9309	CTG			SH,CALC							
1480	WC9310	CTG			SH,CALC	16		.48		.18	.22	46
1510	WC9311	CTG			SH,CALC							
1540	WC9312	CTG			SH,CALC	16		.45		.13	.22	49
1570	WC9313	CTG			SH,CALC							
1600	WC9314	CTG			SH,CALC	13		.70		.23	.56	80
1630	WC9315	CTG			SH,CALC							
1660	WC9316	CTG			SH,CALC	13		.74		.15	.48	65
1690	WC9317	CTG			SH,CALC							
1720	WC9318	CTG			SH,CALC	14		.55		.05	.16	29
1750	WC9319	CTG			SH,CALC							
1780	WC9320	CTG			SH,CALC	14		.88		.17	.53	60
1810	WC9321	CTG			SH,CALC							
1840	WC9322	CTG			SH,CALC	14		.77		.17	.42	55
1870	WC9323	CTG			SH,CALC							
1900	WC9324	CTG			SH,CALC	12		1.20		.32	1.63	136
1930	WC9325	CTG			SH							
1960	WC9326	CTG			SH	8		1.79	1.23	.51	4.24	237
1990	WC9327	CTG			SH							
2020	WC9328	CTG			SH	8		.63		.19	.44	70
2050	WC9329	CTG			SH							
2080	WC9330	CTG			SH	9		1.14		.30	1.47	129
2110	WC9331	CTG			SH							
2140	WC9332	CTG			SH	9		1.16	.88	.35	1.93	166
2170	WC9333	CTG			SH							
2200	WC9334	CTG			SH	8		1.04		.32	1.73	166
2230	WC9335	CTG			SH,CALC							
2260	WC9336	CTG			SH,CALC	10		.68		.14	.63	93
2290	WC9337	CTG			SH,CALC							
2291	XC9337		DEV	ARKN	FORM.TOP							
2320	WC9338	CTG			SH,CALC	10		1.34	1.05	.39	3.20	239
2350	WC9339	CTG			SH,CALC							
2380	WC9340	CTG			SH,CALC	15		3.15		.81	10.93	347
2410	WC9341	CTG			SH,CALC							
2440	WC9342	CTG			SH,CALC	12		1.83	.76	.41	5.32	291
2470	WC9343	CTG			SH,CALC							
2500	WC9344	CTG			SH	4		.71	.68	.25	2.13	300
2530	WC9345	CTG			SH							
2560	WC9346	CTG			SH	9		.18	.62	.16	.20	111
2590	WC9347	CTG			SH							
2620	WC9348	CTG			SH	8		.18	.31	.07	.11	61
2624	XC9348		SIL	MONT	FORM.TOP							
2650	WC9349	CTG			SH							
2680	WC9350	CTG			SH	8		.16		.06	.07	44
2710	WC9351	CTG			SH,V.CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1330															
1360	.25		25												
1390															
1420	.31		25												
1450												.47			
1480	.45		37												
1510															
1540	.37		29												
1570															
1600	.29		33												
1630															
1660	.24		20												
1690												.47			
1720	.24		9												
1750															
1780	.24		19												
1810															
1840	.29		22									.45			
1870															
1900	.16		27		2.02	.60	1.42	168	.42						
1930															
1960	.11	69	28	2	4.51	.99	3.52	252	.28						
1990															
2020	.30		30												
2050															
2080	.17		26		1.96	.58	1.38	172	.42			.54			
2110															
2140	.15	76	30	3	2.37	.55	1.82	204	.30						
2170															
2200	.16		31		1.88	.52	1.36	181	.38						
2230															
2260	.18		21												
2290												.53			
2291															
2320	.11	78	29	3	3.38	.93	2.45	252	.38			.47			
2350															
2380	.07		26		9.89	2.10	7.79	314	.27						
2410															
2440	.07	42	22	2	5.87	1.25	4.62	321	.27						
2470												.54			
2500	.11	96	35	3	2.04	.45	1.59	287	.28						
2530															
2560	.44	344	89	4											
2590															
2620	.39	172	39	4											
2624															
2650															
2680	.46		37												
2710															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2740	WC9352	CTG			SH,V.CALC	27		.31		.11	.15	48
2770	WC9353	CTG			SH,V.CALC	38		.36		.09	.41	114
2800	WC9354	CTG			SH,V.CALC	43		.48		.20	.93	194
2830	WC9355	CTG			SH,CALC	36		.58		.18	1.05	181
2860	WC9376	CTG			SH,CALC	23		.97		.40	2.03	209
2890	WC9377	CTG			SH,CALC	20		1.04		.40	3.00	288
2920	WC9378	CTG			SH,CALC	17		1.67		.79	5.52	331
2950	WC9379	CTG			SH,CALC	14		1.66		.67	7.33	442
2957	XC9379		ORD	POLK	FORM.TOP							
2980	WC9380	CTG			SH,CALC	17		2.22	1.52	1.24	10.17	458
3010	WC9381	CTG			SH,CALC	15		1.90		.98	8.89	468
3011	WC7464	CC			SH	2		5.03		2.12	27.61	549
3033	XC9381		ORD	BGFK	FORM.TOP							
3040	WC9382	CTG			SH,CALC	24		1.16	1.15	.77	4.62	398
3070	WC9383	CTG			SH,V.CALC	43		.70		.39	2.83	404
3100	WC9384	CTG			SH,V.CALC	28		1.05		1.34	3.59	342
3130	WC9385	CTG			SH,V.CALC	38		.71		.41	1.85	261
3160	WC9386	CTG			SH,V.CALC	36		.93	1.64	.51	2.44	262
3190	WC9387	CTG			SH,V.CALC	26		1.65		.83	6.83	414
3220	WC9388	CTG			SH,V.CALC	36		.47	1.95	.47	1.36	289
3250	WC9389	CTG			SH,V.CALC							
3280	WC9390	CTG			SH,CALC	12		.80	1.23	.46	3.06	382
3310	WC9391	CTG			SH,CALC							
3340	WC9392	CTG			SH,V.CALC	27		.55	2.51	1.45	2.16	393
3370	WC9393	CTG			SH,V.CALC							
3400	WC9394	CTG			SH,V.CALC	36		.38	1.46	.43	1.31	345
3430	WC9395	CTG			SH,V.CALC							
3460	WC9396	CTG			SH,V.CALC	45		.39	1.58	.56	1.46	374
3490	WC9397	CTG			SH,V.CALC							
3520	WC9398	CTG			SH,V.CALC	39		.45	1.64	.45	1.38	307
3550	WC9399	CTG			SH,V.CALC							
3580	WC9400	CTG			SH,V.CALC	46		.43	1.46	.43	1.21	281
3610	WC9401	CTG			SH,V.CALC							
3640	WC9402	CTG			SH,V.CALC	35		.58	1.78	.72	2.31	398
3670	WC9403	CTG			SH,V.CALC							
3700	WC9404	CTG			SH,V.CALC	36		.57	1.73	.57	2.09	367
3730	WC9405	CTG			SH,V.CALC							
3760	WC9406	CTG			SH,V.CALC	39		.45	1.37	.42	1.49	331
3790	WC9407	CTG			SH,V.CALC							
3820	WC9408	CTG			SH,V.CALC	42		.52	1.49	.29	1.25	240
3821	XC9408		ORD	WOMB	FORM.TOP							
3850	WC9409	CTG			SH,V.CALC							
3880	WC9410	CTG			SH,V.CALC	20		2.62	2.91	.71	13.08	499
3910	WC9411	CTG			SH,V.CALC							
3940	WC9412	CTG			SH,V.CALC	10		3.82	3.34	2.49	20.42	535
3970	WC9413	CTG			SH,V.CALC							
3980	XC9413	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2740	.42		35												
2770	.18		25												
2800	.18		42												
2830	.15		31												
2860	.16		41												
2890	.12		38												
2920	.13		47		6.38	1.23	5.15	382	.24						
2950	.08		40												
2957															
2980	.11	68	56	1	7.94	1.69	6.25	358	.27			.54			
3010	.10		52												
3011	.07		42		20.91	5.31	15.60	416	.34			.59	30.56		30.88
3033															
3040	.14	99	66	1	3.49	.72	2.77	301	.26						
3070	.12		56												
3100	.27		128		2.99	.67	2.32	285	.29				30.71		31.19
3130	.18		58												
3160	.17	176	55	3											
3190	.11		50												
3220	.26	415	100	4											
3250															
3280	.13	154	57	3	2.44	.66	1.78	305	.37						
3310															
3340	.40	456	264	2											
3370															
3400	.25	384	113	3								.58			
3430															
3460	.28	405	144	3	.81	.27	.54	208	.49						
3490															
3520	.25	364	100	4											
3550															
3580	.26	340	100	3											
3610												.67			
3640	.24	307	124	2											
3670															
3700	.21	304	100	3	1.43	.43	1.00	251	.43						
3730															
3760	.22	304	93	3											
3790															
3820	.19	287	56	5											
3821															
3850															
3880	.12	111	65	2	10.13	1.83	8.30	387	.22				30.18		30.00
3910												.57			
3940	.11	87	65	1	14.61	2.44	12.18	382	.20				30.92		31.22
3970												.51			
3980															

206178

EB 159

H084.0168
C 3

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: Dann May
SPC Mid-Continent Region
Dallas

July 12, 1984

PGW/071284/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

48257

Classification: RESTRICTED

Subject: Source Quality Evaluation of Eight Outcrop Samples from Caddo Gap, Montgomery County, Arkansas -- Exploration Brief (PGW/EB159).

Eight (8) outcrop samples from a measured section located in Sections 18-19, T4S, R24W, Montgomery County, Arkansas, were received for source rock evaluation. The samples were given PGW Field Survey numbers FSE 128 to FSE 135 and represent the Caddo Gap samples 1-8, respectively, in your rotation. The outcrops were analyzed using standardized PGW methods for % TOC (bitumen free), pyrolysis (Rock-Eval) and whole-rock vitrinite reflectance. The geochemical data for these samples are listed on Table 1.

All eight samples were from the Devonian Arkansas Novaculite Formation.

Maturity measurements, via whole-rock vitrinite reflectance, showed that the Arkansas Novaculite from Caddo Gap was thermally spent (considered to be >2.0% R_o by PGW). R_o values ranged from 2.44 to 3.25%. TOC values ranged from 0.32 to 9.66%, indicating that certain intervals of the section had excellent residual total organic carbon contents. Rock-Eval pyrolysis indicated no potential productivity as would be expected from spent sediments.

The primary goal of these analyses was the correlation of the TOC values to the gamma ray response from a surface gamma ray survey. Table 2 lists the pertinent data.

Theoretically, the greater the % TOC, the higher the gamma ray response and, as can be shown by the data in Table 2, an excellent correlation has been obtained. The 3 highest responses (193.5, 235.6 and 253.3 CPS) were recorded from samples with TOC values greater than 2.0%. The 3 lowest responses (1.68.6, 164.6 and 168.3 CPS) were recorded from samples with TOC values less than 2.0%. From these results, it may be concluded that a TOC of 2% is the pivotal value needed before an increase in the gamma ray response can be seen. If this is true, sample FSE 130 should have a response less than 170 CPS while FSE 132 should be greater than 190 CPS.

G. A. Cole

GAC:mlc

Enclosure: Tables 1, 2

cc: H. G. Bassett

R. Burwood

E. Luttrell

R. Drozd

C. Titus

Files (0) (2-5)

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0			0												
0			0												
0			0												
0			0									3.05			
0			0									3.25			
0			0												
0			0												
0			0									2.44			

TABLE 2

GAMMA RAY RESPONSE

Sample No.	Feet	TGR in CPS	% TOC	Lithology
FSE 128	619	168.6	1.67	SH, black
FSE 129	621	164.6	0.46	SH, black
FSE 130	622	--	1.56	SH, black
FSE 131	623	253.3	9.66	SH, black
FSE 132	624	--	2.39	SH, black
FSE 133	625	193.5	2.18	SH, black
FSE 134	627	168.3	0.32	SH, black
FSE 135	643	235.6	4.76	SH, black

HO... C, 3 PGW/EB 22

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: R. Cobb
SPC Mid-Continent Region
Dallas

December 14, 1982

PGW/120982/FM/2-5

5-124

From: Petroleum Geochemistry Group
Warrensville

Job No.: PGW 82-73

Subject: Geochemical Evaluation of Selected Cuttings from the Herndon 1-Flatt Well, Pushmataha County, Oklahoma -- Exploration Brief (PGW/EB 022).

The Herndon 1-Flatt well was drilled in a Stanley Shale Valley in Section 10, T2N-R18E, Pushmataha County, Oklahoma. Spudded in the Mississippian Stanley Fm., the well penetrated this formation to a TD of 2,000 ft.

Three samples from the well were received for a source richness and maturity screen. The samples, given PGW well sample designations WB 6047 - WB 6049, were representative of the 1,450 - 1,490 ft., 1,750 - 1,780 ft., and 1,840 - 1,890 ft. intervals of the well, respectively. The samples were screened using standardized PGW methods which included TOC (bitumen free), pyrolysis (Rock Eval), and vitrinite reflectance (whole rock). Table 1 lists the geochemical data for the three Stanley intervals.

The sediments were found to be incipiently to threshold mature, having reflectance values of 0.55 and 0.60% at 1,450 ft. and 1,750 ft., respectively. The samples only had Moderate TOC contents (0.45 - 0.54 wt%) and Marginal potential productivities (0.50 - 0.64 kg/ton). Based on these data none of the intervals were assessed to have any commercial source potential.

pp F. A. Marsek

FAM:bes

Enclosure: Table 1

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
R. J. Drozd
E. Luttrell
PGW Files (0), (2-5)

TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC10,T2NR18E
WELL/SITE : HERNDON 1-FLATT
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1450	WB6047	CTG	MISS	STAN	SH,CALC	15		.53		.45	.64	121
1750	WB6048	CTG	MISS	STAN	SH,CALC	15		.45		.34	.59	131
1840	WB6049	CTG	MISS	STAN	SH,CALC	17		.54		.55	.50	93

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1450	.41		85									.55			
1750	.37		76									.60			
1840	.52		102												

HO8A 3106 C, 3

PGW/F024

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: R. Cobb
SPC Mid-Continent Region
Dallas

December 22, 1982

PGW/111782/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: 82-77

Subject: Geochemical Evaluation of Selected Core Samples from the Shell 1-Goddard Well, Pittsburg County, Oklahoma -- Exploration Brief (PGW/EB 024).

The Shell 1-Goddard well, located in Section 21, T2N-R15E in southern Pittsburg County, Oklahoma, was a shallow stratigraphic test of the Pennsylvanian Jackfork Fm. The well reached TD at 408 ft.

52172

Two samples of siliceous Jackfork shale were received for source richness and maturity analyses. The samples, representative of the formation at 48 ft., and 407 ft., were given PGW well sample designations WB 6201 and WB 6202, respectively. The samples were analyzed using standardized PGW TOC, pyrolysis, and vitrinite reflectance techniques. Source rock data for the two samples is given in Table 1.

Reflectance values of about 0.70% for the two samples indicated that the Jackfork sediments had reached the early mature stage of oil generation at their maximum depth of burial. The sediments were subsequently uplifted to their present shallow depth.

The samples had only Moderate TOC contents (0.91 and 0.79 wt %) and despite their relative immaturity only poor to lean potential productivity (0.55 and 0.35 kg/ton). On the basis of these data, these siliceous shale member horizons of the Jackfork Fm. were assessed to have no commercial source potential in the vicinity of the 1-Goddard well.

Although not requested for in this piece of work, our wider interest in the Jackfork Fm. as a potential source (eg S.W. Arkansas bitumens, Nix #1 oils, etc.) stimulated us to determine the carbon isotopic characteristics of these kerogen assemblages. The whole kerogen values at $\delta^{13}C \geq -24.1$ ppt were consistent with a highly marine assemblage or alternatively one dominated by coaly/woody detritus. The latter was preferred in that the corresponding kerogen pyrolysates showed large differentials (~ 4 ppt) with their respective whole kerogens. This has been found to be typical of such higher plant dominated depositional environments. Consistent with these observations, gas prone GOGI values at > 0.74 were observed. On this basis these Jackfork horizons are best regarded as immature and insignificant potential gas sources. Any liquid hydrocarbons produced showed an intermediate isotopic composition correlating neither with the isotopic heavy S. W. Arkansas petroleums or the lighter Ouachita Facies sourced? hydrocarbons.

pp F. A. Marsek

FAM:bes

Enclosure: Table 1

cc: H. G. Bassett

J. G. Grasselli

R. Burwood

R. J. Drozd

E. Luttrell

C. A. Titus

PGW Files (0), (2-5)

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PITTSBURG
LOCATION : SEC21,T2NR15E
WELL/SITE : SHELL 1-GODDARD
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
48	WB6201	CC	PENN	JKFK	SH,CALC	11		.91		.32	.55	60
407	WB6202	CC	PENN	JKFK	SH,CALC	16		.79		.14	.35	44

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
48	.37		35		1.29				0.74			.71	24.11		28.62
407	.29		18		0.60				0.98			.73	23.65		27.39

H083.0506
C.2

PGW/EB 29

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

Mt. Herman Section Tuff Interval

To: C. Titus
SPC Mid-Continent Region
Dallas

February 16, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/021583/GC/2-5

Subject: Geochemical Evaluation of Outcrop Samples from Weyerhaeuser Acreage, McCurtain County, Oklahoma. -- Exploration Brief (PGW/EB 029).

Eight (8) outcrop samples from a measured section located in Section 20, T3S-R24E, McCurtain County, Oklahoma, were received for source rock evaluation. The samples were given PGW Field Survey numbers FSC 138 to FSC 145 and represent the Mid-Continent numbers BE/SE-TMC 38 to 49, respectively, in your notation. The outcrops were analyzed using standardized PGW methods for % TOC (bitumen free), pyrolysis (Rock-Eval), and whole-rock vitrinite reflectance. The geochemical data for the Weyerhaeuser samples are given in Table 1.

All eight (8) samples were from the Stanley Formation, Mississippian age and were collected from two adjacent thrust sheets. FSC 138-141 were from the upper thrust sheet and FSC 142-145 were from the lower thrust sheet.

Despite marginal to negligible organic carbon contents, vitrinite or vitrinite-like reflectance measurements were possible on all specimens.

cc: [redacted]

J. G. Grasselli

R. Burwood

R. J. Drozd

E. Luttrell

PGW Files (0), (2-5)

Comparison of the reflectance data showed that the two thrust sheets could be distinguished from each other. The upper thrust sheet was determined to be the cooler thrust sheet. The upper thrust had an average Ro of 2.93% (ranged from 2.14 to 4.15%) but contained one anomalous data point of 4.15%. This one point may be more thermally mature because of some type of localized thermal effect towards one end of the outcrop or may be structurally controlled (another thrust, possibly). The lower thrust sheet was more thermally metamorphosed with an average Ro of 4.36% (ranged from 4.18 to 4.66%).

Source analyses showed that the Stanley Formation in this location was a poor source overall, with an average TOC of 0.34% and virtually no pyrolysis yield. Of course, at these maturities, no pyrolysis yields were expected.

In conclusion, it was determined that the two thrust sheets of the Stanley in this area were poor sources and thermally overmature, no longer generating hydrocarbons. Of the two thrust sheets, the lower thrust was more thermally mature than the upper. Dry gas would be the only indigenous hydrocarbons remaining in either thrust sheet, but the upper thrust is the more likely.

G. A. Cole

G. A. Cole

GAC:bes

Enclosure: Table 1

TABLE 1

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : MCCURTAIN
LOCATION : SEC20,T3SR24E
WELL/SITE : WEYERHAEUSER SAMPLES
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
38	FSC138	OC	MISS	STAN	SLTST	5		.01		.13	.13	1300
39	FSC139	OC	MISS	STAN	SH,CALC	13		.26		.19	.19	73
40	FSC140	OC	MISS	STAN	SH	3		.30		.11	.05	17
41	FSC141	OC	MISS	STAN	SH	3		.57		.15	.15	26
42	FSC142	OC	MISS	STAN	SH,CALC	12		.41		.12	.10	24
43	FSC143	OC	MISS	STAN	SH,CALC	10		.18		0.00	0.00	0
44	FSC144	OC	MISS	STAN	SH,CALC	16		.31		.15	.22	71
49	FSC145	OC	MISS	STAN	SH,CALC	13		.70		.03	0.00	0

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
38	.50		1300									2.14			
39	.50		73									2.53			
40	.69		37									2.91			
41	.50		26									4.15			
42	.55		29									4.28			
43			0									4.66			
44	.41		48									4.33			
49	1.00		4									4.18			

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: D. May
SPC Mid-Continent Region
Dallas

February 16, 1983

PGW/020883/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: 82-80

Classification: RESTRICTED

Subject: Appraisal of Geochemical Data from the Wayne Harper Shaw #1-A Well, Collin County, Texas. -- Exploration Brief (PGW/EB 031).

Geochemical data from a Sunmark Exploration Co. Geochemical Group report on the subject well has been reviewed and relevant data incorporated into the PGW Geochemical Data Base. The incorporated data includes TOC content, carbonate content, vitrinite reflectance values, and thermally extractable hydrocarbon data (equivalent to pyrolysis S1 data).

The Sunmark geochemical data is listed in Table 1. Because the only available solvent-extracted hydrocarbon data was in the form of three gas chromatogram figures, no hydrocarbon data was added to the data base for this well. The thermally extractable hydrocarbon data, reported in ppm's was converted to kg/ton.

The Harper Shaw #1-A, spudded 11-9-79, was drilled 10 miles east-northeast of the town of McKinney 3,275 ft. FNL and 4,800 ft. FN'ly WL of J. Jackson Survey A-474, Collin County, Texas. It reached total depth in the Missouri Mountain Shale at 8,463 ft. on 2-29-80. The well penetrated a section of Cretaceous sediments to 4,549 ft., then encountered a major fault to Paleozoic Ouachita facies including the Stanley Shale, Arkansas Novaculite, and Missouri Mountain formations. Starting at 6,449 ft., repeat occurrences of these three formations were penetrated. The hole was tested dry and operations subsequently suspended.

The only significant geochemical data in the Sunmark report were the TOC and vitrinite reflectance data. The thermally extractable hydrocarbon data was not considered to be of much value without the equivalent S2 counterpart. It was, however, included as part of the data base in order to show the presence of indigenous hydrocarbons with respect to the TOC contents. The absence of pyrolytic S2 data was puzzling.

Vitrinite reflectance values for the Cretaceous sediments ranged from about 0.70 to 1.00% and generally increased with depth in the Cretaceous section. The data showed that the Cretaceous sediments had reached the mature oil to threshold gas generation regime at their maximum depth of burial. Good to Very Good TOC contents were observed for much of the Cretaceous section. However, despite the high organic carbon contents, only minimal amounts of indigenous (i.e. generated) hydrocarbons were present in the sediments as indicated by the thermally extractable hydrocarbon data. This suggested that these sediments had no significant source potential and had, at best, only generated limited quantities of liquid hydrocarbons. Alternatively they may have sourced gaseous hydrocarbons which have been subsequently removed or migrated from the rocks. Another possibility to consider is that the organic matter in the rocks was inertinitic and incapable of ever yielding more than limited quantities of gas. Without any visual kerogen descriptions or pyrolytic S2 data it is impossible to substantiate any of these supositions.

A vitrinite reflectance break was noted between the Cretaceous sediments and the Ouachita facies sediments which were of lower maturity. Reflectance values for the Ouachita sediments ranged from 0.59 to 0.75% and generally increased with depth. These values indicated that the Ouachita sediments had only reached the early stage of oil generation at their maximum depth of burial. Good to Excellent TOC contents indicated that the 5,750 ft. - 6,030 ft. interval of the Arkansas Novaculite was a possible commercial source sequence. Higher thermally extractable hydrocarbon contents were observed for this interval suggesting the possibility of some hydrocarbon generation and further suggesting some source potential. Normal alkane chromatograms of solvent-extractable hydrocarbons from this interval showed large napthenic humps and the presence of long-chain normal alkanes (up to n-C34). Both of these characteristics are indicative of early mature generation products. The reflectance data indicated that these organically rich Arkansas Novaculite sediments had not attained sufficient maturity to have generated any significant quantities of hydrocarbons. Whether or not these sediments are still in the oil generation window is equivocal based on the available Sunmark data. Based on the TOC data none of the other Ouachita sediments were considered to be of possible source interest.

In summary, there was general agreement with the Sunmark conclusions about the 5,800 ft. - 6,000 ft. interval of the Arkansas Novaculite in this well. However, in the opinion of the author the geochemical data compiled by Sunmark was inadequate to fully assess the source potential of the sediments in this well.

P. E. Smith

PP F. A. Marsek

FAM:bes

cc: [redacted]

J. G. Grasselli

R. Burwood

R. Drozd

E. Luttrell

G. Cole

PGW Files (0), (2-5)

Work by: S. White

TABLE 1

PAGE . 1

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : COLLIN
LOCATION : J.JACKSON SUR.A-474
WELL/SITE : HARPER SHAW#A-1
API/OCS : 42-085-30098

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
160	WB9300	CTG	CRET	AUCK		7		.49				
280	WB9301	CTG				8		.43				
400	WB9302	CTG				9		.36				
520	WB9303	CTG				8		.95				
660	WB9304	CTG				7		1.45				
760	WB9305	CTG				9		1.42		.07		
860	XB9305		CRET	EGFD	FORM.TOP							
940	WB9306	CTG				1		2.34		.08		
1050	WB9307	CTG				4		1.15				
1160	WB9308	CTG				1		1.71		.09		
1280	WB9309	CTG				1		1.77				
1290	XB9309		CRET	WDBN	FORM.TOP							
1400	WB9310	CTG				1		2.73		.01		
1550	WB9311	CTG				1		1.70				
1670	WB9312	CTG				1		1.34				
1790	WB9313	CTG				0		1.74				
1890	XB9313		L.CRET	WASH	FORM.TOP							
1920	WB9314	CTG				2		1.46				
2050	WB9315	CTG				1		1.17		.03		
2150	WB9316	CTG				3		1.12				
2250	WB9317	CTG				2		1.12				
2350	WB9318	CTG				3		1.12				
2469	XB9318		L.CRET	GOOD	FORM.TOP							
2470	WB9319	CTG				5		1.24		.04		
2510	XB9319		L.CRET	TRIN	FORM.TOP							
2550	WB9320	CTG				2		1.40		.05		
2650	WB9321	CTG				2		1.48		.06		
2750	WB9322	CTG				2		1.44		.05		
2850	WB9323	CTG				2		1.52		.06		
2950	WB9324	CTG				2		1.43				
3050	WB9325	CTG				2		1.24		.06		
3150	WB9326	CTG				1		1.36		.04		
3250	WB9327	CTG				3		.79				
3310	XB9327		L.CRET	ANDY	FORM.TOP							
3350	WB9328	CTG				2		.98		.05		
3440	WB9329	CTG				2		.84				
3550	WB9330	CTG				4		.56				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
160															
280															
400												.76			
520															
660												.75			
760			5												
860															
940			3									.78			
1050															
1160			5												
1280												.72			
1290															
1400			0												
1550															
1670												.86			
1790															
1890															
1920															
2050			3									.88			
2150															
2250															
2350												.92			
2469															
2470			3												
2510															
2550			4												
2650			4									.95			
2750			3												
2850			4												
2950												1.06			
3050			5												
3150			3												
3250												.94			
3310															
3350			5												
3440															
3550												1.01			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3650	WB9331	CTG				2		.90		.04		
3667	XB9331		L.CRET	TVPK	FORM.TOP							
3750	WB9332	CTG				2		1.11		.05		
3850	WB9333	CTG				3		.34				
3950	WB9334	CTG				2		.96		.03		
4050	WB9335	CTG				2		.51				
4150	WB9336	CTG				1		.95		.04		
4210	XB9336		L.CRET	COTT	FORM.TOP							
4250	WB9337	CTG				1		.96		.05		
4350	WB9338	CTG				2		.75				
4450	WB9339	CTG				2		.75		.05		
4549	XB9339				TOP-PALEO							
4550	WB9340	CTG				2		.66				
4650	WB9341	CTG				1		.54				
4690	XB9341		MISS	STAN	FORM.TOP							
4750	WB9342	CTG				1		.48				
4850	WB9343	CTG				1		.79		.09		
4950	WB9344	CTG				0		.68				
5050	WB9345	CTG				1		.63				
5150	WB9346	CTG				0		.52		.08		
5250	WB9347	CTG				1		.38				
5350	WB9348	CTG				0		.35				
5450	WB9349	CTG				0		.29				
5550	WB9350	CTG				0		.41				
5638	XB9350		DEV	ARKN	FORM.TOP							
5650	WB9351	CTG				0		.64		.06		
5750	WB9352	CTG				0		4.57		.37		
5850	WB9353	CTG				0		2.49		.35		
5950	WB9354	CTG				0		1.84		.30		
6030	XB9354		SIL	MONT	FORM.TOP							
6050	WB9355	CTG				0		.63		.05		
6150	WB9356	CTG				0		.27				
6250	WB9357	CTG				0		.32				
6350	WB9358	CTG				0		.41		.05		
6449	XB9358		MISS	STAN	FORM.TOP							
6450	WB9359	CTG				0		.43				
6550	WB9360	CTG				1		.15				
6650	WB9361	CTG				0		.74		.10		
6750	WB9362	CTG				0		.64				
6850	WB9363	CTG				0		.57				
6950	WB9364	CTG				0		.62		.07		
7050	WB9365	CTG				0		.51				
7150	WB9366	CTG				0		.63		.06		
7250	WB9367	CTG				0		.60				
7350	WB9368	CTG				0		.65		.06		
7440	WB9369	CTG				0		.61				
7550	WB9370	CTG				0		.64				
7650	WB9371	CTG				0		.69		.06		
7750	WB9372	CTG				0		.58				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3650			4												
3667															
3750			5												
3850															
3950			3												
4050															
4150			4									.98			
4210															
4250			5												
4350															
4450			7									1.04			
4549															
4550															
4650															
4690															
4750												.62			
4850			11												
4950															
5050												.66			
5150			15												
5250															
5350												.65			
5450															
5550															
5638															
5650			9									.59			
5750			8												
5850			14												
5950			16												
6030															
6050			8												
6150															
6250												.60			
6350			12												
6449															
6450															
6550												.60			
6650			14												
6750															
6850												.67			
6950			11												
7050															
7150			10									.65			
7250															
7350			9												
7440												.75			
7550															
7650			9												
7750												.73			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
7850	WB9373	CTG				0		.51		.07		
7938	XB9373		DEV	ARKN	FORM.TOP							
7950	WB9374	CTG				0		.51				
8050	WB9375	CTG				0		.47				
8150	WB9376	CTG				0		1.45		.14		
8210	XB9376		SIL	MONT	FORM.TOP							
8250	WB9377	CTG				0		.53				
8350	WB9378	CTG				0		.41				
8463	XB9378	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
7850			14												
7938															
7950															
8050															
8150			10												
8210															
8250															
8350															
8463															

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: D. May
SPC Mid-Continent Region
Dallas

February 18, 1983

PGW/021683/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: 82-81

Classification: RESTRICTED

Subject: Appraisal of Sunmark Exploration Company Geochemical Data for Oils from the Isom Springs Field, Marshall County, Oklahoma. -- Exploration Brief (PGW/EB 032).

The Sunmark data consisted of Simulated Distillation Data, Hydrocarbon Type Analyses (referred to as structured or bulk compositional data), Whole Oil chromatographic data and chromatograms, Saturate Alkane chromatographic data and chromatograms, API Gravities, and Whole Oil sulfur data.

Most of this data is considered to be "inspection data"; of interest in typing and characterizing oils but of no real value in determining generic relationships between oils and oils and source rocks.

The Sunmark conclusions and interpretations were, to a large extent, based on the bulk compositional data. Bulk composition is often a function of the maturation of both the source and ultimately, the reservoir subsequent to emplacement of hydrocarbons. Oils generated from sources of different ages in different basins can have very similar bulk compositions and API gravities. It is also possible to find compositionally different oils generated from a common source. Again, these are generally maturity-related phenomena. It can, therefore, be erroneous to use bulk compositional data to make genetic implications as to the sources or relationships of any oils. The methods best suited to correlate oils and sources are the carbon isotope profile and the kerogen pyrolysis carbon isotope technique which are utilized by the PGW Group and are done in-house.

Compositionally, the Isom Springs oils analyzed by the Sunmark Geochemical Group were alike. Their data was in relatively close agreement with the compositional data (Hydrocarbon Type Analyses data) compiled by the PGW Group for three Isom Springs oils (1). Differences in the weight percentages of the oil components were attributed to variations in separation techniques employed by Sunmark and the PGW Group.

The author is in concurrence with the Sunmark conclusion that all of the Isom Springs oils analyzed were derived from a common stratigraphic source interval. However, this accord was reached on the basis of previous PGW work (1, 2), not on the basis of the Sunmark data. The PGW data also suggested the possibility of a source suite or multiple source which was only vaguely alluded to in the Sunmark conclusions. It was also interesting to note that maturity differences were cited for the variations in the bulk compositions between the Isom Springs oils and an oil from the Sinclair Blackburn #1 well, located south of the Isom Springs field in Grayson County, Texas. The oil produced in the Blackburn well was also thought to be generated by Ouachita facies sediments similar to those sourcing the Isom Springs oils.

The acquisition and subsequent analysis of additional oils from the Isom Springs field and from other wells producing from Ouachita sediments would be of great value in identifying the source of these oils.

F. A. Marsek

FAM:bes

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
[redacted]
E. Luttrell
G. Cole
PGW Files (0), (2-5)

REFERENCES

(1) Halpern, H. I., Marsek, F. A., and Sedivy, R. A. — 1982 — Geochemical Characterization of Oils and Total Soluble Extracts Recovered from the #1 Jones, #1 O'Steen, and #3 Victor Wells, Isom Springs Field, Marshall County, Oklahoma. Report PGW/TM 078.

(2) Halpern, H. I., and Marsek, F. A. — 1982 — Geochemical Source Rock Evaluation for the #3 Victor Well, A Producer in the Isom Springs Field, Marshall County, Oklahoma. Report PGW/TM 065.

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: E. Luttrell
SPC Mid-Continent Region
Dallas

October 26, 1983

PGW/102483/GC/2-5

Attn: D. May

Classification: RESTRICTED

From: Petroleum Geochemistry Group
Warrensville

Subject: Source Rock and Maturity Evaluation of Sixteen Samples from a Measured Section Within the Stringtown Quarry, Atoka County, Oklahoma -- Exploration Brief (PGW/EB081).

Sixteen samples from a measured section within the Stringtown Quarry, Atoka County, Oklahoma were received for source rock evaluation and thermal maturity assessment. The samples were given PGW Field Survey numbers FSC 364 to FSC 379 and represent the Mid-Continent numbers 46' to 102', respectively. All samples were analyzed using standardized PGW methods for vitrinite reflectance (% Ro), % TOC (bitumen free), and pyrolysis (Rock-Eval). The data for these samples are given in Table 1.

The four samples from 46' to 52' (FSC 364-367) were from the Ordovician Polk Creek Shale; the twelve samples from 52.5' to 102' (FSC 368-379) were from the Ordovician Bigfork Chert.

1. SEDIMENT THERMAL MATURITY CONSIDERATIONS:

"Vitrinite-like" reflectance measurements were completed on FSC 366, FSC 367 and FSC 371. The reflectance values ranged from 0.56% R_o in the Polk Creek Shale to 0.65% R_o in the Bigfork Chert. These values are indicative of an incipiently mature to threshold mature sediment (PGW considers 0.6% R_o as threshold maturity for liquid hydrocarbon generation).

To corroborate the "vitrinite-like" R_o measurements, qualitative fluorescence was attempted. Examination via UV fluorescence showed that the organic matter was highly fluorescent and consisted mostly of algal matter. Fluorescence color was dominantly pale yellow which is indicative of incipiently mature sediments. Figure 1 illustrates how qualitative fluorescence compares to other sediment maturity scales.

Note: "Vitrinite-like" is used in place of vitrinite because no vascular plants (from which vitrinite is derived) were present prior to Late Silurian times. Therefore, since the Polk Creek Shale and Bigfork Chert are Ordovician age, no "true" vitrinite can be present.

2. SOURCE ROCK EVALUATION:

All sixteen samples from the measured section were analyzed for their respective source richness (% TOC), potential productivity (Rock-Eval pyrolysis) and kerogen proneness [pyrolysis gas chromatography (PGC)]. Cumulative results are set out in Table 1. The Polk Creek Shale and Bigfork Chert will be discussed separately as follows:

(a) Polk Creek Shale - incipiently mature to oil mature; moderate to excellent richness (% TOC ranged from 0.71 to 10.48%; average was 5.63%); potential productivity was excellent with an average S2 of 33.94 kg/ton; PGC GOGI (gas-oil generation index) values indicated dominant oil prone to mixed dominant oil/gas prone kerogen assemblages (values ranged from 0.22 to 0.31; average was 0.26).

(b) Bigfork Chert - oil mature; lean to very good richness, good overall (% TOC ranged from 0.15 to 4.69%; average was 1.07%); potential productivity was good with an average S2 of 6.42 kg/ton (FSC 377 with a TOC of 4.69% and a S2 of 33.71 kg/ton was an excellent spot horizon); GOGI values of 0.20 to 0.38 indicated dominant oil to mixed oil/gas kerogen assemblages.

Figure 2 graphically illustrates the source evaluation data and gamma log data for the Polk Creek Shale and Bigfork Chert of the Stringtown Quarry.

3. EXPLORATION SIGNIFICANCE:

Assuming that kerogen assemblages of the Ordovician Polk Creek Shale and Bigfork Chert are predominantly Type I (mainly algal sapropel), these sediments should be dominantly oil source rocks. Comparing the Type I kerogen to PGW's GOGI values, an oil prone kerogen that has undergone relatively little conversion would have a GOGI value of $\leq$ 0.23; a kerogen assemblage that has undergone some conversion and is within the oil window should have a GOGI value between 0.23 and 0.50. Using this information, in conjunction with the measured GOGI values of the Polk Creek Shale (average GOGI value was 0.26) and the Bigfork Chert (average GOGI value was 0.28), it can be concluded that these kerogen assemblages have undergone some limited conversion into liquid hydrocarbons. The average Transformation Ratio for the limited interval was 0.07 (i.e., 7%), this being somewhat less than the 10% value normally associated with the conventional hydrocarbon generation threshold.

Further comparison with maturity values would indicate that these formations are not yet sufficiently mature to have generated commercial quantities of oil, but if found at slightly higher maturities (i.e., about 0.7 or 0.8% R_o) commercial amounts of hydrocarbons could have been generated. To keep this in perspective, the above is based on the traditional "oil generation window" concept with Type II kerogens. If the present kerogen assemblages are more labile (or super-labile) than the Type II, commercial amounts of oil could have been generated at a lesser maturity than 0.6% R_o.

4. CONCLUSIONS

(a) The lower 8 feet of the Polk Creek Shale was an excellent source rock as shown by its high % TOC and potential productivity.

(b) Spot horizons of the Bigfork Chert were good to excellent source intervals. In particular was the 10' horizon from 82' to 92' where the kerogen assemblage was dominantly oil prone (GOGI values averaged 0.21). Average % TOC and S2 values were 2.92% and 20.9 kg/ton, respectively, for this interval.

(c) The Polk Creek Shale and Bigfork Chert were incipiently mature to threshold mature.

G. A. Cole

GAC:mlc

Enclosures: Figure 1
Figure 2
Table 1

cc: H. G. Bassett
R. Burwood
R. Drozd
Files (0) (2-5)

Work by: R. Lukco
L. Monnens
R. Chaiken
C. Hodges

APPENDIX

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PCW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. LST.	0-10% qualifying component
SH. CALC LST. ARG	11-25% qualifying component
SH. V. CALC LST. V. ARG	26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): %. Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): %. Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300°C$) - Kg/Tn.

S2 (12): %. Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: %. Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
- AL - Algal/Sapropel
- AM - Amorphous
- HE - Herbaceous
- W - Woody
- C - Coaly
- E - Exinite (Palynomorphs, Cutin, etc.)
- M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

GI (TSE)(14): %. Generation Index. TSE/TOC. Generation intensity based on abundance of Total Soluble Extract.

GI (S1)(15): %. Generation Index. S1/TOC Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): %. Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn. More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) %. Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn. More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): %. Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

ATOKA CO., OKLA - 16 - 1S - 12E

CURVE NUMBER	LEFT MARGIN LIMIT	RIGHT MARGIN LIMIT	TRACK NUMBER	CURVE MODIFIER	LINE TYPE	NAME	TOOL	UNITS
1.0	0.	200.	10.	LIN	0SOL	GR		GAPI
1.0	200.	400.	10.	LIN	OLDA	GR		GAPI
1.0	400.	600.	10.	LIN	0SDA	GR		GAPI
2.0	0.	10.	40.	LIN	0DDT	THOR		CPS
3.0	0.	10.	40.	LIN	0SOL	URAN		CPS
4.0	0.	10.	40.	LIN	OLDA	K		CPS

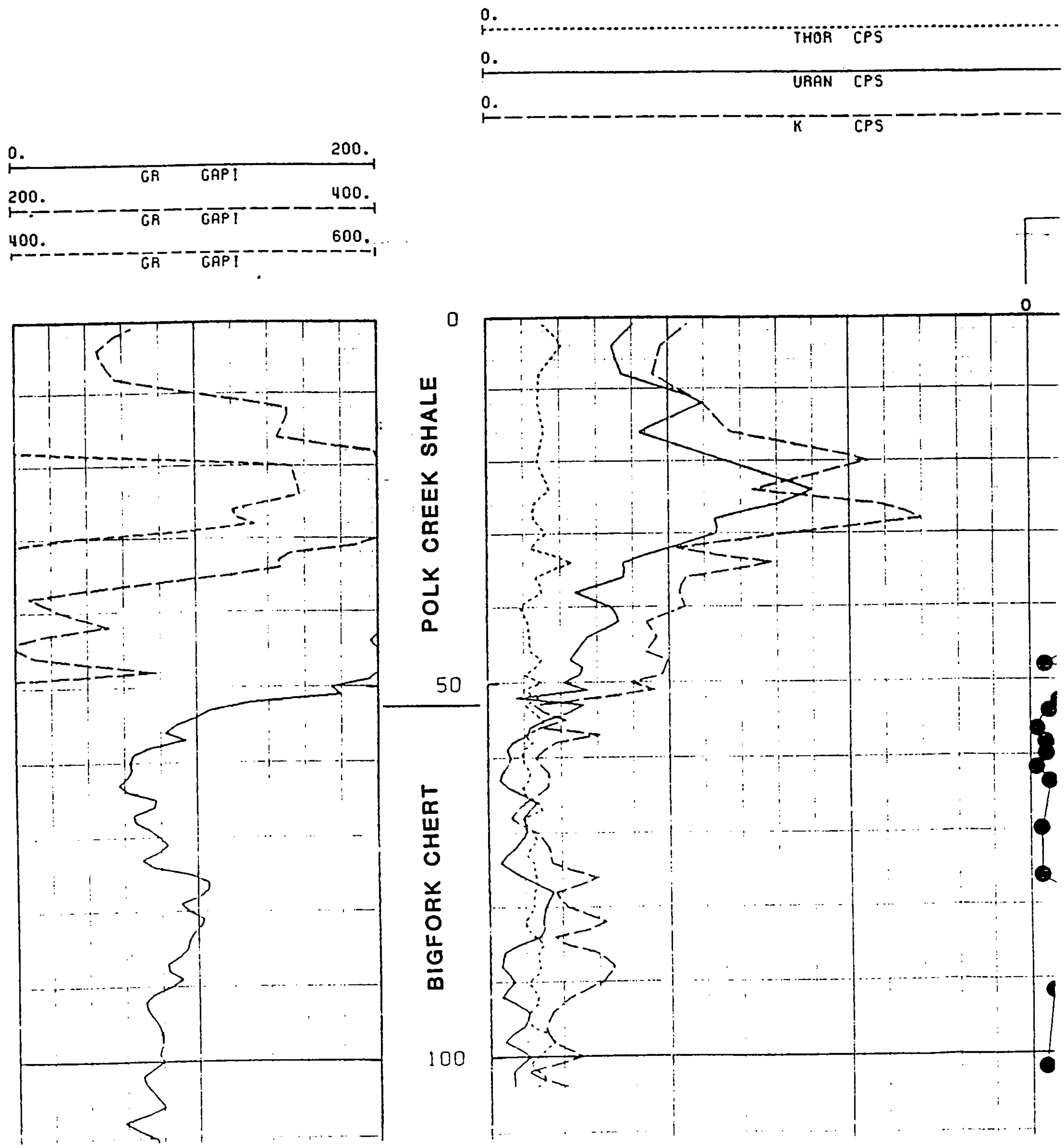
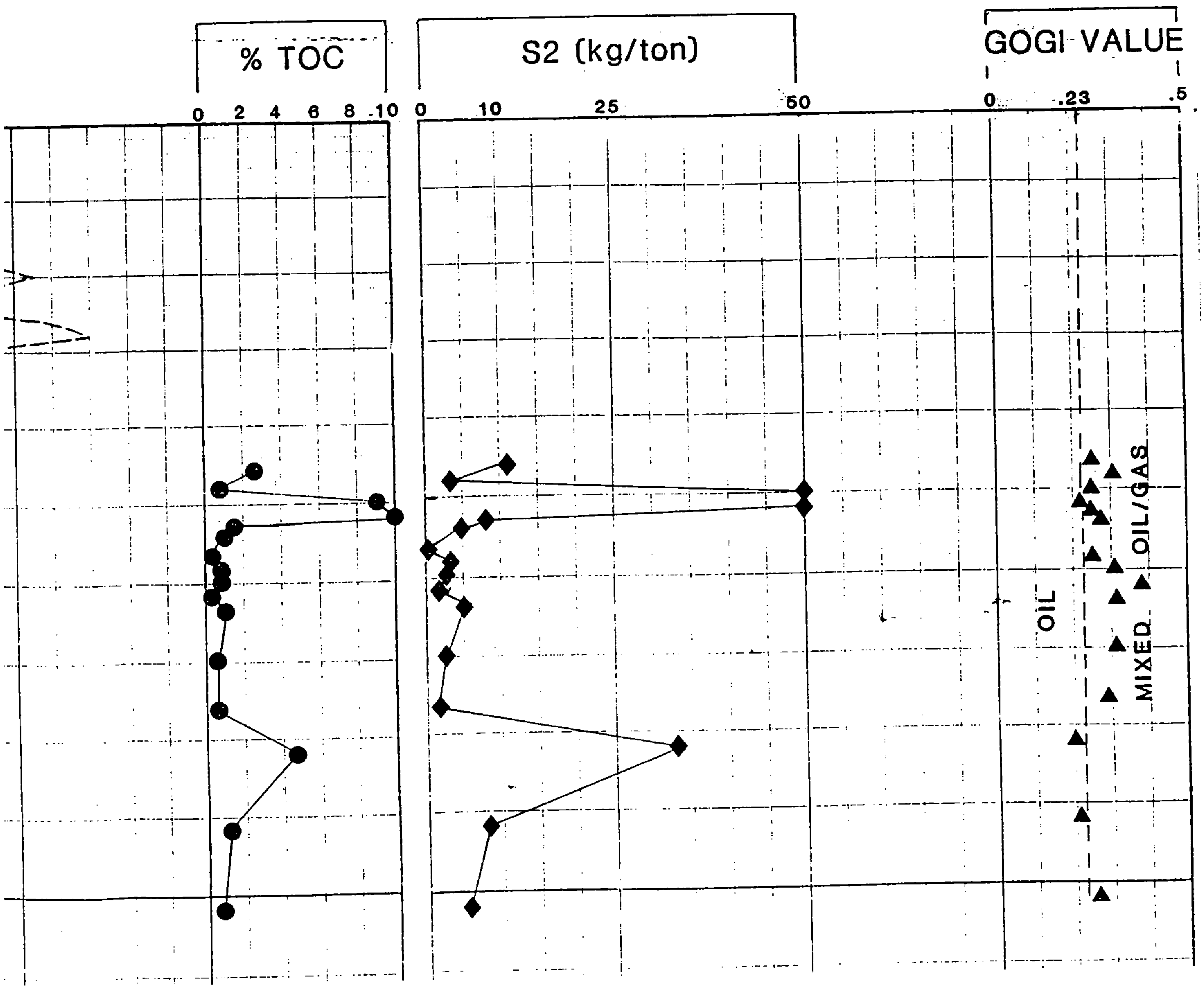


Figure 2: Comparison of the source quality data and gamma log for the Polk Creek Shale and Bigfork Chert, Stringtown Quarry, Atoka County, Oklahoma.

OOL UNITS

GAPI
GAPI
GAPI
CPS
CPS
CPS

10.
CPS
10.
CPS
10.
CPS



SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : ATOKA
LOCATION : SEC16,1S12E
WELL/SITE : STRINGTOWN QU.SMPLS
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
46	FSC364	OC	ORD	POLK	SH	4		2.20	2.14	.44	11.07	503
[illegible]	[illegible]5	OC	ORD	POLK	SH,V.CALC	28		.71	1.36	.13	3.51	494
						10		9.14	8.32	4.35	65.35	715
52	FSC367	OC	ORD	POLK	SH			10.48	8.63	5.21	75.83	724
53	FSC368	OC	ORD	BGFK	CHT	4		1.67	3.66	.51	8.02	480
54	FSC369	OC	ORD	BGFK	LST,ARG	80		.92	2.39	.24	4.51	490
56	FSC370	OC	ORD	BGFK	LST,V.ARG	52		.15	.66	.02	.31	207
58	FSC371	OC	ORD	BGFK	LST,V.ARG	60		.64	2.82	.45	3.60	562
60	FSC372	OC	ORD	BGFK	CHT,CALC	22		.60	1.34	.25	2.89	482
62	FSC373	OC	ORD	BGFK	CHT	5		.27	1.13	.11	1.53	567
64	FSC374	OC	ORD	BGFK	CHT	6		.98	2.13	.38	5.00	510
70	FSC375	OC	ORD	BGFK	CHT,V.CALC	32		.59	1.42	.16	2.74	464

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
46	.04	97	20	5	10.79	2.16	8.63	490	.25						
48	.04	192	18	10	4.86	1.15	3.71	685	.31						
50	.06	91	48	2	47.23	9.14	38.09	517	.24			.63			
52	.06	82	50	2	55.09	9.93	45.16	526	.22			.56			
53	.06	219	31	7	9.17	1.77	7.40	549	.24						
54	.05	260	26	10	4.36	.93	3.43	474	.27						
56	.06	440	13	33											
58	.11	441	70	6	2.69	.54	2.15	420	.25			.68			
60	.08	223	42	5	2.26	.53	1.73	377	.31						
62	.07	419	41	10	1.41	.39	1.02	522	.38						
64	.07	217	39	6	3.69	.87	2.82	377	.31						
70	.06	241	27	9	2.22	.54	1.68	376	.32						

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
76	FSC376	OC	ORD	BGFK	CHT	8		.41	1.42	.10	1.79	437
82	FSC377	OC	ORD	BGFK	CHT,V.CALC	31		4.69	7.08	3.16	33.71	719
92	FSC378	OC	ORD	BGFK	CHT,CALC	14		1.15	5.10	1.28	8.09	703
102	FSC379	OC	ORD	BGFK	CHT,CALC	13		.79	3.60	.62	5.16	653

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
76	.05	346	24	14	1.94	.44	1.50	473	.29						
82	.09	151	67	2	21.39	3.57	17.83	456	.20						
92	.14	443	111	4	6.04	1.09	4.95	525	.22						
102	.11	456	78	6	4.26	.88	3.38	539	.26						

OPEN FILE 5-96

EXPLORATION BRIEFS
&
TECHNICAL MEMORANDA

PT 2

P Z

FC... C 2

THE STANDARD OIL COMPANY

To: D. May
SPC Mid-Continent Office
Dallas

June 30, 1982

File: PGW/063082/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job: #PGW 82-25,26,27,28,29

Technical Memorandum (PGW/TM 053) - Geochemical Evaluation of Paleozoic Sections from Five Wells Drilled in the Ouachita Overthurst Belt of Northeastern Texas.

Summary: Geochemical data was obtained from Pennsylvanian Foreland rocks penetrated in the #1 Miller, #1 Moore, and #1 Armstrong wells. Although most of the Pennsylvanian sediments in these wells were concluded to have entered into either the oil or gas generation phase of thermal maturity, none showed any notable source potential. Ordovician Sylvan Fm. sediments from the #1 Armstrong showed strong indications of being the source of the hydrocarbons produced from this well. Both the #1 Beene and #1 Nina Steel wells penetrated Ouachita Facies sections. Maturity levels in these wells differed significantly. Ouachita sediments in the #1 Nina Steel reached the oil generation window while those in the #1 Beene had reached the gas generation window. In the #1 Nina Steel, intervals of the Arkansas Novaculite, Polk Creek, and Bigfork Fms. had good source potential, but at their present shallow depths these sediments were not now in the oil generation window. Moderate source potentials were assessed for intervals of the Arkansas Novaculite, Bigfork Chert, and Womble Fms. in the #1 Beene well. However, these formations were subjected to a more severe paleothermal regime and their potentials were probably significantly diminished. Although at a very advanced level of maturity, an 890 ft. interval of the #1 Beene well, including the Caney, Sycamore and Woodford Fms. , had Good to Excellent sustained organic carbon contents and showed some residual potential productivity. This suggested much better productivity prior to entering the hydrocarbon generation regime.

Page 1
PART 2

1. INTRODUCTION

This report presents the results and conclusions of a geochemical evaluation of selected intervals from five wells drilled in the Ouachita Overthrust Belt in northeastern Texas. The five wells, listed by name and location, are:

a. CSG #1 Beene, Rene Allred Survey A-13, 990' FNEL, 1800' FNWL, Grayson Co., TD - 16,348'

b. Gulf #1 Nina Steel, J. Hamilton Survey A-529, 1839' FSL, 1294' FWL, Grayson Co., TD - 3,700'

c. Humble #1 Miller, L. Searcy Survey, 110' FNL, 840' FWL, Collin Co., TD - 11,407'

d. Midwest #1 Armstrong, Carrico Survey A-255, 675' FSL, 643 FWL, Grayson Co., TD - 15,506'

e. Texaco #1 Moore, Porter M. Davis Survey A-335, 2,385' FNL, 330' FWL, Grayson Co., TD - 14,405'

2. MATERIALS AND METHODS

2.1 Materials

All of the samples obtained from the five wells were dried cuttings in intervals ranging from 10 to 120 feet. The samples obtained from each well are listed in Tables 1-5. The quantity of sample and section examined depended upon sample quality and availability.

2.2 Methods

Samples from each of the wells were screened for source richness and maturity using standardized PGW methods. Source richness screen procedures included Total Organic Carbon (TOC - bitumen free) content and pyrolysis (Rock Eval). Sediment maturity levels were assessed using whole rock vitrinite reflectance data. Hydrocarbon proneness was evaluated by using proprietary pyrolysis-gas chromatography to determine the gas/oil generation index (GOGI) for samples selected on the basis of screen data.

3. RESULTS AND CONCLUSIONS

A summary listing of the geochemical data from the five wells is presented in Tables 6-10 and Figures 1-5. Also included is a key for the Tables and Figures which is listed as Appendix 1.

Each of the wells will be discussed separately in the following text.

Because of limited availability of materials from the #1 Miller, the #1 Moore and the #1 Armstrong wells, sample selection and geochemical interpretation were directed toward the assessment of maturity levels, only.

3.1 Humble #1 Miller

A summary listing of the geochemical data for this well is given in Table 6.

3.1.1 The #1 Miller penetrated only Foreland rocks and encountered a diabase sill in the Ellenburger Group rocks (Kinblade Fm.). The well was plugged as a dry hole with a minor gas show in the Ellenburger interval.

3.1.2 Although this well was drilled to 11,154 ft., because of limited sample availability, and the non-source lithologies penetrated (abundant limestones and sandstones below 8,650 ft.), only the Pennsylvanian interval was examined for source potential with emphasis on the level of maturity. Samples representing 5,320 ft. of Pennsylvanian sediments occurring between 3,330 and 8,650 ft. in the well were examined. These included about 2,540 ft. of undifferentiated upper Pennsylvanian rocks (3,330 - 5,873 ft.) and about 2,780 ft. of Atoka Fm. sediments (5,873 - 8,650 ft.).

3.1.3 Reasonably good vitrinite reflectance data was obtained from the #1 Miller cuttings samples and was used to construct a thermal maturity profile for the well (Figure 1). The Pennsylvanian sediments were shown to span the oil generation window, with R_o values ranging from 0.66 to 0.97% and increasing with depth. Extrapolation of the profile indicated that the gas generation threshold occurred at about 8,700 ft.

3.1.4 Although in the oil generation window, none of the Pennsylvanian sediments penetrated showed any indications of being source rocks. Total Organic Carbon (TOC) contents were only in the Marginal to Moderate range (0.35 - 0.79 wt %) and the sediments showed no significant hydrocarbon potential upon pyrolysis, with S2 yields no greater thn 0.25 kg/ton. This could not be ascribed to an advanced maturity (i.e. spent) effect with reflectances not exceeding R_o 1.0%. Hydrogen Indices were invariably low ($HI \leq 35$ kg/ton) and suggested rather unproductive kerogen assemblages.

3.2 Texaco #1 Moore

A summary listing of the geochemical data for this well is given in Table 7.

3.2.1 The #1 Moore penetrated Foreland rocks overlaid by poorly sorted detrital sediments postulated to be early Ouachita Facies erosional debris. Hydrocarbon shows were reported from the Pennsylvanian Baker, Atoka, Davis and Cardell sands and the Ordovician Oil Creek and Joins Fms., but the well was plugged and abandoned as a dry hole. The well TD'd at 14,405 ft. Sample availability was also limited for this well and efforts were concentrated on the Pennsylvanian sediments. These included: Ouachita (?) alluvium (2,800 - 4,460 ft.), Ouachita (?) chert conglomerate (4,460 - 7,562 ft.), the Strawn Fm. (7,562 - 8,765 ft.), the Baker Sandstone (8,765 - 9,240 ft.), and the Atoka Fm. (9,240 - 11,960 ft.).

3.2.2 A thermal maturity profile developed from the vitrinite reflectance data (Figure 2) showed that all of the Pennsylvanian sediments from about 7,500 ft. had attained sufficient thermal maturity to generate hydrocarbons in one form or another. The threshold of the oil generation window was placed at about 5,000 ft. and the gas generation threshold at about 10,000 ft. Sediments of the Strawn Fm., having R_o values from 0.¯9 to 0.90% with increasing depth, had reached the peak oil generation regime while most of the Atoka sediments had reached the gas generation regime (R_o's from about 1.00 to 1.19%).

3.2.3 Although most of the Pennsylvanian sediments were in the hydrocarbon generation window, few of them had sufficient organic carbon contents to be considered as source rocks and were concluded to have no source potential. Only an interval of Ouachita alluvium at 2,800 - 2,860 ft. had a noteable TOC content (1.06 wt %) and potential productivity (S2 = 1.78 kg/ton). However, the interval was well above the oil generation threshold (R_o of 0.40%) and concluded to be of no commercial significance. Atoka Fm. Hydrogen Indices were again generally indifferent (HI << 70 kg/ton) and thought to be representative of non-productive kerogen assemblages.

3.3 Midwest #1 Armstrong

A summary listing of geochemical data for this well is given in Table 8.

3.3.1 This well was initially a Ouachita Facies test drilled in the authochthonous block but very near the Ouachita Thrust Fault plane. It penetrated pre-Stanley Ouachita rocks to 3,140 ft. where the thrust contact with Foreland Facies rocks was encountered. The well, which bottomed in Pennsylvanian Atoka sediments (9,347 ft.), was initially a dry hole with only an oil show in the Womble Fm. penetrated between 2,950 and 3,140 ft. The hole was re-entered and drilled through Pennsylvanian and Ordovician Foreland rocks to 15,506 ft., encountering oil and gas in the Pennsylvanian sediments. The #1 Armstrong was subsequently completed as a producing well with production from the Pennsylvanian Armstrong Sand (10,766 - 10,787 ft.), the New Years Eve Sand (11,190 - 11,198 ft.), and the Woodlake Lime (11,535 - 11,885 ft.). Initial production flowed 104 BPD of 50° API oil (GOR 2911:1) from the Armstrong, 286 BPD of 50° API oil (GOR 1740:1) from the New Years Eve, and 457 BPD of 49° API oil (GOR 1777:1) from the Woodlake Lime.

3.3.2 Sample availability for this well was very limited and those samples obtained were of relatively poor quality.

3.3.3 There was a scarcity of vitrinite in the sediments which, in addition to the poor sample quality, hampered efforts to establish a thermal maturity profile for the well. Only three good R_o determinations could be made from the samples. One of these was made on vitrinite-like organic matter in an Ordovician Sylvan Fm. sample. With the limited data available, a very tentative maturity profile only could be established for the well (Figure 3). The oil and gas generation thresholds were placed at about 9, 980 and 11,500 ft., respectively. Both the Armstrong and New Years Eve producing intervals were well into the oil generation window and the Woodlake Lime interval extended from the bottom of the oil window into the gas generation window. All of these producing intervals were in the mature to very mature hydrocarbon generation regime. The high API gravity oils and high associated gas to oil ratios (GOR's) reported for the well would be expected because of the advanced level of maturity at which the reservoir rocks existed.

3.3.4 None of the Pennsylvanian sediments analyzed showed any clear indications of being the source of the reservoired hydrocarbons in this well. Although TOC contents in the Pennsylvanian sediments were Moderate to Good (0.71 to 1.48 wt %), none of the sediments showed any noteable potential productivity (S2). The absence of any significant S2 pyrolysate indicated either the presence of an abundance of reworked organic matter or depletion of the organic matter potential due to advanced maturity. However, the sediments were not assessed to be overmature thus suggesting that the organic matter was probably reworked and that these Pennsylvanian sediments were never significant source rocks. Atoka Fm. Hydrogen Indices were low as in the case of the previous two wells. These conclusions point toward a deeper source for the hydrocarbons in this well.

3.3.5 Samples of the Ordovician Sylvan Fm. from 12,400 to 12,510 ft. had Good TOC contents averaging about 1.07 wt %. Although not significant, they also showed some residual potential productivity (0.25 - 0.41 kg/ton). The Sylvan sediments were assessed to be well into the gas generation regime. Residual potential at this level of maturity implied that the Sylvan had better source potential prior to entering the hydrocarbon generation regime.

3.3.6 Although not conclusive, the geochemical data suggested that the Sylvan sediments should be considered as a possible source for the hydrocarbons reservoired in the overlying Pennsylvanian sediments. In addition, there appeared to be a sufficient volume of rich Sylvan sediments present to have sourced these hydrocarbons.

3.3.7 In conclusion, the close proximity of the well to a major thrust fault and the absence of any potential productivity in the Pennsylvanian sediments analyzed supported a deeper source hypothesis for the hydrocarbons in the #1 Armstrong. This source may have been the Sylvan Fm. however, no definitive assessment of its source potential could be made because of the advanced stage of maturity attained by the formation.

3.4 C.S.G. #1 Beene Well

A summary listing of the geochemical data for this well is given in Table 9.

3.4.1 The #1 Beene well penetrated both Ouachita and Foreland Facies rocks. The well was a dry hole but had hydrocarbon shows in the Arkansas Novaculite, Polk Creek, Womble, Sycamore and Basal Oil Creek formations. It TD'd at 16,348 feet in Ellenburger Group rocks.

3.4.2 Ouachita Facies rocks penetrated included the Mississippian Stanley Fm. (2,078 - 3,250 feet); the Devonian/Mississippian Arkansas Novaculite (3,250 - 3,760 feet); the Silurian Missouri Mountain Fm. (3,760 - 4,280 feet) and the Ordovician Polk Creek Fm. (4,280 - 4,370 feet), Bigfork Chert (4,370 - 5,007 feet), the Womble Fm. (5,007 - 10,070 feet), and the Mazarn Shale (10,070 - 10,667 feet). At 10,667 feet, a thrust to Lower Pennsylvanian Foreland rocks was encountered.

3.4.3 A vitrinite reflectance thermal maturity profile was established from R_o determinations on the Mississippian and Devonian sediments and extrapolated to the thrust fault (Figure 1). The reflectance data showed that all of the Ouachita section penetrated was mature and in the gas generation window. TAI values of 4-for lower Womble and Mazarn samples indicated that these rocks had begun to experience low grade thermal metamorphic conditions.

The maturity data indicated that these Ouachita sediments were buried to a much greater depth at some time in the geological past prior to the thrusting event. With the possible exception of the lower Womble and Mazarn sediment, it is doubtful that any of these sediments are presently in the hydrocarbon generation regime at their current depths. Any significant hydrocarbon generation would have taken place prior to the thrusting.

A discontinuity between the maturity profile for the Ouachita and Foreland rocks, representative of the thrust, is shown on Figure 1.

3.4.4 The Foreland Facies sediments penetrated were at very advanced levels of maturity. Reflectance measurements on the Mississippian Caney and Sycamore, and Devonian Woodford sediment samples ranged from 1.47 to 1.81% with increasing depth. The overburden created by the thrusting of the Ouachita allochthon probably contributed substantially to the maturation of these Foreland rocks. However, from the data obtained it was impossible to determine to what extent the Foreland sediments had matured prior to the overthrusting event.

3.4.5 Although all of the Ouachita Facies sediments examined from the #1 Beene well were in the gas generation window, several intervals of the Arkansas Novaculite, Bigfork Chert and Womble formations showed residual hydrocarbon generating capability. This suggested that the sediments had better source potential prior to entering the hydrocarbon generation regime of thermal maturity.

3.4.6 Three intervals of the Arkansas Novaculite between 3,560 and 3,680 feet had Good TOC contents ranging from 1.38 to 1.78 wt %. Potential productivities (S2) for the intervals ranged from 1.28 to 1.81 kg/ton. These intervals were probably responsible for the hydrocarbon shows reported in the formation during drilling. They may have had commercial significance prior to entering the peak oil generation regime, however apparently no significant quantities of hydrocarbons were ever trapped. The sediments are now only of marginal source potential and of no commercial significance.

3.4.7 Similar statements can be made for Bigfork Chert intervals at 4,371 - 4,400; 4,490 - 4,520; 4,730 - 4,760; and 4,910 - 5,007 feet, respectively. TOC contents were in the Moderate to Excellent range (0.88 -3.41 wt %) but potential productivities for these intervals were marginal to moderate (0.41 - 1.94 kg/ton). This further corroborated the 1.00+ reflectance values determined for the Ouachita section in the well and indicated that the source potential of these sediment intervals had significantly diminished with maturation.

3.4.8 The Womble interval in this well (5,007 - 10,007 feet) was surprisingly lean. Only the upper 320 feet of the formation had any substantial organic carbon content. TOC contents ranged from 0.70 to 1.92 wt %. All of the remaining intervals had TOC contents of less than 0.60 wt %, with a majority of the intervals being less than 0.40 wt %. the 5,007 - 5,120 foot interval had TOC contents in excess of 1.00% but, as was the case with Arkansas Novaculite and Bigfork intervals, showed only marginal potential productivity as a result of advanced maturity.

3.4.9 No significant source richness was observed for the Mississippian Stanley (2,300 - 3,250 feet), Silurian Missouri Mountain (3,760-4,280 feet) or the Ordovician Polk Creek (4,280 - 4,370 feet) sediments. The Ordovician Mazarn Fm. (10,070 - 10,667 feet) showed some organic richness (TOC ranging from 0.63 to 1.32 wt %) and some residual potential productivity suggesting that the formation had better hydrocarbon generating capability prior to attaining its present advanced level of maturity.

3.4.10 Except for three intervals having Moderate TOC contents, all of the sediments from the Lower Pennsylvanian thrust (10,667 feet) to the Viola Fm. (11,610 feet) had Good to Excellent TOC contents ranging from about 1.00 to 4.36 wt %. These organically rich sections included Mississippian Caney (10,667 - 11,204 feet), Mississippian Sycamore (11,204 - 11,327 feet), Devonian Woodford (11,327 - 11,510 feet), and Ordovician Sylvan (11,510 - 11,610 feet), with TOC contents ranging between 1.14 - 3.39 wt %, 0.70 -2.94 wt %, 0.67 - 4.36 wt %, 0.95 wt %, respectively.

3.4.11 Although at a very advanced level of maturity (R_o range of 1.47 - 1.81%) residual potential productivity was observed over the entire above approximately 890 foot interval. Potential productivities were not high (0.27 - 1.37 kg/ton) but the fact that even this much potential remain in the sediments suggested that the Caney, Sycamore, Woodford and Sylvan sediments had significant source potential prior to entry into the hydrocarbon generation regime.

Hydrocarbon shows reported in the Sycamore interval could easily be attributed to any or all of the above sediments in the organically rich 10,667 - 11,510 foot section.

3.4.12 Ordovician Bromide and Oil Creek Fm. sediments had Marginal to Moderate organic carbon contents but the lack of a continuous sample interval and the advanced maturity of the sediments prevented any definitive assessment of source potential.

3.5 <u>Gulf #1 Nina Steel</u>

A summary listing of geochemical data for this well is given in Table 10.

3.5.1 The #1 Nina Steel penetrated Ouachita Facies rocks to a depth of 3,700 ft. bottoming in the Womble Fm. The well was drilled through a thrust sheet to 1,700 ft. penetrating Mississippian Stanley sediments to 1,314 ft. and Mississippian/ Devonian Arkansas Novaculite from 1,314 to 1,700 ft. From 1,700 ft. a typical Ouachita Facies succession was encountered which included Stanley Fm. rocks (1,700 - 2,200 ft.); Arkansas Novaculite (2,200 - 2,361 ft.); Silurian Missouri Mountain sediments (2,361 - 2,660 ft.); and Ordovician Polk Creek (2,660 - 2,748 ft.), Bigfork (2,748 - 3,134 ft.), and Womble Fm. (3,134 - 3,700 ft.) rocks. Hydrocarbon shows were reported in the Arkansas Novaculite, Bigfork Chert, Missouri Mountain and Womble Fms. The well was reported to have blown out in the Womble, but flow declined rapidly.

3.5.2 Extrapolation of the thermal maturity profile established from reflectance data indicated that all of the sediments penetrated in the well had passed into the oil generation window. Data sets for the pre-Novaculite interval are best described as vitrinite-like phytoclasts. Both the Stanley and Novaculite sediments in the thrusted upper 1,700 ft. of the well and the undisturbed Stanley and Novaculite were at incipient/early maturity. The Silurian and Ordovician sediments were more mature and at 3,700 ft. the Womble sediments were entering the peak oil generation regime. With their present overburdens, none of these sediments were concluded to be currently in the hydrocarbon generation regime. Maturation of the sediments probably occurred prior to Ouachita Tectonic activity.

3.5.3 Most of the Stanley sediments in the well had Marginal to Moderate TOC contents and showed lean to marginal potential productivity despite having only reached incipient/early maturity. However, an approximately 100 ft. interval between 1,220 and 1,314 ft. had Good TOC contents and showed Moderate potential productivities averaging about 1.16 wt % and 1.44 kg/ton, respectively. Based on these data this basal Stanley interval was assessed to be of marginal source potential. On the whole the Stanley sediments encountered in this well were surprisingly rich. A Gas/Oil Generation Index (GOGI) of 0.53 indicated that the basal Stanley sediments would probably be both oil and gas prone in the peak generation regime.

3.5.4 Good sustained TOC contents were observed for the Arkansas Novaculite in both the 1,314 - 1,700 ft. and the 2,200 - 2,361 ft. intervals penetrated in the well. TOC contents ranged from about 0.90 to 1.62 wt % for the intervals examined. The Novaculite samples also showed Moderate to Good potential productivities, generally in excess of 1 kg/ton but as high as 5.29 kg/ton. The 1,314 - 1,700 ft. interval of the Novaculite was especially productive having approximately 325 feet of sediments with S2's greater than 2.50 kg/ton. From these data the Novaculite was concluded to be a good, early mature hydrocarbon source.

GOGI's between 0.34 and 0.38 suggested that these sediments would be both oil and gas prone, leaning toward oil proneness at peak generation. Hydrogen indices (HI) in excess of 200 kg/ton for most of the intervals indicated in abundance of primary organic matter with good convertibility into hydrocarbons. Overall, the 1,314 - 1,700 ft. interval of Novaculite was far richer than the thinner 2,200 - 2,361 ft. interval possibly indicating a variety of lithotypes not uncommon in this formation.

3.5.5 The Ordovician Polk Creek sediments (2,660 - 2,748 ft.) were assessed to be good, early mature source rocks. These sediments averaged 1.74 wt % TOC and 4.35 kg/ton of potential productivity. A GOGI of 0.34 indicated that the sediments had both oil and gas prone potential leaning toward oil proneness. Occupying approximately 90 ft. of the stratigraphic column, the Polk Creek sediments could be significant commercial source rocks in the vicinity of this well.

3.5.6 Good sustained organic carbon contents, ranging from 0.90 to 1.88 wt %, were exhibited by approximately 215 ft. of Ordovician Bigfork Chert sediments in the 2,920 - 3,134 ft. interval of the well. The samples in this interval also showed good potential productivities ranging from 2.26 to 6.02 kg/ton. These data supported a conclusion that the basal Bigfork had good source potential. GOGI's of 0.38 and 0.49 suggested that this potential was of mixed oil and gas type. Hydrogen indices in excess of 250 kg/ton indicated good convertibility of the organic matter into hydrocarbons. These factors, plus the volume of rich sediments present, led to the assessment of good commercial source potential for the Bigfork in the vicinity of the well.

3.5.7 Only the upper thirty feet of the Ordovician Womble Fm. (3,134 - 3,160 ft.) showed any indication of source richness or potential. The interval had a TOC content of 1.25 wt % and a potential productivity of 2.37 kg/ton. From these data the interval was assessed to have moderate source potential. However, in the author's opinion, none of the Womble sediments examined exhibited the kind of potential necessary to overpressure the formation and cause the well to blow out. The lower Bigfork sediments were a much more likely candidate to have sourced the hydrocarbons responsible for the blow out.

Frank A. Marsek
F. A. Marsek

FAM:bes
Figures (5)
Tables (10)
Appendices (1,2)

cc: H. G. Bassett
J. G. Grasselli
E. Luttrell (4)
R. Burwood
R. Drozd
PCW Files (0), (2-5)

Work by: S. Adams
G. Cole
R. Lukco
I. Penfield

APPENDIX 1

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. LST.	} 0-10% qualifying component
SH. CALC LST. ARG	} 11-25% qualifying component
SH. V. CALC LST. V. ARG	} 26-50% qualifying component

<u>Carbonate</u> (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

<u>ELECTRIC LOG/WELL DATA (Track 2)</u>

<u>ELOG</u> (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

<u>Casing</u> (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

<u>Test</u> (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

<u>SOURCE RICHNESS SCREEN (Track 3)</u>

<u>TOC</u> (9): % Total Organic Carbon (bitumen-free)

<u>TSE</u> (10): ‰ Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

<u>S1</u> (11): ‰ Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^{\circ}C$) - Kg/Tn.

<u>S2</u> (12): ‰ Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval $300-550^{\circ}C$) - Kg/Tn.

<u>HI</u>: ‰ Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

<u>TR</u>: Transformation Ratio $\frac{S1}{S1 + S2}$

<u>Visual Kerogen Description</u> (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

<u>SOURCE MATURATION (Track 4)</u>

<u>GI (TSE)</u>(14): ‰ Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

<u>GI (S1)</u>(15): ‰ Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

<u>TSE/S1</u>: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

<u>KPI</u> (16): ‰ Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

<u>K2</u> (17) ‰ Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

<u>K2(G)</u>: ‰ Potential Productivity - Pyrolytic Hydrocarbon yield as Gas ($C_1 - C_5$) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

COGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

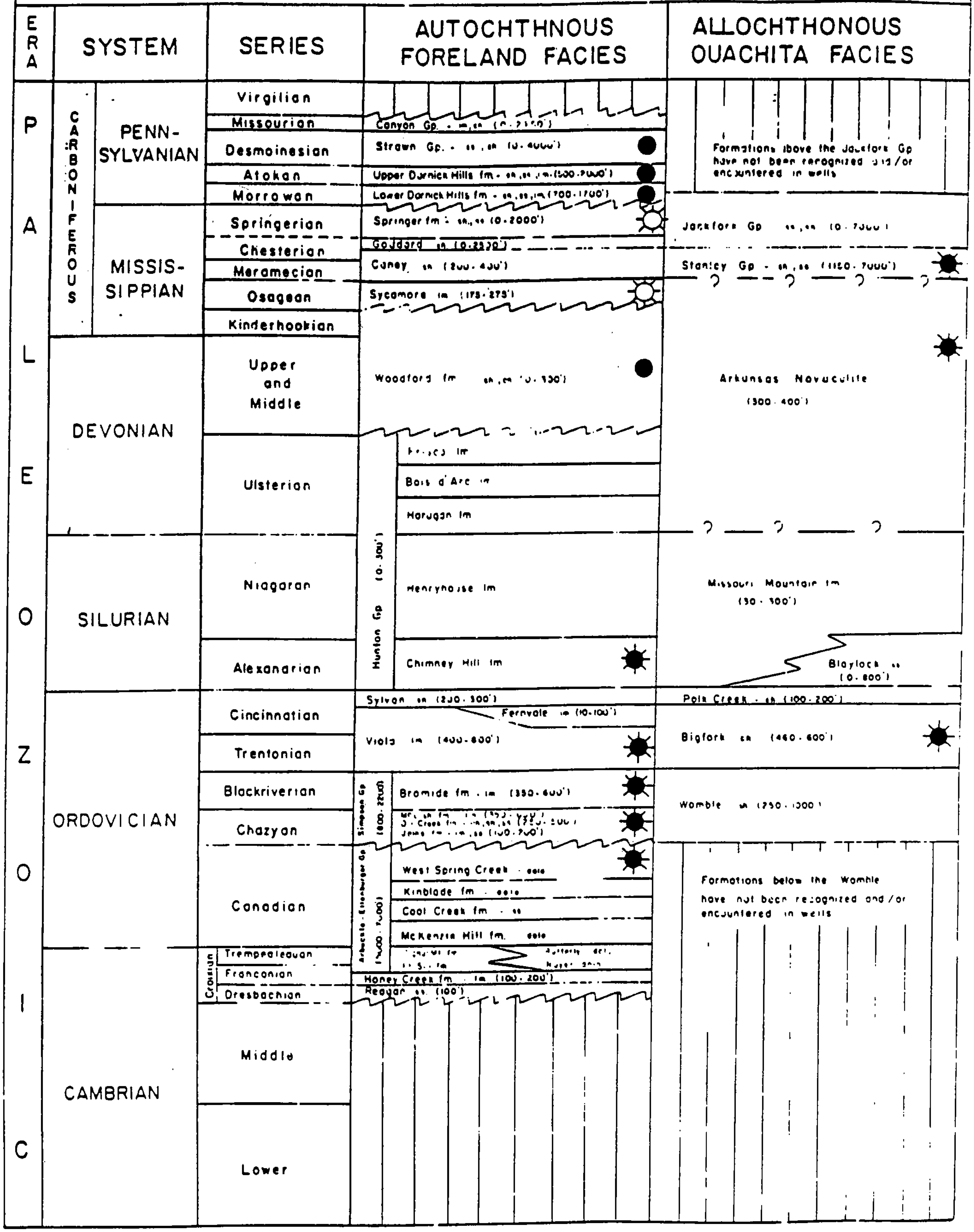
D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

FORMATION LEGEND

ATOK - Atoka
JOIN - Joins
ELLE - Ellenburger
KINB - Kinblade
COOL - Cool Creek
STRA - Strawn
BAKE - Baker Sand
VIOL - Viola
SIMP - Simpson Group
MCLI - Mclish
OLCK - Oil Creek
ARMS - Armstrong Sand
NYEV - New Years Eve Sand
MORR - Morrow
WDLK - Woodlake Lime
SYLV - Sylvan
BROM - Bromide
STAN - Stanley
ARKN - Arkansas Novaculite
MOMT - Missouri Mountain
POLK - Polk Creek
BGFK - Bigfork
WOMB - Womble
MAZN - Mazarn
WOOD - Woodford
HUNT - Hunton Group

Correlation of the Paleozoic Formations of the Autochthonous Foreland Facies and the Allochthonous Ouachita Facies of Northeast Texas and Southeast Oklahoma.



Reproduced from Stratigraphic Chart of Ouachita Overthrust (D. May, Sohio Petroleum Company, Mid Continent Region)

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

WELL : HUMBLE#1 MILLER

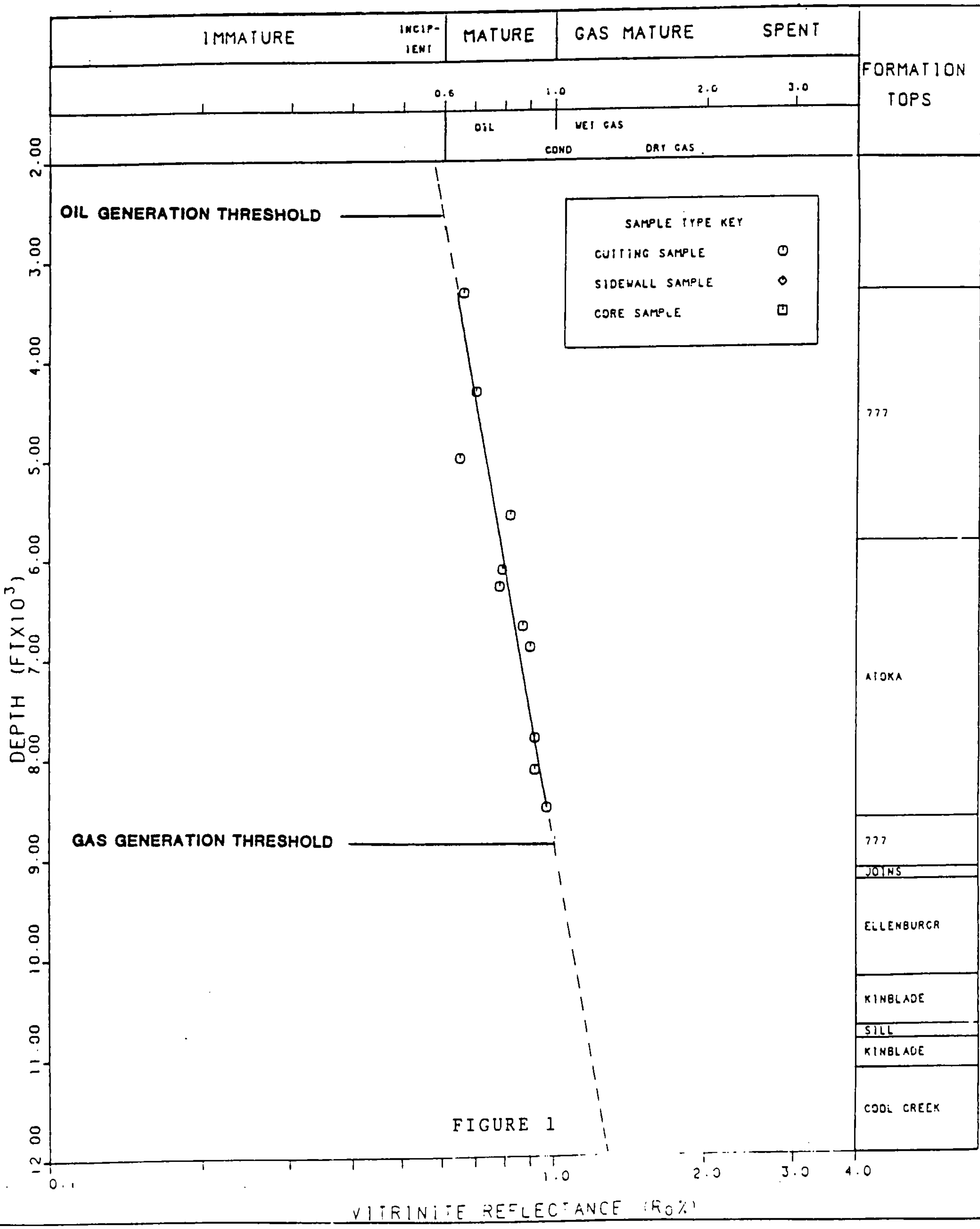
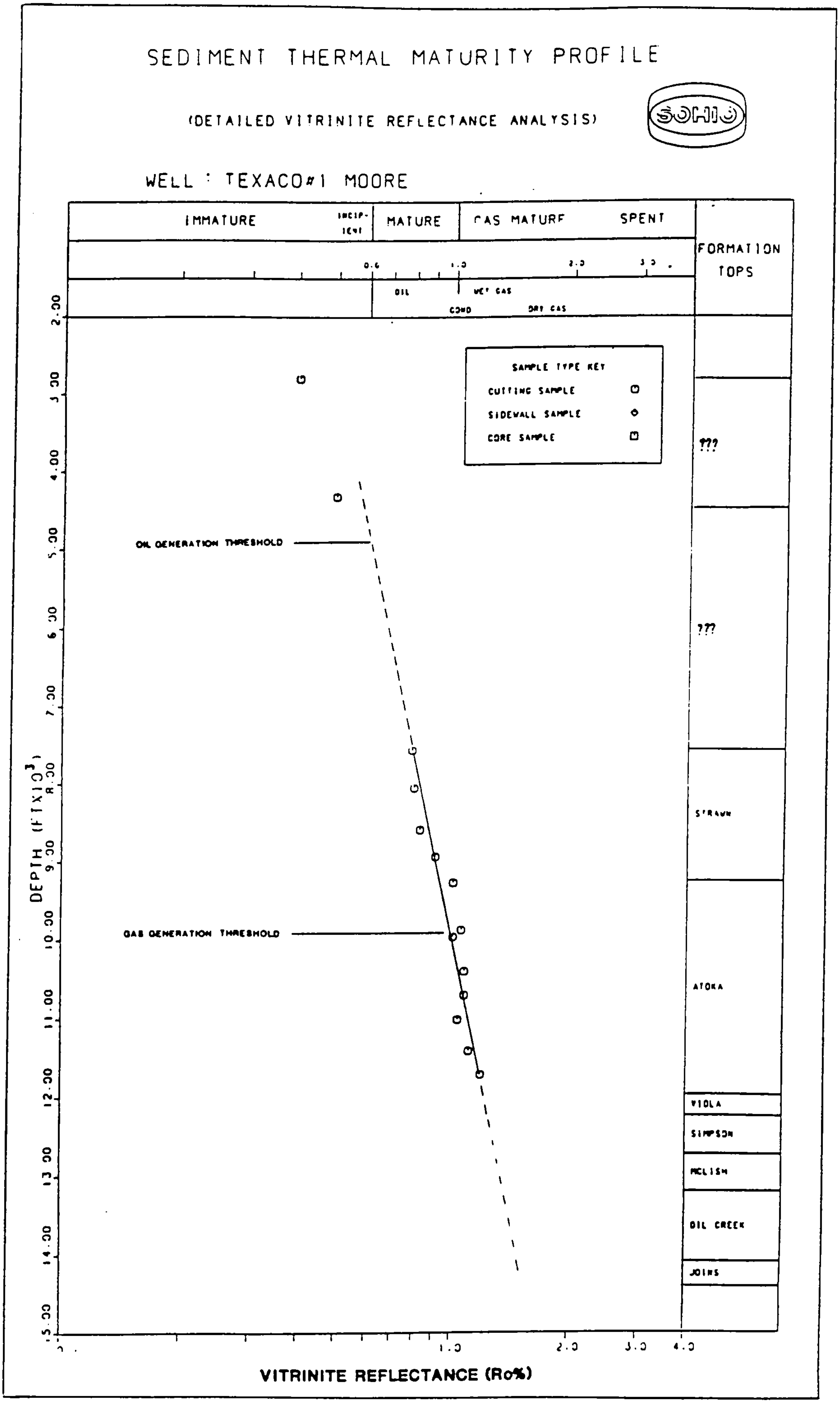


FIGURE 1



SEDIMENT THERMAL MATURITY PROFILE
(DETAILED VITRINITE REFLECTANCE ANALYSIS)
SOHIO
WELL : TEXACO#1 MOORE
IMMATURE
INCIP-IENT
MATURE
GAS MATURE
SPENT
0.6
1.0
2.0
3.0
OIL
WET GAS
COND
DRY GAS
FORMATION TOPS
SAMPLE TYPE KEY
CUTTING SAMPLE
SIDEWALL SAMPLE
CORE SAMPLE
OIL GENERATION THRESHOLD
GAS GENERATION THRESHOLD
???
???
STRAWN
ATOKA
VIOLA
SIMPSON
MCLISH
OIL CREEK
JOINS
DEPTH (FTX10^3)
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
1.0
2.0
3.0
4.0
VITRINITE REFLECTANCE (Ro%)

FIGURE 2

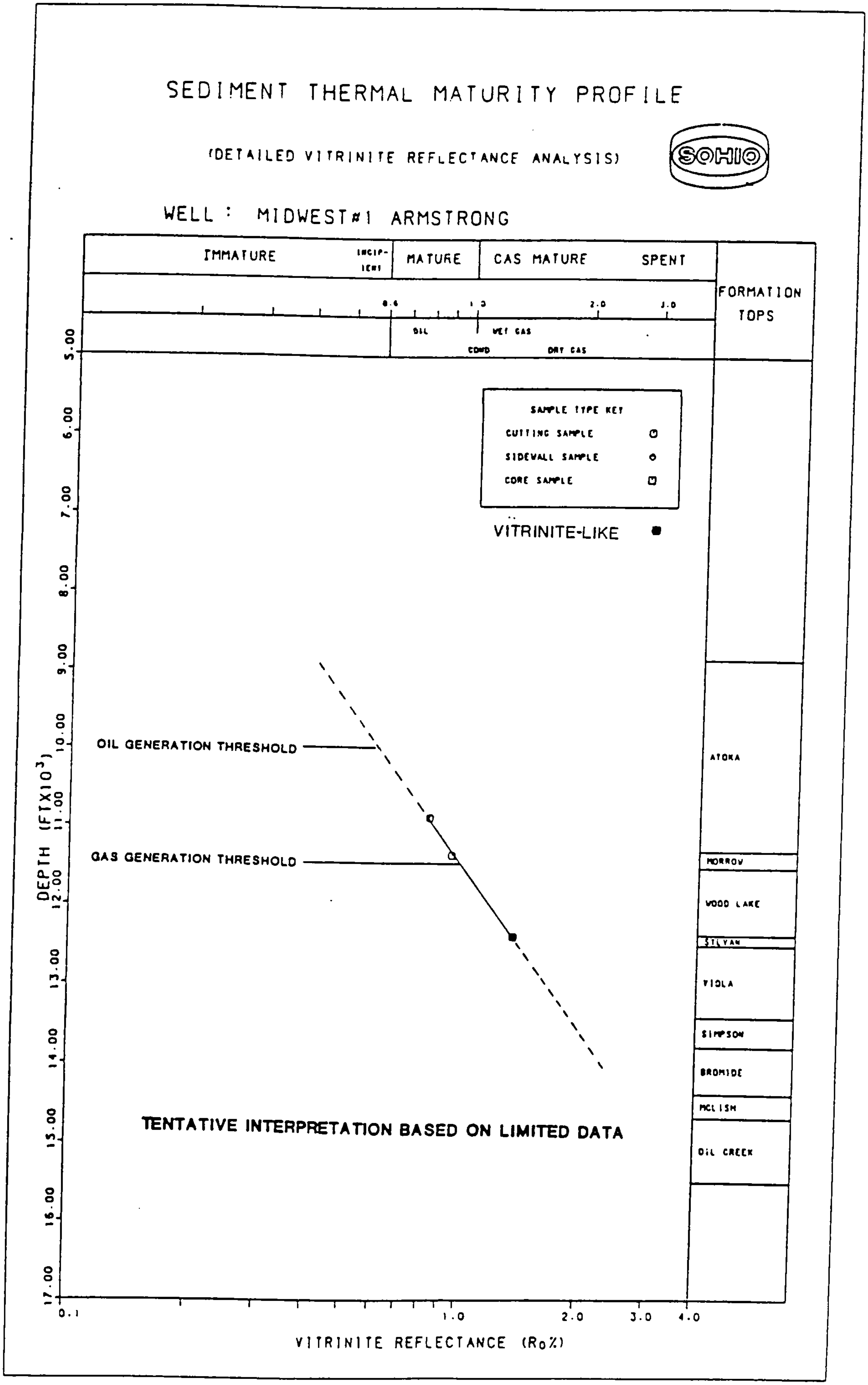

SEDIMENT THERMAL MATURITY PROFILE
(DETAILED VITRINITE REFLECTANCE ANALYSIS)
SOHIO
WELL : MIDWEST#1 ARMSTRONG
IMMATURE
INCIPIENT
MATURE
GAS MATURE
SPENT
FORMATION TOPS
OIL
WET GAS
COND
DRY GAS
SAMPLE TYPE KEY
CUTTING SAMPLE
SIDEWALL SAMPLE
CORE SAMPLE
VITRINITE-LIKE
OIL GENERATION THRESHOLD
GAS GENERATION THRESHOLD
TENTATIVE INTERPRETATION BASED ON LIMITED DATA
ATOKA
MORROW
WOOD LAKE
SYLVAN
VIOLA
SIMPSON
BROMIDE
MCLISH
OIL CREEK
DEPTH (FTX10^3)
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
0.1
1.0
2.0
3.0
4.0
VITRINITE REFLECTANCE (Ro%)

FIGURE 3

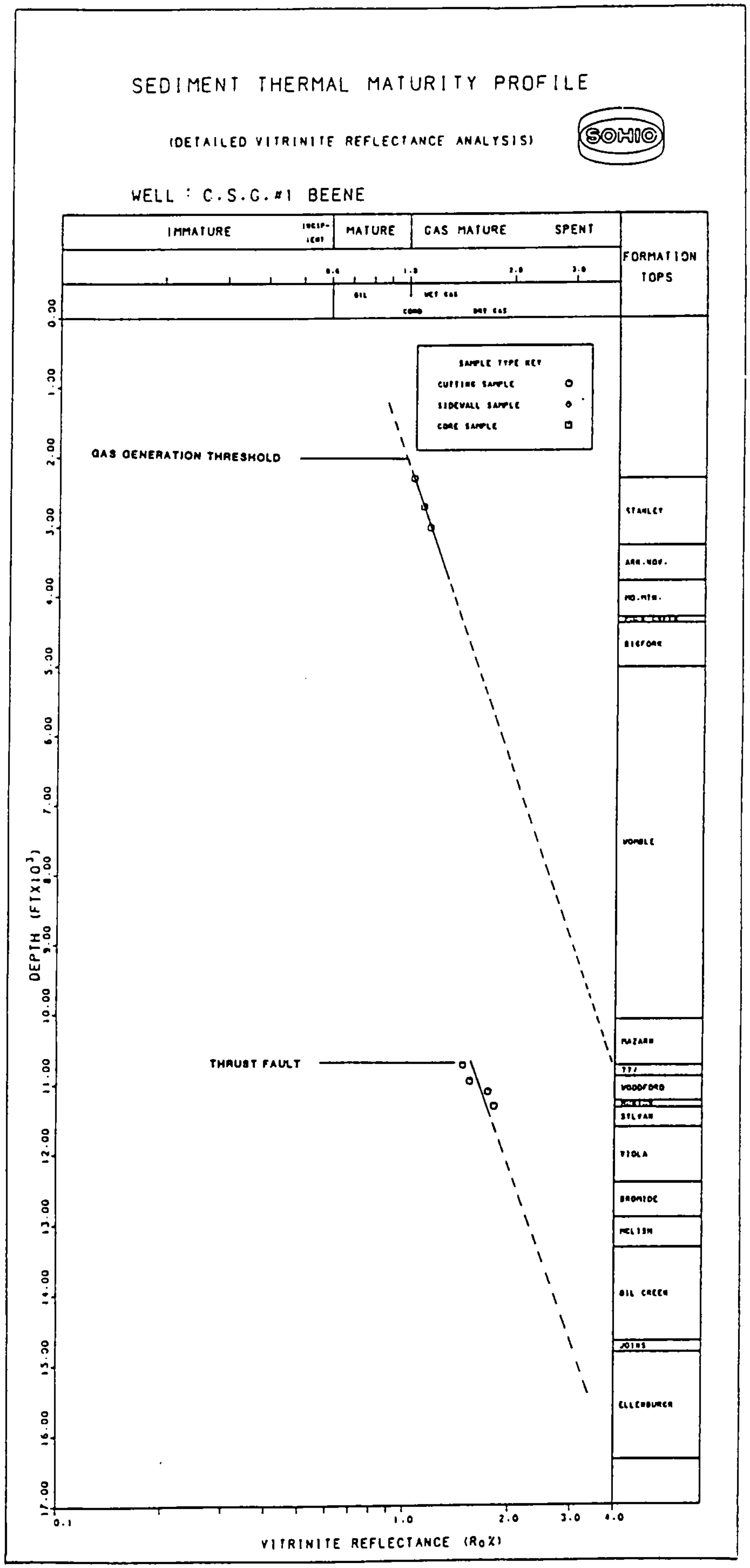
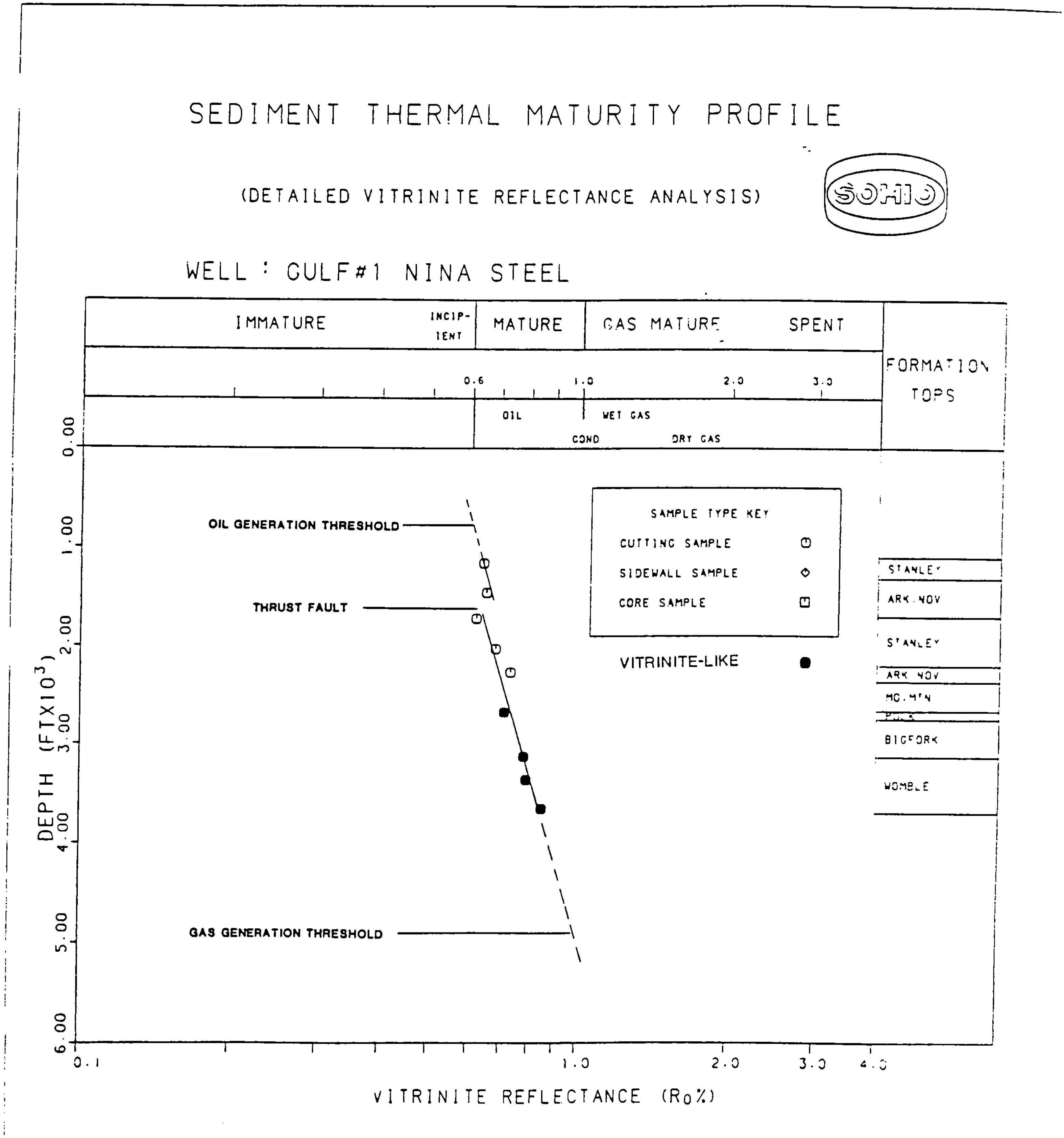

SEDIMENT THERMAL MATURITY PROFILE
(DETAILED VITRINITE REFLECTANCE ANALYSIS)
SOHIO
WELL : C.S.G.#1 BEENE
IMMATURE
MATURE
GAS MATURE
SPENT
FORMATION TOPS
GAS GENERATION THRESHOLD
THRUST FAULT
DEPTH (FTX10^3)
VITRINITE REFLECTANCE (Ro%)
STANLEY
BIGFORK
WOMBLE
WOODFORD
SYLVAN
VIOLA
BROMIDE
MCLISH
OIL CREEK
JOINS
ELLENBURGER

FIGURE 4



SEDIMENT THERMAL MATURITY PROFILE
(DETAILED VITRINITE REFLECTANCE ANALYSIS)
SOHIO
WELL : GULF#1 NINA STEEL
IMMATURE
INCIP-IENT
MATURE
GAS MATURE
SPENT
FORMATION TOPS
0.6
1.0
2.0
3.0
OIL
WET GAS
COND
DRY GAS
OIL GENERATION THRESHOLD
THRUST FAULT
GAS GENERATION THRESHOLD
SAMPLE TYPE KEY
CUTTING SAMPLE
SIDEWALL SAMPLE
CORE SAMPLE
VITRINITE-LIKE
STANLEY
ARK.NOV
STANLEY
ARK NOV
MO.MTN
BIGFORK
WOMBLE
DEPTH (FTX10³)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
0.1
1.0
2.0
3.0
4.0
VITRINITE REFLECTANCE (Ro%)

FIGURE 5

TABLE 1

Humble #1 Miller		Collin County, Texas	
Sampling Intervals	Continuous Samples	Sampling Intervals	Continuous Samples
3330 - 3350	3330 - 3350		
3360 - 3390	3360 - 3450		
3390 - 3420	↓		
3420 - 3450	↓		
4330 - 4360	4330 - 4360		
5000 - 5030	5000 - 5090		
5030 - 5060	↓		
5060 - 5090	↓		
5580 - 5600	5580 - 5600		
5770 - 5800	5770 - 5800		
6130 - 6160	6130 - 6160		
6300 - 6350	6300 - 6350		
6540 - 6570	6540 - 6570		
6700 - 6730	6700 - 6760		
6730 - 6760	↓		
6790 - 6850	6790 - 7030		
6850 - 6910	↓		
6910 - 6970	↓		
6970 - 7030	↓		
7350 - 7420	7350 - 7470		
7420 - 7470	↓		
7530 - 7590	7530 - 7590		
7820 - 7880	7820 - 7880		
8140 - 8170	8140 - 8170		
8280 - 8340	8280 - 8700		
8340 - 8400	↓		
8400 - 8460	↓		
8460 - 8520	↓		
8520 - 8580	↓		
8580 - 8640	↓		
8640 - 8700	↓		
9160 - 9170			
9420 - 9430			
10399 -			

TABLE 2

Texaco #1 Moore

Sampling Intervals	Continuous Samples
2800 - 2860	2800 - 2860
2880 - 2940	2880
2940 - 3000	↑
3000 - 3120	│
3120 - 3240	│
3240 - 3360	↓
3360 - 3480	3480
3800 - 3920	3800
3920 - 4040	↑
4040 - 4160	↓
4160 - 4220	4220
4240 - 4320	4240
4320 - 4400	↑
4400 - 4480	│
4480 - 4600	│
4600 - 4720	↓
4720 - 4840	4840
7550 - 7600	7550 - 7600
8050 - 8110	8050 - 8110
8110 - 8170	8110 - 8170
8590 - 8650	8590 - 8650
8930 - 8990	8930 - 8990
9260 - 9340	9260
9340 - 9400	↕
9390 - 9480	9480
9800 - 9860	9800
9860 - 9950	↑
9950 - 10020	↓
10020 - 10140	10140
10390 - 10490	10390 - 10490
10600 - 10690	10600
10690 - 10800	↑
10800 - 10900	│
10900 - 11000	│
11000 - 11100	│
11100 - 11200	│
11200 - 11300	│
11300 - 11400	│
11400 - 11500	│

Grayson County, Texas

Sampling Intervals	Continuous Samples
11500 - 11600	│
11600 - 11700	│
11700 - 11900	↓
11900 - 11980	11980
12140 - 12150	12140 - 12150
12640 - 12690	12640 - 12690
13090 - 13150	13090 - 13150
14240 - 14270	14240 - 14270
14360 - 14370	14360 - 14370

TABLE 3

Midwest #1 Armstrong		Grayson County, Texas	
Sampling Intervals	Continuous Samples	Sampling Intervals	Continuous Samples
10890 - 10920	10890		
10920 - 10950	↑		
10950 - 10980			
10980 - 11010			
11010 - 11040			
11040 - 11070			
11070 - 11100			
11100 - 11160	↓		
11160 - 11180	11180		
11370 - 11400	11370		
11400 - 11440	↑		
11440 - 11470			
11470 - 11500			
11500 - 11530			
11530 - 11560	↓		
11560 - 11590	11590		
11900 - 11930	11900		
11930 - 11950	11950		
12400 - 12430	12400		
12430 - 12460	↑		
12460 - 12490	↓		
12490 - 12520	12520		
14770 - 14830	14770		
14830 - 14890	14890		
14990 - 15050	14990		
15050 - 15110	15110		

TABLE 4

CSG #1 Beene — Grayson County, Texas

Sampling Intervals	Continuous Samples	Sampling Intervals	Continuous Samples
2300 - 2310	2300 - 2310	5060 - 5090	
2400 - 2430	2400 - 2430	5090 - 5120	
2700 - 2730	2700 - 2730	5120 - 5150	
3000 - 3030	3000 - 3030	5150 - 5180	
3100 - 3130	3100 - 3130	5180 - 5210	
3200 - 3230	3200 - 3230	5210 - 5240	
3260 - 3290	3260	5240 - 5270	
3290 - 3300	3300	5270 - 5300	
3310 - 3340	3310	5300 - 5330	
3340 - 3360	3360	5330 - 5360	
3370 - 3400	3370	5360 - 5390	
3400 - 3420	3420	5390 - 5420	
3430 - 3460	3430	5420 - 5450	
3460 - 3490	↑	5450 - 5480	
3490 - 3520		5480 - 5510	
3520 - 3560		5690 - 5730	
3560 - 3590		5730 - 5760	
3590 - 3620		5760 - 5790	
3620 - 3650		5790 - 5820	
3650 - 3680		5820 - 5850	
3680 - 3710		5850 - 5880	
3710 - 3740		5880 - 5910	
3740 - 3770		5910 - 5940	
3770 - 3830	↓	5940 - 5970	
3830 - 3890	3890	5970 - 6000	
3920 - 3980	3920	6000 - 6030	
3980 - 4040	4040	6030 - 6060	
4280 - 4310	4280	6060 - 6090	
4310 - 4340	↑	6090 - 6120	
4340 - 4370		6120 - 6150	
4370 - 4400		6150 - 6180	
4400 - 4430		6180 - 6210	↓
4430 - 4460		6210 - 6240	6240
4460 - 4490		6250 - 6280	6250
4490 - 4520		6280 - 6310	↑
4520 - 4550		6310 - 6340	
4550 - 4580		6340 - 6370	
4580 - 4610		6370 - 6400	
4610 - 4640		6400 - 6430	
4640 - 4670		6430 - 6460	
4670 - 4700		6460 - 6490	
4700 - 4730		6490 - 6520	
4730 - 4760		6520 - 6550	
4760 - 4790		6550 - 6580	
4790 - 4820		6580 - 6610	
4820 - 4850		6610 - 6640	
4850 - 4880		6640 - 6670	
4880 - 4910		6670 - 6700	
4910 - 4940		6700 - 6730	
4940 - 4970		6730 - 6760	
4970 - 5000		6760 - 6790	
5000 - 5030		6790 - 6820	
5030 - 5060		6820 - 6850	

TABLE 4 (con't)

CSG #1 Beene (cont'd)

Sampling Intervals	Continuous Samples	Sampling Intervals	Continuous Samples
6850 - 6880		9230 - 9260	
6880 - 6910		9260 - 9290	
6910 - 6940		9290 - 9320	
6940 - 6970		9320 - 9350	
6970 - 7000		9350 - 9380	
7000 - 7030		9380 - 9410	
7030 - 7060		9410 - 9440	
7060 - 7090		9440 - 9470	
7090 - 7120		9470 - 9500	
7120 - 7150		9500 - 9530	
7150 - 7180		9530 - 9560	
7180 - 7210		9560 - 9590	
7210 - 7270		9590 - 9620	
7270 - 7300		9620 - 9650	
7300 - 7330		9650 - 9680	
7330 - 7360		9680 - 9710	
7360 - 7390		9710 - 9740	
7390 - 7420		9740 - 9770	
7420 - 7450		9770 - 9800	
7450 - 7480		9800 - 9830	
7480 - 7510		9830 - 9860	
7510 - 7540		9860 - 9890	
7540 - 7570		9890 - 9920	
7570 - 7600		9920 - 9950	
7600 - 7630		9950 - 9980	
7630 - 7660		9980 - 10010	
7660 - 7690		10010 - 10040	
7690 - 7730		10040 - 10080	↓
7730 - 7760		10080 - 10100	10100
7760 - 7790		10110 - 10140	10110
7790 - 7820		10140 - 10170	↑
7820 - 7850		10170 - 10200	
7850 - 7880		10200 - 10230	
7880 - 7910		10230 - 10260	
7910 - 7940		10260 - 10290	
7940 - 7970		10290 - 10320	
7970 - 8000		10320 - 10350	
8030 - 8060		10350 - 10380	
8060 - 8090		10380 - 10410	
8090 - 8120		10410 - 10440	
8120 - 8150		10440 - 10470	
8150 - 8180		10470 - 10500	
8180 - 8210		10500 - 10530	
8990 - 9020		10530 - 10560	
9020 - 9050		10560 - 10590	
9050 - 9080		10590 - 10620	
9080 - 9110		10620 - 10650	
9110 - 9140		10650 - 10680	
9140 - 9170		10680 - 10710	
9170 - 9200		10710 - 10740	
9200 - 9230		10740 - 10770	
9230 - 9260		10770 - 10800	
9260 - 9290		10830 - 10860	
9290 - 9320		10860 - 10880	
		10880 - 10910	

TABLE 4 (con't)

CSG #1 Beene (cont'd) — Grayson County, Texas

Sampling Intervals	Continuous Samples	Sampling Intervals	Continuous Samples
10910 - 10940			
10940 - 10970			
10970 - 11000			
11000 - 11030			
11030 - 11060			
11060 - 11090			
11090 - 11120			
11120 - 11150			
11150 - 11180			
11180 - 11210			
11210 - 11240			
11240 - 11270			
11270 - 11300			
11300 - 11330			
11360 - 11390			
11390 - 11420			
11420 - 11450			
11450 - 11480			
11480 - 11510			
11510 - 11540			
11540 - 11570			
11570 - 11600			
11600 - 11630	11630		
11640 - 11670	11640		
11670 - 11690			
11690 - 11720			
11720 - 11750			
11750 - 11850			
11850 - 11940			
11940 - 12040			
12040 - 12140			
12140 - 12240			
12240 - 12340			
12340 - 12390	12390		
12400 - 12500	12400 - 12500		
13610 - 13640	13610		
13640 - 13680	13680		
13890 - 13920	13890 - 13920		

TABLE 5

Gulf #1 Steel

Sampling Intervals	Continuous Samples
1100 - 1130	1100
1130 - 1160	↑
1160 - 1190	
1190 - 1220	
1220 - 1250	
1250 - 1280	
1280 - 1310	
1310 - 1340	
1340 - 1370	
1370 - 1400	
1400 - 1430	
1430 - 1460	
1460 - 1490	
1490 - 1520	
1520 - 1550	
1550 - 1580	
1580 - 1610	
1610 - 1640	↓
1640 - 1670	1670
1690 - 1720	1690
1720 - 1750	↑
1750 - 1780	↓
1780 - 1810	1810
1820 - 1850	
1850 - 1880	↑
1880 - 1910	
1910 - 1940	
1940 - 1970	
1970 - 2000	
2000 - 2030	
2030 - 2060	
2060 - 2090	
2090 - 2120	
2120 - 2150	
2150 - 2180	
2180 - 2210	
2210 - 2240	
2240 - 2270	↓
2270 - 2300	2300
2340 - 2370	2340
2370 - 2400	↑
2400 - 2430	
2430 - 2470	
2470 - 2500	
2500 - 2530	
2530 - 2560	
2560 - 2590	
2590 - 2620	
2620 - 2650	
2650 - 2680	
2680 - 2710	

Grayson County, Texas

Sampling Intervals	Continuous Samples
2710 - 2740	
2740 - 2770	
2770 - 2800	
2800 - 2830	
2830 - 2860	
2860 - 2890	
2890 - 2920	
2920 - 2950	
2950 - 2980	
2980 - 3010	
3010 - 3040	
3040 - 3070	
3070 - 3100	
3100 - 3130	
3130 - 3160	
3160 - 3190	
3190 - 3220	
3220 - 3250	
3250 - 3280	
3280 - 3310	
3310 - 3340	
3340 - 3370	
3370 - 3400	
3400 - 3430	
3430 - 3460	
3460 - 3490	
3490 - 3520	
3520 - 2550	
3550 - 3580	
3580 - 3630	
3630 - 3660	↓
3660 - 3700	3700

SOHIO

PETROLEUM COMPANY
--------- -------

PETROLEUM GEOCHEMISTRY
WARRENSVILLE

HUMBLE#1 MILLER

TABLE 6

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : COLLIN
LOCATION : L.SEARCY SURVEY
WELL/SITE : HUMBLE#1 MILLER
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3330	WA9554	CTG	PENN	???	SH,CALC	13		.71		.03	.13	18
3360	WA9555	CTG										
3390	WA9556	CTG			SH,CALC	13		.38		.01	0.00	0
3420	WA9557	CTG										
4330	WA9558	CTG			SH,CALC	14		.42		.07	.15	36
5000	WA9559	CTG			SH,CALC	14		.44		.11	.20	45
5030	WA9560	CTG										
5060	WA9561	CTG			SH,CALC	14		.44		.03	.03	7
5580	WA9562	CTG			SH,CALC	23		.35		.03	.10	29
5770	WA9563	CTG			SH,CALC	13		.40		.05	.08	20
5873	XA9563		PENN	ATOK	FORM.TOP							
6130	WA9564	CTG			SH,CALC	14		.34		0.00	0.00	0
6300	WA9565	CTG			SH,CALC	13		.46		.03	.07	15
6540	WA9566	CTG			SH,CALC	12		.52		.01	.06	12
6700	WA9567	CTG			SH,CALC	12		.73		.06	.24	33
6730	WA9568	CTG										
6790	WA9569	CTG			SH,CALC	13		.69		.01	.13	19
6850	WA9570	CTG			SH,CALC	13		.79		.08	.28	35
6910	WA9571	CTG			SH,CALC	13		.64		.03	.18	28
6970	WA9572	CTG			SH,CALC	14		.62		.03	.14	23
7350	WA9573	CTG										
7420	WA9574	CTG			SH,CALC	13		.74		.02	.08	11
7530	WA9575	CTG			SH,CALC	13		.79		.05	.25	32
7820	WA9576	CTG			SH,CALC	11		.69		0.00	.08	12
8140	WA9577	CTG			SH,CALC	12		.58		.05	.21	36
8280	WA9578	CTG			SH,CALC	11		.52		.04	.18	35
8340	WA9579	CTG										
8400	WA9580	CTG			SH	10		.60		0.00	.15	25
8460	WA9581	CTG			SH,CALC	11		.55		0.00	.01	2
8520	WA9582	CTG			SH,CALC	11		.55		0.00	.20	36
8580	WA9583	CTG										
8650	XA9583		MISS	???	TOP							
8651	WA9584	CTG			SH,CALC	11		.54		0.00	.17	31
9152	XA9584		ORD	JOIN	FORM.TOP							
9270	XA958A		ORD	ELLE	FORM.TOP							
10240	XA958B		ORD	KINB	FORM.TOP							
10725	XA958C		???	SILL	DIABASE							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3330	.19		4									.66			
3360															
3390	1.00		3												
3420															
4330	.32		17									.70			
5000	.35		25									.65			
5030															
5060	.50		7												
5580	.23		9									.82			
5770	.38		12												
5873															
6130			0									.79			
6300	.30		7									.78			
6540	.14		2												
6700	.20		8									.87			
6730															
6790	.07		1												
6850	.22		10												
6910	.14		5									.90			
6970	.18		5												
7350															
7420	.20		3												
7530	.17		6												
7820	0.00		0									.92			
8140	.19		9									.92			
8280	.18		8									.95			
8340															
8400	0.00		0												
8460	0.00		0												
8520	0.00		0									.97			
8580															
8650															
8651	0.00		0												
9152															
9270															
10240															
10725															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
10859	XA958D		???	SILL BOTTOM								
11154	XA958E		ORD	COOL FORM.TOP								

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -‰	D-13C (TSE) -‰	D-13C (KPY) -‰
10859															
11154															

SOHIO

PETROLEUM COMPANY
--------- -------

PETROLEUM GEOCHEMISTRY
WARRENSVILLE

TEXACO#1 MOORE

TABLE 7

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : GRAYSON
LOCATION : PORTER DAVIS SURVEY
WELL/SITE : TEXACO#1 MOORE
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2800	WA9400	CTG	OUACH. ???		SH,CALC	36		1.06		.10	1.78	168
2880	WA9401	CTG			SH,SLTY	27		.47		.07	.30	64
2940	WA9402	CTG			MDST,CALC	19		.39		.01	.18	46
3000	WA9403	CTG			CONG,ARG	15		.57		.07	.55	96
3120	WA9404	CTG			SH,SNDY	14		.34		.07	.26	76
3240	WA9405	CTG			CONG,CHT	9		.22		.03	.07	32
3360	WA9406	CTG			CONG,CHT	9		.15		.05	.12	80
3800	WA9407	CTG			SH,CALC	14		.35		.05	.31	89
3920	WA9408	CTG			SH,CALC	21		.60		0.00	.23	38
4040	WA9409	CTG			SH,CALC	18		.73		.06	.12	16
4160	WA9410	CTG			SH,CALC	21		.71		.01	.07	10
4240	WA9411	CTG			SH,CALC	23		.87		0.00	.04	5
4320	WA9412	CTG			SH,CALC	22		.78		0.00	0.00	0
4400	WA9413	CTG			CONG,ARG	19		.63		.01	.25	40
4460	XA9413		OUACH. ???		CHT.CONG							
4480	WA9414	CTG			CONG							
4600	WA9415	CTG			CONG							
4720	WA9416	CTG			CONG							
7562	XA9416		PENN	STRA	FORM.TOP							
7563	WA9417	CTG			SH,SNDY	12		.29		0.00	0.00	0
8050	WA9418	CTG			SH,SNDY	14		.37		.09	.19	51
8110	WA9419	CTG			SH,SNDY	13		.41		0.00	.03	7
8590	WA9420	CTG			SH,SNDY	13		.34		0.00	0.00	0
8765	XA9420		PENN	ATOK	FORM.TOP							
8930	WA9421	CTG			SH,SNDY	12		.27		0.00	0.00	0
9260	WA9422	CTG			SH,SNDY	13		.47		0.00	.07	15
9340	WA9423	CTG			SH,SNDY	12		.46		0.00	0.00	0
9390	WA9424	CTG			SH,CALC	12		.42		0.00	0.00	0
9800	WA9425	CTG			SH,CALC	13		.47		0.00	0.00	0
9860	WA9426	CTG			SH,CALC	12		.56		.02	.11	20
9950	WA9427	CTG			SH,CALC	12		.63		0.00	.07	11
10020	WA9428	CTG			SH,CALC	15		.67		.06	.14	21
10390	WA9429	CTG			SH,CALC	12		.64		.10	.23	36
10600	WA9430	CTG			SH,SLTY	11		.61		.17	.35	57
10690	WA9431	CTG			SH,SLTY	10		.61		.12	.27	44
10800	WA9432	CTG			SH,SNDY	10		.59		.04	.08	14
10900	WA9433	CTG			SH,SNDY	10		.57		.04	.09	16

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2800	.05		9									.40			
2880	.19		15												
2940	.05		3												
3000	.11		12												
3120	.21		21												
3240	.30		14												
3360	.29		33												
3800	.14		14												
3920	0.00		0												
4040	.33		8												
4160	.13		1												
4240	0.00		0												
4320			0									.50			
4400	.04		2												
4460															
4480															
4600															
4720															
7562															
7563			0									.79			
8050	.32		24									.80			
8110	0.00		0												
8590			0									.83			
8765															
8930			0									.91			
9260	0.00		0									1.01			
9340			0												
9390			0												
9800			0												
9860	.15		4									1.06			
9950	0.00		0									1.01			
10020	.30		9												
10390	.30		16									1.08			
10600	.33		28												
10690	.31		20									1.08			
10800	.33		7												
10900	.31		7												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
10900	WA9433	CTG			SH,SNDY	10		.57		.04	.09	16
11000	WA9434	CTG			SH	10		.56		.02	.08	14
11100	WA9435	CTG			SH	10		.62		.10	.15	24
11200	WA9436	CTG			SH	11		.63		.08	.17	27
11300	WA9437	CTG			SH,CALC	12		.61		.11	.20	33
11400	WA9438	CTG			SH	10		.70		.14	.24	34
11500	WA9439	CTG			SH	10		.65		.15	.24	37
11600	WA9440	CTG			SH,SNDY	10		.66		.10	.18	27
11700	WA9441	CTG			SH,SNDY	10		.70		.27	.48	69
11900	WA9442	CTG			SST,V.ARG	10		.60		.14	.25	42
11960	XA9442		ORD	VIOL	FORM.TOP							
12228	XA944A		ORD	SIMP	FORM.TOP							
12640	WA9443	CTG			SH,CALC	25		.29		.03	.03	10
12718	XA9443		ORD	MCLI	FORM.TOP							
13090	WA9444	CTG			SH,CALC	20		.45		.22	.32	71
13190	XA9444			OLCK	FORM.TOP							
14087	XA944B			JOIN	FORM.TOP							
14405	XA944C	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
10900	.31		7												
11000	.20		4									1.04			
11100	.40		16												
11200	.32		13												
11300	.35		18												
11400	.37		20									1.11			
11500	.38		23												
11600	.36		15												
11700	.36		39									1.19			
11900	.36		23												
11960															
12228															
12640	.50		10												
12718															
13090	.41		49												
13190															
14087															
14405															

SOHIO

PETROLEUM COMPANY
--------- -------

PETROLEUM GEOCHEMISTRY
WARRENSVILLE

MIDWEST#1 ARMSTRONG

TABLE 8

S U M M A R Y   D A T A   F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY	:	US
STATE	:	TX
COUNTY/REGION/PROSPECT	:	GRAYSON
LOCATION	:	CARRICO SURVEY
WELL/SITE	:	MIDWEST#1 ARMSTRONG
API/OCS	:	-

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
8855	XA9445		PENN	ATOK	FORM.TOP							
10756	XA944A			ARMS	UNIT-TOP							
10871	XA944B			ARMS	UNIT-BOT							
10890	WA9445	CTG			SST,ARG	15		.71		0.00	.21	30
10920	WA9446	CTG										
10950	WA9447	CTG			SH,CALC	17		.76		0.00	0.00	0
10980	WA9448	CTG										
11010	WA9449	CTG			SH,CALC	14		.86		0.00	.16	19
11040	WA9450	CTG										
11070	WA9451	CTG			SH,CALC	19		1.09		0.00	.08	7
11100	WA9452	CTG			SH,SNDY	20		.97		.03	.15	15
11160	WA9453	CTG			SH,CALC	16		.90		.09	.24	27
11190	XA9453			NYEV	UNIT-TOP							
11200	XA945A			NYEV	UNIT-BOT							
11315	XA945B		PENN	MORR	FORM.TOP							
11370	WA9454	CTG			SH,CALC	26		1.10		0.00	0.00	0
11400	WA9455	CTG										
11440	WA9456	CTG			SH,CALC	21		1.48		.04	.16	11
11470	WA9457	CTG										
11500	WA9458	CTG			SH,CALC	23		1.48		.06	.09	6
11530	XA9458		PENN	WDLK	FORM.TOP							
11531	WA9459	CTG			SH,CALC	21		1.49		.04	.16	11
11560	WA9460	CTG										
11900	WA9461	CTG			SH,V.CALC	31		.76		.14	.24	32
11930	WA9462	CTG										
12378	XA9462		ORD	SYLV	FORM.TOP							
12400	WA9463	CTG			SH,V.CALC	31		1.10		.09	.25	23
12430	WA9464	CTG										
12460	WA9465	CTG			SH,V,CALC	30		1.05		.20	.41	39
12490	WA9466	CTG										
12510	XA9466		ORD	VIOL	FORM.TOP							
13415	XA946A		ORD	SIMP	FORM.TOP							
13790	XA946B		ORD	BROM	FORM.TOP							
14382	XA946C		ORD	MCLI	FORM.TOP							
14680	XA946D		ORD	OLCK	FORM.TOP							
14770	WA9467	CTG			SH,CALC	18		.25		0.00	0.00	0
14830	WA9468	CTG			SH,CALC	20		.46		.05	.17	35

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
8855															
10756															
10871															
10890	0.00		0									.82			
10920															
10950			0												
10980															
11010	0.00		0												
11040															
11070	0.00		0												
11100	.17		3												
11160	.27		10												
11190															
11200															
11315															
11370			0									.94			
11400															
11440	.20		3												
11470															
11500	.40		4												
11530															
11531	.20		3												
11560															
11900	.37		18												
11930															
12378															
12400	.26		8									1.35			
12430															
12460	.33		19												
12490															
12510															
13415															
13790															
14382															
14680															
14770			0												
14830	.23		10												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
14990	WA9469	CTG			SH;V.CALC	26		.42		.09	.22	52
15050	WA9470	CTG			SH;CALC	21		.30		.04	.02	7
15492	XA9470		ORD	JOIN	FORM.TOP							
15506	XA947A	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
14990	.29		21												
15050	.67		13												
15492															
15506															

SOHIO

PETROLEUM COMPANY
--------- -------

PETROLEUM GEOCHEMISTRY
WARRENSVILLE

C.S.G.#1 BEENE

TABLE 9

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY	: US
STATE	: TX
COUNTY/REGION/PROSPECT	: GRAYSON
LOCATION	: RENE ALLRED SURVEY
WELL/SITE	: C.S.G.#1 BEENE
API/OCS	: -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2300	WA9099	CTG	MISS	STAN	SH,CALC	15		.43				
2400	WA9100	CTG			SH	6		.55				
2700	WA9101	CTG			SH,CALC	11		.43				
3000	WA9102	CTG			SH	9		.58				
3100	WA9103	CTG			SH	6		.43				
3200	WA9104	CTG			CHT,ARG	6		.39				
3250	XA9104		DEV	ARKN	FORM.TOP							
3260	WA9105	CTG			CHT,ARG	17		.37				
3290	WA9106	CTG			CHT,ARG	15		.45				
3310	WA9107	CTG			SH,CHTY	35		.23				
3340	WA9108	CTG			SH,CHTY	22		.21				
3370	WA9109	CTG			SH,CHTY	8		.12				
3400	WA9110	CTG			SH,CHTY	11		.15				
3430	WA9111	CTG			SH,CHTY	16		.14				
3460	WA9112	CTG			SH,CHTY	13		.10				
3490	WA9113	CTG			SH,CHTY	15		.18				
3520	WA9114	CTG			SH,CHTY	6		.37				
3560	WA9115	CTG			CHT	7		1.58		.34	1.73	109
3590	WA9116	CTG			CHT	5		1.78		.49	1.81	102
3620	WA9117	CTG			CHT	8		.62				
3650	WA9118	CTG			CHT	6		1.38		.38	1.28	93
3680	WA9119	CTG			SH,CHTY	8		.66				
3710	WA9120	CTG			SH,CHTY	6		.50				
3740	WA9121	CTG			CHT	5		.35				
3760	XA9121		SIL	MOMT	FORM.TOP							
3770	WA9122	CTG			SH,RED							
3830	WA9123	CTG			SH,RED							
3920	WA9124	CTG			SH,RED							
3980	WA9125	CTG			SH,RED							
4280	XA9125		ORD	POLK	FORM.TOP							
4281	WA9126	CTG			SH,CHTY	4		.14				
4310	WA9127	CTG			SH,CHTY	4		.17				
4340	WA9128	CTG			SH,CHTY	6		.30				
4370	XA9128		ORD	BGFK	FORM.TOP							
4371	WA9129	CTG			SH	6		2.85		.55	1.05	37
4400	WA9130	CTG										
4430	WA9131	CTG			SH,CHTY	22		.87		.29	.43	49

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2300												1.04			
2400															
2700											3	1.11			
3000												1.16			
3100															
3200															
3250															
3260															
3290															
3310															
3340															
3370															
3400											3+	1.09			
3430															
3460															
3490															
3520															
3560	.16		22												
3590	.21		28												
3620															
3650	.23		28												
3680															
3710											3+	1.10			
3740															
3760															
3770															
3830															
3920															
3980															
4280															
4281											3+	1.13			
4310															
4340															
4370															
4371	.34		19												
4400											3+				
4430	.40		33												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
4460	WA9132	CTG										
4490	WA9133	CTG			SH,CHTY	28		.88		.32	.41	47
4520	WA9134	CTG										
4550	WA9135	CTG			CHT,CALC	23		.70				
4580	WA9136	CTG										
4610	WA9137	CTG			CHT,CALC	28		.49				
4640	WA9138	CTG										
4670	WA9139	CTG			CHT,CALC	44		.45				
4700	WA9140	CTG										
4730	WA9141	CTG			CHT,CALC	28		.96		.47	.54	56
4760	WA9142	CTG										
4790	WA9143	CTG			CHT,CALC	37		.66				
4820	WA9144	CTG										
4850	WA9145	CTG			CHT,CALC	41		.55				
4880	WA9146	CTG										
4910	WA9147	CTG			CHT,CALC	16		1.62		.56	1.01	62
4940	WA9148	CTG										
4970	WA9149	CTG			CHT,CALC	7		3.41		.86	1.94	57
5007	XA9149		ORD	WOMB	FORM.TOP							
5010	WA9150	CTG										
5030	WA9151	CTG			SH,CALC	12		1.92		.52	1.05	55
5060	WA9152	CTG										
5090	WA9153	CTG			SH	8		1.06		.26	.56	53
5120	WA9154	CTG										
5150	WA9155	CTG			SH,SNDY	12		.73				
5180	WA9156	CTG										
5210	WA9157	CTG			SH,SNDY	14		.70				
5240	WA9158	CTG										
5270	WA9159	CTG			SH,SNDY	16		.59				
5300	WA9160	CTG										
5330	WA9161	CTG			SH,SNDY	16		.49				
5360	WA9162	CTG										
5390	WA9163	CTG			SH,CALC	13		.37				
5420	WA9164	CTG										
5450	WA9165	CTG			SH,CALC	12		.33				
5480	WA9166	CTG										
5510	WA9167	CTG			SH,CALC	12		.37				
5540	WA9168	CTG										
5570	WA9169	CTG			SH,CALC	14		.33				
5600	WA9170	CTG										
5630	WA9171	CTG			SH,CALC	12		.31				
5660	WA9172	CTG										
5690	WA9173	CTG			SH,CALC	13		.29				
5730	WA9174	CTG										
5760	WA9175	CTG			SH,CALC	14		.27				
5790	WA9176	CTG										
5820	WA9177	CTG			SH,CALC	14		.28				
5850	WA9178	CTG										
5880	WA9179	CTG			SH,CALC	13		.33				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
4460															
4490	.44		36												
4520															
4550															
4580															
4610															
4640															
4670															
4700															
4730	.47		49												
4760															
4790															
4820															
4850															
4880															
4910	.36		35												
4940															
4970	.31		25												
5007															
5010															
5030	.33		27												
5060															
5090	.32		25												
5120															
5150															
5180															
5210											3				
5240															
5270															
5300															
5330															
5360															
5390															
5420															
5450															
5480															
5510											3				
5540															
5570															
5600															
5630															
5660															
5690															
5730															
5760											3				
5790															
5820															
5850															
5880															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5910	WA9180	CTG										
5940	WA9181	CTG			SH,CALC	16		.39				
5970	WA9182	CTG										
6000	WA9183	CTG			SH,CALC	11		.40				
6030	WA9184	CTG										
6060	WA9185	CTG			SH,CALC	11		.42				
6090	WA9186	CTG										
6120	WA9187	CTG			SH	10		.49				
6150	WA9188	CTG										
6180	WA9189	CTG			SH	10		.47				
6210	WA9190	CTG										
6250	WA9191	CTG			SH,CALC	12		.53				
6280	WA9192	CTG										
6310	WA9193	CTG			SH,CALC	13		.52				
6340	WA9194	CTG										
6370	WA9195	CTG			SH,CALC	13		.45				
6400	WA9196	CTG										
6430	WA9197	CTG			SH,CALC	14		.41				
6460	WA9198	CTG										
6490	WA9199	CTG			SH,CALC	15		.44				
6520	WA9200	CTG										
6550	WA9201	CTG			SH,CALC	11		.43				
6580	WA9202	CTG										
6610	WA9203	CTG			SH CALC	11		.38				
6640	WA9204	CTG										
6670	WA9205	CTG			SH,CALC	11		.38				
6700	WA9206	CTG										
6730	WA9207	CTG			SH	10		.38				
6760	WA9208	CTG										
6790	WA9209	CTG			SH	10		.34				
6820	WA9210	CTG										
6850	WA9211	CTG			SH	10		.36				
6880	WA9212	CTG										
6910	WA9213	CTG			SH	10		.35				
6940	WA9214	CTG										
6970	WA9215	CTG			SST,ARG	10		.38				
7000	WA9216	CTG										
7030	WA9217	CTG			SST,ARG	8		.37				
7060	WA9218	CTG										
7090	WA9219	CTG			SST,ARG	8		.45				
7120	WA9220	CTG										
7150	WA9221	CTG			SST,ARG	7		.50				
7180	WA9222	CTG										
7210	WA9223	CTG			SST,ARG	7		.53				
7240	WA9224	CTG										
7270	WA9225	CTG			SST,ARG	7		.47				
7300	WA9226	CTG										
7330	WA9227	CTG			SST,ARG	12		.43				
7360	WA9228	CTG										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5910															
5940															
5970															
6000											3				
6030															
6060															
6090															
6120															
6150															
6180															
6210															
6250															
6280															
6310											3+				
6340															
6370															
6400															
6430															
6460															
6490															
6520															
6550											3+				
6580															
6610															
6640															
6670															
6700															
6730															
6760															
6790															
6820															
6850															
6880															
6910											3+				
6940															
6970															
7000															
7030															
7060															
7090															
7120															
7150															
7180															
7210															
7240															
7270											4-				
7300															
7330															
7360															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
7390	WA9229	CTG			SST,ARG	14		.42				
7420	WA9230	CTG										
7450	WA9231	CTG			SH	10		.45				
7480	WA9232	CTG										
7510	WA9233	CTG			SH,CALC	12		.38				
7540	WA9234	CTG										
7570	WA9235	CTG			SH,SNDY	11		.38				
7600	WA9236	CTG										
7630	WA9237	CTG			SH,SNDY	12		.39				
7660	WA9238	CTG										
7690	WA9239	CTG			SH,SNDY	10		.36				
7730	WA9240	CTG										
7760	WA9241	CTG			SH,SNDY	11		.36				
7790	WA9242	CTG										
7820	WA9243	CTG			SH,SNDY	10		.36				
7850	WA9244	CTG										
7880	WA9245	CTG			SH,SNDY	10		.35				
7910	WA9246	CTG										
7940	WA9247	CTG			SH,SNDY	10		.32				
7970	WA9248	CTG										
8000	WA9249	CTG			SH,SNDY	11		.33				
8030	WA9250	CTG										
8060	WA9251	CTG			SH,SNDY	10		.35				
8090	WA9252	CTG										
8120	WA9253	CTG			SH,SNDY	9		.32				
8150	WA9254	CTG										
8180	WA9255	CTG			SH,SNDY	10		.29				
8210	WA9256	CTG										
8240	WA9257	CTG			SH,SNDY	10		.31				
8270	WA9258	CTG										
8300	WA9259	CTG			SH,SNDY	9		.38				
8330	WA9260	CTG										
8360	WA9261	CTG			SH,SNDY	10		.36				
8390	WA9262	CTG										
8420	WA9263	CTG			SH,SNDY	11		.45				
8450	WA9264	CTG										
8480	WA9265	CTG			SH,SNDY	10		.44				
8510	WA9266	CTG										
8540	WA9267	CTG			SH,SNDY	10		.41				
8570	WA9268	CTG										
8600	WA9269	CTG			SH,SNDY	10		.48				
8630	WA9270	CTG										
8660	WA9271	CTG			SH,SNDY	8		.40				
8690	WA9272	CTG										
8720	WA9273	CTG			SH,SNDY	10		.39				
8750	WA9274	CTG										
8780	WA9275	CTG			SH,SNDY	10		.40				
8810	WA9276	CTG										
8840	WA9277	CTG			SH,SNDY	10		.40				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
7390															
7420															
7450															
7480															
7510															
7540															
7570															
7600															
7630											3+				
7660															
7690															
7730															
7760															
7790															
7820															
7850															
7880															
7910															
7940															
7970															
8000															
8030															
8060											3+				
8090															
8120															
8150															
8180															
8210															
8240											3+				
8270															
8300															
8330															
8360															
8390															
8420															
8450															
8480											3+				
8510															
8540															
8570															
8600															
8630															
8660															
8690															
8720											4-				
8750															
8780															
8810															
8840															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
8870	WA9278	CTG										
8900	WA9279	CTG			SH,SNDY	9		.42				
8930	WA9280	CTG										
8960	WA9281	CTG			SH	10		.42				
8990	WA9282	CTG										
9020	WA9283	CTG			SH	10		.42				
9050	WA9284	CTG										
9080	WA9285	CTG			SH	10		.39				
9110	WA9286	CTG										
9140	WA9287	CTG			SH,CALC	11		.46				
9170	WA9288	CTG										
9200	WA9289	CTG			SH,SNDY	6		.46				
9230	WA9290	CTG										
9260	WA9291	CTG			SH,SNDY	9		.32				
9290	WA9292	CTG										
9320	WA9293	CTG			SH	7		.31				
9350	WA9294	CTG										
9380	WA9295	CTG			SH	9		.36				
9410	WA9296	CTG										
9440	WA9297	CTG			SH	10		.38				
9470	WA9298	CTG										
9500	WA9299	CTG			SH	10		.34				
9530	WA9300	CTG										
9560	WA9301	CTG			SH	10		.36				
9590	WA9302	CTG										
9620	WA9303	CTG			SH	10		.38				
9650	WA9304	CTG										
9680	WA9305	CTG			SH	10		.34				
9710	WA9306	CTG										
9740	WA9307	CTG			SH	8		.37				
9770	WA9308	CTG										
9800	WA9309	CTG			SH	10		.37				
9830	WA9310	CTG										
9860	WA9311	CTG			SH	8		.39				
9890	WA9312	CTG										
9920	WA9313	CTG			SH,SNDY	10		.36				
9950	WA9314	CTG										
9980	WA9315	CTG			SH,SNDY	10		.36				
10010	WA9316	CTG										
10040	WA9317	CTG			SH,CALC	14		.51				
10070	XA9317		ORD	MAZN	FORM.TOP							
10080	WA9318	CTG			SH,CALC	11		1.03		.15	.28	27
10110	WA9319	CTG										
10140	WA9320	CTG			SH	8		.76		.18	.36	47
10170	WA9321	CTG										
10200	WA9322	CTG			SH	6		.73				
10230	WA9323	CTG										
10260	WA9324	CTG			SH	6		.63				
10290	WA9325	CTG										

DEPTH FT	TR BRT	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
8870															
8900															
8930															
8960															
8990															
9020															
9050															
9080															
9110															
9140															
9170															
9200															
9230															
9260											4-				
9290															
9320															
9350															
9380															
9410															
9440															
9470															
9500															
9530															
9560															
9590															
9620															
9650															
9680															
9710															
9740															
9770															
9800															
9830															
9860															
9890															
9920															
9950															
9980															
10010															
10040															
10070															
10080	.35		15												
10110															
10140	.33		24												
10170															
10200															
10230															
10260											4-				
10290															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
10320	WA9326	CTG			SH	9		.68				
10350	WA9327	CTG										
10380	WA9328	CTG			SH	8		.69				
10410	WA9329	CTG										
10440	WA9330	CTG			SH	10		.73				
10470	WA9331	CTG										
10500	WA9332	CTG			SH	9		.68				
10530	WA9333	CTG										
10560	WA9334	CTG			SH	9		.67				
10590	WA9335	CTG										
10620	WA9336	CTG			SH,SNDY	14		.66				
10650	WA9337	CTG										
10650	WA9338	CTG			SH,SNDY	14		.82		.15	.35	43
10667	XA9338		MISS	CANY	THRUST							
10680	WA9339	CTG										
10710	WA9340	CTG			SH,CALC	21		1.32		.20	.38	29
10740	WA9341	CTG										
10770	WA9342	CTG			SH	9		2.72		.63	.86	32
10830	WA9343	CTG										
10860	WA9344	CTG			SH	8		3.11		.46	.63	20
10883	WA9345	CTG			SH,CALC	11		1.14		.16	.30	26
10910	WA9346	CTG			SH,SNDY	10		2.30		.31	.41	18
10940	WA9347	CTG			SH,CALC	11		1.31		.18	.10	8
10970	WA9348	CTG			SH,CALC	11		1.95		.27	.39	20
11000	WA9349	CTG			SH,SNDY	5		3.39		.43	.60	18
11030	WA9350	CTG			SH	5		3.08		.40	.53	17
11060	WA9351	CTG			SH	5		3.01		.38	.60	20
11090	WA9352	CTG			SH	9		2.38		.37	.52	22
11120	WA9353	CTG			SH,CALC	11		2.96		.47	.53	18
11150	WA9354	CTG			SH	10		2.52		.36	.54	21
11180	WA9355	CTG			SH	8		3.32		.67	.69	21
11204	XA9352		MISS	SYCA	FORM.TOP							
11210	WA9356	CTG			SH,SNDY	7		2.94		.82	.80	27
11240	WA9357	CTG			SH,CALC	23		.89		.37	.39	44
11270	WA9358	CTG			SH,CALC	16		1.04		.37	.61	59
11300	WA9359	CTG			SH,CALC	24		.70				
11327	XA9359		DEV	WOOD	FORM.TOP							
11331	WA9360	CTG			SH,CALC	20		.67				
11360	WA9361	CTG			SH,CALC	13		1.82		.53	.42	23
11390	WA9362	CTG			SH,CALC	12		3.21		.96	1.37	43
11420	WA9363	CTG			SH	10		3.24		.55	.62	19
11450	WA9364	CTG			SH	7		3.67		.82	.88	24
11480	WA9365	CTG			SH	8		4.06		.57	.72	18
11510	XA9365		ORD	SYLV	FORM.TOP							
11511	WA9366	CTG			SH	10		4.36		.47	.74	17
11540	WA9367	CTG			SH	7		.95		.13	.27	28
11570	WA9368	CTG			SH	12		.95		.19	.37	39
11610	XA9368		ORD	VIOL	FORM.TOP							
11611	WA9369	CTG			LST							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
10320															
10350															
10380															
10410															
10440															
10470															
10500															
10530															
10560															
10590															
10620															
10650															
10650	.30		18												
10667															
10680															
10710	.34		15									1.47			
10740															
10770	.42		23												
10830															
10860	.42		15												
10883	.35		14												
10910	.43		13												
10940	.64		14									1.54			
10970	.41		14												
11000	.42		13												
11030	.43		13												
11060	.39		13												
11090	.42		16									1.74			
11120	.47		16												
11150	.40		14												
11180	.49		20												
11204															
11210	.51		28												
11240	.49		42												
11270	.38		36												
11300												1.81			
11327															
11331															
11360	.56		29												
11390	.41		30												
11420	.47		17												
11450	.48		22												
11480	.44		14												
11510															
11511	.39		11												
11540	.33		14												
11570	.34		20												
11610															
11611															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
11640	WA9370	CTG			LST							
11670	WA9371	CTG			LST							
11690	WA9372	CTG			LST							
11720	WA9373	CTG			LST							
11750	WA9374	CTG			LST							
11850	WA9375	CTG			LST							
11940	WA9376	CTG			LST							
12040	WA9377	CTG			LST							
12140	WA9378	CTG			LST							
12240	WA9379	CTG			LST							
12340	WA9380	CTG			LST							
12394	XA9380		ORD	BROM	FORM.TOP							
12400	WA9381	CTG			SH,V.CALC	39		.50				
12890	XA9381		ORD	MCLI	FORM.TOP							
13320	XA938A		ORD	OLCK	FORM.TOP							
13610	WA9382	CTG			SH,CALC	19		.59				
13640	WA9383	CTG			SH,CALC	22		.72				
13890	WA9384	CTG			SH,CALC	24		.50				
14650	XA9384		ORD	JOIN	FORM.TOP							
14810	XA938B		ORD	ELLE	FORM.TOP							
16348	XA938C	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
11640															
11670															
11690															
11720															
11750															
11850															
11940															
12040															
12140															
12240															
12340															
12394															
12400															
12890															
13320															
13610															
13640															
13890															
14650															
14810															
16348															

SOHIO

PETROLEUM COMPANY
--------- -------

PETROLEUM GEOCHEMISTRY
WARRENSVILLE

GULF#1 NINA STEEL

TABLE 10

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : GRAYSON
LOCATION : J.HAMILTON SURVEY
WELL/SITE : GULF#1 NINA STEEL
API/OCS : 42-181-30710

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1100	WA9471	CTG	MISS	STAN	SH,CALC	16		.69		.05	.33	48
1130	WA9472	CTG										
1160	WA9473	CTG			SH,CALC	14		.78		.08	.30	38
1190	WA9474	CTG										
1220	WA9475	CTG			SH,CALC	11		1.10		.30	1.52	138
1250	WA9476	CTG										
1280	WA9477	CTG			SH,CALC	11		1.22		.37	1.35	111
1314	XA9477		DEV	ARKN	FORM.TOP							
1315	WA9478	CTG			CHT	7		1.25		.24	2.72	218
1340	WA9479	CTG										
1370	WA9480	CTG			CHT	6		1.62		.46	5.29	327
1400	WA9481	CTG										
1430	WA9482	CTG			CHT	6		1.09		.32	3.51	322
1460	WA9483	CTG										
1490	WA9484	CTG			CHT	6		1.04		.28	3.12	300
1520	WA9485	CTG										
1550	WA9486	CTG			CHT	7		1.11		.30	3.35	302
1580	WA9487	CTG										
1610	WA9488	CTG			CHT	6		1.11		.24	2.58	232
1640	WA9489	CTG										
1690	WA9490	CTG			CHT	8		1.07		.22	1.21	113
1700	XA9490		MISS	STAN	THRUST							
1720	WA9491	CTG			SH,CALC	11		.87		.20	.88	101
1750	WA9492	CTG										
1780	WA9493	CTG			SH,CALC	14		.59		.08	.30	51
1820	WA9494	CTG										
1850	WA9495	CTG			SH,CALC	14		.46		.10	.25	54
1880	WA9496	CTG										
1910	WA9497	CTG			SH,CALC	15		.44		.09	.25	57
1940	WA9498	CTG										
1970	WA9499	CTG			SH,CALC	15		.46		.07	.16	35
2000	WA9500	CTG										
2030	WA9501	CTG			SH,CALC	15		.58		.05	.19	33
2060	WA9502	CTG										
2090	WA9503	CTG			SH,CALC	15		.63		.10	.32	51
2120	WA9504	CTG										
2150	WA9505	CTG			SH,CALC	14		.95		.04	.37	39

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1100	.13		7												
1130															
1160	.21		10									.64			
1190															
1220	.16		27		1.94	.67	1.27	176	.53						
1250															
1280	.22		30												
1314															
1315	.08		19												
1340															
1370	.08		28		3.62	.92	2.70	223	.34						
1400															
1430	.08		29												
1460												.65			
1490	.08		27												
1520															
1550	.08		27		3.80	1.05	2.75	342	.38						
1580															
1610	.09		22												
1640															
1690	.15		21												
1700															
1720	.19		23									.62			
1750															
1780	.21		14												
1820															
1850	.29		22												
1880															
1910	.26		20												
1940															
1970	.30		15												
2000															
2030	.21		9									.68			
2060															
2090	.24		16												
2120															
2150	.10		4												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2180	WA9506	CTG										
2200	XA9506		DEV	ARKN	FORM.TOP							
2210	WA9507	CTG			CHT	9		1.31		.29	1.09	83
2240	WA9508	CTG										
2270	WA9509	CTG			CHT	10		.89		.09	.46	52
2340	WA9510	CTG										
2361	XA9510		SIL	MOMT	FORM.TOP							
2370	WA9511	CTG			SH	9		.17		.01	.04	24
2400	WA9512	CTG										
2430	WA9513	CTG			SH	10		.08		0.00	.01	12
2470	WA9514	CTG			SH	9		.23		.06	.20	87
2500	WA9515	CTG			SH	7		.47		.11	.57	121
2530	WA9516	CTG										
2560	WA9517	CTG			SH	7		.38		.21	.47	124
2590	WA9518	CTG										
2620	WA9519	CTG			SH	9		.18		0.00	0.00	0
2660	XA9519		ORD	POLK	FORM.TOP							
2661	WA9520	CTG			SH,CALC	12		1.78		.59	4.17	234
2680	WA9521	CTG			SH,CALC	16		1.70		.75	4.53	266
2710	WA9522	CTG										
2748	XA9522		ORD	BGFK	FORM.TOP							
2749	WA9523	CTG			SH,V.CALC	33		.57		.25	.80	140
2770	WA9524	CTG										
2800	WA9525	CTG			SH,V.CALC	26		.60		.35	.92	153
2830	WA9526	CTG										
2860	WA9527	CTG			SH,V.CALC	44		.41		.34	.70	171
2890	WA9528	CTG										
2920	WA9529	CTG			SH,CALC	23		.90		.71	2.26	251
2950	WA9530	CTG										
2980	WA9531	CTG			SH,CALC	30		1.38		1.14	3.75	272
3010	WA9532	CTG										
3040	WA9533	CTG			SH,CALC	11		1.71		1.20	4.74	277
3070	WA9534	CTG			SH,CALC	14		1.88		1.33	6.02	320
3100	WA9535	CTG			SH,CALC	22		1.76		1.03	5.41	307
3134	XA9535		ORD	WOMB	FORM.TOP							
3135	WA9536	CTG			SH,V.CALC	35		1.25		.51	2.37	190
3160	WA9537	CTG										
3190	WA9538	CTG			SH,CALC	19		.80		.21	.65	81
3220	WA9539	CTG										
3250	WA9540	CTG			SH,CALC	18		.71		.26	.60	85
3280	WA9541	CTG										
3310	WA9542	CTG			SST,CALC	20		.44		.13	.38	86
3340	WA9543	CTG										
3370	WA9544	CTG			SST,CALC	21		.26		.01	.06	23
3400	WA9545	CTG										
3430	WA9546	CTG			SST,CALC	18		.34		.14	.31	91
3460	WA9547	CTG										
3490	WA9548	CTG			SH,CALC	16		.60		.13	.43	72
3520	WA9549	CTG										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2180															
2200															
2210	.21		22												
2240															
2270	.16		10									.73			
2340															
2361															
2370	.20		6												
2400															
2430	0.00		0												
2470	.23		26												
2500	.16		23												
2530															
2560	.31		55												
2590															
2620			0												
2660															
2661	.12		33												
2680	.14		44		4.87	1.24	3.63	286	.34			.71			
2710															
2748															
2749	.24		44												
2770															
2800	.28		58												
2830															
2860	.33		83												
2890															
2920	.24		79												
2950															
2980	.23		83												
3010															
3040	.20		70		4.93	1.62	3.31	288	.49						
3070	.18		71												
3100	.16		59		5.21	1.43	3.78	296	.38						
3134															
3135	.18		41									.78			
3160															
3190	.24		26												
3220															
3250	.30		37												
3280															
3310	.25		30												
3340															
3370	.14		4									.79			
3400															
3430	.31		41												
3460															
3490	.23		22												
3520															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3550	WA9550	CTG			SST,CALC	17		.50		.03	.17	34
3580	WA9551	CTG										
3630	WA9552	CTG			SH,CALC	14		.79		.19	.79	100
3660	WA9553	CTG										
3700	XA9553	TD										

WELL/SITE :GULF#1 NINA STEEL

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3550	.15		6												
3580															
3630	.19		24									.85			
3660															
3700															

To: E. Luttrell
SPC Mid-Continent Office
Dallas

September 20, 1982

PGW/092082/RB/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Source Characterization Exercise for Well #3 Victor-Isom Springs Field (Report PGW/TM 065)

Herewith two copies [redacted] of the subject report. Final preparation of this item has been some time in gestation in order to incorporate the kerogen and kerogen pyrolysate source to oil correlation data. We believe that this capability adds a new dimension to this type of source potential and characterization work.

The shaley intervals within the Arkansas Novaculite again demonstrated attractive oil source potential if but of a limited volumetric extent. All thrust slices of this formation appeared to be immature to incipiently mature at best. It is unlikely that the sediments penetrated "on-structure" could have in fact contributed much in the way of a hydrocarbon charge.

However, the surprise (or unexpected) conclusion to the source evaluation aspect of this work was the attractive, and sustained potential, of the Missouri Mountain Fm. Extending over a 1,000 ft.+ interval, Good to Excellent mixed oil plus gas potential was observed. Although again assessed to be immature to incipiently mature only, this section would be an impressive source under a more forcing thermal regime. The source richness of the Missouri Mountain Fm. here was quite unlike the situation previously observed in outcrop and, more particularly, in the Taylor #1 well.

Examination of Soluble Extract (TSE) and kerogen carbon isotope values suggested a strong circumstantial correlation to the isotopic composition of the Isom Springs Novaculite produced oil. This relationship was further, and substantially, corroborated by the detailed study of both Arkansas Novaculite and Missouri Mountain kerogen pyrolysate carbon isotope values. The mean pyrolysate D-13C values fell close to (within $\pm$ 0.4 ^{o}/oo) of the Isom Spring petroleum. Although not distinguishing which formation was the likely source, these observations confirmed the strong candidacy of both of these potential source units. Allowing for the proviso raised by F. Marsek that other Early Paleozoic Ouachita Facies sediments (e.g. Polk Creek and Womble Fms.) have similar isotopic compositions, both the

Novaculite and Missouri Mountain Fm. could provide a convenient source, of isotopic match, for the Isom Springs petroleums. A conceivable senario would involve a mixed source origin, drawing on more thermally mature off-structure sediments, with migration up to the numerous listric faults attendant to the overthrusting. Noting the adjacent stratigraphic juxtaposition of the two formations, it is inconceivable that one should be a contributor and not the other.

Work on the detailed characterization of the Isom Springs oils is now complete and F. Marsek and co-workers will be putting out a sequel to this report in the near future.

R. Burwood

RB:bes
Enclosures: 3

cc: H. G. Bassett
J. G. Grasselli
R. J. Drozd
F. A. Marsek
H. I. Halpern
PGW Files (0), (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY

Geochemistry Group

To:	D. May SPC Mid-Continent Division Dallas	September 15, 1982 PGW/082082/FM/2-5
From:	Petroleum Geochemistry Group Warrensville	Job #PGW 81-57

Technical Memorandum (PGW/TM 065) -- Geochemical Source Rock Evaluation For The #3 Victor Well, A Producer In The Isom Springs Field, Marshall County, Oklahoma.

SUMMARY: Ouachita Facies sediments penetrated in the #3 Victor well were analyzed for source richness and maturity. Each of four repeat sections of the Arkansas Novaculite penetrated in the well contained intervals showing Good commercial mixed oil and gas source potential. Most of the Missouri Mountain sediments (approximately 1,900 ft.) were assessed to be of Good to Excellent commercial mixed oil and gas source potential. However, all of the sediments penetrated were found to be thermally immature and could not have generated the reservoired hydrocarbons encountered in the well. Carbon isotope values determined on extracted hydrocarbons and on kerogen pyrolysates were in close agreement. This suggested that the reservoired hydrocarbons in the #3 Victor well were sourced from sediments

with similar kerogen carbon isotopic composition to the immature Arkansas Novaculite and Missouri Mountain sediments encountered in the well. Ordovician-age sediments, because of their isotopic similarity, were also considered to be possible sources. The Missouri Mountain sediments from the #3 Victor well were among the richest potential source rocks from the Ouachita region analyzed to date by the SPC Geochemistry Group.

1. INTRODUCTION

The Isom Springs field is located in the SE 1/4 of T7S-R5E and the NE 1/4 of T8S-R5E Marshall County, Oklahoma. The field occurs in the complexly folded and faulted western margin of the Ouachita frontal system. Here deformed Paleozoic rocks of the Ouachita Facies have been thrust over Pennsylvanian Foreland Facies rocks. A total of 52 wells drilled in this field have cummulatively produced more than 1.85 million barrels of oil through July of 1981. The oil ranges from 29 to 54 API gravity averaging 39 . The average GOR is 527:1, but can be considerably higher. Production occurs from the Mississippian/Devonian Arkansas Novaculite and the Ordovician Bigfork Chert between about 1,500 and 5,500 ft., throughout the field.

This report presents the results and conclusions of a geochemical source evaluation of cuttings samples from one well in the Isom Springs field. The well examined was the Westheimer-Neustadt #3 Victor, located in Section 2, T8S-R5E. The well produces oil and gas from repeat and overturned sections of the Arkansas Novaculite occurring between 4,900 and 5,400 ft. The well TD'd at 6,192 ft. The structural complexity of the field is shown in the cross section in Figure 1 which includes the #3 Victor well.

2. MATERIALS AND METHODS

2.1 Materials

Cuttings samples representative of the 800 - 6,000 ft. interval of the well were submitted for source evaluation. The samples were composited into 30 and 60 ft. intervals depending upon the quantities available.

2.2 Methods

The samples were screened for source richness and maturity. Source richness screen procedures included Total Organic Carbon (TOC - bitumen free) and Rock Eval pyrolysis performed as per standardized PGW methods. Source maturity was assessed using whole-rock Vitrinite Reflectance determinations. The hydrocarbon proneness (oil or gas) of intervals of source interest was assessed by using proprietary pyrolysis-gas chromatography which produces a gas/oil generation index (GOGI). Carbon isotope determinations (D-13C) were performed on methylene chloride soluble extracts, kerogen concentrates (bitumen free), and on kerogen pyrolysates (bitumen free sediment) from samples selected on the basis of screen data. The extracts from intervals in each formation were combined into single aliquots in order to have sufficient quantities of the extracts for analysis. Isotope values were determined using standardized PGW methods and are reported as (-) parts per thousand (^{o}/oo) relative to PDB 1.

3. RESULTS AND CONCLUSIONS

The geochemical data for the #3 Victor well is presented in Table 1 and Figures 2 and 3.

3.1 Vitrinite reflectance values measured from the cuttings samples ranged from about 0.40 to 0.60%. For the Pre-Devonian sediments, measurements were made on vitrinite-like clasts. The reflectance values did not increase uniformly with depth as a consequence of the repeat and overturned sections encountered in this well. Although the data appeared to be randomly scattered, it was possible to pick reflectance breaks and a thermal maturity profile was established for the well (Figure 2). All of the Ouachita Facies sediments penetrated in this well to TD were shown to be immature to incipiently mature on the basis of a conventional Ro = 0.6% Generation Threshold. None of the sediments penetrated on-structure had ever entered into the peak oil generation window and subsequently it was doubtful whether they could have generated the commercial quantities of hydrocarbons trapped in the Isom Springs field.

3.2 Total organic carbon (TOC) contents in excess of 1.00 wt% were present in numerous intervals of all four Arkansas Novaculite sections penetrated in this well. In all but one case the highest TOC contents in each of the Novaculite sections occurred in intervals very near or at the tops and/or bottoms of the sections. These occurrences may correlate to the shalely or laminated zones of the Novaculite where structural failure of the formation might have occurred. Pyrolytic potentials (S2) in many intervals of the Novaculite were high (> 2 to 12.84 kg/ton) indicating Good commercial source potential in each of the sections encountered. Gas/Oil Generation Indices (GOGI's) ranging from 0.25 to 0.35 $\leq$ 0.46 suggested that this potential would be for mixed oil and gas at peak generation, being significantly oil prone.

3.3 Most of the Silurian Missouri Mountain sediments penetrated in this well (1,700 - 3,560 ft., and 4,764 - 4,820 ft.) were assessed to be of Good to Excellent commercial source potential. High TOC contents and high pyrolytic potentials were observed over much of the section. GOGI's ranging between 0.33 and 0.49 suggested that these sediments would be mixed oil and gas, possibly leaning toward some condensate proneness during peak generation. It should be noted that the Missouri Mountain sediments encountered in this well are among the richest Ouachita Facies sediments analyzed to date by the SPC Geochemistry Group. All samples of the Missouri Mountain formation previously analyzed have shown no source potential suggesting that the high organic content of the sediments may be a localized phenomenon or that some stratigraphic confusion exists and the sediments were possibly misidentified as Missouri Mountain.

3.4 None of the Mississippian Stanley Fm. sediments penetrated in this well showed indications of any significant commercial source potential. The sample WA 7101, showing high TOC and pyrolytic potential, is listed as part of the Stanley section. However, this sample is predominantly an Arkansas Novaculite return. Because of insertion of the formation top at 1,034 ft., the sample appears as part of the Stanley section.

3.5 Carbon isotope measurements (D-13C) were made on hydrocarbons extracted from the sediments (Total Soluble Extracts - TSE's) and on kerogen pyrolysates (KPY's) produced from the extracted sediments.

Because the sediments were not mature enough to have generated any significant quantities of hydrocarbons, the TSE's obtained were believed to be fairly representative of the reservoired hydrocarbons encountered in the well. This was certainly true of several of the Novaculite extracts (D-13C @ 30.2 - 30.3 ^{o}/oo) which agreed very closely with the Isom Springs produced Novaculite oil (D-13C @ -30.4 ^{o}/oo). The kerogen pyrolysates were obtained from extracted samples and were essentially free of any influence or contamination from these associated hydrocarbons.

3.6 For Pre-Mississippian materials, the carbon isotope values of the TSE's (D-13C/TSE) fell within a range of -29.25 to -30.29 ^{o}/oo averaging -29.56 ^{o}/oo. Isotope values in the -29 to -31 ^{o}/oo range are not inconsistent with oils sourced from Lower Paleozoic sediments. Similarly, carbon isotope values for the kerogen pyrolysates (D-13C/KPY) ranged from -28.92 to -31.16 ^{o}/oo. Pyrolysate isotope values from Arkansas Novaculite sediments (with one exception) ranged from -29.77 to -30.36 ^{o}/oo and averaged -30.14 ^{o}/oo indicating that any hydrocarbons generated by Novaculite sediments would also fall into the -29 to -31 ^{o}/oo range. Pyrolysates from the Missouri Mountain sediments ranged from -30.59 to -31.16 ^{o}/oo averaging -30.81 ^{o}/oo. A comparison of the pyrolysate isotope values showed that a distinction could be made between the Miss./Devonian Arkansas Novaculite and the Silurian Missouri Mountain sediments. The Missouri Mountain sediments yielded hydrocarbons slightly depleted in C13 (i.e. lighter) relative to the Arkansas Novaculite sediments.

3.7 The difference between the isotopic compositions of pyrolysates from the two formations above were inconclusive in comparing these values to those of the extracted hydrocarbons. The isotope values measured for the pyrolysates from both the Novaculite and the Missouri Mountain sediments were virtually identical to those of the TSE fractions (i.e. the oil). This strongly suggested that the hydrocarbons occuring in the Isom Springs field could have been sourced from Arkansas Novaculite and Missouri Mountain sediments very similar in composition to the immature sediments penetrated in the #3 Victor well. However, because of the similarity between the isotopic compositions of the Novaculite and the Missouri Mountain kerogens and other Ordovician-aged sediments (e.g. Polk Creek and Womble Fms. Ref. 1), it was impossible to say with certainty from which age group of sediments the reservoired hydrocarbons in the #3 Victor well were generated. In all probability, a multiple source appeared to be a likely possibility. In this context, the D-13C value for the Isom Springs Novaculite produced oils (-30.4 ^{o}/oo) fell midway between the average pyrolysate values for both the Novaculite and Missouri Mountain kerogens examined in this study!

3.8 Production of source quality and source-hydrocarbon correlation data in bulk provides the means of evaluating the mean characteristics of a potential source interval. This in turn provides a useful summary guide to the respective source interval. A collection of such mean data for the Arkansas Novaculite and Missouri Mountain Fm. sediments penetrated in this well is tabulated in Table 2. Overall, the Missouri Mountain interval appeared to be the superior of two potentially attractive oil + gas prone source intervals. Despite only Moderate to Good mean Total Organic Carbon contents (0.8 - 1.4%), potential productivity values (3.4 - 4.7 kg/ton) equated to quite healthy ultimate oil yeilds of about 60 - 80 bbls/AF. Interestingly, the hydrocarbon proneness for both formations was almost identical mixed oil + gas (with emphasis on oil) at GOGI values of 0.34 - 0.37. Mean kerogen carbon isotope values were again very similar at -30.03 to -30.08 ^{o}/oo. Kerogen pyrolysates, however, indicated that the Missouri Mountain kerogen assemblage gave a somewhat lighter (D-13C at -30.81 ^{o}/oo) product. Both pyrolytic products correlated very closely with the specimens of Isom Springs Novaculite produced oil examined (D-13C at -30.4 ^{o}/oo). Both the siliceous shale component of the Arkansas Novaculite and the Missouri Mountain Fm. should thus be seen as strong potential candidates as to the source of the Isom Springs petroleums. On the basis of present data, the latter formation would appear to have the edge as the major contributor of what conceivably could be a mixed source accumulation.

3.9 Vitrinite reflectance measurements, substantiated by pyrolysis data, clearly showed that all of the sediments in the #3 Victor well were thermally immature and could not have generated any significant quantities of hydrocarbons. At their maximum depth of burial these sediments had just about reached the threshold of the oil generation window. The sediments were probably disrupted by the tectonic activity of the Ouachita Orogen stopping the maturation process at the level now observed. The hydrocarbons reservoired in the Isom Springs field were generated at greater depths. Unfortunately the geochemical data does not shed much light on the timing of generation or emplacement of the hydrocarbons in the field. However, the structural complexity of the field and its location along the Ouachita frontal fault suggest that the hydrocarbons in the field had migrated upward along the numerous listric faults, and into structures, after tectonic activity in the region had subsided.

4. REFERENCES

R. Burwood, F. Marsek and S. White 1982 Well Taylor #1 Source Rock Potential Evaluation and Characterization. Summary of Data Base and Results. Report PGW 015.

Henry I. Halpern

Henry I. Halpern

Frank A. Marsek

Frank A. Marsek

Figures 1, 2, 3
Tables 1, 2

cc: H. G. Bassett
J. G. Grasselli
E. Luttrell
R. Burwood
R. Drozd
PGW Files (0), (2-5)

Work By: S. Adams
G. Cole
R. Lukco
I. Penfield
J. Reymander
R. Roseman
R. Sedivy

E. Tausch

S. White

B. Smith

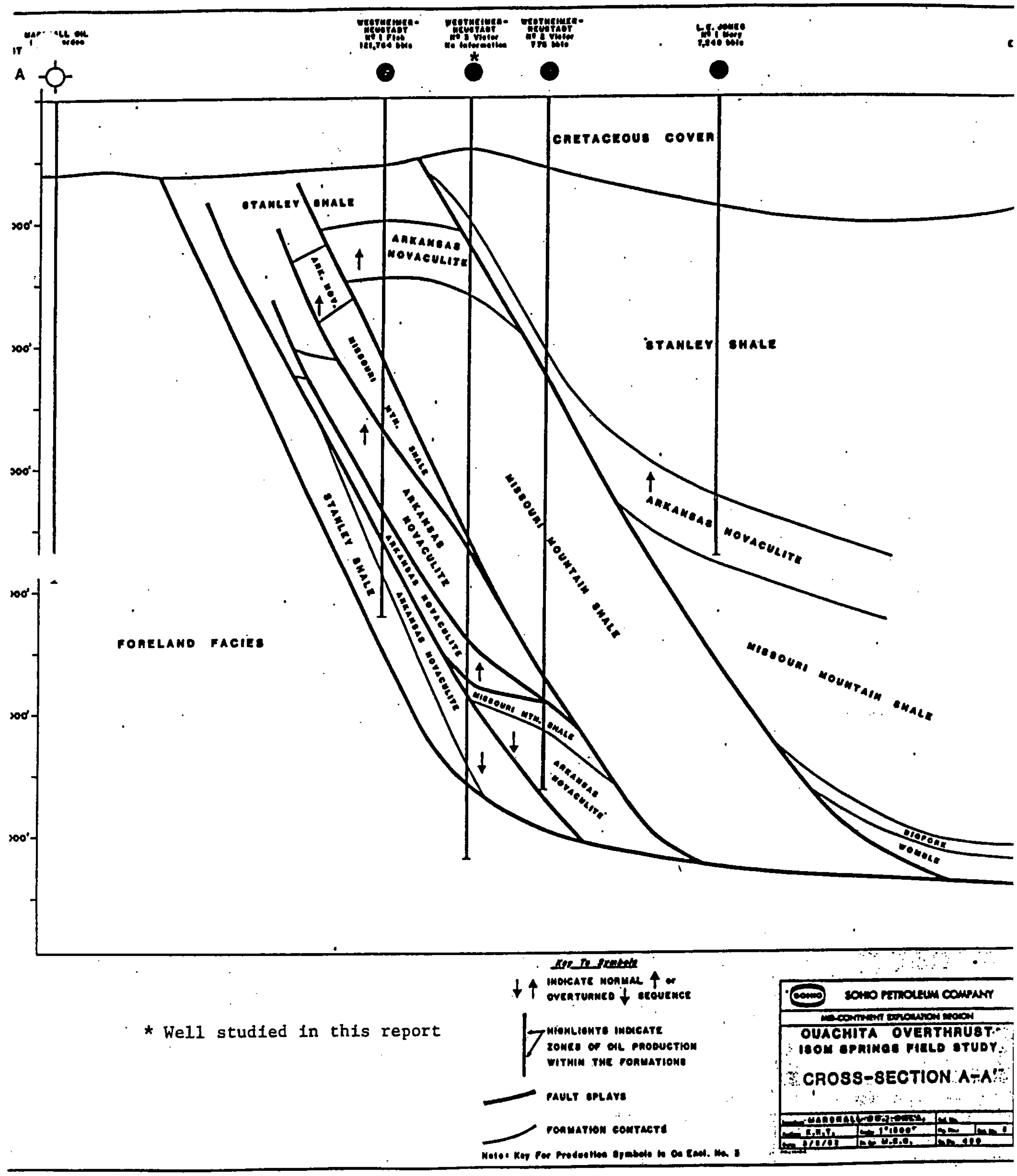

WESTHEIMER-NEUSTADT Nº 1 Fish 121,764 bbls
WESTHEIMER-NEUSTADT Nº 3 Victor No information
WESTHEIMER-NEUSTADT Nº 2 Victor 776 bbls
L.E. JONES Nº 1 Mary 7,240 bbls
A
CRETACEOUS COVER
STANLEY SHALE
ARKANSAS NOVACULITE
ARK. NOV.
MISSOURI MTN. SHALE
STANLEY SHALE
ARKANSAS NOVACULITE
MISSOURI MOUNTAIN SHALE
FORELAND FACIES
STANLEY SHALE
ARKANSAS NOVACULITE
MISSOURI MTN. SHALE
MISSOURI MOUNTAIN SHALE
BIGFORK
WOMBLE
* Well studied in this report
Key To Symbols
INDICATE NORMAL or OVERTURNED SEQUENCE
HIGHLIGHTS INDICATE ZONES OF OIL PRODUCTION WITHIN THE FORMATIONS
FAULT SPLAYS
FORMATION CONTACTS
Note: Key For Production Symbols is On Encl. No. 5
SOHIO PETROLEUM COMPANY
MID-CONTINENT EXPLORATION REGION
OUACHITA OVERTHRUST
ISOM SPRINGS FIELD STUDY
CROSS-SECTION A-A'

Figure 1

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

WELL : #3 VICTOR

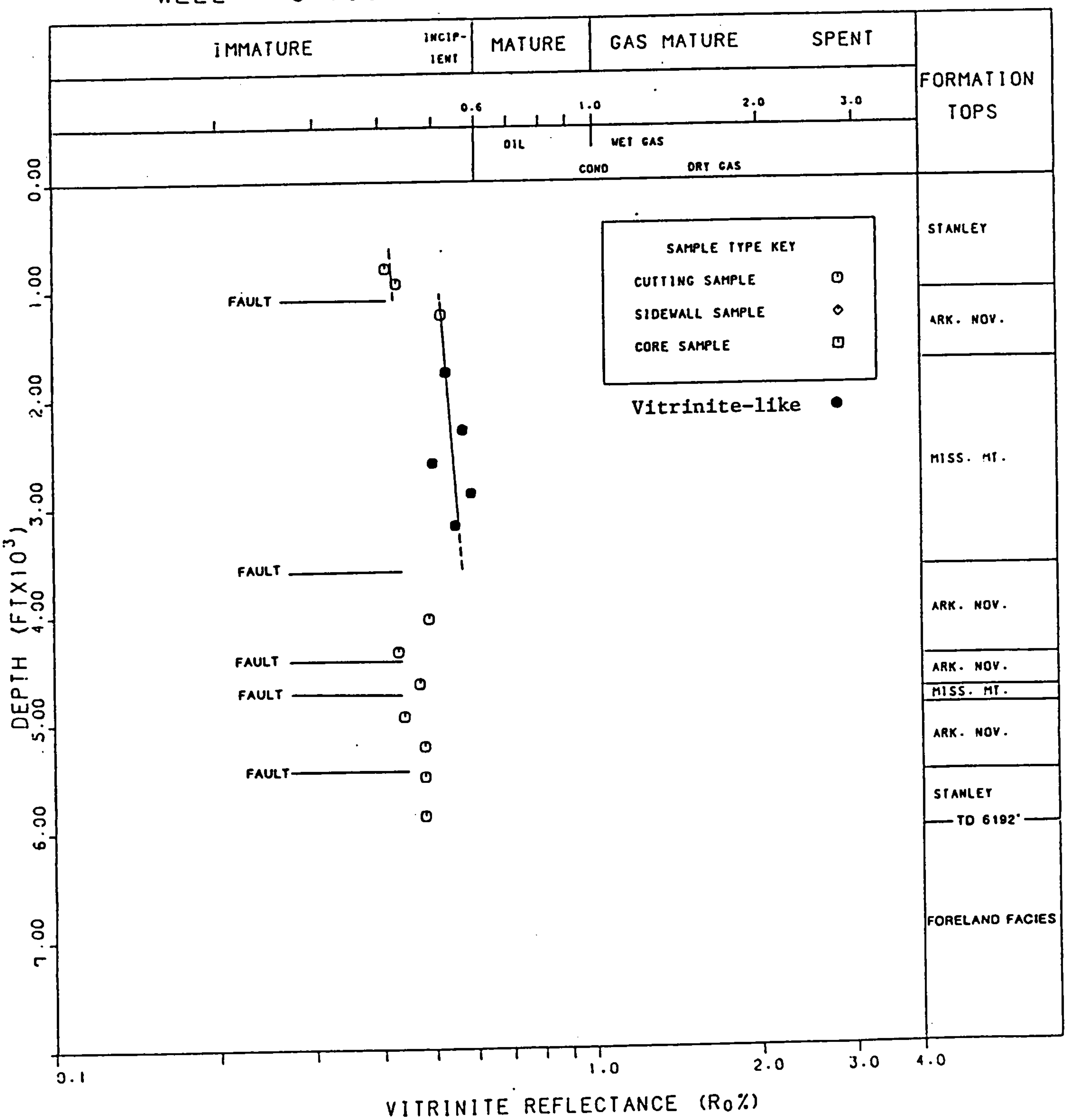


Figure 2

TABLE 2

WELL #3 VICTOR - ISOM SPRINGS FIELD

Mean Source Rock Potential/Characterization Data for the Arkansas Novaculite and Missouri Mountain Formations

Source Interval	Total Organic Carbon TOC (% wt)	Potential Productivity K2 (kg/ton)	Potential Productivity Oil (bbls/AF)	Hydrocarbon Proneness (GOGI)	Kerogen $\delta^{13}C$	Kerogen Pyrolysate $\delta^{13}C$	Kerogen Pyrolysate - Kerogen Differential $\Delta\ \delta^{13}C$
Arkansas Novaculite	0.8	3.4	60	0.34	-30.08	-30.14	0.06
Missouri Mountain	1.4	3.7	80	0.37	-30.03	-30.81	0.78

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/ Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:

- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. } 0-10% qualifying component
LST.

SH. CALC } 11-25% qualifying component
LST. ARG

SH. V. CALC } 26-50% qualifying component
LST. V. ARG

<u>Carbonate</u> (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

<u>ELECTRIC LOG/WELL DATA (Track 2)</u>

<u>ELOG</u> (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

<u>Casing</u> (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

<u>Test</u> (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

<u>SOURCE RICHNESS SCREEN (Track 3)</u>

<u>TOC</u> (9): % Total Organic Carbon (bitumen-free)

<u>TSE</u> (10): ‰ Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

<u>S1</u> (11): ‰ Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300°C$) - Kg/Tn.

<u>S2</u> (12): ‰ Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

<u>HI</u>: ‰ Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

<u>TR</u>: Transformation Ratio $\frac{S1}{S1 + S2}$

<u>Visual Kerogen Description</u> (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

<u>SOURCE MATURATION (Track 4)</u>

<u>G1 (TSE)</u>(14): ‰ Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

<u>G1 (S1)</u>(15): ‰ Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

<u>TSE/S1</u>: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

<u>KPI</u> (16): ‰ Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

<u>K2</u> (17) ‰ Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

<u>K2(G)</u>: ‰ Potential Productivity - Pyrolytic Hydrocarbon yield as Gas ($C_1 - C_5$) - Kg/Tn.

K2(O): %• Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

FORMATION LEGEND

STAN - Stanley
ARKN - Arkansas Novaculite
MOMT - Missouri Mountain

TABLE 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : MARSHALL
LOCATION : SEC2,T8SR5E
WELL/SITE : #3 VICTOR
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	RT7096											
880	WA7096	CTG	MISS	STAN	SH,CALC	17		.69		.03	.39	57
910	WA7097	CTG			SH,CALC	22		.42		.03	.17	40
940	WA7098	CTG			SH,CALC	23		.43		.03	.07	16
970	WA7099	CTG			SH,V.CALC	30		.39		.07	.21	54
1000	WA7100	CTG			SH,CALC	21		.37		.08	.28	76
1030	WA7101	CTG			SH,CHTY	6		1.48		.46	5.73	387
1034	XA7101		DEV	ARKN	FORM.TOP							
1100	WA7102	CTG			CHT,ARG	7		1.11		.19	3.67	331
1200	WA7103	CTG			CHT,V.ARG	8		.14		.02	.04	29
1230	WA7104	CTG			CHT,V.ARG	10		.21		.05	.20	95
1490	WA7105	CTG			CHT,V.ARG	6		.40		.40	1.76	440
1520	WA7106	CTG			CHT,V.ARG	5		.43		.29	1.12	260
1550	WA7107	CTG			SH,CHTY	7		.26		.19	.65	250
1580	WA7108	CTG			CHT,V.ARG	11		1.52		.36	6.49	427
1610	WA7109	CTG			SH,CHTY	13		2.67		.65	12.84	481
1640	WA7110	CTG			LST,CHTY	52		.61		.26	4.36	715
1660	WA7111	CTG			SH,CHTY	12		1.58		.27	4.34	275
1684	XA7111		SIL	MONT	FORM.TOP							
1700	WA7112	CTG			SH,CALC	14		1.12		.23	1.76	157
1730	WA7113	CTG			SH,CALC	17		.73		.19	1.21	166
1760	WA7114	CTG			SH,CALC	17		.86		.17	1.66	193
1820	WA7115	CTG			LST,V.ARG	62		.60		.21	3.17	528
1880	WA7116	CTG			SH,CALC	24		1.09		.15	2.40	220
1940	WA7117	CTG			SH,CALC	14		1.10		.09	2.24	204
2000	WA7118	CTG			SH,CALC	17		1.01		.07	1.64	162
2060	WA7119	CTG			SH,CHTY	15		.82		.10	1.51	184
2120	WA7120	CTG			SH,CALC	14		1.22		.18	3.75	307
2180	WA7121	CTG			SH,CALC	15		.90		.08	2.00	222
2240	WA7122	CTG			SH,CALC	15		1.06		.09	2.12	200
2300	WA7123	CTG			SH,CALC	21		2.29		.32	7.50	328
2360	WA7124	CTG			SH,CALC	19		1.57		.33	4.73	301
2420	WA7125	CTG			SH,CALC	21		2.50		.62	10.51	420
2480	WA7126	CTG			SH,CALC	23		2.21		.38	7.24	328
2540	WA7127	CTG			SH,CALC	20		2.13		.26	6.11	287
2600	WA7128	CTG										
2640	WA7129	CTG			SH,CALC	19		2.73		.21	6.85	251

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
880	.07		4									.41		28.63	
910	.15		7												
940	.30		7									.43			
970	.25		18												
1000	.22		22												
1030	.07		31												
1034															
1100	.05		17		3.03	.87	2.16	273	.40				29.87		30.00
1200	.33		14												
1230	.20		24									.52			
1490	.19		100										30.20		
1520	.21		67												
1550	.23		73												
1580	.05		24		5.06	1.08	3.98	333	.27				30.43	30.20	30.80
1610	.05		24		11.12	2.22	8.90	416	.25						
1640	.06		43												
1660	.06		17		4.84	.97	3.87	306	.25				29.36		30.25
1684															
1700	.12		21												
1730	.14		26										30.38		31.16
1760	.09		20									.53			
1820	.06		35												
1880	.06		14		2.69	.82	1.87	247	.44				29.61		30.59
1940	.04		8												
2000	.04		7												
2060	.06		12												
2120	.05		15		3.72	.94	2.78	305	.34				29.72		30.66
2180	.04		9												
2240	.04		8												
2300	.04		14		6.86	1.70	5.16	300	.33			.57	29.73		30.67
2360	.07		21												
2420	.06		25		8.15	1.83	6.32	326	.29				29.92	29.25	30.71
2480	.05		17												
2540	.04		12												
2600												.50			
2640	.03		8												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2670	WA7130	CTG			SH,CALC	21		2.42		.25	5.71	236
2700	WA7131	CTG			SH,CALC	17		1.43		.11	2.19	153
2760	WA7132	CTG			SH,CALC	20		1.93		.24	4.45	231
2820	WA7133	CTG			SH,CALC	21		2.00		.16	4.40	220
2880	WA7134	CTG			SH,CALC	20		2.00		.21	5.94	297
2940	WA7135	CTG			SH,CALC	17		1.77		.15	3.88	219
3000	WA7136	CTG			SH,CALC	18		1.61		.11	2.01	125
3060	WA7137	CTG			SH,CALC	20		1.48		.05	1.87	126
3120	WA7138	CTG			SH,CALC	19		1.47		.16	2.05	139
3180	WA7139	CTG										
3240	WA7140	CTG			SH,CALC	14		.89		.12	1.07	120
3300	WA7141	CTG			SH,CALC	20		1.59		.17	2.81	177
3360	WA7142	CTG			SH,CALC	32		.97		0.00	1.00	103
3420	WA7143	CTG			SH,CALC	16		1.06		.09	1.61	152
3500	WA7144	CTG			SH,CALC	21		.68		.05	.72	106
3530	WA7145	CTG			SH,CALC	16		.82		.02	.85	104
3560	WA7146	CTG			SH,CALC	14		1.22		.17	3.07	252
3598	XA7146		DEV	ARKN	FORM.TOP							
3620	WA7147	CTG			SH,CALC	21		1.06		.08	1.54	145
3680	WA7148	CTG			SH,CHTY	14		.76		.11	1.25	164
3740	WA7149	CTG			SH,CHTY	19		.86		.11	2.32	270
3800	WA7150	CTG										
3860	WA7151	CTG			SH,CHTY	14		.54		.05	.46	85
3920	WA7152	CTG			SH,CHTY	13		.59		.09	.35	59
3980	WA7153	CTG			SH,CHTY	13		.64		.12	.77	120
4040	WA7154	CTG										
4100	WA7155	CTG			SH,CHTY	12		.35		.08	.30	86
4160	WA7156	CTG			SH,CHTY	12		.42		.16	.81	193
4220	WA7157	CTG			CHT,ARG	6		.34		.20	1.03	303
4280	WA7158	CTG			SH,CHTY	10		.61		.17	1.90	311
4340	WA7159	CTG										
4400	WA7160	CTG			SH,CHTY	11		1.14		.25	4.82	423
4420	XA7160		DEV	ARKN	FORM.TOP							
4460	WA7161	CTG			SH,CHTY	19		1.50		.14	3.35	223
4520	WA7162	CTG			SH,CHTY	13		1.10		.21	2.67	243
4580	WA7163	CTG			SH,CHTY	13		.99		.21	3.63	367
4640	WA7164	CTG			CHT,ARG	9		.39		.09	.83	213
4700	WA7165	CTG			CHT,ARG	7		.40		.24	1.26	315
4760	WA7166	CTG			CHT,ARG	9		.69		.19	1.38	200
4764	XA7166		SIL	MOHT	FORM.TOP							
4820	WA7167	CTG			SH,CALC	12		1.13		.21	2.96	262
4875	XA7167		DEV	ARKN	FORM.TOP							
4880	WA7168	CTG			SH,CALC	14		1.09		.25	3.29	302
4910	WA7169	CTG			CHT,ARG	19		1.26		.22	4.06	322
4940	WA7170	CTG			CHT,ARG	10		.47		.28	1.35	287
4970	WA7171	CTG			CHT,ARG	8		.65		.23	1.62	249
5060	WA7172	CTG			CHT,ARG	7		.51		.32	1.56	306
5100	WA7173	CTG			CHT,ARG	10		.63		.19	1.37	217
5160	WA7174	CTG			SH,CALC	14		.64		.08	1.21	189

WELL/SITE :#3 VICTOR

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2670	.04		10		6.68	1.66	5.02	276	.33				30.12		30.89
2700	.05		8												
2760	.05		12												
2820	.04		8												
2880	.03		10		6.89	1.55	5.34	344	.29			.59	30.24		30.90
2940	.04		8												
3000	.05		7												
3060	.03		3												
3120	.07		11		2.56	.84	1.72	174	.49				30.30		30.88
3180												.55			
3240	.10		13												
3300	.06		11		3.14	.94	2.20	197	.43				29.96		30.94
3360	0.00		0												
3420	.05		8												
3500	.06		7									.48			
3530	.02		2												
3560	.05		14		2.99	.93	2.06	245	.45				30.15		
3598															
3620	.05		8												
3680	.08		14												
3740	.05		13		2.47	.60	1.87	287	.32				29.27	29.29	28.92
3800												.57			
3860	.10		9												
3920	.20		15												
3980	.13		19		.98	.31	.67	153	.46				29.58		29.70
4040												.49			
4100	.21		23												
4160	.16		38										30.34		
4220	.16		59												
4280	.08		28												
4340												.43			
4400	.05		22		4.00	1.01	2.99	351	.34				30.58		30.68
4420															
4460	.04		9		3.92	.83	3.09	261	.27				30.07	30.29	29.95
4520	.07		19												
4580	.05		21		3.68	.87	2.81	372	.31				30.01		29.96
4640	.10		23									.47			
4700	.16		60												
4760	.12		28										30.24		30.03
4764															
4820	.07		19		3.31	.78	2.53	293	.31				30.25	30.29	30.68
4875															
4880	.07		23		3.84	1.00	2.84	352	.35				30.42	29.71	30.59
4910	.05		17												
4940	.17		60									.44			
4970	.12		35		1.57	.48	1.09	242	.44				30.18		
5060	.17		63												
5100	.12		30												
5160	.06		12										30.32		30.16

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5220	WA7175	CTG			SH,CALC	13		.60		.08	.81	135
5280	WA7176	CTG			SH,CALC	14		.64		.08	.77	120
5340	WA7177	CTG			SH,CALC	16		.68		.08	1.04	153
5380	WA7178	CTG			CHT,ARG	12		.79		.18	1.73	219
5410	WA7179	CTG			CHT,ARG	10		1.02		.22	2.67	262
5440	WA7180	CTG			CHT,ARG	9		1.38		.31	4.55	330
5470	WA7181	CTG			CHT,ARG	8		2.04		.30	5.30	260
5490	XA7181		MISS	STAN	FORM.TOP							
5500	WA7182	CTG			SH,CALC							
5560	WA7183	CTG			SH,CALC	16		.69		.08	.72	104
5620	WA7184	CTG			SH,CALC	14		.71		.14	.74	104
5680	WA7185	CTG			SH,CALC	15		.87		.10	1.32	152
5740	WA7186	CTG			SH,CALC	16		.67		.05	.48	72
5800	WA7187	CTG			SH,CALC	16		.74		.27	.61	82
5860	WA7188	CTG			SH,CALC	14		.65		0.00	.55	85
5920	WA7189	CTG			SH,CALC	16		.60		0.00	.38	63
6192	XA7189	TD										

WELL/SITE :#3 VICTOR

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -‰	D-13C (TSE) -‰	D-13C (KPY) -‰
5220	.09		13									.48			
5280	.09		12												
5340	.07		12												
5380	.09		23		2.42	.60	1.82	306	.33				30.34		30.35
5410	.08		22												
5440	.06		22		5.12	1.24	3.88	371	.32				30.00		30.37
5470	.05		15												
5490															
5500												.48			
5560	.10		12										29.59		30.21
5620	.16		20												
5680	.07		11		1.55	.45	1.10	178	.41				29.72	28.84	30.59
5740	.09		7												
5800	.31		36												
5860	0.00		0									.48	29.00		30.84
5920	0.00		0												
6192															

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: C. Titus
SPC Mid-Continent Division
Dallas

October 18, 1982

From: Petroleum Geochemistry Group
Warrensville

PGW/101582/HH/2-5

Technical Memorandum (PGW/TM 074) -- Geochemical Characterization of Two Liquid Hydrocarbons Recovered from Sevier Oil Co. #1 Mix Well, Sevier County, Arkansas.

Summary: Results of an isotopic and chromatographic analysis of two liquid hydrocarbon samples recovered from the #1 Mix well showed the oils to be representative of a mature crude oil. No evidence for extensive biodegradation was found, however, an abundance of non-hydrocarbons (asphaltenes and polar compounds) in the samples was attributed to either deasphalting or water washing of the mature crude or both. The petroleum was probably derived from a Post-Devonian, or younger, source kerogen assemblage deposited under marine (middle neritic -- pelagic?) conditions.

1. INTRODUCTION

This report presents the results of the characterization of two samples of a liquid hydrocarbon recovered from the Sevier Oil Company #1 Nix well at an unknown depth. The well, drilled in Sevier County, Arkansas, was reported to have penetrated Cretaceous sediments and the Pennsylvanian Jackfork Fm. to a TD of about 2,000 ft. The hydrocarbon was believed to have flowed from the basal Cretaceous sediments or the Jackfork Fm. Carbon isotopic analyses performed on these two oil samples and reported in TM 045 (1) suggested that they were sourced from Upper Paleozoic sediments and may be related to natural asphalt occurrences in Sevier County. A full characterization of the two samples was undertaken as a development exercise and as part of the PGW oil characterization program.

2. MATERIALS AND METHODS

2.1 Materials

Two samples of hydrocarbons were received and given PGW hydrocarbon designations HCB-147 and HCB-148. Sample HCB-147 was a water oil mix. Sample HCB-148 was taken from the capped well after it was opened and allowed to flow.

2.1 Methods

The hydrocarbon samples were clarified by centrifugation and were characterized using the following standardized PGW techniques: Gravity Determinations (API and Sp. Gr.), Asphaltene Content

(C5 insolubles), Simulated Distillation (performed only on HCB 148), Hydrocarbon Type Analysis, and Saturate Alkane Analysis. Carbon isotopic analysis was performed as described in GGPM 17 A, B (2). Light hydrocarbon range analysis and topping were not performed due to the heaviness (API° 22.9° and 16.9°) of the oils.

3. RESULTS AND CONCLUSIONS

The results of the characterization of the samples are given in tabular and graphic form in Tables 1 and 2 and Figures 1 - 5.

3.1 Simulated Distillation of HCB-148 showed that about ~14% of the sample consisted of low boiling point (< 200° C) light hydrocarbons (Fig. 1) and there were almost no hydrocarbons of boiling point < 100° C.

3.2 Results of the Hydrocarbon Type Analysis indicated that the hydrocarbon samples were relatively high in aromatics (HCB 147 ~ 23%, HCB 148 ~ 26%) and polars (HCB 147 ~22%, HCB 148 ~24%).

3.3 Both samples were relatively high in asphaltenes (HCB 147 ~25%, HCB 148 ~20%) which was not unexpected due to the low API°.

3.4 The Saturate Alkane Analysis gas chromatograms (Figures 2 and 3) show that the n-alkanes form a homologous series *n*-C11 to *n*-C29. The slight hump on the chromatograms indicated the presence of some napthenes. No steranes or triterpanes were detected. The narrow n-alkane distribution, with apparently no significant components in the > n C_{30} range was typical of extreme thermal maturity. In view of the abundant asphaltene content in these oils this was thought unlikely. An alternative, and more plausible explanation, was that the source kerogen assemblage(s) were highly marine in depositional character and embraced little, if any, terrestrially derived materials.

3.5 Whole oil carbon isotope values have previously been reported (1). The "heavy" $\delta^{13}C$ values at -25.5 ppt strongly suggest that the petroleums had a provenance in U. Paleozoic or younger source sediments. Significantly isotopically lighter oils ($\delta^{13}C \leq -29$ ppt) would be expected from L. Paleozoic (ie Pre-Devonian) sources. The isotopic type curves indicate a decrease in the ^{13}C content of the polar and asphaltene fractions relative to the "classical" type curve for unaltered oils (Figure 4). This non-traditional case does not appear to have a simple explanation. Slight biodegradation resulting in isotopically light microbial detritus being incorporated into the asphaltene fraction is a possibility. More plausible, however, is the entrainment of higher molecular weight n-alkanes in the asphaltenes.

3.6 The isotopic results, type analyses, and pristane/phytane, pristane/n-C17, phytane/n-C18 ratios indicate that the water mixed with sample HCB-147 caused no discernable alteration effects. (cf typical saturate alkane gas chromatogram of biodegraded oil - Figure 5).

3.7 The dominance of n-C12 - n-C18 alkanes and the absence of any steranes or triterpanes in the saturate alkane analysis indicated that the Nix hydrocarbon was a mature product. The presence of an abundance of asphaltenes (~ 20 - 25%) and polar compounds (~ 23%) suggested that the Nix crude had been altered in some way. However, a n-alkane content of ≥ 20% wt. saturates indicated that biodegradation was not a significant altering agent. The composition of the Nix hydrocarbon appeared to be the result of deasphalting or water washing of a mature, primarily marine derived crude oil.

4. REFERENCES

1. Sedivy, R. (1982) Stable Carbon Isotopic Investigation of Five Asphalt Samples, and Nix #1 Crude Oil Samples from Pike and Sevier Counties, Arkansas. PGW/TM 045.

2. Sedivy, R. (1981) Stable Carbon Isotopic Analysis of Sedimentary Organic Materials Part-A Sample Preparation, Part-B Instrumental Analysis, Petroleum Geochemistry. GGPM 017 A, B.

Henry I. Halpern

Frank A. Marsek

/bes

Attachments: Tables 1, 2
Figures 1, 2, 3

cc: [redacted]
J. G. Grasselli
R. Burwood
R. J. Drozd
PCM Files (0), (2-5)

TABLE 1

08.49.27. 11/05/82

S U M M A R Y H Y D R O C A R B O N D A T A S H E E T

COUNTRY:US	WELL/SITE:#1 NIX	SAMPLE ID:HCB147 FORMATION:UNKNOWN
STATE :AR	LOCATION :SEC1,T10SR31W	TYPE: OIL AGE/EPOCH:
COUNTY :SEVIER	API/OCS :-	DEPTH(FT): UNKNOWN
PGW JOB:8220	REPORT :	DATA BASE: PGW

INSPECTION DATA

SPECIFIC GRAV.		.916
API GRAV.		22.90
SULFUR	%WT:	2.82
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	25.20
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C		
TYPE ANALYSIS		
SATURATES	%WT:	29.30
AROMATICS	%WT:	23.10
POLARS	%WT:	22.40
ASPHALTENE(2)	%WT:	25.20
N-ALKANE	%WT:	21.53
N-ALKANE CPI	:	1.24
ACYCLIC ISOPRENOID		
FARNESANE	%WT:	.77
ACYCLIC C16	%WT:	1.35
ACYCLIC C18	%WT:	1.08
PRISTANE	%WT:	1.18
PHYTANE	%WT:	.74
PRISTANE/PHYTANE	:	1.60
PRISTANE/N-C17	:	.55
PHYTANE/N-C18	:	.50
NICKEL/VANADIUM	:	
D-13 C(OIL)	:	-25.53 %.
D-13 C(DISTILLATE)	:	%.
D-13 C(SATURATES)	:	-26.13 %.
D-13 C(AROMATICS)	:	-25.03 %.
D-13 C(POLARS)	:	-25.11 %.
D-13 C(ASPHALTENES)	:	-25.52 %.
D-13 C(RESINS)	:	%.
D-34 SULFUR	:	-.60 %.
D-2 DEUTERIUM	:	%.
D-15 NITROGEN	:	%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

	% WT SATURATES
C10	
C11	
C12	2.197
C13	3.375
C14	3.481
C15	3.380
C16	2.669
C17	2.124
C18	1.471
C19	1.169
C20	.656
C21	.401
C22	.220
C23	.133
C24	.095
C25	.066
C26	.020
C27	.016
C28	.016
C29	.003
C30	
C31	
C32	.014
C33	.004
C34	
C35	
C36	

PENTACYCLANE CONTENT

	NORMALISED DIST
H	
B	
D	
G	
N	
O	
U	
V	
ALPHA	
BETA	
GAMA	
DELTA	
EPSILON	
ZETA	

STERANE CONTENT

	NORMALISED DIST
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	

TABLE 2

08.49.28. 11/05/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US
STATE :AR
COUNTY :SEVIER
PGW JOB:8220

WELL/SITE:#1 NIX
LOCATION :SEC1,T10SR31W
API/OCS :-
REPORT :

SAMPLE ID:HCB148 FORMATION: UNKNOWN
TYPE: OIL AGE/EPOCH:
DEPTH(FT): UNKNOWN
DATA BASE: PGW

INSPECTION DATA

SPECIFIC GRAV.	:	.954
API GRAV.	:	16.90
SULFUR	%WT:	3.00
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	20.00
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE		
BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	30.50	
AROMATICS	%WT:	26.10	
POLARS	%WT:	23.50	
ASPHALTENE(2)	%WT:	20.00	
N-ALKANE	%WT:	31.61	
N-ALKANE CPI	:	1.27	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.91	
ACYCLIC C16	%WT:	2.26	
ACYCLIC C18	%WT:	1.79	
PRISTANE	%WT:	2.70	
PHYTANE	%WT:	1.58	
PRISTANE/PHYTANE	:	1.70	
PRISTANE/N-C17	:	.60	
PHYTANE/N-C18	:	.57	
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-25.54	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-26.14	%.
D-13 C(AROMATICS)	:	-25.13	%.
D-13 C(POLARS)	:	-25.14	%.
D-13 C(ASPHALTENES)	:	-25.48	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:	.40	%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP	81		
2	118	52	393
4	143	54	404
6	157	56	415
8	168	58	426
10	178	60	437
12	188	62	449
14	198	64	461
16	204	66	473
18	212	68	485
20	221	70	497
22	232	72	510
24	241	74	524
26	249	76	540
28	259	78	560
30	272	80	
32	282	82	
34	295	84	
36	308	86	
38	319	88	
40	331	90	
42	342	92	
44	353	94	
46	364	96	
48	374	98	
50	383	FBP	

N-ALKANE CONTENT

% WT SATURATES	
C10 :	
C11 :	
C12 :	.883
C13 :	2.529
C14 :	4.408
C15 :	5.787
C16 :	5.413
C17 :	4.467
C18 :	2.795
C19 :	2.343
C20 :	1.249
C21 :	.735
C22 :	.388
C23 :	.228
C24 :	.153
C25 :	.098
C26 :	.028
C27 :	.015
C28 :	.037
C29 :	.003
C30 :	
C31 :	.011
C32 :	.045
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT

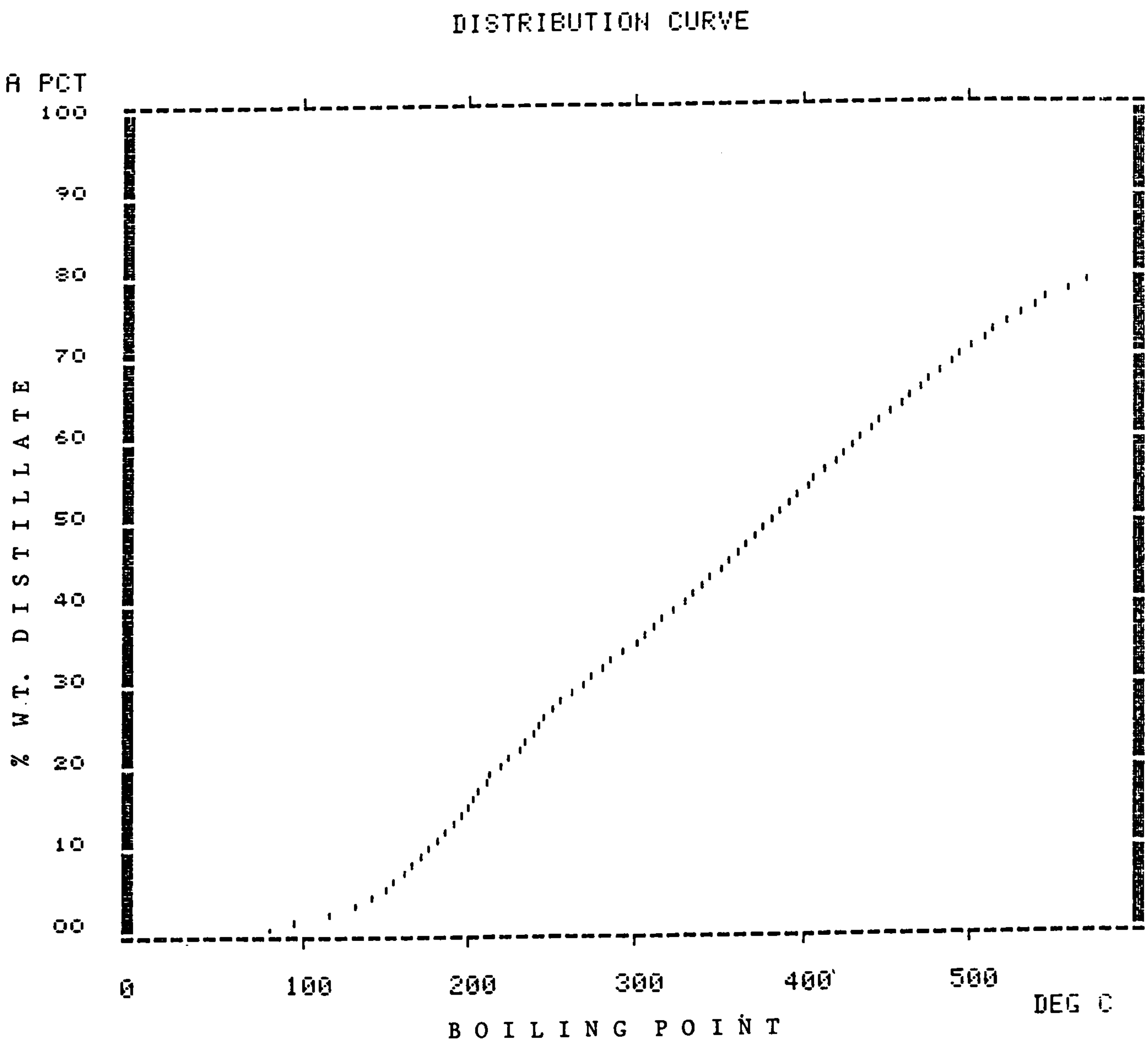
NORMALISED DIST	
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT

NORMALISED DIST	
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

FIGURE 1

SIMULATED DISTILLATION



CONDITIONS FOR SATURATE HYDROCARBON
GAS CHROMATOGRAPH ANALYSIS

G.C.	- Varian 3700
Column	- Alltech WCOT 14, .25 mm I.D., .2µ film
Carrier	- Helium, 1ml/min., 8 P.S.I.G.
Detector	- F.I.D., 350°C
Temp. Program	- Initial 60°C, 4 min. hold
	- Program Rate of 7°C/min.
	- Final 270°C, 26 min. hold
Range	- 10^{-11} amps/mv
Solvent	- n-Hexane
Injector	- split 10:1
Attenuation	- 16
Injection Volume	- 2µl
Concentration	- 6 mg/ml
Analysis Time	- 54 min.

F' 'RE 2

#1 NIX HYDROCARBON (HCB-147)
SATURATE ALKANE ANALYSIS

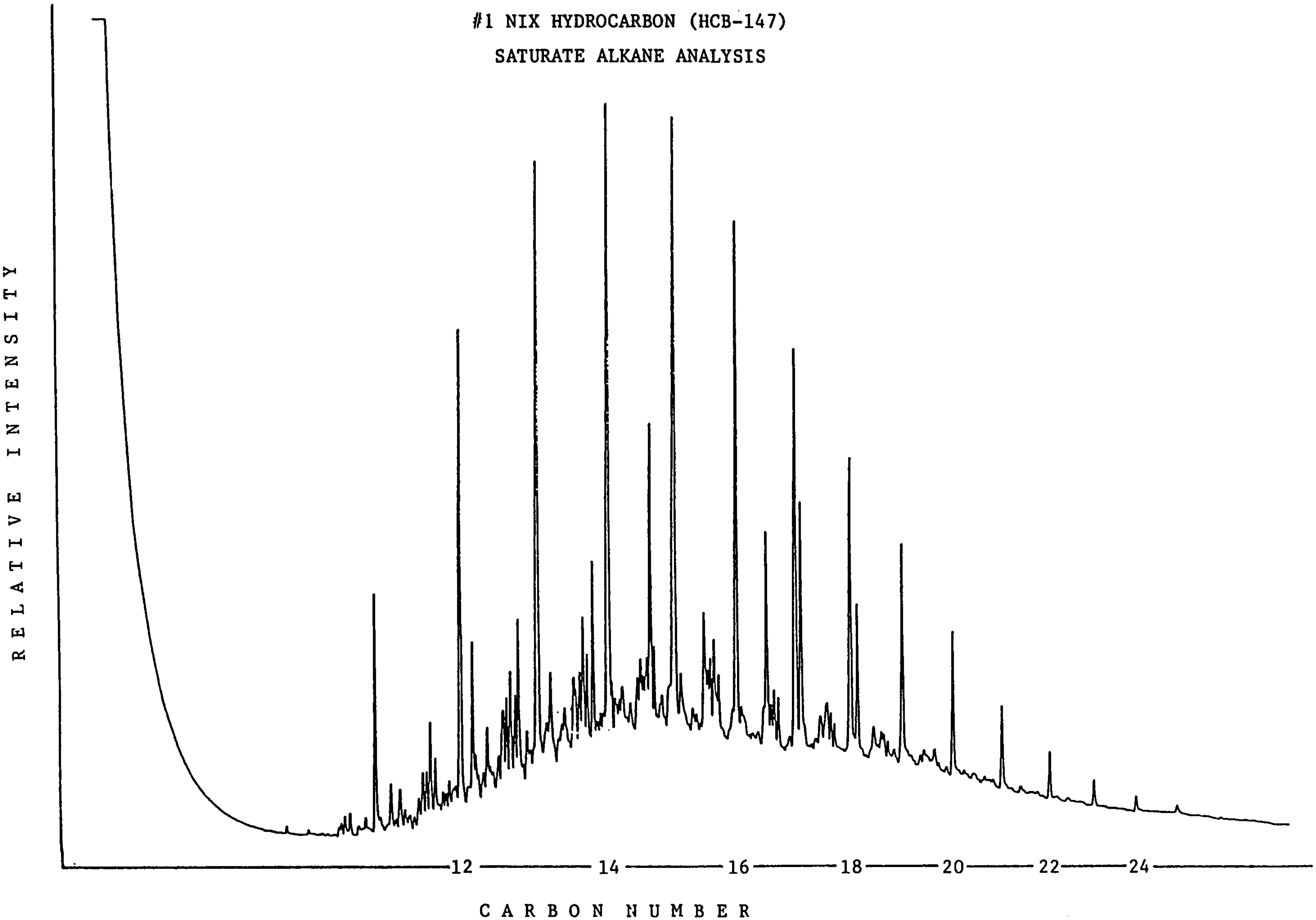


FIGURE 3

#1 NIX HYDROCARBON (HCB-148)

SATURATE ALKANE ANALYSIS

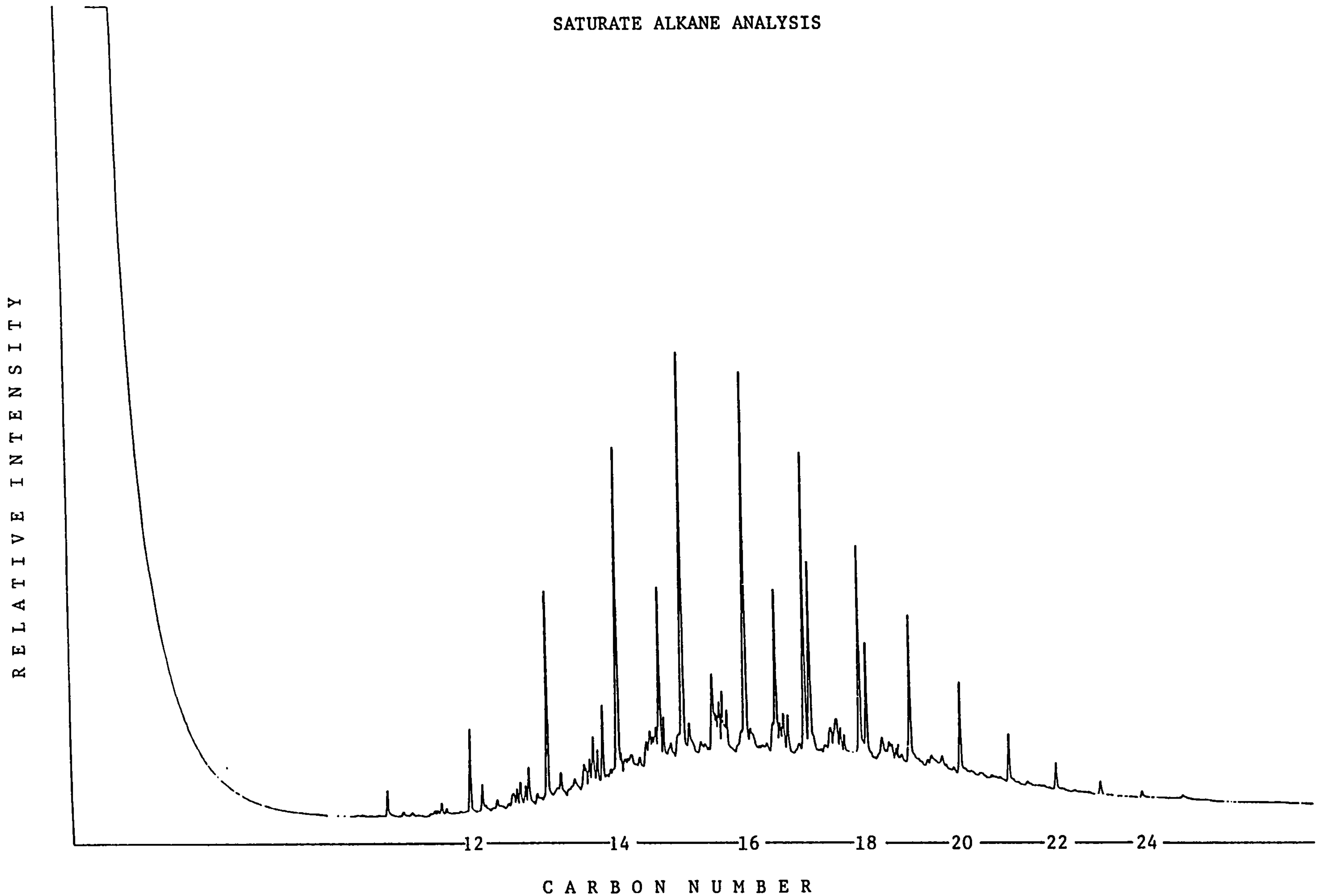


FIGURE 4

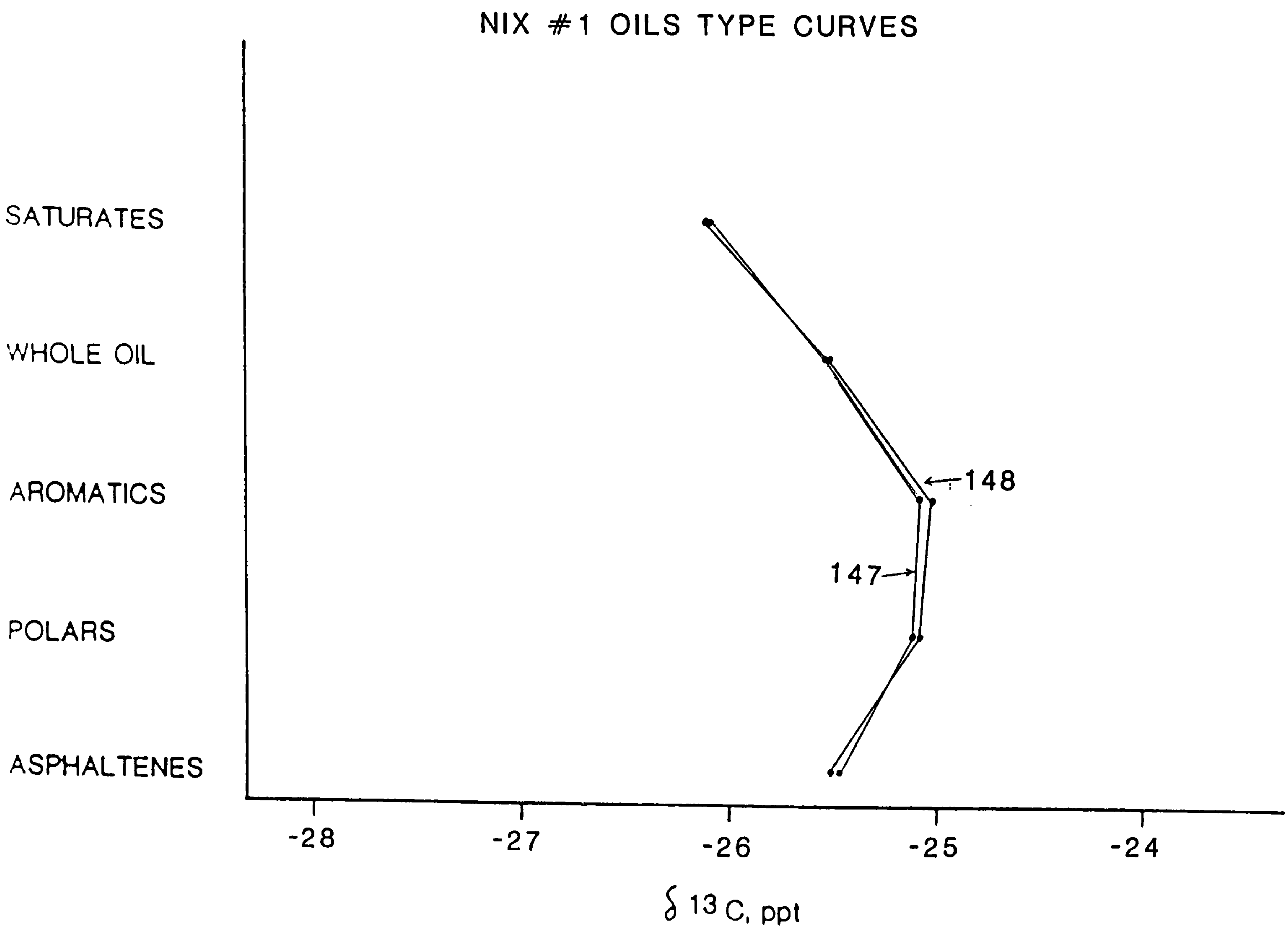
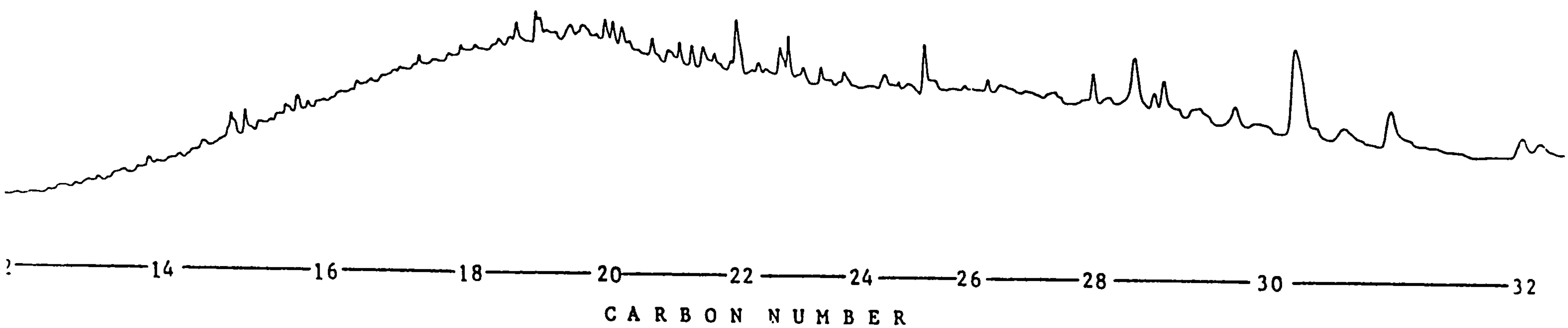

NIX #1 OILS TYPE CURVES
SATURATES
WHOLE OIL
AROMATICS
POLARS
ASPHALTENES
148
147
-28
-27
-26
-25
-24
δ 13 C, ppt

FIGURE 5

SATURATE ALKANE GAS CHROMATOGRAM
OF SOLID HYDROCARBON SAMPLE AK 188 (FSA 720, HCB 088)



CONDITIONS:

G.C. - Varian 3700
Column - Alltech WCOT 14, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min., 8 P.S.I.G.
Dectector - F.I.D., 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final - 270°C, 26 min. hold

Range - 10^{-12}
Solvent - n-Hexane
Injector - Splitless for 30 sec.
Attenuation - 2
Injection Volume - 4μl
Concentration - 2.5 mg/ml
Analysis Time - 54 min.

H002.0401 PGW/TM74 [illegible]
C.2

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: E. Luttrell — November 8, 1982
SPC Mid-Continent Office
Dallas

From: Petroleum Geochemistry Group — PGW/110882/RB/2-5
Warrensville

Subject: Characterization of the Arkansas Nix #1 Petroleum. Report PGW/TM 074.

6735

Herewith for your retention two (2) copies (one for C. Titus) of the subject report.

All of the S. W. Arkansas petroleums (including bitumens) in our possession have previously been carbon isotopically characterized and reported on. A consistent, isotopic heavy, grouping of these materials was recognized. This has stimulated further work in an attempt to refine ideas as to the provenance of these petroleums. All the bitumens were found to be heavily, and not unexpectedly, biodegraded. A typical saturate alkane chromatogram is illustrated in Figure 5.

The Nix #1 produced oil proved to be of an interesting, and of somewhat unusual, composition. Despite the low API gravities, both oils supplied were seen to be paraffinic in nature and no compelling evidence for biodegradation was observed. The low API gravity was probably due in part to both a high asphaltene content and the absence of light ends. Both of these considerations tended to suggest that atmospheric weathering and settling of the petroleums may have occurred. According to whatever sampling procedure was then used, this could significantly prejudice the composition of the collected specimens.

The carbon isotopic profile, showing a $\delta^{13}C$ "light" asphaltene component, is extremely unusual. Several suggestions have been made as to how this may have arisen. Noting the abundance of the asphaltene component, however, this observation is thought to be real.

In conjunction with the isotopic heavy ($\delta^{13}C$, - 25.5 ppt) nature of the oil, and its narrow lower carbon number n-alkane range, a source kerogen drawing largely on open marine detrital input, is strongly suggested. This in turn would suggest an open marine (middle neritic to pelagic) depositional environment. Such a conclusion causes one of us some problem (F.M.). Marsek is concerned that the source of petroleum is from the Jackfork Fm. which is regarded as a

???

turbidite sequence showing strong terrestrial influences. I believe it is still premature to name progenitor formations, by default or otherwise. To date the information assembled for the Mix petroleum (and the Arkansas bitumens through carbon isotopic similarity) tends to suggest an U. Paleozoic or younger provenance from a dominantly marine kerogen assemblage.

R. Burwood.
R. Burwood

RB:bes
Enclosures: 2

cc: [redacted]
J. G. Grasselli (w/o report)
R. J. Drozd
H. I. Halpern
F. A. Marsek
PGW Files (0), (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

TABLE 2

Summary

Taylor 3/3
PGW015

Well Data for Sohio #1 Taylor

Location:	150' N of C, SE1/4, Section 15-T3S-R11E
Elevation:	562' GL Zero: 21.5' above GL
Operator:	Sohio
Contractor:	Arden Drilling Co.
Rig:	#4
Spud Date:	4/20/80
Date reached TD:	4/10/81
Date completed:	
Date rig released:	4/16/81
TD:	14,540'
Hole sizes:	17 1/2" to 1,875'; 12 1/2" to 8,944'; 8 1/2" to 12,591' 6" to 14,540'
Casing sizes:	20" Conductor @ 62'; 13 3/8" @ 1,875'; 9 5/8" @ 8,944'; 7" liner 8,484' to 12,577'
Electric logs:	At 1,868' : DIL-GR; CNL/FDC-GR; BHC-GR; FIL-HDT; CWL At 8,956' : TDT-M; CNL/GR-CCL; CBL-UD At 10,180': DIL-GR; CNL/FDC-GR; BHC-GR; CWL; FIL-HDT At 12,577': DIL-GR; CNL/FDC-GR; BHC-GR; GIL-HDT; CBL At 14,540': DIL-GR; CNL/FDC-Gr; BHC-GR; NGT from 1300'-3355' and 9400' - 12,240'

Velocity Survey
Borehole Gravimeter Survey
Mudlog: Surface to TD
Shale Density: 3,220' - 12,120'
Mud Temperature Monitor: 6,840' - TD

Formation Tops:

Spud in Antlers	
Stanley	148'
Arkansas Novaculite	1,440'
Missouri Mountain Polk Creek	1,693'
Bigfork Chert	1,884'

Formation Tops (cont'd)

Womble	2,558'
2nd Bigfork Chert	2,770'
Thrust	3,195'
Atokan	3,195'
Spiro Equivalent	9,619'
Wapanucka	9,835'
Springer	10,185'
Caney	11,300'
Woodford	11,690'
Sylvan	11,945'
Viola	12,085'
Bromide	12,390'
Basal McLish	13,092'
Oil Creek	13,140'
Basal Oil Creek	13,434'
Joins	13,705'
Arbuckle	13,798'
TD	14,540'

TABLE 3

14.00.47. 02/17/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US
STATE :OK
COUNTY :ATOKA
PGW JOB:803

WELL/SITE:TAYLOR#1
LOCATION :SEC15,T3SR11E
API/OCS :35-A00520087
REPORT :

SAMPLE ID:HCB006 FORMATION:BGFK
TYPE:PRO AGE/EPOCH:ORD
DEPTH(FT): 2110
DATA BASE:GEOCHEM/PGW

INSPECTION DATA		SIMULATED DISTILLATION %WT	DEG C	%WT	DEG C	N-ALKANE CONTENT % WT SATURATES	PENTACYCLANE CONTENT NORMALISED DIST
SPECIFIC GRAV. :	1.000						
API GRAV. :	10.00						
SULFUR %WT:	.80						
NITROGEN %WT:		IBP	257			C10 :	H :
WAX %WT:		2	287	52		C11 :	B :
WAX MPT DEG C:		4	305	54		C12 :	D :
ASPHALTENE (1) %WT:	12.00	6	320	56		C13 :	G :
NICKEL (PPM):	42	8	336	58		C14 :	N :
VANADIUM (PPM):	180	10	352	60		C15 :	O :
RESIDUE		12	366	62		C16 :	U :
BPT>200C %WT:	100	14	384	64		C17 :	V :
		16	399	66		C18 :	ALPHA :
GEOCHEMICAL DATA		18	414	68		C19 :	BETA :
		20	427	70		C20 :	GAMA :
RESIDUE BPT>200C		22	440	72		C21 :	DELTA :
TYPE ANALYSIS		24	452	74		C22 :	EPSILON :
SATURATES %WT:	33.04	26	463	76		C23 :	ZETA :
AROMATICS %WT:	23.94	28	474	78		C24 :	
POLARS %WT:	35.55	30	486	80		C25 :	STERANE CONTENT NORMALISED DIST
ASPHALTENE(2)%WT:		32	498	82		C26 :	
N-ALKANE %WT:		34	510	84		C27 :	
N-ALKANE CPI :	1.03	36	522	86		C28 :	
ACYCLIC ISOPRENOID		38	532	88		C29 :	
FARNESANE %WT:		40	541	90		C30 :	1 :
ACYCLIC C16 %WT:		42		92		C31 :	2 :
ACYCLIC C18 %WT:		44		94		C32 :	3 :
PRISTANE %WT:		46		96		C33 :	4 :
PHYTANE %WT:		48		98		C34 :	5 :
PRISTANE/PHYTANE :	1.17	50		FBP		C35 :	6 :
PRISTANE/N-C17 :	.75					C36 :	7 :
PHYTANE/N-C18 :	.76						8 :
NICKEL/VANADIUM :	.2						9 :
D-13 C(OIL) :	-30.21 %.						10 :
D-13 C(DISTILLATE) :	%.						11 :
D-13 C(SATURATES) :	%.						12 :
D-13 C(AROMATICS) :	%.						13 :
D-13 C(POLARS) :	%.						14 :
D-13 C(ASPHALTENES) :	-30.99 %.						15 :
D-13 C(RESINS) :	%.						16 :
D-34 SULFUR :	%.						17 :
D-2 DEUTERIUM :	%.						18 :
D-15 NITROGEN :	%.						19 :

TABLE 4

Well Taylor #1
Hydrocarbon Characterization Data

Petroleum / Analysis	Bigfork Bitumen	Arkansas Novaculite Extracts			Missouri Mtn Extract	Polk Creek Extract	"Upper" Bigfork Fm. Extracts		Womble Fm. Extracts	"Lower" Bigfork Fm. Extracts	
	HCB-006	HCB-058	HCB-059	HCB-060	HCB-061	HCB-062	HCB-031	HCB-032	HCB-063	HCB-033	HCB-034
Interval	2110-50'	1450'	1540'	1600'	1810'	1870'	2000'	2140'	2570'	2810'	2870'
Hydrocarbon Type Analysis											
Saturates(wt%)	33.0	25.9	26.4	25.5	17.6	45.7	44.4	17.7	53.0	38.5	38.8
Aromatics(wt%)	23.9	27.4	23.8	25.7	31.4	23.9	15.7	9.2	19.0	20.3	20.4
Polars(wt%)	35.5	48.4	45.4	42.9	34.8	26.3	16.8	30.5	27.0	36.5	32.0
n-Alkane CPI	1.0	0.94	0.98	1.05	1.01		0.95	1.02	1.11	1.08	1.06
Pristane/Phytane Ratio	1.17	1.32	2.09	1.56	1.76	1.17	0.96	1.24	1.30	1.22	1.11
nC_{17}/Pristane Ratio	1.33	1.10	1.00	1.12	1.29	1.84	1.24	1.37	0.88	1.31	1.30
nC18/Phytane Ratio	1.32	1.36	1.63	1.47	1.78	2.03	1.15	1.41	0.62	1.28	1.26
Carbon Isotope ($\delta^{13}C$ ‰) Whole Oil	-30.21	-30.02	-29.55	-29.76	-30.31	-29.83			-30.35		
Carbon Isotope ($\delta^{13}C$ ‰) Deasphaltened Oil	-30.73						-30.40	-30.65		-30.47	-30.78
Carbon Isotope ($\delta^{13}C$ ‰) Asphaltene	-30.99						-30.38	-29.91		-30.81	-30.86

TABLE 5

Well Taylor #1

Wapanucka Fm. Gas Analysis

Specific Gravity (60°F)	0.578
Calorific Value (60°F)	986 BTU Cu. $ft.^{-1}$

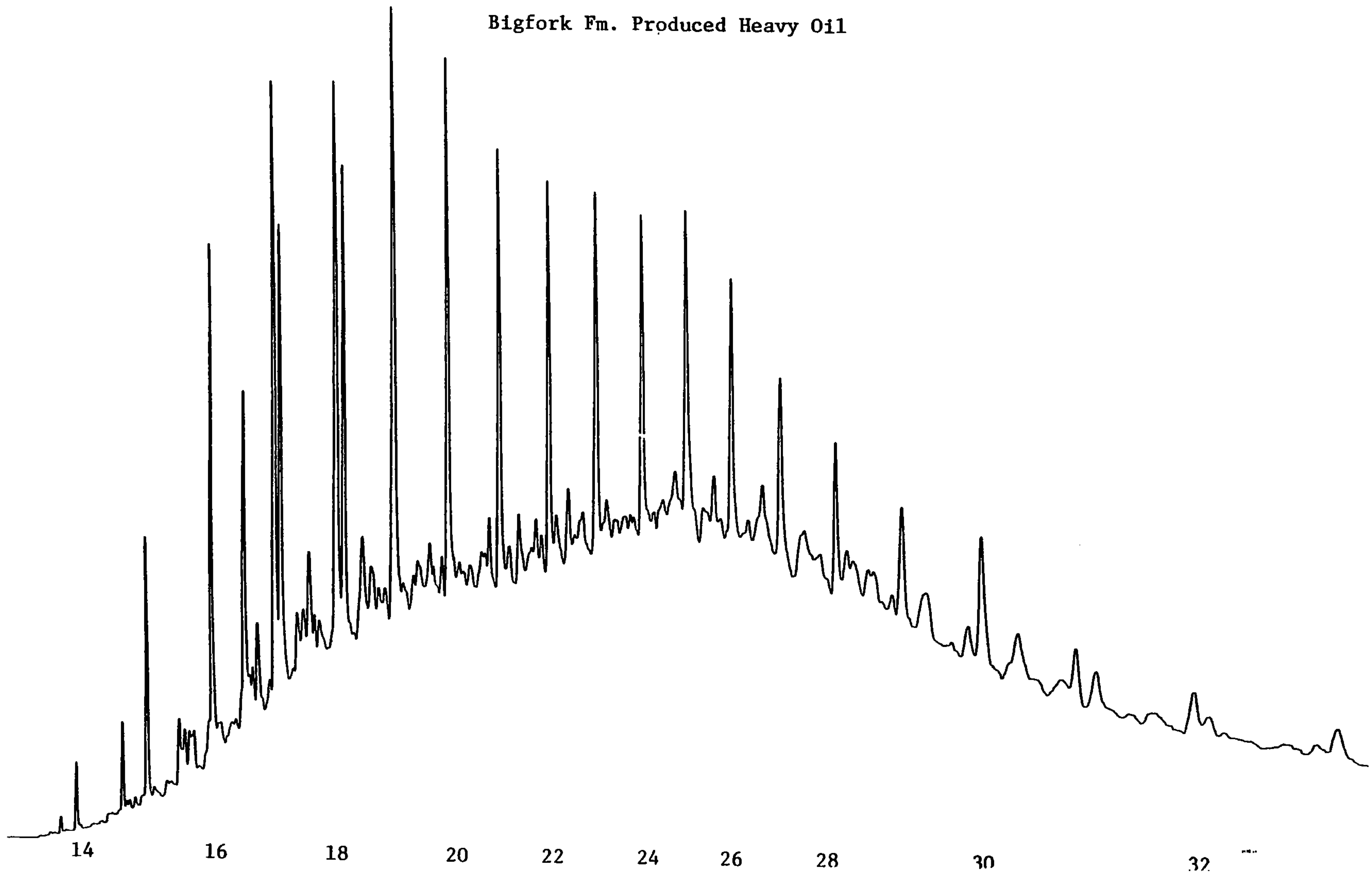
Composition

Component	Mole %
Methane	97.08
Ethane	0.78
Propane	0.11
Iso Butane	0.03
n Butane	0.04
Hexanes +	0.10
CO_2	1.31
N_2	0.45

Gas Dryness $\frac{C_1}{C_1 \rightarrow C_4}$ 99%

FIGURE 3a
Deasphaltened Total Solu Extract (TSE) HCB-006
Saturate Hydrocarbon Distribution

Bigfork Fm. Produced Heavy Oil



CONDITIONS:

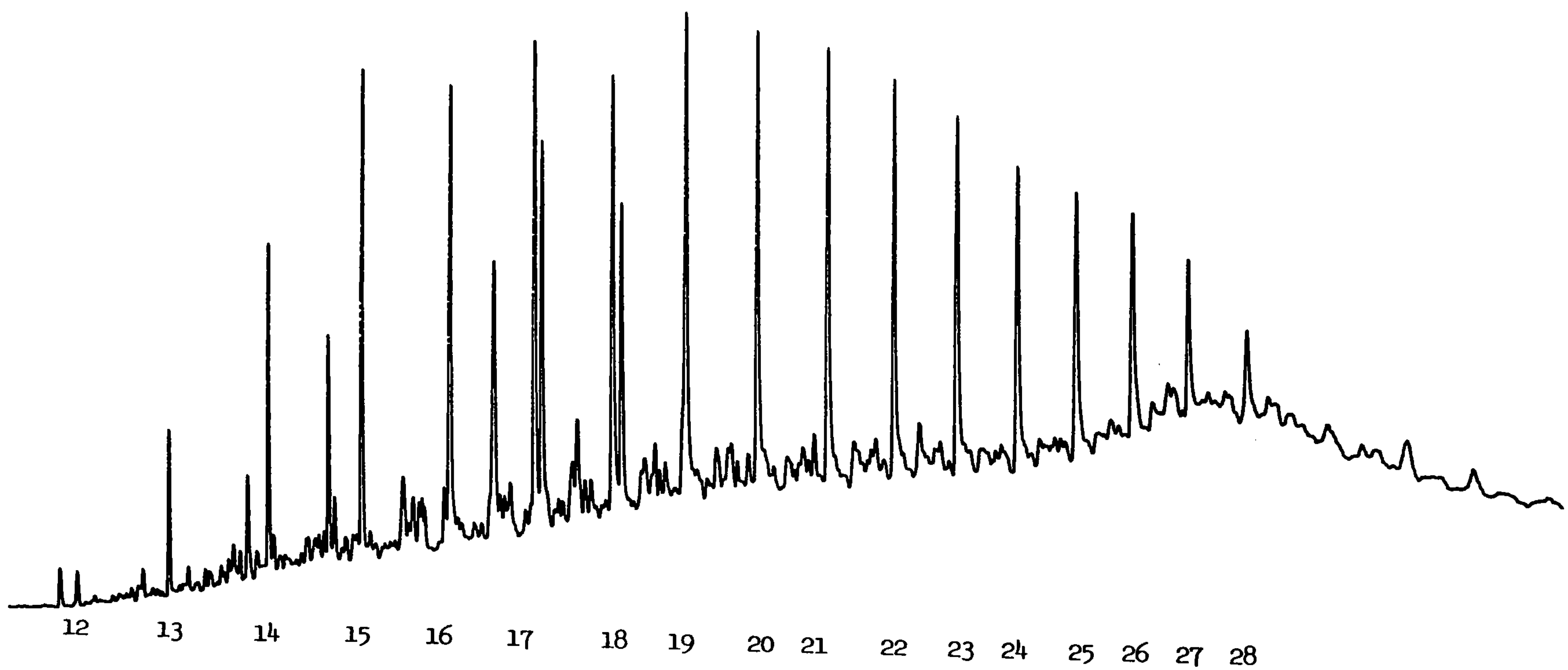
GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final 270°C, 26 min. hold
Analysis Time - 54 min.

Range - 10^{-12} amps/mv
Solvent - n-Pentane
Injector - Splitless
Attenuation - 4
Concentration - 2.5 mg/ml
Injection Volume - 2 μl

Fl. .tE 3b

Deasphaltened Total Soluble Extract (TSE) HCB-058
Saturate Hydrocarbon Distribution

Arkansas Novaculite Extract (1450')



CONDITIONS:

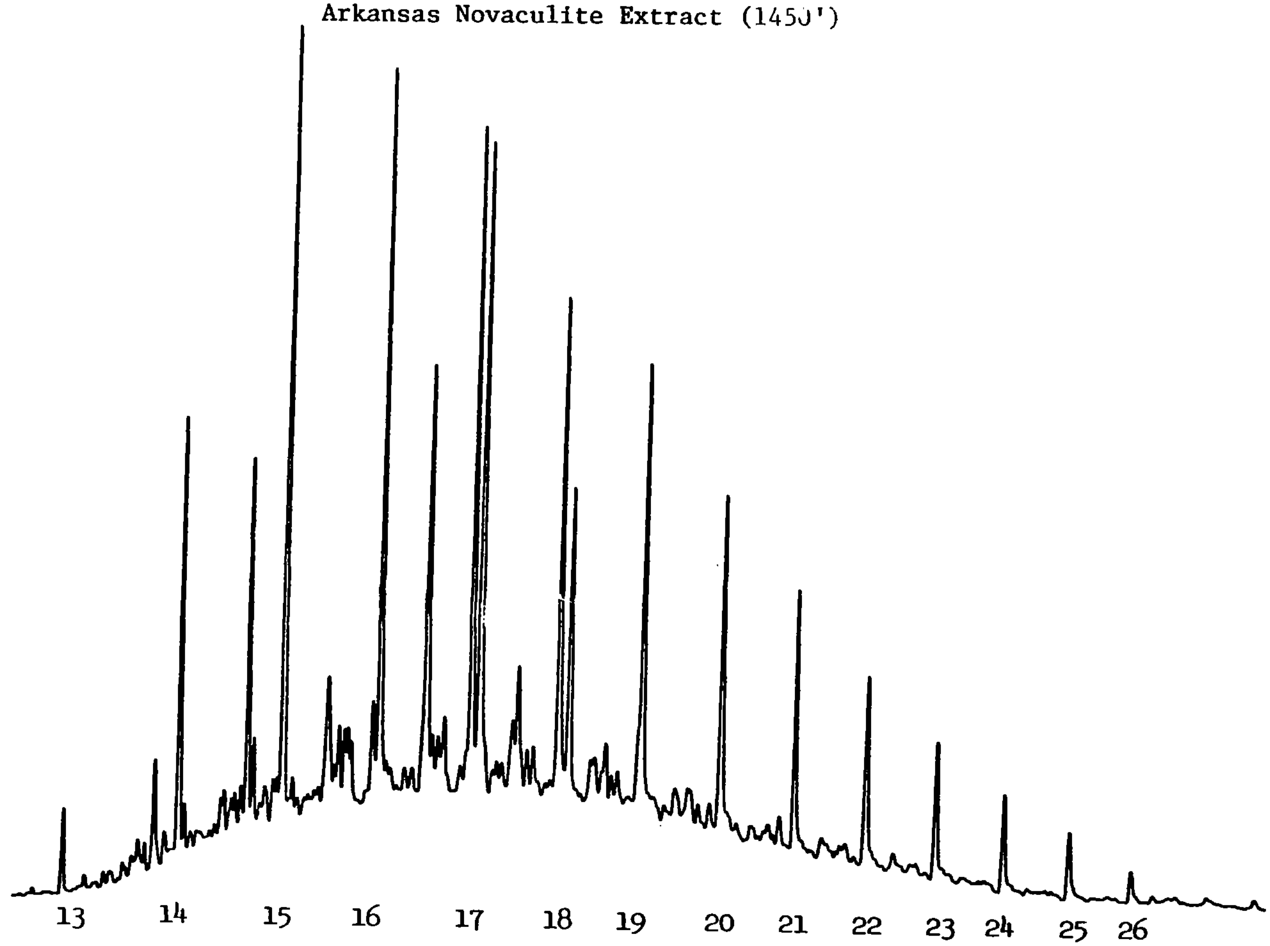
GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final 270°C, 26 min. hold
Analysis Time - 54 min.

Range - 10^{-11} amps/mv
Solvent - n-Pentane
Injector - Split, 200:1
Attenuation - 4
Concentration - 100%
Injection Volume - .2 μl

FI E 3c

Deaspheltened TSE HCB-059
Saturate Hydrocarbon Distribution

Arkansas Novaculite Extract (1450')



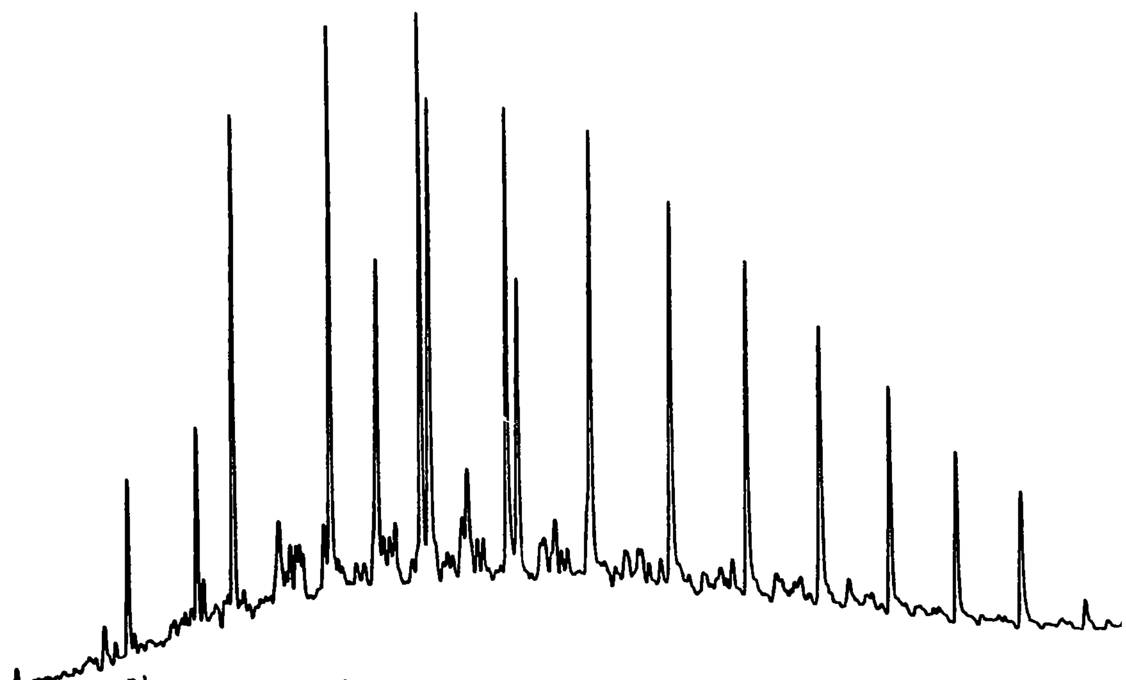
CONDITIONS:

GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final 270°C, 26 min. hold

Range - 10^{-11} amps/mv
Solvent - n-Pentane
Injector - Splitless
Attenuation - 8
Concentration - 1%
Injection Volume - .2 μl

FIGURE 3d

Deasphaltened TSE HCB-060
Saturate Hydrocarbon Distribution
Arkansas Novaculite Extract (1600')



CONDITIONS:

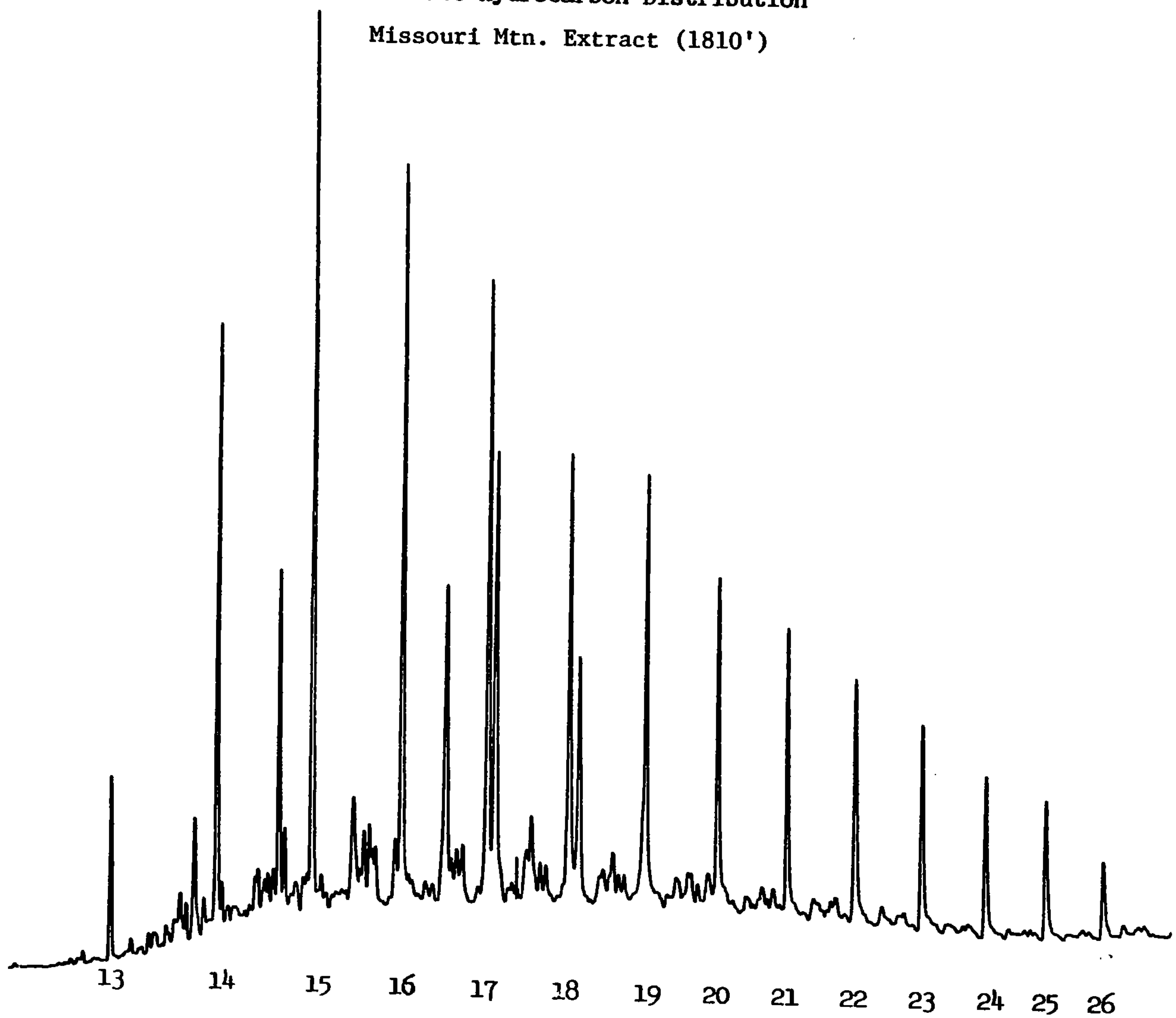
GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2 μ film
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350^{o}C
Temp. Program - Initial 60^{o}C, 4 min. hold
Program Rate - 7^{o}C/min.
Final 270^{o}C, 26 min. hold
Analysis Time - 54 min.

Range - 10^{-11} amps/mv
Solvent - n-Pentane
Injector - Splitless
Attenuation - 8
Concentration - 1%
Injection Volume - .2 μl

FIGURE 3e

Deasphalten TSE HCB-061
Saturate Hydrocarbon Distribution

Missouri Mtn. Extract (1810')



CONDITIONS:

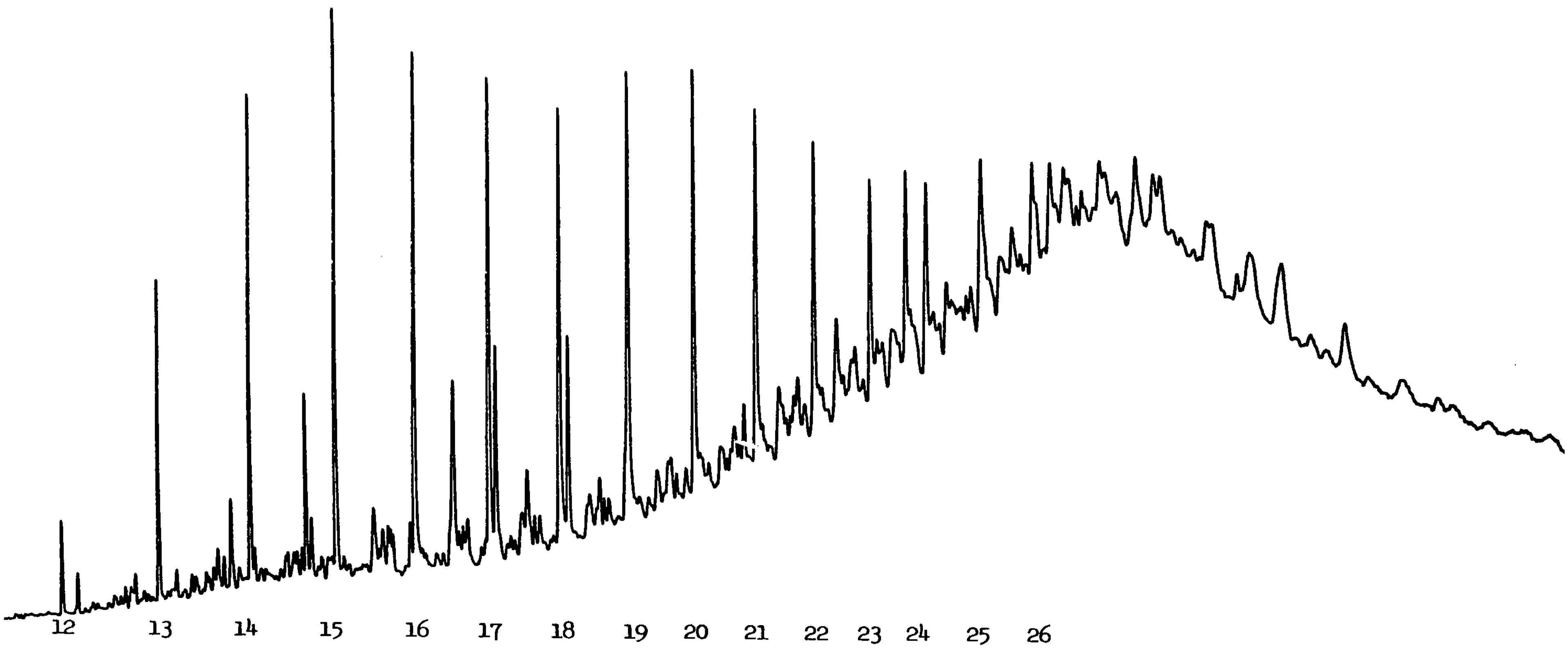
GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final 270°C, 25 min. hold
Analysis Time - 54 min.

Range - 10^{-11} amps/mv
Solvent - n-Pentane
Injector - Splitless
Attenuation - 8
Concentration - 1%
Injection Volume - .2 μl

FIG. 3F

Deasphaltened TSE HCB-062
Saturate Hydrocarbon Distribution

Polk Creek Extract (1870')



CONDITIONS:

GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final 270°C, 26 min. hold
Analysis Time - 54 min.

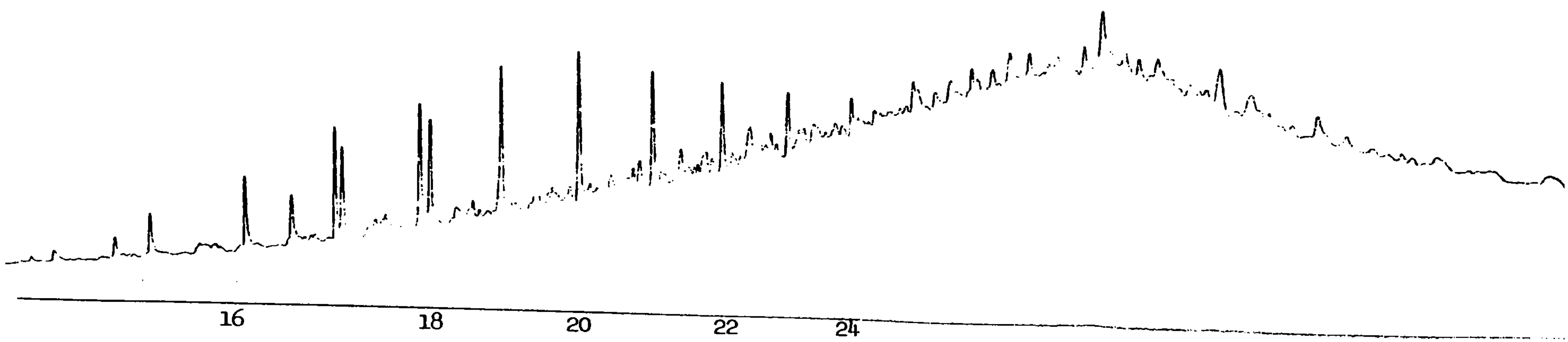
Range - 10^{-11} amps/mv
Solvent - n-Pentane
Injector - Split, 200:1
Attenuation - 4
Concentration - 100%
Injection Volume - .2 μl

1 JRE 3g

DEASPHALTENED TOTAL SOLUBLE EXTRACT (TSE) (HCB-031)

SATURATE HYDROCARBON DISTRIBUTION

Bigfork Fm. Extract (2000')



CONDITIONS:

GC-VARIAN 3700
COLUMN - SP 2100, 25m, ID .25 mm
CARRIER - He, 1.36 ml/min., 20 psi
INJECTOR - SPLITLESS, 300°C
DETECTOR - FID, 350°C
TEMP. PROGRAM - INITIAL 60°C, 4 min. hold
PROGRAM RATE - 7°C/min.
FINAL 270°C

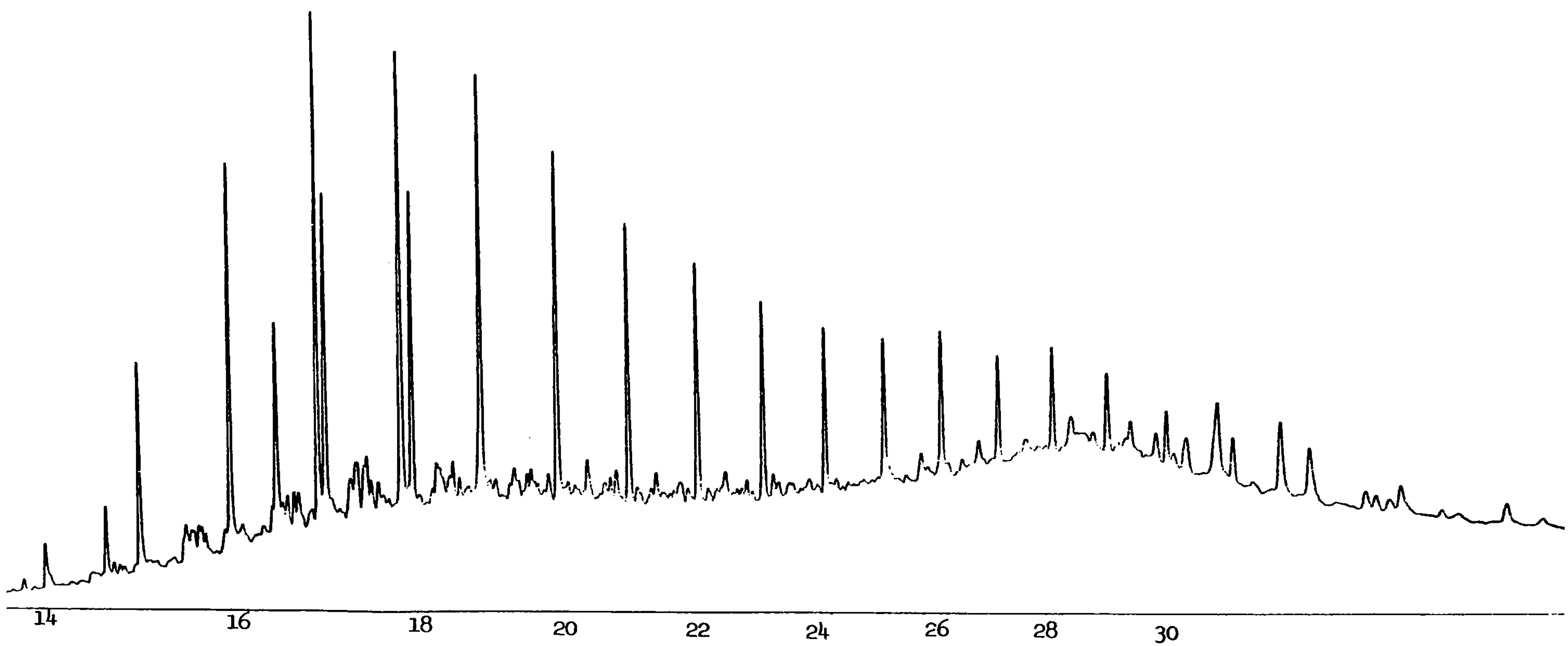
ANALYSIS TIME - 54 mins.
RANGE - 10^{-11} amps/mv
SOLVENT - n-PENTANE
ATTENUATION - 4
CONCENTRATION - .15 gm/ml
INJECTION VOL. - 3 μl

F1 ꓤE 3h

DEASPHALTENED TSE (HCB-032)

SATURATE HYDROCARBON DISTRIBUTION

Bigfork Fm. Extract (2140')



CONDITIONS:

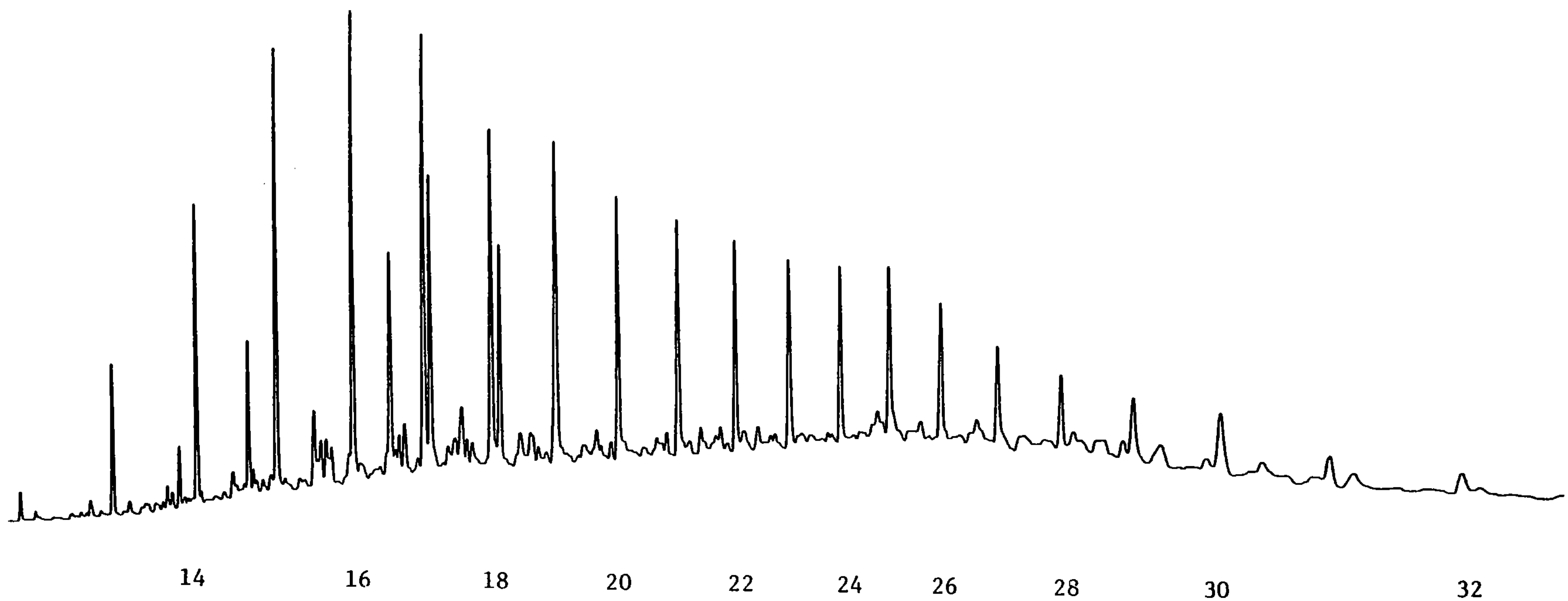
GC-VARIAN 3700
COLUMN - SP 2100, 25m, ID .25 mm
CARRIER - He, 1.36 ml/min., 20 psi
INJECTOR - SPLITLESS, 300°C
DETECTOR - FID, 350°C
TEMP. PROGRAM - INITIAL 60°C, 4 min. hold
PROGRAM RATE - 7°C/min.
FINAL 270°C

ANALYSIS TIME - 54 mins.
RANGE - 10^{-11} amps/mv
SOLVENT - n-PENTANE
ATTENUATION - 4
CONCENTRATION - .1 gm/ml
INJECTION VOL. - 3 µl

FIGURE 3i

Deasphaltened Total Soluble Extract (TSE) HCB-063+HCB-064 Composite
Saturate Hydrocarbon Distribution

Polk Creek Fm. Extract (1840')



CONDITIONS:

GC - Varian 3700
Column - Alltech WCOT 14, 25 m, .25 mm I.D., .2 μfilm
Carrier - He, .9 ml/min, 8 psi
Detector - FID, 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final 270°C, 26 min. hold
Analysis Time - 54 min.

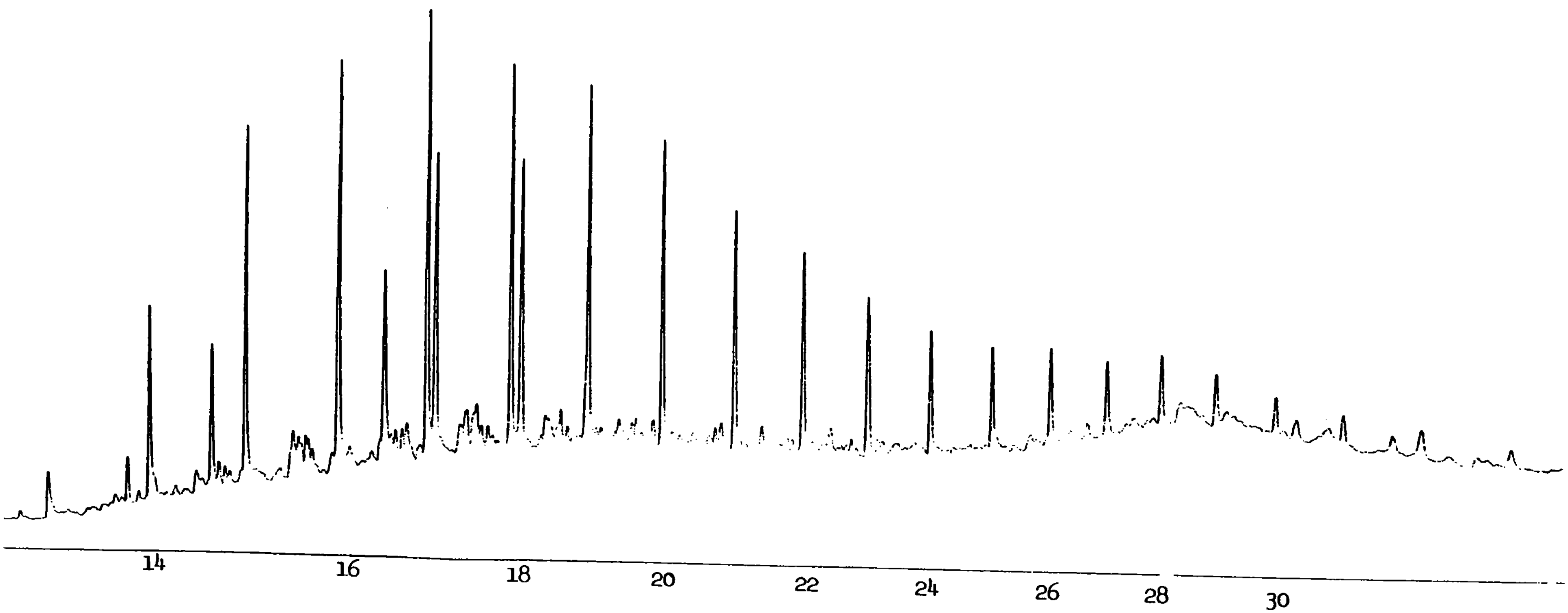
Range - 10^{-12} amps/mv
Solvent - n-Pentane
Injector - Splitless
Attenuation - 8
Concentration - 2.1 mg/ml
Injection Volume - 3 μl

FIGURE 3j

DEASPHALTENED TSE (HCB-033)

SATURATE HYDROCARBON DISTRIBUTION

Bigfork Fm. Extract (2810')



CONDITIONS:

GC-VARIAN 3700
COLUMN - SP 2100, 25m, ID .25 mm
CARRIER - He, 1.36 ml/min., 20 psi
INJECTOR - SPLITLESS, 300°C
DETECTOR - FID, 350°C
TEMP. PROGRAM - INITIAL 60°C, 4 min. hold
PROGRAM RATE - 7°C/min.
FINAL 270°C

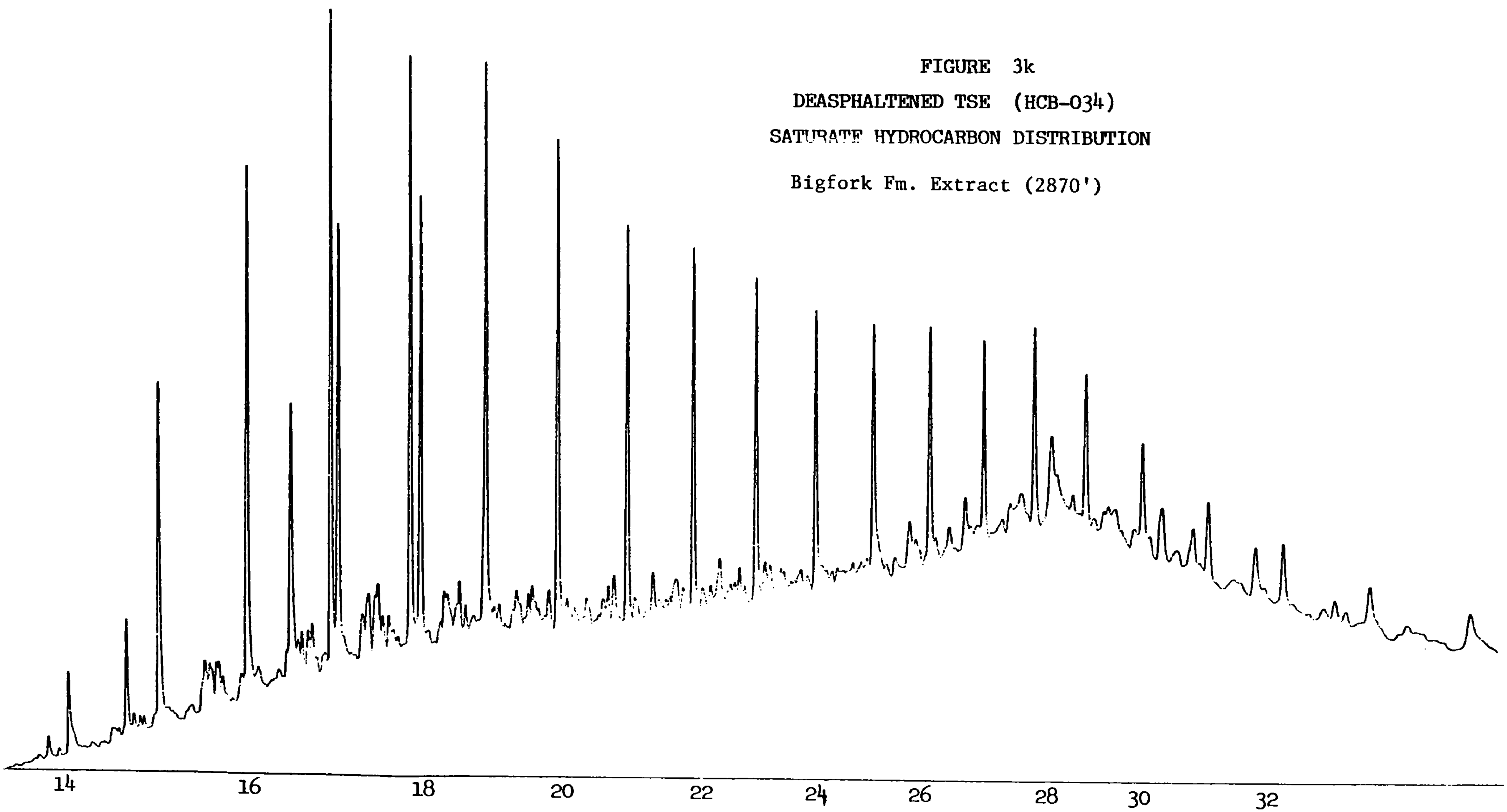
ANALYSIS TIME - 54 mins.
RANGE - 10^{-11} amps/mv
SOLVENT - n-PENTANE
ATTENUATION - 4
CONCENTRATION - .14 gms/ml
INJECTION VOL. - 3 μl

FIGURE 3k

DEASPHALTENED TSE (HCB-034)

SATURATE HYDROCARBON DISTRIBUTION

Bigfork Fm. Extract (2870')



CONDITIONS:

GC-VARIAN 3700
COLUMN - SP 2100, 25m, ID .25 mm
CARRIER - He, 1.36 ml/min., 20 psi
INJECTOR - SPLITLESS, 300°C
DETECTOR - FID, 350°C
TEMP. PROGRAM - INITIAL 60°C, 4 min. hold
PROGRAM RATE - 7°C/min.
FINAL 270°C

ANALYSIS TIME - 54 mins.
RANGE - 10^{-11} amps/mv
SOLVENT - n-PENTANE
ATTENUATION - 4
CONCENTRATION - .15 gms/ml
INJECTION VOL. - 3 μl

PGW/TM22

903237

THE STANDARD OIL COMPANY

To: E. Luttrell
SPC Mid-Continent Office
Dallas

December 22, 1981

PGW/122281/RB/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Source Evaluation of the Stanley Fm. in the Sanchez-O'Brien #1 Ferguson Well

Herewith enclosed for your retention are two copies of F. Marsek's note (PGW/TM22) on the source potential of the Stanley Fm. in the subject well.

In retrospect, I am somewhat dismayed at the amount of work that has been put in on characterizing what appears to be a singularly impressive non-source rock interval. However, as per D. May's original request, a detailed screen was conducted, we taking the liberty of diminishing the sampling density by a factor of two.

As Marsek comments, the organic carbon richness was consistently Lean over the whole section. Pyrolysis data confirmed a negligible to non-existent Potential Productivity. Maturity-wise, the formation had attained gas generative status, however, the leaness in residual organic carbon level suggested that only a negligible level of hydrocarbons would have been generated. The Stanley Fm. at this location was adjudged to be devoid of any significant source potential.

Although geographically separated, the leaness of the Stanley Fm. was even more marked than that observed in the Taylor #1 well. In the latter case, although some intervals of Marginal to Moderate organic richness were noted, potential productivities again confirmed a negligible source potential. The significant difference in the two locations, however, was their respective thermal maturity levels. Whereas, gas generative status had been achieved in the Texas well, the Stanley in Taylor #1 was still assessed to be oil immature. Evidently, the succession in the subject Texas well had experienced a more vigorous thermal history regime, presumably involving a greater depth and/or duration of burial. This may prove to be an interesting sidelight on regional Lower Paleozoic thermal maturity trends.

In conclusion, data accumulated to date suggested that the Stanley Fm. was probably one of the less promising Ouachita Facies candidate source rocks.

R. Burwood

R. Burwood

RB/plk

Enclosures - 2

cc: H.G. Bassett
J.G. Grasselli
R. Drozd
F. Marsek
PGW Files (0) (2-5)

THE STANDARD OIL COMPANY

To: D.J. May
SPC Mid-Continent Office
Dallas

November 27, 1981

From: Petroleum Geochemistry Group
Warrensville

File PGW/FM/112781/2-5
Job # PGW 81-49

Technical Memorandum (PGW/TM 22) - Geochemical Evaluation of the Mississippian Stanley Group in the Sanchez-O'Brien #1 Ferguson Well, Kaufman County, Texas.

This report details the source rock geochemistry of the Stanley Group encountered in the Sanchez-O'Brien #1 Ferguson well located 5500 ft FSL and 5600 ft FEL of A. Nail Survey A-355, Kaufman County, Texas. Approximately 170 cuttings samples in 30, 20, and 10 ft intervals were received representing the Stanely Group encountered in the well between 5270 and 8680 ft. The samples were examined for source richness and maturity using standard geochemical techniques which included Total Organic Carbon (TOC) determinations, pyrolysis, and vitrinite reflectance measurements. The samples were initially screened for TOC content and kerogen potential (pyrolysis) using every other sample for 20 and 30 ft intervals and every third sample for 10 ft intervals. A summary listing of source rock evaluation data is given in Table 1.

The Total Organic Carbon (TOC) contents of the Stanley Group were consistently Lean from the top to the basal intervals. The majority of the Stanley samples had TOC contents below 0.30 %. The highest value observed was only 0.35 % in the basal 10 ft interval. On the basis of the lack of sufficient organic carbon contents, the Stanely Group, as represented by the samples collected during penetration of the formation in this well, was assessed to have no source potential. Negligible pyrolysis S2 values showed that the kerogen present in the sediments had little to no potential productivity. Negligible pyrolysis S1 values indicated that there were also no generated hydrocarbons present in any of the Stanley intervals.

Vitrinite reflectance measurements and observations revealed that most of the organic matter in the Stanley sediments was reworked and oxidized. The low amounts of organic matter in the sediments, together with the presence of reworked/oxidized organic matter, and the absence of good vitrinite particles made the assessment of the thermal maturity for the Stanley sediments extremely difficult. The best interpretation of the reflectance data obtained suggested that sediments at the top of the Stanley (5270 ft) were at the gas generation threshold having reflectance values of about 1.00 %. Sediments at the base of the formation were well into the gas generation window with reflectance values of about 1.37 % or greater.

Frank A. Marsek

F.A. Marsek

Table 1

cc: G. Bassett
J.G. Grasselli
R. Burwood
E. Luttrell
PGW Files (0), (2-5)

Work by: S. Adams
E. Brown
R. Lukco
I. Penfield

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 ft.$^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

FORMATION LEGEND

CTNV - Cotton Valley
STAN - Stanley

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/ Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. } 0-10% qualifying component
LST.

SH. CALC } 11-25% qualifying component
LST. ARG

SH. V. CALC } 26-50% qualifying component
LST. V. ARG

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): ‰ Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): ‰ Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^{\circ}C$) - Kg/Tn.

S2 (12): ‰ Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: ‰ Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

G1 (TSE)(14): ‰ Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

G1 (S1)(15): ‰ Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): ‰ Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) ‰ Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): ‰ Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

TABLE 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY	: US
STATE	: TX
COUNTY/REGION/PROSPECT	: KAUFMAN
LOCATION	: N.TEXAS OVERTHRUST
WELL/SITE	: S-O FERGUSON#1
API/OCS	: -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5100	XA5521		JUR	CTNV								
5101	WA5521	CTG			SST,CALC	11		.11		0.00	.01	9
5130	WA5522	CTG										
5160	WA5523	CTG			SH,CALC	18		.10		0.00	0.00	0
5190	WA5524	CTG										
5220	WA5525	CTG			SH	9		.06		.02	.05	83
5250	WA5526	CTG										
5270	XA5526		MISS	STAN								
5280	WA5527	CTG			SLTST,CALC	14		0.00		.01	.04	
5310	WA5528	CTG										
5340	WA5529	CTG			SST,CALC	15		.11		0.00	0.00	0
5370	WA5530	CTG										
5400	WA5531	CTG			SLTST,CALC	11		.08		.01	.04	50
5430	WA5532	CTG										
5460	WA5533	CTG			SLTST,CALC	20		.16		0.00	0.00	0
5490	WA5534	CTG										
5520	WA5535	CTG			SLTST,CALC	15		.17		0.00	0.00	0
5550	WA5536	CTG										
5580	WA5537	CTG			SLTST,CALC	23		.25		.02	.08	32
5610	WA5538	CTG										
5640	WA5539	CTG			SH,CALC	20		.23		0.00	0.00	0
5670	WA5540	CTG										
5700	WA5541	CTG			SH,CALC	18		.26		0.00	0.00	0
5730	WA5542	CTG										
5760	WA5543	CTG			SH,CALC	18		.27		0.00	.01	4
5790	WA5544	CTG										
5820	WA5545	CTG			SH,CALC	16		.28		0.00	0.00	0
5850	WA5546	CTG										
5880	WA5547	CTG			SH,V.CALC	32		.21		0.00	0.00	0
5910	WA5548	CTG										
5940	WA5549	CTG			LST,V.ARG	54		.14		.01	0.00	0
5970	WA5550	CTG										
6000	WA5551	CTG			SH,CALC	15		.28		0.00	0.00	0
6020	WA5552	CTG										
6040	WA5553	CTG			SH,CALC	16		.31		.01	.02	6
6060	WA5554	CTG										
6080	WA5555	CTG			SH,CALC	16		.29		0.00	0.00	0

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5100															
5101	0.00		0												
5130												1.03			
5160			0												
5190															
5220	.29		33												
5250															
5270															
5280	.20														
5310															
5340			0												
5370												.90			
5400	.20		12												
5430															
5460			0												
5490															
5520			0												
5550															
5580	.20		8												
5610															
5640			0												
5670															
5700			0												
5730															
5760	0.00		0												
5790															
5820			0												
5850															
5880			0												
5910															
5940	1.00		7												
5970															
6000			0												
6020															
6040	.33		3												
6060															
6080			0												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
6100	WA5556	CTG										
6120	WA5557	CTG			SH,CALC	15		.27		.02	.04	15
6140	WA5558	CTG										
6160	WA5559	CTG			SH,CALC	14		.21		0.00	.01	5
6180	WA5560	CTG										
6200	WA5561	CTG			SST,CALC	16		.24		.02	.02	8
6220	WA5562	CTG										
6240	WA5563	CTG			SST,CALC	14		.26		0.00	0.00	0
6260	WA5564	CTG										
6280	WA5565	CTG			SST,CALC	11		.14		0.00	0.00	0
6300	WA5566	CTG										
6320	WA5567	CTG			SH,CALC	14		.26		0.00	0.00	0
6340	WA5568	CTG										
6360	WA5569	CTG			SST,CALC	15		.23		0.00	0.00	0
6380	WA5570	CTG										
6400	WA5571	CTG			SH,CALC	12		.18		0.00	0.00	0
6420	WA5572	CTG										
6440	WA5573	CTG			SH,CALC	12		.22		0.00	0.00	0
6460	WA5574	CTG										
6480	WA5575	CTG			SH,CALC	15		.34		.01	.02	6
6500	WA5576	CTG										
6520	WA5577	CTG			SH,CALC	12		.21		.01	.02	10
6540	WA5578	CTG										
6560	WA5579	CTG			SH,CALC	12		.16		0.00	0.00	0
6580	WA5580	CTG										
6600	WA5581	CTG			SH,CALC	15		.20		0.00	0.00	0
6620	WA5582	CTG										
6640	WA5583	CTG			SLTST,CALC	16		.27		.02	.04	15
6660	WA5584	CTG										
6680	WA5585	CTG			SH,CALC	17		.32		.01	.03	9
6700	WA5586	CTG										
6720	WA5587	CTG			SH,CALC	15		.21		0.00	0.00	0
6740	WA5588	CTG										
6760	WA5589	CTG			SH,CALC	15		.27		0.00	0.00	0
6780	WA5590	CTG										
6800	WA5591	CTG			SH,CALC	15		.26		.01	0.00	0
6820	WA5592	CTG										
6840	WA5593	CTG			SLTST,CALC	15		.18		0.00	0.00	0
6860	WA5594	CTG										
6880	WA5595	CTG			SH,CALC	14		.21		.02	.03	14
6900	WA5596	CTG										
6920	WA5597	CTG			SLTST,CALC	15		.19		.06	.09	47
6940	WA5598	CTG										
6960	WA5599	CTG			SH,CALC	17		.28		0.00	0.00	0
6980	WA5600	CTG										
7000	WA5601	CTG			SH,CALC	16		.24		.03	.04	17
7020	WA5602	CTG										
7040	WA5603	CTG			SH,CALC	16		.27		.07	.09	33
7060	WA5604	CTG										

WELL/SITE :S-O FERGUSON#1

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
6100															
6120	.33		7												
6140															
6160	0.00		0												
6180															
6200	.50		8												
6220															
6240			0												
6260															
6280			0												
6300															
6320			0												
6340															
6360			0									1.22			
6380															
6400			0												
6420															
6440			0												
6460															
6480	.33		3												
6500															
6520	.33		5												
6540															
6560			0												
6580															
6600			0									1.13			
6620															
6640	.33		7												
6660															
6680	.25		3												
6700															
6720			0												
6740															
6760			0												
6780															
6800	1.00		4												
6820															
6840			0												
6860															
6880	.40		10												
6900															
6920	.40		32												
6940															
6960			0												
6980															
7000	.43		12												
7020															
7040	.44		26												
7060															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
7080	WA5605	CTG			SH,CALC	16		.18		.02	0.00	0
7100	WA5606	CTG										
7120	WA5607	CTG			SLTST,CALC	15		.22		.03	.01	5
7140	WA5608	CTG										
7160	WA5609	CTG			SH,CALC	14		.21		.01	0.00	0
7180	WA5610	CTG										
7200	WA5611	CTG			SH,CALC	15		.17		.05	.06	35
7220	WA5612	CTG										
7240	WA5613	CTG			SH,CALC	14		.21		0.00	0.00	0
7260	WA5614	CTG										
7280	WA5615	CTG			SH,CALC	14		.18		0.00	0.00	0
7300	WA5616	CTG										
7320	WA5617	CTG			SH,CALC	13		.18		0.00	0.00	0
7340	WA5618	CTG										
7360	WA5619	CTG			SST,CALC	13		.15		.04	.08	53
7380	WA5620	CTG										
7400	WA5621	CTG			SST,CALC	11		.12		0.00	0.00	0
7420	WA5622	CTG										
7440	WA5623	CTG			SST,CALC	10		.09		0.00	.01	11
7460	WA5624	CTG										
7480	WA5625	CTG			SH,CALC	15		.24		.03	.01	4
7500	WA5626	CTG										
7520	WA5627	CTG			SH,CALC	15		.28		.03	0.00	0
7540	WA5628	CTG										
7560	WA5629	CTG			SH,CALC	13		.15		0.00	0.00	0
7580	WA5630	CTG										
7600	WA5631	CTG			SH,CALC	13		.22		.05	.11	50
7620	WA5632	CTG										
7640	WA5633	CTG			SLTST,CALC	18		.18		0.00	0.00	0
7660	WA5634	CTG										
7680	WA5635	CTG			SH,CALC	16		.23		0.00	0.00	0
7700	WA5636	CTG										
7720	WA5637	CTG			SH,CALC	15		.25		.01	.01	4
7740	WA5638	CTG										
7760	WA5639	CTG			SLTST	10		.12		0.00	0.00	0
7780	WA5640	CTG										
7800	WA5641	CTG			SH,CALC	11		.16		0.00	0.00	0
7820	WA5642	CTG										
7840	WA5643	CTG			SLTST	9		.11		0.00	.02	18
7860	WA5644	CTG										
7880	WA5645	CTG			SLTST,CALC	12		.12		0.00	0.00	0
7900	WA5646	CTG										
7920	WA5647	CTG			SH,CALC	18		.27		0.00	0.00	0
7940	WA5648	CTG										
7960	WA5649	CTG			SH,CALC	17		.28		.02	0.00	0
7980	WA5650	CTG										
8000	WA5651	CTG			SH,CALC	15		.21		0.00	0.00	0
8020	WA5652	CTG										
8040	WA5653	CTG			SST,CALC	12		0.00		.02	0.00	

WELL/SITE :S-O FERGUSON#1

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
7080	1.00		11												
7100															
7120	.75		14												
7140															
7160	1.00		5												
7180															
7200	.45		29												
7220															
7240			0												
7260															
7280			0												
7300															
7320			0												
7340															
7360	.33		27												
7380															
7400			0												
7420															
7440	0.00		0												
7460															
7480	.75		12												
7500															
7520	1.00		11												
7540															
7560			0												
7580															
7600	.31		23									1.37			
7620															
7640			0												
7660															
7680			0												
7700															
7720	.50		4												
7740															
7760			0												
7780															
7800			0												
7820															
7840	0.00		0												
7860															
7880			0												
7900															
7920			0												
7940															
7960	1.00		7												
7980															
8000			0												
8020															
8040	1.00														

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
8060	WA5654	CTG										
8080	WA5655	CTG			SST,CALC	15		.11		.01	0.00	0
8100	WA5656	CTG										
8120	WA5657	CTG			SH,CALC	17		.22		.02	.02	9
8140	WA5658	CTG										
8160	WA5659	CTG			SH,CALC	11		.18		.01	.03	17
8180	WA5660	CTG										
8200	WA5661	CTG			SH,CALC	14		.25		0.00	0.00	0
8220	WA5662	CTG										
8240	WA5663	CTG			SH,CALC	17		.23		.03	.02	9
8260	WA5664	CTG										
8280	WA5665	CTG			SH,CALC	17		.28		.02	.02	7
8300	WA5666	CTG										
8320	WA5667	CTG			SH,CALC	14		.21		.03	.05	24
8340	WA5668	CTG										
8360	WA5669	CTG			SH,CALC	14		.20		0.00	0.00	0
8380	WA5670	CTG										
8400	WA5671	CTG										
8410	WA5672	CTG			SH,CALC	17		.31		0.00	0.00	0
8420	WA5673	CTG										
8430	WA5674	CTG										
8440	WA5675	CTG			SH,CALC	17		.30		.05	.07	23
8450	WA5676	CTG										
8460	WA5677	CTG										
8470	WA5678	CTG										
8480	WA5679	CTG										
8490	WA5680	CTG			SH,CALC	15		.28		.01	.01	4
8500	WA5681	CTG										
8510	WA5682	CTG										
8520	WA5683	CTG			SH,CALC	16		.31		.01	0.00	0
8530	WA5684	CTG										
8540	WA5685	CTG										
8550	WA5686	CTG			SH,CALC	16		.32		0.00	0.00	0
8560	WA5687	CTG										
8570	WA5688	CTG										
8580	WA5689	CTG			SH,CALC	17		.33		.01	.03	9
8590	WA5690	CTG										
8600	WA5691	CTG			SH,CALC	16		.32		.01	.03	9
8610	WA5692	CTG										
8620	WA5693	CTG										
8630	WA5694	CTG			SH,CALC	14		.26		0.00	0.00	0
8640	WA5695	CTG										
8650	WA5696	CTG										
8660	WA5697	CTG			SH,CALC	17		.32		.01	.02	6
8670	WA5698	CTG			SH,CALC	18		.35		0.00	0.00	0

WELL/SITE :S-0 FERGUSON#1

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
8060															
8080	1.00		9												
8100															
8120	.50		9												
8140															
8160	.25		6												
8180															
8200			0												
8220															
8240	.60		13												
8260															
8280	.50		7												
8300															
8320	.38		14												
8340															
8360			0												
8380															
8400															
8410			0												
8420															
8430															
8440	.42		17												
8450															
8460															
8470															
8480															
8490	.50		4												
8500															
8510															
8520	1.00		3												
8530															
8540															
8550			0												
8560															
8570															
8580	.25		3												
8590															
8600	.25		3												
8610															
8620															
8630			0												
8640															
8650															
8660	.33		3												
8670			0												

PGW/TM 31

THE STANDARD OIL COMPANY

903224

PGW/31682/RB/2-5

March 16, 1982

To: E. Luttrell
SPC Mid-Continent Office
Dallas

From: Petroleum Geochemistry Group
Warrensville

Subject: Technical Memorandum PGW/TM 031 - Pennsylvanian Jackfork Fm. Bitumens

Herewith two copies (one for C. Titus) of the subject memo describing characterization of two field sampled bitumens collected during the 1981 Southern Overthrust program. As Marsek demonstrates, these are classically biodegraded residues. Despite the level of biodegradation, carbon isotope characterization strongly suggested that these materials were not sourced in an early Paleozoic source sequence but in later Paleozoic or younger sediments. If potential Mesozoic and Tertiary sources are indeed inappropriate for the region, then Mississippian and/or Pennsylvanian sediments would be strong *a priori* candidate progenitors.

An interesting corollary, not developed in the report, concerns the isotope dissimilarity of the present bitumens with the Grahamites typical of the Ouachita area. As developed in our discussion to the Taylor #1 report (PGW/015), the Grahamites characterized by Curiale et al were typically biodegraded, but isotopically light (ie $\delta^{13}C$ @ -29.8 ppt) residues. Such isotopically light compositions were entirely consistent with an early Paleozoic source. The 4 ppt differential observed between the Grahamites and the present bitumens, is clearly indicative of an entirely different provenance for these materials. One can thus speculate that we have both early and late Paleozoic (or younger) source intervals in the Ouachita Overthrust of southeastern Oklahoma and western Arkansas, respectively.

Characterization of the Isom Springs Novaculite produced oils indicated isotopically light (∿ -30.4 ppt) hydrocarbons consistent with an early Paleozoic source provenance. This should provide an interesting contrast or similarity with further Sevier and Pike County bitumens, and the Sevier Co. Nix #1 oil, that have been provided to us.

R. Burwood

R. Burwood

RB:yg

Enclosures - 2

cc: **H.G. Bassett**
J.G. Grasselli
C.A.O. Titus
R. Drozd/R. Roseman
F. Marsek
PGW Files (0) (2-5)

THE STANDARD OIL COMPANY
WARRENSVILLE LABORATORY

To: C.A.O. Titus
SPC Mid Continent Office
Dallas

March 3, 1982

File PGW/030382/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job #PGW 81-30A

Technical Memorandum (PGW/TM 31). Geochemical Investigation of Two Solid Hydrocarbon Samples from the Pennsylvanian Jackfork Fm., Sevier County, Arkansas.

Summary: Two samples of solid hydrocarbons occurring in outcrops of the Pennsylvanian Jackfork Fm. are severely biodegraded crude oils now comprised primarily of polar and asphaltene components. Carbon isotopic data suggest that the hydrocarbons were sourced from Upper Paleozoic sediments.

1. INTRODUCTION

This report presents the results of the characterization of two solid hydrocarbons occurring in outcrops of the Pennsylvanian Jackfork Fm. from NE, NW, Sec. 12, T. 8 S., R. 30 W., Sevier County, Arkansas. The samples, designated AK 187 and AK 188, were collected as part of the Ouachita Outcrop Sampling Program conducted by the SPC Mid-Continent region in the summer of 1981.

2. MATERIALS AND METHODS

2.1 Materials

Two bags of the solid hydrocarbon samples, AK 187 and AK 188, were received and given the PGW field sample designations FSA 719 and FSA 720 and the PGW hydrocarbon designations HCB 087 and HCB 088, respectively.

2.2 Methods

The samples were characterized using the following standardized PGW techniques: Asphaltene Content (C5 insolubles), Hydrocarbon Type Analysis (BPT > 200°C) and Saturate Alkane Analysis (BPT > 200°C). Carbon isotopic analyses were performed as per contractor's methods.

3. RESULTS AND CONCLUSIONS

The results of the characterization of the samples are presented in tabular and graphic form in Tables 1 and 2 and Figures 1 and 2.

3.1 The absence of any identifiable n-alkane components in the Saturate Alkane chromatograms indicated that the samples were severely biodegraded (Figures 1 and 2).

3.2 Hydrocarbon Type Analyses and Asphaltene removal data showed both AK 187 and AK 188 to be dominated by polar and asphaltene components amounting to 76.5 and 74.3% of the samples, respectively (Tables 1 and 2).

3.3 Carbon isotope values of -25.85 and -25.72 ppt determined for AK 187 and 188 respectively, suggested that these hydrocarbons were sourced in Upper Paleozoic sediments. This age range was arrived at based on results of work by a number of researchers who have demonstrated that there is a general trend of enrichment of crude oils in the light carbon isotope ^{12}C with increasing geological age (1, 2, 3). Although carbon isotope values for crude oils of specific geological ages often vary within a range of about ± 3 ppt, oils sourced from Lower Paleozoic sediments generally show carbon isotope values significantly lighter than the approximately -26 ppt values measured for samples AK 187 and 188. These values also fell within the range of carbon isotope values for Tertiary and Mesozoic sourced crude oils. However, no Tertiary or Mesozoic source intervals have been identified in the region from which AK 187 and 188 were collected.

Although the samples were biodegraded, the carbon isotope values measured for AK 187 and 188 were probably not significantly different from those of the unbiodegraded parent crude oil(s). Work by Stahl has shown biodegradation of hydrocarbons changes carbon isotope values by no more than about 1 ppt (4).

3.4 The severe biodegraded nature of these samples precluded any definitive evaluations of their type, maturity, or age.

3.5 The proximity of these hydrocarbon occurrences to probable/potential source intervals may give some indication of the maturity of the parent crude oil. Early products of hydrocarbon generation do not in general, migrate far from their source.

4. REFERENCES

1. Stahl, W.J., 1977, Carbon and Nitrogen Isotopes in Hydrocarbon Research and Exploration, Chemical Geology, v. 20, p. 121-149.

2. Welte, D.H., Kalkreuth, W., and Hoefs, J., 1975, Age Trend in Carbon-Isotope Composition in Paleozoic Sediments. Naturwissen Schaften, v. 62, p. 482-483.

3. Degens, E.T., 1969, Biochemistry of Stable Carbon Isotopes, In: Organic Geochemistry, Springer, Berlin, p. 304-329.

4. Stahl, W.J., 1980, Compositional Changes and $^{13}C/^{12}C$ Fractions During the Degradation of Hydrocarbons by Bacteria, Geochem. et Cosmo. Acta., v. 44, p. 1903-1907.

Frank A. Marsek

Frank A. Marsek

FAM:yg

Tables 1, 2
Figures 1, 2

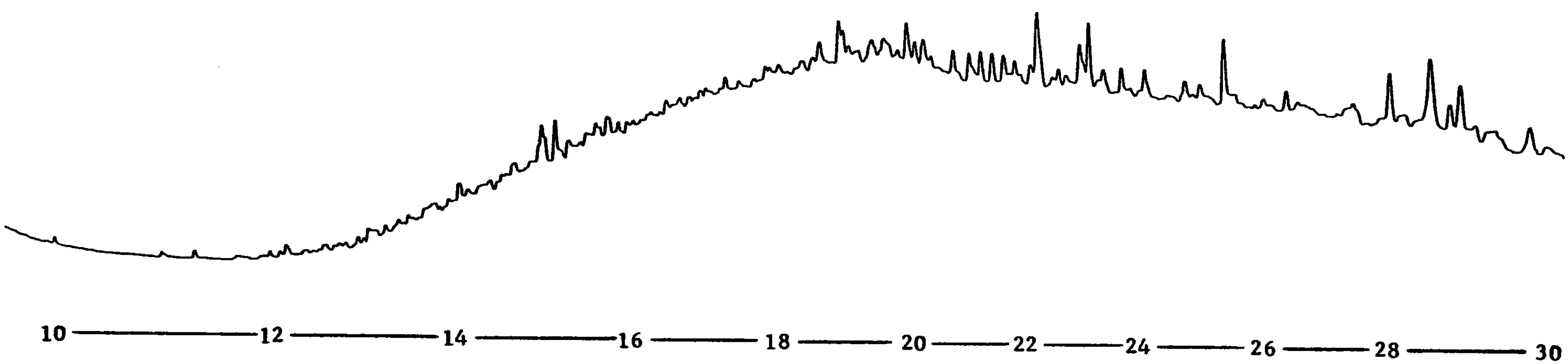
Work by: R. Cavalier
R. Roseman

cc: J.G. Grasselli
H.G. Bassett
R. Burwood
R. Drozd
E. Luttrell
PGW Files (0), (2-5)

FIGU 1

SATURATE ALKANE GAS CHROMATOGRAM

OF SOLID HYDROCARBON SAMPLE AK 187 (FSA 719, HCB 087)



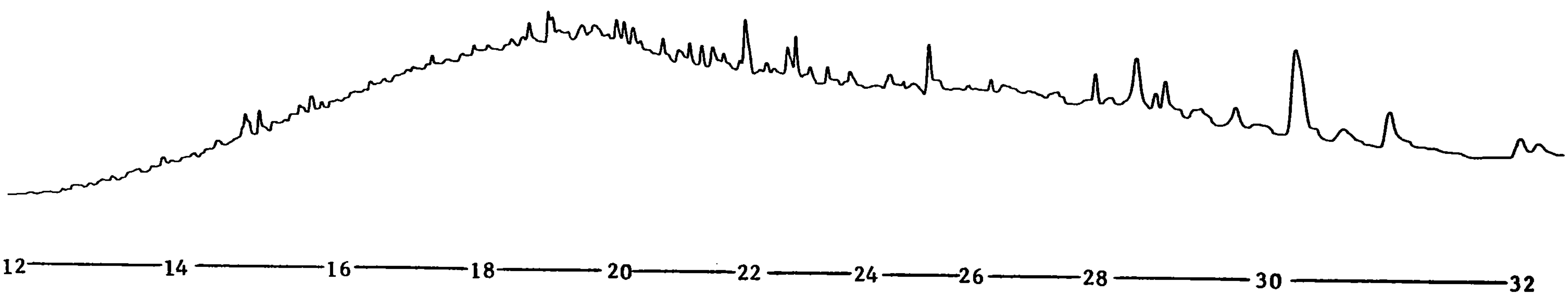
CONDITIONS:

G. C. - Varian 3700
Column - Alltech WCOT 14, .25 mm I. D., 2μ film
Carrier - He, .9 ml/min., 8 P. S. I. G.
Detector - F. I. D., 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final - 270°C, 26 min. hold

Range - 10^{-12}
Solvent - n-Hexane
Injector - Split for 1 min.
Attenuation - 2
Injection Volume - 3μl
Concentration - 2.5 mg/ml
Analysis Time - 54 min.

FIGU. 2

SATURATE ALKANE GAS CHROMATOGRAM
OF SOLID HYDROCARBON SAMPLE AK 188 (FSA 720, HCB 088)



CONDITIONS:

G.C. - Varian 3700
Column - Alltech WCOT 14, .25 mm I.D., .2μ film
Carrier - He, .9 ml/min., 8 P.S.I.G.
Dectector - F.I.D., 350°C
Temp. Program - Initial 60°C, 4 min. hold
Program Rate - 7°C/min.
Final - 270°C, 26 min. hold

Range - 10^{-12}
Solvent - n-Hexane
Injector - Splitless for 30 sec.
Attenuation - 2
Injection Volume - 4μl
Concentration - 2.5 mg/ml
Analysis Time - 54 min.

TABLE 1

 10.21.31. 02/03/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE: Ouachita Mts.	SAMPLE ID:HCB087	FORMATION: Jackfork
STATE :AR	LOCATION : Sec. 12, T8S, R30W	TYPE:SPG	AGE/EPOCH: Penn.
COUNTY : Sevier	API/OCS :-	DEPTH(FT): ROC	
PGW JOB:8130A	REPORT :	DATA BASE:PGW	

INSPECTION DATA		SIMULATED DISTILLATION %WT	DEG C	%WT	DEG C	N-ALKANE CONTENT	% WT SATURATES	PENTACYCLANE CONTENT NORMALISED DIST	
SPECIFIC GRAV. :									
API GRAV. :									
SULFUR %WT:									
NITROGEN %WT:		IBP				C10 :		H :	
WAX %WT:		2		52		C11 :		B :	
WAX MPT DEG C:		4		54		C12 :	0.000	D :	
ASPHALTENE (1) %WT:	28.20	6		56		C13 :	0.000	G :	
NICKEL (PPM):		8		58		C14 :	0.000	N :	
VANADIUM (PPM):		10		60		C15 :	0.000	O :	
RESIDUE		12		62		C16 :	0.000	U :	
BPT>200C %WT:		14		64		C17 :	0.000	V :	
		16		66		C18 :	0.000	ALPHA :	
GEOCHEMICAL DATA		18		68		C19 :	0.000	BETA :	
		20		70		C20 :	0.000	GAMA :	
RESIDUE BPT>200C		22		72		C21 :	0.000	DELTA :	
TYPE ANALYSIS		24		74		C22 :	0.000	EPSILON :	
SATURATES %WT:	14.20	26		76		C23 :	0.000	ZETA :	
AROMATICS %WT:	18.60	28		78		C24 :	0.000		
POLARS %WT:	67.30	30		80		C25 :	0.000	STERANE	
ASPHALTENE(2)%WT:		32		82		C26 :	0.000	CONTENT	
N-ALKANE %WT:	0.00	34		84		C27 :	0.000	NORMALISED DIST	
N-ALKANE CPI :		36		86		C28 :	0.000		
ACYCLIC ISOPRENOID		38		88		C29 :	0.000		
FARNESANE %WT:	0.00	40		90		C30 :	0.000	1 :	
ACYCLIC C16 %WT:	0.00	42		92		C31 :	0.000	2 :	
ACYCLIC C18 %WT:	0.00	44		94		C32 :	0.000	3 :	
PRISTANE %WT:	0.00	46		96		C33 :	0.000	4 :	
PHYTANE %WT:	0.00	48		98		C34 :	0.000	5 :	
PRISTANE/PHYTANE :		50		FBP		C35 :	0.000	6 :	
PRISTANE/N-C17 :						C36 :	0.000	7 :	
PHYTANE/N-C18 :								8 :	
NICKEL/VANADIUM :								9 :	
D-13 C(OIL) :	-25.85 %.							10 :	
D-13 C(DISTILLATE) :	%.							11 :	
D-13 C(SATURATES) :	%.							12 :	
D-13 C(AROMATICS) :	%.							13 :	
D-13 C(POLARS) :	%.							14 :	
D-13 C(ASPHALTENES):	%.							15 :	
D-13 C(RESINS) :	%.							16 :	
D-34 SULFUR :	%.							17 :	
D-2 DEUTERIUM :	%.							18 :	
D-15 NITROGEN :	%.							19 :	

TABLE 2

 10.21.31. 02/03/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE: Ouachita Mts.	SAMPLE ID:HCB088	FORMATION: Jackfork
STATE :AR	LOCATION : Sec. 12, T8S, R30W	TYPE:SPG	AGE/EPOCH: Penn.
COUNTY : Sevier	API/OCS :-	DEPTH(FT): ROC	
PGW JOB:8130A	REPORT :	DATA BASE:PGW	

INSPECTION DATA		SIMULATED DISTILLATION				N-ALKANE CONTENT		PENTACYCLANE CONTENT	
		%WT	DEG C	%WT	DEG C	% WT SATURATES		NORMALISED DIST	
SPECIFIC GRAV. :									
API GRAV. :									
SULFUR %WT:									
NITROGEN %WT:		IBP				C10 :		H :	
WAX %WT:		2		52		C11 :		B :	
WAX MPT DEG C:		4		54		C12 :	0.000	D :	
ASPHALTENE (1) %WT:	39.70	6		56		C13 :	0.000	G :	
NICKEL (PPM):		8		58		C14 :	0.000	N :	
VANADIUM (PPM):		10		60		C15 :	0.000	O :	
RESIDUE		12		62		C16 :	0.000	U :	
BPT>200C %WT:		14		64		C17 :	0.000	V :	
		16		66		C18 :	0.000	ALPHA :	
GEOCHEMICAL DATA		18		68		C19 :	0.000	BETA :	
		20		70		C20 :	0.000	GAMA :	
RESIDUE BPT>200C		22		72		C21 :	0.000	DELTA :	
TYPE ANALYSIS		24		74		C22 :	0.000	EPSILON :	
SATURATES %WT:	15.90	26		76		C23 :	0.000	ZETA :	
AROMATICS %WT:	26.80	28		78		C24 :	0.000		
POLARS %WT:	57.40	30		80		C25 :	0.000	STERANE CONTENT	
ASPHALTENE(2)%WT:		32		82		C26 :	0.000		
N-ALKANE %WT:	0.00	34		84		C27 :	0.000	NORMALISED DIST	
N-ALKANE CPI :		36		86		C28 :	0.000		
ACYCLIC ISOPRENOID		38		88		C29 :	0.000		
FARNESANE %WT:	0.00	40		90		C30 :	0.000	1 :	
ACYCLIC C16 %WT:	0.00	42		92		C31 :	0.000	2 :	
ACYCLIC C18 %WT:	0.00	44		94		C32 :	0.000	3 :	
PRISTANE %WT:	0.00	46		96		C33 :	0.000	4 :	
PHYTANE %WT:	0.00	48		98		C34 :	0.000	5 :	
PRISTANE/PHYTANE :		50		FBP		C35 :	0.000	6 :	
PRISTANE/N-C17 :						C36 :	0.000	7 :	
PHYTANE/N-C18 :								8 :	
NICKEL/VANADIUM :								9 :	
D-13 C(OIL) :	-25.72 %.							10 :	
D-13 C(DISTILLATE) :	%.							11 :	
D-13 C(SATURATES) :	%.							12 :	
D-13 C(AROMATICS) :	%.							13 :	
D-13 C(POLARS) :	%.							14 :	
D-13 C(ASPHALTENES):	%.							15 :	
D-13 C(RESINS) :	%.							16 :	
D-34 SULFUR :	%.							17 :	
D-2 DEUTERIUM :	%.							18 :	
D-15 NITROGEN :	%.							19 :	

PGW/TM 45

C.2

903218

THE STANDARD OIL COMPANY

PGW/52482/RB/2-5

May 24, 1982

61792

To: E. Luttrell
SPC Mid-Continent Office
Dallas

From: Petroleum Geochemistry Group
Warrensville

Subject: S.W. Arkansas Asphalts and Crude Oils - PGW/TM 45.

Herewith enclosed for your retention two copies (one for C. Titus) of the subject report.

This note forms a preliminary discussion on the fuller characterization of the Pike and Sevier County sampled bitumens and the Nix #1 crude oils, to be reported later. All petroleums examined fell into a narrow carbon isotopic range of -25.5 $\pm$0.4 ppt and were very similar to the previously reported data for Sevier Co. outcrop bitumens (cf PGW/TM 31). Although the current suite of bitumens were clearly highly biodegraded they showed a sufficiently close isotopic similarity to the Nix #1 petroleum, that a common origin seemed a distinct possibility.

However, the most significant aspects of this piece of work was confirmation of the conspicuous isotopic difference between the S.W. Arkansas and S. Oklahoma Ouachita overthrust petroleums. Whether asphalts (Grahamites) or produced oils (e.g. Isom springs Novaculite hydrocarbons), the Oklahoma materials were consistently isotopically lighter by a differential of $\geq$4 ppt. This was clearly indicative of an entirely different origin and provenance for the two groups of petroleums. Similarly, whereas the Oklahoma materials could conceivably have had an origin in Early Paleozoic sediments, the heavier $\delta^{13}C$ values observed for the Arkansas petroleums were inconsistent with a source pre-dating the Mississippian. A Mississippian or younger source provenance therefore needs to be considered for these Arkansas occurrences.

It is hoped that these observations may have some useful bearing on evaluation of the hydrocarbon habitat for the S.W. Arkansas portion of the Southern Overthrust. In this connection it would be useful to attempt a source-petroleum correlation on the basis of kerogen carbon isotopic correlation. Are there good outcrops of potential source rock containing sediments of Mississippian and younger age exposed in this area? If so, a short Mid-Continent - PGW field trip could be beneficial.

R. Burwood

R. Burwood

RB:yg

Enclosures 2

cc: H.G. Bassett
J.G. Grasselli
R. Drozd
F. Marsek
R. Roseman
PGW Files (Ø) (2-5)

THE STANDARD OIL COMPANY
WARRENSVILLE LABORATORY

To: C.A.O. Titus
SPC Mid Continent Office
Dallas

May 3, 1982

File PGW/Ø5Ø382/RS/2-5

From: Petroleum Geochemistry Group
Warrensville

Job #PGW 81-62

Technical Memorandum (PGW/TM 45) Stable Carbon Isotopic Investigation of Five Asphalt Samples, and Nix #1 Crude Oil Samples from Pike and Sevier Counties, Arkansas.

Summary: Carbon isotopic data from five Arkansas asphalt and two crude oil samples are in agreement with results previously obtained from similar asphalts, suggesting a late Paleozoic source for these materials.

1. INTRODUCTION

This report presents carbon isotopic data for five asphalt samples collected from outcrops in Pike and Sevier counties, Arkansas, and for the Nix #1 crude oil (Jackfork Fm.?), Sevier county. The preliminary discussion included forms an extension to the observations made in the issue memoranda (PGW/31682/RB/2-5) to our report PGW/TM 31, "Geochemical Investigation of Two Solid Hydrocarbon Samples, from the Pennsylvanian Jackfork Fm., Sevier County, Arkansas."

2. MATERIALS

2.1 Five asphalt samples from Arkansas were received and given PGW field sample designations FSB 872-874, 891, and 892, and hydrocarbon designations HCB 18Ø-184. These samples are described in Table 1. Sample HMB #1 was reportedly collected from an Upper Paleozoic outcrop, possibly of Pennsylvanian (Jackfork Fm.) age. The remaining samples were acquired from outcrops of Lower Cretaceous sandstones in close proximity to Upper Paleozoic sediments.

2.2 Two oil samples from the Sevier Oil Co. #1 Nix well, sec. 1 - T1ØS-R31W, Sevier county, Arkansas, were given PGW hydrocarbon designations HCB 147 and 148. Although unconfirmed to date, the oil is believed to have been recovered from the Jackfork Fm.

3. METHODS

Carbon isotopic analyses were performed on the solvent (CH_2Cl_2) extractable fraction from each asphalt sample, and both specimens of clarified whole crude oil. All determinations were carried out in duplicate, using PGW - developed techniques.

4. RESULTS AND CONCLUSIONS

Isotopic data for the asphalt and oil samples are presented in Table 2. Included in this table are isotopic values for two previously submitted asphalt samples, AK 187 and AK 188, which were obtained from the same outcrop location as sample HMB #1.

4.1 The isotopic values determined during the present study ranged from -25.08 to -25.72 ppt. Results for the Pike county asphalts indicated a slight enrichment in the $\delta^{13}C$ isotope in these samples, relative to the Sevier county specimens. It is probable that these slight differences reflect subtle variations in source facies, as all the values are, in general, internally consistent.

4.2 The present results are in very good agreement with previously determined isotopic values for asphalts from this area. This strongly suggested that these hydrocarbons all shared a common, or similar, source provenance and were derived from the same source, or suite of source, rocks.

4.3 The isotopic similarity between the Sevier and Pike county asphalts and the Nix #1 oil was consistent with the former being weathered and possibly biodegraded residuals of the latter crude oil type. Carbon isotope profiling of the hydrocarbon fraction make-up of the oil and asphalts (yet to be conducted) should better substantiate this relationship.

4.4 As initially discussed in PGW/31682/RB/2-5, the carbon isotopic composition of the Arkansas asphalts clearly distinguished them from the analogous Grahamites typical of the S.E. Oklahoma Ouachita area. The 4 ppt differential between the two sets of asphalts strongly suggested that each group had an entirely different source identity and provenance.

4.5 The source identity for these Arkansas hydrocarbons is still problematical. It is evident that they were derived from an isotopically heavy source kerogen assemblage, ranging from $\delta^{13}C$ = -23 to -26 ppt; such material is not typically in keeping with Early Paleozoic sediments (i.e. Devonian or older). A provenance from sediments of Mississippian - Pennsylvanian age, or younger, may thus be expected.

4.6 It is recommended that an effort be made to collect representative organic-rich sediments, of Post-Mississippian age, from S.W. Arkansas in order to investigate their source kerogen and kerogen pyrolysate carbon isotopic make-up. In this way a possible source-hydrocarbon correlation may be established.

R. A. Sedivy

R.A. Sedivy

RAS:yg

Attachments

cc: H.G. Bassett
J.G. Grasselli
E. Luttrell
R. Burwood
R. Drozd
F. Marsek
PGW Files (Ø), (2-5)

Work by: J. Reymander
R. Cavalier

TABLE 1

SAMPLE	PGW-FSB#	PGW-HCB#	LOCATION	COUNTY
HMB #1	891	180	11- 8S-30W	Sevier
McLeod Lbr #1	892	181	36- 7S-24W	Pike
Moody Shoal #1	872	182	8- 8S-30W	Sevier
Green's Chapel #1	873	183	4- 8S-29W	Sevier
Arkansas Asphalt #1	874	184	4- 8S-24W	Pike
Sevier Oil Co. #1 Nix		147	1-10S-31W	Sevier
Sevier Oil Co. #1 Nix		148	1-10S-31W	Sevier

TABLE 2

SAMPLE	PGW-HCB #	$\delta^{13}C$, ppt
HMB #1	180	-25.72
McLeod Lbr #1	181	-25.14
Moody Shoal #1	182	-25.36
Green's Chapel #1	183	-25.34
Arkansas Asphalt #1	184	-25.08
Sevier Oil Co. #1 Nix	147	-25.56
Sevier Oil Co. #1 Nix	148	-25.54
AK 187, Sevier Co.	087	-25.85
AK 188, Sevier Co.	088	-25.72

HOY... PGW/TM 44

903217

THE STANDARD OIL COMPANY

PGW/5Ø582/RB/2-5

May 5, 1982

To: E. Luttrell
SPC Mid-Continent Division
Dallas

6

From: Petroleum Geochemistry Group
Warrensville

Subject: Source Characterization of the Stanley Fm. in the McCormick #1 Meyers Well - PGW/TM Ø44

Herewith two copies of Marsek's note (one for D. May) on the subject study for your retention.

The majority of the source richness data was very much like that typically found for the Stanley Fm. on previous occasions, Lean. However, the limited carbargillite interval proved to be of considerable interest. Despite the low kerogen Pyrolysis Index (convertibility), the high kerogen content conferred an attractive Potential Productivity on this interval (46 kg ton^{-1}). Pyrolysis and maturity data suggested that the sediment was best regarded currently as a thoroughly immature, but potentially productive, gas-condensate to wet gas source. As Marsek comments, the exploration significance of this interval undoubtedly depends on its thickness, distribution and overburdens it could have experienced elsewhere in the area.

Along with Frank, I would concur that the carbargillite is so unlike previous Stanley Fm. sediments examined that one wonders about its true identity. However, log analysis would tend to confirm that it is in-situ as opposed to a concentrated and local case of cavings. Is the stratigraphy definitive here, or are we dealing with a localized curiosity within the Stanley Fm.?

Frank A. Marsek
pp. R. Burwood

RB:yg

cc: H.G. Bassett
J.G. Grasselli
R. Drozd
F. Marsek
PGW Files (Ø) (2-5)

To: D. May
SPC Mid-Continent Division
Dallas

April 28, 1982

File PGW/042882/FM/2-5

From: Petroleum Geochemistry Group,
Warrensville

Job # PGW 82-3

Technical Memorandum (PGW/TM 44) - Geochemical Evaluation of a Section of the Stanley Fm. in the McCormick #1 Meyers Well, Rockwall County, Texas.

A total of 15 cuttings samples, reported to be of Stanley Fm. sediments, were received for source richness and maturity analyses. The samples were representative of the 6,500 - 6,672 ft interval in the McCormick #1 Meyers well located 600 ft FNWL and 3,200 ft FSWL of Leonard Eastwood Survey A-79, Rockwall County, Texas. The well, which TD'd at 6,672 ft, was drilled as a Smackover and Ouachita facies test.

The samples were composited into 30 ft intervals and screened for Total Organic Carbon (TOC) content using standardized PGW methods. Whole rock vitrinite reflectance determinations were performed on selected samples. A summary listing of the data is given in Table 1.

Except for an occurrence of coal in the 6,590 - 6,630 ft interval, none of the sediments examined had enough organic carbon to be of interest as source rocks. A relatively low TOC content in the coal (58.06 wt %) suggested that it was a carbargillite. Pyrolysis of this coaly sediment yielded a moderately high amount of volatiles (S1 = 5.71 kg/ton) and a very high potential productivity (S2 = 48.31 kg/ton). Vitrinite reflectance data obtained from the carbargillite and a typical shale lithology in the 6,660 - 6,672 ft interval (0.47 and 0.49 %, respectively) showed the sediments to be immature. This further suggested that the relatively high volatile yield (S1) of the carbargillite was a result of the presence of lipid-like biopolymers or humic acids incorporated into the sediments during initial deposition and not the result of thermal decomposition of kerogen.

The high potential productivity of the carbargillite indicated that this sediment, as represented by the sample, had Excellent source rock potential. Its commercial potential would depend upon maturation of the carbargillite in addition to the thickness and regional extent of this sediment. The exact thickness of the carbargillite in the McCormick #1 Meyers well was not clearly established. Only one ten foot sample of the carbargillite (6,590 - 6,600 ft) was received for analysis. However, electric log analysis of the well section between 6,590 and 6,630 ft indicated that the carbargillite was approximately 25 ft thick. The maturation of a good potential source rock of this thickness in close proximity to reservoir rocks would constitute an attractive senario for hydrocarbon generation and entrapment.

Although expected to be exclusively gas prone, pyrolysis-gas chromatography demonstrated that the carbargillite would be gas condensate to gas prone at maturity (GOGI = 0.65).

A number of geochemical evaluations of Stanley Fm. sediments have been conducted for the SPC Mid-Continent Division. In none of this previous work were any carbargillite-like or coaly intervals or samples encountered. The occurrence of the Stanley Fm. has been attributed to the result of turbidite and sea fan depositional environments. The existance of coaly sediments infers a much different deposition of environment in the part of the Stanley in which the carbargillite reportedly occurs. It is therefore suggested that the carbargillite may actually be part of the basal Jurassic Cotton Valley Fm. which occurred above the Stanley in the #1 Meyers well.

Frank A. Marsek

Frank A. Marsek

Table 1

cc: H. G. Bassett
J. G. Grasselli
E. E. Luttrell
R. Burwood
R. Drozd
PGW Files (0), (2-5)

Work by: S. Adams
M. Bordonaro
G. Cole
R. Lukco

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:

- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. / LST. } 0-10% qualifying component

SH. CALC / LST. ARG } 11-25% qualifying component

SH. V. CALC / LST. V. ARG } 26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): ‰ Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): ‰ Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^{\circ}C$) - Kg/Tn.

S2 (12): ‰ Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: ‰ Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

G1 (TSE)(14): ‰ Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

G1 (S1)(15): ‰ Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): ‰ Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) ‰ Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): ‰ Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

TABLE 1

PAGE . 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : ROCKWALL
LOCATION : LEONARD EASTWOOD SVY
WELL/SITE : MCCORMICK#1 MEYERS
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
6500	WA9385	CTG	MISS	STAN	SH,CALC	11		.02				
6510	WA9386	CTG			SH,CALC							
6520	WA9387	CTG			SH,CALC							
6530	WA9388	CTG			SH,CALC	13		.10				
6540	WA9389	CTG			SH,CALC							
6550	WA9390	CTG			SH,CALC							
6560	WA9391	CTG			SH,CALC	21		.42				
6570	WA9392	CTG			SH,CALC							
6580	WA9393	CTG			SH,CALC							
6590	WA9394	CTG			COAL,V.ARG	13		58.06		5.71	48.31	83
6630	WA9395	CTG			SH,CALC	14		.21				
6631	WA9396	CTG			SH,CALC							
6640	WA9397	CTG			SH,CALC	15		.21				
6650	WA9398	CTG			SH,CALC							
6660	WA9399	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
6500															
6510															
6520															
6530															
6540															
6550															
6560															
6570															
6580															
6590	.11		10		45.51	17.93	27.58	78	.65			.47			
6630															
6631															
6640															
6650															
6660												.49			

PGW/TM 50
H0i2.0430
C.2

903064

SOHIO PETROLEUM COMPANY

OFFICE CORRESPONDENCE

To: E. Luttrell
SPC Mid-Continent Office - Dallas

Date: June 14, 1982

From: Petroleum Geochemistry Group
Warrensville

File: PGW Files (0), (2-5)

67330

Subject: Sheraton #1 Bean Well,
Clark County Arkansas
-- Report PGW/TM 50

Ref.:

Herewith for your retention two copies (one for C.A.O. Titus) of the subject report.

As on previous occasions, the Stanley Fm. again appeared to have been a rather unattractive and poor source rock. Despite the advanced thermal maturity observed, it is likely that the now spent organic richness never exceeded 1% TOC content and was probably, and frequently, less than 0.5%. Thus the trend seems to be consistent from south central Texas, through southern Oklahoma and into S.W. Arkansas.

The advanced thermal maturity of the Stanley Fm. observed in the well is interesting and undoubtedly relates to its proximity to the core of the Ouachita's. Whether maturity was derived from overburden considerations or was a facet of tectonic controlled heat flow, is conjectural. I would suspect the latter.

We have had some contact with C. Titus concerning a possible Mid-Continent -- PGW field trip to S. W. Arkansas. Our objective would be to obtain Miss-Pennsylvanian (possibly Cretaceous) outcrop sampled materials in an effort to track down the possible progenitor(s) of the Arkansas asphalts. As you know, there are isotopically significantly different to the Ouachita Grahamites from S. Oklahoma, and a quite separate source provenance is suspected. We are hoping that this trip can be arranged for September next.

R. Drozd
pp R. Burwood

RB:bes
Enclosures: 2

cc: H. G. Bassett
J. G. Grasselli
R. J. Drozd
F. A. Marsek
PGW Files (0), (2-5)

SOHIO PETROLEUM COMPANY

To: C. A. O. Titus
SPC Mid-Continent Division
Dallas

June 14, 1982

File: PGW/052882/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job #PGW 82-42

Technical Memorandum (PGW/TM 50) - Geochemical Evaluation of Mississippian Stanley Fm. Sediments Penetrated in the Sheraton #1 Bean Well, Clark County, Arkansas

The Sheraton #1 Bean well, located in SE, NE, Section 15 T5S - R23W, Clark County, Arkansas, was spudded in the Stanley and TD'd in the Stanley at 2,905 ft below the surface. Cuttings samples representative of the 40 to 2,905 ft interval of the well were received and analyzed for source richness and maturity using standardized PGW methods.

A summary listing of the geochemical data for this well is presented in Table 1. As in previous geochemical evaluations of Stanley Fm. sediments conducted for the SPC Mid-Continent Division, none of the Stanley sediments examined were concluded to be of commercial source interest. Only 4 of 94 samples analyzed had TOC contents in excess of 0.50 wt% and all were less than 0.60 wt% (Table 1). Based on these low TOC values the Stanley sediments penetrated in the #1 Bean well were dismissed as possible source rocks.

Reasonably good whole rock vitrinite reflectance data were obtained from the cuttings samples. Reflectance values ranged from 1.60 to 2.42% increasing with depth. These data indicated that the Stanley sediments in the vicinity of the #1 Bean were well into the gas generation regime and any Stanley sediments with source potential would probably be spent. The high reflectance values also suggested that the Stanley sediments toward the bottom of the well had been subjected to conditions approaching low grade thermal metamorphism and that the Stanley Fm. in the general vicinity had been buried to a much greater depth at some time in the geological past. Any reservoired liquid hydrocarbons in these Stanley sediments would have been thermally cracked and would now be dominantly to exclusively gaseous.

Frank A. Marsek

FAM:bes
Table 1

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
R. J. Drozd
E. Luttrell
PGW Files (0), (2-5)

Work by: G. A. Cole
S. S. White

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. LST.	}	0-10% qualifying component
SH. CALC LST. ARG	}	11-25% qualifying component
SH. V. CALC LST. V. ARG	}	26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): ‰ Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): ‰ Thermally Distillable Hydrocarbons (Rock Eval @ $\leq$ 300°C) - Kg/Tn.

S2 (12): ‰ Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: ‰ Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

G1 (TSE)(14): ‰ Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

G1 (S1)(15): ‰ Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): ‰ Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) ‰ Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): ‰ Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 ft.$^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

TABLE 1

PAGE , 1

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : CLARK
LOCATION : SEC15,T5SR23W
WELL/SITE : SHERATON#1 BEAN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
40	WB2209	CTG	MISS	STAN	SH	8		.46				
75	WB2210	CTG			SH	6		.31				
103	WB2211	CTG			SH	8		.45				
131	WB2212	CTG			SH	8		.42				
159	WB2213	CTG			SH,CALC	14		.31				
186	WB2214	CTG			SH	6		.37				
241	WB2215	CTG			SH	8		.45				
269	WB2216	CTG			SH	8		.35				
297	WB2217	CTG			SH	9		.36				
324	WB2218	CTG			SH	9		.28				
352	WB2219	CTG			SH,CALC	11		.41				
379	WB2220	CTG			SH	4		.53				
407	WB2221	CTG			SH	4		.51				
435	WB2222	CTG			SH	5		.39				
462	WB2223	CTG			SH	7		.53				
493	WB2224	CTG			SH	4		.32				
525	WB2225	CTG			SH	6		.29				
557	WB2226	CTG			SH	9		.34				
588	WB2227	CTG			SH	9		.34				
620	WB2228	CTG			SH	8		.39				
651	WB2229	CTG			SH	7		.41				
682	WB2230	CTG			SH	10		.40				
714	WB2231	CTG			SH	10		.36				
755	WB2232	CTG			SH,V.CALC	26		.37				
785	WB2233	CTG			SH	8		.42				
815	WB2234	CTG			SH	9		.40				
845	WB2235	CTG			SH	7		.45				
875	WB2236	CTG			SH	9		.47				
930	WB2237	CTG			SH	9		.46				
960	WB2238	CTG			SH	9		.43				
990	WB2239	CTG			SH	9		.41				
1020	WB2240	CTG			SH	9		.39				
1050	WB2241	CTG			SH	8		.43				
1080	WB2242	CTG			SH	8		.44				
1110	WB2243	CTG			SH	9		.43				
1140	WB2244	CTG			SH	9		.44				
1170	WB2245	CTG			SH	9		.44				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
40												1.60			
75															
103															
131															
159															
186															
241															
269															
297															
324												1.73			
352															
379															
407															
435															
462												1.75			
493															
525															
557															
588															
620															
651												1.91			
682															
714															
755															
785															
815															
845															
875															
930															
960												1.93			
990															
1020															
1050															
1080															
1110															
1140															
1170															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1200	WB2246	CTG			SH	7		.42				
1230	WB2247	CTG			SH	9		.39				
1260	WB2248	CTG			SH	7		.42				
1290	WB2249	CTG			SH	9		.38				
1320	WB2250	CTG			SH	8		.40				
1350	WB2251	CTG			SH	8		.40				
1380	WB2252	CTG			SH	7		.39				
1410	WB2253	CTG			SH	8		.34				
1440	WB2254	CTG			SH	8		.35				
1470	WB2255	CTG			SH	10		.34				
1500	WB2256	CTG			SH	8		.35				
1530	WB2257	CTG			SH	8		.35				
1560	WB2258	CTG			SH	9		.40				
1590	WB2259	CTG			SH	8		.40				
1620	WB2260	CTG			SH	8		.42				
1650	WB2261	CTG			SH,CALC	11		.41				
1680	WB2262	CTG			SH	10		.39				
1710	WB2263	CTG			SH,CALC	11		.34				
1740	WB2264	CTG			SH,CALC	13		.40				
1770	WB2265	CTG			SH	8		.39				
1800	WB2266	CTG			SH	9		.43				
1830	WB2267	CTG			SH	8		.59				
1860	WB2268	CTG			SH	10		.40				
1890	WB2269	CTG			SH,CALC	15		.38				
1920	WB2270	CTG			SH	10		.39				
1950	WB2271	CTG			SH,CALC	12		.35				
1980	WB2272	CTG			SH	9		.36				
2010	WB2273	CTG			SH	9		.36				
2040	WB2274	CTG			SH	8		.39				
2070	WB2275	CTG			SH	9		.38				
2100	WB2276	CTG			SH,CALC	11		.36				
2130	WB2277	CTG			SH	9		.37				
2160	WB2278	CTG			SH	7		.39				
2190	WB2279	CTG			SH	9		.40				
2200	WB2280	CTG			SH	9		.41				
2250	WB2281	CTG			SH	9		.39				
2280	WB2282	CTG			SH	9		.41				
2310	WB2283	CTG			SH	8		.46				
2340	WB2284	CTG			SH	8		.42				
2370	WB2285	CTG			SH	7		.44				
2400	WB2286	CTG			SH	7		.43				
2430	WB2287	CTG			SH	7		.41				
2460	WB2288	CTG			SH	8		.44				
2490	WB2289	CTG			SH	9		.42				
2520	WB2290	CTG			SH	8		.40				
2550	WB2291	CTG			SH	8		.38				
2580	WB2292	CTG			SH	5		.38				
2610	WB2293	CTG			SH	4		.39				
2640	WB2294	CTG			SH	6		.35				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1200															
1230															
1260												2.01			
1290															
1320															
1350															
1380															
1410															
1440															
1470															
1500															
1530															
1560												2.11			
1590															
1620															
1650															
1680															
1710															
1740															
1770															
1800															
1830															
1860												2.25			
1890															
1920															
1950															
1980															
2010															
2040															
2070															
2100															
2130															
2160												2.25			
2190															
2200															
2250															
2280															
2310															
2340															
2370															
2400															
2430												2.42			
2460															
2490															
2520															
2550															
2580															
2610															
2640															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2670	WB2295	CTG			SH	6		.40				
2700	WB2296	CTG			SH	7		.39				
2730	WB2297	CTG			SH	6		.35				
2760	WB2298	CTG			SH	6		.40				
2790	WB2299	CTG			SH	5		.38				
2820	WB2300	CTG			SH	6		.39				
2850	WB2301	CTG			SH	6		.37				
2880	WB2302	CTG			SH	6		.38				

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2670															
2700															
2730															
2760												2.46			
2790															
2820															
2850															
2880												2.49			

H082.0395
C.2

PGW/EB17

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: R. Cobb
SPC Mid-Continent Region
Dallas

November 18, 1982

PGW/111782/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: 82-72

Subject: Geochemical Evaluation of Selected Cuttings from the Sinclair 1-Herrick Well, Pushmataha County, Oklahoma. Exploration Brief (PGW/EB 017).

62105

The Sinclair 1-Herrick well is located in Section 11, T2N-R20E of Pushmataha County. It was drilled on the crest of the Albion Anticline in the southern Potatoe Hills. The well reportedly spudded in Womble Shale, penetrated a thrust fault, and went into Bigfork Chert. It reached TD at 3,002 ft. in Womble Shale.

A total of five 30 foot composited cuttings samples from a depth range of 430 - 2,800 ft. were received and given PGW well sample designations WB 6042 - WB 6046. The samples were screened for source richness and maturity using standardized PGW methods which included TOC (bitumen free), pyrolysis (Rock Eval), and vitrinite reflectance (whole rock). Detailed pyrolysis gas chromatography was performed on samples of source interest selected on the basis of the screen data.

The geochemical data for the five well cuttings is given in Table 1. The vitrinite reflectance values reported were determined on vitrinite-like matter and may not be indicative of the true thermal maturity of the sediments. However, the pyrolysis results tended to support an oil mature to threshold gas mature assessment of the sediments as suggested by Ro values of 0.79% and 1.06% at 500 ft. and 2,700 ft., respectively. Limited to only two determinations, the reflectance data gave no indication of a thrust fault but did show that the sediments were previously buried to a greater depth. They were probably uplifted out of the hydrocarbon generation window and are now dormant at their present depth.

The three Womble samples between 430 ft. and 600 ft. all had Good TOC contents in excess of 1.00% and Moderate to Good pyrolytic (S2) yields ranging from 1.45 to 4.73 kg/ton. Based on their maturity levels these sediments had probably generated some hydrocarbons at depth but generation apparently ceased before the sediments reached their peak generative capability. The sediments were assessed to still have Moderate to Good commercial source potential remaining. Gas/Oil Generation Indices (GOGI's) ranging from 0.34 to 0.47 suggested that these sediments now have mixed oil and gas prone potential. They may have been more oil prone prior to their entry into the oil generation window.

The Womble samples from 2,700 ft. and 2,800 ft. had only Marginal TOC contents and Negligible pyrolytic yields. Neither of these samples ever had any commercial source potential and appeared to be representative of a facies change in the Womble Formation.

With the proximity of reservoir rocks, the occurrence of Womble sediments similar to those between 430 ft. and 600 ft. in a sustained, mature geothermal regime, would constitute a prospective exploration target.

Frank A. Marsek

F. A. Marsek

FAM:bes
Enclosure: Table 1

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
R. J. Drozd
E. Luttrell
PGW Files (0), (2-5)

TABLE 1

PAGE . 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC11,T2NR20E
WELL/SITE : SINCLAIR 1-HERRICK
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
430	WB6042	CTG	ORD	WOMB	SH,CALC	14		1.17		.25	1.45	124
500	WB6043	CTG	ORD	WOMB	SH,CALC	13		1.51		.23	2.05	136
600	WB6044	CTG	ORD	WOMB	SH,V.CALC	29		2.37		.50	4.73	200
2700	WB6045	CTG	ORD	WOMB	SH,CALC	14		.46		.23	.41	89
2800	WB6046	CTG	ORD	WOMB	SH,CALC	12		.48		.20	.30	63

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
430	.15		21		1.84	.47	1.37	157	.34						
500	.10		15		2.57	.75	1.82	170	.41			.79			
600	.10		21		4.88	1.56	3.32	206	.47						
2700	.36		50									1.06			
2800	.40		42												

C,3

PGW/E...

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: R. Cobb
SPC Mid-Continent Region
Dallas

December 13, 1982

PGW/121082/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: PGW 82-78

Subject: Geochemical Evaluation of Selected Cuttings from the Gragg 1-Kenman and 1-Laycock Wells, Pushmataha County, Oklahoma -- Exploration Brief (PGW/EB 021).

The 1-Kenman well was drilled in Section 8, T2N-R19E of northern Pushmataha County, Oklahoma to a TD of 3,898 ft. The well penetrated a section of Arkansas Novaculite, Missouri Mountain Shale, and Blaylock Sandstone; a partial section of Polk Creek Shale and reached TD in the Big Fork Chert or Womble Shale.

Four composited cuttings samples, two representative of the Arkansas Novaculite (250 - 270 ft., and 500 - 530 ft.), one representative of the Missouri Mountain Fm. (870 - 910 ft.) and one representative of the Polk Creek Shale (1,380 - 1,410 ft.) were received for source rock analyses. The samples were given PGW well sample identification numbers WB 6520 - WB 6523, respectively, and analyzed using standardized PGW methods including TOC (bitumen free), pyrolysis (Rock Eval) and whole-rock vitrinite reflectance. The geochemical data for these 1-Kenman well samples is given in Table 1.

Only one sample representative of the Arkansas Novaculite between 500 ft., and 530 ft., had sufficient TOC contents (0.59 wt%) to be considered as a possible source sediment. However, the TOC content of this sample was not considered to be characteristic of a commercial source rock. All of the samples showed negligible potential productivities (S2).

A reflectance value of 0.96% determined on the Novaculite sample from the 500 - 530 ft. interval indicated that the sediments penetrated in the well had reached oil to threshold gas maturity at their maximum depth of burial.

The 1-Laycock was drilled in Section 17, T2N-R19E of northern Pushmataha County about one mile south of the 1-Kenman. This well was spudded in Mississippian Stanley Shale and reached TD at 3,520 ft. in the Stanley.

Three 30 ft. composited cuttings representative of the 860 - 890 ft., 1,590 - 1,620 ft., and 2,250 - 2,280 ft. intervals of the well were received for source rock analyses. The samples were given PGW well sample designations WB 6524 - WB 6526, respectively. The geochemical data for these three samples are presented in Table 2.

Vitrinite reflectance values of 0.83% (860 ft.) and 0.90% (1,590 ft.) were consistent with a 0.96% Ro value determined on a Novaculite sample from the nearby 1-Kenman well. These data indicated that most the Ouachita facies sediments in the vicinity of the 1-Kenman and 1-Laycock wells were thermally mature and had reached the peak oil generation regime during their burial history. Significantly, the thermal maturity of the Stanley sections penetrated were apparently greater than in the adjacent Herndon 1-Flatt well (Section 10, T2N-R18E) of PGW/EB 022.

One interval of the Stanley (860 - 890 ft.) showed a Good organic carbon content (1.31 wt%) and Moderate potential productivity (1.47 kg/ton). Pyrolysis-gas chromatographic analyses of this sample produced a Gas/Oil Generation Index of 0.39 indicating mixed oil and gas potential for the interval. Based on these data the interval was assessed to have limited local hydrocarbon generating potential and might be expected to source non-commercial oil and gas shows in wells drilled in the area.

R. Burwood
pp F. A. Marsek

FAM:bes

Enclosures: Tables 1 and 2

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
R. J. Drozd
E. Luttrell
PGW Files (0), (2-5)

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC8,T2NR19E
WELL/SITE : GRAGG 1-KENMAN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
250	WB6520	CTG	DEV	ARKN	SH,,CHTY	9		.42		.16	.25	60
500	WB6521	CTG	DEV	ARKN	SH,CHTY	10		.59		.16	.45	76
870	WB6522	CTG	SIL	MONT	SH	9		.27		.14	.30	111
1380	WB6523	CTG	ORD	POLK	SH,CALC	11		.36		.12	.18	50

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
250	.39		38												
500	.26		27									.96			
870	.32		52												
1380	.40		33												

TABLE 2

PAGE , 1

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC17,T2NR19E
WELL/SITE : GRAGG 1-LAYCOCK
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
860	WB6524	CTG	MISS	STAN	SH	10		1.31		.22	1.47	112
1590	WB6525	CTG	MISS	STAN	SH,CALC	14		.31		.06	.30	97
2250	WB6526	CTG	MISS	STAN	SH,CALC	17		.43		.02	.12	28

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
860	.13		17		1.87	.52	1.35	143	.39			.83			
1590	.17		19		.43	.13	.30	139	.42			.90			
2250	.14		5												

MUB... C,3 PGW/EB

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: R. Cobb
SPC Mid-Continent Region
Dallas

December 13, 1982

PGW/121082/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: PGW 82-78

Subject: Geochemical Evaluation of Selected Cuttings from the Gragg 1-Kenman and 1-Laycock Wells, Pushmataha County, Oklahoma -- Exploration Brief (PGW/EB 021).

The 1-Kenman well was drilled in Section 8, T2N-R19E of northern Pushmataha County, Oklahoma to a TD of 3,898 ft. The well penetrated a section of Arkansas Novaculite, Missouri Mountain Shale, and Blaylock Sandstone; a partial section of Polk Creek Shale and reached TD in the Big Fork Chert or Womble Shale.

Four composited cuttings samples, two representative of the Arkansas Novaculite (250 - 270 ft., and 500 - 530 ft.), one representative of the Missouri Mountain Fm. (870 - 910 ft.) and one representative of the Polk Creek Shale (1,380 - 1,410 ft.) were received for source rock analyses. The samples were given PGW well sample identification numbers WB 6520 - WB 6523, respectively, and analyzed using standardized PGW methods including TOC (bitumen free), pyrolysis (Rock Eval) and whole-rock vitrinite reflectance. The geochemical data for these 1-Kenman well samples is given in Table 1.

Only one sample representative of the Arkansas Novaculite between 500 ft., and 530 ft., had sufficient TOC contents (0.59 wt%) to be considered as a possible source sediment. However, the TOC content of this sample was not considered to be characteristic of a commercial source rock. All of the samples showed negligible potential productivities (S2).

A reflectance value of 0.96% determined on the Novaculite sample from the 500 - 530 ft. interval indicated that the sediments penetrated in the well had reached oil to threshold gas maturity at their maximum depth of burial.

The 1-Laycock was drilled in Section 17, T2N-R19E of northern Pushmataha County about one mile south of the 1-Kenman. This well was spudded in Mississippian Stanley Shale and reached TD at 3,520 ft. in the Stanley.

Three 30 ft. composited cuttings representative of the 860 - 890 ft., 1,590 - 1,620 ft., and 2,250 - 2,280 ft. intervals of the well were received for source rock analyses. The samples were given PGW well sample designations WB 6524 - WB 6526, respectively. The geochemical data for these three samples are presented in Table 2.

Vitrinite reflectance values of 0.83% (860 ft.) and 0.90% (1,590 ft.) were consistent with a 0.96% Ro value determined on a Novaculite sample from the nearby 1-Kenman well. These data indicated that most the Ouachita facies sediments in the vicinity of the 1-Kenman and 1-Laycock wells were thermally mature and had reached the peak oil generation regime during their burial history. Significantly, the thermal maturity of the Stanley sections penetrated were apparently greater than in the adjacent Herndon 1-Flatt well (Section 10, T2N-R18E) cf PGW/EB 022.

One interval of the Stanley (860 - 890 ft.) showed a Good organic carbon content (1.31 wt%) and Moderate potential productivity (1.47 kg/ton). Pyrolysis-gas chromatographic analyses of this sample produced a Gas/Oil Generation Index of 0.39 indicating mixed oil and gas potential for the interval. Based on these data the interval was assessed to have limited local hydrocarbon generating potential and might be expected to source non-commercial oil and gas shows in wells drilled in the area.

R. Burwood
pp F. A. Marsek

FAM:bes

Enclosures: Tables 1 and 2

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
R. J. Drozd
E. Luttrell
PGW Files (0), (2-5)

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC8,T2NR19E
WELL/SITE : GRAGG 1-KENMAN
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
250	WB6520	CTG	DEV	ARKN	SH,,CHTY	9		.42		.16	.25	60
500	WB6521	CTG	DEV	ARKN	SH,CHTY	10		.59		.16	.45	76
870	WB6522	CTG	SIL	MONT	SH	9		.27		.14	.30	111
1380	WB6523	CTG	ORD	POLK	SH,CALC	11		.36		.12	.18	50

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
250	.39		38												
500	.26		27									.96			
870	.32		52												
1380	.40		33												

TABLE 2

PAGE . 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC17,T2NR19E
WELL/SITE : GRAGG 1-LAYCOCK
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
860	WB6524	CTG	MISS	STAN	SH	10		1.31		.22	1.47	112
1590	WB6525	CTG	MISS	STAN	SH,CALC	14		.31		.06	.30	97
2250	WB6526	CTG	MISS	STAN	SH,CALC	17		.43		.02	.12	28

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
860	.13		17		1.87	.52	1.35	143	.39			.83			
1590	.17		19		.43	.13	.30	139	.42			.90			
2250	.14		5												

SOURCE QUALITY EVALUATION

AND

THERMAL MATURITY ASSESSMENT

OF THE

STEWART 1-8 WELL

WEYERHAEUSER ACREAGE

HEMPSTEAD COUNTY, ARKANSAS

EXPLORATION BRIEF (PGG/EB413)

Author: G.A. Cole

STANDARD OIL PRODUCTION COMPANY

Petroleum Geochemistry Group

TO: A. Krancer
Exploration-Onshore, Houston

DATE: January 12, 1988

FILE: PGG/011288/GC/2-8

FROM: Petroleum Geochemistry Group
Freeport Laboratory, Dallas

CLASS.: CONFIDENTIAL

SUBJECT: Source Quality Evaluation and Thermal Maturity Assessment of the Stewart 1-8 Well, Weyerhaeuser Acreage, Hempstead County, Arkansas--Exploration Brief (PGG/EB413)

Well cuttings samples from the 0-8518' interval (TD at 8518') from the Stewart 1-8 well, Weyerhaeuser acreage, Hempstead County, Arkansas, were received for thermal maturity assessment vial whole-rock vitrinite reflectance techniques and for source quality determination (total organic carbon [TOC], Rock-Eval S_1 and S_2 pyrolytic yields). Samples were selected on a 500' basis. Data results are listed in Table 1 and the vitrinite reflectance profile is graphically illustrated in Figure 1. No detailed stratigraphic information was provided for this well site, but PGG was informed that the 0-1000' section was Cretaceous in age and the interval greater than 1000' belonged to the Ouachita flysch series.

A total of 25 samples were selected for vitrinite reflectance analyses. From these twenty-five (25) samples, seven (7) contained no measurable vitrinite and were reported as "NDP" (no determination possible). Two (2) samples (from 300' and 500') were from the Cretaceous rocks which indicated that this section was immature as shown by a R_o of 0.33% at 500'. Sixteen (16) samples from the Pennsylvanian age flysch rocks yielded useable results and a linear regression was applied to this data set . The regression analysis indicated:

1.) The surface R_o was approximately 0.3% indicating that the surface rocks of Cretaceous age were immature.

2.) The Cretaceous-Pennsylvanian unconformity occurred at approximately 1000'. The pennsylvanian rocks at this boundary had an R_o of about 1.0%. The dominant gas generation threshold (DGGT; 1.00% R_o) occurred at this point. DGGT is where the kerogen begins generation of gaseous products and where oils begin to thermally crack into lighter components. All Pennsylvanian age rocks in this well, therefore, are beyond the oil generation window of 0.6 to 1.0% R_o.

3.) The rocks between 1000' to 3440' (1.0 to 1.35% R_o) could reservoir oils, and the rocks between 3440 to about 5900' (1.35 to 1.75% R_o) could reservoir light oils and condensates, respectively. Only dry gas would be expected from 5900' to TD (R_o greater than 1.75%).

4.) Thermally spent rocks (>2.0% R_o) were penetrated from 6890' to TD. Only dry gas would be reservoired in these rocks.

5.) The regression calculated a maturity gradient of 4.94 DOD units/1000' with a correlation coefficient of 96%. The gradient of the Stewart 1-8 well correlated reasonably well with gradients calculated from other wells in the Ouachita region. However, this well had a slightly higher maturity gradient possibly indicating that this local area had a higher geothermal gradient in the past. Gradients for other wells were: Shell 1-26 Arivett (Pike County, Arkansas)- 4.06 DOD units/1000', Campbell 1-24 well (Atoka County, Oklahoma)- 4.85 DOD units/1000', Getty 1-20 Morris well (Pushmataha County, Oklahoma)- 4.43 DOD units/1000', Trotter-Dees 1-29 well (Pushmataha County, Oklahoma)- 4.31 DOD units/1000', the Weyerhaeuser 1-15 well (Pushmataha County, Oklahoma)- 4.43 DOD units/1000', and the Weyerhaeuser 1-7 well (Le Flore County, Oklahoma)- 4.24 DOD units/1000'.

6.) Typical surface R_o values without erosion are generally accepted as being 0.15-0.20%. Using a 0.20% R_o value for the surface, about 13340' of erosion has occurred at this site.

Source rock analyses for the Stewart 1-8 well indicated that the Pennsylvanian section penetrated had no source potential, whatsoever. The TOC contents averaged 0.33% (ranged from 0.17-0.62%); S_1 and S_2 pyrolytic yields averaged 0.03 and 0.14 kg/ton, respectively. All pyrolytic yields were considered negligible.

The Cretaceous section (0-1000') had poor source potential based on two sample results. TOC was less than 0.15% and pyrolytic yields were negligible.

CONCLUSIONS:

The Pennsylvanian age rocks penetrated by the Stewart 1-8 well were gas mature (1.0% R_o at the unconformity boundary) to thermally spent at TD (about 2.35% R_o). These rocks contained no source rocks capable of generating or reservoiring commercial quantities of hydrocarbons. If a source rock and reservoir rock were available, this site could have yielded liquid hydrocarbons (oils and /or condensates-wet gases) in the 0-5900' interval and gaseous hydrocarbons at depths greater than 5900'.

G.A. Cole

encl: Table 1
Figure 1

cc: T. Legg
R. Jantzen
M. Rahman
Exploration Briefs

TABLE 1

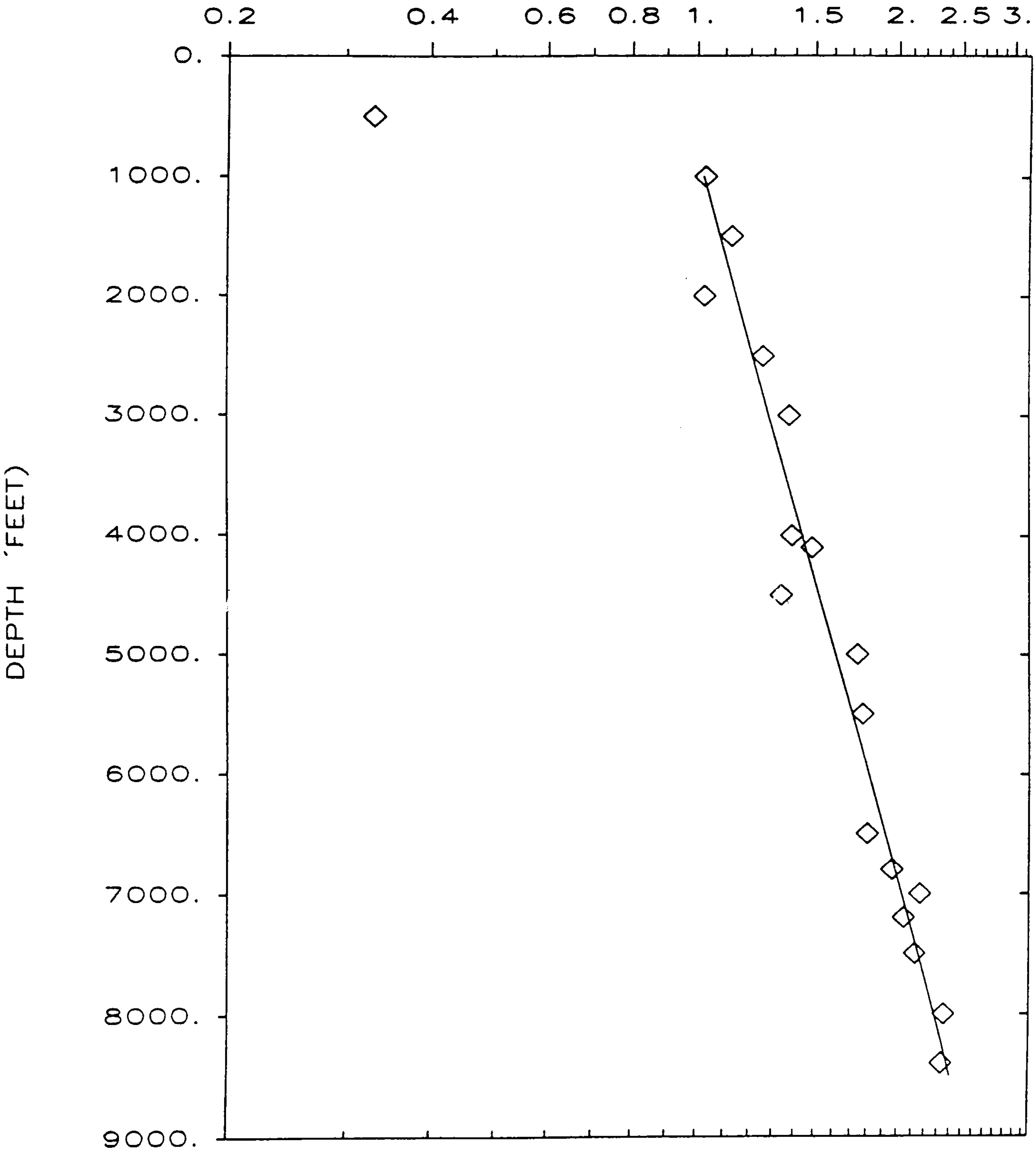
Sample #	Depth	Age	Form.	TOC	S1	S2	Ro	# Pts.
WE9750	0	CRET						
WE9751	100							
WE9752	200							
WE9753	300			0.00	0.00	0.00	NDP	---
WE9754	400							
WE9755	500			0.13	0.02	0.07	0.33	17
WE9756	600							
WE9757	700							
WE9758	800							
WE9759	900							
WE9760	1000	PENN	JKFK	0.43	0.02	0.20	1.03	11
WE9761	1100							
WE9762	1200							
WE9763	1300							
WE9764	1400							
WE9765	1500			0.62	0.14	0.60	1.13	5
WE9766	1600							
WE9767	1700							
WE9768	1800							
WE9769	1900							
WE9770	2000			0.35	0.00	0.04	1.03	3
WE9771	2100							
WE9772	2200							
WE9773	2300							
WE9774	2400							
WE9775	2500			0.28	0.02	0.12	1.26	12
WE9776	2600							
WE9777	2700							
WF0001	2800							
WF0002	2900							
WF0003	3000			0.27	0.05	0.12	1.38	8
WF0004	3100							
WF0005	3200							
WF0006	3300							
WF0007	3400							
WF0008	3500			0.26	0.02	0.04	NDP	---
WF0009	3600							
WF0010	3700							
WF0011	3800							
WF0012	3900							
WF0013	4000			0.21	0.02	0.09	1.39	6
WF0014	4100						1.49	4
WF0015	4200							
WF0016	4300						NDP	---
WF0017	4400							
WF0018	4500			0.17	0.02	0.07	1.34	7
WF0019	4600							
WF0020	4700						NDP	---
WF0021	4800							
WF0022	4900							
WF0023	5000			0.23	0.04	0.32	1.74	5
WF0024	5100							
WF0025	5200							
WF0026	5300						NDP	---
WF0027	5400							
WF0028	5500			0.25	0.04	0.14	1.77	4
WF0029	5600							
WF0030	5700							
WF0031	5800						NDP	---
WF0032	5900							
WF0033	6000			0.23	0.02	0.00	NDP	---
WF0034	6100							
WF0035	6200							
WF0036	6300							
WF0037	6400							
WF0038	6500			0.42	0.00	0.02	1.80	5
WF0039	6600							
WF0040	6700							
WF0041	6800						1.96	3
WF0042	6900							
WF0043	7000			0.39	0.00	0.09	2.16	12
WF0044	7100							
WF0045	7200						2.04	21
WF0046	7300							
WF0047	7400							
WF0048	7500			0.23	0.09	0.17	2.12	14
WF0089	7600							
WF0090	7700							
WF0091	7800							
WF0092	7900							
WF0093	8000			0.50	0.04	0.02	2.35	18
WF0094	8100							
WF0095	8200							
WF0096	8300							
WF0097	8400			0.37	0.02	0.14	2.33	11
WF0098	8500							

TD-8518

FIGURE 1

WEYERHAEUSER ACREAGE: STEWART 1-8

VITRINITE REFLECTANCE (% Ro)



STANDARD OIL PRODUCTION

Petroleum Geochemistry Group

THE STANDARD OIL COMPANY

SOURCE ROCK POTENTIAL EVALUATION
OF SELECTED OUTCROP SAMPLED ORDOVICIAN SEDIMENTS FROM
THE OUACHITA OVERTHRUST
ATOKA COUNTY, OKLAHOMA

Topical Report No. 5915
Petroleum Geochemistry Report PGW 003
Project: 2013
Authors: R. Burwood, F. Marsek
Date: July 30, 1980

Work by: R. Burwood
F. Marsek

Approved: J. Grasselli
RB

SYNOPSIS

Ordovician sediments sampled from two faulted measured sections in Atoka County, S.E. Oklahoma, have been screened for Source Rock Potential.

Dark shales taken from spot horizons in the Womble, Bigfork and Polk Creek Formations showed Good to Excellent Source Richness. However, for all cases the formations were assessed to be thermally immature, to incipiently mature, not having attained hydrocarbon generation and expulsion status.

For the Ordovician of S.E. Oklahoma to be hydrocarbon productive, a more forceful palaeothermal regime, hence greater palaeo-overburden or heat flow than that experience by the two subject outcrop sections is a prerequisite.

RB:dlc

cc: Full Copies

B. E. Reed (Dallas) 3
Library
L. W. Evans
Geological Services (San Francisco) 1
SPC Library (San Francisco) 2
PGW Files

Synopsis Only

G. G. Cross
N. W. Standish

1. CONCLUSIONS AND RECOMMENDATIONS

1.1 Fifteen outcrop samples, all showing significant surface weathering, from early Palaeozoic sections in the Ouachita Overthrust (Atoka County, S.E. Oklahoma) have been screened for Source Rock Potential.

1.2 Spot horizons in the basal interval of a thrust faulted unit of the Womble Fm. (M. Ordovician - North Boggy Creek Bride Section) were assessed to have Very Good to Excellent source potential but to be presently of pre-mature-incipiently mature status. On attaining maturity, the kerogen assemblage would initially be expected to be oil, as opposed to gas, prone.

1.3 Contingent upon the thickness-volumetric extent of these basal Womble sediments, the interval may have significant source potential elsewhere in the area where a somewhat more forceful palaeothermal regime (i.e., greater palaeo-overburden and/or heat flow) has been experienced.

1.4 Spot horizons in the Polk Creek Fm (U. Ordovician - Scratch Hill Section) showed Good to Very Good source richness but where again assessed to be thermally immature. Potential productivity and kerogen type suggested a source of moderate potential.

1.5 The reflectance of graptolite debris showed some indication of being a useful tool for sediment maturity assessment in early Palaeozoic (Pre-Devonian) sediments.

1.6 For outcrop sampling exercises, the acquisition of a portable rock drill is recommended in order to attempt to obtain better (unweathered) material capable of giving more definitive results.

2. INTRODUCTION

Wildcat exploration activity in the Ouachita Overthrust area flanking the Arkoma Basin of S.E. Oklahoma is currently in progress with the Sohio Taylor #1 Well, Atoka County. Concurrent with geochemical screening of early Palaeozoic sediments penetrated in this well, analogous sediments exposed in the outcropping thrust sheet to the north have similarly been examined for source potential.

In this report source evaluation data, comprising source richness (kerogen content) and source maturity (hydrocarbon generation status), is presented for materials sampled from Middle-Upper Ordovician and Silurian spot horizons from measured sections at the North Boggy Creek Bride and Scratch Hill (Atoka County) localities.

Outcrop sampling is often biased towards horizons of apparently attractive properties (i.e., dark fine texture sediments). For this reason the volumetric significance of the spot horizons sampled needs careful quantification before definitive conclusions as to the source potential of the parent formation is reached. Problems with the interpretation of data from weathered outcrop samples and maturity information for early Palaeozoic sediments are similarly discussed.

3. MATERIALS AND METHODS

3.1 Materials

3.1.1 North Boggy Creek Bride Section.
Ten samples collected over 120' section of faulted M. Ordovician. Sample Series FSA 001 to 010. Measured down section from datum at 0' in Bigfork Fm (FSA 001).

3.1.2 Scratch Hill Section.
Five samples collected over unspecified section from Silurian through U. to M. Ordovician. FSA 011-014, 016.

Both sampled outcrop sections comprised near surface materials, the bulk of which showed conspicuous aerial weathering and growth of mosses/ lichen, etc. Sample quality - Poor.

3.1.3 Shale Shaker Sample from Unlimitee LTD Well.
Set of unspecified well cuttings from subject well.

3.2 Methods

Source richness screening procedures, including total soluble extract (TSE - sulfur free); Total Organic carbon (TOC - bitumen free); screening pyrolysis FID (Rock Eval) and vitrinite reflectance (whole rock determination) were performed by standardized methods laid out in Group Procedure Manual (1). Visual Kerogen and Palynomorph Thermal Alteration Indices (TAI) were performed as per contractors subjective methods.

Kerogen carbon isotope values (to be reported) were determined by Global Geochemistry Corp.

4. RESULTS AND DISCUSSION

Summary source rock evaluation data sheets for the North Boggy Creek Bride and Scratch Hill sections are set out in Tables 1, 2 respectively. Key Phytoclast Reflectance distribution sets are illustrated in Fig. 1 with a tabulated Visual Kerogen Description and Thermal Alteration Index (TAI) commentary summarized in Fig. 2. A Summary Palaeozoic Stratigraphy for the area is described in Fig. 3.

4.1 North Boggy Creek Bride Section (Table 1)

4.1.1 The measured section comprised thrust faulted M. Ordovician Womble Fm (~70') unit over- and underlain by stratagraphic younger Bigfork Fm. Shale to shale-calcareous (cherty?) lithologies dominated.

4.1.2 An attempt to assess the thermal maturity of these sediments was made from phytoclast reflectance and fluorescence. Vitrinite-like material was abundantly observed, however in view of the Ordovician age of the sediments it was disputed whether the vitrinite was of a true lignin (higher plant) derived source. The reflecting material probably had a provenance in dispersed graptolite detritus (cf Section 4.4). Reflectance data sets suggested autochthonous populations of R_o(ave) 0.45 to 0.56% with three key sets at R_o(ave) 0.50% (FSA 008-010; cf Fig. 1).

Palynomorph Thermal Alteration Indices (1+ to 2-) and fluorescence (pale orange) were consistent with a "true" vitrinite reflectance of R_o ~0.5%.

4.1.3 On the basis of a Hydrocarbon Generation Threshold placed at R_o 0.6%, these sediments were regarded to be pre-mature/approaching incipient maturity. Conspicuous bitumen staining supported the possible onset of kerogen degradation. It is, however, stressed that a somewhat higher R_o ($>$0.6%) should have been attained before generation and expulsion of significant migratable quantities of hydrocarbon could have been anticipated.

4.1.4 With the exception of the basal thrusted unit of the Womble Fm, Bigfork and Womble Total Organic Carbon (TOC) contents were indicative of Marginal-Moderate kerogen contents ($\leq$1.0%) only. For more mature locations, the source potential of these pre-mature sediments (Potential Productivity being $\leq$4.0 kg ton^{-1}) was assessed as Marginal only.

4.1.5 Three spot horizons at the thrusted basal Womble - Bigfork Fm boundary ($\sim$40') showed Very Good to Excellent source richness (TOC 3.0 - 15.0%). Although presently pre-mature/incipiently mature, hydrogen indices ($>$560 kg ton^{-1}) and potential productivity (18-90 kg ton^{-1}) indicated significant to exceptional potential source capability.

If of sufficient thickness/volumetric extent, and under a slightly more forceful palaeothermal regime (i.e., greater palaeo-overburden and/or higher heat flow), these sediments would be abundantly hydrocarbon productive and constitute a significant source bed.

4.1.6 Visual kerogen description for these sediments is as reported as "Herbaceous". This is believed to be erroneous, being the misrecognition of comminuted graptolite (communal algal) debris. On the basis of an algal detritus, these sediments should be initially oil, as opposed to gas, prone. (N.B. when our PGC-FID unit is successfully commissioned, more quantitative and less subjective assessments of kerogen hydrocarbon type proneness will be possible).

4.1.7 The high present potential productivity ($\leq$90 kg ton^{-1}) and low generation indices ($\leq$23%) (cf Section 4.5) of the basal interval again supported the pre-maturity of these sediments.

4.2 Scratch Hill Section (Table 2)

4.2.1 Scratch Hill material consisted of an unordered sequence of Silurian (Missouri Mountain) and U.-M. Ordovician (Polk Creek, Bigfork and Womble Fms) sediments. Dominant lithology was again shale to shale calcareous (cherty?).

4.2.2 Sediment thermal maturity assessment via phytoclast reflectance and palynomorph color (TAI) again followed the trend set by the North Boggy Creek section, with sediments being observed as immature, possibly incipiently mature at the Womble level.

4.2.3 Kerogen contents for the spot horizons sampled in the Missouri Mountain, Bigfork and Womble Fms were Lean to Moderate and with attendant low potential productivities ($\leq$0.7 kg ton^{-1}) these horizons have little potential as prospective sources.

4.2.4 The Polk Creek Fm (M. Ordovician) samples were more encouraging, showing Good to Very Good kerogen contents (TOC, 1.0 - 2.5%). Hydrogen indices (370 kg ton^{-1}) and potential productivity (9 kg ton^{-1}) were consistent with an immature source of Moderate potential. Kerogen type was again erroneously described as "Herbaceous", being thought to be more representative of communited graptolite debris.

4.2.5 Contingent upon the thickness/volumetric extent and representativeness of the Polk Creek data, this formation has possible moderate source potential at locations having experienced a great palaeothermal regime (i.e., greater palaeo-overburden and/or heat flow).

4.3 Unlimited LTD Well Sample

4.3.1 Data for this specimen is included in Table 2. The sediment (shale, calcareous) was assessed as unremarkable, being immature of Moderate kerogen content but of negligible source potential (potential productivity <0.1 kg ton^{-1}).

4.4 Assessment of Thermal Maturities for Early Palaeozoic Sediments

Vitrinite reflectance techniques have been applied with confidence back as far as Devonian, possibly Silurian, sediments. The existence of "true" higher plant lignin derived vitrinite phytoclasts in the Ordovician is conjectural. However, vitrinite-like materials have frequently been observed and these are thought to have a provenance in the colonial algal graptolite debris. In the experience of the author (RB), these vitrinite-like materials have been observed to have a reflectance approximately coincident with that expected of true vitrinites over a rank range of R_o 0.85 - 1.0% and greater.

The comparative reflectance of lower rank vitrinite-like and true vitrinite is less certain. However, in view of the supporting Palynomorph TAI and fluorescence data, the reflectance trends are thought to be comparable on this occasion.

The ability to use graptolite reflectance as a thermal maturity indicator for early Palaeozoics would be a useful development.

4.5 Sediment Quality vs. Reliability of Geochemical Data Determined on weather Outcrop Sampled Sediments

Where sampled at surface or near surface, outcrop materials present problems in the acquisition of reliable data, particularly where leaching or adulteration of the mobile component (TSE) or oxidation of immobile (kerogen) component is concerned.

The present suite of samples showed conspicuous signs of surface weathering and considerable care had to be exercised in getting sufficient material for the key determinations (TOC, R_o, etc.).

Results of the Total Soluble Extract (TSE) and Thermally Distillable Hydrocarbon (S1) analyses, however, showed particularly well the effects of weathering. Comparison of the Generation indices (TSE/TOC; S1/TOC) based on these determinations showed a dramatic order of magnitude difference. S1/TOC Generation indices were of the order anticipated, perhaps reduced by 5<<10 fold or so due to the atmospheric weathering of the hydrocarbon component. Except for the organic rich sediments 008/009, TSE/TOC

Generation indices were considerably in excess of what would be expected from immature sediments. On this occasion, the situation has been complicated by not only the weathering of the hydrocarbon component, but its adulterative replacement by contemporaneous oxygenated plant/moss/lichen derived organics. These are extractable from the sediment by organic solvents and tare as TSE, but being highly oxygenated they do not respond to the pyrolysis FID technique, degrading to carbon dioxide and a carbonaceous residue only. Detailed hydrocarbon compositional studies of these extracts could be almost meaningless through adulteration by contemporous materials. Unless a strict quality control and requirements is exerted over the acquisition of outcrop samples, soluble extract characterization is not warranted.

5. REFERENCES

1. Petroleum Geochemistry Group Warrensville   1980   Group Procedures Manual

KEY TO TABLES AND FIGURES

CO_3^{2-}	% Carbonate by acidimetry
TOC	% Total Organic Carbon (Bitumen-free)
TSE	‰ Total Soluble Extract (C15+; sulfur free)
S1	‰ Thermally Distillable Hydrocarbons
G1 (TSE)	‰ Generation Index. TSE/TOC
G1 (S1)	‰ Generation Index. S1/TOC
IH/TOC	‰ Hydrogen Index. Pyrolytic Hydrocarbons - Total Organic Carbon (kg ton^{-1} kerogen)
PET.POT	‰ Petroleum Potential. Hydrocarbons (kg ton^{-1} sediment)
IO/TOC	‰ Oxygen Index. Pyrolytic Carbon Dioxide-Total Organic Carbon.
Pyrol.Temp	°C Maxima for Kerogen Degradation
Ro (ave)	% Phytoclast Vitrinite Reflectance
$\delta^{13}C$	Carbon Isotope Value relative to PDB 1 Standard.
VKD	Visual Kerogen Description. AL - Algal AM - Amorphous/Sapropel H - Herbaceous W - Woody C - Coaly E - Exinite (Palynomorphs)
TAI	Palynomorph Color (Thermal Alteration Index (1 → 5 Scale).

SUMMARY DATA SHEET

SOURCE ROCK EVALUATION DATA FOR OUTCROP SAMPLED SEDIMENTS

US/OK/ATOKA COUNTY - MEASURED SECTION #1, NORTH BOGGY CREEK BRIDE LOCALITY

Sample#	Dallas #	Feet Below Datum	Age	Formation	Lithology	CO_3^{2-} (%wt)	VKD	TOC (%wt)	TSE (kg.ton^{-1})	S1 (kg.ton^{-1})	Asphaltene (kg.ton^{-1})	G1 (TSE)	G1 (S1)	Hydrogen Index (kg.ton^{-1})	Potential Product. (kg.ton^{-1})	Oxygen Index (kg.ton^{-1})	Pyrolysis T Max °C	R_o (ave) %	TAI	$\delta^{13}C$ ‰
A 001	1	0	M.Ord.	Bigfork	Sh.V.Calc.	25	AM-H	0.64	1.179	0.09	0.466	184	14	371	2.3	59	444	0.55	1+	
002	2	10	M.Ord.	Bigfork	Sh.g.	2	AM-H	0.58	1.145	0.04	0.400	197	7	351	2.0	57	440	0.54	1+	
003	3	20	M.Ord.	Transition	Sh.Calc.b.	10	AM-H	0.66	0.927	0.05	0.409	140	8	271	1.7	42	444	0.45	1+	
004	4	30	M.Ord.	Womble	Sh.g.	6	H	0.85	1.628	0.15	0.684	191	18	437	3.7	42	441	0.52	2-	
005	5	40	M.Ord.	Womble	Sh.g.	3	H	0.34	0.859	0.02	0.559	253	6	212	0.7	66	446	-	1+	
006	6	50	M.Ord.	Womble	Sh.g.	3	AM-H	0.76	1.645	0.15	0.283	216	20	346	2.7	61	440	0.51	1+	
007	7	60	M.Ord.	Womble	Sh.dk.g.	2	H	0.93	0.849	0.07	0.406	91	7	395	3.8	23	440	0.56	1+	
008	8	80	M.Ord.	Womble	Sh.dk.g.	2	H	15.58	7.872	1.57	2.116	50	10	561	89.8	5	428	0.50	2-	
009	9	100	M.Ord.	Womble	Sh.dk.g.	2	H	9.64	5.637	1.54	0.358	58	16	633	62.3	7	433	0.50	2-	
010	10	120	M.Ord.	Bigfork	Sh.b.	3	AM-H	3.03	3.736	0.71	0.649	123	23	572	17.9	48	433	0.49	1+	

Table 1

SUMMARY DATA SHEET

SOURCE ROCK EVALUATION DATA FOR OUTCROP SAMPLED SEDIMENTS

US/OK/ATOKA COUNTY SCRATCH HILL SECTION

Sample#	Dallas#	Feet Above Datum	Age	Formation	Lithology	CO_3^{2-} (%wt)	VKD	TOC (%wt)	TSE ($kg.ton^{-1}$)	S1 ($kg.ton^{-1}$)	Asphaltene ($kg.ton^{-1}$)	G1 (TSE)	G1 (S1)	Hydrogen Index ($kg.ton^{-1}$)	Potential Product. ($kg.ton^{-1}$)	Oxygen Index ($kg.ton^{-1}$)	Pyrolysis T Max (°C)	R_o(ave) (%)	TAI	$\delta^{13}C$ ‰
SA 011	11		M.Ord.	Bigfork	Sh.b.	4	H-AM-W	0.89	0.500	0.03	0.197	56	3	76	0.7	151	439	-	2-	
012	12		U.Ord.	Polk Creek	Sh.dk.g.	2	H	2.48	1.311	0.36	0.222	53	15	367	9.2	26	433	0.43	2	
013	13		U.Ord.	Polk Creek	Sh.Calc.dk.b.	8	H-W	1.11	0.169	0.05	0.068	15	5	-	-	261	-	0.57?	2-/2	
014	14		Sil.	Missouri Mt.	Sh.Calc.lt.b.	9	H	0.20	0.172	0.01	0.072	86	5	-	-	389	-	-	2-	
016	15		M.Ord.	Womble	Sh. b.	4	H	0.44	0.250	0.02	0.046	57	5	12	<0.1	180	433	0.54	2	

S/OK/? UNLIMITEE LTD. SHAKER SAMPLE

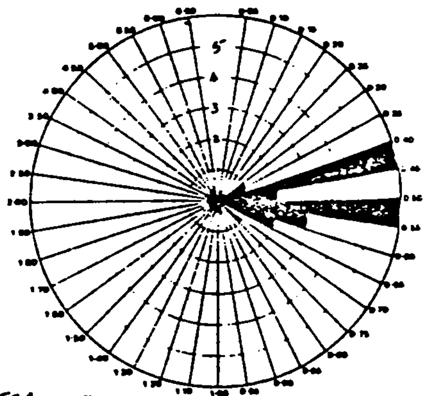
Sample#	Dallas#	Feet Above Datum	Age	Formation	Lithology	CO_3^{2-} (%wt)	VKD	TOC (%wt)	TSE ($kg.ton^{-1}$)	S1 ($kg.ton^{-1}$)	Asphaltene ($kg.ton^{-1}$)	G1 (TSE)	G1 (S1)	Hydrogen Index ($kg.ton^{-1}$)	Potential Product. ($kg.ton^{-1}$)	Oxygen Index ($kg.ton^{-1}$)	Pyrolysis T Max (°C)	R_o(ave) (%)	TAI	$\delta^{13}C$ ‰
SA 015	15		?	?	Sh.Calc.dk.g.	10	W	0.79	0.346	0.03	0.035	44		1	<0.1	195	434	-	2	

Table 2

Phytoclast reflectance histograms for Womble Fm. Sediments - North Boggy Creek Bride Section.

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546nm.	1.576

0.63	0.56	0.44	0.44	0.57	
0.40	0.53	0.43	0.54	0.48	
0.51	0.31	0.45	0.40		
0.53	0.44	0.54	0.38		
0.62	0.59	0.76	0.51		



FSA 008

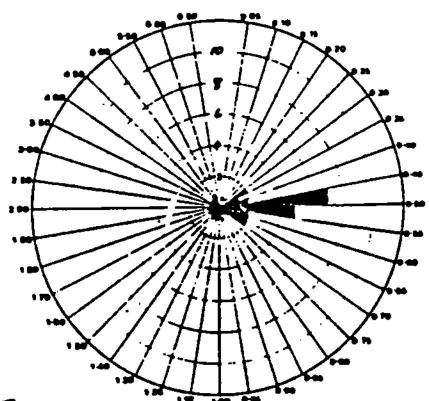
TOTAL No. OF PARTICLES MEASURED 22

	REFLECTIVITY (%)	No. OF PARTICLES
R̄max.		
R̄aver.	0.50	22

EQUIVALENT CHEMICAL PARAMETERS DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO
73		

0.45	0.45	0.30	0.49	0.59	
0.65	0.52	0.46	0.56	0.53	
0.60	0.54	0.51	0.40	0.44	
0.32	0.45	0.61	0.68		
0.48	0.36	0.51	0.49		



FSA 009

TOTAL No. OF PARTICLES MEASURED 23

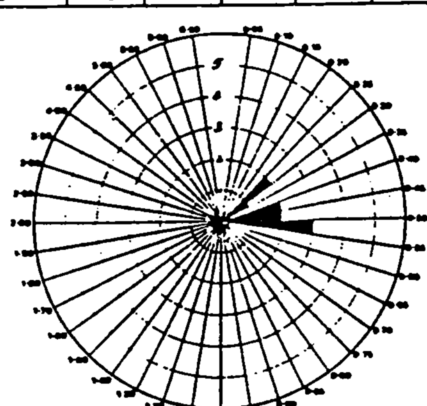
	REFLECTIVITY (%)	No. OF PARTICLES
R̄max.		
R̄aver.	0.50	23

EQUIVALENT CHEMICAL PARAMETERS DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO
73		

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546nm.	1.576

0.31	0.40				
0.52	0.52				
0.48	0.28				
0.40	0.57				
0.45	0.28				



FSA 010

TOTAL No. OF PARTICLES MEASURED 10

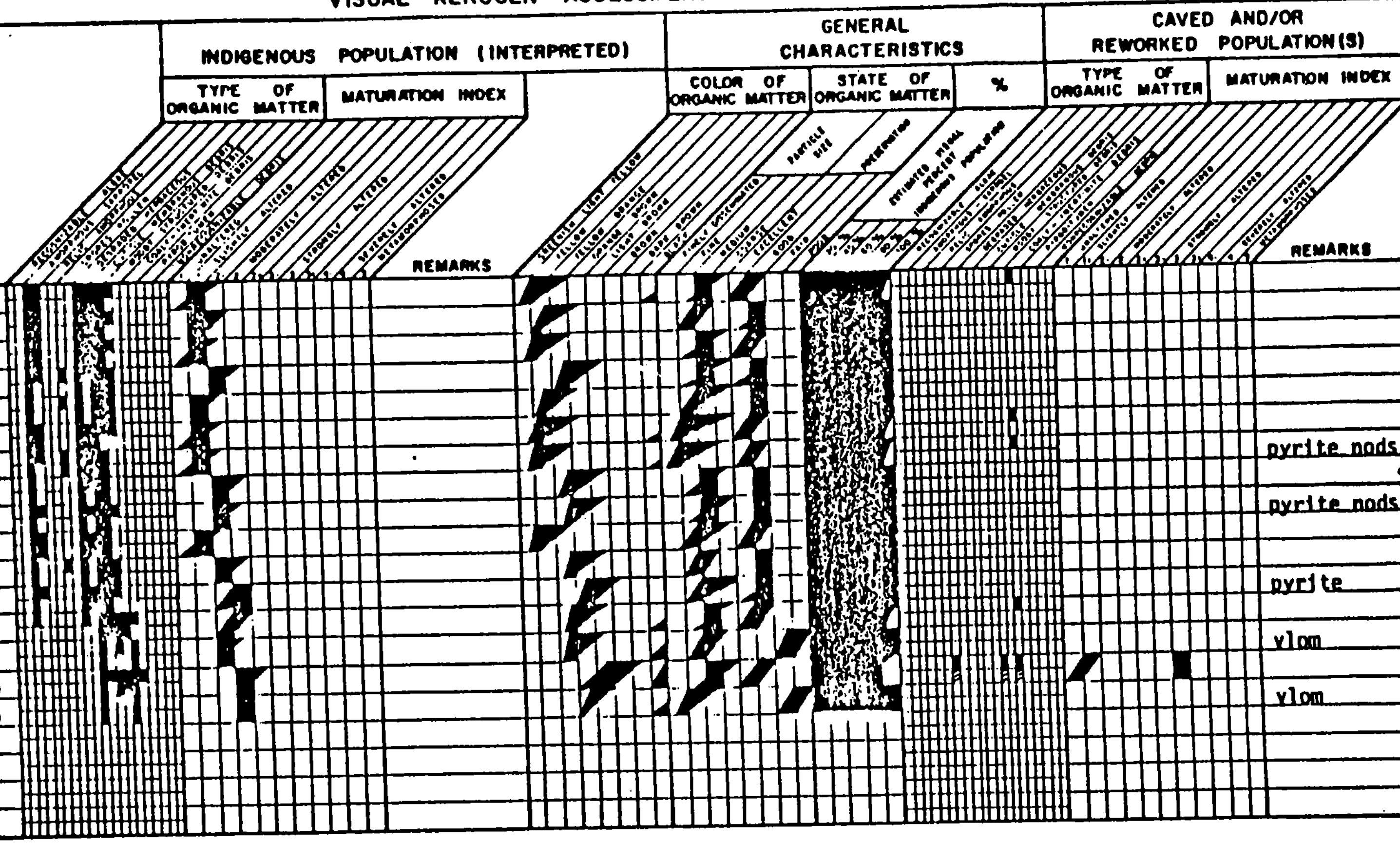
	REFLECTIVITY (%)	No. OF PARTICLES
R̄max.		
R̄aver.	0.49	7
	0.29	3 BITUMEN

EQUIVALENT CHEMICAL PARAMETERS DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO
71		

Fig. 1

VISUAL KEROGEN ASSESSMENT WORKSHEET



	I.D.	Caved and/or reworked population(s): Remarks	Summary Organic Matter Type
1669-001	FSA-001		Am-H*;-;W-C
1669-002	FSA-002		Am-H*;-;W
1669-003'	FSA-003		Am-H*;-;W
1669-004	FSA-004		H*;Am;W
1669-005	FSA-005		H;Am-W;-
1669-006'	FSA-006		Am;H*;W-C
1669-007	FSA-007	pyrite nods	H*;Am;C
1669-008	FSA-008		H*;Am;-
1669-009	FSA-009	pyrite nods	H*;Am;W
1669-010	FSA-010		Am-H*;-;-
1669-011	FSA-011		H;Am-W;-
1669-012	FSA-012	pyrite	H*;Am;W
1669-013'	FSA-013		H-W;-;Am-C
1669-014	FSA-014	vlom	H-C;W;-
1669-015	FSA-015		W;H-C;-
1669-016	FSA-016	vlom	H-C;-;-

VLOM = very little organic matter.

Fig. 2

Stratigraphic sequence and description of Paleozoic rocks in Ouachita Mountains (after Flawn et al., 1961, Fig. 2).

AGE	FORMATION	THICKNESS (feet) / (meters)	Rock Type
	Major unconformity		
Pennsylvanian	Atoka	1,500-19,000 / 4,500-5,700	Shale, light gray, silty, micaceous, and flaky with interbedded fine- to coarse-grained, micaceous sandstone with very abundant sole markings. Thin siliceous shales near base and in lower part of formation.
Mississippian and Pennsylvanian	Johns Valley	200-1,000 / 60-330	Shale, light gray to tan, dark gray near base, and thin beds of sandstone and limestone. Large erratic masses of limestone or shale of foreland facies are found near the base of the formation, and exotic boulders, pebbles, and granules occur at numerous horizons. Formation equivalent in part to Caney, Sycamore(?), Springer, Wapanucka, and Chickachoc of frontal belt.
Mississippian	Jackfork	1,150-7,000 / 350-2,100	Sandstone, medium to coarse grained, hard, with intercalated shale. Sole markings are abundant in the sandstones. Four beds of siliceous shale and one bed of maroon to green shale are identifiable over long distances and form marker beds.
	Stanley Hatton tuff lentil	6,000-12,000 / 1,800-3,300 (0-90)	Shale, dark colored, mostly gray, interbedded with dark gray argillaceous siltstone and very poorly sorted fine- to very fine-grained argillaceous chloritic sandstone. Beds of siliceous shale identifiable over long distances are found at several horizons. Cone-in-cone concretions are abundant at places. Several beds of acidic vitric tuff are found near the base of the formation.
	Hot Springs sandstone	0-200 / 0-60	Sandstone, hard, quartzose, fine to very fine grained. Small amounts of interbedded shale and locally conglomeratic near base. Crops out only in relatively small area near Hot Springs, Arkansas.
	unconformity		
Devonian and Mississippian	Arkansas novaculite	230-950 / 70-290	Upper member—green, brown, and gray radiolarian chert and radiolarian shale. Upper middle member—red and green radiolarian shale, siliceous shale, radiolarian chert, and bituminous chert. Lower middle member—light gray to black bituminous spore-bearing chert and black papery bituminous shale. Lower member—white to green massive spiculitic chert and green laminated siliceous shale. (In Broken Bow—Benton uplift the upper and upper middle members are combined into a single member of white, calcareous, manganiferous chert.) Woodford and Pinetop cherts of frontal belt are equivalent in part to Arkansas novaculite.
	unconformity		
Silurian	Missouri Mountain	0-300 / 0-90	Shale, hard, green, siliceous, sandy in part. Thin beds of finely laminated chert and quartzose sandstone and local lenses of sandy chert conglomerate.
	unconformity		
	Blaylock	0-1,500 / 0-450	Sandstone, gray to green, thin bedded, fine grained, with interbedded shaly micaceous siltstone and dark fissile shales. Veins of quartz and smoky quartz are abundant. Formation is present only in part of Broken Bow—Benton uplift.
	unconformity		
Ordovician	Polk Creek	0-175 / 0-53	Shale, soft, brown, platy in most of formation; hard, black, bituminous, and siliceous near base. Abundant graptolites. Thin streaks of quartzitic sandstone and oolitic limestone in Arkansas.
	Bigfork	600-800 / 180-240	Upper unit—black, noncalcareous, bituminous chert and black bituminous papery shale. Lower unit—gray to brown calcareous chert, siliceous limestone, clastic limestone, and cherty shale.
	Womble	240-1,000 / 73-300	Shale, black to green, with thin interbeds of quartzose sandstone and limestone. Mostly schistose, micaceous, chloritic, fine-grained sandstone in McCurtain County, Oklahoma. Some siliceous bituminous shale near contact with Bigfork chert.
	Blakely	0-500 / 0-150	Shale, black to green, interbedded with fine- to medium-grained quartzose sandstone. Some veins of smoky quartz.
	Mazarn	1,000± / 300±	Shale, black to green, banded, clayey, fissile, with thin layers of gray sandstone and bluish-black limestone. Veins of quartz and calcite.
Cambrian(?) or Lower Ordovician	Crystal Mountain	5-100± / 1.5-30±	Sandstone, massive, light gray, calcareous to quartzitic. Many quartz veins and crystals. Chert conglomerate at base of formation in McCurtain County.
	unconformity		
	Collier	180±	Shale, black, graphitic, and dark-colored siliceous limestone. Some dense black chert in Arkansas.
	Lukfata	145+ / 43+	Upper member—massive quartzose, fine- to medium-grained sandstone with shale laminae. Middle member—interbedded platy sandstone and shale. Lower member—thin-bedded limestone and shale. Base of formation is not exposed.

Fig. 3

THE STANDARD OIL COMPANY

SOURCE ROCK POTENTIAL EVALUATION OF SELECTED OUTCROP-SAMPLED PALEOZOIC SEDIMENTS FROM S.E. OKLAHOMA AND S.W. TEXAS

Topical Report No. 5975
Petroleum Geochemistry Report PGW 008
Project: 2013
Author: F. Marsek
Date: September 18, 1980

Work by: R. Burwood
F. Marsek

Approved: R. Burwood.

Classification: CONFIDENTIAL

SYNOPSIS

Miscellaneous outcrop sampled sediments from the Ouachita Overthrust of S.E. Oklahoma and the Marathon region of S.W. Texas have been analyzed for Source Rock Potential.

The only samples that proved to be of any interest were three Middle Ordovician sediments from the Ouachita Overthrust. Although found to be thermally immature, these samples had Excellent organic carbon contents and petroleum potentials. Geochemical data for the three Womble samples was similar to that previously reported (PGW 003).

The Womble has been found to be an excellent Potential Source Rock. If of sufficient volumetric extent, its occurrence in a more thermally mature geological setting could constitute an attractive prospect for this area of S.E. Oklahoma.

FM:dlc

cc: Full Copies

E. Luttrell (Dallas) 2
B. Reed (Dallas)
Library 3
L. W. Evans
Geological Services (San Francisco)
SPC Library (San Francisco) 2
R. Burwood
J. G. Grasselli

Synopsis Only

G. G. Cross
N. W. Standish

1. CONCLUSIONS AND RECOMMENDATIONS

1.1 Twenty outcrop samples, six from the Ouachita Overthrust (Atoka County), S.E. Oklahoma and fourteen from the Marathon region of S.W. Texas, have been screened for Source Rock Potential. All samples showed varying degress of weathering.

1.2 Three shale samples from the Womble Fm. in the Ouachita Overthrust were found to be of Very Good to Excellent source potential. However, they lacked the thermal maturity to as yet have generated and expelled significant levels of hydrocarbons.

1.3 The kerogen assemblages in the Womble samples were those Amorphous-Algal detritus, potential oil sources. This observation was in marked contrast to the Herbaceous designation previously recorded for Womble sediments (PGW 003). This can be attributed to a lack of contractor consistency and/or a high degree of subjectivity in their observations. It is thought that the present designation (Am-Al) is probably the more reliable.

1.4 None of the samples from the Marathon region showed any richness parameters which would make them of interest as source rocks. Most of the samples, however, were extensively weathered, thus casting doubt about the reliability of geochemical data obtained from them.

1.5 Vitrinite Reflectance data was, where vitrinite data was listed, obtained from vitrinite-like material believed to be graptolitic detritus and not true vitrinitic phytoclasts. Only samples of Pennsylvanian and Permian age contained true vitrinite material.

2. INTRODUCTION

Geochemical screening of Paleozoic outcrop sediments was conducted by assessing source richness and source maturity parameters.

Problems encountered with interpretation of data from weathered outcrop samples and maturity information for early Paleozoic sediments has been discussed in Petroleum Geochemistry Report PGW 003. Comments made for samples in PGW 003 also apply to the samples analyzed in this report.

Samples from S.E. Oklahoma are outcrops of formations penetrated by the Sohio Taylor #1 Well, currently being drilled in Atoka County, Oklahoma.

3. MATERIALS AND METHODS

3.1 Materials

3.1.1 Outcrop-sampled sediments from the Marathon region, S.W. Texas. Fourteen samples (designated FSA 043 - FSA 059) of carbonates, siltstones, and shales from Lower Ordovician to Permian (Wolfcampian) age.

3.1.2 Outcrop-samples sediments from Atoka County, Oklahoma. Six samples (designated FSA 060 - FSA 066) of Middle Ordovician to Pennsylvanian aged siltstones and shales.

Both groups of samples showed conspicuous signs of weathering and lower plant growth which was removed when observed.

3.2 Methods

Source richness screening procedures, including total soluble extract (TSE - sulfur free); total organic carbon (TOC - bitumen free); screening pyrolysis FID (Rock Eval) and vitrinite reflectance (whole rock determination) were performed by standardized methods laid out in Group Procedures Manual (1). Visual Kerogen and Palynomorph Thermal Alteration Indices (TAI) were performed as per contractors subjective methods.

4. RESULTS AND DISCUSSION

A summary table of source rock data is given in Tables 1 and 2 for the Marathon and Atoka suites, respectively.

4.1 Miscellaneous Marathon Region Outcrop Sampled Materials

Of the group of outcrop samples from the Marathon region only two were of sufficient richness to qualify as marginal source rocks based on TOC. These were: FSA 048 and FSA 054 having 0.51 and 0.65 wt. % TOC, respectively. FSA 048, a sample of the Woods Hollow Formation of Middle Ordovician age, had an equivalent vitrinite rank of 1.20% for vitrinite-like material. This rank placed the Woods Hollow Formation in the gas generation zone. Pyrolysis of the sample produced no kerogen breakdown products giving the sample a "spent" status. However, weathering may have oxidized the kerogen and rendered it inactive. Sample FSA 054, a sample of the Silurian-aged Persimmon Gap Formation, had no vitrinite or vitrinite-like material. The maturity level of this sample was assessed to be similar to that of FSA 048 based on a Thermal Alteration Index (TAI) of 3 to 3-. This sample also produced no kerogen breakdown products. Only five of fourteen samples from the Marathon region contained vitrinite or vitrinite-like material. This may be to a large part attributed to the effects of weathering. The Permian Alta Formation showed reflectance values of 1.60+ indicating advanced maturity. One other sample from this region produced an anomalous value - FSA 049. This sample produced a high TSE (2.56 kg ton^{-1}) indicating the presence of a large quantity of bitumens, especially for a weathered outcrop. A subsequent large pyrolysis S1 peak would be expected for a sample with a substantial bitumen fraction present. The actual S1 measured (0.03 kg ton^{-1}) revealed that no large bitumen quantity was present. The only explanation for the high TSE is the presence of contemporaneous plant matter in the sample. Plant matter is extractable and can contribute substantially to the TSE. However, oxygenated plant-derived matter cannot be abundantly detected during pyrolysis.

4.2 Miscellaneous Atoka County Outcrop Sampled Material

Of the samples from Atoka County, only the samples from the Womble Fm. were of significance. The three Womble samples, FSA 060 - FSA 062, were very rich having TOC contents ranging from 5.67 - 9.57 wt. %. Although the samples showed conspicuous signs of weathering, they all contained appreciable amounts of bitumens as evidenced by pyrolysis S1 values of 0.83 - 1.78 kg ton^{-1}. High TSE's were also produced, however, they were probably contaminated and enhanced by contemporaneous plant extracts. The Womble samples contained vitrinite-like material having R_o values in the range of 0.45 to 0.55% which placed these sediments in an immature to incipiently mature zone. Thus, the Womble was determined to be well below its peak generation/expulsion capability with the generation window yet to be attained. This conclusion was also supported by pyrolysis data. The Excellent Petroleum Potentials (38.93 - 75.09 kg ton^{-1}) observed were consistent with the assessment that the kerogen had not yet been subjected to significant thermal cracking. Kerogen types present were identified as Algal (Al) and Amorphous (Am) which are oil-prone types. This was in marked contrast to the Herbaceous designation previously recorded for Womble Fm. sediments and confirms our previous suspicions and remarks (PGW 003) as to mis-identification of the assemblage on that occasion.

4.3 In conjunction with the data previously reported (2), the Womble has been assessed to be of Very Good to Excellent source rock potential. However, on both occasions it appeared to be thermally immature, not having attained generation/expulsion status. Should the Womble Fm., elsewhere in the locality, have experienced a more forceful thermal regime, it could have been an abundant hydrocarbon yielding source. Quantification of the extent of the organics by spot horizon sampling and their relevance to the Womble Fm. as a whole, would be the final criteria in establishing whether this formation was a regional source bed of significance.

5. REFERENCES

1. Petroleum Geochemistry Group Warrensville — 1980 — Group Procedures Manual

2. Burwood, R. and Marsek, F. — 1980 — Source Rock Potential Evaluation of Selected Outcrop-Sampled Ordovician Sediments from the Ouachita Overthrust, Atoka County, Oklahoma, PGW Report 003

KEY TO TABLES AND FIGURES

CO_3^{2-}	% Carbonate by acidimetry
TOC	% Total Organic Carbon (Bitumen-free)
TSE	‰ Total Soluble Extract (C15+; sulfur free)
S1	‰ Thermally Distillable Hydrocarbons
G1 (TSE)	‰ Generation Index. TSE/TOC
G1 (S1)	‰ Generation Index. S1/TOC
HYDROGEN INDEX	‰ Hydrogen Index. Pyrolytic Hydrocarbons - Total Organic Carbon (kg ton^{-1} kerogen)
PET.POT	‰ Petroleum Potential. Hydrocarbons (kg ton^{-1} sediment)
OXYGEN INDEX	‰ Oxygen Index. Pyrolytic Carbon Dioxide- Total Organic Carbon. (kg ton^{-1} kerogen)
Pyrol.Temp	^{o}C Maxima for Kerogen Degradation
Ro (ave)	% Phytoclast Vitrinite Reflectance
$\delta^{13}C$	Carbon Isotope Value relative to PDB 1 Standard.
VKD	Visual Kerogen Description. AL - Algal AM - Amorphous/Sapropel H - Herbaceous W - Woody C - Coaly E - Exinite (Palynomorphs)
TAI	Palynomorph Color (Thermal Alteration Index (1 → 5 Scale).

SUMMARY DATA SHEET

Source Rock Evaluation Data for Outcrop-Sampled Sediments
from the Marathon Region, S.W. Texas

PGW Sample#	Dallas#	Depth	Age	Formation	Lithology	CO_3^{2-} (%wt)	VKD	TOC (%wt)	TSE ($kg.ton^{-1}$)	S1 ($kg.ton^{-1}$)	Asphaltene ($kg.ton^{-1}$)	GI TSE/TOC	GI S_1/TOC	Hydrogen Index ($kg.ton^{-1}$)	Potential Product. ($kg.ton^{-1}$)	Oxygen Index ($kg.ton^{-1}$)	Pyrolysis T Max °C	R_o(avg) %	TAI	$\delta^{13}C$ %
FSA 043	--	Outcrop	L.Ord.	L.Marathon	SH.	8.62		0.34	0.51	0.10	0.28	150	29	--	--	188	--	No vit.	+2 to -3	
FSA 044	--	Outcrop	L.Ord.	L.Marathon	L.S.	89.60		0.14	0.35	0.03	0.19	250	21	--	--	193	--	No vit.	2 to +2	
FSA 045	--	Outcrop	L.Ord.	Alstate	SH.	30.76		0.07	0.19	0.02	0.13	271	29	--	--	486	--	No vit.	-2 to 2	
FSA 046	--	Outcrop	M.Ord.	Ft.Pena?	L.S.	51.97		0.19	0.19	0.02	0.09	100	11	--	--	674	--	0.98	2+ to 3-	
FSA 048	--	Outcrop	M.Ord.	Woods Hollow	SH.	5.90		0.51	0.24	0.05	0.14	47	10	--	--	200	--	1.20	3 to 3+	
FSA 049	--	Outcrop	M.Ord.	U.Woods Hollow	SH.	6.73		0.30	2.56	0.03	2.48	853	10	--	--	253	--	0.93	3 to 3+	
FSA 050	--	Outcrop	U.Ord.	Maryvillas	SH.	1.75		0.11	0.23	0.03	0.13	209	27	--	--	218	--	No vit.	3- to 3	
FSA 051A	--	Outcrop	U.Ord.	Maryvillas	L.S.	89.33		0.05	0.16	0.02	0.08	320	40	--	--	500	--	No vit.	3- to 3	
FSA 051B	--	Outcrop	U.Ord.	Maryvillas	L.S.	90.10		0.05	0.12	0.02	0.05	240	40	--	--	325	--	No vit.	2+ to 3-	
FSA 052	--	Outcrop	U.Ord.	Maryvillas	SH.	9.87		0.30	0.42	0.10	0.17	140	33	230	0.69	87	430	No vit.	2- to 2	
FSA 054	--	Outcrop	Silurian	Persimmon Gap	SH.,Calc.	10.32		0.65	0.20	0.02	0.10	31	3	--	--	266	--	No vit.	3 to 3+	
FSA 057	--	Outcrop	Miss.	Basa Tesnus	SH.	4.05		0.09	0.16	0.01	0.10	177	11	--	--	311	—	No vit.	2- to 2	
FSA 058	--	Outcrop	L.Perm. (Wolfcamp)	Alta	SH.	4.23		0.38	0.14	0.01	0.07	37	3	3	0.01	105	510	1.6-1.9	3- to 3	
FSA 059	--	Outcrop	L.Perm. (Wolfcamp)	Alta	SH.	6.28		0.42	0.22	0.02	0.16	52	5	2	0.01	119	505	1.65	3 to 3+	

Table 1

SUMMARY DATA SHEET

Source Rock Evaluation Data for Outcrop-Samples Sediments

from Atoka County, S.E. Oklahoma

iW Sample#	Dallas#	Depth	Age	Formation	Lithology	CO_3^{2-} (%wt)	VKD	TOC (%wt)	TSE ($kg.ton^{-1}$)	S1 ($kg.ton^{-1}$)	Asphaltene ($kg.ton^{-1}$)	GI TSE/TOC	GI S_1/TOC	Hydrogen Index ($kg.ton^{-1}$)	Potential Product. ($kg.ton^{-1}$)	Oxygen Index ($kg.ton^{-1}$)	Pyrolysis T Max °C	R_o(avg) %	TAI	$\delta^{13}C$ %
FSA 060	1	Outcrop	M.Ord.	Womble	SH.	3.90		6.43	5.71	1.22	2.21	89	19	870	56.65	49	412	0140	-2 to 2	
FSA 061	2	Outcrop	M.Ord.	Womble	SH.	1.62		9.57	9.56	1.78	4.58	100	19	785	75.09	4	431	0.50	2- to 2	
FSA 062	3	Outcrop	M.Ord.	Womble	SH.	1.77		5.67	4.34	0.83	2.28	77	15	687	38.93	44	428	0.40	2- to 2	
FSA 063	4	Outcrop	U.Ord.	Big Fork	SH.	2.08		0.31	0.90	0.20	0.44	290	65	410	1.27	229	423	No Vit.	2+ to 3-	
FSA 065	6	Outcrop	Penn.	Akata	SH.	2.67		0.33	0.16	0.05	0.06	48	33	--	--	167	--	0.60-1.20	3 to 3+	
FSA 066	7	Outcrop	Penn.	Stanley	SH.,V.Calc.	37.63		0.14	0.22	0.03	0.11	157	21	--	--	286	--	1.15	3- to 3	

Table 2

FIGURE 1

VISUAL KEROGEN ASSESSMENT WORKSHEET

	SOHIO ID.	Indigenous Population (Interpreted) — Remarks	Caved and/or Reworked Population(s) — Remarks	Summary Organic Matter Type	
1782-001	FSA-043	Am(Al);-;-	recent	Am(Al);-;-	VLOM
1782-002	FSA-044	Am(Al);-;-		Am(Al);-;-	
1782-003	FSA-045	Am-I;-;-		Am-I;-;-	VLOM
1782-004	FSA-046	I;Al;-	recent	I;Al;-	VLOM
1782-005	FSA-048	Al;I;-		Al;I;-	
1782-006	FSA-049	Al;I;-		Al;I;-	
1782-007	FSA-050	Am(Al);-;I		Am(Al);-;I	
1782-008	FSA-051	Am(Al);-;I		Am(Al);-;I	
1782-009	FSA-051	Am;-;I		Am;-;I	
1782-010	FSA-052	Am(Al);-;-		Am(Al);-;-	
1782-011	FSA-054	Am(Al)-U;-;-		Am(Al)-U;-;-	
1782-012	FSA-057	W-I;-;-		W-I;-;-	VLOM
1782-013	FSA-058	H-I;-;-		W-I;-;-	
1782-014	FSA-059	H-I;-;H		W-I;-;H	
1782-015	FSA-060	Am(Al);-;I		Am(Al);-;I	
1782-016	FSA-061	Am(Al);-;I		Am(Al);-;I	
1782-017	FSA-062	Am(Al);-;-		Am(Al);-;-	
1782-018	FSA-063	U;Am(Al);-		U;Am(Al);-	
1782-019	FSA-065	W-I;-;H		W-I;-;H	
C 1782-020	FSA-066	U;I;Am		U;I;Am	

VLOM - Very little organic material.

(shaded symbol) Recent material.

#11 contains 40% chitinozoan and graptolite debris (C and G).

#12 may not be wood.

THE STANDARD OIL COMPANY

To: T. Legg, R.C. Cobb, D. May
SPC Mid-Continent Region
Dallas

July 7, 1981

From: Petroleum Geochemistry Group
Warrensville

File PGW/FM/70781/2-5
Job #PGW 80-3

Technical Memorandum (PGW/TM13) - Geochemical Evaluation of Arkansas Novaculite Lithologies, Taylor #1 Well, Atoka County, Oklahoma.

Summary: Eight lithic types picked from cuttings of the Arkansas Novaculite penetrated in the Taylor #1 well between 1440-1700' were assessed for source rock potential based on source richness parameters. Lithologies of chert, black shale, brown shale, and dark gray/brown shale in a 160' sequence of the Novaculite from 1530-1690' showed Good to Excellent source potential. The presence of these potential source lithologies suggested that the Novaculite may have self-sourcing reservoir possibilities. Favorable exploration targets would appear to be those where the Novaculite contained thick sequences of dark shale and had attained thermal maturity.

1. INTRODUCTION

A detailed geochemical evaluation of picked lithologies from the Arkansas Novaculite encountered in the Taylor #1 well, Atoka County, Oklahoma, Sec. 15, T3S, R11E, has been undertaken and completed. The objectives of the work were to determine the source potential of selected lithologies from the Novaculite and to identify any source intervals in the formation.

Lithologies of suspected source rock potential were picked from cuttings obtained during drilling of the Taylor well which penetrated an approximately 250' thick sequence of the Novaculite in a depth interval from 1440-1700'. The cuttings were examined and picked by D. Barnes, SPC Geological Services. Eight lithologies were identified and are listed in Table 1 as they occurred in the well.

A full source evaluation exercise for the section penetrated in the subject well has been completed and will be issued as Petroleum Geochemical Report PGW013.

2. MATERIALS AND METHODS

2.1 Materials

The 1440-1700' interval was sampled in 10' composites for a total of 26 samples from which the following lithic types were identified and segregated: chert, black shale, gray shale, brown shale, dark gray/brown shale, black-brown shale, light brown shale, and green shale. Because of sample volume requirements it was necessary to combine 10' intervals of the same lithic type into larger intervals. The intervals used for analyses are listed in Table 2. In the case of the brown shale (1650-60'), the black-brown shale (1670-80') and the light brown shale (1690-1700'), where there was no continuous occurrence of the lithic type and insufficient sample volume for analyses, the three lithologies were combined and treated as a single lithology over the interval 1650-1700'.

2.2 Methods

The source rock potential of each lithic interval was determined by assessing the source richness of the lithic type. Source richness parameters utilized were Total Organic Carbon content (TOC, bitumen-free) and screen pyrolysis (S1/S2) results. These parameters were determined as per standardized PGW methods. Detailed source rock analyses were performed using pyrolysis gas chromatography to determine the gas or oil proneness (GOGI ratio) of lithologies/intervals of source richness.

3. RESULTS AND CONCLUSIONS

The results of TOC analyses, screen pyrolysis determinations and pyrolysis/gas chromatography are given in Table 2.

The Arkansas Novaculite in the Taylor well was assessed to be in an incipient to threshold mature stage of hydrocarbon generation (PGW/TM3). Therefore, the potential productivities (S2) as determined by pyrolysis had not been significantly diminished and showed very reliably the full source rock potential of the lithologies within the Novaculite.

Due to the selective nature of the material and small quantities of samples recevied, only qualitative evaluations of source potential were made.

3.1 Chert

Chert was present in all but the 1570-80' interval. Moderate to Good TOC contents (0.63-1.24%) observed for the 1440-1570' interval were unexpected as were the moderate potential productivities (S2's) of the organic matter in the interval (2.48-4.09 kg/ton). These data indicated that chert from the 1440-1570' interval was of Moderate source potential. The organic matter in the interval was assessed to be both oil and gas prone based on GOGI values of 0.44 and 0.31. Even the 1580-1660' interval having only Marginal TOC contents ($\approx$.30%) showed indications of source potential based on potential productivities of about 1.2 kg/ton.

3.2 Black Shale

The black shale lithic type was present in most of the 10' composites (Table 1). Source richness data clearly indicated that this lithology types was an Excellent potential hydrocarbon source within the Arkansas Novaculite encountered in the Taylor well. The entire 1540-1690' showed Excellent TOC contents ranging from 6.84-11.30% and Excellent potential productivity ranging from 23.89-42.02 kg/ton. GOGI values of about 0.32 showed the organic matter in the black shale to be more oil prone than gas prone.

The 1440-1520' interval of black shale had Moderate TOC contents but showed insufficient potential productivity to be of source interest.

3.3 Brown Shale

This lithology proved to be an Excellent potential hydrocarbon source in the 1520-60' and 1590-1620' intervals of the Novaculite. Both intervals had Excellent TOC's of about 8.50% and showed Excellent potential productivities of about 28 kg/ton. As was the case of the black shale, GOGI values of about 0.32 suggested that the organic matter was both oil and gas prone but leaning toward oil proneness.

3.4 Dark Gray/Brown Shale

This lithic type, occuring in the 1630-40' interval had Excellent TOC contents (3.20%) and Good potential productivity (11.82 kg/ton) making it a Good potential hydrocarbon source. Because of its limited extent and occurrence, the dark gray/brown shale was alone, not regarded as a major potential source lithology in the Novaculite.

3.5 Gray Shale, Brown/Black-Brown/Light Brown Shale, Green Shale

Of these three lithologies only the gray shale had sufficient organic contents to be of minor source interest. However, on more detailed examination, none of these three lithic types had sufficient potential productivity to quality as source lithologies and all could be discounted as effective or potential contributors.

3.6

Hydrogen indices for the richer dark shale intervals (~350) indicated good kerogen to hydrocarbon convertibility. However, Transformation Ratios (TR) at only 0.022 - 0.047, corresponding to less than 5% conversion of kerogen to hydrocarbon, were consistent with an incipient to threshold mature status previously recorded for the Novaculite (PGW/TM3).

The cherty lithotype was interesting in again showing attractive Hydrogen indices (300-450) and somewhat higher Transformation Ratios at 6.0-10.0% conversion. Whether this represented a possible subtle lithological control over kerogen cracking is equivocal.

3.7

Source richenss data has indicated that lithologies having Excellent source potential occurred in an approximately 160'-thick section of the Arkansas Novaculite penetrated in the Taylor well between 1530-1690'. Occurring mainly in the darker black, dark gray and brown shales, the existence of these sediments suggested that the formation had self-sourcing, source-reservoir possibilities.

3.8 Exploration Significance (contributed by R. Burwood and F. Marsek)

Dark shale intervals penetrated in the Arkansas Novaculite in Taylor #1, although of incipient-threshold mature status, showed Excellent indications of oil/gas prone potential. The formation of a self-sourcing, source-reservoir combination drawing on these dark shale horizons and fractured chert reservoirs of adequate poroperm capacity, provides valid exploration targets.

Identification of optimum wildcat prospects would be contingent upon a volumetric assessment of the potential source intervals characterized above and recognition of a somewhat more forceful burial history (maximum overburden) than experienced in the subject well.

As has previously been commented upon (PGW/TM3), the maximum thermal history experienced by the L. Paleozoic upper thrust sheet in Taylor #1 was possibly a pre-thrust event. However, due to the complications and ramifications of overthrusting and palinspastics, a wide time range of hydrocarbon generating situations may be applicable to the Ouachita Overthrust.

4. REFERENCE

PGW/TM3	Burwood, R. and Marsek, F.	Provisional Evaluation and Interpretation of the Sediment Thermal Maturity Trend in Sohio Well Taylor #1, Atoka County, Oklahoma.

F. A. Marsek

I.E. Penfield

FAM/IEP:dlc

Tables 1,2

cc: G. Bassett
J.G. Grasselli
[redacted]
D. Barnes
E. Luttrell
PGW Files (0), (2-5)

Work by: R. Lukco
F. Marsek
I. Penfield

KEY TO TABLES AND FIGURES

CO_3^{2-}	% Carbonate by acidimetry
TOC	% Total Organic Carbon (Bitumen-free)
TSE	‰ Total Soluble Extract (C15+; sulfur free)
S1	‰ Thermally Distillable Hydrocarbons
G1 (TSE)	‰ Generation Index. TSE/TOC
G1 (S1)	‰ Generation Index. S1/TOC
HI	‰ Hydrogen Index. Pyrolytic Hydrocarbons/ Total Organic Carbon (kg ton^{-1} kerogen)
S2	‰ Potential Productivity Hydrocarbons (kg ton^{-1} sediment)
K2	‰ Potential Productivity Hydrocarbons (kg ton^{-1} sediment based on bitumen-free sediment)
TR	Transformation Ratio. $\frac{S1}{S1 + S2}$
R_o (ave)	% Phytoclast Vitrinite Reflectance
$D\ ^{13}C$	Carbon Isotope Value relative to PDB 1 Standard.
Visual Kerogen Description	AL – Algal AM – Amorphous/Sapropel HE – Herbaceous W – Woody C – Coaly E – Exinite (Palynomorphs) M – Major; S – Secondary; T – Trace
TAI	Palynomorph Color (Thermal Alteration Index) (1 → 5 Scale).
ROC	Random Outcrop
GOGI	Gas/Oil Generation Index - K2(gas)/K2(oil) 0.2 or less = oil prone 0.2 - 0.5 = oil and gas prone 0.5 or greater = gas prone

TABLE 1

TAYLOR #1 - Dry Cuttings Lithic Samples

DEPTH IN FEET	LITHIC TYPES
1440-50	chert, black shale
1450-60	chert, black shale
1460-70	chert, black shale
1470-80	chert, black shale
1480-90	chert, black shale
1490-1500	chert, black shale
1500-10	chert, black shale, green shale
1510-20	chert, black shale, green shale
1520-30	chert, brown shale, grey shale
1530-40	chert, brown shale, grey shale
1540-50	chert, black shale, green shale
1550-60	chert, brown shale, green shale
1560-70	chert, black shale, green shale
1570-80	black shale, green shale
1580-1590	chert, black shale, green shale
1590-1600	chert, brown shale, green shale, grey shale
1600-10	chert, black shale, green shale
1610-20	chert, brown shale, green shale
1620-30	chert, black shale, green shale
1630-40	chert, dark grey/brown shale, green shale
1640-50	chert, black shale, green shale
1650-60	chert, brown shale, green shale
1660-70	chert, black shale, green shale
1670-80	chert, black/brown shale, green shale
1680-90	chert, black shale, green shale
1690-1700	chert, light brown shale

TABLE 2

GEOCHEMICAL EVALUTION OF
ARKANSAS NOVACULITE LITHOLOGIES

	GO3(%)	TOC(%)	S1(%.)	S2(%.)	HI	GOGI	TR
CHERT							
1440-1490'	9	0.63	0.26	2.48	94		0.095
1490-1530'	9	0.90	0.26	2.76	307	0.44	0.086
1530-1570'	21	1.24	0.26	4.09	330	0.31	0.060
1580-1620'	5	0.27	0.09	1.19	441		
1620-1650'	5	0.31	0.09	1.15	371		
1660-1700'	5	0.12	0.07	0.54	450		
BLACK SHALE							
1440-1480'	14	0.91	0.12	0.60	66		
1480-1520'	13	0.84	0.10	0.60	71		
1540-1580'	7	11.30	1.92	42.02	372	0.34	0.044
1580-1630'	5	6.84	0.94	23.89	349	0.32	0.038
1640-1690'	7	8.70	1.21	25.12	289	0.32	0.046
GRAY SHALE							
1520-1540'	10	0.97	0.10	0.82	85		
1590-1600'	14	0.59	0.11	0.40	68		
BROWN SHALE							
1520-1560'	8	8.47	1.39	27.90	329	0.34	0.047
1590-1620'	4	8.59	0.91	29.00	338	0.30	0.030
DK GRAY/ BROWN SHALE							
1630-1640'	9	3.20	0.27	11.82	369	0.32	0.022
BROWN/BL-BROWN/ LT. BROWN SHALE							
1650-1700'	9	0.16	0.09	0.16	100		
GREEN SHALE							
1500-1520'	9	0.50	0.06	0.15	30		
1540-1570'	10	0.27	0.06	0.00	0		
1570-1610'	8	0.58	0.05	0.46	79		
1610-1650'	8	0.35	0.07	0.16	46		
1650-1690'	8	0.17	0.05	0.15	88		

TABLE 1

Taylor 1-15
PGW 015
2/2

SOHIO

PETROLEUM COMPANY
--------- -------

PETROLEUM GEOCHEMISTRY
WARRENSVILLE

TAYLOR#1

FEBRUARY 10, 1982

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : ATOKA
LOCATION : SEC15,T3SR11E
WELL/SITE : TAYLOR#1
API/OCS : 35-A00520087

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	XA0000		CRET	ANTL								
100	WA0001	CTG			SH.CALC	14		.21		.07	.01	5
148	XA0001		MISS	STAN	FORM.TOP							
200	WA0002	CTG			SH.CALC	16		.26		.08	0.00	0
300	WA0003	CTG			SH.CALC	12		.63		.04	.33	52
400	WA0004	CTG			SH.CALC	13		.32		.03	.07	22
500	WA0005	CTG			SH.CALC	12		.39		.01	.11	28
600	WA0006	CTG			SH.CALC	13		.38		.04	.19	50
700	WA0007	CTG			SH.CALC	12		.53		.04	.36	68
800	WA0008	CTG			SH.CALC	14		.38		.03	.05	13
900	WA0009	CTG			SH.CALC	13		.35		.02	.08	23
1000	WA0010	CTG			SH.CALC	11		.42		.05	.19	45
1100	WA0011	CTG			SH.CALC	12	C(M),HE-W(S)	.50		.03	.08	16
1200	WA0012	CTG			SH.CALC	13		.42		.03	.13	31
1300	WA0013	CTG			SH.CALC	13		.51		.05	.23	45
1330	WA0014	CTG			SH.CALC	12		.64		.05	.24	37
1360	WA0015	CTG			SH.CALC	13		.86		.05	.23	27
1390	WA0016	CTG			SH.CALC	12		.82		.05	.11	13
1420	WA0017	CTG			SH.CALC	12		.77		.06	.13	17
1440	XA0017		DEV	ARKN	FORM.TOP							
1450	WA0018	CTG			CHT.V.ARG	8		.78	1.50	.11	.48	62
1480	WA0019	CTG			CHT.V.ARG	9		.96	.93	.09	.50	52
1510	WA0020	CTG			SH.CHTY	9	AM(M),HE W-C(T)	2.10	1.61	.40	5.49	261
1540	WA0021	CTG			SH.CHTY	9		3.16	.92	.40	5.32	168
1570	WA0022	CTG			SH.CHTY	6	AM(M),HE C(T)	4.30	1.93	.43	11.05	257
1600	WA0023	CTG			CHT.ARG	6		1.75	1.10	.17	2.40	137
1630	WA0024	CTG			CHT.ARG	7		1.08	.68	.12	1.31	121
1660	WA0025	CTG			CHT.ARG	7	AM(M),HE C(T)	1.25	.83	.11	.44	35
1690	WA0026	CTG			CHT.ARG	8		.26		.03	.15	58
1693	XA0026		SIL	MOMT	FORM.TOP							
1720	WA0027	CTG			SH	7	AM(M),HE(S)	.27		.03	.10	37
1750	WA0028	CTG			SH.CALC	11		.24		.04	.09	37
1780	WA0029	CTG			SH.CALC	11		.25		.03	.13	52
1810	WA0030	CTG			SH.V.CALC	30		.47		.04	.99	211
1840	XA0030		ORD	POLK	FORM.TOP							
1841	WA0072	CTG			SH.CALC	18	AM(M),W(S)	1.79	1.83	.44	7.02	392
1870	WA0073	CTG			SH	7		3.88	1.80	3.74	35.43	913

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
100	.88		33												
148															
200	1.00		31												
300	.11		6									.47			
400	.30		9												
500	.08		3												
600	.17		11												
700	.10		8									.54			
800	.38		8												
900	.20		6												
1000	.21		12												
1100	.27		6								1+	.48			
1200	.19		7												
1300	.18		10												
1330	.17		8												
1360	.18		6												
1390	.31		6												
1420	.32		8												
1440															
1450	.19	192	14	14											
1480	.15	97	9	10						.94				30.02	
1510	.07	77	19	4	9.60	2.22	7.38	457	.30				29.25		
1540	.07	29	13	2	7.10	1.84	5.26	225	.35	.98			29.95	29.55	
1570	.04	45	10	4	9.10	2.05	7.05	212	.29			.47	29.95		
1600	.07	63	10	6	4.00	1.18	2.82	229	.42	1.05				29.76	
1630	.08	63	11	6	2.30	.77	1.53	213	.50				28.96		
1660	.20	66	9	8	1.00	.35	.65	80	.54						
1690	.17		12												
1693															
1720	.23		11								1+	.37			
1750	.31		17												
1780	.19		12												
1810	.04		9												
1840															
1841	.06	102	25	4	6.80	1.73	5.07	380	.34	1.01		.45	30.37	30.31	
1870	.10	46	96	0	18.45	4.68	13.77	476	.34				31.33	29.83	

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSC KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1884	XA0073		ORD	BGFK	FORM.TOP							
1900	WA0074	CTG			CHT.V.CALC	26		1.01	4.18	3.47	9.81	971
1930	WA0075	CTG			CHT.CALC	22		.58	2.17	1.06	3.85	664
1960	WA0076	CTG			CHT.V.CALC	29		.44	5.24	5.81	1.93	439
1990	WA0077	CTG			CHT.V.CALC	42		.36	10.67			
2020	WA0078	CTG			CHT.CALC	23		.48	10.63			
2050	WA0079	CTG			CHT.V.CALC	26		.48	6.60			
2080	WA0080	CTG			CHT.V.CALC			.50	7.57			
2140	WA0082	CTG			CHT.V.CALC	34		.61	16.12			
2170	WA0083	CTG			CHT.V.CALC	40		.41	6.78			
2200	WA0084	CTG			CHT.V.CALC	42		.34	2.84	1.30	2.61	768
2230	WA0085	CTG			CHT.V.CALC	46		.28		.82	2.33	832
2260	WA0086	CTG			CHT.V.CALC	41		.27		.50	1.24	459
2290	WA0087	CTG			CHT.V.CALC	29		.36		.37	1.30	361
2320	WA0088	CTG			CHT.V.CALC	39		.35		.74	1.12	320
2350	WA0089	CTG			CHT.V.CALC	37		.34		.35	.48	141
2380	WA0090	CTG			CHT.V.CALC	46		.28	3.12	1.29	1.22	436
2410	WA0091	CTG			CHT.V.CALC	36		.33	4.50	2.44	1.91	579
2440	WA0092	CTG			CHT.V.CALC	40		.33		.77	1.52	461
2470	WA0093	CTG			CHT.V.CALC	30	AM(M),C(S),W(T)	.51	4.66	1.50	3.88	761
2510	WA0094	CTG			CHT.V.CALC	34		.57	5.38	2.48	2.51	440
2540	WA0095	CTG			CHT.V.CALC	27	AM(M),HE(S)	1.13	2.65	.85	6.37	564
2558	XA0095		ORD	WOMB	FORM.TOP							
2570	WA0096	CTG			SH.CALC	21	AM(M),C(T)	1.03	1.80			
2600	WA0097	CTG			SH.CALC	19		1.08	3.11			
2630	WA0098	CTG			SH.CALC	12		.76	5.20			
2660	WA0099	CTG			SH.CALC	11		.74	4.17			
2690	WA0100	CTG			SH	10		.66	6.08			
2720	WA0101	CTG			SH.CALC	11		.82	6.69			
2750	WA0102	CTG			SH	10		.63	7.51			
2770	XA0102		ORD	BGFK	FORM.TOP							
2780	WA0103	CTG			CHT.CALC	14		.70	3.84			
2810	WA0104	CTG			CHT.CALC	15		.61	12.77			
2840	WA0105	CTG			CHT.V.CALC	33		.57	8.26			
2870	WA0106	CTG			CHT.V.CALC	33		.46	11.60			
2900	WA0107	CTG			CHT.V.CALC	28		.65	4.87			
2930	WA0108	CTG			CHT.V.CALC	29		.51	4.64			
2960	WA0109	CTG			CHT.V.CALC	29		.48	10.12			
2990	WA0110	CTG			CHT.V.CALC	33	AM(M),C(T)	.46	9.72			
3020	WA0111	CTG			CHT.V.CALC	34		.43	8.00			
3050	WA0112	CTG			CHT.V.CALC	31		.50	3.61			
3080	WA0113	CTG			CHT.CALC	25		.62	3.56			
3110	WA0114	CTG			CHT.CALC	23		.61	5.01			
3140	WA0115	CTG			CHT.CALC	24		.60	3.47			
3170	WA0116	CTG			CHT.V.CALC	29		.58	3.00			
3195	XA0116		PENN	ATOK	FORM.TOP							
3200	WA0117	CTG			SH.CALC	19	AM(M),C(T)	.81		.08	1.43	177
3230	WA0118	CTG			SH.CALC	15		.97		.09	.58	60
3260	WA0119	CTG			SH.CALC	16		2.09	2.15	.34	5.14	246

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1884															
1900	.26	414	344	1	5.60	1.36	4.24	554	.32						
1930	.22	374	183	2											
1960	.75	1191	1320	1											
1990		2964													
2020		2215								.95				30.40	
2050		1375													
2080		1305													
2140		2643								1.02		.54		30.65	
2170		1654													
2200	.33	835	382	2											
2230	.26		293												
2260	.29		185												
2290	.22		103												
2320	.40		211												
2350	.42		103												
2380	.51	1114	461	2											
2410	.56	1364	739	2											
2440	.34		233												
2470	.28	914	294	3							2				
2510	.50	944	435	2											
2540	.12	235	75	3											
2558															
2570		175			5.40	.94	4.46	524	.21		2-	.49	30.47	30.62	
2600		288			6.10	1.51	4.59	565	.33				30.20	30.09	
2630		684			2.49	.86	1.63	328	.53						
2660		564			2.57	.93	1.64	347	.57						
2690		921													
2720		816			2.55	.97	1.58	311	.61						
2750		1192													
2770															
2780		549										.51			
2810		2093								1.08				30.47	
2840		1449													
2870		2522								1.06				30.68	
2900		749													
2930		910													
2960		2108													
2990		2113									2	.66			
3020		1860													
3050		722													
3080		574													
3110		821													
3140		578													
3170		517													
3195															
3200	.05		10								2	.48			
3230	.13		9												
3260	.06	103	16	6	5.00	1.64	3.36	239	.49						

WELL/SITE :TAYLOR#1

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3290	WA0120	CTG			SH.CALC	14	AM(M),HE-W-C(S)	3.03	2.78	.61	8.99	297
3320	WA0121	CTG			SH.CALC	13		2.41	2.30	.31	4.69	195
3350	WA0122	CTG			SH.CALC	12	AM(M),C(T)	2.31	1.83	.33	3.41	148
3380	WA0123	CTG			SH.CALC	12		2.56	1.98	.41	3.98	155
3410	WA0124	CTG			SH.CALC	13		2.09	1.84	.18	2.11	101
3440	WA0125	CTG			SH.CALC	12	W-C(M),HE(S)	2.03	2.05	.19	2.36	116
3470	WA0126	CTG			SH.CALC	12		2.88	2.42	.46	4.33	150
3500	WA0127	CTG			SH.CALC	11	AM(M),W(S)	4.46	3.99	.80	11.98	269
3530	WA0128	CTG			SH.CALC	11		2.21	2.15	.33	3.42	155
3560	WA0129	CTG			SH	10	AM(M),C(T)	3.04	3.61	.77	7.96	262
3590	WA0130	CTG			SH.CALC	14		3.28	3.04	.54	4.91	150
3620	WA0131	CTG			SH.CALC	18		2.04	1.72	.30	2.12	104
3650	WA0132	CTG			SH.CALC	13	W-C(M),HE(S)	2.12	1.34	.33	2.43	115
3680	WA0133	CTG			SH.CALC	13		1.61	1.56	.24	1.50	93
3710	WA0134	CTG			SH.CALC	13		2.72	2.16	.48	4.27	157
3740	WA0135	CTG			SH.CALC	14	AM(M),HE-W-C(T)	2.47	2.23	.47	3.22	130
3770	WA0136	CTG			SH.CALC	12		.99	1.85	.31	1.38	139
3800	WA0137	CTG			SH	9		.97	1.17	.28	.93	96
3830	WA0138	CTG			SH	10		2.23	2.95	.36	3.05	137
3860	WA0139	CTG			SH.CALC	12	AM(M),C(T)	2.37	2.08	.56	3.93	166
3890	WA0140	CTG			SH.CALC	15		.77	2.11	.21	1.87	243
3920	WA0141	CTG			SH.CALC	11		1.60	1.36	.24	1.47	92
3950	WA0142	CTG			SH	9	C(M),HE-W(S)	.85		.17	.62	73
3980	WA0143	CTG			SH	9		.85		.08	.42	49
4010	WA0144	CTG			SH	9		.83				
4040	WA0145	CTG			SH	9		.73		.14	.74	101
4070	WA0146	CTG			SH.CALC	11	W-C(M),HE(T)	1.56	1.61	.16	1.82	117
4100	WA0147	CTG			SH.CALC	12		1.03	.81	.10	.78	76
4130	WA0148	CTG			SH	10		1.05	.93	.22	1.02	97
4160	WA0149	CTG			SH	10		.87		.16	.84	97
4190	WA0150	CTG			SH.CALC	13	C(M),HE-W(S)	.98		.18	1.32	135
4220	WA0151	CTG			SH.CALC	11		.83	1.12	.15	.74	89
4250	WA0152	CTG			SH	10		.87		.11	.42	48
4280	WA0153	CTG			SH	10		.86		.18	.40	47
4310	WA0154	CTG			SH.CALC	11		.82		.17	.37	45
4340	WA0155	CTG			SH	10		.81		.18	.64	79
4370	WA0156	CTG			SH.CALC	11		.75		.08	.50	67
4400	WA0157	CTG			SH.CALC	12		.82		.12	.55	67
4430	WA0158	CTG			SH	10	C(M),HE-W(S)	.78		.19	.81	104
4460	WA0159	CTG			SH.CALC	11		.80		.27	1.38	172
4490	WA0160	CTG			SH.CALC	11		.96		.27	1.38	144
4520	WA0161	CTG			SH.CALC	11		.94		.21	.93	99
4550	WA0162	CTG			SH	10		.91		.14	.69	76
4580	WA0163	CTG			SH	9	W-C(M),HE(S)	.92		.21	1.24	135
4610	WA0164	CTG			SH.CALC	11		.80		.20	.52	65
4640	WA0165	CTG			SH	10		.84		.26	1.09	130
4670	WA0166	CTG			SH	10		.85		.26	1.31	154
4700	WA0167	CTG			SH	10	C(M),HE-W(S)	1.02	1.42	.28	1.10	108
4730	WA0170	CTG			SH	9	HE-W(M),C(S)	1.01	.97	.14	1.16	115

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3290	.06	92	20	5	7.90	2.13	5.77	261	.37	1.12			26.56	28.96	
3320	.06	95	13	7											
3350	.09	79	14	6	4.40	1.47	2.93	190	.50		2+		25.82	28.50	
3380	.09	77	16	5											
3410	.08	88	9	10									25.49	28.63	
3440	.07	101	9	11	2.80	1.06	1.74	138	.61						
3470	.10	84	16	5	5.20	1.49	3.71	181	.40						
3500	.06	89	18	5	11.70	3.46	8.24	262	.42	1.17			26.57	28.78	
3530	.09	97	15	7											
3560	.09	119	25	5	8.44	2.81	5.63	278	.50	.96	2+	.47	25.99	29.26	
3590	.10	93	16	6											
3620	.12	84	15	6									25.56	28.14	
3650	.12	63	16	4	3.50	1.09	2.41	165	.45						
3680	.14	97	15	7									25.18	28.36	
3710	.10	79	18	4											
3740	.13	90	19	5						1.11			25.72	28.86	
3770	.18	187	31	6											
3800	.23	121	29	4	1.20	.45	.75	124	.60						
3830	.11	132	16	8											
3860	.12	88	24	4							2+	.57			
3890	.10	274	27	10											
3920	.14	85	15	6	2.10	.75	1.35	131	.55						
3750	.22		20								2-	.52			
3980	.16		9												
4010															
4040	.16		19												
4070	.08	103	10	10											
4100	.11	79	10	8											
4130	.18	89	21	4											
4160	.16		18												
4190	.12		18								2-	.64			
4220	.17	135	18	7											
4250	.21		13												
4280	.31		21												
4310	.31		21												
4340	.22		22												
4370	.14		11												
4400	.18		15												
4430	.19		24								2-	.53			
4460	.16		34												
4490	.16		28												
4520	.18		22												
4550	.17		15												
4580	.14		23												
4610	.28		25												
4640	.19		31												
4670	.17		31												
4700	.20	139	27	5	1.10	.44	.66	108	.67		2-	.51			
4730	.11	96	14	7							2-	.42			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
10810	WA0365	CTG			SH.CALC	14		.82		.04	.13	16
10840	WA0366	CTG			SH.CALC	14		.73		.08	.09	12
10870	WA0367	CTG			SH.CALC	13		.77		.03	.08	10
11050	WA0368	CTG			SH.CALC	12		.69		.04	.04	6
11140	WA0369	CTG			SH.CALC	12		1.36		.19	.19	14
11230	WA0370	CTG			SH	8	C(M),HE-W(S)	1.79		.22	.32	18
11260	WA0371	CTG			SH	7		1.69		.23	.21	12
11290	WA0372	CTG			SH.CALC	13		1.77		.35	.02	1
11300	XA0372		MISS	CANY	FORM.TOP							
11350	WA0373	CTG			SH.CALC	20		2.14		.38	.40	19
11380	WA0374	CTG			SH.CALC	14		2.19		.31	.64	29
11410	WA0375	CTG			SH.CALC	17		1.93		.29	.98	51
11440	WA0376	CTG			SH	6	HE(M),AM-W(S)	1.62		.19	.27	17
11690	XA0376		DEV	WOOD	FORM.TOP							
11710	WA2560	CTG			SH.CALC	12	HE(M),AM(S)	2.75	1.06	.76	.72	26
11740	WA2561	CTG			SH.CALC							
11770	WA2562	CTG			SH.CALC	11	AM(M)	3.41	.96	.78	.35	10
11800	WA2563	CTG			SH.CALC							
11830	WA2564	CTG			SH.CALC	14		2.33	.97	.61	.46	20
11860	WA2565	CTG			SH.CALC							
11890	WA2566	CTG			SH.CALC	15		2.32	.80	.21	0.00	0
11920	WA2567	CTG			SH.CALC							
11945	XA2567		ORD	SYLV	FORM.TOP							
11950	WA2568	CTG										
11980	WA2569	CTG										
12010	WA2570	CTG										
12040	WA2571	CTG										
12070	WA2572	CTG										
12085	XA2572		ORD	VIOL	FORM.TOP							
12100	WA2573	CTG										
12130	WA2574	CTG										
12160	WA2575	CTG										
12190	WA2576	CTG										
12220	WA2577	CTG										
12250	WA2578	CTG										
12280	WA2579	CTG										
12310	WA2580	CTG										
12340	WA2581	CTG										
12370	WA2582	CTG										
12390	XA2582		ORD	BROM	FORM.TOP							
12400	WA2583	CTG										
12430	WA2584	CTG										
12460	WA2585	CTG			LST,ARG	77	HE(M),AM-W(S)	1.22		.55	.13	11
12490	WA2586	CTG										
12520	WA2587	CTG			LST,ARG	80	AM(M),HE-W(S)	1.21		.38	.12	10
12550	WA2588	CTG										
12580	WA2589	CTG										
12610	WA2590	CTG			LST,ARG	76	AM(M),HF-W(S)	.94		.17	.25	27
12640	WA2591	CTG										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
10810	.24		5												
10840	.47		11												
10870	.27		4												
11050	.50		6												
11140	.50		14												
11230	.41		12								3-	1.43			
11260	.52		14												
11290	.95		20												
11300															
11350	.49		18												
11380	.33		14												
11410	.23		15												
11440	.41		12								3-	1.57			
11690															
11710	.51	39	28	1	1.50	.92	.58	55	1.57		3-	1.55			
11740															
11770	.69	28	23	1	1.50	.89	.61	44	1.45		3-	1.58			
11800															
11830	.57	42	26	2	.93	.54	.39	40	1.38						
11860															
11890	1.00	34	9	4								1.44			
11920															
11945															
11950															
11980												1.41			
12010															
12040															
12070															
12085															
12100															
12130															
12160															
12190															
12220															
12250															
12280															
12310															
12340															
12370															
12390															
12400															
12430															
12460	.81		45								3-				
12490															
12520	.76		31								3-				
12550															
12580															
12610	.40		18								3-				
12640															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
4760	WA0171	CTG			SH	8		1.01	.94	.08	1.10	109
4790	WA0172	CTG			SH	7		.96		.03	.90	94
4820	WA0173	CTG			SH	7		.93		.15	1.50	161
4850	WA0174	CTG			SH	6		1.06	1.42	.15	1.62	153
4880	WA0175	CTG			SH	8	HE-W(S)	1.16	1.43	.31	1.25	108
4910	WA0176	CTG			SH	9		.96		.13	1.41	147
4940	WA0177	CTG			SH	9	W(M),HE(S)	1.01	1.48	.07	.90	89
4970	WA0178	CTG			SH	8		1.02	1.01	.11	1.12	110
5000	WA0179	CTG			SH	9	HE(M),AM-W-C(S)	.97		.12	1.22	126
5030	WA0180	CTG			SH	9		.98		.10	.76	78
5060	WA0181	CTG			SH	9	W(M),HE-C(S)	1.04	1.94	.09	1.64	158
5090	WA0182	CTG			SH	9		1.14	2.25	.20	2.06	181
5120	WA0183	CTG			SH	9	HE-W(M),C(S)	1.22	2.79	.25	2.16	177
5150	WA0184	CTG			SH	9		1.05	1.72	.04	.95	90
5180	WA0185	CTG			SH	10	HE(M),W-C(S)	1.02	1.77	.12	.84	82
5210	WA0186	CTG			SH	9		.74		.32	1.73	234
5240	WA0187	CTG			SH	9		.68		.13	.27	40
5270	WA0188	CTG			SH	9		.61		.09	.87	143
5300	WA0189	CTG			SH	8	W(M),HE(S)	.59		.07	.57	97
5330	WA0190	CTG			SH	8		.66		.08	.30	45
5360	WA0191	CTG			SH	8	HE-W(M),C(S)	1.15	.71	.03	.53	46
5390	WA0192	CTG			SH	7		.92		.09	1.08	117
5420	WA0193	CTG			SH	6	W(M),HE-C(S)	.64		.08	.73	114
5450	WA0194	CTG			SH	9		.68		.07	.26	38
5480	WA0195	CTG			SH	10	HE-W(M),C(S)	.96		.05	.59	61
5510	WA0196	CTG			SH.CALC	11	HE-W(M),C(S)	.81		.09	.84	104
5540	WA0197	CTG			SH	10		.54		.04	.11	20
5600	WA0198	CTG			SH	9	C(M),HE-W(S)	.58		.03	.30	52
5630	WA0199	CTG			SH	10		.72		.09	.74	103
5660	WA0200	CTG			SH.CALC	11		.58		.05	.42	72
5690	WA0201	CTG			SH.CALC	12		.87		.03	.42	48
5720	WA0202	CTG			SH	10	HE(M),W-C(S)	.63		.03	.14	22
5750	WA0203	CTG			SH	10		.54		.04	.17	31
5780	WA0204	CTG			SH	9		.46		.05	.27	59
5810	WA0205	CTG			SH	8	HE-W(M),C(S)	.58		.02	.36	62
5840	WA0206	CTG			SH	9	HE-W(M),C(M)	.56		.05	.69	123
5870	WA0207	CTG			SH.CALC	11		.70		.07	.88	126
5900	WA0208	CTG			SH.CALC	11	HE-W(M),C(S)	.58		.07	.71	122
5930	WA0209	CTG			SH	10		.56		.05	.47	84
5960	WA0210	CTG			SH	10	HE(M),W-C(S)	.60		.08	.64	107
5990	WA0211	CTG			SH	9		.68		.03	.34	50
6020	WA0212	CTG			SH	9		.70		.06	.35	50
6050	WA0213	CTG			SH	10	C(M),HE-W(S)	.65		.05	.27	42
6080	WA0214	CTG			SH	10		.92		.08	.43	47
6110	WA0215	CTG			SH.CALC	12		.79		.11	.59	75
6140	WA0216	CTG			SH.CALC	12		.77		.11	.66	86
6170	WA0217	CTG			SH.CALC	14	HE-W(M),C(S)	.46		.02	.15	33
6200	WA0218	CTG			SH.CALC	12		.59		.08	.37	63
6230	WA0219	CTG			SH.CALC	12		.62		.07	.25	40

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
4760	.07	93	8	12	1.30	.51	.79	129	.64						
4790	.03		3												
4820	.09		16												
4850	.08	134	14	9	1.40	.51	.89	132	.57						
4880	.20	123	27	5							2-	.38			
4910	.08		14												
4940	.07	147	7	21	1.40	.54	.86	139	.63		2-				
4970	.09	99	11	9											
5000	.09		12								2-				
5030	.12		10												
5060	.05	187	9	22							2-				
5090	.09	197	18	11											
5120	.10	229	20	11							2				
5150	.04	164	4	43											
5180	.13	174	12	15							2				
5210	.16		43												
5240	.33		19												
5270	.09		15												
5300	.11		12								2-	.45			
5330	.21		12												
5360	.05	62	3	24							2-				
5390	.08		10												
5420	.10		12								2-	.54			
5450	.21		10												
5480	.08		5								2-				
5510	.10		11								2-	.52			
5540	.27		7												
5600	.09		5								2-				
5630	.11		12												
5660	.11		9												
5690	.07		3												
5720	.18		5								2	.47			
5750	.19		7												
5780	.16		11												
5810	.05		3								2	.50			
5840	.07		9								2	.60			
5870	.07		10												
5900	.09		12								2-				
5930	.10		9												
5960	.11		13								2-	.61			
5990	.08		4												
6020	.15		9												
6050	.16		8								2-	.58			
6080	.16		9												
6110	.16		14												
6140	.14		14												
6170	.12		4								2				
6200	.18		14												
6230	.22		11												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
6260	WA0220	CTG			SH.CALC	11		.71		.04	.38	54
6290	WA0221	CTG			SH.CALC	11		.71		.08	.58	82
6320	WA0222	CTG			SH	10		.84		.09	.52	62
6350	WA0223	CTG			SH.CALC	12		.85		.04	.52	61
6380	WA0224	CTG			SH.CALC	11		.82		.06	.46	56
6410	WA0225	CTG			SH	10		.89		.05	.44	49
6440	WA0226	CTG			SH	7		.85		.09	.36	42
6470	WA0227	CTG			SH	7		.84		.09	.42	50
6500	WA0228	CTG			SH	7	HE-W(M),AM-C(S)	.57		.07	.54	95
6530	WA0229	CTG			SH	7		.87		.05	.45	52
6560	WA0230	CTG			SH	7		.88		.06	.41	47
6590	WA0231	CTG			SH	9		.68		.05	.24	35
6620	WA0232	CTG			SH	7		.67		.04	.24	36
6650	WA0233	CTG			SH	6		.58		.04	.25	43
6680	WA0234	CTG			SH	6		.67		.01	.05	7
6710	WA0235	CTG			SH	6		.70		.07	.27	39
6740	WA0236	CTG			SH	6		.65		.04	.26	40
6770	WA0237	CTG			SH	6		.63		.04	.12	19
6800	WA0238	CTG			SH	6	HE(M),W(S)	.61		.05	.22	36
6830	WA0239	CTG			SH	8		.68		.07	.43	63
6860	WA0240	CTG			SH	8		.79		.13	.73	92
6890	WA0241	CTG			SH	8		.70		.07	.35	50
6920	WA0242	CTG			SH	7		.73		.04	.27	37
6950	WA0243	CTG			SH	8		.90		.08	.35	39
6980	WA0244	CTG			SH	8		.86		.06	.59	69
7010	WA0245	CTG			SH	8		.86		.04	.41	48
7040	WA0246	CTG			SH	8		.81		.04	.41	51
7070	WA0247	CTG			SH	8		.87		.06	.38	44
7100	WA0248	CTG			SH	8	HE(M),W-C(S)	.98		.07	.32	33
7130	WA0249	CTG			SH	8		.87		.06	.43	49
7160	WA0250	CTG			SH	8	C(M),W(S),HE(T)	.99		.09	.42	42
7190	WA0251	CTG			SH	8		1.04	.79	.08	.82	79
7220	WA0252	CTG			SH	7	W(M),HE-C(S)	1.05	.89	.10	.47	45
7250	WA0253	CTG			SH	7		.89		.09	.44	49
7280	WA0254	CTG			SH	6		.90		.05	.44	49
7310	WA0255	CTG			SH	5		.79		.06	.33	42
7340	WA0256	CTG			SH	5		.85		.06	.27	32
7370	WA0257	CTG			SH	4		.75		.04	.37	49
7400	WA0258	CTG			SH	7	HE(M),W-C(S)	.76		.05	.33	43
7430	WA0259	CTG			SH	8		.56		.13	.24	43
7460	WA0260	CTG			SH	7	C(M),HE(S),W(T)	.99		.04	.44	44
7490	WA0261	CTG			SH	10		.82		.04	.45	55
7520	WA0262	CTG			SH	9		.89		.11	.69	78
7550	WA0263	CTG			SH	9		.77		.12	.71	92
7580	WA0264	CTG			SH.CALC	11	HE-W(M),C(S)	1.13	.74	.10	.66	58
7610	WA0265	CTG			SH	10		.85		.11	.84	99
7640	WA0266	CTG			SH	10		.79		.10	.75	95
7670	WA0267	CTG			SH	10		1.01	.90	.06	.32	32
7700	WA0268	CTG			SH	10	W(M),HF-C(S)	.97		.14	.92	95

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
6260	.10		6												
6290	.12		11												
6320	.15		11												
6350	.07		5												
6380	.12		7												
6410	.10		6												
6440	.20		11												
6470	.18		11												
6500	.11		12								2-	.57			
6530	.10		6												
6560	.13		7												
6590	.17		7												
6620	.14		6												
6650	.14		7												
6680	.17		1												
6710	.21		10												
6740	.13		6												
6770	.25		6												
6800	.19		8								2	.53			
6830	.14		10												
6860	.15		16												
6890	.17		10												
6920	.13		5												
6950	.19		9												
6980	.09		7												
7010	.09		5												
7040	.09		5												
7070	.14		7												
7100	.18		7								2-	.56			
7130	.12		7												
7160	.18		9								2-				
7190	.09	76	8	10											
7220	.18	85	10	9							2-				
7250	.17		10												
7280	.10		6												
7310	.15		8												
7340	.18		7												
7370	.10		5												
7400	.13		7								2-	.59			
7430	.35		23												
7460	.08		4								2				
7490	.08		5												
7520	.14		12												
7550	.14		16												
7580	.13	65	9	7							2				
7610	.12		13												
7640	.12		13												
7670	.16	89	6	15											
7700	.13		14								2	.57			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KFROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
7730	WA0269	CTG			SH	10		.79		.12	.59	75
7760	WA0270	CTG			SH	10		.79		.11	.35	44
7790	WA0271	CTG			SH	10		.83		.08	.39	47
7820	WA0272	CTG			SH	10	HE-W(M),C(S)	1.08	1.08	.14	.49	45
7850	WA0273	CTG			SH	10		1.05	.97	.09	.78	74
7880	WA0274	CTG			SH.CALC	12	HE-W(M),C(S)	1.11	1.03	.13	1.00	90
7910	WA0275	CTG			SH.CALC	12		.97		.13	.81	84
7940	WA0276	CTG			SH.CALC	11	C(M),W(S),AM(T)	1.05	1.14	.13	.50	48
7970	WA0277	CTG			SH.CALC	11		1.02	1.14	.17	1.09	107
8000	WA0278	CTG			SH.CALC	12	HE-W(M),C(S)	1.22	.87	.12	.78	64
8030	WA0279	CTG			SH.CALC	13		1.55	1.40	.12	.59	38
8060	WA0280	CTG			SH.CALC	13		.73		.16	.37	51
8090	WA0281	CTG			SH	10		.84		.17	.65	77
8120	WA0282	CTG			SH	7		.83		.15	.64	77
8150	WA0283	CTG			SH	9	HE-W(M),C(S)	1.13	.74	.08	.49	43
8180	WA0284	CTG			SH	8		.96		.08	.48	50
8210	WA0285	CTG			SH	8	HE-W(M),C(S)	1.20	.78	.06	.65	54
8240	WA0286	CTG			SH	8		.79		.09	.66	84
8270	WA0287	CTG			SH	7		.76		.12	.69	91
8300	WA0288	CTG			SH	7	HE-W(M),C(S)	.79		.07	.48	61
8330	WA0289	CTG			SH	7		.98		.11	.93	95
8360	WA0290	CTG			SH	8		.89		.13	.68	76
8390	WA0291	CTG			SH	10	HE-W(M),AM-C(S)	1.56	1.29	.18	1.51	97
8420	WA0292	CTG			SH	10		1.35	1.92	.06	.64	47
8450	WA0293	CTG			SH.CALC	12	W(M),HE-C(S)	1.16	1.33	.13	1.14	98
8480	WA0294	CTG			SH.CALC	11		1.17	1.53	.07	1.11	95
8510	WA0295	CTG			SH.CALC	11	HE-W(M),AM-C(S)	1.18	1.44	.12	1.29	109
8540	WA0296	CTG			SH.CALC	11		1.24	1.54	.07	1.16	94
8570	WA0297	CTG			SH.CALC	11		1.50	1.62	.14	.89	59
8600	WA0298	CTG			SH.CALC	11	HE-W(M),AM-C(S)	1.26	2.48	.14	1.49	118
8630	WA0299	CTG			SH.CALC	11		1.53	1.67	.08	1.17	76
8660	WA0300	CTG			SH	10	W(M),HE-C(S)	1.22	1.11	.06	.86	70
8690	WA0301	CTG			SH.CALC	13		1.13	2.00	.12	.55	49
8720	WA0302	CTG			SH	8		1.16		.09	1.06	91
8750	WA0303	CTG			SH	8		1.06		.16	1.09	103
8780	WA0304	CTG			SH	9		.99		.11	1.02	103
8810	WA0305	CTG			SH	9		1.20		.12	.75	62
8840	WA0306	CTG			SH	9		1.23		.13	1.01	82
8870	WA0307	CTG			SH	9		.82		.15	.41	50
8900	WA0308	CTG			SH	8		.92		.09	.50	54
8930	WA0309	CTG			SH.CALC	19	C(M),HF-W(S)	.62		.10	.26	42
8960	WA0310	CTG			SH.V.CALC			13.19		3.07	.64	5
8990	WA0311	CTG			SH	9		1.14		.39	.45	39
9020	WA0312	CTG			SH	9		.63		.03	.13	21
9050	WA0313	CTG			SH	9		.81		.07	.41	51
9080	WA0314	CTG			SH	9		1.17		.11	.27	23
9110	WA0315	CTG			SH	9	HE-W(M),AM-C(S)	.99		.10	.48	48
9140	WA0316	CTG			SH.CALC	14		.98		.06	.23	23
9170	WA0317	CTG			SH	7		.68		.07	.24	35

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
7730	.17		15												
7760	.24		14												
7790	.17		10												
7820	.22	100	13	8							2				
7850	.10	92	9	11											
7880	.12	93	12	8							2				
7910	.14		13												
7940	.21	109	12	9							2+				
7970	.13	112	17	7											
8000	.13	71	10	7							2+				
8030	.17	90	8	12	1.40	.65	.75	90	.86						
8060	.30		22												
8090	.21		20												
8120	.19		18												
8150	.14	65	7	9							2+				
8180	.14		8												
8210	.08	65	5	13							2+				
8240	.12		11												
8270	.15		16												
8300	.13		9								2	.54			
8330	.11		11												
8360	.16		15												
8390	.11	83	12	7	2.60	1.22	1.38	167	.89		2				
8420	.09	142	4	32											
8450	.10	115	11	10	1.70	.76	.94	147	.81		2				
8480	.06	131	6	22											
8510	.09	122	10	12	1.90	.88	1.02	161	.87		2				
8540	.06	124	6	22	1.50	.69	.81	121	.85						
8570	.14	108	9	12	1.90	.83	1.07	127	.78						
8600	.09	197	11	18	1.60	.67	.93	127	.72		2				
8630	.06	109	5	21											
8660	.07	91	5	18							2				
8690	.18	177	11	17											
8720	.08		8												
8750	.13		15												
8780	.10		11												
8810	.14		10												
8840	.11		11												
8870	.27		18												
8900	.15		10												
8930	.28		16									.91			
8960	.83		23												
8990	.46		34												
9020	.19		5												
9050	.15		9												
9080	.29		9												
9110	.17		10								2+	1.08			
9140	.21		6												
9170	.23		10												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
9200	WA0318	CTG			SH	7		.67		.05	.16	24
9230	WA0319	CTG			SH	8		.61		.18	.13	21
9260	WA0320	CTG			SH	8	HE(M),W-C(S)	.66		.04	.23	35
9290	WA0321	CTG			SH	8		.58		.12	.13	22
9320	WA0322	CTG			SH	7		.59		.05	.14	24
9350	WA0323	CTG			SH	7		.38		.06	.08	21
9380	WA0324	CTG			SH	7		.47		.03	.10	21
9410	WA0325	CTG			SH	7		.51		.13	.32	63
9440	WA0326	CTG			SH	7		.41		.05	.01	2
9470	WA0327	CTG			SH	5		.46		.21	.08	17
9500	WA0328	CTG			SH	4		.25		.11	.01	4
9530	WA0329	CTG			SH	3		.29		.10	.05	17
9560	WA0330	CTG			SH	4		.38		.07	.07	18
9590	WA0331	CTG			SH	3	HE-W(M),C(S)	.21		0.00	.06	29
9620	WA0332	CTG			SH	4		.19		.10	.02	11
9650	WA0333	CTG			SH	5		.23		.04	.05	22
9680	WA0334	CTG			SH	5		.21		.06	.05	24
9710	WA0335	CTG			SH	6		.25		.28	0.00	0
9740	WA0336	CTG			SH	8		.45		.05	.05	11
9800	WA0337	CTG			SH	8		.67		.06	.23	34
9830	WA0338	CTG			SH.V.CALC	31		.54		.10	.08	15
9835	XA0338		PENN	WAPA	FORM.TOP							
9860	WA0339	CTG			SH.CALC	22		.69		.24	.08	12
9890	WA0340	CTG			SH.CALC	13	HE(M),W-C(S)	.93		.11	.14	15
9920	WA0341	CTG			SH.CALC	15		.78		.12	.29	37
9950	WA0342	CTG			SH.CALC	17		.71		.05	.10	14
9980	WA0343	CTG			SH.V.CALC	39		.57		.33	.08	14
10010	WA0344	CTG			SH.V.CALC	27		.60		.19	.06	10
10030	WA0345	CTG			SH.V.CALC	37		.52		.02	.06	12
10040	WA0346	CTG										
10070	WA0347	CTG										
10090	WA0348	CTG										
10120	WA0349	CTG			SH.V.CALC	29		.63		.19	.05	8
10150	WA0350	CTG			LST.ARG	81		.58		.16	.43	74
10185	XA0350		MISS	SPRN	FORM.TOP							
10270	WA0351	CTG			SH.CALC	14	HE(M),W-C(S)	.63		.08	.14	22
10300	WA0352	CTG			SH.CALC	17		.54		.08	.10	19
10360	WA0353	CTG			SH.CALC	17		.58		.06	.10	17
10390	WA0354	CTG			SH.CALC	18		.58		.07	.11	19
10420	WA0355	CTG			SH.CALC	16		.63		.06	.04	6
10450	WA0356	CTG			SH.CALC	15		.62		.04	.11	18
10480	WA0357	CTG			SH.CALC	17		.58		.03	.05	9
10510	WA0358	CTG			SH.CALC	13		.62		.03	.11	18
10570	WA0359	CTG			SH.CALC	12		.66		.03	.05	8
10600	WA0360	CTG			SH.CALC	11		.66		.06	.10	15
10630	WA0361	CTG			SH	0		.65		.08	.11	17
10660	WA0362	CTG			SH	10		.65		.02	.04	6
10690	WA0363	CTG			SH	9	C(M),HE-W(S)	.72		.05	.01	1
10720	WA0364	CTG			SH.CALC	11		.71		.05	.12	17

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
9200	.24		7												
9230	.58		30												
9260	.15		6								2+	1.29			
9290	.48		21												
9320	.26		8												
9350	.43		16												
9380	.23		6												
9410	.29		25												
9440	.83		12												
9470	.72		46												
9500	.92		44												
9530	.67		34												
9560	.50		18												
9590	0.00		0								2+	1.07			
9620	.83		53												
9650	.44		17												
9680	.55		29												
9710	1.00		112												
9740	.50		11												
9800	.21		9												
9830	.56		19												
9835															
9860	.75		35												
9890	.44		12								2+	1.14			
9920	.29		15												
9950	.33		7												
9980	.80		58												
10010	.76		32												
10030	.25		4												
10040															
10070															
10090															
10120	.79		30												
10150	.27		28												
10185															
10270	.36		13								2+	1.21			
10300	.44		15												
10360	.38		10												
10390	.39		12												
10420	.60		10												
10450	.27		6												
10480	.38		5												
10510	.21		5												
10570	.38		5												
10600	.38		9												
10630	.42		12												
10660	.33		3												
10690	.83		7								2+	1.47			
10720	.29		7												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
12670	WA2592	CTG										
12700	WA2593	CTG			LST,ARG	81	AM(M),HE-W-C(T)	.88		.12	.07	8
12730	WA2594	CTG										
12760	WA2595	CTG										
12790	WA2596	CTG			LST	92		.72		.17	.09	12
12820	WA2597	CTG										
12840	XA2597		ORD	MCLI	FORM.TOP							
12850	WA2598	CTG										
12880	WA2599	CTG			LST	91	AM(M),HE-W-C(T)	.55		.13	.31	56
12910	WA2600	CTG										
12940	WA2601	CTG										
12970	WA2602	CTG			LST	93		.28		.19	.28	100
13000	WA2603	CTG										
13030	WA2604	CTG										
13060	WA2605	CTG			LST	91	AM(M),HE-W-C(T)	.80		.15	.24	30
13090	WA2606	CTG										
13120	WA2607	CTG										
13140	XA2607		ORD	OLCK	FORM.TOP							
13150	WA2608	CTG			LST,ARG	85	AM(M),HE(S)	1.34		.57	.82	61
13180	WA2609	CTG										
13210	WA2610	CTG										
13240	WA2611	CTG			LST,ARG	83		.69		.22	.22	32
13270	WA2612	CTG										
13300	WA2613	CTG										
13330	WA2614	CTG			LST,ARG	82		.22		.15	.04	18
13360	WA2615	CTG										
13390	WA2616	CTG										
13420	WA2617	CTG			LST,V.ARG	66	AM-C(M)	.69		.43	.34	49
13450	WA2618	CTG										
13480	WA2619	CTG										
13510	WA2620	CTG			SH,V.CALC	46		.30		.13	.08	27
13540	WA2621	CTG										
13570	WA2622	CTG										
13600	WA2623	CTG			LST,V.ARG	64		.32		.16	.10	31
13630	WA2624	CTG										
13660	WA2625	CTG										
13690	WA2626	CTG			LST,V.ARG	63		.09		.02	.01	11
13705	XA2627		ORD	JOIN	FORM.TOP							
13720	WA2627	CTG										
13750	WA2628	CTG										
13780	WA2960	CTG			LST,ARG.	81		.15		.72	.06	40
13798	XA2960		ORD	ARBK	FORM.TOP							
13810	WA2961	CTG										
13840	WA2962	CTG										
13870	WA2963	CTG			LST,ARG.	90		.09		.07	0.00	0
13900	WA2964	CTG										
13930	WA2965	CTG										
13960	WA2966	CTG			LST,ARG.	85		.09		.38	.01	11
13990	WA2967	CTG										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
12670															
12700	.63		14								3-				
12730															
12760															
12790	.65		24												
12820															
12840															
12850															
12880	.30		24								3-				
12910															
12940															
12970	.40		68												
13000															
13030															
13060	.38		19								3-				
13090															
13120															
13140															
13150	.41		43								3-				
13180															
13210															
13240	.50		32												
13270															
13300															
13330	.79		68												
13360															
13390															
13420	.56		62								3				
13450															
13480															
13510	.62		43												
13540															
13570															
13600	.62		50												
13630															
13660															
13690	.67		22												
13705															
13720															
13750															
13780	.92		480												
13798															
13810															
13840															
13870	1.00		78												
13900															
13930															
13960	.97		422												
13990															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
14020	WA2968	CTG										
14050	WA2969	CTG			LST,ARG.	89		.06		.09	0.00	0
14080	WA2970	CTG										
14110	WA2971	CTG										
14140	WA2972	CTG			LST,ARG.	89		.06		.21	.01	17
14170	WA2973	CTG										
14200	WA2974	CTG										
14230	WA2975	CTG			LST,ARG.	90		.04		.03	0.00	0
14260	WA2976	CTG										
14290	WA2977	CTG										
14320	WA2978	CTG			LST	92		.07		.11	.04	57
14350	WA2979	CTG										
14380	WA2980	CTG										
14410	WA2981	CTG			LST	94		.18		.06	.02	11
14440	WA2982	CTG										
14470	WA2983	CTG										
[illegible]	[illegible]2984	CTG			LST	97		.17		.07	0.00	0
[illegible]30	WA2985	CTG			LST	95		.10		.04	.06	60
[illegible]540	XA2985	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
14020															
14050	1.00		150												
14080															
14110															
14140	.95		350												
14170															
14200															
14230	1.00		75												
14260															
14290															
14320	.73		157												
14350															
14380															
14410	.75		33												
14440															
14470															
14500	1.00		41												
14530	.40		40												
14540															

OPEN FILE 5-96

EXPLORATION BRIEFS
&
TECHNICAL MEMORANDA

PT 3

PT 3

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: E. Luttrell
SPC Mid-Continent Division
Dallas

December 20, 1982

From: Petroleum Geochemistry Group
Warrensville

PGW/121682/RB/2-5

Subject: Geochemical Characterization of Isom Springs Arkansas Novaculite Produced Petroleums -- Report PGW/TM 078.

Herewith for your retention are two (2) copies (one for D. May) of the subject report. This item forms an interesting sequel to TM 065 in which the source potential of Paleozoic sediments penetrated in the #3 Victor well were discussed.

The three Isom Spring Novaculite oils showed a strong carbon isotopic generic co-identity despite some minor quality variations. All three petroleums were of high API gravity and paraffinic nature and as such were probably generated under optimum to advanced oil mature conditions. Although showing some isotopic similarities, extracts from the organic rich Arkansas Novaculite and Missouri Mountain intervals in #3 Victor showed typical indications of immature/low maturity and could not be correlated with the produced oils. This tends to strengthen our confidence that the reservoired oils occur considerably out of structural context with their source(s). A provenance "off-structure", at some considerable extra depth of burial seems inevitable. Listric fault controlled migration completes the source-reservoir combination.

We have been unable to be unequivocal about the exact provenance of these petroleums, be it from the Arkansas Novaculite and Missouri Mountain as opposed to the older Bigfork and Womble Fms. However, current technology in use in the group has provided convincing circumstantial evidence that the former sediments are at least potential sources. We see an important future for the carbon isotope profile - kerogen pyrolysis carbon isotope oil-source correlation technique.

R. Burwood

R. Burwood

RB:bes
Enclosures:2

Page 1
part 3

cc: H. G. Bassett
J. G. Grasselli
R. J. Drozd
H. I. Halpern
F. A. Marsek
R. A. Sedivy
PGW Files (0), (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: D. May
SPC Mid-Continent Division
Dallas

November 16, 1982

PGW/111282/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No: PGW 81-58

Classification: RESTRICTED

Technical Memorandum (PGW/TM 078) — Geochemical Characterization of Oils and Total Soluble Extracts Recovered from the #1 Jones, #1 O'Steen, and #3 Victor Wells, Isom Springs Field, Marshall County, Oklahoma.

Summary: Three samples of petroleum produced from the Devonian Arkansas Novaculite in the Isom Springs Field, Oklahoma, were characterized as relatively high API gravity, thermally mature, highly paraffinic crude oils. Carbon isotopic profiling indicated that the oils originated from a common source or source suite. Whole oil isotopic results were consistent with Arkansas Novaculite and Missouri Mountain kerogen pyrolysate values obtained in a previous study. Variations in the API gravity, hydrocarbon composition, and isotopic composition of the oils were attributed to differences in migration histories.

Eight total soluble extracts (TSE's) were obtained from Arkansas Novaculite, Stanley, and Missouri Mountain sediments from the #3 Victor well. Characteristic to these samples were high abundances of polar compounds and asphaltenes. Isotopic type curves demonstrated a wide range of $\delta^{13}C$ enrichments in all hydrocarbon groups. $\delta^{13}C$ values for the TSE's were comparable to, or significantly heavier than, values for corresponding fractions of the produced oils. The physical and isotopic results were consistent with low thermal maturity data previously reported, but may reflect certain biases due to the extraction process.

1. INTRODUCTION

The results of a comprehensive investigation of the source rock potential of Paleozoic Ouachita Facies sediments, as represented in the Westheimer - Neustadt #3 Victor well, were summarized in PGW/TM 065 (1). Good and Good to Excellent commercial mixed oil and gas source potential were reported for the Devonian Arkansas Novaculite and Silurian Missouri Mountain formations, noting, however, the low thermal maturity levels of the sediments. Comparison of kerogen - kerogen pyrolysate, total soluble extract, and limited petroleum stable carbon isotopic data identified these sediments, presumably at higher maturity outside the Isom Springs Field, as a possible source for oils reservoired in the Novaculite.

This report addresses the results of a characterization of three Isom Springs oil samples produced from the #1 Jones, #1 O'Steen, and #3 Victor wells, Sec. 2, T8SR5E, Marshall County, Oklahoma. Also incorporated in this report are the results of the characterization of total soluble extracts (TSE's) from sediments penetrated in the #3 Victor well.

2. MATERIALS AND METHODS

2.1 Materials

Samples of Arkansas Novaculite reservoired oil, produced from the #1 O'Steen (3,356 ft. prod. depth), #3 Victor (4,900 ft.), and #1 Jones (4,000 ft.) wells were received and given PGW designations HCB-090, HCB-091, and HCB-092, respectively. The structural juxtaposition of the latter two producing horizons is given in Figure 13. TSE's from the #3 Victor well were extracted from Arkansas Novaculite, Missouri Mountain, and Stanley formation sediments, as indicated in Table 1.

2.2 Methods

The oil samples and TSE's were characterized using the following standardized PGW techniques: Gravity Determinations (API and Sp. Gr.), Asphaltene Content (C_5 insolubles), Simulated Distillation, Light Hydrocarbon Range Analysis (distillate fraction BPT < 200^oC), Hydrocarbon Type Analysis (BPT > 200^oC), Saturate Alkane Analysis, and Stable Carbon Isotope Analysis. Due to the limited quantities available, no Simulated Distillation or Light Hydrocarbon Gas Analyses were performed on the TSE's, and complete isotopic profiles were obtained for four TSE's only.

3. RESULTS AND CONCLUSIONS

Results of the analyses were compiled in Tables 2-8 and Figures 1-12.

3.1 A significant fraction of each oil ($\geq$ 19%) consisted of low boiling (< 200°C) light hydrocarbons. Sample HCB-091, from the #3 Victor well, is particularly noteworthy in this regard, containing 42% light hydrocarbons. The results of Simulated Distillation and Light Hydrocarbon Gas Chromatography are shown in Tables 2-4 and Figures 1-3.

3.2 Hydrocarbon Type Analyses (Tables 2-4) indicated that the oils contained a large proportion of saturates (70% - 79%). Aromatic and polar compounds were equally abundant (13% - 15%) in samples HCB-090 and HCB-092. Polar compounds were particularly lacking in sample HCB-091. All of the oil samples contained < 1% asphaltenes.

3.3 The TSE's contained a much smaller proportion of saturates (21% - 27%), relative to the produced oils. Aromatic contents were comparable (12% - 16%) to those of the oils, however, the polar compounds and asphaltenes were in much greater abundance in the extracts (33% - 43% and 16% - 31%, respectively). (See Tables 5-8).

3.4 Saturate Alkane Analyses of the oils (Figures 4-6) demonstrated that the saturate fractions were largely normal- and iso- alkanes, with only small napthene components present. The dominance of nC_{10} to nC_{20} alkanes, supported by Carbon Preference Index (CPI) values of about 1.0, indicated that these oils were thermally mature.

3.5 The comparatively smaller saturate alkane percentages together with the dominance of higher molecular weight n-alkanes, the presence of pronounced napthenic "humps" (see Figures 7-10), and the abundance of asphaltenes observed in the #3 Victor TSE's strongly suggested that these hydrocarbons were of low maturity.

3.6 The very high polars and asphaltenes content of the TSE's may in part be an artifact of the extraction process. PGW experience has shown that the extraction of hyrocarbons from shales in the laboratory may remove components from the sediments that would not appear in an oil produced from the same source via natural maturation - expulsion processes.

3.7 Whole oil and hydrocarbon fraction stable carbon isotopic data, expressed in "delta" notation, appear in Tables 1-7. The results, plotted as a series of isotopic type curves, are shown in Figures 11 and 12. The curves for the #1 O'Steen and #1 Jones oils were virtually identical, as were the whole oil, aromatic, polar, and asphaltene values for all three samples (Figure 11). The type curve for the #3 Victor oil indicated a slightly greater abundance of isotopically light components in the saturate and distillate (BPT < 200°C) fractions of this oil. The isotopic similarity of these three oils strongly suggested that they originated from a common source kerogen assemblage or suite of assemblages, as discussed in PGW/TM 065 (1).

3.8 Available isotopic data for the TSE's were presented in Figure 12. Considerable scatter was observed for both whole TSE and hydrocarbon fraction $\delta^{13}C$ values for extracts from each formation; most of the results showing some $\delta^{13}C$ enrichment, relative to corresponding fractions of the produced oil. This was particularly true of the Stanley Fm. extracts. However, a group of Arkansas Novaculite and Missouri Mountain extracts showed a superficial resemblance to the produced oils (125, 128, 129, 130).

3.9 The relationships described in 3.8 (and 3.5) above are consistent with the low maturity observed for sediments in the Isom Springs area, and support the conclusion that oils produced from the #1 O'Steen, #3 Victor, and #1 Jones wells were not locally sourced.

3.10 The oil recovered from the #3 Victor well, sample HCB-091, was clearly distinguished from the #1 Jones and #1 O'Steen oils. It was a higher API gravity crude, containing a significantly higher proportion of light and saturate hydrocabons that were enriched in the ^{12}C isotope. It is probable that these characteristics reflect the influence of different migration histories for initially homogeneous oils. Additionally, generation under a more forcing thermal regime involving fault controlled migration from greater depths, may be operative.

3.11 The observations noted above and in PGW/TM 065 (1) indicated that, at sufficient maturity, Arkansas Novaculite and/or Missouri Mountain sediments might provide a suitable source for liquid hydrocarbons similar to those reservoired within the Isom Springs field. Verification of this hypothesis would require an examination of maturity levels in potential source and drainage areas adjacent to the Isom Springs field.

3.12 The Ordovician Polk Creek and Womble formations have also been proposed as possible sources for the Isom Springs oils; their role in the generation of these hydrocarbons is problematical.

4. REFERENCES

1. Halpern, H.I. and F. Marsek — 1982 — Geochemical Source Rock Evaluation for the #3 Victor Well, a Producer in the Isom Springs

Field, Marshall County,
Oklahoma.
Report PGW/TM 065.

H. I. Halpern

F. A. Marsek

R. A. Sedivy

/bes

Enclosures: Tables 1-8
Figures 1-13

cc: H. G. Bassett
J. G. Grasselli (Summary Only)
R. Burwood
R. J. Drozd
E. Luttrell
T. Uphoff
PGW Files (0), (2-5)

Work by: R. Cavalier
H. Halpern
J. Reymander
R. Sedivy
E. Tausch

TABLE 1

#3 Victor Total Soluble Extract Data

HCB #	DEPTH INTERVAL, FT.	FORMATION
124	880 - 1030	Stanley
125	1034 - 1660	Ark. Novaculite
126	1684 - 3560	Mo. Mountain
127	3598 - 4400	Ark. Novaculite
128	4420 - 4760	Ark. Novaculite
129	4764 - 4820	Mo. Mountain
130	4875 - 5470	Ark. Novaculite
131	5490 - 6192	Stanley

FILES

090 STREN

091 VICTOR

092 JONES

TABLE 5

PAGE 1 09.18.04. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#3 VICTOR	SAMPLE ID:HCB125	FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:TSE	AGE/EPOCH:DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 1100	
PGW JOB:8157	REPORT :	DATA BASE:PGW	

INSPECTION DATA

SPECIFIC GRAV.	:	
API GRAV.	:	
SULFUR	%WT:	
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	16.30
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	24.00	
AROMATICS	%WT:	15.90	
POLARS	%WT:	43.80	
ASPHALTENE(2)	%WT:	16.30	
N-ALKANE	%WT:	27.27	
N-ALKANE CPI	:	1.01	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.08	
ACYCLIC C16	%WT:	.49	
ACYCLIC C18	%WT:	1.81	
PRISTANE	%WT:	2.29	
PHYTANE	%WT:	1.87	
PRISTANE/PHYTANE	:	1.22	
PRISTANE/N-C17	:	.58	
PHYTANE/N-C18	:	.62	
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-30.20	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-30.17	%.
D-13 C(AROMATICS)	:	-30.15	%.
D-13 C(POLARS)	:	-30.29	%.
D-13 C(ASPHALTENES)	:	-30.20	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

% WT SATURATES		
C10	:	
C11	:	
C12	:	
C13	:	.090
C14	:	.770
C15	:	2.380
C16	:	3.880
C17	:	3.930
C18	:	3.040
C19	:	2.580
C20	:	1.620
C21	:	1.220
C22	:	1.180
C23	:	.990
C24	:	.830
C25	:	.860
C26	:	.900
C27	:	.680
C28	:	.560
C29	:	.520
C30	:	.680
C31	:	.260
C32	:	.110
C33	:	.210
C34	:	
C35	:	
C36	:	

PENTACYCLANE CONTENT

NORMALISED DIST		
H	:	
B	:	
D	:	
G	:	
N	:	
O	:	
U	:	
V	:	
ALPHA	:	
BETA	:	
GAMA	:	
DELTA	:	
EPSILON	:	
ZETA	:	

STERANE CONTENT

NORMALISED DIST		
1	:	
2	:	
3	:	
4	:	
5	:	
6	:	
7	:	
8	:	
9	:	
10	:	
11	:	
12	:	
13	:	
14	:	
15	:	
16	:	
17	:	
18	:	
19	:	

TABLE 6

PAGE 1 09.18.05. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#3 VICTOR	SAMPLE ID:HCB126	FORMATION:MOMT
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:TSE	AGE/EPOCH:SIL
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 2420	
PGW JOB:8157	REPORT :	DATA BASE:PGW	

INSPECTION DATA

SPECIFIC GRAV.	:	
API GRAV.	:	
SULFUR	%WT:	
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	24.20
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	25.70	
AROMATICS	%WT:	14.30	
POLARS	%WT:	35.70	
ASPHALTENE(2)	%WT:	24.20	
N-ALKANE	%WT:	30.66	
N-ALKANE CPI	:	1.05	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	0.00	
ACYCLIC C16	%WT:	.09	
ACYCLIC C18	%WT:	1.09	
PRISTANE	%WT:	1.34	
PHYTANE	%WT:	1.25	
PRISTANE/PHYTANE	:	1.07	
PRISTANE/N-C17	:	.31	
PHYTANE/N-C18	:	.31	
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-29.25	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-29.38	%.
D-13 C(AROMATICS)	:	-29.43	%.
D-13 C(POLARS)	:	-29.47	%.
D-13 C(ASPHALTENES)	:	-28.56	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

% WT SATURATES		
C10	:	
C11	:	
C12	:	
C13	:	
C14	:	.170
C15	:	2.080
C16	:	3.770
C17	:	4.370
C18	:	3.990
C19	:	3.740
C20	:	2.340
C21	:	1.800
C22	:	1.750
C23	:	1.350
C24	:	1.220
C25	:	1.160
C26	:	.900
C27	:	.650
C28	:	.670
C29	:	.450
C30	:	.260
C31	:	
C32	:	
C33	:	
C34	:	
C35	:	
C36	:	

PENTACYCLANE CONTENT

NORMALISED DIST		
H	:	
B	:	
D	:	
G	:	
N	:	
O	:	
U	:	
V	:	
ALPHA	:	
BETA	:	
GAMA	:	
DELTA	:	
EPSILON	:	
ZETA	:	

STERANE CONTENT

NORMALISED DIST		
1	:	
2	:	
3	:	
4	:	
5	:	
6	:	
7	:	
8	:	
9	:	
10	:	
11	:	
12	:	
13	:	
14	:	
15	:	
16	:	
17	:	
18	:	
19	:	

TABLE 7

 09.19.35. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#3 VICTOR	SAMPLE ID:HCB127	FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:TSE	AGE/EPOCH:DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 3740	
PGW JOB:8157	REPORT :	DATA BASE:PGW	

INSPECTION DATA

SPECIFIC GRAV.	:	
API GRAV.	:	
SULFUR	%WT:	
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	24.30
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE		
BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	26.80	
AROMATICS	%WT:	12.40	
POLARS	%WT:	36.50	
ASPHALTENE(2)	%WT:	24.30	
N-ALKANE	%WT:	83.28	
N-ALKANE CPI	:	1.08	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	0.00	
ACYCLIC C16	%WT:	.13	
ACYCLIC C18	%WT:	2.03	
PRISTANE	%WT:	2.81	
PHYTANE	%WT:	3.85	
PRISTANE/PHYTANE	:		
PRISTANE/N-C17	:		
PHYTANE/N-C18	:		
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-29.29	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-29.07	%.
D-13 C(AROMATICS)	:	-29.91	%.
D-13 C(POLARS)	:	-29.35	%.
D-13 C(ASPHALTENES)		-28.89	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

% WT SATURATES	
C10 :	
C11 :	
C12 :	
C13 :	
C14 :	.250
C15 :	4.910
C16 :	10.490
C17 :	10.040
C18 :	9.150
C19 :	8.160
C20 :	5.580
C21 :	5.010
C22 :	4.660
C23 :	4.510
C24 :	4.620
C25 :	4.540
C26 :	3.300
C27 :	2.580
C28 :	1.870
C29 :	1.620
C30 :	1.330
C31 :	.670
C32 :	
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT

NORMALISED DIST	
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT

NORMALISED DIST	
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

TABLE 8

 09.21.09. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#3 VICTOR	SAMPLE ID:HCB130 FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:TSE AGE/EPOCH:DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 4880
PGW JOB:8157	REPORT :	DATA BASE:PGW

INSPECTION DATA

SPECIFIC GRAV.	:	
API GRAV.	:	
SULFUR	%WT:	
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	31.20
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	21.30	
AROMATICS	%WT:	13.90	
POLARS	%WT:	33.60	
ASPHALTENE(2)	%WT:	31.20	
N-ALKANE	%WT:	39.48	
N-ALKANE CPI	:	.98	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	0.00	
ACYCLIC C16	%WT:	.16	
ACYCLIC C18	%WT:	1.24	
PRISTANE	%WT:	1.46	
PHYTANE	%WT:	1.21	
PRISTANE/PHYTANE	:	1.21	
PRISTANE/N-C17	:	.33	
PHYTANE/N-C18	:	.38	
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-29.71	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-29.60	%.
D-13 C(AROMATICS)	:	-30.08	%.
D-13 C(POLARS)	:	-29.78	%.
D-13 C(ASPHALTENES)	:	-29.22	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT % WT SATURATES

C10	:	
C11	:	
C12	:	
C13	:	
C14	:	.390
C15	:	4.000
C16	:	5.460
C17	:	4.400
C18	:	3.140
C19	:	3.500
C20	:	2.400
C21	:	1.990
C22	:	2.160
C23	:	1.810
C24	:	1.790
C25	:	1.830
C26	:	1.770
C27	:	1.180
C28	:	1.210
C29	:	.990
C30	:	1.140
C31	:	.320
C32	:	
C33	:	
C34	:	
C35	:	
C36	:	

PENTACYCLANE CONTENT NORMALISED DIST

H	:
B	:
D	:
G	:
N	:
O	:
U	:
V	:
ALPHA	:
BETA	:
GAMA	:
DELTA	:
EPSILON	:
ZETA	:

STERANE CONTENT NORMALISED DIST

1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:
16	:
17	:
18	:
19	:

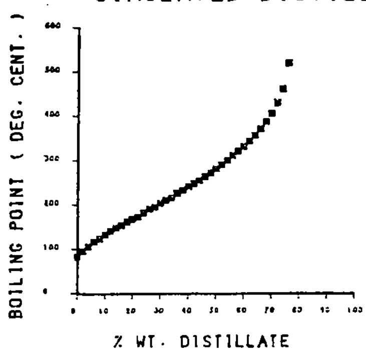
CONDITIONS FOR SATURATE HYDROCARBON
GAS CHROMATOGRAPH ANALYSIS

G.C.	- Varian 3700
Column	- Alltech WCOT 14, .25 mm I.D., .2µ film
Carrier	- Helium, 1ml/min., 8 P.S.I.G.
Detector	- F.I.D., 350°C
Temp. Program	- Initial 60°C, 4 min. hold
	- Program Rate of 7°C/min.
	- Final 270°C, 26 min. hold
Range	- 10^{-11} amps/mv
Solvent	- n-Hexane
Injector	- split 10:1
Attenuation	- 16
Injection Volume	- 2µl
Concentration	- 6 mg/ml
Analysis Time	- 54 min.

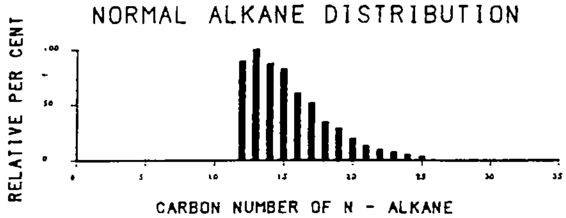
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

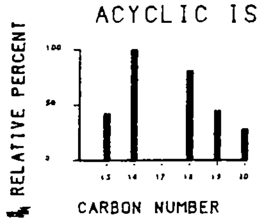
SIMULATED DISTILLATION



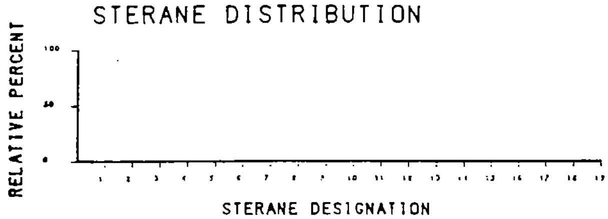
NORMAL ALKANE DISTRIBUTION



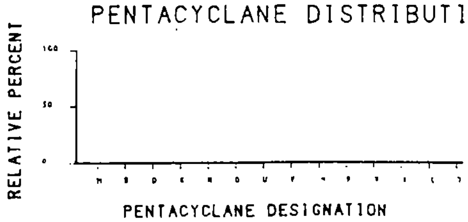
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



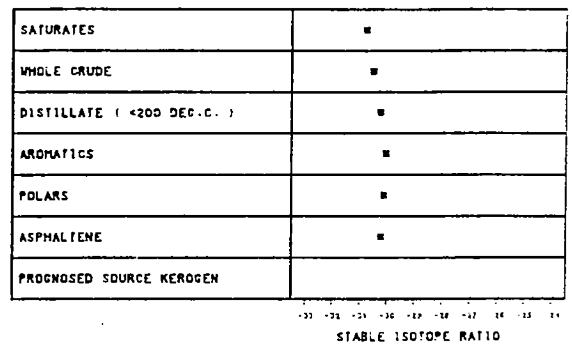
PENTACYCLANE DISTRIBUTION



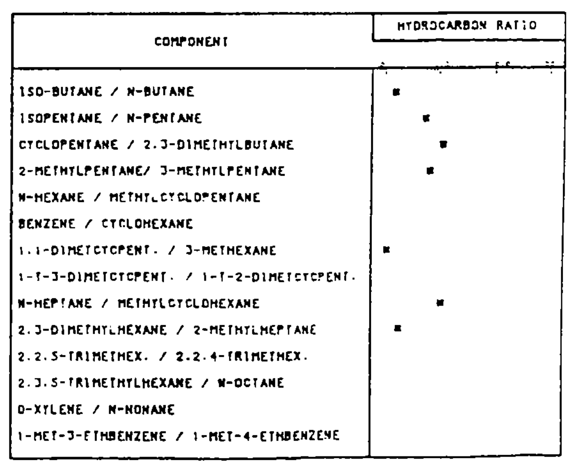
HYDROCARBON DATA

API GRAVITY	60 DEG. F.	48.10
SPECIFIC GRAVITY	60 DEG. F.	0.79
SULPHUR	% WT.	0.13
WAX	% WT.	
WAX M. PT.	DEG. C.	
ASPHALTENES	% WT.	0.38
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.33
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	79.00
AROMATICS	% WT.	12.40
POLARS	% WT.	7.80
N - ALKANE CPI	% WT.	1.16
N - ALKANE	% WT.	29.07
PRISTANE / PHYTANE RATIO		1.62
PRISTANE / N - C17		0.22
PHYTANE / N - C18		0.20
CARBON ISOTOPE RATIO C13 %		-30.50
SULPHUR ISOTOPE RATIO S34 %		
DEUTERIUM ISOTOPE RATIO D2 %		
NITROGEN ISOTOPE RATIO N15 %		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE



COUNTRY US STATE OK COUNTY MARSHALL LOCATION SECT. 'S5R5E WELL #3 VICTOR DEPTH 4900 SAMPLE TYPE OIL SAMPLE ID MC805 DATA BASE ORIGIN PCW	SOHIO PETROLEUM GEOCHEMISTRY GROUP WARRENSVILLE

FIGURE 2

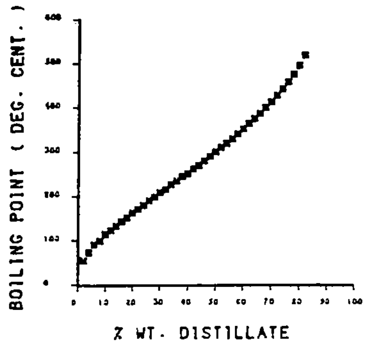
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

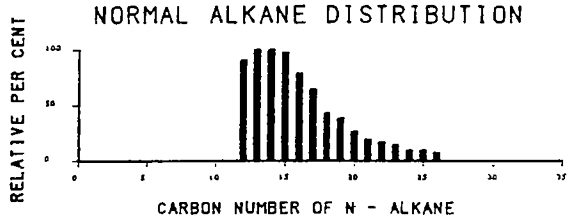
HYDROCARBON DATA

API GRAVITY	60 DEG. F.	39.90
SPECIFIC GRAVITY	60 DEG. F.	0.83
SULPHUR	% WT.	0.29
WAX	% WT.	
WAX M. PT.	DEG. C.	
ASPHALTENES	% WT.	0.66
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.45
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	71.10
AROMATICS	% WT.	15.00
POLARS	% WT.	13.00
N - ALKANE CPI	% WT.	1.04
N - ALKANE	% WT.	30.10
PRISTANE / PHYTANE RATIO		1.59
PRISTANE / N - C17		0.30
PHYTANE / N - C18		0.28
CARBON ISOTOPE RATIO C13 %		-30.29
SULPHUR ISOTOPE RATIO S34 %		17.20
DEUTERIUM ISOTOPE RATIO D2 %		
NITROGEN ISOTOPE RATIO N15 %		

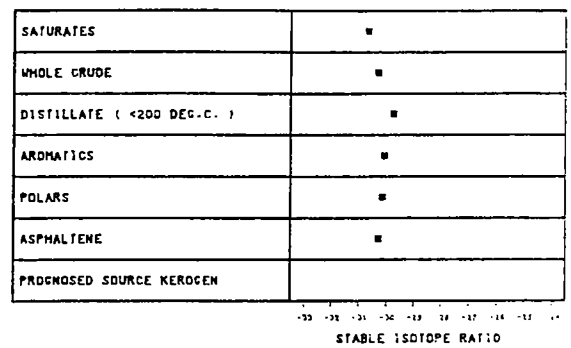
SIMULATED DISTILLATION



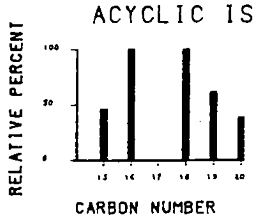
NORMAL ALKANE DISTRIBUTION



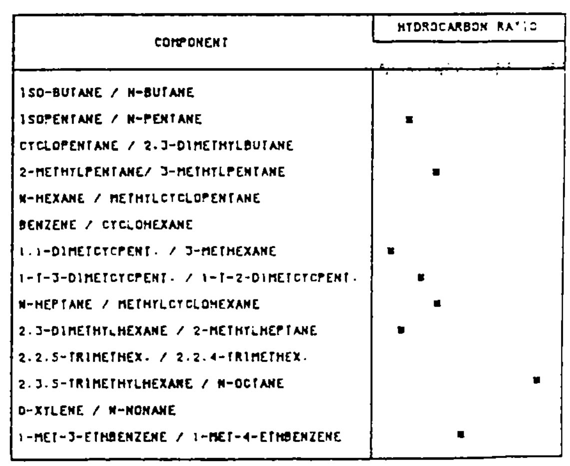
STABLE CARBON ISOTOPE PROFILE



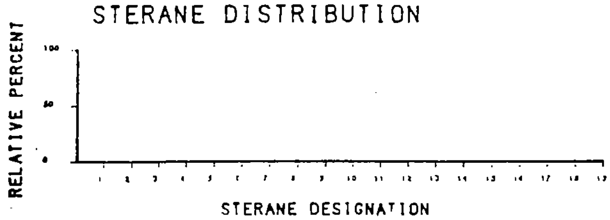
ACYCLIC ISOPRENOID DISTRIBUTION



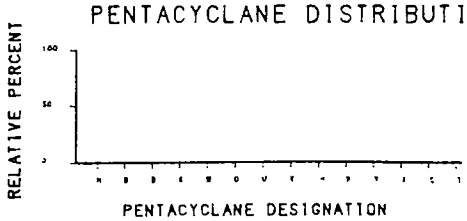
LIGHT HYDROCARBON PROFILE



STERANE DISTRIBUTION



PENTACYCLANE DISTRIBUTION



COUNTRY US
STATE OK
COUNTY MARSHALL
LOCATION
WELL #1
DEPTH
SAMPLE TYPE OIL
SAMPLE ID
DATA BASE ORIGIN

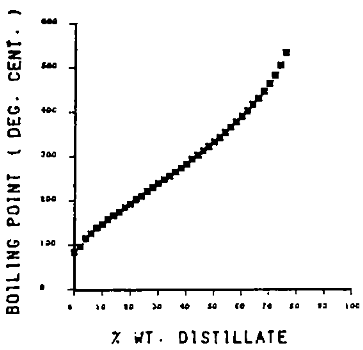
SOHIO
PETROLEUM GEOCHEMISTRY GROUP WARRENSVILLE

FIGURE 1

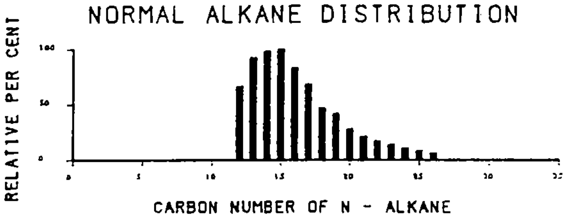
SUMMARY HYDROCARBON DATA LOG

PETROLEUM TYPE

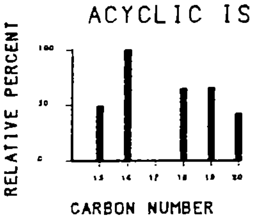
SIMULATED DISTILLATION



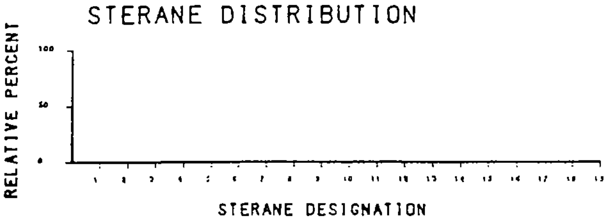
NORMAL ALKANE DISTRIBUTION



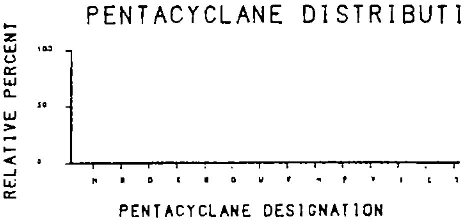
ACYCLIC ISOPRENOID DISTRIBUTION



STERANE DISTRIBUTION



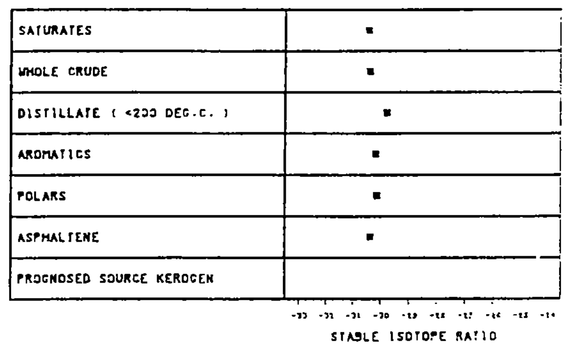
PENTACYCLANE DISTRIBUTION



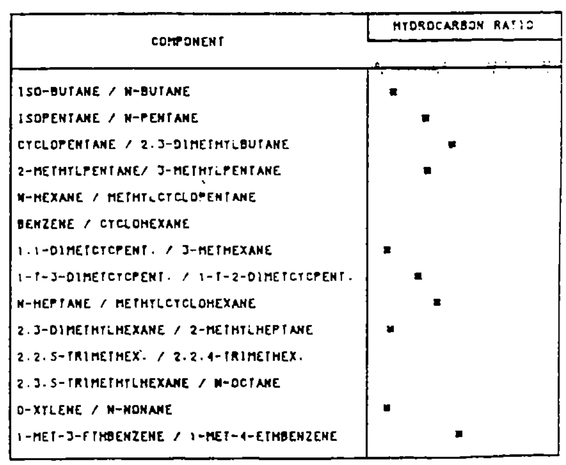
HYDROCARBON DATA

API GRAVITY	60 DEG. F.	40.70
SPECIFIC GRAVITY	60 DEG. F.	0.82
SULPHUR	% WT.	0.31
WAX	% WT.	
WAX M. PT.	DEG. C.	
ASPHALTENES	% WT.	0.44
NICKEL	PPM	0.00
VANADIUM	PPM	0.00
NICKEL / VANADIUM RATIO		0.40
NITROGEN	% WT.	
TYPE ANALYSIS		
SATURATES	% WT.	70.30
AROMATICS	% WT.	14.00
POLARS	% WT.	15.20
N - ALKANE CPI	% WT.	1.08
N - ALKANE	% WT.	32.90
PRISTANE / PHYTANE RATIO		1.56
PRISTANE / N - C17		0.31
PHYTANE / N - C18		0.29
CARBON ISOTOPE RATIO C13 %		-30.37
SULPHUR ISOTOPE RATIO S34 %		18.80
DEUTERIUM ISOTOPE RATIO D2 %		
NITROGEN ISOTOPE RATIO N15 %		

STABLE CARBON ISOTOPE PROFILE



LIGHT HYDROCARBON PROFILE



COUNTRY US STATE OK COUNTY MARSHALL LOCATION SEC21.T8SR5E WELL #1 JONES DEPTH 4000 SAMPLE TYPE OIL SAMPLE ID MC0093 DATA BASE ORIGIN PCW	SOHIO PETROLEUM GEOCHEMISTRY GROUP WARRENSVILLE

FIGURE 3

FIGURE 4

SATURATE ALKANE GAS CHROMATOGRAM

#1 O'Steen Oil (HCB 090)

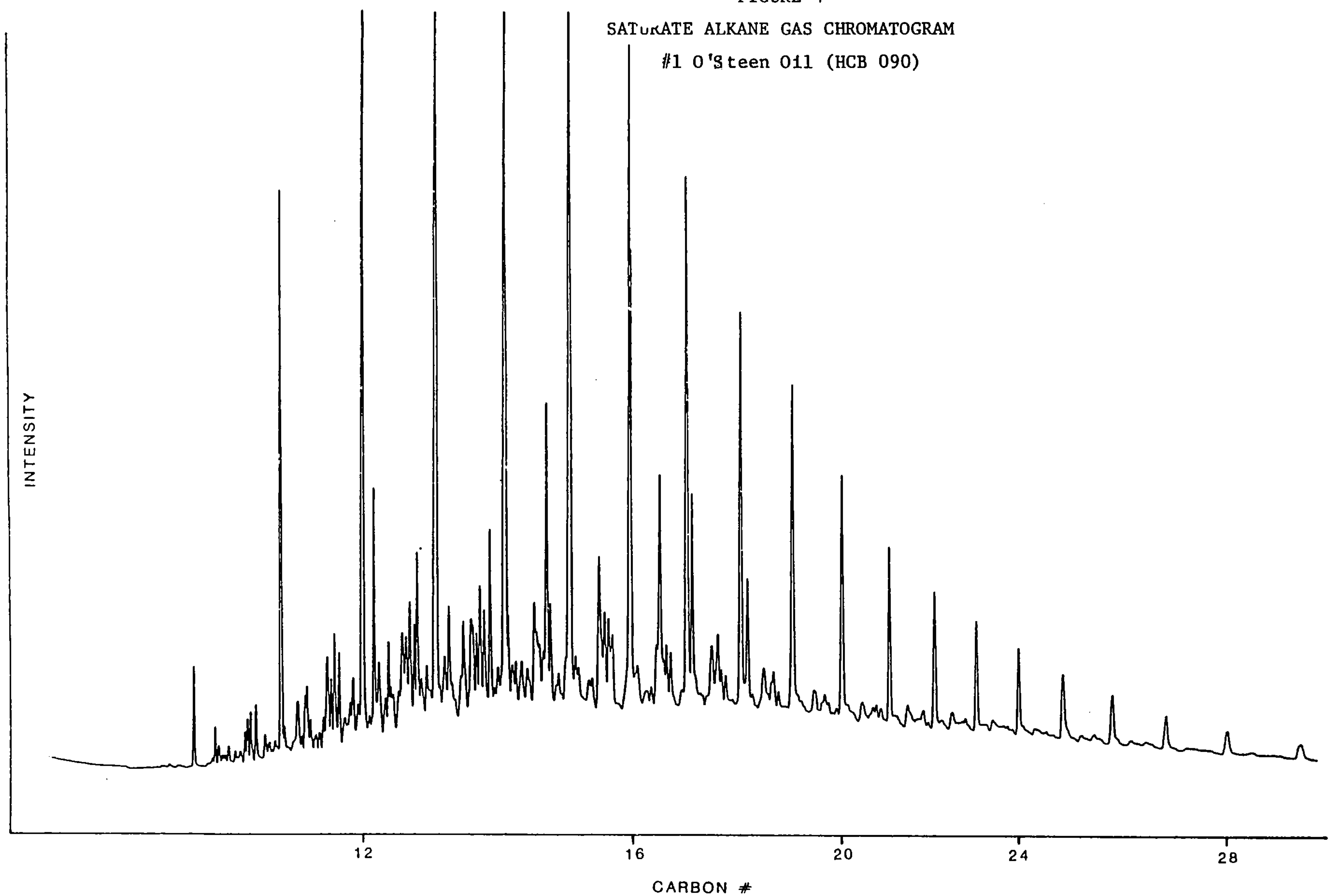


FIGURE 5

SATURATE ALKANE GAS CHROMATOGRAM

#3 Victor Oil (HCB 091)

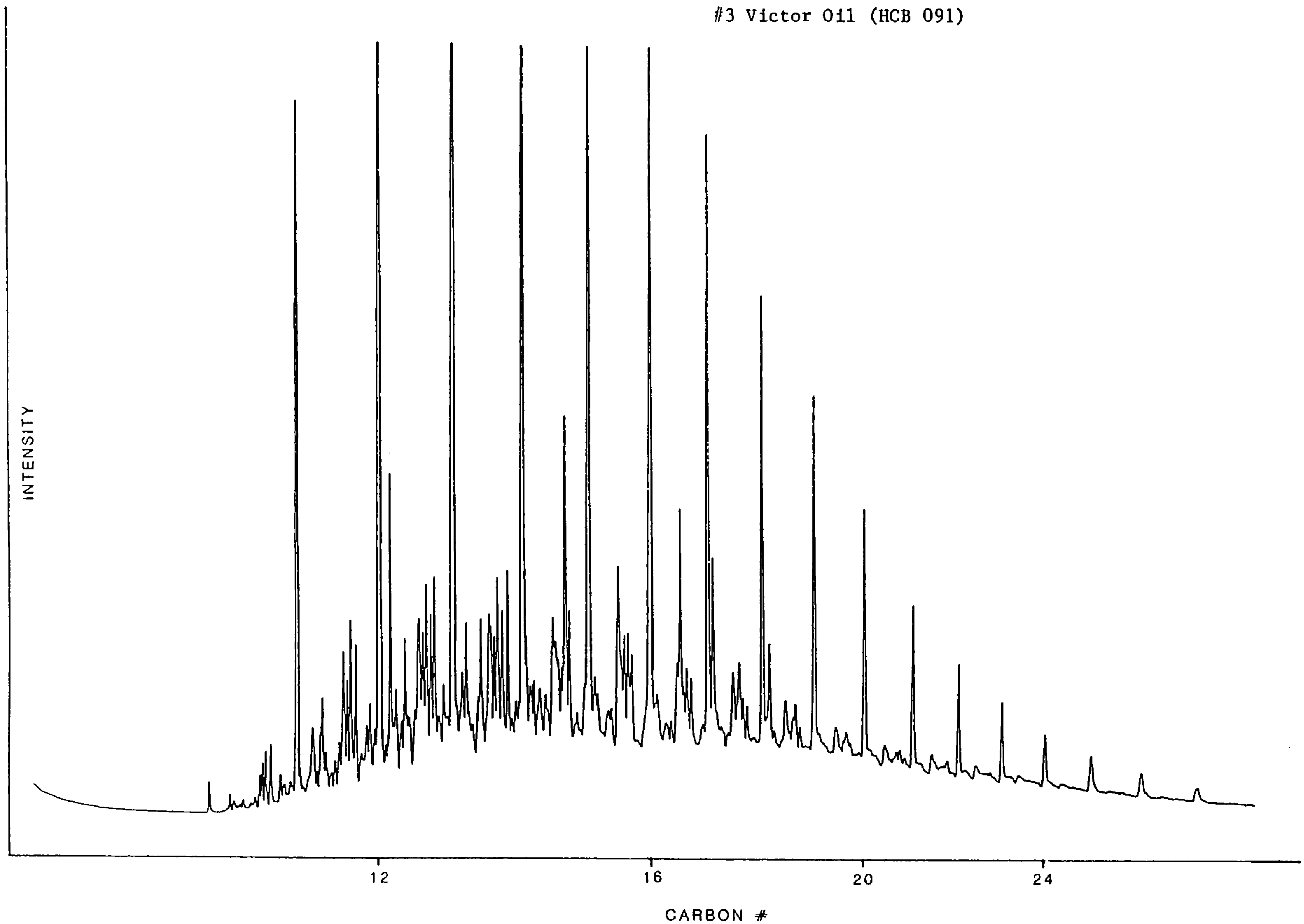


FIGURE 6

SATURATE ALKANE GAS CHROMATOGRAM

#1 Jones Oil (HCB 092)

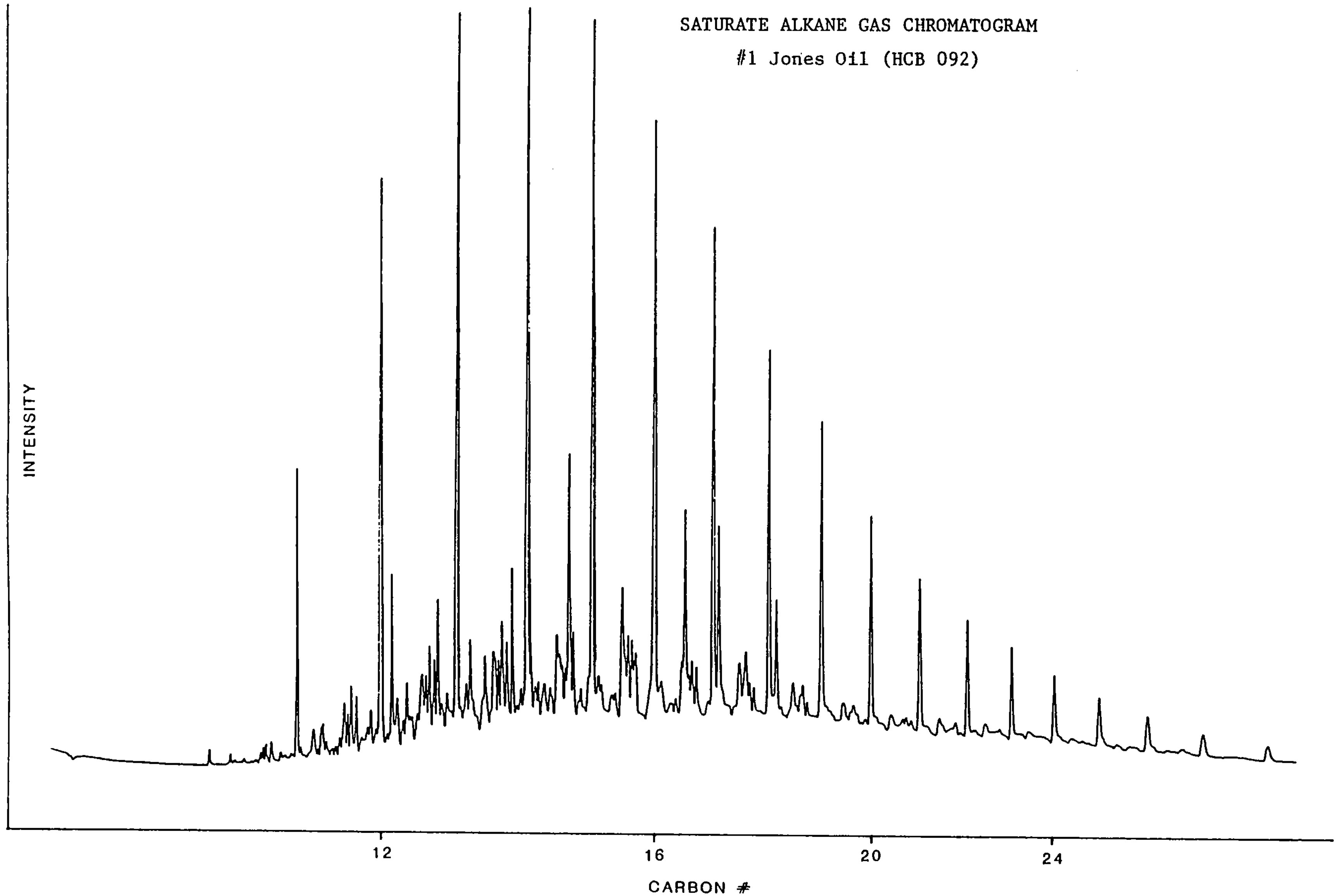


FIGURE 7

SATURATE ALKANE GAS CHROMATOGRAM

Arkansas Novaculite TSE (HCB 125)

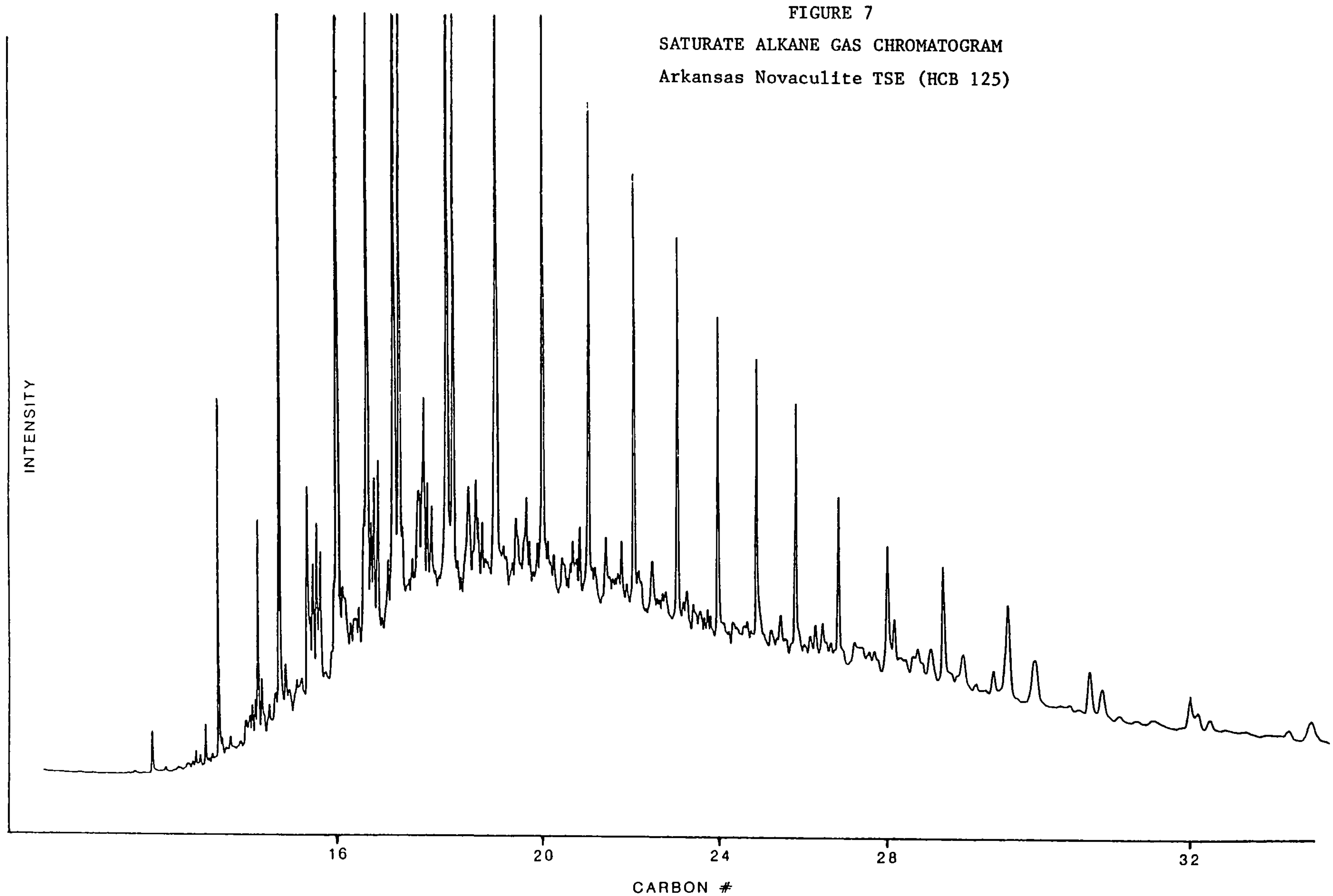
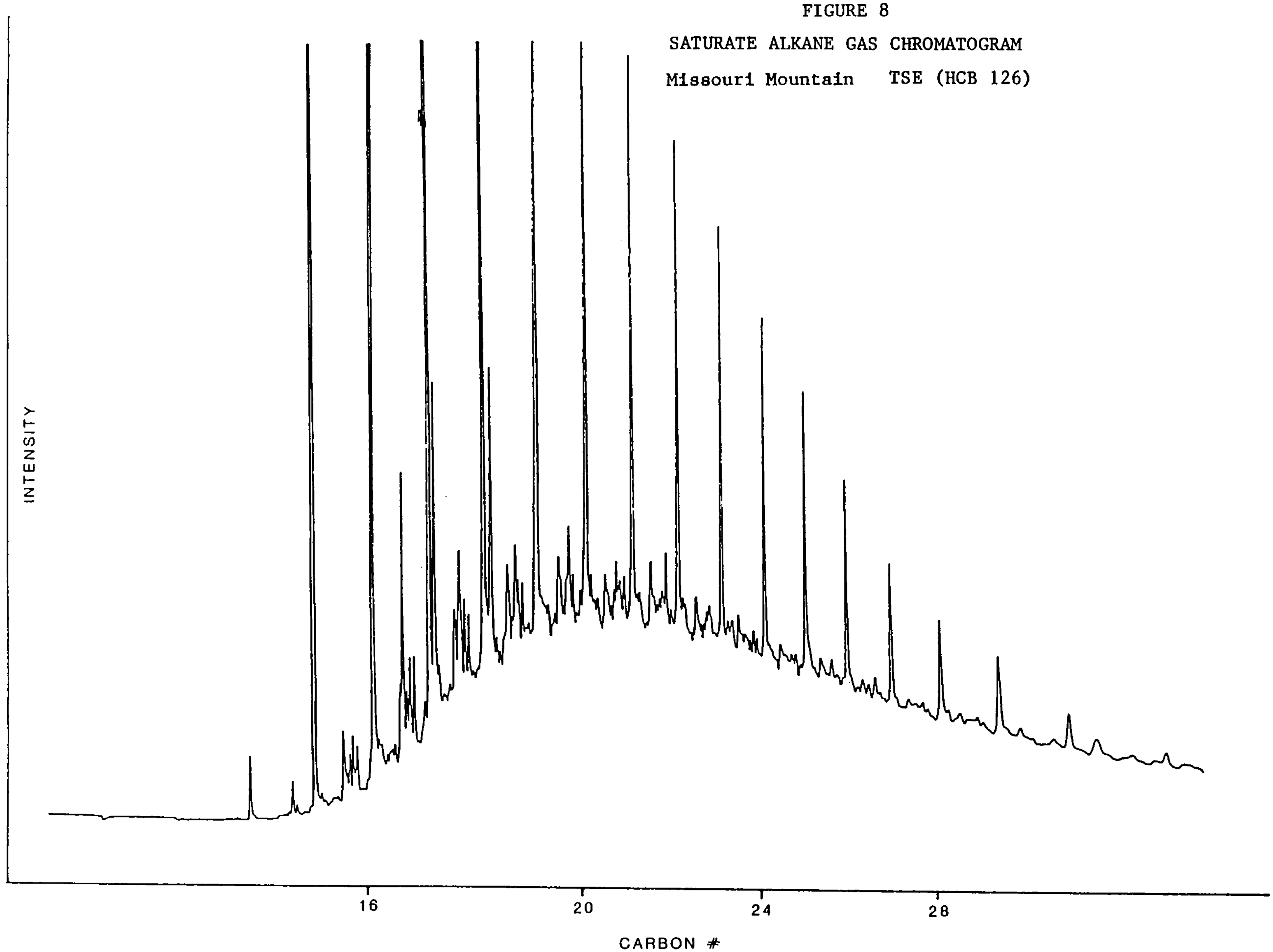


FIGURE 8

SATURATE ALKANE GAS CHROMATOGRAM

Missouri Mountain   TSE (HCB 126)



'URE 9

SATURATE ALKANE GAS CHROMATOGRAM

Arkansas Novaculite TSE (HCB 127)

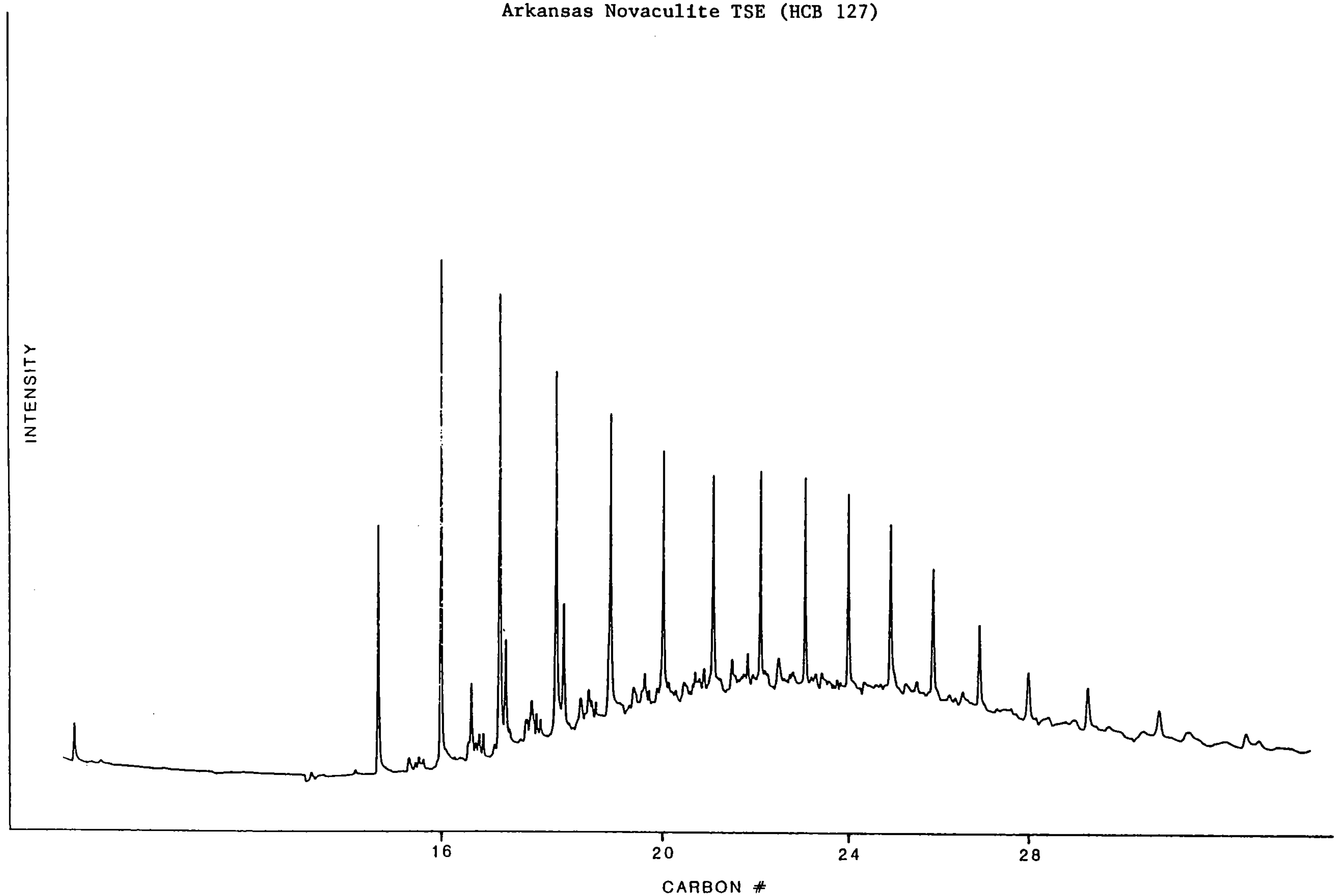
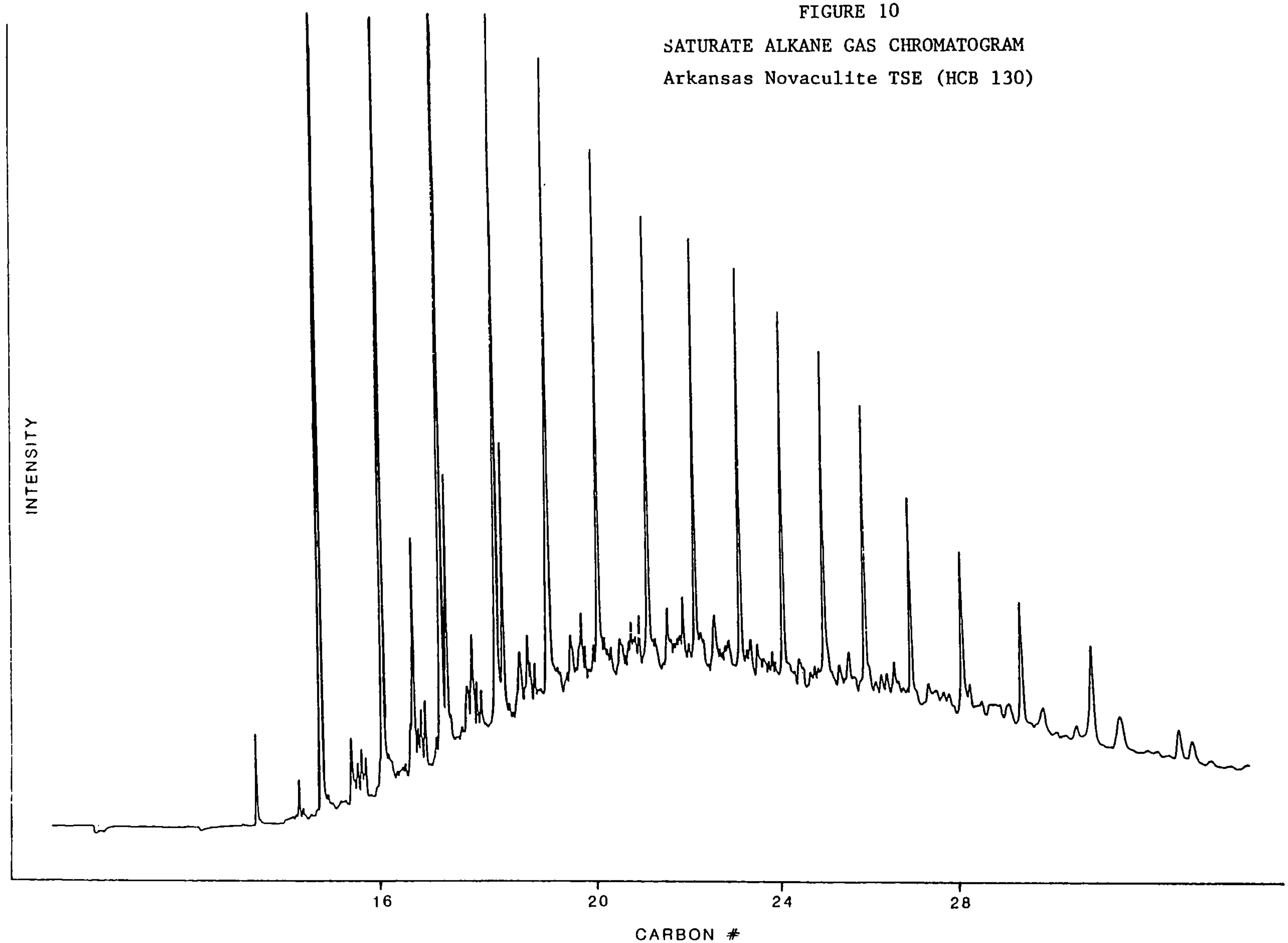


FIGURE 10

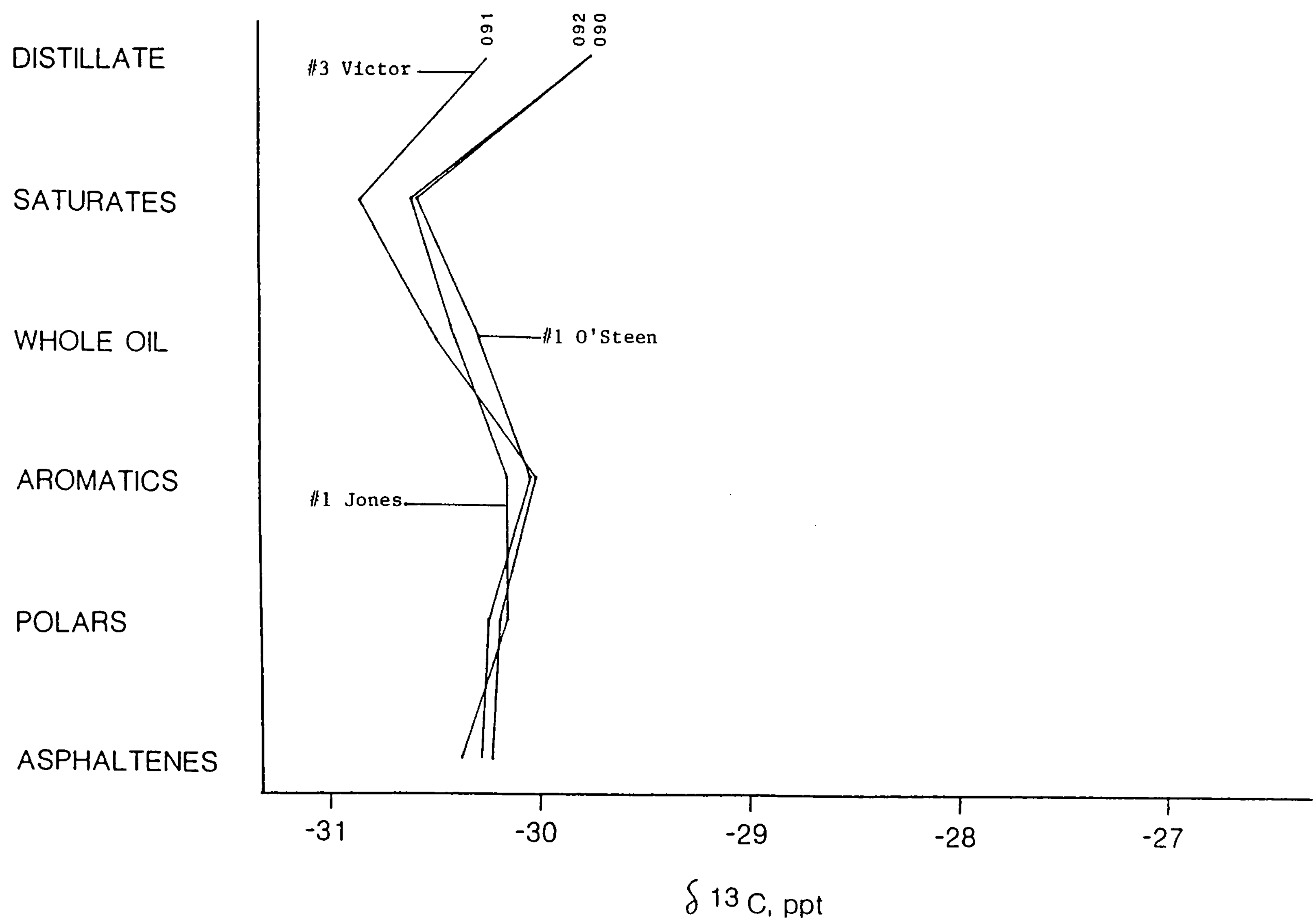
SATURATE ALKANE GAS CHROMATOGRAM

Arkansas Novaculite TSE (HCB 130)



F' 'RE 11

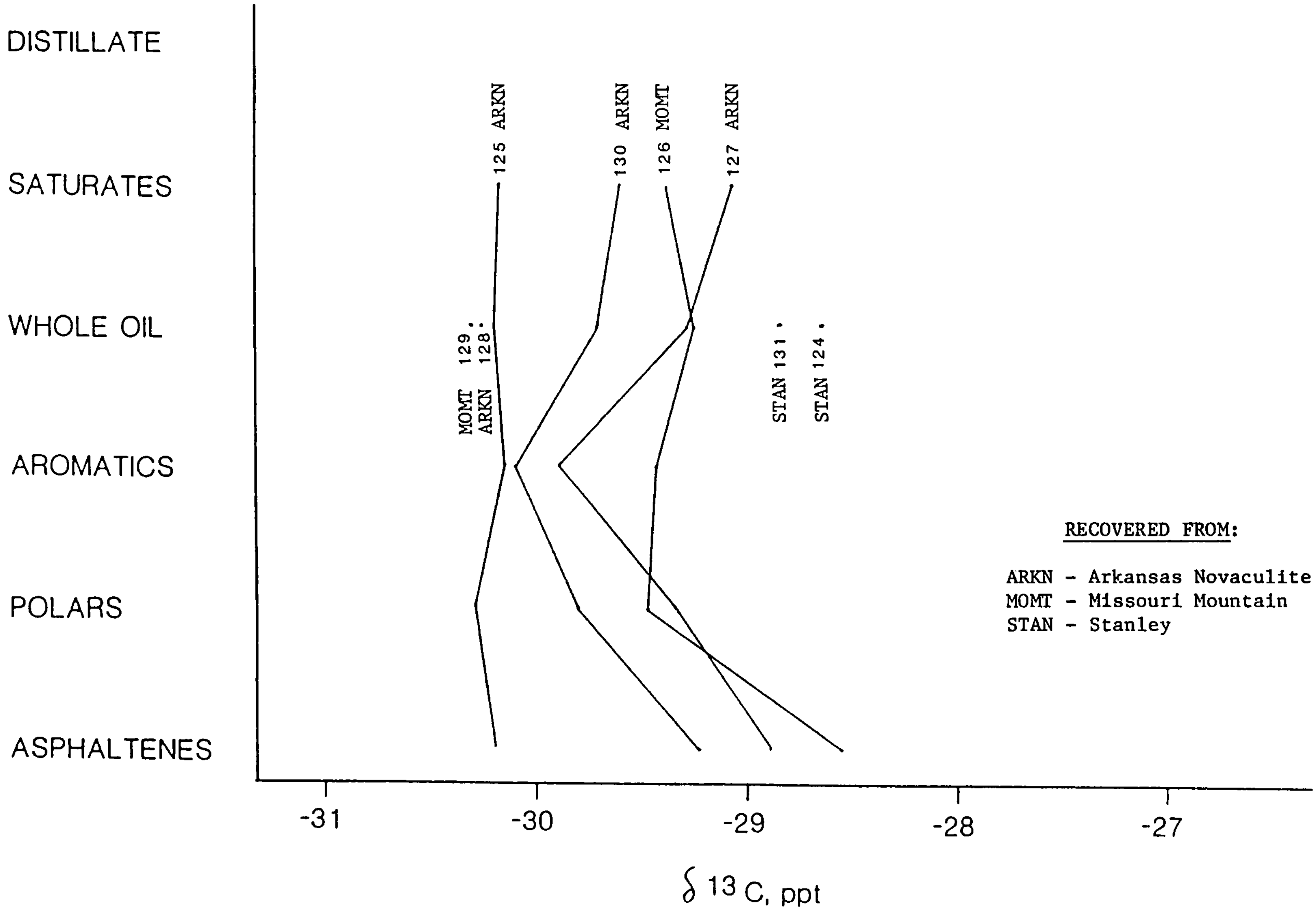
TYPE CURVES, ISOM SPRINGS OILS



F' 'RE 12.

TYPE CURVES, #3 VICTOR

TOTAL SOLUBLE EXTRACTS



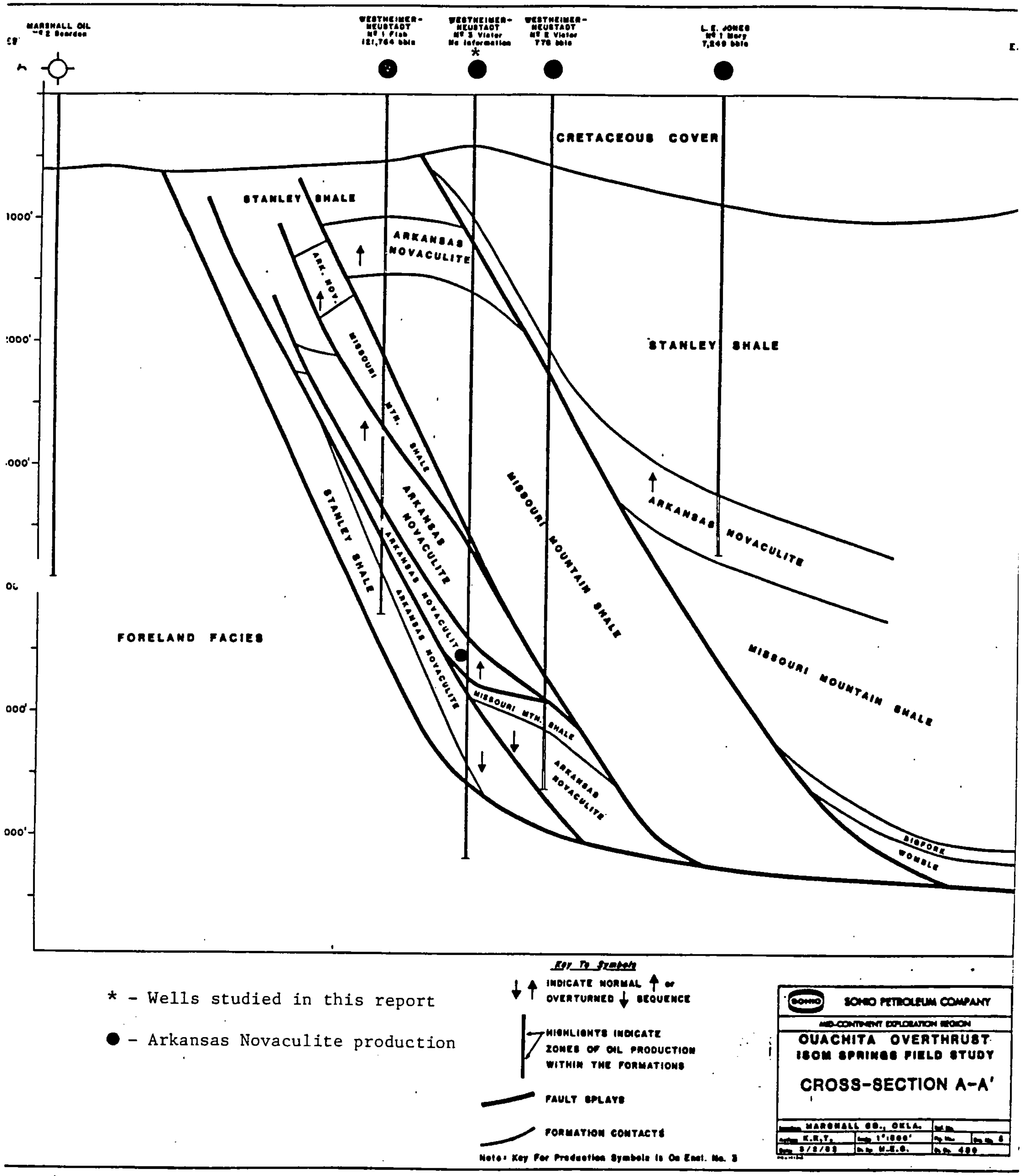

MARSHALL OIL
WESTHEIMER-NEUSTADT
Nº 1 Fish
121,764 bbls
WESTHEIMER-NEUSTADT
Nº 3 Victor
No information
WESTHEIMER-NEUSTADT
Nº 2 Victor
778 bbls
L. E. JONES
Nº 1 Mary
7,249 bbls
CRETACEOUS COVER
1000'
2000'
STANLEY SHALE
ARKANSAS NOVACULITE
ARK. NOV.
MISSOURI MTN. SHALE
STANLEY SHALE
ARKANSAS NOVACULITE
MISSOURI MOUNTAIN SHALE
ARKANSAS NOVACULITE
MISSOURI MOUNTAIN SHALE
STANLEY SHALE
ARKANSAS NOVACULITE
ARKANSAS NOVACULITE
ARKANSAS NOVACULITE
FORELAND FACIES
MISSOURI MTN. SHALE
ARKANSAS NOVACULITE
BIGFORK
WOMBLE
* - Wells studied in this report
● - Arkansas Novaculite production
Key To Symbols
INDICATE NORMAL or OVERTURNED SEQUENCE
HIGHLIGHTS INDICATE ZONES OF OIL PRODUCTION WITHIN THE FORMATIONS
FAULT SPLAYS
FORMATION CONTACTS
Note: Key For Production Symbols Is On Encl. No. 3
SOHIO PETROLEUM COMPANY
MID-CONTINENT EXPLORATION REGION
OUACHITA OVERTHRUST
ISOM SPRINGS FIELD STUDY
CROSS-SECTION A-A'
MARSHALL CO., OKLA.
K.R.T.
1"=1000'
M.E.C.

FIGURE 13

TABLE 2

09.17.05. 09/03/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#1 O'STEEN	SAMPLE ID:HCB090	FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:OIL	AGE/EPOCH:MS/DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 3356	
PGW JOB:8158	REPORT :	DATA BASE:PGW	

INSPECTION DATA

SPECIFIC GRAV.	:	.830
API GRAV.	:	39.90
SULFUR	%WT:	.29
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	.66
NICKEL	(PPM):	9
VANADIUM	(PPM):	20
RESIDUE BPT>200C	%WT:	78

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	71.10	
AROMATICS	%WT:	15.00	
POLARS	%WT:	13.00	
ASPHALTENE(2)	%WT:	.85	
N-ALKANE	%WT:	30.10	
N-ALKANE CPI	:	1.04	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.60	
ACYCLIC C16	%WT:	1.30	
ACYCLIC C18	%WT:	1.30	
PRISTANE	%WT:	.80	
PHYTANE	%WT:	.50	
PRISTANE/PHYTANE	:	1.59	
PRISTANE/N-C17	:	.30	
PHYTANE/N-C18	:	.28	
NICKEL/VANADIUM	:	.45	
D-13 C(OIL)	:	-30.29	%.
D-13 C(DISTILLATE)	:	-29.74	%.
D-13 C(SATURATES)	:	-30.66	%.
D-13 C(AROMATICS)	:	-30.07	%.
D-13 C(POLARS)	:	-30.15	%.
D-13 C(ASPHALTENES)	:	-30.28	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:	17.20	%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2	56	52	310
4	74	54	319
6	92	56	329
8	100	58	341
10	115	60	352
12	123	62	364
14	133	64	375
16	144	66	387
18	152	68	400
20	163	70	413
22	171	72	427
24	180	74	442
26	191	76	458
28	199	78	475
30	209	80	495
32	216	82	518
34	227	84	
36	235	86	
38	245	88	
40	251	90	
42	262	92	
44	270	94	
46	280	96	
48	290	98	
50	300	FBP	

N-ALKANE CONTENT % WT SATURATES

C10 :	
C11 :	
C12 :	3.800
C13 :	4.200
C14 :	4.200
C15 :	4.100
C16 :	3.300
C17 :	2.700
C18 :	1.800
C19 :	1.600
C20 :	1.100
C21 :	.800
C22 :	.700
C23 :	.600
C24 :	.400
C25 :	.400
C26 :	.300
C27 :	
C28 :	
C29 :	
C30 :	
C31 :	
C32 :	
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT NORMALISED DIST

H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT NORMALISED DIST

1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

TABLE 2 (cont.)

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB090 WELL/SITE : #1 O'STEEN

1	ISOBUTANE		39	2,3-DIMETHYLHEXANE	.532
2	N-BUTANE		40	2-METHYL-3-ETHYLPENTANE	
3	ISOPENTANE	.042	41	2-METHYLHEPTANE	2.699
4	N-PENTANE	.157	42	4-METHYLHEPTANE	
5	2,2-DIMETHYLBUTANE		43	3,4-DIMETHYLHEXANE	
6	CYCLOPENTANE	.065	44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	
7	2,3-DIMETHYLBUTANE	.069	45	3-ETHYLHEXANE	1.240
8	2-METHYLPENTANE	.535	46	3-METHYLHEPTANE	4.654
9	3-METHYLPENTANE	.450	47	1-C-3-DIMETHYLCYCLOHEXANE	
10	N-HEXANE	1.935	48	3-METHYL-3-ETHYLPENTANE	1.064
11	2,2-DIMETHYLPENTANE	.925	49	2,2,5-TRIMETHYLHEXANE	.220
12	METHYLCYCLOPENTANE		50	1,1-DIMETHYLCYCLOHEXANE	.430
13	2,4-DIMETHYLPENTANE	.111	51	1-METHYL-C-2-ETHYLCYCLOPENTANE	
14	2,2,3-TRIMETHYLBUTANE		52	1-METHYL-C-3-ETHYLCYCLOPENTANE	
15	BENZENE		53	2,2,4-TRIMETHYLHEXANE	
16	CYCLOHEXANE	1.623	54	1-T-2-DIMETHYLCYCLOHEXANE	1.319
17	2-METHYLHEXANE	1.718	55	N-OCTANE	7.765
18	2,3-DIMETHYLPENTANE		56	2,4,4-TRIMETHYLHEXANE	
19	1,1-DIMETHYLCYCLOPENTANE	.212	57	2,3,3-TRIMETHYLHEXANE	.679
20	3-METHYLHEXANE	1.684	58	2,2-DIMETHYLHEPTANE	.119
21	1-C-3-DIMETHYLCYCLOPENTANE	.433	59	2,3,5-TRIMETHYLHEXANE	.126
22	1-T-3-DIMETHYLCYCLOPENTANE	.408	60	ETHYLCYCLOHEXANE	2.441
23	1-T-2-DIMETHYLCYCLOPENTANE	.902	61	ETHYLBENZENE	.425
24	2,2,4-TRIMETHYLPENTANE		62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
25	3-ETHYLPENTANE		63	M-XYLENE	2.001
26	N-HEPTANE	5.646	64	P-XYLENE	.626
27	2,2-DIMETHYLHEXANE	.098	65	O-XYLENE	.876
28	METHYLCYCLOHEXANE	6.269	66	N-NONANE	9.429
29	1,1,3-TRIMETHYLCYCLOPENTANE	.340	67	ISOPROPYLBENZENE	.149
30	ETHYLCYCLOPENTANE	.385	68	N-PROPYLBENZENE	.396
31	2,5-DIMETHYLHEXANE	.254	69	1-METHYL-3-ETHYLBENZENE	.926
32	2,4-DIMETHYLHEXANE	.370	70	1-METHYL-4-ETHYLBENZENE	.376
33	2,2,3-TRIMETHYLPENTANE		71	1,3,5-TRIMETHYLBENZENE	.731
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.433	72	1-METHYL-2-ETHYLBENZENE	1.220
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	.503	73	N-DECANE	3.409
36	2,3,4-TRIMETHYLPENTANE		74	P-METHYLISOPROPYLBENZENE	.146
37	TOLUENE	.770	75	N-BUTYLBENZENE	
38	3,3-DIMETHYLHEXANE	.156	76	N-UNDECANE	.436

TABLE 3

09.22.46. 11/12/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US
STATE :OK
COUNTY :MARSHALL
PGW JOB:8157

WELL/SITE:#3 VICTOR
LOCATION :SEC2,T8SR5E
API/OCS :-
REPORT :

SAMPLE ID:HCB091 FORMATION:ARKN
TYPE:OIL AGE/EPOCH:MS/DEV
DEPTH(FT): 4900
DATA BASE:PGW

INSPECTION DATA

SPECIFIC GRAV.	:	.787
API GRAV.	:	48.10
SULFUR	%WT:	.13
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	.38
NICKEL	(PPM):	4
VANADIUM	(PPM):	12
RESIDUE		
BPT>200C	%WT:	58

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	79.00	
AROMATICS	%WT:	12.40	
POLARS	%WT:	7.80	
ASPHALTENE(2)	%WT:	.66	
N-ALKANE	%WT:	29.07	
N-ALKANE CPI	:	1.16	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.52	
ACYCLIC C16	%WT:	1.24	
ACYCLIC C18	%WT:	1.00	
PRISTANE	%WT:	.55	
PHYTANE	%WT:	.34	
PRISTANE/PHYTANE	:	1.62	
PRISTANE/N-C17	:	.22	
PHYTANE/N-C18	:	.20	
NICKEL/VANADIUM	:	.33	
D-13 C(OIL)	:	-30.50	%.
D-13 C(DISTILLATE)	:	-30.24	%.
D-13 C(SATURATES)	:	-30.76	%.
D-13 C(AROMATICS)	:	-30.03	%.
D-13 C(POLARS)	:	-30.11	%.
D-13 C(ASPHALTENES)	:	-30.22	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP	83		
2	96	52	290
4	106	54	300
6	117	56	311
8	124	58	321
10	133	60	331
12	141	62	343
14	148	64	357
16	154	66	371
18	162	68	387
20	168	70	406
22	173	72	430
24	182	74	461
26	190	76	519
28	195	78	
30	204	80	
32	210	82	
34	216	84	
36	226	86	
38	233	88	
40	241	90	
42	248	92	
44	255	94	
46	264	96	
48	272	98	
50	281	FBP	

N-ALKANE CONTENT

	% WT SATURATES
C10 :	
C11 :	
C12 :	4.400
C13 :	4.920
C14 :	4.280
C15 :	4.040
C16 :	2.970
C17 :	2.530
C18 :	1.680
C19 :	1.420
C20 :	.950
C21 :	.640
C22 :	.470
C23 :	.350
C24 :	.250
C25 :	.170
C26 :	
C27 :	
C28 :	
C29 :	
C30 :	
C31 :	
C32 :	
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT

NORMALISED DIST	
H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT

NORMALISED DIST	
1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB091

WELL/SITE : #3 VICTOR

1	ISOBUTANE	.276	39	2,3-DIMETHYLHEXANE	.385
2	N-BUTANE	1.745	40	2-METHYL-3-ETHYLPENTANE	
3	ISOPENTANE	2.185	41	2-METHYLHEPTANE	2.110
4	N-PENTANE	3.824	42	4-METHYLHEPTANE	
5	2,2-DIMETHYLBUTANE	.214	43	3,4-DIMETHYLHEXANE	
6	CYCLOPENTANE	.249	44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	
7	2,3-DIMETHYLBUTANE	.352	45	3-ETHYLHEXANE	.983
8	2-METHYLPENTANE	2.324	46	3-METHYLHEPTANE	1.973
9	3-METHYLPENTANE	1.586	47	1-C-3-DIMETHYLCYCLOHEXANE	
10	N-HEXANE	5.414	48	3-METHYL-3-ETHYLPENTANE	.872
11	2,2-DIMETHYLPENTANE	1.590	49	2,2,5-TRIMETHYLHEXANE	.120
12	METHYLCYCLOPENTANE		50	1,1-DIMETHYLCYCLOHEXANE	.331
13	2,4-DIMETHYLPENTANE	.238	51	1-METHYL-C-2-ETHYLCYCLOPENTANE	
14	2,2,3-TRIMETHYLBUTANE	.041	52	1-METHYL-C-3-ETHYLCYCLOPENTANE	.111
15	BENZENE		53	2,2,4-TRIMETHYLHEXANE	
16	CYCLOHEXANE	2.124	54	1-T-2-DIMETHYLCYCLOHEXANE	.895
17	2-METHYLHEXANE	2.462	55	N-OCTANE	5.976
18	2,3-DIMETHYLPENTANE		56	2,4,4-TRIMETHYLHEXANE	
19	1,1-DIMETHYLCYCLOPENTANE	.241	57	2,3,3-TRIMETHYLHEXANE	.483
20	3-METHYLHEXANE	2.181	58	2,2-DIMETHYLHEPTANE	.096
21	1-C-3-DIMETHYLCYCLOPENTANE	.413	59	2,3,5-TRIMETHYLHEXANE	
22	1-T-3-DIMETHYLCYCLOPENTANE	.376	60	ETHYLCYCLOHEXANE	1.637
23	1-T-2-DIMETHYLCYCLOPENTANE		61	ETHYLBENZENE	.212
24	2,2,4-TRIMETHYLPENTANE		62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
25	3-ETHYLPENTANE	.791	63	M-XYLENE	1.278
26	N-HEPTANE	6.246	64	P-XYLENE	.339
27	2,2-DIMETHYLHEXANE	.121	65	O-XYLENE	.503
28	METHYLCYCLOHEXANE	5.843	66	N-NONANE	6.544
29	1,1,3-TRIMETHYLCYCLOPENTANE	.263	67	ISOPROPYLBENZENE	.133
30	ETHYLCYCLOPENTANE	.226	68	N-PROPYLBENZENE	.208
31	2,5-DIMETHYLHEXANE	.258	69	1-METHYL-3-ETHYLBENZENE	.334
32	2,4-DIMETHYLHEXANE	.372	70	1-METHYL-4-ETHYLBENZENE	
33	2,2,3-TRIMETHYLPENTANE		71	1,3,5-TRIMETHYLBENZENE	.601
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.293	72	1-METHYL-2-ETHYLBENZENE	1.001
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	.264	73	N-DECANE	4.730
36	2,3,4-TRIMETHYLPENTANE		74	P-METHYLISOPROPYLBENZENE	.152
37	TOLUENE	.552	75	N-BUTYLBENZENE	.325
38	3,3-DIMETHYLHEXANE	.161	76	N-UNDECANE	1.209

TABLE 4

 09.30.33. 09/03/82

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:#1 JONES	SAMPLE ID:HCB092 FORMATION:ARKN
STATE :OK	LOCATION :SEC2,T8SR5E	TYPE:OIL AGE/EPOCH:MS/DEV
COUNTY :MARSHALL	API/OCS :-	DEPTH(FT): 4000
PGW JOB:8158	REPORT :	DATA BASE:PGW

INSPECTION DATA			SIMULATED DISTILLATION				N-ALKANE CONTENT		PENTACYCLANE CONTENT	
			%WT	DEG C	%WT	DEG C	% WT SATURATES		NORMALISED DIST	
SPECIFIC GRAV.	:	.822								
API GRAV.	:	40.70								
SULFUR	%WT:	.31								
NITROGEN	%WT:		IBP	85			C10 :		H :	
WAX	%WT:		2	98	52	343	C11 :		B :	
WAX MPT	DEG C:		4	116	54	354	C12 :	3.110	D :	
ASPHALTENE (1)	%WT:	.44	6	127	56	366	C13 :	4.320	G :	
NICKEL	(PPM):	10	8	140	58	378	C14 :	4.610	N :	
VANADIUM	(PPM):	25	10	148	60	390	C15 :	4.710	O :	
RESIDUE			12	159	62	403	C16 :	3.920	U :	
BPT>200C	%WT:	81	14	168	64	417	C17 :	3.210	V :	
			16	175	66	431	C18 :	2.200	ALPHA :	
GEOCHEMICAL DATA			18	186	68	446	C19 :	1.960	BETA :	
			20	194	70	464	C20 :	1.300	GAMA :	
RESIDUE BPT>200C			22	204	72	483	C21 :	.980	DELTA :	
TYPE ANALYSIS			24	211	74	505	C22 :	.790	EPSILON :	
SATURATES	%WT:	70.30	26	222	76	533	C23 :	.640	ZETA :	
AROMATICS	%WT:	14.00	28	231	78		C24 :	.490		
POLARS	%WT:	15.20	30	240	80		C25 :	.380	STERANE	
ASPHALTENE(2)	%WT:	.54	32	248	82		C26 :	.290	CONTENT	
N-ALKANE	%WT:	32.90	34	256	84		C27 :		NORMALISED DIST	
N-ALKANE CPI	:	1.08	36	265	86		C28 :			
ACYCLIC ISOPRENOID			38	274	88		C29 :			
FARNESANE	%WT:	.74	40	283	90		C30 :		1 :	
ACYCLIC C16	%WT:	1.50	42	294	92		C31 :		2 :	
ACYCLIC C18	%WT:	.97	44	303	94		C32 :		3 :	
PRISTANE	%WT:	.98	46	313	96		C33 :		4 :	
PHYTANE	%WT:	.63	48	323	98		C34 :		5 :	
PRISTANE/PHYTANE	:	1.56	50	333	FBP		C35 :		6 :	
PRISTANE/N-C17	:	.31					C36 :		7 :	
PHYTANE/N-C18	:	.29							8 :	
NICKEL/VANADIUM	:	.40							9 :	
D-13 C(OIL)	:	-30.37 %.							10 :	
D-13 C(DISTILLATE)	:	-29.76 %.							11 :	
D-13 C(SATURATES)	:	-30.42 %.							12 :	
D-13 C(AROMATICS)	:	-30.17 %.							13 :	
D-13 C(POLARS)	:	-30.12 %.							14 :	
D-13 C(ASPHALTENES)	:	-30.37 %.							15 :	
D-13 C(RESINS)	:	%.							16 :	
D-34 SULFUR	:	18.80 %.							17 :	
D-2 DEUTERIUM	:	%.							18 :	
D-15 NITROGEN	:	%.							19 :	

TABLE 4 (cont.)

SUMMARY HYDROCARBON DATA SHEET

LIGHT HYDROCARBON RANGE ANALYSIS - DISTILLATE FRACTION BPT<200 DEG C

SAMPLE ID : HCB092 WELL/SITE : #1 JONES

1	ISOBUTANE	.256	39	2,3-DIMETHYLHEXANE	.280
2	N-BUTANE	1.571	40	2-METHYL-3-ETHYLPENTANE	
3	ISOPENTANE	1.647	41	2-METHYLHEPTANE	1.867
4	N-PENTANE	2.670	42	4-METHYLHEPTANE	
5	2,2-DIMETHYLBUTANE	.117	43	3,4-DIMETHYLHEXANE	
6	CYCLOPENTANE	.212	44	1-C-2-T-4-TRIMETHYLCYCLOPENTANE	
7	2,3-DIMETHYLBUTANE	.196	45	3-ETHYLHEXANE	.821
8	2-METHYLPENTANE	1.353	46	3-METHYLHEPTANE	3.211
9	3-METHYLPENTANE	.893	47	1-C-3-DIMETHYLCYCLOHEXANE	
10	N-HEXANE	2.872	48	3-METHYL-3-ETHYLPENTANE	.724
11	2,2-DIMETHYLPENTANE	1.008	49	2,2,5-TRIMETHYLHEXANE	.156
12	METHYLCYCLOPENTANE		50	1,1-DIMETHYLCYCLOHEXANE	.286
13	2,4-DIMETHYLPENTANE	.107	51	1-METHYL-C-2-ETHYLCYCLOPENTANE	.110
14	2,2,3-TRIMETHYLBUTANE		52	1-METHYL-C-3-ETHYLCYCLOPENTANE	.274
15	BENZENE		53	2,2,4-TRIMETHYLHEXANE	
16	CYCLOHEXANE	1.241	54	1-T-2-DIMETHYLCYCLOHEXANE	.943
17	2-METHYLHEXANE	1.182	55	N-OCTANE	6.423
18	2,3-DIMETHYLPENTANE		56	2,4,4-TRIMETHYLHEXANE	
19	1,1-DIMETHYLCYCLOPENTANE	.140	57	2,3,3-TRIMETHYLHEXANE	.654
20	3-METHYLHEXANE	1.085	58	2,2-DIMETHYLHEPTANE	.109
21	1-C-3-DIMETHYLCYCLOPENTANE	.274	59	2,3,5-TRIMETHYLHEXANE	
22	1-T-3-DIMETHYLCYCLOPENTANE	.248	60	ETHYLCYCLOHEXANE	2.125
23	1-T-2-DIMETHYLCYCLOPENTANE	.539	61	ETHYLBENZENE	.379
24	2,2,4-TRIMETHYLPENTANE		62	1-C-3-C-5-TRIMETHYLCYCLOHEXANE	
25	3-ETHYLPENTANE		63	M-XYLENE	1.855
26	N-HEPTANE	3.306	64	P-XYLENE	.617
27	2,2-DIMETHYLHEXANE	.053	65	O-XYLENE	1.235
28	METHYLCYCLOHEXANE	3.348	66	N-NONANE	9.552
29	1,1,3-TRIMETHYLCYCLOPENTANE	.189	67	ISOPROPYLBENZENE	.146
30	ETHYLCYCLOPENTANE	.211	68	N-PROPYLBENZENE	.426
31	2,5-DIMETHYLHEXANE	.152	69	1-METHYL-3-ETHYLBENZENE	1.005
32	2,4-DIMETHYLHEXANE	.217	70	1-METHYL-4-ETHYLBENZENE	.404
33	2,2,3-TRIMETHYLPENTANE		71	1,3,5-TRIMETHYLBENZENE	.850
34	1-T-2-C-4-TRIMETHYLCYCLOPENTANE	.235	72	1-METHYL-2-ETHYLBENZENE	1.464
35	1-T-2-C-3-TRIMETHYLCYCLOPENTANE	.289	73	N-DECANE	4.879
36	2,3,4-TRIMETHYLPENTANE		74	P-METHYLISOPROPYLBENZENE	.212
37	TOLUENE	.401	75	N-BUTYLBENZENE	.334
38	3,3-DIMETHYLHEXANE	.084	76	N-UNDECANE	.717

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: D. May
SPC Mid-Continent Region
Dallas

December 13, 1982

PGW/112982/FM/2-5

From: Petroleum Geochemistry Group
Warrensville

Job No.: PGW 82-67

Classification: RESTRICTED

Technical Memorandum (PGW/TM 092) -- Geochemical Evaluation of Wayne Harper #1 Ayers Well, Grayson County, Texas.

Summary: A geochemical evaluation of cuttings samples from the #1 Ayers well showed that the Ouachita facies sediments penetrated were gas mature. The gas generation threshold was placed at about 2,720 ft. suggesting that the sediments had been buried to a significantly much greater depth in the past. Intervals of Good to Excellent TOC contents were identified in the Arkansas Novaculite, Polk Creek Shale, Bigfork Chert, and the Womble Shale formations. Because of the advanced maturity of these sediments most of their generative potential was probably significantly depleted. The Bigfork Chert sediments had high, sustained TOC contents over the entire formation (509 ft. in thickness) and were believed to have generated significiant quantities of hydrocarbon while in the oil generation window.

1. INTRODUCTION

The #1 Ayers well was drilled along the western frontal margin of the Ouachita allochthon. The well was located 3,000 ft. FNL and 3,600 ft. EWL of the E.M. Jones Survey, A-623, Grayson County, Texas. It penetrated 2,920 ft. of Cretaceous sediments and went into a typical Ouachita facies section bottoming in the Womble Fm. at 5,116 ft. Oil shows were reported in Arkansas Novaculite intervals between 3,160 - 3,190 ft., and 3,265 - 3,287 ft.

2. MATERIALS AND METHODS

2.1 Materials

Cuttings samples in 10 ft. intervals were received from 2,800 ft. to TD (5,116 ft.). Equal portions of the intervals were composited into 30 ft. samples for subsequent analyses. The 30 ft. samples were given PGW well sample designations WB 5194 - WB 5270.

2.2 Methods

The samples were screen for source richness and maturity. Source richness screen procedures included Total Organic Carbon (TOC - bitumen free) and Rock Eval pyrolysis performed as per standardized PGW methods. Source maturity was assessed using whole rock vitrinite reflectance determinations.

3. RESULTS AND CONCLUSIONS

A summary of the geochemical data for this well is presented in Table 1 and Figure 1.

3.1 The maturity assessment of this well was extremely difficult. Because of the absence of vitrinite particles in some of the sediments and because of the ages of the sediments below 3,880 ft. only four reflectance data points spanning a very limited stratigraphic interval were obtained. The reflectance data was obtained from Arkansas Novaculite and Missouri Mountain sediments between 3,100 ft. and 3,850 ft. Reflectance values ranged from 1.07 to 1.28% indicating that the sediments below 3,100 ft. had reached the gas generation regime of thermal maturity. Although of questionable accuracy because of the limited data points, a thermal maturity profile was developed based on a linear regression analysis. Extrapolation of the maturity profile placed the oil generation threshold (0.60% reflectance) at about 135 ft. and the gas generation threshold (1.00% reflectance) at about 2,720 ft. The sediments penetrated in this well were obviously buried to a much greater depth in the past and have since been uplifted to their present depths. Although the data was limited in volume, it did show that the sediments below 3,100 ft. were gas mature and suggested that those below 3,880 ft. were at an even more advanced level of thermal maturity. This assertion was also supported by the pyrolysis data (Section 3.3 and 3.4). A moderately high, and statistically risky, sediment thermal gradient (8.6 DOD units/1,000 ft., 28 units/km) was recorded for this well.

3.2 Based on Good to Excellent TOC contents, possible source intervals were identified in the Arkansas Novaculite (3,100 ft. - 3,160 ft.), the Polk Creek Shale (entire interval 3,880 ft. - 4,029 ft.), the Bigfork Chert (entire interval 4,029 ft. - 4,538 ft.) and the Womble Shale (4,540 ft. - 4,600 ft., and 4,960 ft. - 5,116 ft.).

3.3 TOC contents in the 3,100 ft. - 3,160 ft. interval of the Arkansas Novaculite ranged from 1.02 to 1.28 wt%. The Polk Creek Fm. (3,880 ft. - 4,029 ft.) had TOC contents in about the same range (0.77 to 1.33 wt%). Despite their organic richness the sediments in these intervals showed Negligible potential productivities (S2). These results suggested that the intervals were essentially spent, now yielding only residue hydrocarbons upon pyrolysis. Both the Novaculite and Polk Creek intervals probably generated and expelled some quantities of hydrocarbons while in the oil generation window. This would account for the oil shows reported in the Novaculite.

3.4 The Bigfork Chert had Good to Excellent sustained TOC contents over the entire 509 ft. thickness of the formation. TOC contents ranged from about 1.15 to as high as 3.69 wt% however, none of the sediments showed any significant potential productivity. These sediments were believed to be at an advanced stage of maturity based on reflectance data from the overlying sediments thus accounting for the absence of any significant pyrolytic potentials. Although inconclusive alone, the high sustained organic carbon contents of the Bigfork Fm. in this well strongly suggested that the formation had Good to Excellent source rock potential prior to entry into the oil generation window. This assessment was also based on the results of previous investigations of the source potential of the Bigfork Fm. for the SPC Mid-Continent office (1, 2). The previous work has demonstrated that thermally unaltered Bigfork sediments with high organic carbon contents have shown Good to Excellent source potential. The Bigfork sediments penetrated in the #1 Ayers well probably generated and expelled significant quantities of hydrocarbons while in the oil generation window.

3.5 The Missouri Mountain sediments penetrated in the well had Lean TOC contents (one interval had a Marginal TOC content of 0.59 wt%) and were dismissed as possible source rocks on this basis. The organic richness of these Missouri Mountain sediments was in marked contrast to that of the Missouri Mountain sediments penetrated in the Westheimer-Neustadt #3 Victor well reported previously (). This suggested a dramatic facies variability in this formation.

4. REFERENCES

1. F. A. Marsek — 1982 — Geochemical Evaluation of Paleozoic Sections from Five Wells Drilled in the Ouachita Overthrust Belt of Northwestern Texas. PGW/TM 053.

2. F. A. Marsek and S. S. White — 1982 — Summary Report for 1981 SPC Mid-Continent Appalachian and Ouachita Outcrop Sampling Program. PGW/TM 072.

3. H. I. Halpern and F. A. Marsek | 1982 | Geochemical Source Rock Evaluation for the #3 Victor Well, A Producer in the Isom Springs Field, Marshall County, Oklahoma. PGW/TM 065.

G. A. Cole

F. A. Marsek

/bes

Enclosures: Table 1
Figure 1

cc: H. G. Bassett
J. G. Grasselli (title page only)
R. Burwood
R. J. Drozd
E. Luttrell
PGW Files (0), (2-5)

Work by: S. White

APPENDIX

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. } 0-10% qualifying component
LST.

SH. CALC } 11-25% qualifying component
LST. ARG

SH. V. CALC } 26-50% qualifying component
LST. V. ARG

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): %. Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): %. Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^\circ C$) - Kg/Tn.

S2 (12): %. Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: %. Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

G1 (TSE)(14): %. Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

G1 (S1)(15): %. Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): %. Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) %. Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): %. Potential Productivity - Pyrolytic Hydrocarbon yield as Gas ($C_1 - C_5$) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 ft.$^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

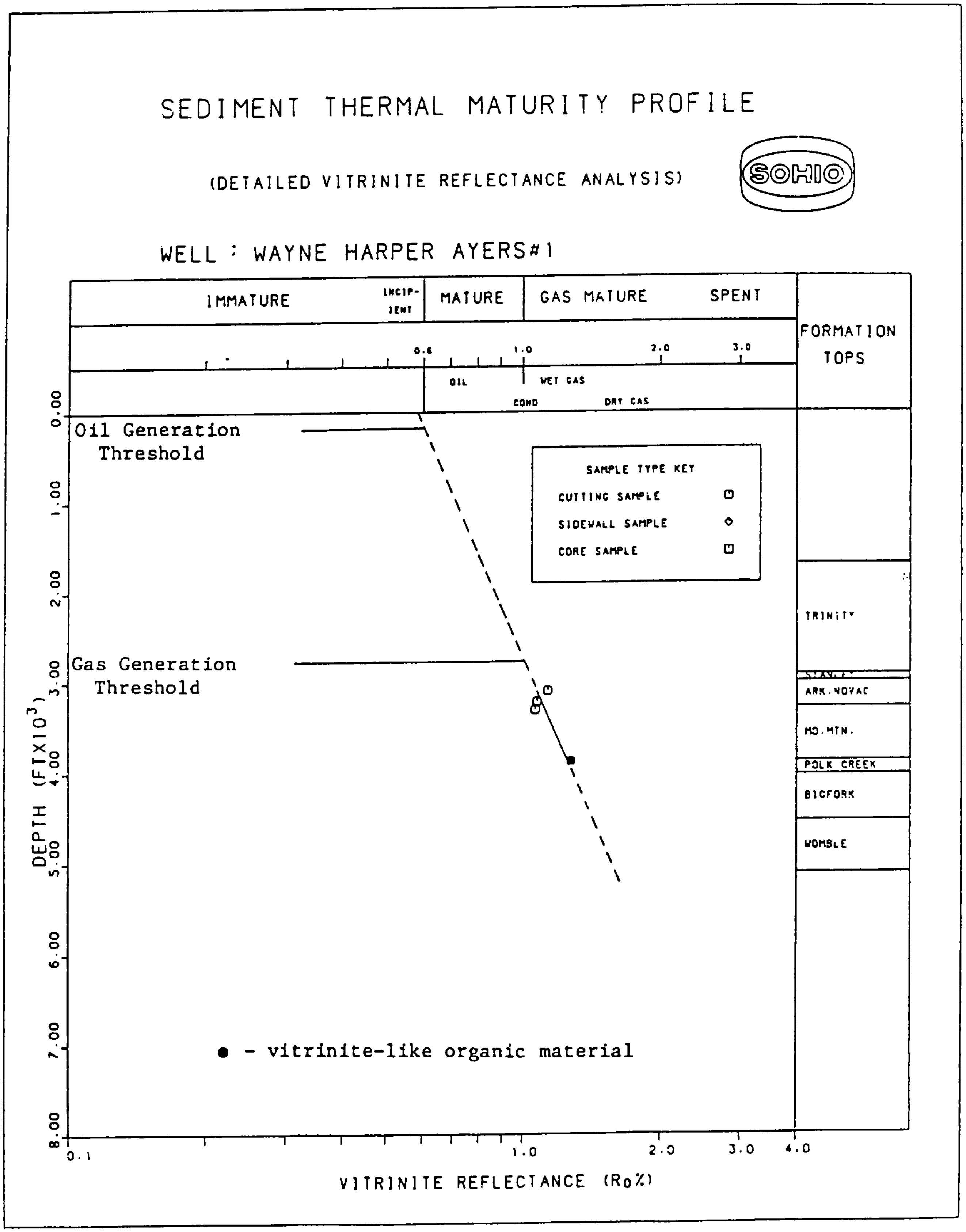

SEDIMENT THERMAL MATURITY PROFILE
(DETAILED VITRINITE REFLECTANCE ANALYSIS)
SOHIO
WELL : WAYNE HARPER AYERS#1
IMMATURE
INCIP-IENT
MATURE
GAS MATURE
SPENT
OIL
WET GAS
COND
DRY GAS
FORMATION TOPS
Oil Generation Threshold
Gas Generation Threshold
SAMPLE TYPE KEY
CUTTING SAMPLE
SIDEWALL SAMPLE
CORE SAMPLE
TRINITY
ARK.NOVAC
MO.MTN.
POLK CREEK
BIGFORK
WOMBLE
● - vitrinite-like organic material
DEPTH (FTX10³)
VITRINITE REFLECTANCE (Ro%)

FIGURE 1

TABLE 1

PAGE . 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : GRAYSON
LOCATION : EM JONES SURVEY A623
WELL/SITE : WAYNE HARPER AYERS#1
API/OCS : 42-181-30677

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	RT5194											
2800	WB5194	CTG	CRET	TRIN	SST,ARG	25		.20		.10	.10	50
2830	WB5195	CTG			SST,ARG	31		.14		.10	.10	71
2860	WB5196	CTG			SST,ARG	26		.11		.10	.10	91
2890	WB5197	CTG			SST,ARG	29		.13		.10	.10	77
2919	XB5197		MISS	STAN	FORM.TOP							
2920	WB5198	CTG			CHT,ARG	13		.13		.10	.10	77
2950	WB5199	CTG			CHT,ARG	8		.10		.10	.10	100
2980	WB5200	CTG			CHT	5		.11		.10	.10	91
3000	XB5200		DEV	ARKN	FORM.TOP							
3010	WB5201	CTG			CHT	11		.14		.10	.11	79
3040	WB5202	CTG			CHT,ARG	11		.25		.10	.16	64
3070	WB5203	CTG			CHT	15		.42		.10	.23	55
3100	WB5204	CTG			CHT,ARG	10		1.02		.10	.36	35
3130	WB5205	CTG			CHT,ARG	8		1.28		.12	.46	36
3160	WB5206	CTG			CHT,ARG	6		1.17		.17	.38	32
3190	WB5207	CTG			CHT	11		.49		.10	.21	43
3220	WB5208	CTG			CHT	10		.29		.10	.17	59
3250	WB5209	CTG			CHT	8		.14		.10	.12	86
3280	WB5210	CTG			SH	10		.16		.10	.11	69
3285	XB5210		SIL	MONT	FORM.TOP							
3310	WB5211	CTG			SH,CALC	13		.22		.10	.11	50
3340	WB5212	CTG			SH	6		.09		.10	.10	111
3370	WB5213	CTG			SH	4		.11		.10	.10	91
3400	WB5214	CTG			SH	7		.09		.10	.10	111
3430	WB5215	CTG			SH	5		.12		.10	.10	83
3460	WB5216	CTG			SH	5		.09		.10	.10	111
3490	WB5217	CTG			SH	8		.19		.10	.12	63
3520	WB5218	CTG			SH	6		.25		.10	.13	52
3550	WB5219	CTG			SH	2		.14		.10	.11	79
3580	WB5220	CTG			CH	4		.16		.10	.11	69
3610	WB5221	CTG			SH	8		.14		.10	.11	79
3640	WB5222	CTG			SH	7		.14		.10	.11	79
3670	WB5223	CTG			SH	9		.13		.10	.10	77
3700	WB5224	CTG			SH	10		.20		.10	.11	55
3730	WB5225	CTG			SH	7		.23		.10	.11	48
3760	WB5226	CTG			SH	8		.19		.10	.11	58

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
2800	.50		50												
2830	.50		71												
2860	.50		91												
2890	.50		77												
2919															
2920	.50		77												
2950	.50		100												
2980	.50		91												
3000															
3010	.48		71												
3040	.38		40												
3070	.30		24												
3100	.22		10									1.14			
3130	.21		9												
3160	.31		15												
3190	.32		20												
3220	.37		34									1.08			
3250	.45		71												
3280	.48		62												
3285															
3310	.48		45									1.07			
3340	.50		111												
3370	.50		91												
3400	.50		111												
3430	.50		83												
3460	.50		111												
3490	.45		53												
3520	.43		40												
3550	.48		71												
3580	.48		62												
3610	.48		71												
3640	.48		71												
3670	.50		77												
3700	.48		50												
3730	.48		43												
3760	.48		53												

WELL/SITE :WAYNE HARPER AYERS#1

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3790	WB5227	CTG			SH	6		.13		.10	.10	77
3820	WB5228	CTG			SH	5		.25		.10	.10	40
3850	WB5229	CTG			SH	9		.59		.10	.16	27
3879	XB5229		ORD	POLK	FORM.TOP							
3880	WB5230	CTG			SH,CALC	15		1.18		.11	.22	19
3910	WB5231	CTG			SH	9		1.37		.13	.30	22
3940	WB5232	CTG			SH,CALC	12		1.33		.19	.30	23
3970	WB5233	CTG			SH,CALC	12		.77		.14	.22	29
4000	WB5234	CTG			SH,CALC	12		1.02		.20	.35	34
4029	XB5234		ORD	BGFK	FORM.TOP							
4030	WB5235	CTG			SH	9		1.26		.19	.33	26
4060	WB5236	CTG			SH	7		1.85		.28	.46	25
4090	WB5237	CTG			SH,CALC	12		1.63		.31	.32	20
4120	WB5238	CTG			SH,CALC	14		.74		.13	.15	20
4150	WB5239	CTG			SH,CALC	16		1.80		.25	.35	19
4180	WB5240	CTG			SH,CHTY	8		2.67		.39	.52	19
4210	WB5241	CTG			SH,CHTY	8		2.99		.68	.73	24
4240	WB5242	CTG			SH	9		2.35		.35	.49	21
4270	WB5243	CTG			SH	8		3.69		.32	.51	14
4300	WB5244	CTG			SH	7		3.48		.21	.39	11
4330	WB5245	CTG			SH	7		3.28		.18	.39	12
4360	WB5246	CTG			SH	6		3.25		.24	.38	12
4390	WB5247	CTG			SH,CALC	12		1.98		.33	.46	23
4420	WB5248	CTG			SH,CALC	19		1.15		.14	.28	24
4450	WB5249	CTG			SH,CALC	11		1.64		.20	.37	23
4480	WB5250	CTG			SH,CALC	14		2.08		.25	.39	19
4510	WB5251	CTG			SH,CALC	13		2.85		.41	.59	21
4538	XB5251		ORD	WOMB	FORM.TOP							
4540	WB5252	CTG			SH,CALC	16		1.67		.23	.36	22
4570	WB5253	CTG			SH,CALC	14		1.17		.15	.23	20
4600	WB5254	CTG			SH,CALC	19		1.10		.15	.26	24
4630	WB5255	CTG			SH,CALC	18		.97		.13	.25	26
4660	WB5256	CTG			SH,CALC	16		.95		.12	.18	19
4690	WB5257	CTG			SH,CALC	15		.79		.12	.16	20
4720	WB5258	CTG			SH,CALC	20		.68		.10	.14	21
4750	WB5259	CTG			SH,CALC	18		.60		.10	.11	18
4780	WB5260	CTG			SH	10		.68		.10	.11	16
4810	WB5261	CTG			SH	9		.58		.10	.11	19
4840	WB5262	CTG			SH	8		.72		.10	.15	21
4870	WB5263	CTG			SH,CALC	13		.66		.10	.15	23
4900	WB5264	CTG			SH,CALC	13		.75		.10	.15	20
4930	WB5265	CTG			SH	10		.68		.10	.18	26
4960	WB5266	CTG			SH	10		.90		.10	.19	21
4990	WB5267	CTG			SH	5		1.10		.13	.19	17
5020	WB5268	CTG			SH,CALC	15		.94		.10	.19	20
5050	WB5269	CTG			SH,CALC	15		.92		.12	.19	21
5080	WB5270	CTG			SH,CALC	20		1.00		.11	.22	22
5116	XB5270	TD		WOMB								

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -‰	D-13C (TSE) -‰	D-13C (KPY) -‰
3790	.50		77												
3820	.50		40												
3850	.38		17												
3879															
3880	.33		9									1.28			
3910	.30		9												
3940	.39		14												
3970	.39		18												
4000	.36		20												
4029															
4030	.37		15												
4060	.38		15												
4090	.49		19												
4120	.46		18												
4150	.42		14												
4180	.43		15												
4210	.48		23												
4240	.42		15												
4270	.39		9												
4300	.35		6												
4330	.32		5												
4360	.39		7												
4390	.42		17												
4420	.33		12												
4450	.35		12												
4480	.39		12												
4510	.41		14												
4538															
4540	.39		14												
4570	.39		13												
4600	.37		14												
4630	.34		13												
4660	.40		13												
4690	.43		15												
4720	.42		15												
4750	.48		17												
4780	.48		15												
4810	.48		17												
4840	.40		14												
4870	.40		15												
4900	.40		13												
4930	.36		15												
4960	.34		11												
4990	.41		12												
5020	.34		11												
5050	.39		13												
5080	.33		11												
5116															

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: C.A.O. Titus
SPC Mid-Continent Division
Dallas

February 15, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/20783/RS/2-5

Job No.: 81-62

Classification: RESTRICTED

Technical Memorandum (PGW/TM 100) -- Geochemical Characterization and Comparison of Five Asphalt Samples from Pike and Sevier Counties, Arkansas, and Oil from the Sevier Co. Nix #1 Well.

Summary: Preliminary carbon isotopic data for five Arkansas Asphalts (PGW/TM 045) were supplemented via a complete geochemical characterization exercise. All samples contained predominantly asphaltenes, as a result of severe biodegradation. Carbon isotopic profiling strongly suggested a generic relationship between these residual asphalts and thermally mature, non-biodegraded petroleum recovered from the Nix #1 well, Sevier County.

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

1. INTRODUCTION

The results of a preliminary geochemical investigation of five asphalt samples recovered from Pike and Sevier Counties, Arkansas, and two oil samples from the Nix #1 well, Sevier County, were presented in report PGW/TM 045 (1). Limited stable carbon isotopic data suggested that these materials were probably generically related, sharing a common, post-Devonian, source or suite of sources. Detailed analyses of the Nix oils were discussed in report PGW/TM 074 (2). The samples were found to represent a thermally mature crude oil, containing an anomalously high abundance of isotopically light asphaltenes and polar compounds. Chromatographic data and isotopic profiling suggested that the oils were not significantly biodegraded, but may have experienced water washing and/or deasphalting. A source kerogen assemblage deposited under marine (middle neritic-pelagic?) conditions was inferred from the analytical results.

This report addresses the results of the detailed geochemical characterization of the five asphalt samples discussed above, and a comparison of the asphalt and Nix oil data.

2. MATERIALS AND METHODS

2.1 Materials

Five asphalt samples from Arkansas were received and given PGW field sample designations FSB 872-874, 891, and 892, and hydrocarbon designations HCB 180-184. Summary location data are shown in Table 1. Sample FSB 891 (HMB #1) was reportedly collected from an Upper Paleozoic outcrop, possibly of Pennsylvanian (Jackfork Fm.) age.

The remaining samples were acquired from outcrops of Lower Cretaceous sandstones in close proximity to Upper Paleozoic sediments.

2.2 Methods

The solvent (CH_2Cl_2) extractable fraction from each sample was characterized using the following standardized PGW techniques: Asphaltene Content (C_5 isolubles), Hydrocarbon Type Analysis (BPT > 200^oC), Saturate Alkane Analysis, and Stable Carbon Isotopic Profiling.

3. RESULTS AND CONCLUSIONS

Results of the various characterization analyses were compiled in Tables 2-6 and Figures 1-3.

3.1 All five samples analyzed contained asphaltenes as their predominant component. Asphaltene contents ranged from 34% (HCB-180, HCB-181) to 94% (HCB-183).

3.2 Samples HCB-181 and HCB-184, from Pike county localities, were fairly uniform in composition, containing 18-19% saturates, 11-13% aromatics, and 26-34% polar compounds. In contrast, saturate, aromatic, and polar fraction abundances varied considerably for the Sevier County samples (3-12%, 1-19%, and 2-35%, respectively).

3.3 A representative Saturate Alkane Analysis gas chromatogram was illustrated in Figure 1. These samples contained virtually no normal or branched alkanes, the chromatograms being dominated by napthenic compounds.

3.4 The high abundance of asphaltenes and total absence of normal alkanes observed clearly indicated that these hydrocarbon samples were severely biodegraded, precluding any speculation regarding their type, maturity, or possible relationship on the basis of physical/chemical parameters.

3.5 Stable Carbon Analysis results were plotted as isotopic profiles, or "type curves", in Figure 2. No data for the saturate fraction of HCB-182 were obtained due to insufficient sample quantity. Type curves for the Nix #1 well oil samples were presented in Figure 3. Whole extract and most hydrocarbon fraction data for the three Sevier county asphalts (HCB-180, 182, 183) were in good agreement with the Nix results. The profile for HCB-183 is somewhat anomalous in that it indicates an isotopically light aromatic component in this sample; the significance of this value is questionable, however, due to the very low abundance of material in this fraction.

3.6 The isotopic results for Pike County samples (HCB-181, 184) showed an average 0.5 ppt enrichment in the ^{13}C isotope, relative to the Sevier asphalts and Nix oils, which was most evident in the aromatic fraction.

3.7 The general isotopic similarity of the Pike and Sevier County asphalts to the Nix oils strongly suggested that these hydrocarbons were generically related. Chromatographic results supported an origin for the asphalts as biodegraded residues from a parent oil, most probably of the type recovered from the Nix #1 well. The isotopic and compositional variations observed for the various asphalts may reflect slight local differences in the source facies of these materials. These results are in accord with the provisional conclusions reached in report PGW/TM 045.

3.8 The results of this exercise clearly demonstrated the utility of the stable carbon isotopic profiling technique as a hydrocarbon characterization and correlation tool, and the relative insensitivity and/or resistance of carbon isotopic parameters to alteration by common physical/chemical processes encountered in the geosphere.

4. REFERENCES

1. Sedivy, R. 1982 Stable Carbon Isotopic Investigation of Five Asphalt Samples, and Nix #1 Crude Oil Samples from Pike and Sevier Counties, Arkansas. PGW/TM 045.

2. Halpern, H. and Marsek, F. 1982 Geochemical Characterization of Two Liquid Hydrocarbons Recovered from Sevier Co. #1 Nix Well, Sevier County, Arkansas. PGW/TM 074.

H. I. Halpern

R. A. Sedivy

/bes

Enclosures: Tables 1-6
Figures 1-3

cc: H. G. Bassett
J. G. Grasselli (Title Page Only)
R. Burwood
R. Drozd
G. Cole
F. Marsek
PGW Files (0), (2-5)

Work by: S. Adams
R. Cavalier
J. Reymander

TABLE 1

SUMMARY LOCATION DATA

Sample	PGW-FSB#	PGW-HCB#	Location	County
HMB #1	891	180	11-8S-30W	Sevier
McLeod Lbr #1	892	181	36-7S-24W	Pike
Moody Shoal #1	872	182	8-8S-30W	Sevier
Green's Chapel #1	873	183	4-8S-29W	Sevier
Arkansas Asphalt #1	874	184	4-8S-24W	Pike
Sevier Oil Co. #Nix		147,8	1-10S-31W	Sevier

TABLE 2

11.20.43. 02/03/83

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:-	SAMPLE ID:HCB180	FORMATION:
STATE :AR	LOCATION :SEC11,T8SR30W	TYPE:SEP	AGE/EPOCH:
COUNTY :SEVIER	API/OCS :-	DEPTH(FT):	
PGW JOB:8162	REPORT :	DATA BASE:PGW	

INSPECTION DATA		SIMULATED DISTILLATION				N-ALKANE CONTENT	PENTACYCLANE CONTENT
		%WT	DEG C	%WT	DEG C	% WT SATURATES	NORMALISED DIST
SPECIFIC GRAV. :							
API GRAV. :							
SULFUR %WT:							
NITROGEN %WT:		IBP				C10 :	H :
WAX %WT:		2		52		C11 :	B :
WAX MPT DEG C:		4		54		C12 :	D :
ASPHALTENE (1) %WT:	33.60	6		56		C13 :	G :
NICKEL (PPM):		8		58		C14 :	N :
VANADIUM (PPM):		10		60		C15 :	O :
RESIDUE		12		62		C16 :	U :
BPT>200C %WT:	100	14		64		C17 :	V :
		16		66		C18 :	ALPHA :
GEOCHEMICAL DATA		18		68		C19 :	BETA :
		20		70		C20 :	GAMA :
RESIDUE BPT>200C		22		72		C21 :	DELTA :
TYPE ANALYSIS		24		74		C22 :	EPSILON :
SATURATES %WT:	11.94	26		76		C23 :	ZETA :
AROMATICS %WT:	19.10	28		78		C24 :	
POLARS %WT:	35.35	30		80		C25 :	STERANE
ASPHALTENE(2)%WT:	33.60	32		82		C26 :	CONTENT
N-ALKANE %WT:	0.00	34		84		C27 :	NORMALISED DIST
N-ALKANE CPI :		36		86		C28 :	
ACYCLIC ISOPRENOID		38		88		C29 :	
FARNESANE %WT:		40		90		C30 :	1 :
ACYCLIC C16 %WT:		42		92		C31 :	2 :
ACYCLIC C18 %WT:		44		94		C32 :	3 :
PRISTANE %WT:		46		96		C33 :	4 :
PHYTANE %WT:		48		98		C34 :	5 :
PRISTANE/PHYTANE :		50		FBP		C35 :	6 :
PRISTANE/N-C17 :						C36 :	7 :
PHYTANE/N-C18 :							8 :
NICKEL/VANADIUM :							9 :
D-13 C(OIL) :	-25.48 %.						10 :
D-13 C(DISTILLATE) :	%.						11 :
D-13 C(SATURATES) :	-26.09 %.						12 :
D-13 C(AROMATICS) :	-25.28 %.						13 :
D-13 C(POLARS) :	-25.36 %.						14 :
D-13 C(ASPHALTENES) :	-25.57 %.						15 :
D-13 C(RESINS) :	%.						16 :
D-34 SULFUR :	%.						17 :
D-2 DEUTERIUM :	%.						18 :
D-15 NITROGEN :	%.						19 :

11.28.52. 02/03/83

TABLE 3

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:-	SAMPLE ID:HCB181	FORMATION:
STATE :AR	LOCATION :SEC36,T7SR24W	TYPE:SEP	AGE/EPOCH:
COUNTY :PIKE	API/OCS :-	DEPTH(FT):	
PGW JOB:8162	REPORT :	DATA BASE:PGW	

INSPECTION DATA

SPECIFIC GRAV.	:	
API GRAV.	:	
SULFUR	%WT:	
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	34.10
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C		
TYPE ANALYSIS		
SATURATES	%WT:	18.68
AROMATICS	%WT:	13.22
POLARS	%WT:	33.99
ASPHALTENE(2)	%WT:	34.10
N-ALKANE	%WT:	0.00
N-ALKANE CPI	:	
ACYCLIC ISOPRENOID		
FARNESANE	%WT:	
ACYCLIC C16	%WT:	
ACYCLIC C18	%WT:	
PRISTANE	%WT:	
PHYTANE	%WT:	
PRISTANE/PHYTANE	:	
PRISTANE/N-C17	:	
PHYTANE/N-C18	:	
NICKEL/VANADIUM	:	
D-13 C(OIL)	:-25.02	%.
D-13 C(DISTILLATE)	:	%.
D-13 C(SATURATES)	:-25.57	%.
D-13 C(AROMATICS)	:-24.67	%.
D-13 C(POLARS)	:-25.02	%.
D-13 C(ASPHALTENES)	:-25.19	%.
D-13 C(RESINS)	:	%.
D-34 SULFUR	:	%.
D-2 DEUTERIUM	:	%.
D-15 NITROGEN	:	%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT

% WT SATURATES	
C10	:
C11	:
C12	:
C13	:
C14	:
C15	:
C16	:
C17	:
C18	:
C19	:
C20	:
C21	:
C22	:
C23	:
C24	:
C25	:
C26	:
C27	:
C28	:
C29	:
C30	:
C31	:
C32	:
C33	:
C34	:
C35	:
C36	:

PENTACYCLANE CONTENT

NORMALISED DIST	
H	:
B	:
D	:
G	:
N	:
O	:
U	:
V	:
ALPHA	:
BETA	:
GAMA	:
DELTA	:
EPSILON	:
ZETA	:

STERANE CONTENT

NORMALISED DIST	
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:
16	:
17	:
18	:
19	:

TABLE 4

S U M M A R Y H Y D R O C A R B O N D A T A S H E E T

COUNTRY:US	WELL/SITE:-	SAMPLE ID:HCB182 FORMATION:
STATE :AR	LOCATION :SEC8,T8SR30W	TYPE:SEP AGE/EPOCH:
COUNTY :SEVIER	API/OCS :-	DEPTH(FT):
PGW JOB:8162	REPORT :	DATA BASE:PGW

INSPECTION DATA

SPECIFIC GRAV.	:	
API GRAV.	:	
SULFUR	%WT:	
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	88.00
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	2.84	
AROMATICS	%WT:	1.34	
POLARS	%WT:	7.81	
ASPHALTENE(2)	%WT:	88.00	
N-ALKANE	%WT:	0.00	
N-ALKANE CPI	:		
ACYCLIC ISOPRENOID			
FARNESANE	%WT:		
ACYCLIC C16	%WT:		
ACYCLIC C18	%WT:		
PRISTANE	%WT:		
PHYTANE	%WT:		
PRISTANE/PHYTANE	:		
PRISTANE/N-C17	:		
PHYTANE/N-C18	:		
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-25.35	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:		%.
D-13 C(AROMATICS)	:	-25.12	%.
D-13 C(POLARS)	:	-25.12	%.
D-13 C(ASPHALTENES)	:	-25.38	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT % WT SATURATES

C10	:
C11	:
C12	:
C13	:
C14	:
C15	:
C16	:
C17	:
C18	:
C19	:
C20	:
C21	:
C22	:
C23	:
C24	:
C25	:
C26	:
C27	:
C28	:
C29	:
C30	:
C31	:
C32	:
C33	:
C34	:
C35	:
C36	:

PENTACYCLANE CONTENT NORMALISED DIST

H	:
B	:
D	:
G	:
N	:
O	:
U	:
V	:
ALPHA	:
BETA	:
GAMA	:
DELTA	:
EPSILON	:
ZETA	:

STERANE CONTENT NORMALISED DIST

1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:
16	:
17	:
18	:
19	:

TABLE 5

S U M M A R Y H Y D R O C A R B O N D A T A S H E E T

COUNTRY:US	WELL/SITE:-	SAMPLE ID:HCB183 FORMATION:
STATE :AR	LOCATION :SEC4,T8SR29W	TYPE:SEP AGE/EPOCH:
COUNTY :SEVIER	API/OCS :-	DEPTH(FT):
PGW JOB:8162	REPORT :	DATA BASE:PGW

INSPECTION DATA		SIMULATED DISTILLATION %WT	DEG C	%WT	DEG C	N-ALKANE CONTENT % WT SATURATES	PENTACYCLANE CONTENT NORMALISED DIST
SPECIFIC GRAV. :							
API GRAV. :							
SULFUR %WT:							
NITROGEN %WT:		IBP				C10 :	H :
WAX %WT:		2		52		C11 :	B :
WAX MPT DEG C:		4		54		C12 :	D :
ASPHALTENE (1) %WT:	93.60	6		56		C13 :	G :
NICKEL (PPM):		8		58		C14 :	N :
VANADIUM (PPM):		10		60		C15 :	O :
RESIDUE		12		62		C16 :	U :
BPT>200C %WT:	100	14		64		C17 :	V :
		16		66		C18 :	ALPHA :
GEOCHEMICAL DATA		18		68		C19 :	BETA :
		20		70		C20 :	GAMA :
RESIDUE BPT>200C		22		72		C21 :	DELTA :
TYPE ANALYSIS		24		74		C22 :	EPSILON :
SATURATES %WT:	3.17	26		76		C23 :	ZETA :
AROMATICS %WT:	.98	28		78		C24 :	
POLARS %WT:	2.24	30		80		C25 :	STERANE CONTENT NORMALISED DIST
ASPHALTENE(2)%WT:	93.60	32		82		C26 :	
N-ALKANE %WT:	0.00	34		84		C27 :	
N-ALKANE CPI :		36		86		C28 :	
ACYCLIC ISOPRENOID		38		88		C29 :	
FARNESANE %WT:		40		90		C30 :	1 :
ACYCLIC C16 %WT:		42		92		C31 :	2 :
ACYCLIC C18 %WT:		44		94		C32 :	3 :
PRISTANE %WT:		46		96		C33 :	4 :
PHYTANE %WT:		48		98		C34 :	5 :
PRISTANE/PHYTANE :		50		FBP		C35 :	6 :
PRISTANE/N-C17 :						C36 :	7 :
PHYTANE/N-C18 :							8 :
NICKEL/VANADIUM :							9 :
D-13 C(OIL) :	-25.29 %.						10 :
D-13 C(DISTILLATE) :	%.						11 :
D-13 C(SATURATES) :	-25.91 %.						12 :
D-13 C(AROMATICS) :	-25.45 %.						13 :
D-13 C(POLARS) :	-25.37 %.						14 :
D-13 C(ASPHALTENES) :	-25.26 %.						15 :
D-13 C(RESINS) :	%.						16 :
D-34 SULFUR :	%.						17 :
D-2 DEUTERIUM :	%.						18 :
D-15 NITROGEN :	%.						19 :

TABLE 6

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:-	SAMPLE ID:HCB184	FORMATION:
STATE :AR	LOCATION :SEC4,T8SR24W	TYPE:SEP	AGE/EPOCH:
COUNTY :PIKE	API/OCS :-	DEPTH(FT):	
PGW JOB:8162	REPORT :	DATA BASE:PGW	

INSPECTION DATA		SIMULATED DISTILLATION %WT	DEG C	%WT	DEG C	N-ALKANE CONTENT % WT SATURATES	PENTACYCLANE CONTENT NORMALISED DIST
SPECIFIC GRAV. :							
API GRAV. :							
SULFUR %WT:							
NITROGEN %WT:		IBP				C10 :	H :
WAX %WT:		2		52		C11 :	B :
WAX MPT DEG C:		4		54		C12 :	D :
ASPHALTENE (1) %WT:	45.70	6		56		C13 :	G :
NICKEL (PPM):		8		58		C14 :	N :
VANADIUM (PPM):		10		60		C15 :	O :
RESIDUE		12		62		C16 :	U :
BPT>200C %WT:	100	14		64		C17 :	V :
		16		66		C18 :	ALPHA :
GEOCHEMICAL DATA		18		68		C19 :	BETA :
		20		70		C20 :	GAMA :
RESIDUE BPT>200C		22		72		C21 :	DELTA :
TYPE ANALYSIS		24		74		C22 :	EPSILON :
SATURATES %WT:	18.15	26		76		C23 :	ZETA :
AROMATICS %WT:	10.69	28		78		C24 :	
POLARS %WT:	25.45	30		80		C25 :	STERANE
ASPHALTENE(2)%WT:	45.70	32		82		C26 :	CONTENT
N-ALKANE %WT:	0.00	34		84		C27 :	NORMALISED DIST
N-ALKANE CPI :		36		86		C28 :	
ACYCLIC ISOPRENOID		38		88		C29 :	
FARNESANE %WT:		40		90		C30 :	1 :
ACYCLIC C16 %WT:		42		92		C31 :	2 :
ACYCLIC C18 %WT:		44		94		C32 :	3 :
PRISTANE %WT:		46		96		C33 :	4 :
PHYTANE %WT:		48		98		C34 :	5 :
PRISTANE/PHYTANE :		50		FBP		C35 :	6 :
PRISTANE/N-C17 :						C36 :	7 :
PHYTANE/N-C18 :							8 :
NICKEL/VANADIUM :							9 :
D-13 C(OIL) :	-25.04 %.						10 :
D-13 C(DISTILLATE) :	%.						11 :
D-13 C(SATURATES) :	-25.56 %.						12 :
D-13 C(AROMATICS) :	-24.36 %.						13 :
D-13 C(POLARS) :	-24.88 %.						14 :
D-13 C(ASPHALTENES):	-25.10 %.						15 :
D-13 C(RESINS) :	%.						16 :
D-34 SULFUR :	%.						17 :
D-2 DEUTERIUM :	%.						18 :
D-15 NITROGEN :	%.						19 :

Conditions for Saturate Hydrocarbon Gas Chromatograph Analysis

G.C.	-	Varian 3700
Column	-	Alltech WCOT 14, .25mm I.D., .2μ film
Carrier	-	Helium, 1 ml/min., 8 P.S.I.G.
Detector	-	F.I.D., 350°C
Temp. Program	-	Inititial 60°C, 4 min. hold
	-	Program Rate of 7°C/min.
	-	Final 270°C, 26 min. hold
Range	-	10^{-11} amps/mv
Solvent	-	n-Hexane
Injector	-	Split 10:1
Attenuation	-	16
Injection Volume	-	2 μL
Concentration	-	6 mg/ml
Analysis Time	-	54 min.

FIGURE 1

Saturate Alkane
Gas Chromatogram
HCB-181

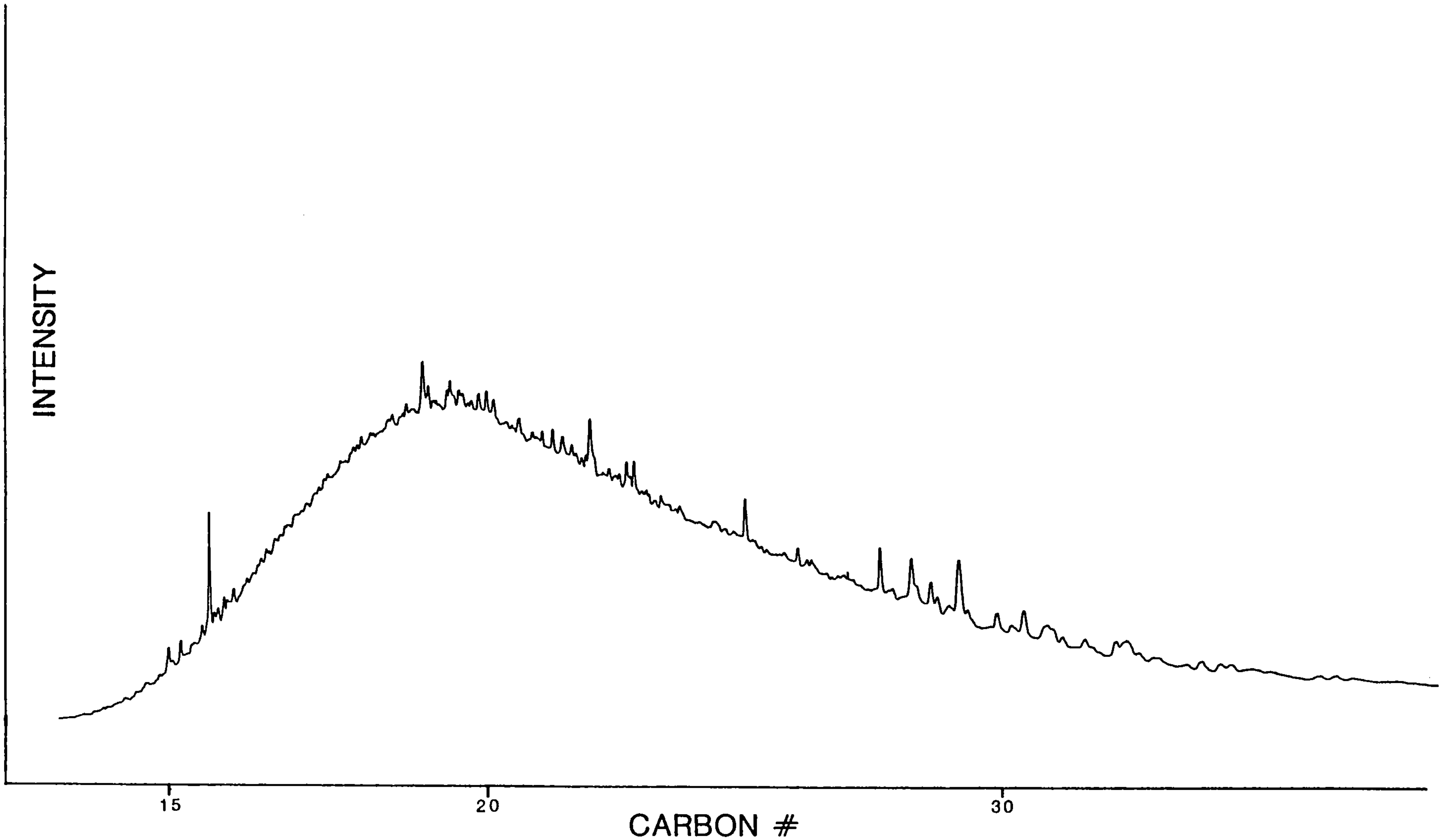


FIGURE 2

ISOTOPIC PROFILES

ARKANSAS ASPHALT SAMPLES

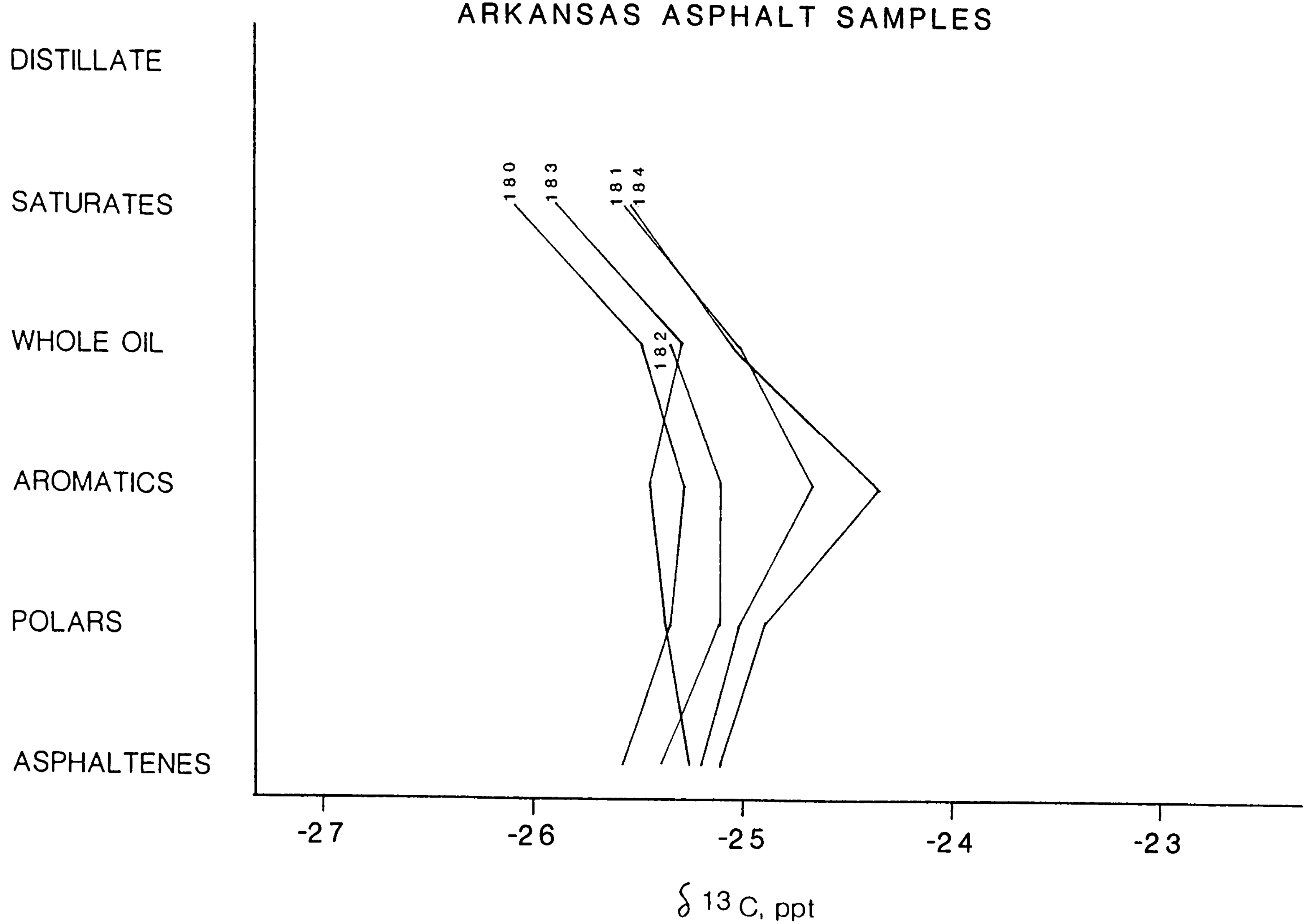
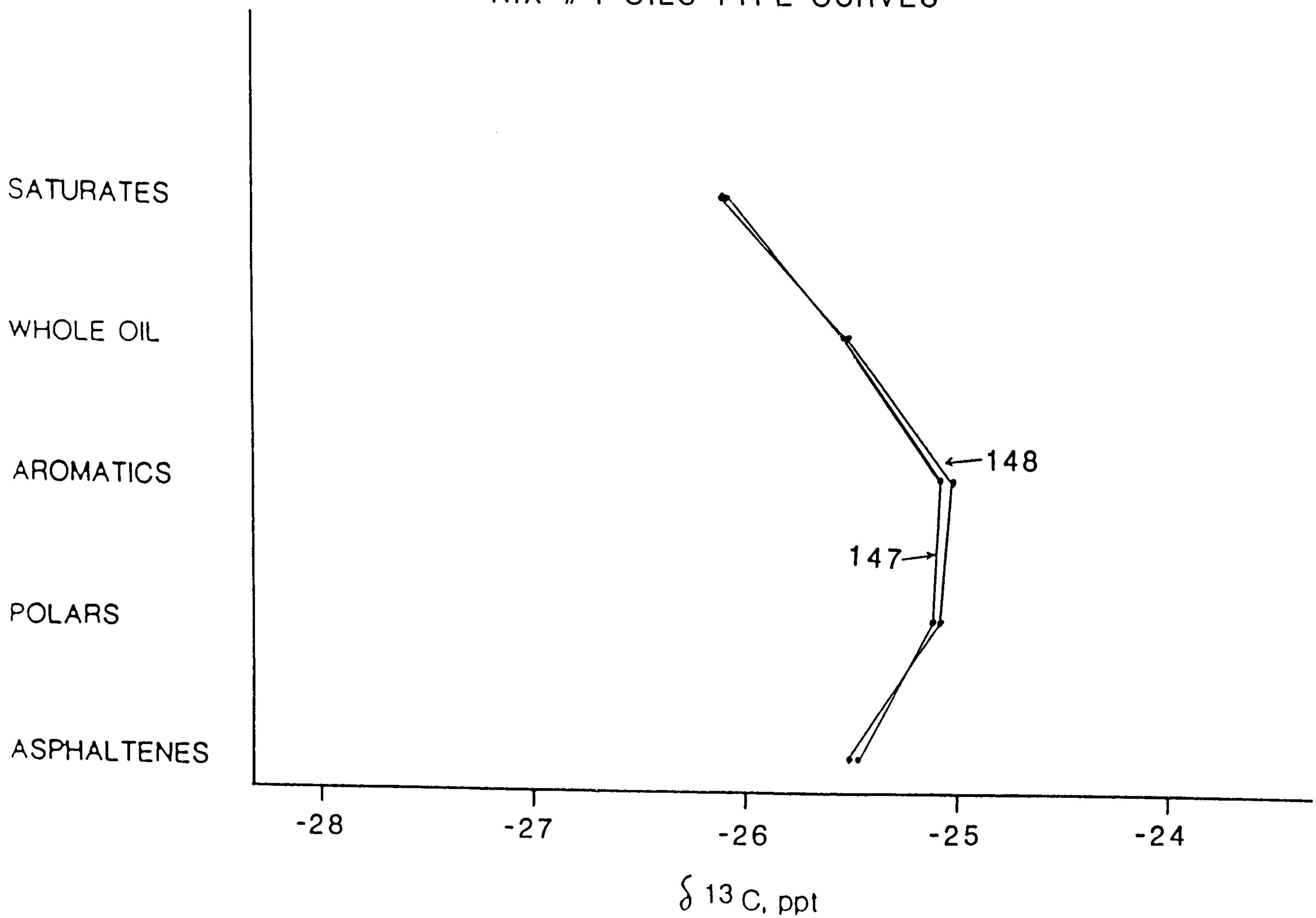


FIGURE 3

NIX #1 OILS TYPE CURVES



SOHIO PETROLEUM COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: E. Luttrell
SPC Mid-Continent Division
Dallas

March 14, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/31483/RB/2-5

Subject: Geochemical Characterization and Comparison of S. W. Arkansas Pike and Sevier Co. Surface Bitumens and the Nix #1 Crude Oil. (Report PGW/TM 100).

Herewith for your retention are two copies (one for C. Titus) of the subject report.

Contributions in this area have previously been issued in a piece meal fashion and the present item is intended to consolidate and close-out this item of work.

Whereas we had already anticipated a strong generic interrelationship between the bitumens and the Nix #1 petroleum, the application of the carbon isotopic profiling technique further corroborated this conclusion. In detail, it was really rather remarkable how closely the Sevier Co. bitumens and Nix #1 (again Sevier Co. derived) oil matched each other. As with our current work on the Stringtown Quarry Bigfork Fm. bitumen, it is apparent that Carbon Isotopic Profiling is insensitive to biodegradation and allows convincing correlations to be achieved between highly biodegraded materials (e.g. the Greens Chapel Specimen) and progenitor petroleums.

R. Burwood

RB:bes
Enclosures: 2

cc: H. G. Bassett
J. G. Grasselli
R. Drozd
[redacted]
H. Halpern
R. Sedivy
F. Marsek
PGW Files (0), (2-5)

1083.02 C 3

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: E. Luttrell
SPC Mid-Continent Division
Dallas

5237

March 12, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/30983/RB/2-5

Subject: Geochemical Source Evaluation in Ouachita Overthrust Quinton Little 1-18 Kings Ranch Well, Bryan County, OK. (Report PGW/TM 104).

Herewith for your retention are two copies of Gary Cole's report on the subject well. Other than for some joint efforts on Eastern Seaboard and a Gulf of Mexico well, this is Gary's first effort at a comprehensive well report. I think congratualtions are in order for what is a succinct and timely contribution.

As per our previous work on Ouachita and Arbuckle Facies sediments, the Bigfork, Womble and Woodford Shales have again identified themselves as potential sources of interest. On this occasion thermal maturity levels were modest and all units of potential were either incipiently or of threshold maturity, only. Although thermal maturity data was scant for the lower thrust sheet, it is unlikely that any of the sediments have progressed beyond optimum oil, possibly incipient gas maturity.

We have recently completed work on the Stringtown Quarry Bigfork Fm. bitumen show. As anticipated this is heavily biodegraded, but has allowed a very convincing comparison of heavy non-biodegraded vs. heavy biodegraded bitumens to be made. As you may recall, this has considerable interest as to the nature of the Taylor #1 Bigfork bitumen show. We will be reporting on this item soon.

R. Burwood

R. Burwood

RB:bes
Enclosures: 2

cc: H. G. Bassett
J. G. Grasselli
R. Drozd
G. Cole
[redacted], (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

THE STANDARD OIL COMPANY

SOHIO PETROLEUM COMPANY
Geochemistry Group

To: E. M. Luttrell
SPC Mid-Continent Region

February 22, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/021183/GC/2-5

Job No.: 82-101

Classification: RESTRICTED

Technical Memorandum (PGW/TM 104) -- Source Evaluation of the Quinton Little 1-18 Kings Ranch Well, Bryan County, Oklahoma.

Summary: Geochemical evaluation and interpretation of the stratigraphic sequences penetrated by the Quinton Little 1-18 Kings Ranch well indicated that the Bigfork and Upper Womble Formations had good oil/gas potential in the upper thrust sheet; the middle thrust sheet had little to marginal potential; and the Caney, Sycamore and Woodford Formations had good oil/gas potential in the lower thrust sheet. Thermal maturity data indicated the upper thrust sheet to be immature to incipiently mature; the middle thrust sheet to be incipiently mature to oil mature; and the lower thrust sheet to be incipiently mature through gas generative. The three formations of good potential in the lower thrust sheet are incipiently mature to oil mature.

1. INTRODUCTION

This report details the source rock geochemistry of the Quinton Little 1-18 Kings Ranch Well. The well is located in Bryan County, Oklahoma at Section 18, T7S, R10E and was drilled to a total depth of 10,508 ft. The well penetrated three thrust sheets, two which were Ouachita facies (upper two sheets) and one of Arbuckle facies (lower sheet).

2. MATERIALS AND METHODS

2.1 Materials

A total of one hundred forty three (143) dry cuttings were submitted for geochemical source rock evaluation covering the gross well intervals 1,580 ft. to 8,500 ft., and 10,060 ft. to 10,400 ft.

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGW methods. Analyses consisted of vitrinite reflectance determinations to establish a thermal maturity profile, rapid screen Rock Eval pyrolysis and total Organic Carbon (% TOC - bitumen free) to assess the overall source quality.

The hydrocarbon proneness (oil or gas) of any interval of interest was assessed by means of proprietary pyrolysis gas chromatography (PGC) which established the GOGI ratio (gas-oil generation index).

3. RESULTS AND CONCLUSIONS

A summary of source rock evaluation data for the sediments penetrated by the 1-18 Kings Ranch well is listed in Table 1 and Figure 1. A Source Evaluation Log is appended as Figure 2.

3.1 Thermal maturity determinations for the 1-18 Kings Ranch well were based on the results of vitrinite reflectance measurements. A suite of twenty (20) samples were selected with one (1) sample from the upper thrust sheet, eleven (11) from the middle thrust sheet and eight (8) from the lower thrust sheet. Samples were selected primarily from Mississippian and Devonian strata but some lower Paleozoics were used. These lower Paleozoic data points, though, are questionable being determined on vitrinite-like particles as opposed to true vitrinite phytoclasts. Figure 1 illustrates the thermal maturity profile for this well.

3.1.1 Upper Thrust Sheet (0 - 2,875 ft.) Ouachita Facies.

Only one data point was selected for this interval. This data point was from the Womble Formation, Ordovician Age and indicated that the upper thrust sheet was incipiently mature for oil.

3.1.2 Middle Thrust Sheet (2,875 - 6,989 ft.) Ouachita Facies.

A linear regression analysis applied to this data set (11 data points) identified the Oil Generation Threshold, considered by PGW to be at 0.6% Ro, to have occurred at approximately 4,355 ft. If thrusting had not occurred at 6,989 ft., the Gas Generation Threshold (Ro = 1.0%) would have occurred at approximately 8,940 ft.

This interval had a gradient of 4.84 DOD units/1,000 ft. (15.9 DOD units/Km) and a correlation coefficient of 0.90. Covering a 3,000 ft. plus interval, this trend was thought to be statistically reasonably reliable.

3.1.3 Lower Thrust Sheet (6,989 - 10,508 ft.) Arbuckle Facies.

A linear regression analysis applied to this data set (8 data points) identified the Oil Generation Threshold to have occurred at approximately 7,470 ft. and the Gas Generation Threshold at 9,340 ft. For reasons discussed below, this threshold may be interpreted to be too shallow, with dominant gas status not attained until beyond TD.

This interval had a gradient of 11.89 DOD units/1,000 ft. (38.9 DOD units/Km) and a correlation coefficient of 0.98.

3.1.4 Comparison of the Ouachita and Arbuckle facies initially suggested that the Arbuckle facies underwent more thermal maturation and therefore, had a higher geothermal gradient than the Ouachita facies. However, as the bulk of the data processed covered less than a 1,000 ft. interval, this gradient is thought rather unreliable. Whether a steeper gradient does apply, indicating a higher heat flow in the Arbuckle sheet is equivocal on such limited data.

3.2 Overall, only two (2) main zones and three (3) minor zones of interest were observed for this well based on good to very good amounts of pyrolytic hydrocarbons. These were recorded by both Rock Eval (S2) and Pyrolysis Gas Chromatography (K2).

3.2.1 The first main zone of interest was found in the upper thrust sheet from 1,730 to 2,220 ft. These sediments were from the Bigfork and Womble Formations, Ordovician in age. Kerogen richness and potential productivity for this interval were good with values of 1.64% TOC and 4.48 kg/ton of pyrolyzable S2 hydrocarbons, respectively. The GOGI ratio average of 0.34 obtained from proprietary Pyrolysis Gas Chromatography indicated that these sediments were oil + gas prone. Only one maturity data point was available for this interval. The vitrinite reflectance for that point was 0.58% indicating these sediments were incipiently mature to threshold mature. No shows were reported from this interval.

3.2.2 The middle thrust sheet contained three (3) minor zones of interest. The first minor zone was from 4,390 to 4,460 ft. in the Missouri Mountain Formation, Silurian Age. Kerogen richness and S2 pyrolyzable hydrocarbons were good with 1.59% TOC and 2.32 kg/ton, respectively. The GOGI for this interval was 0.34 indicating that it was oil + gas prone.

The second minor zone of interest was from 4,810 to 4,860 ft., at the top of the Womble. Kerogen richness and S2 pyrolysable hydrocarbons were good with 2.38% TOC and 2.37 kg/ton, respectively. The GOGI for this interval was 0.30 indicating that it was oil + gas prone.

The third zone of minor interest was from 6,560 to 6,810 ft. Kerogen richness was good with average TOC of 1.79%; pyrolyzable hydrocarbons was moderate with an average value of 1.3 kg/ton. The GOGI ratio was 0.60 indicating that these sediments were gas prone.

The three minor zones discussed above were all oil mature (0.6 - 1.0% Ro) as indicated by vitrinite reflectance. One oil show was reported for the middle thrust sheet and occurred within the Arkansas Novaculite.

3.2.3 The second main zone of interest occurred in the lower thrust sheet from 6,990 to 7,510 ft. This interval included all of the Mississippian Caney and Sycamore Formations and the Devonian Woodford Formation. Kerogen richness and S2 pyrolyzable hydrocarbons were good to very good with 2.90% TOC and 6.43 kg/ton, respectively. The mean GOGI for this interval was 0.39 indicating that it was oil + gas prone. These sediments were incipiently mature to threshold mature according to the vitrinite reflectance values which ranged from 0.53 to 0.62% Ro.

One oil show was reported from the lower thrust sheet and this occurred within the Oil Creek Sandstone.

G. A. Cole

G. A. Cole

GAC:bes

Enclosures: Table 1
Figures 1 and 2

cc: H. G. Bassett
J. G. Grasselli
R. Burwood
R. Drozd
PGW Files (0), (2-5), (8-3)

Work by: R. Lukco
R. Chaikin
L. Monnens
S. White

APPENDIX

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. / LST. } 0-10% qualifying component

SH. CALC / LST. ARG } 11-25% qualifying component

SH. V. CALC / LST. V. ARG } 26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): %. Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): %. Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^{\circ}C$) - Kg/Tn.

S2 (12): %. Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: %. Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

G1 (TSE)(14): %. Generation Index. TSE/TOC
Generation intensity based on abundance of Total Soluble Extract.

G1 (S1)(15): %. Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): %. Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) %. Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): %. Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(0): % Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(0). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

S U M M A R Y D A T A F I L E
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : BRYAN
LOCATION : SEC18,T7SR10E
WELL/SITE : 1-18 KINGS RANCH
API/OCS : 35-013-20078

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	RT8234											
1200	XB823A		DEV	ARKN	FORM.TOP							
1418	XB823B		SIL	MOMT	FORM.TOP							
1535	XB823C		ORD	POLK	FORM.TOP							
1580	WB8234	CTG			SH,V.CALC	45		.39		.03	.09	23
1585	XB8234		ORD	BGFK	FORM.TOP							
1630	WB8235	CTG			SH,V.CALC	46		.41		.08	.46	112
1680	WB8236	CTG			SH,V.CALC	32		.51		.13	1.08	212
1730	WB8237	CTG			SH,V.CALC	34		.79		.26	2.37	300
1770	WB8238	CTG			SH,CALC	17		2.73		.41	11.64	426
1775	XB8238		ORD	WOMB	FORM.TOP							
1820	WB8239	CTG			SH,CALC	14		1.70		.44	5.14	302
1870	WB8240	CTG			SH,CALC	12		1.76		.23	5.18	294
1920	WB8241	CTG			SH,CALC	11		1.07		.12	1.09	102
1970	WB8242	CTG			SH	10		1.17		.20	.95	81
2020	WB8243	CTG			SH,CALC	14		1.25		.22	2.43	194
2070	WB8244	CTG			SH,CALC	13		1.38		.27	3.30	239
2120	WB8245	CTG			SH,CALC	14		1.99		.32	5.17	260
2170	WB8246	CTG			SH,CALC	14		2.78		.47	9.80	353
2220	WB8247	CTG			SH,CALC	13		1.42		.17	2.24	158
2270	WB8248	CTG			SH,CALC	14		1.14		.19	1.24	109
2320	WB8249	CTG			SH,CALC	14		1.16		.24	1.44	124
2370	WB8250	CTG			SH,CALC	13		1.04		.05	.83	80
2420	WB8251	CTG			SH,CALC	13		.78		.04	.13	17
2470	WB8252	CTG			SH,CALC	13		.92		.22	.27	29
2520	WB8253	CTG			SH,CALC	13		.77		.19	.05	6
2570	WB8254	CTG			SH,CALC	12		.79		.12	.56	71
2620	WB8255	CTG			SH,CALC	11		.91		.19	.98	108
2670	WB8256	CTG			SH,CALC	12		.93		.12	1.12	120
2720	WB8257	CTG			SH,CALC	13		1.22		.16	1.35	111
2770	WB8258	CTG			SH,CALC	12		1.06		.21	.56	53
2870	WB8259	CTG			SH,CALC	13		.88		.07	.26	30
2875	XB8259		MISS	STAN	FORM.TOP							
2920	WB8260	CTG			SH,CALC	13		.74		.19	.22	30
2970	WB8261	CTG			SH,CALC	14		.58		.13	.13	22
3020	WB8262	CTG			SH,CALC	14		.60		.03	.06	10
3070	WB8263	CTG			SH,CALC	14		.52		.03	.03	6

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
1200															
1418															
1535															
1580	.25		8												
1585															
1630	.15		20												
1680	.11		25		1.16	.40	.76	227	.53						
1730	.10		33		3.06	.71	2.35	387	.30						
1770	.03		15		11.08	2.36	8.72	406	.27						
1775															
1820	.08		26		5.14	1.12	4.02	302	.28						
1870	.04		13		6.21	1.32	4.89	353	.27						
1920	.10		11												
1970	.17		17		2.26	.73	1.53	193	.48			.58			
2020	.08		18		3.48	.84	2.64	278	.32						
2070	.08		20		3.94	1.08	2.86	286	.38						
2120	.06		16		6.85	1.58	5.27	344	.30						
2170	.05		17		10.03	2.37	7.66	361	.31						
2220	.07		12		2.74	.85	1.89	193	.45						
2270	.13		17		2.46	.78	1.68	216	.46						
2320	.14		21		2.78	.77	2.01	240	.38						
2370	.06		5												
2420	.24		5												
2470	.45		24												
2520	.79		25												
2570	.18		15												
2620	.16		21												
2670	.10		13		1.85	.47	1.38	199	.34						
2720	.11		13		2.76	.92	1.84	226	.50						
2770	.27		20												
2870	.21		8												
2875															
2920	.46		26									.52			
2970	.50		22												
3020	.33		5												
3070	.50		6												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3120	WB8264	CTG			SH,CALC	14		.64		.14	.12	19
3170	WB8265	CTG			SH,CALC	14		.55		.11	.17	31
3220	WB8266	CTG			SH,CALC	14		.64		.08	.23	36
3270	WB8267	CTG			SH,CALC	14		.82		.15	.92	112
3320	WB8268	CTG			SH,CALC	14		.70		.09	.29	41
3370	WB8269	CTG			SH,CALC	15		.75		.11	.28	37
3420	WB8270	CTG			SH,CALC	14		.69		.09	.28	41
3470	WB8271	CTG			SH,CALC	13		.85		.09	.31	36
3520	WB8272	CTG			SH,CALC	12		.92		.14	.96	104
3570	WB8273	CTG			SH,CALC	13		.65		.17	.28	43
3620	WB8274	CTG			SH,CALC	14		.75		.20	.36	48
3670	WB8275	CTG			SH,CALC	10		1.04		.12	.30	29
3720	WB8276	CTG			SH,CALC	12		.84		.19	.50	60
3770	WB8277	CTG			SH,CALC	11		.76		.12	.27	36
3820	WB8278	CTG			SH,CALC	11		.76		.18	.21	28
3870	WB8279	CTG			SH,CALC	11		.84		.15	.51	61
3920	WB8280	CTG			SH,CALC	11		.71		.15	.63	89
3970	WB8281	CTG			SH,CALC	17		.70		.05	.30	43
4020	WB8282	CTG			SH,CALC	17		.69		.13	.42	61
4070	WB8283	CTG			SH,CALC	20		.80		.20	.35	44
4120	WB8284	CTG			SH,CALC	13		.52		.08	.11	21
4170	WB8285	CTG			SH	9		.40		.15	.34	85
4215	XB8285		DEV	ARKN	FORM.TOP							
4220	WB8286	CTG			SH,CALC	12		.54		.19	.37	69
4270	WB8287	CTG			SH,CALC	12		1.32		.26	1.74	132
4320	WB8288	CTG			SH,CALC					.21	.75	
4340	WB8289	CTG			SH,CALC	11		.47		.16	.40	85
4343	XB8289		SIL	MONT	FORM.TOP							
4390	WB8290	CTG			SH,CALC	18		1.52		.18	2.38	157
4440	WB8291	CTG			SH,CALC	11		1.66		.38	2.25	136
4459	XB8291		ORD	POLK	FORM.TOP							
4460	WB8292	CTG			SH,CALC	10		1.72		.32	1.80	105
4509	XB8292		ORD	BGFK	FORM.TOP							
4510	WB8293	CTG			SH,CALC	14		.92		.26	.68	74
4560	WB8294	CTG			SH,V.CALC	26		.69		.15	.37	54
4610	WB8295	CTG			SH,V.CALC	30		.56		.12	.44	79
4660	WB8296	CTG			SH,CALC	24		.56		.14	.26	46
4710	WB8297	CTG			SH,V.CALC	28		.59		.13	.27	46
4760	WB8298	CTG			SH,CALC	16		.48		.09	.06	12
4809	XB8298		ORD	WOMB	FORM.TOP							
4810	WB8299	CTG			SH,CALC	11		2.38		.15	2.37	100
4860	WB8300	CTG			SH,CALC	12		1.73		.09	1.07	62
4910	WB8301	CTG			SH,CALC	14		1.27		.11	.90	71
4960	WB8302	CTG			SH,CALC	15		1.02		.09	.51	50
5010	WB8303	CTG			SH,CALC	17		1.20		.22	.51	42
5060	WB8304	CTG			SH,CALC	14		.92		.15	.71	77
5110	WB8305	CTG			SH,CALC	15		1.08		.10	.48	44
5160	WB8306	CTG			SH,CALC	14		1.01		.26	.52	51
5210	WB8307	CTG			SH,CALC	13		1.05		.15	.28	27

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3120	.54		22									.50			
3170	.39		20												
3220	.26		12												
3270	.14		18												
3320	.24		13												
3370	.28		15									.53			
3420	.24		13												
3470	.23		11												
3520	.13		15		1.72	.49	1.23	187	.40						
3570	.38		26												
3620	.36		27									.56			
3670	.29		12												
3720	.28		23												
3770	.31		16												
3820	.46		24									.61			
3870	.23		18												
3920	.19		21												
3970	.14		7												
4020	.24		19												
4070	.36		25									.56			
4120	.42		15												
4170	.31		37												
4215															
4220	.34		35												
4270	.13		20									.54			
4320	.22											.61			
4340	.29		34												
4343															
4390	.07		12		4.00	1.01	2.99	263	.34						
4440	.14		23												
4459															
4460	.15		19		3.21	1.29	1.92	187	.67						
4509															
4510	.28		28												
4560	.29		22												
4610	.21		21												
4660	.35		25												
4710	.33		22												
4760	.60		19												
4809															
4810	.06		6		5.85	1.35	4.50	246	.30						
4860	.08		5		2.59	.86	1.73	150	.50						
4910	.11		9												
4960	.15		9									.71			
5010	.30		18												
5060	.17		16												
5110	.17		9												
5160	.33		26												
5210	.35		14												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5260	WB8308	CTG			SH,CALC	14		.99		.09	.34	34
5310	WB8309	CTG			SH,CALC	14		1.19		.19	.62	52
5360	WB8310	CTG			SH,CALC	14		1.04		.12	.74	71
5410	WB8311	CTG			SH,CALC	14		.94		.06	.18	19
5470	WB8312	CTG			SH,CALC	14		.91		.16	.30	33
5520	WB8313	CTG			SH,CALC	23		.73		.08	.16	22
5570	WB8314	CTG			SH,CALC	14		.79		.10	.32	41
5620	WB8315	CTG			SH,CALC	14		1.11		.27	.41	37
5660	WB8316	CTG			SH,CALC	13		1.06		.23	.57	54
5710	WB8317	CTG			SH,CALC	14		1.65		.24	.67	41
5760	WB8318	CTG			SH,CALC	14		1.23		.23	.52	42
5810	WB8319	CTG			SH,CALC	15		1.15		.30	.82	71
5860	WB8320	CTG			SH,CALC	14		1.45		.21	.73	50
5910	WB8321	CTG			SH,CALC	13		1.72		.14	1.22	71
5960	WB8322	CTG			SH,CALC	14		1.82		.77	1.72	95
6010	WB8323	CTG			SH,CALC	13		2.18		.14	.68	31
6060	WB8324	CTG			SH,CALC	13		1.58		.09	.41	26
6110	WB8325	CTG			SH,CALC	15		1.68		.21	.83	49
6160	WB8326	CTG			SH,CALC	19		1.70		.29	.97	57
6210	WB8327	CTG			SH,CALC	17		1.72		.11	.48	28
6260	WB8328	CTG			SH,CALC	17		1.68		.41	.84	50
6310	WB8329	CTG			SH,CALC	18		1.44		.14	.67	47
6360	WB8330	CTG			SH,CALC	14		1.59		.08	.35	22
6410	WB8331	CTG			SH,CALC	15		1.79		.09	.77	43
6460	WB8332	CTG			SH,CALC	19		1.62		.32	.88	54
6510	WB8333	CTG			SH,CALC	20		1.59		.26	.73	46
6560	WB8334	CTG			SH,CALC	20		1.85		.30	1.12	61
6610	WB8335	CTG			SH,CALC	22		1.59		.17	.89	56
6660	WB8336	CTG			SH,CALC	14		1.79		.25	1.24	69
6710	WB8337	CTG			SH,CALC	17		1.90		.41	1.98	104
6760	WB8338	CTG			SH,CALC	18		1.81		.15	1.27	70
6810	WB8339	CTG			SH,CALC	20		1.45		.27	.74	51
6860	WB8340	CTG			SH,CALC	18		1.44		.17	.51	35
6910	WB8341	CTG			SH,CALC	16		1.60		.20	.61	38
6960	WB8342	CTG			SH,CALC	17		1.46		.12	.45	31
6989	XB8342		MISS	CANY	FORM.TOP							
6990	WB8343	CTG			SH,CALC	18		2.37		.28	2.41	102
7040	WB8344	CTG			SH,CALC	21		2.95		.57	3.60	122
7075	XB8344		MISS	SYCA	FORM.TOP							
7080	WB8345	CTG			SH,CALC	18		4.00		.48	7.11	178
7130	WB8346	CTG			SH,CALC	21		2.45		.61	5.51	225
7180	WB8347	CTG			SH,CALC	20		1.91		.32	1.43	75
7230	WB8348	CTG			SH,CALC	18		1.46		.17	.74	51
7280	WB8349	CTG			SH,CALC	16		3.00		.72	6.95	232
7282	XB8349		DEV	WOOD	FORM.TOP							
7330	WB8350	CTG			SH,CALC	11		2.61		.75	7.91	303
7380	WB8351	CTG			SH,CALC	10		2.90		.76	8.62	297
7430	WB8352	CTG			SH,CALC	9		3.32		.82	8.41	253
7480	WB8353	CTG			SH,CALC	12		4.89		1.27	18.00	368

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5260	.21		9												
5310	.23		16												
5360	.14		12												
5410	.25		6												
5470	.35		18												
5520	.33		11												
5570	.24		13												
5620	.40		24												
5660	.29		22												
5710	.26		15												
5760	.31		19												
5810	.27		26												
5860	.22		14												
5910	.10		8		1.63	.71	.92	95	.78						
5960	.31		42		1.63	.71	.92	90	.78			.74			
6010	.17		6												
6060	.18		6												
6110	.20		12												
6160	.23		17												
6210	.19		6									.69			
6260	.33		24												
6310	.17		10												
6360	.19		5												
6410	.10		5												
6460	.27		20												
6510	.26		16												
6560	.21		16		1.78	.71	1.07	96	.67						
6610	.16		11												
6660	.17		14		2.16	.84	1.32	121	.64						
6710	.17		22		2.37	.79	1.58	125	.50						
6760	.11		8												
6810	.27		19												
6860	.25		12												
6910	.25		12												
6960	.21		8												
6989															
6990	.10		12		2.23	1.15	1.08	94	1.07						
7040	.14		19		5.78	1.62	4.16	196	.39			.54			
7075															
7080	.06		12		11.25	3.04	8.21	281	.37			.53			
7130	.10		25		5.96	1.70	4.26	243	.40						
7180	.18		17												
7230	.19		12									.54			
7280	.09		24		8.67	2.52	6.15	289	.41			.58			
7282															
7330	.09		29		8.24	2.23	6.01	316	.37						
7380	.08		26		8.08	2.22	5.86	279	.38						
7430	.09		25		8.41	2.18	6.23	253	.35						
7480	.07		26		14.63	4.25	10.38	299	.41			.62			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
7510	XB835A		SIL	HUNT	FORM.TOP							
7738	XB8353		ORD	SYLV	FORM.TOP							
7750	WB8354	CTG			SH,CALC	23		1.02		.14	.58	57
7800	WB8355	CTG			SH,CALC	24		1.00		.29	.65	65
7850	WB8356	CTG			SH,CALC	24		1.06		.24	.69	65
7900	WB8357	CTG			SH,CALC	21		1.25		.10	.56	45
7950	WB8358	CTG			SH,CALC	18		1.16		.22	.76	66
8000	WB8359	CTG			SH,CALC	17		1.43		.28	1.12	78
8050	WB8360	CTG			SH,CALC	15		1.24		.08	.72	58
8100	WB8361	CTG			SH,CALC	24		1.17		.14	.64	55
8150	WB8362	CTG			SH,CALC	20		1.27		.26	.75	59
8200	WB8363	CTG			SH,CALC	22		1.17		.14	.54	46
8250	WB8364	CTG			SH,CALC	19		1.26		.23	.82	65
8300	WB8365	CTG			SH,CALC	18		1.37		.30	.84	61
8350	WB8366	CTG			SH,CALC	21		1.19		.20	.51	43
8400	WB8367	CTG			SH,CALC	18		1.30		.10	.48	37
8450	WB8368	CTG			SH,CALC	17		1.30		.16	.62	48
8500	WB8369	CTG			SH,CALC	18		1.13		.10	.37	33
8538	XB836A		ORD	VIOL	FORM.TOP							
9090	XB836B		ORD	BROM	FORM.TOP							
9416	XC836C		ORD	MCLI	FORM.TOP							
9795	XB8369		ORD	OLCK	FORM.TOP							
10060	WB8370	CTG			SH,V.CALC	32		.18		.05	.03	17
10110	WB8371	CTG			SH,V.CALC	30		.38		.10	.01	3
10160	WB8372	CTG			SH,CALC	24		.24		.10	.02	8
10210	WB8373	CTG			SH,V.CALC	44		.15		.25	.13	87
10300	WB8374	CTG			SH,CALC	20		.20		.09	.01	5
10350	WB8375	CTG			SST,CALC	14		.18		.21	.07	39
10400	WB8376	CTG			SST,CALC	16		.11		.10	0.00	0
10458	XB837A		ORD	JOIN	FORM.TOP							
10508	XB8376	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
7510															
7738															
7750	.19		14												
7800	.31		29												
7850	.26		23												
7900	.15		8												
7950	.22		19												
8000	.20		20		1.66	.66	1.00	116	.66			.72			
8050	.10		6												
8100	.18		12												
8150	.26		20												
8200	.21		12												
8250	.22		18												
8300	.26		22		1.59	.60	.99	116	.61						
8350	.28		17												
8400	.17		8												
8450	.21		12												
8500	.21		9									.77			
8538															
9090															
9416															
9795															
10060	.63		28												
10110	.91		26												
10160	.83		42												
10210	.66		167												
10300	.90		45												
10350	.75		117												
10400	1.00		91												
10458															
10508															

c.3

Geochemistry Group

15173

To: E. Luttrell
SPC Mid-Continent Division
Dallas

April 19, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/41483/RB/2-5

Subject: Bigfork Chert Bitumens - Ouachita Overthrust/Stringtown Quarry. Report PGW/TM 109.

Herewith for your retention are two copies (one for T. Legg/C. Titus) of the subject report.

As we have commented in a previous communication, there is a strong generic co-identity between the Stringtown Quarry seep bitumen and the Taylor #1 produced analogue. Both are heavy (i.e. very low API^{o} gravity) materials and demonstrate, in an almost classical sense, the confusion that could arise in differentiating between an early mature-heavy oil and a (heavy) biodegraded oil. We are completely satisfied that the Stringtown seep, with its lack of n-alkanes, is the biodegraded residium of a heavy oil (i.e. early mature) the same provenance as the show reported in Taylor #1 (Bigfork Chert @ approximately 2,100 ft.).

Computer matching of the two saturate alkane chromatograms clearly demonstrated the co-identity of the n-alkane - less hump in the biodegraded product (Stringtown) with the "normal" un-biodegraded Taylor show. Similarly, the two carbon isotopic profiles show a classic disposition revolving, as they do, around the Aromatic fraction. The Aromatics would be the fraction least expected to be influenced by biodegradative effects. The isotopic heavier Saturates and lighter Polars/Asphaltenes in the case of the biodegraded product, are entirely consistent with the metabolism of light n-alkanes with the cognate production of a lighter residium of metabolic products/detritus (sic polar/asphaltene-like components).

This present piece of work thus has considerable scientific merit in that it clearly demonstrates:

A. an actual <u>in vivo</u> biodegradative comparison as opposed to contrieved <u>in vitro</u> cases that have previously been published.

B. provides a fairly definitive case in the differention of an "early mature" vs. a "biodegraded residium" heavy oil.

C. finally it provides an interesting development and sequel to work recently published by J. Curiale on Ouachita oils, bitumens and grahamites, etc. (AAPG Bull., 65, 24-26).

Along these lines, have you any reservations or objections in principle as to PGW thinking in terms of a short publication on this matter? As indicated above, we see this as an obvious sequel to the publication mentioned. We look forward to your response here.

R. Burwood

RB:bes
Enclosures: 2

cc: H. G. Bassett
W. E. Bischoff
J. G. Grasselli
R. Drozd
G. Cole
R. Sedivy
PGW Files (0), (2-5), RB

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY

Geochemistry Group

To: T. Legg
SPC Mid-Continent Region
Dallas

April 7, 1983

From: Petroleum Geochemistry Group
Warrensville

PGW/32183/RS/2-5

Job No.: 82-102

Classification: RESTRICTED

Technical Memorandum (PGW/TM 109) -- Geochemical Characterization and Comparison of Two Asphalt Samples from the Bigfork Chert, Atoka County, Oklahoma.

Summary: An asphalt sample recovered from the Bigfork Chert, Stringtown Quarry, Atoka County, Oklahoma, was characterized and compared to an historic asphalt collected from the same formation as it occurs in the Taylor #1 well, located 12 miles to the south. The Quarry sample was found to be severely weathered and/or biodegraded. Stable carbon isotopic data indicated that the two asphalts were generically related; an origin as residual fractions, derived from a common precursor oil, was postulated.

1. INTRODUCTION

An asphalt sample from the Stringtown Quarry, Atoka County, Oklahoma, was received for hydrocarbon characterization. It was compared to a historical asphalt sample, retrieved from the Sohio #1 Taylor well at a depth of 2,100 ft. Both samples were from the Bigfork Chert, Ordovician age. The Stringtown Quarry is located approximately 12 miles north of the Taylor #1 well.

2. MATERIALS AND METHODS

The Taylor #1 and Stringtown Quarry samples were given PGW hydrocarbon designations HCB-006 and HCB-275, respectively. The Soxhlet (CH_2CL_2) extractable fraction from each sample was characterized using the following PGW standardized techniques: Asphaltene Content, Hydrocarbon Type Analysis, Saturate Alkane Analysis, and Stable Carbon Isotopic Profiling.

3. RESULTS AND CONCLUSIONS

Results of the geochemical analyses are summarized in Tables 1 and 2 and Figures 1 - 3.

3.1 Hydrocarbon Type data are shown in Tables 1 and 2. The Stringtown Quarry sample, HCB-275, contained a much greater proportion of asphaltenes (52.2% versus 12.0%), and lesser saturates and aromatics (6.6% and 11.8% versus 31.4% and 22.8%) in comparison to the Taylor #1 sample, HCB-006.

3.2 Saturate Alkane chromatograms (Figures 1 and 2) revealed a complete series of normal alkanes, from n-C_{13} to n-C_{30} plus, for the Taylor asphalt. HCB-275 contained few peaks and no identifiable normal alkanes; the high asphaltene content and chromatographic character of this sample were indicative of weathering/biodegradation. Similarities in the bimodal napthenic distributions of both samples suggested that the asphalts were generically related.

3.3 Stable carbon isotopic data, depicted in Figure 3, confirmed the above interpretation. The isotopic profiles were, generally, in close agreement. The Stringtown asphalt contained slightly heavier saturates (and whole), and lighter polars and asphaltenes, relative to HCB-006.

3.4 The isotopic results clearly demonstrated a generic relationship between the Stringtown Quarry and Taylor #1 asphalts; it is probable that these materials represented residues derived from one and the same precursor oil. The variations in physical and isotopic properties observed for the Stringtown Quarry asphalt, relative to the Taylor #1 sample (high asphaltene content, absence of normal alkanes, isotopically heavier saturate and lighter polar and asphaltene fractions) were characteristic artifacts of severe weathering and/or biodegradation of the former sample.

R. A. Sedivy

R. A. Sedivy

G. A. Cole

G. A. Cole

/bes

Enclosures: Tables 1 and 2
Figures 1 - 3

cc: H. G. Bassett
J. G. Grasselli (Title Page only)
E. Luttrell
C. Titus
R. Burwood
R. Drozd
PGW Files (0), (2-5)

Work by: S. Adams
R. Cavalier
H. Halpern
J. Reymander

TABLE 1

12.58.10. 03/21/83

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:TAYLOR#1	SAMPLE ID:HCB006 FORMATION:BGFK
STATE :OK	LOCATION :SEC15,T3SR11E	TYPE:PRO AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :35-A00520087	DEPTH(FT): 2110
PGW JOB:8003	REPORT :	DATA BASE:GEOCHEM/PGW

INSPECTION DATA

SPECIFIC GRAV.	:	1.000
API GRAV.	:	10.00
SULFUR	%WT:	.80
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	12.00
NICKEL	(PPM):	42
VANADIUM	(PPM):	180
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	31.40	
AROMATICS	%WT:	22.80	
POLARS	%WT:	33.80	
ASPHALTENE(2)	%WT:	12.00	
N-ALKANE	%WT:	38.23	
N-ALKANE CPI	:	1.07	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.65	
ACYCLIC C16	%WT:	1.48	
ACYCLIC C18	%WT:	2.37	
PRISTANE	%WT:	3.18	
PHYTANE	%WT:	2.86	
PRISTANE/PHYTANE	:	1.11	
PRISTANE/N-C17	:	.86	
PHYTANE/N-C18	:	.81	
NICKEL/VANADIUM	:	.23	
D-13 C(OIL)	:	-30.40	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-30.60	%.
D-13 C(AROMATICS)	:	-30.40	%.
D-13 C(POLARS)	:	-30.18	%.
D-13 C(ASPHALTENES)	:	-30.13	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP	257		
2	287	52	
4	305	54	
6	320	56	
8	336	58	
10	352	60	
12	368	62	
14	384	64	
16	399	66	
18	414	68	
20	427	70	
22	440	72	
24	452	74	
26	463	76	
28	474	78	
30	486	80	
32	498	82	
34	510	84	
36	522	86	
38	532	88	
40	541	90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT (% WT SATURATES)

C10 :	
C11 :	
C12 :	.150
C13 :	.700
C14 :	1.600
C15 :	2.870
C16 :	3.340
C17 :	3.700
C18 :	3.550
C19 :	3.520
C20 :	2.550
C21 :	2.300
C22 :	1.760
C23 :	1.800
C24 :	1.420
C25 :	2.160
C26 :	1.590
C27 :	1.090
C28 :	1.080
C29 :	.900
C30 :	1.470
C31 :	.480
C32 :	.190
C33 :	
C34 :	
C35 :	
C36 :	

PENTACYCLANE CONTENT NORMALISED DIST

H :	
B :	
D :	
G :	
N :	
O :	
U :	
V :	
ALPHA :	
BETA :	
GAMA :	
DELTA :	
EPSILON :	
ZETA :	

STERANE CONTENT NORMALISED DIST

1 :	
2 :	
3 :	
4 :	
5 :	
6 :	
7 :	
8 :	
9 :	
10 :	
11 :	
12 :	
13 :	
14 :	
15 :	
16 :	
17 :	
18 :	
19 :	

TABLE 2

13.03.16. 03/21/83

SUMMARY HYDROCARBON DATA SHEET

COUNTRY:US	WELL/SITE:STRINGTOWN QUARRY	SAMPLE ID:HCB275 FORMATION:BGFK
STATE :AR	LOCATION :SEC16,T1SR12E	TYPE:TSE AGE/EPOCH:ORD
COUNTY :ATOKA	API/OCS :-	DEPTH(FT):
PGW JOB:82102	REPORT :	DATA BASE:GEOCHEM/PGW

INSPECTION DATA

SPECIFIC GRAV.	:	1.250
API GRAV.	:	
SULFUR	%WT:	4.98
NITROGEN	%WT:	
WAX	%WT:	
WAX MPT	DEG C:	
ASPHALTENE (1)	%WT:	52.18
NICKEL	(PPM):	
VANADIUM	(PPM):	
RESIDUE BPT>200C	%WT:	100

GEOCHEMICAL DATA

RESIDUE BPT>200C			
TYPE ANALYSIS			
SATURATES	%WT:	6.63	
AROMATICS	%WT:	11.84	
POLARS	%WT:	29.35	
ASPHALTENE(2)	%WT:	52.18	
N-ALKANE	%WT:	15.49	
N-ALKANE CPI	:	1.56	
ACYCLIC ISOPRENOID			
FARNESANE	%WT:	.09	
ACYCLIC C16	%WT:	.14	
ACYCLIC C18	%WT:	.35	
PRISTANE	%WT:	.43	
PHYTANE	%WT:	.18	
PRISTANE/PHYTANE	:	2.45	
PRISTANE/N-C17	:	1.40	
PHYTANE/N-C18	:	.36	
NICKEL/VANADIUM	:		
D-13 C(OIL)	:	-30.25	%.
D-13 C(DISTILLATE)	:		%.
D-13 C(SATURATES)	:	-30.31	%.
D-13 C(AROMATICS)	:	-30.44	%.
D-13 C(POLARS)	:	-30.29	%.
D-13 C(ASPHALTENES)	:	-30.32	%.
D-13 C(RESINS)	:		%.
D-34 SULFUR	:		%.
D-2 DEUTERIUM	:		%.
D-15 NITROGEN	:		%.

SIMULATED DISTILLATION

%WT	DEG C	%WT	DEG C
IBP			
2		52	
4		54	
6		56	
8		58	
10		60	
12		62	
14		64	
16		66	
18		68	
20		70	
22		72	
24		74	
26		76	
28		78	
30		80	
32		82	
34		84	
36		86	
38		88	
40		90	
42		92	
44		94	
46		96	
48		98	
50		FBP	

N-ALKANE CONTENT % WT SATURATES

C10	:	
C11	:	
C12	:	
C13	:	
C14	:	
C15	:	.330
C16	:	.220
C17	:	.310
C18	:	.490
C19	:	.590
C20	:	.390
C21	:	.950
C22	:	.200
C23	:	1.960
C24	:	.300
C25	:	.150
C26	:	.770
C27	:	.240
C28	:	2.300
C29	:	.990
C30	:	
C31	:	3.150
C32	:	2.180
C33	:	
C34	:	
C35	:	
C36	:	

PENTACYCLANE CONTENT NORMALISED DIST

H	:
B	:
D	:
G	:
N	:
O	:
U	:
V	:
ALPHA	:
BETA	:
GAMA	:
DELTA	:
EPSILON	:
ZETA	:

STERANE CONTENT NORMALISED DIST

1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:
16	:
17	:
18	:
19	:

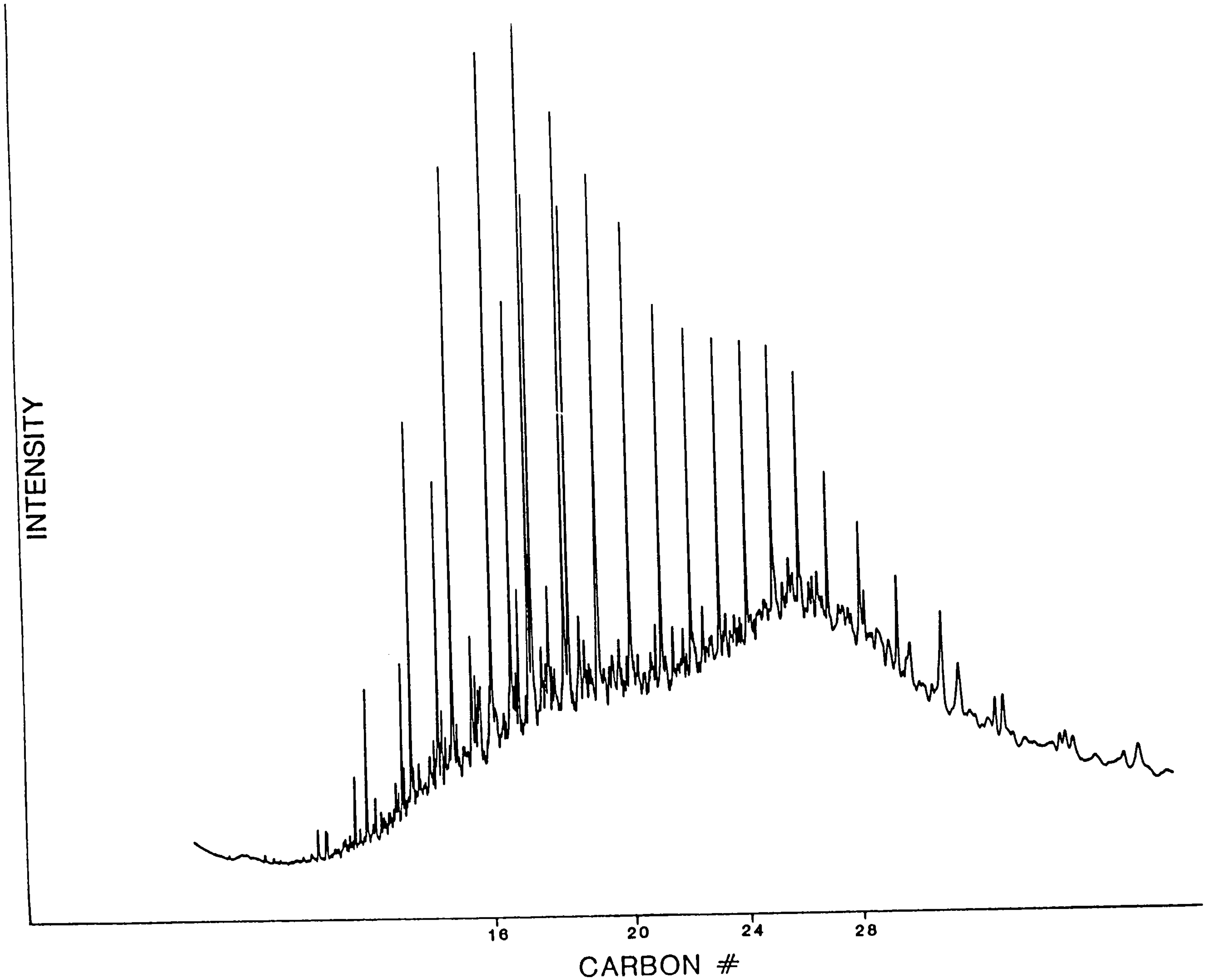


FIGURE 1: Saturate Chromatogram HCB-006

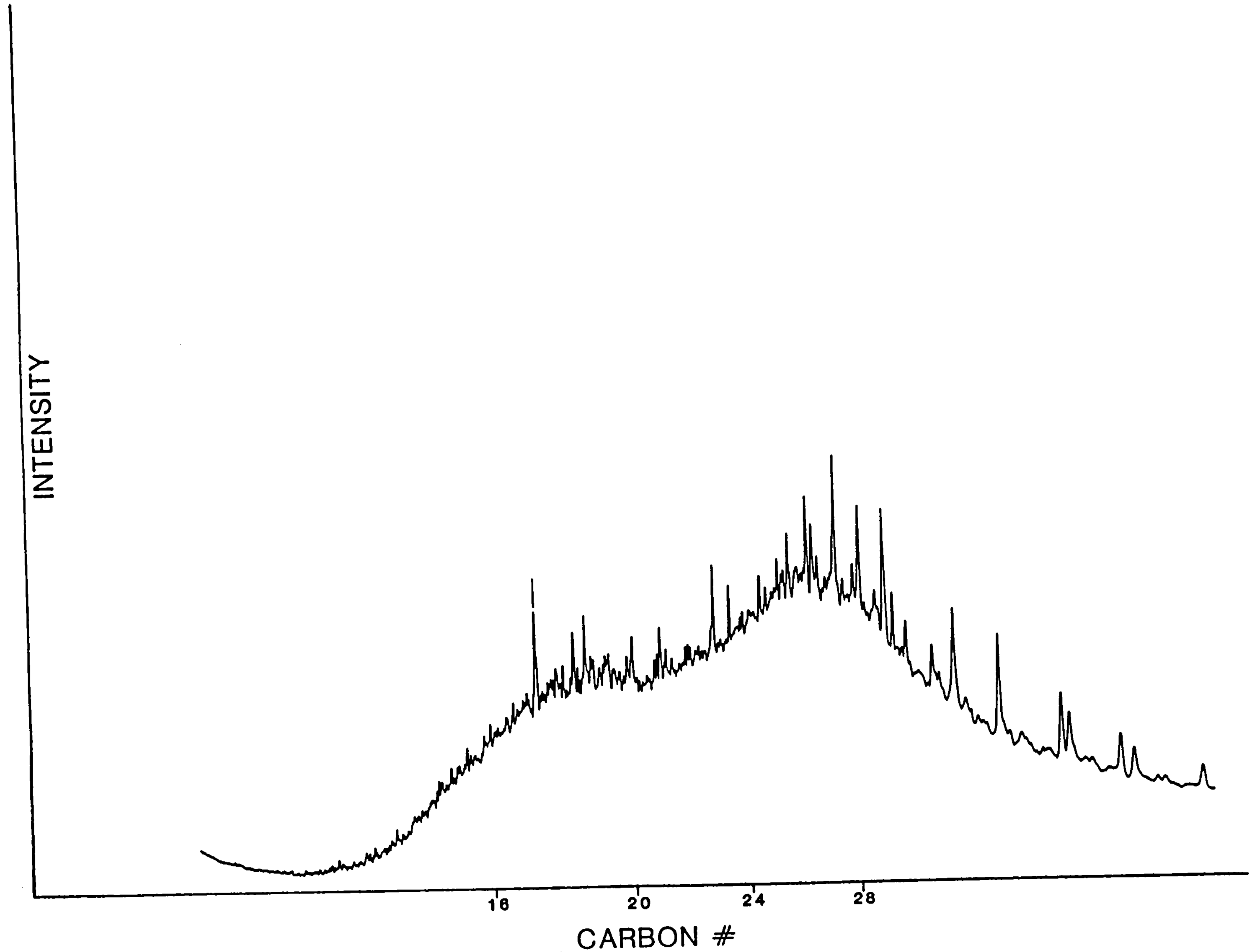


FIGURE 2: Saturate Chromatogram HCB-275

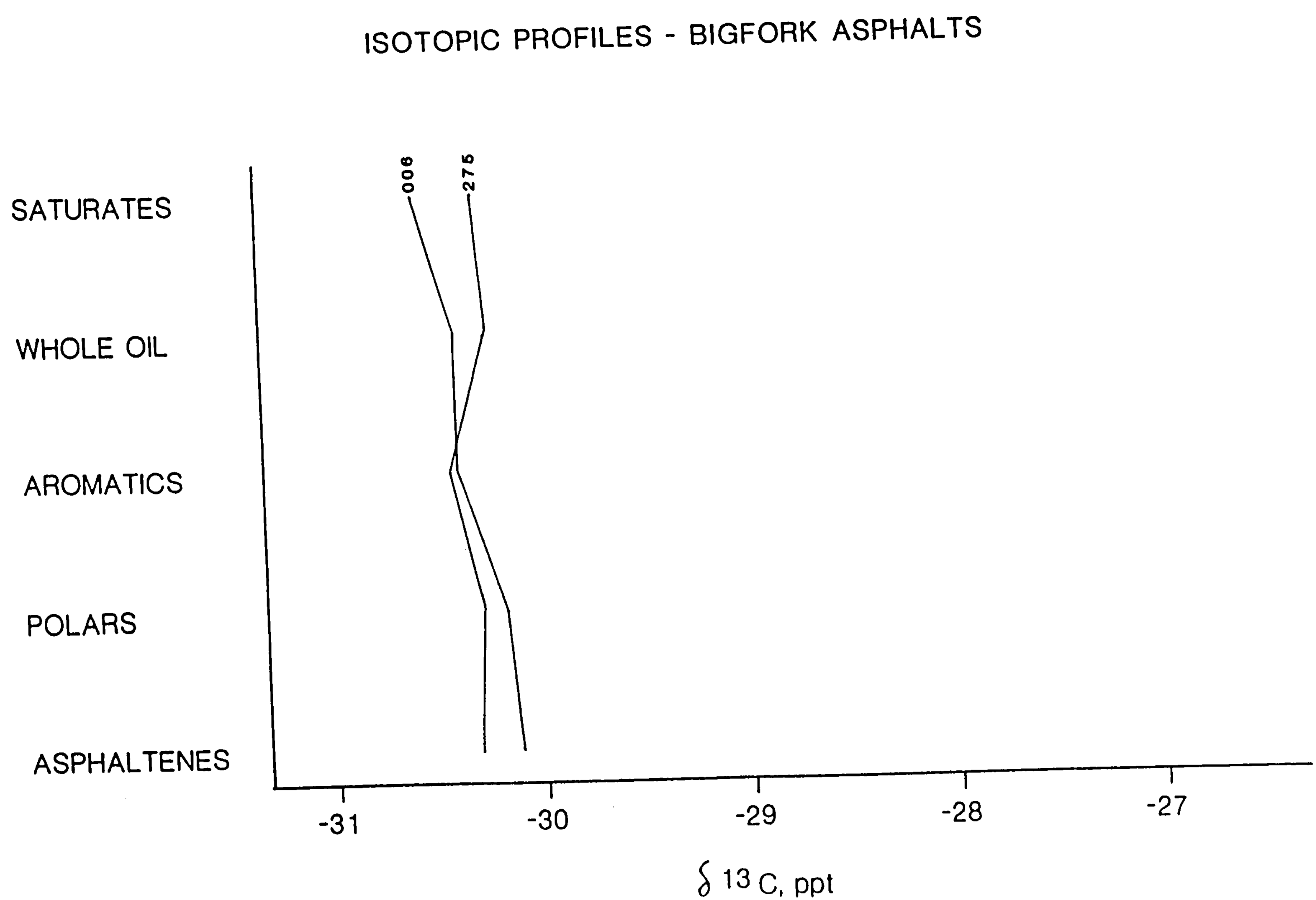

ISOTOPIC PROFILES - BIGFORK ASPHALTS
SATURATES
WHOLE OIL
AROMATICS
POLARS
ASPHALTENES
006
275
-31
-30
-29
-28
-27
δ 13 C, ppt

FIGURE 3

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: E. Luttrell — November 7, 1983
SPC Mid-Continent Region

Attn: D. May — PGW/101883/GC/2-5

From: Petroleum Geochemistry Group
Warrensville — Classification: RESTRICTED

Subject: Technical Memorandum (PGW/TM 132) -- Source Evaluation of The Conoco #1 Lloyd Moore Well, Lamar County, Texas.

Summary: Geochemical evaluation and interpretation of the stratigraphic sequences of four thrust sheets penetrated by the Conoco #1 Lloyd Moore well indicated that the Ouachita Facies contained negligible to poor source potential, except for very limited spot horizons within the Arkansas Novaculite. Thermal maturity data indicated the thrust sheets were gas mature to thermally spent; therefore, only gas would be generated and/or preserved at this site.

1. INTRODUCTION

This report details the source rock geochemistry of the Conoco #1 Lloyd Moore well. The well is located in Lamar County, Texas. The well was drilled to a total depth of 8,831 feet, penetrating four thrust sheets of the Ouachita Facies. Mesozoic sediments were laid unconformably above the Ouachita Facies.

2. MATERIALS AND METHODS

2.1 Materials

A total of one hundred, thirty-four (134) dry cuttings samples were submitted for geochemical source rock evaluation covering the gross well interval from 700 to 8780 feet. Cuttings were composited into 60 foot geochemical samples.

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGW methods. Analyses consisted of vitrinite reflectance determinations to establish a thermal maturity profile, rapid screen Rock Eval pyrolysis and total Organic Carbon (% TOC - bitumen free) to assess the overall source quality.

The hydrocarbon proneness (oil or gas) of any interval of interest was assessed by means of proprietary pyrolysis gas chromatography (PGC) which established the GOGI ratio (gas-oil generation index).

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the Conoco #1 Lloyd Moore well is listed in Table 1 and Figure 1. A Source Evaluation Log is appended as Figure 2.

3.1 Thermal maturity determinations for the Conoco #1 Lloyd Moore well were based primarily on the results of vitrinite reflectance measurements (and "vitrinite-like" reflectance measurements for the Silurian and Ordovician sediments) for the upper thrust sheet. A linear regression applied to this data set (15 data points) identified a very gentle gradient of 10.6 DOD units/Km (3.21 DOD units/1000 feet) and a correlation coefficient of 0.78 (61% correlation).

Reflectance measurement ranged from 1.31 to 2.11 for all data points for the four thrust sheets of the Ouachita Facies. Therefore, the sediments penetrated by the well were dominantly gas mature with some thermally spent intervals. Table 2 summarizes the maturity data for the four thrust sheets and this data should be considered questionable for two reasons:

(1) The source richness was only marginally rich throughout the entire well. With such low %TOC in the sediments, the low number of R_o measurements recorded per sample may not be totally representative for each sample; and

(2) All samples from 6,000 feet to TD were received as fine powders. This made identification of lithologies and organics extremely difficult; also the distinguishing of cavings from indigenous material was not possible.

3.2 Source quality for the four thrust sheets of the Ouachita Facies is summarized in Table 3.

Overall source quality for the Ouachita Facies penetrated by the Conoco #1 Lloyd Moore well was negligible to poor except for limited intervals within the Arkansas Novaculite. The Stanley, Missouri Mountain, Polk Creek Shale and Bigfork Chert were considered non-source formations for this well site.

3.2.1 Two 60' sample intervals of the Arkansas Novaculite had good source richness. The two intervals were at 6,330 feet and 8,010 feet and had TOC values of 1.34% and 1.51%, respectively. Maturities for these two samples were 2.11 and 2.01 (thermally spent; PGW considers $\geq$ 2.0% R_o as spent source rocks); therefore, only dry gas has been generated and preserved at these sample intervals.

3.3 Source quality and maturity of the Mesozoic sediments.

3.3.1 Organic petrographic techniques identified coal cuttings in samples within the Trinity Sandstone. The vitrinite reflectance measurements for this coal material were from 0.28 to 0.35% R_o indicating that these sediments were immature.

3.3.2 Source richness and potential for the Mesozoic sediments were negligible to poor except for an occasional spot horizon. Three 60' samples had good to excellent source richness and potential productivity:

Depth (ft.)	% TOC	S2 (kg/ton)
1780	5.03	7.95
1900	3.06	3.07
2080	2.95	2.43

These three intervals were mixed gas/oil sources according to their respective GOGI values. Further examination of cuttings and by petrography (sample WC6506), indicated that the sediments of these intervals consisted, in part, of coal cuttings and should be considered as an immature gas source.

4. EXPLORATION SIGNIFICANCE

The Conoco #1 Lloyd Moore well penetrated sediments that were gas mature to thermally spent. The source richness and potential productivity of the well was neglibile to poor except for two 60' intervals within the Arkansas Novaculite. Therefore, this well would not have generated any hydrocarbons (gas) of any significance. The Arkansas Novaculite might have generated some limited amounts of gas, enough for possible shows, but no commercial quantities.

G. A. Cole

GAC:mlc

Enclosures: Figures 1-2
Tables 1-3
Appendix 1

cc: H. G. Bassett
R. Burwood
R. Drozd
C. Titus
Files (0) (2-5)

Work by: R. Lukco
L. Monnens
C. Hodges
J. Reymander
R. Chaikin

TABLE 2

SUMMARY OF MATURITY DATA

Thrust Sheet	Formation	% R_o Range	Maturity
#1	Stanley (MISS)	1.31 TO 1.78	gas
(2334'-6056')	Novaculite (DEV)	1.77 to 1.91	gas
	Mo. Mtn. (SIL)	1.86	gas
	Polk Cr. (ORD)	1.98	gas
	Bigfork (ORD)	1.82	gas
#2	Novaculite (DEV)	2.02 to 2.11	spent
(6056'-6644')	Mo. Mtn. (SIL)	-	-
#3	Stanley (MISS)	1.77 to 1.93	gas
(6644'-8500')	Novaculite (DEV)	2.01	spent
	Mo. Mtn. (SIL)	-	-
#4	Stanley (MISS)	1.93	gas
(8500' to TD)			

TABLE 3

SUMMARY OF SOURCE QUALITY DATA

Thrust Sheet	Formation	% TOC	S2 (kg/ton)	Overall Quality
#1	Stanley	0.28 -0.56	0.0 - 0.61	Negligible to Poor
(2334'-6056')	Novaculite	0.30 -0.68	0.0 - 0.18	Negligible to Poor
	Mo. Mtn.	0.21 - 0.41	0.0	Negligible
	Polk Cr.	0.20 - 0.26	0.0 - 0.03	Negligible
	Bigfork	0.15 - 0.27	0.0	Negligible
#2	Novaculite	0.07 - 1.34	0.0 - 0.60	Negligible to Good
(6056'-6644')	Mo. Mtn.	0.01 - 0.29	0.11- 0.50	Negligible
#3	Stanley	0.05 - 0.50	0.0 - 0.81	Negligible to Poor
(6644'-8500')	Novaculite	0.03 - 1.51	0.0 - 0.08	Negligible to Good
	Mo. Mtn.	0.03 - 0.64	0.0 - 0.14	Negligible to Poor
#4	Stanley	0.36 - 0.44	0.0 - 0.18	Negligible
(8500'-TD)				

TABLE 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : TX
COUNTY/REGION/PROSPECT : LAMAR
LOCATION : -
WELL/SITE : CONOCO #1LOYD MOORE
API/OCS : 42-277-30108

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
700	WC6486	CTG			SH,CALC	23		.24		0.00	.09	37
760	WC6487	CTG			SH,CALC	18		.18		.02	.11	61
820	WC6488	CTG			SH,CALC	23		.35		.02	.12	34
880	WC6489	CTG			LST,V.ARG	58		.22		0.00	.02	9
940	WC6490	CTG			SH,V.CALC	41		.43		0.00	.03	7
1000	WC6491	CTG			LST,V.ARG	67		.20		0.00	.07	35
1060	WC6492	CTG			LST,V.ARG	67		.20		0.00	0.00	0
1120	WC6493	CTG			LST,V.ARG	56		.39		0.00	.05	13
1180	WC6494	CTG			LST,V.ARG	54		.44		0.00	.06	14
1224	XC6494		CRET	KIAM								
1240	WC6495	CTG			LST,V.ARG	50		.48		0.00	.13	27
1258	XC6495		CRET	GOOD								
1270	XC649A		CRET	TRIN								
1300	WC6496	CTG			LST,V.ARG	55		.47		0.00	.10	21
1360	WC6497	CTG			SH,CALC	24		.42		0.00	.05	12
1420	WC6498	CTG			SH,V.CALC	33		.66		0.00	.02	3
1480	WC6499	CTG			SH,V.CALC	49		.29		0.00	0.00	0
1540	WC6500	CTG			SH,V.CALC	44		.24		0.00	0.00	0
1600	WC6501	CTG			SH,V.CALC	41		1.08		0.00	.08	7
1660	WC6502	CTG			SH,V.CALC	35		.48		0.00	0.00	0
1720	WC6503	CTG			SH,V.CALC	30		1.06		0.00	.11	10
1780	WC6504	CTG			SH,V.CALC	36		5.03		0.00	7.95	158
1840	WC6505	CTG			SH,V.CALC	33		.66		0.00	.04	6
1900	WC6506	CTG			SH,V.CALC	27		3.06		0.00	3.07	100
1960	WC6507	CTG			SST	9		.67		0.00	.05	7
2020	WC6508	CTG			SST,CALC	23		.91		0.00	.10	11
2080	WC6509	CTG			SST,CALC	24		2.95		0.00	2.43	82
2140	WC6510	CTG			SST,CALC	23		.86		.01	.23	27
2200	WC6511	CTG			SH,CALC	16		.29		0.00	.03	10
2260	WC6512	CTG			SST	10		.10		0.00	.02	20
2320	WC6513	CTG			SST,CALC	13		.28		0.00	.04	14
2334	XC6513		MISS	STAN								
2380	WC6514	CTG			SH,CALC	16		.56		.03	.15	27
2440	WC6515	CTG			SH,CALC	12		.55		0.00	.06	11
2500	WC6516	CTG			SH,CALC	11		.54		.01	.05	9
2560	WC6517	CTG			SH,CALC	14		.32		0.00	0.00	0
2620	WC6518	CTG			SH,CALC	15		.28		0.00	0.00	0

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
700	0.00		0												
760	.15		11												
820	.14		6												
880	0.00		0												
940	0.00		0												
1000	0.00		0												
1060			0												
1120	0.00		0												
1180	0.00		0												
1224															
1240	0.00		0												
1258															
1270															
1300	0.00		0												
1360	0.00		0												
1420	0.00		0												
1480			0												
1540			0												
1600	0.00		0												
1660			0												
1720	0.00		0												
1780	0.00		0		8.58	2.13	6.45	171	.33						
1840	0.00		0												
1900	0.00		0		4.84	1.17	3.67	158	.32			.28			
1960	0.00		0												
2020	0.00		0												
2080	0.00		0		3.61	1.09	2.52	122	.43						
2140	.04		1												
2200	0.00		0									.35			
2260	0.00		0												
2320	0.00		0												
2334															
2380	.17		5												
2440	0.00		0									1.34			
2500	.17		2									1.31			
2560			0												
2620			0												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2680	WC6519	CTG			SH,CALC	17		.32		0.00	0.00	0
2740	WC6520	CTG			SH,CALC	16		.34		0.00	0.00	0
2800	WC6521	CTG			SH,CALC	15		.33		0.00	0.00	0
2860	WC6522	CTG			SH,CALC	15		.39		0.00	.01	3
2920	WC6523	CTG			SH,CALC	16		.35		0.00	0.00	0
2980	WC6524	CTG			SH,CALC	18		.33		0.00	0.00	0
3040	WC6525	CTG			SH,CALC	15		.56		.44	.61	109
3100	WC6526	CTG			SH,CALC	15		.41		0.00	0.00	0
3160	WC6527	CTG			SH,CALC	16		.42		.02	.04	10
3220	WC6528	CTG			SH,CALC	16		.39		.02	.02	5
3280	WC6529	CTG			SH,CALC	14		.38		.03	.03	8
3340	WC6530	CTG			SH,CALC	14		.37		.01	.02	5
3400	WC6531	CTG			SH,CALC	16		.34		.01	.03	9
3460	WC6532	CTG			SH,CALC	13		.29		0.00	0.00	0
3520	WC6533	CTG			SH,CALC	14		.44		.02	.02	5
3580	WC6534	CTG			SH,CALC	14		.44		0.00	.02	5
3640	WC6535	CTG			SH,CALC	14		.42		0.00	.01	2
3700	WC6536	CTG			SH,CALC	14		.42		0.00	0.00	0
3760	WC6537	CTG			SH,CALC	14		.37		0.00	.02	5
3820	WC6538	CTG			SH,CALC	15		.38		.04	.04	11
3880	WC6539	CTG			SH,CALC	15		.37		0.00	0.00	0
3940	WC6540	CTG			SH,CALC	13		.35		.01	.01	3
4000	WC6541	CTG			SH,CALC	14		.58		.04	.08	14
4060	WC6542	CTG			SH,CALC	13		.49		.04	.04	8
4120	WC6543	CTG			SH,CALC	13		.41		0.00	0.00	0
4180	WC6544	CTG			SH,CALC	13		.41		0.00	.02	5
4240	WC6545	CTG			SH,CALC	14		.50		.17	.27	54
4300	WC6546	CTG			SH,CALC	14		.30		.06	.06	20
4360	WC6547	CTG			SH,CALC	14		.37		.04	.06	16
4420	WC6548	CTG			SH,CALC	14		.36		.02	.04	11
4480	WC6549	CTG			SH,CALC	14		.37		0.00	.04	11
4540	WC6550	CTG			SH,CALC	14		.40		.02	.04	10
4600	WC6551	CTG			SH,CALC	15		.42		.07	.12	29
4660	WC6552	CTG			SH,CALC	15		.45		0.00	.02	4
4720	WC6553	CTG			SH,CALC	15		.42		0.00	.02	5
4780	WC6554	CTG			SH,CALC	15		.39		0.00	.04	10
4840	WC6555	CTG			SH,CALC	14		.38		0.00	.04	11
4900	WC6556	CTG			SH,CALC	14		.39		0.00	.02	5
4960	WC6557	CTG			SH,CALC	15		.39		0.00	.05	13
5020	WC6558	CTG			SH,CALC	15		.40		0.00	.04	10
5080	WC6559	CTG			SH,CALC	15		.39		0.00	.04	10
5140	WC6560	CTG			SH,CALC	14		.35		0.00	.03	9
5151	XC6560		DEV	ARKN								
5200	WC6561	CTG			SH,CALC	14		.30		.04	.18	60
5256	WC6562	CTG			SH,CALC	16		.34		.01	.03	9
5310	WC6563	CTG			SH,CALC	15		.25		0.00	0.00	0
5370	WC6564	CTG			SH,CALC	15		.56		.02	.05	9
5430	WC6565	CTG			SH,CALC	13		.65		.03	.01	2
5490	WC6566	CTG			SH,CALC	12		.68		.07	0.00	0

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2680			0												
2740			0									1.61			
2800			0												
2860	0.00		0												
2920			0												
2980			0												
3040	.42		79									1.68			
3100			0												
3160	.33		5												
3220	.50		5												
3280	.50		8												
3340	.33		3									1.78			
3400	.25		3												
3460			0												
3520	.50		5												
3580	0.00		0												
3640	0.00		0									1.48			
3700			0												
3760	0.00		0												
3820	.50		11												
3880			0												
3940	.50		3									1.59			
4000	.33		7												
4060	.50		8												
4120			0												
4180	0.00		0									1.62			
4240	.39		34												
4300	.50		20												
4360	.40		11												
4420	.33		6												
4480	0.00		0									1.72			
4540	.33		5												
4600	.37		17												
4660	0.00		0												
4720	0.00		0												
4780	0.00		0									1.69			
4840	0.00		0												
4900	0.00		0												
4960	0.00		0												
5020	0.00		0												
5080	0.00		0												
5140	0.00		0												
5151															
5200	.18		13									1.91			
5256	.25		3												
5310			0												
5370	.29		4												
5430	.75		5												
5490	1.00		10									1.77			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5549	XC6566		SIL	MOMT								
5550	WC6567	CTG			SH,CALC	14		.41		.02	0.00	0
5610	WC6568	CTG			SH,CALC	13		.26		0.00	0.00	0
5670	WC6569	CTG			SH,CALC	12		.21		0.00	0.00	0
5710	XC6569		ORD	POLK								
5730	WC6570	CTG			SH,CALC	13		.26		.01	.03	12
5790	WC6571	CTG			SH,CALC	13		.20		0.00	0.00	0
5821	XC6571		ORD	BGFK								
5850	WC6572	CTG			SH,CALC	14		.17		0.00	0.00	0
5910	WC6573	CTG			SH,CALC	18		.23		.02	0.00	0
5970	WC6574	CTG			SH,CALC	16		.27		.01	0.00	0
6030	WC6575	CTG			SH,CALC	15		.15		0.00	0.00	0
6056	XC6575		DEV	ARKN								
6090	WC6576	CTG			SH,CALC	14		.07		.01	0.00	0
6150	WC6577	CTG			SH,CALC	14		.83		.26	.28	34
6210	WC6578	CTG			SH,CALC	12		.74		.47	.28	38
6270	WC6579	CTG			SH,CALC	12		.76		.56	.59	78
6330	WC6580	CTG			SH,CALC	10		1.34		.36	.60	45
6390	WC6581	CTG			SH,CALC	16		.34		.10	.15	44
6397	XC6581		SIL	MOMT								
6450	WC6582	CTG			SH,CALC	12		.01		.03	.22	2200
6510	WC6583	CTG			SH,CALC	11		.01		.05	.47	4700
6570	WC6584	CTG			SH,CALC	13		.09		.02	.50	556
6630	WC6585	CTG			SH,CALC	15		.29		.08	.11	38
6644	XC6585		MISS	STAN								
6690	WC6586	CTG			SH,CALC	18		.39		.11	.10	26
6750	WC6587	CTG			SH,CALC	17		.34		.12	.21	62
6810	WC6588	CTG			SH,CALC	16		.40		.10	.81	202
6870	WC6589	CTG			SH,CALC	16		.43		.09	.69	160
6930	WC6590	CTG			SH,CALC	15		.44		.04	.39	89
6990	WC6591	CTG			SH,CALC	15		.44		.03	.44	100
7050	WC6592	CTG			SH,CALC	15		.44		.03	.31	70
7110	WC6593	CTG			SH,CALC	15		.35		.04	.41	117
7170	WC6594	CTG			SH,CALC	14		.44		.01	.18	41
7230	WC6595	CTG			SH,CALC	12		.26		.01	.13	50
7290	WC6596	CTG			SH,CALC	12		.33		.02	.06	18
7350	WC6597	CTG			SH,CALC	14		.39		0.00	0.00	0
7410	WC6598	CTG			SH,CALC	15		.40		0.00	.06	15
7470	WC6599	CTG			SH,CALC	16		.50		.01	.11	22
7530	WC6600	CTG			SH,CALC	16		.37		.03	.15	41
7590	WC6601	CTG			SH,CALC	14		.26		.10	.08	31
7650	WC6602	CTG			SH,CALC	13		.49		.05	.05	10
7710	WC6603	CTG			SH,CALC	11		.21		.01	0.00	0
7770	WC6604	CTG			SH,CALC	16		.18		.01	0.00	0
7830	WC6605	CTG			SH,V.CALC	26		.17		.01	0.00	0
7890	WC6606	CTG			SH,CALC	12		.05		.01	0.00	0
7900	XC6606		DEV	ARKN								
7950	WC6607	CTG			SH,CALC	10		.16		0.00	0.00	0
8010	WC6608	CTG			SH,CALC	14		1.51		.02	.08	5

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5549															
5550	1.00		5												
5610			0									1.86			
5670			0												
5710															
5730	.25		4												
5790			0									1.98			
5821															
5850			0												
5910	1.00		9												
5970	1.00		4									1.82			
6030			0												
6056															
6090	1.00		14												
6150	.48		31												
6210	.63		64									2.02			
6270	.49		74												
6330	.38		27												
6390	.40		29									2.11			
6397															
6450	.12		300												
6510	.10		500												
6570	.04		22												
6630	.42		28												
6644															
6690	.52		28												
6750	.36		35									1.80			
6810	.11		25												
6870	.12		21												
6930	.09		9												
6990	.06		7									1.81			
7050	.09		7												
7110	.09		11												
7170	.05		2												
7230	.07		4												
7290	.25		6									1.92			
7350			0												
7410	0.00		0									1.93			
7470	.08		2												
7530	.17		8												
7590	.56		38									1.77			
7650	.50		10												
7710	1.00		5												
7770	1.00		6												
7830	1.00		6												
7890	1.00		20												
7900															
7950			0												
8010	.20		1									2.01			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
8070	WC6609	CTG			SH,CALC	11		.70		.02	0.00	0
8130	WC6610	CTG			SH	8		.70		.01	.03	4
8190	WC6611	CTG			SH,CALC	15		.03		0.00	0.00	0
8200	XC6611		SIL	MONT								
8250	WC6612	CTG			SH,CALC	14		.03		.01	0.00	0
8310	WC6613	CTG			SH,CALC	14		.07		.02	.03	43
8370	WC6614	CTG			SH,CALC	10		.64		.07	0.00	0
8430	WC6615	CTG			SH,CALC	17		.30		.04	.14	47
8490	WC6616	CTG			SH,CALC	13		.32		.06	.31	97
8500	XC6616		MISS	STAN								
8660	WC6617	CTG			SH,CALC	14		.36		0.00	.04	11
8720	WC6618	CTG			SH,CALC	16		.38		0.00	0.00	0
8780	WC6619	CTG			SH,CALC	16		.44		.01	.18	41

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
8070	1.00		3												
8130	.25		1												
8190			0												
8200															
8250	1.00		33												
8310	.40		29												
8370	1.00		11												
8430	.22		13												
8490	.16		19												
8500															
8660	0.00		0												
8720			0												
8780	.05		2									1.93			

rw07.010
c.2

Office Correspondence

RESTRICTED

STANDARD OIL
PRODUCTION

BPA CONFIDENTIAL

TO:	R. Jantzen	DATE:	August 26, 1987.
FROM:	K. Leskiw	REF:	GS(M)TM/147 TC(GEO)M-87.0227

SUBJECT: MICROPALEONTOLOGICAL ANALYSIS OF WEYERHAEUSER 1-22

INTRODUCTION AND SUMMARY

The purpose of this study was to determine the age and paleoenvironment of the sediments from the 11,000 to 18,930 foot interval in Weyerhaesuer 1-22, Ouachita Trend (Oklahoma).

A thirty foot composite sample every 100' was analyzed for microfossils. The entire 11,000-18930' interval is barren of microfossils. Therefore, an age and paleoenvironment cannot be assigned to this interval.

K. Leskiw

pc: C.H. Ellis
M.A. Rahman
W. Waloweek
E.G. Werren

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: E. Luttrell
SPC Mid-Continent Division
Dallas

March 27, 1984
PGW/32684/RB/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Source Potential Evaluation in the #1-24 Campbell Well, Atoka County, OK. - Report PGW/TM156.

We are pleased to forward three copies (one each for D. May and C. Titus) of the subject report for your retention.

Gary Cole's reporting is pretty comprehensive and little more needs to be added. Although all of the section penetrated appeared to be immature to just of threshold status, both the Polk Creek and Womble Fms. indentified themselves as excellent potential source beds. As on previous occasions, the Arkansas Novaculite and Bigfork Fms. also had not insignificant potential.

The curiosity on this occasion was the Missouri Mountain Fm. which showed a basal interval of richness. This is unlikely to be due to caving from the up-hole Novaculite and, if not ascribable to a depressed placement of the Polk Creek formation top, is an unusual departure. Routinely, the Missouri Mountain has been characterized as organically lean.

A noteable exception to this was in the case of the Isom Springs #3 Victor test (PGW/TM065). Here, the Missouri Mountain was observed to contain almost 2000 ft. of sustained attractive source potential of comparable incipiently mature status to the above. The proximity of Marshall and Atoka Counties suggest that the present situation is a north easterly thinning and decline of the depositional environment present in the Isom Springs area. Does this fit into the regional prognosis?

R. Burwood

RB:mc
Encs. 3

cc: H. G. Bassett
R. Drozd
G. Cole
PGW Files (0) (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed three (3) reports.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: E. Luttrell
SPC Mid-Contnent Region
Dallas

March 6, 1984

PGW/021084/GC/2-5

Attn: D. May

Job No.: 83-150

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Technical Memorandum (PGW/TM156) -- Source Rock Potential Evaluation of the #1-24 Campbell Well, Atoka County, Oklahoma.

Summary: A geochemical source quality screen and detailed thermal maturity evaluation of the stratigraphic sequence penetrated in the #1-24 Campbell well was completed by PGW. A complete Ouachita sequence from Ordovician through Mississippian sediments in the 300 to 3940' interval were assessed for source richness, potential productivity and maturity. Source quality considerations identified six zones (at least part of each formation penetrated had an attractive source zone) from which mixed oil/gas or oil were potentially the most likely hydrocarbon products. Maturity of these zones ranged from immature in the Stanley Group to threshold mature (HGT-hydrocarbon generation threshold) in the Womble Shale. This well was completed as a dry hole. However, two asphalt zones were encountered during drilling (Stanley at 1020'; Polk Creek at 3011').

1. INTRODUCTION

This report details the source rock geochemistry of the #1-24 Campbell well, Atoka County, Oklahoma. The well was drilled in Section 24, T3S, R11E to a total depth of 3980 feet. The well was spudded in the Pennsylvanian Jackfork Formation and penetrated the Mississippian Stanley Group, the Devonian Arkansas Novaculite, the Silurian Missouri Mountain, and the Ordovician Polk Creek Shale, Bigfork Chert and Womble Shale. For technical reasons, a TD (3980 ft) at the top of the Womble Shale was decided upon, the well being subsequently plugged and abandoned. The only hydrocarbon shows were asphalts found in the Stanley group (1020-40') and Polk creek Shale (3011'). The asphalts are currently being characterized and will be reported on independently.

2. MATERIALS AND METHODS

2.1 Materials

A total of one hundred twenty-five (125) cuttings samples and one conventional core sample were submitted for geochemical source rock evaluation covering the gross well interval from 150 to 3970 feet. Samples were analyzed on a screen basis every 60 feet. Each sample was given a unique PGW well sample number from WC9269 to WC9355 and WC9376 to WC9413. The Polk Creek core sample was given the well sample number WC7464.

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGW methods. Analyses consisted of organic petrographic determinations to establish a thermal maturity profile, rapid screen Rock-Eval pyrolysis and Total Organic Carbon (% TOC - bitumen free) to assess the overall source quality.

The hydrocarbon proneness (oil or gas) of any interval of interest was assessed by means of proprietary pyrolysis gas chromatography (PGC) which established the GOGI ratio (gas-oil generation index).

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the #1-24 Campbell well is listed in Table 1 and Figure 1. A Source Evaluation Log is enclosed as Figure 2.

3.1 Sediment Thermal Maturity Assessment

The most common method for determining maturity in use today is vitrinite reflectance (% R_o of the vitrinite maceral). Past studies have shown that vitrinite reflectance increases at a constant rate from 0.2-0.3% R_o (immature sediments) to >4.0% R_o (meta-sediments). Since R_o is measured on the vitrinite maceral (derived from woody plants), it is only useable on sediments of Devonian age or younger since higher vascular plants (woody tissues) had not evolved prior to this time. Unfortunately, the #1-24 Campbell well penetrated sediments older than the Devonian; therefore, maturity quantification is more difficult. To measure the maturity on the Silurian and Ordovician sediments, two methods were used:

1. R_o measurement of the solid bitumen (or vitrinite-like) component. At R_o values <1.0% bitumens usually have lower R_o values than the vitrinite component, but for this well bitumens (or vitrinite-like materials) were used to extend the maturity (R_o) profile.

2. Qualitative fluorescence. As maturity increases, the fluorescence spectra of the liptinite group shifts from green to red and finally disappears at equivalent R_o values between 1.1-1.2%.

Figure 3 illustrates the maturity parameters used in this report.

3.1.1 Sediment Thermal Maturity Profile (STAMP):

The STAMP for the #1-24 Campbell well is a graphic representation of the detailed vitrinite reflectance analyses performed on eleven selected samples from 400 to 2470 feet for the Mississippian Stanley and Devonian Arkansas Novaculite sediments; and the reflectance of the solid bitumens (or vitrinite-like material) performed on six samples from 2980 to 3970 feet for the Ordovician Polk Creek, Bigfork and Womble sediments. Therefore, a total of seventeen samples were used for the STAMP. A linear regression applied to this data set indicated a correlation coefficient of 0.86 (r^2=74%). The maturity gradient for this interval was 15.9 DOD units/km (4.85 DOD units/1000 ft.). This implied:

1. The sediments above 3870 feet were immature to incipiently mature (PGW considers 0.6% as the hydrocarbon generation threshold (HGT).

2. HGT was attained at about 3870 feet.

3. Maximum oil generation (~0.85% R_o) was projected to occur at approximately 6990 feet with dominant gas generation (R_o=1.0%) having set in at 8440 feet and deeper.

3.1.2 Qualitative Fluorescence:

Qualitative fluorescence was performed on selected samples from the Ordovician age sediments. The dominant fluorescing color was pale yellow (some green/yellow) indicating that the bottom samples were incipiently mature, at best. This agreed moderately well wth the R_o values which indicated HGT at 3870 feet.

3.2 Source Quality

The source rock quality for the #1-24 Campbell well was determined by using PGW standrdized methods for % TOC (bitumen free), rapid screen pyrolysis (Rock-Eval), and pyrolysis gas chromatography (PGC). The source quality data will be discussed by formation and is summarized in Table 2.

3.2.1 Stanley Group (Mississippian) - 290 to 2290' - immature to incipiently mature; source richness was moderate with an average TOC of 0.66% (range was from 0.35-1.79%); potential productivity was marginal (S2 averaged 0.57 kg/ton and ranged from 0.07 to 4.24 kg/ton); average GOGI was 0.36 indicating a mixed oil/gas kerogen assemblage.

Of particular interest was the bottom 390' of the Stanley Group. This interval contained a good source richness of 1.09% TOC and had S2 values up to 4.24 kg/ton.

3.2.2 Arkansas Novaculite (Devonian) - 2290 to 2624'- incipiently mature; source richness was good with an average TOC of 1.23%; (ranged from 0.18-3.15%); potential productivity was good (S2 averaged 3.65 kg/ton and ranged from 0.11-10.93 kg/ton); GOGI values averaged 0.30 indicating a mixed oil/gas kerogen assemblage.

3.2.3 Missouri Mountain (Silurian) - 2624 to 2957'- incipiently mature; source richness was moderate with an average TOC of 0.72% (ranged from 0.16-1.67%);

potential productivity was moderate (S2 averaged 1.74 kg/ton and ranged from 0.07-5.52 kg/ton); the one GOGI value indicated a mixed dominant oil/minor gas kerogen assemblage.

The single sample at 2920' had good source richness (1.67% TOC) and good potential productivity (5.52 kg/ton).

3.2.4 Polk Creek Shale (Ordovician) - 2957 to 3033'- incipiently mature; source richness was excellent with an average TOC of 3.63% (range was from 2.22-5.03%); potential productivity was very good (S2 averaged 18.9 kg/ton and ranged from 10.17-27.61 kg/ton); the average GOGI value of 0.31 indicated a mixed oil/gas kerogen assemblage.

3.2.5 Bigfork Chert (Ordovician) - 3033 to 3820'- incipiently mature; source richness was moderate with an average TOC of 0.62% (ranged from 0.38-1.16%); potential productivity was good (S2 averaged 2.12 kg/ton and ranged from 1.21-4.62 kg/ton); the average GOGI value of 0.37 indicated a mixed oil/gas kerogen assemblage.

3.2.6 Womble Shale (Ordovician) - 3820 to 3970' - hydrocarbon generation threshold mature; source richness was excellent and averaged 3.22% (ranged from 2.62-3.82%); potential productivity was very good (S2 averaged 16.75 kg/ton and ranged from 13.08-20.42 kg/ton); the average GOGI of 0.21 indicated an oil prone kerogen assemblage.

4. EXPLORATION SIGNIFICANCE

4.1 The #1-24 Campbell well had six attractive zones of source richness and potential productivity. These were:

Zone

1.	Stanley Group	from 1900-2290'
2.	Arkansas Novaculite	from 2290-2440'
3.	Missouri Mountain	from 2860-2920'
4.	Polk Creek Shale	from 2957-3033' (total formation interval)
5.	Bigfork Chert	from 3033-3160'
6.	Womble Shale	from 3850-3940'

All of these six zones had good to excellent source richness (% TOC), good to very good potential productivities (S2 kg/ton) and oil prone or mixed oil/gas kerogen assemblages. Unfortunately, though, these sediments have not reached peak oil maturity. The HGT was reached in the Campbell well at 3870' (TD was 3,980); therefore, except for the very basal section, the sediments penetrated were only immature to incipiently mature. Due to a lack of maturity, large amounts of hydrocarbons have not yet been generated. This is further reinforced by using the general values for the transformation ratio $\frac{(S1+S2)}{S1}$ located in Table 1. Results for this ratio showed:

Formation	Transformation Ratio*
Stanley	no values >5.0 kg/ton S2
Ark. Nov.	7% (2 values)
Mo. Mtn.	13% (1 values)
Polk Cr.	7-11% (2 values)
Bigfork	no values >5.0 kg/ton S2
Womble	11-12% (2 values)

*The transformation ratio is a pyrolysis parameter used to determine how much of the kerogen has been transformed into hydrocarbons. This is a qualitative parameter and is affected by many factors such as migrated hydrocarbons, incomplete pyrolysis, etc. The ratio is presented as a normalized parameter (i.e. 0.07≡7%). As a general rule, the higher the ratio, the more mature the kerogen assemblage. A 10% value is generally used for HGT. For this study only transformation ratios based on S2 >5.0 kg/ton were used. This was to avoid biased (exaggerated) values of this parameter deriving from lower organic richness sediments.

By using an S2 value >5.0 kg/ton, it was observed that the transformation ratio hovers near the 10% value or below. This indicates that the sediments penetrated in the #1-24 Campbell well were immature to threshold mature and agrees favorably with the thermal maturity profile.

4.2 The #1-24 Campbell well contained six immature to threshold mature, rich source zones. It is suggested, therefore, that these sediments may be more favorable to hydrocarbon generation if found at deeper depths of burial, having experienced a greater thermal stress. From the linear regression of the R_o data, peak oil generation (0.85% R_o) was determined to be at 6990' (or 3000' deeper than TD). Applying this regression data to the zones encountered in the Campbell well, additional overburden needed to reach peak oil generation (R_o about 0.85%) would be:

Formation (zone)	Present Depth (top)	Additional Depth Of Burial to Reach 0.85% R_o
Stanley (1)	1900'	5000'
Ark. Nov. (2)	2290'	4700'
Mo. Mtn. (3)	2860'	4130'
Polk Cr. (4)	2957'	4030'
Bigfork (5)	3033'	3960'
Womble (6)	3850'	3140'

G. A. Cole

GAC:mlc

Enclosures: Tables 1-2

Figures 1-3

cc: C. Titus

T. Legg

H. G. Bassett

R. Burwood

R. Drozd

Files (0) (2-5)

Work by: R. Lukco

R. Chaikin

D. Noffsinger

C. Hodges

J. Reymander

M. Jordan

NOTE- TABLE 1
FIGS 1,2] MISSING

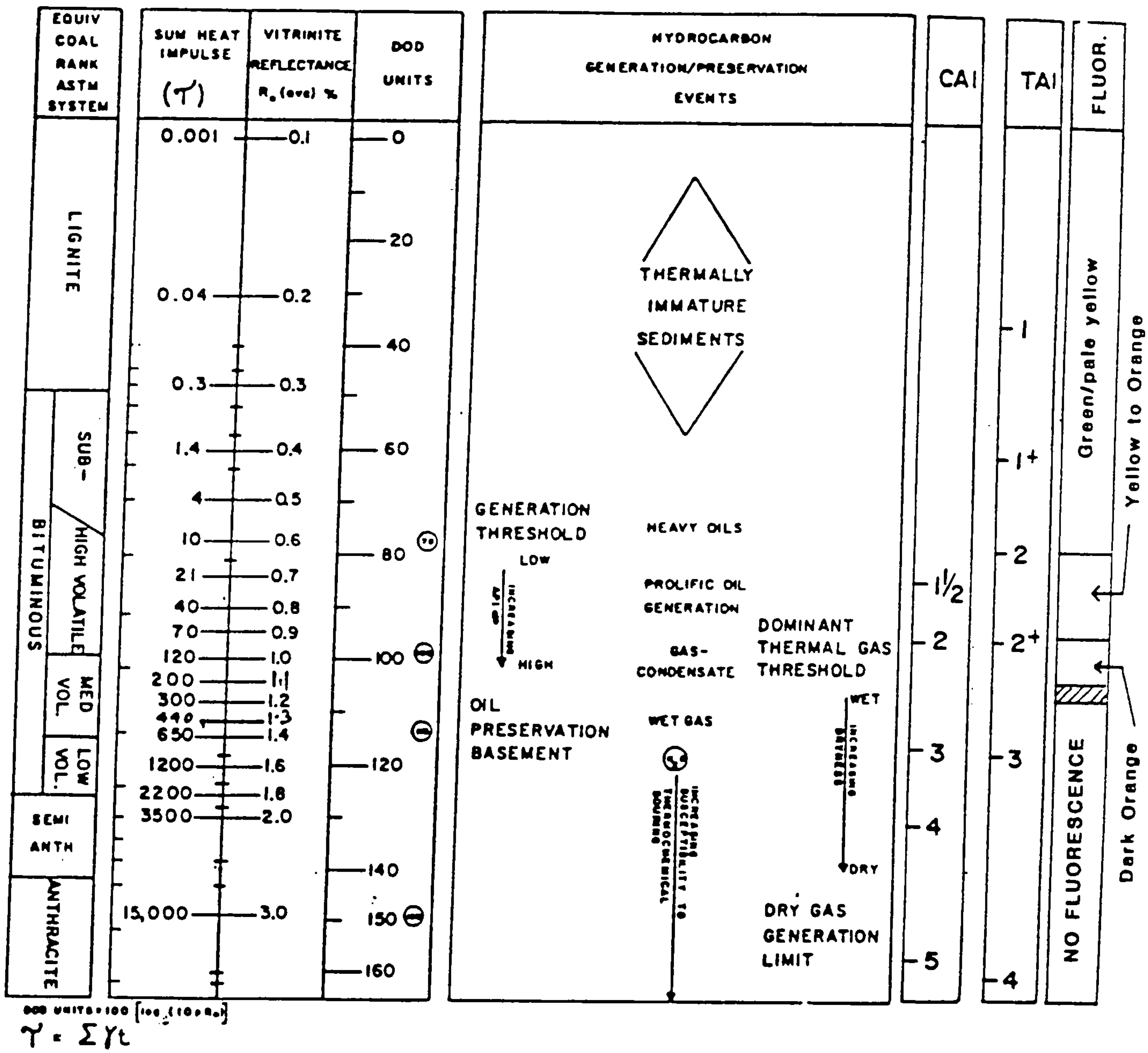
TABLE 2

SOURCE EVALUATION DATA SUMMARY

FORMATION	TOC (%) AVE.	TOC (%) RANGE	POTENTIAL PRODUCTIVITY AVE. S2	POTENTIAL PRODUCTIVITY S2 RANGE	AVE. GOGI	MATURITY
Stanley	0.66	0.35-1.79	0.57	0.07-4.24	0.36	Immature to Incip. Mature
Ark. Nov.	1.23	0.28-3.15	3.65	0.11-10.93	0.30	Incipiently Mature
Mo. Mtn.	0.72	0.16-1.67	1.74	0.07-5.52	0.24	Incipiently Mature
Polk Cr.	3.63	2.22-5.03	18.9	10.17-27.61	0.31	Incipiently Mature
Bigfork	0.62	0.38-1.16	2.12	1.21-4.62	0.37	Incipiently Mature
Womble	3.22	2.62-3.82	16.75	13.08-20.42	0.21	HGT Mature

FIGURE 3

SEDIMENT THERMAL MATURITY SCALES AND HYDROCARBON GENERATION-PRESERVATION



APPENDIX

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/ Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH. }
LST. } 0-10% qualifying component

SH. CALC }
LST. ARG } 11-25% qualifying component

SH. V. CALC }
LST. V. ARG } 26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): %. Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): %. Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^{\circ}C$) - Kg/Tn.

S2 (12): %. Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: %. Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
- AL - Algal/Sapropel
- AM - Amorphous
- HE - Herbaceous
- W - Woody
- C - Coaly
- E - Exinite (Palynomorphs, Cutin, etc.)
- M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

G1 (TSE)(14): %. Generation Index. TSE/TOC-
Generation intensity based on abundance of Total Soluble Extract.

G1 (S1)(15): %. Generation Index. S1/TOC
Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): %. Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn.
More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) %. Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn.
More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): %. Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units·1000 ft.$^{-1}$ or Km^{-1}.

· **CPI (21):** Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) — $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) — $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) — $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

TABLE 1

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : ATOKA
LOCATION : SEC24,T3SR11E
WELL/SITE : #1-24 CAMPBELL
API/OCS : 35-005-20138

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
150	WC9269	CTG			SH,CALC							
290	XC9269		MISS	STAN	FORM.TOP							
300	WC9270	CTG			SH,CALC	16		.46		.04	.10	22
310	WC9271	CTG			SH,CALC							
360	WC9272	CTG			SH,CALC	15		.48		.03	.10	21
370	WC9273	CTG			SH,CALC							
400	WC9274	CTG			SH,CALC	15		.46		.12	.17	37
430	WC9275	CTG			SH,CALC							
460	WC9276	CTG			SH,CALC	16		.45		.07	.07	16
490	WC9277	CTG			SH,CALC							
520	WC9278	CTG			SH,CALC	15		.46		.12	.12	26
550	WC9279	CTG			SH,CALC							
580	WC9280	CTG			SH,CALC	14		.56		.23	.23	41
610	WC9281	CTG			SH,CALC							
640	WC9282	CTG			SH,CALC	14		.52		.12	.22	42
670	WC9283	CTG			SH,CALC							
700	WC9284	CTG			SH,CALC	14		.58		.13	.40	69
730	WC9285	CTG			SH,CALC							
760	WC9286	CTG			SH,CALC	15		.43		.09	.17	40
790	WC9287	CTG			SH,CALC							
820	WC9288	CTG			SH,CALC	15		.35		.05	.08	23
850	WC9289	CTG			SH,CALC							
880	WC9290	CTG			SH,CALC							
910	WC9291	CTG			SH,CALC							
940	WC9292	CTG			SH,CALC	15		.40		.07	.10	25
970	WC9293	CTG			SH,CALC							
1000	WC9294	CTG			SH,CALC	14		.43		.09	.12	28
1030	WC9295	CTG			SH,CALC							
1060	WC9296	CTG			SH,CALC	12		.47		.07	.28	60
1090	WC9297	CTG			SH,CALC							
1120	WC9298	CTG			SH,CALC	13		.53		.13	.29	55
1150	WC9299	CTG			SH,CALC							
1180	WC9300	CTG			SH,CALC	14		.57		.10	.31	54
1210	WC9301	CTG			SH,CALC							
1240	WC9302	CTG			SH,CALC	14		.68		.13	.33	49
1270	WC9303	CTG			SH,CALC							
1300	WC9304	CTG			SH,CALC	14		.59		.15	.17	29

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
150															
290															
300	.29		9												
310															
360	.23		6												
370															
400	.41		26												
430												.41			
460	.50		16												
490															
520	.50		26												
550															
580	.50		41												
610															
640	.35		23												
670															
700	.25		22									.39			
730															
760	.35		21												
790															
820	.38		14												
850												.43			
880															
910															
940	.41		17												
970															
1000	.43		21												
1030												.43			
1060	.20		15												
1090															
1120	.31		25												
1150															
1180	.24		18												
1210															
1240	.28		19												
1270															
1300	.47		25												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1330	WC9305	CTG			SH,CALC							
1360	WC9306	CTG			SH,CALC	14		.59		.15	.44	75
1390	WC9307	CTG			SH,CALC							
1420	WC9308	CTG			SH,CALC	14		.69		.17	.38	55
1450	WC9309	CTG			SH,CALC							
1480	WC9310	CTG			SH,CALC	16		.48		.18	.22	46
1510	WC9311	CTG			SH,CALC							
1540	WC9312	CTG			SH,CALC	16		.45		.13	.22	49
1570	WC9313	CTG			SH,CALC							
1600	WC9314	CTG			SH,CALC	13		.70		.23	.56	80
1630	WC9315	CTG			SH,CALC							
1660	WC9316	CTG			SH,CALC	13		.74		.15	.48	65
1690	WC9317	CTG			SH,CALC							
1720	WC9318	CTG			SH,CALC	14		.55		.05	.16	29
1750	WC9319	CTG			SH,CALC							
1780	WC9320	CTG			SH,CALC	14		.88		.17	.53	60
1810	WC9321	CTG			SH,CALC							
1840	WC9322	CTG			SH,CALC	14		.77		.17	.42	55
1870	WC9323	CTG			SH,CALC							
1900	WC9324	CTG			SH,CALC	12		1.20		.32	1.63	136
1930	WC9325	CTG			SH							
1960	WC9326	CTG			SH	8		1.79	1.23	.51	4.24	237
1990	WC9327	CTG			SH							
2020	WC9328	CTG			SH	8		.63		.19	.44	70
2050	WC9329	CTG			SH							
2080	WC9330	CTG			SH	9		1.14		.30	1.47	129
2110	WC9331	CTG			SH							
2140	WC9332	CTG			SH	9		1.16	.88	.35	1.93	166
2170	WC9333	CTG			SH							
2200	WC9334	CTG			SH	8		1.04		.32	1.73	166
2230	WC9335	CTG			SH,CALC							
2260	WC9336	CTG			SH,CALC	10		.68		.14	.63	93
2290	WC9337	CTG			SH,CALC							
2291	XC9337		DEV	ARKN	FORM.TOP							
2320	WC9338	CTG			SH,CALC	10		1.34	1.05	.39	3.20	239
2350	WC9339	CTG			SH,CALC							
2380	WC9340	CTG			SH,CALC	15		3.15		.81	10.93	347
2410	WC9341	CTG			SH,CALC							
2440	WC9342	CTG			SH,CALC	12		1.83	.76	.41	5.32	291
2470	WC9343	CTG			SH,CALC							
2500	WC9344	CTG			SH	4		.71	.68	.25	2.13	300
2530	WC9345	CTG			SH							
2560	WC9346	CTG			SH	9		.18	.62	.16	.20	111
2590	WC9347	CTG			SH							
2620	WC9348	CTG			SH	8		.18	.31	.07	.11	61
2624	XC9348		SIL	MOMT	FORM.TOP							
2650	WC9349	CTG			SH							
2680	WC9350	CTG			SH	8		.16		.06	.07	44
2710	WC9351	CTG			SH,V.CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1330															
1360	.25		25												
1390															
1420	.31		25												
1450												.47			
1480	.45		37												
1510															
1540	.37		29												
1570															
1600	.29		33												
1630															
1660	.24		20												
1690												.47			
1720	.24		9												
1750															
1780	.24		19												
1810															
1840	.29		22									.45			
1870															
1900	.16		27		2.02	.60	1.42	168	.42						
1930															
1960	.11	69	28	2	4.51	.99	3.52	252	.28						
1990															
2020	.30		30												
2050															
2080	.17		26		1.96	.58	1.38	172	.42			.54			
2110															
2140	.15	76	30	3	2.37	.55	1.82	204	.30						
2170															
2200	.16		31		1.88	.52	1.36	181	.38						
2230															
2260	.18		21												
2290												.53			
2291															
2320	.11	78	29	3	3.38	.93	2.45	252	.38			.47			
2350															
2380	.07		26		9.89	2.10	7.79	314	.27						
2410															
2440	.07	42	22	2	5.87	1.25	4.62	321	.27						
2470												.54			
2500	.11	96	35	3	2.04	.45	1.59	287	.28						
2530															
2560	.44	344	89	4											
2590															
2620	.39	172	39	4											
2624															
2650															
2680	.46		37												
2710															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2740	WC9352	CTG			SH,V.CALC	27		.31		.11	.15	48
2770	WC9353	CTG			SH,V.CALC							
2800	WC9354	CTG			SH,V.CALC	43		.48		.20	.93	194
2830	WC9355	CTG			SH,CALC							
2860	WC9376	CTG			SH,CALC	23		.97		.40	2.03	209
2890	WC9377	CTG			SH,CALC							
2920	WC9378	CTG			SH,CALC	17		1.67		.79	5.52	331
2950	WC9379	CTG			SH,CALC							
2957	XC9379		ORD	POLK	FORM.TOP							
2980	WC9380	CTG			SH,CALC	17		2.22	1.52	1.24	10.17	458
3010	WC9381	CTG			SH,CALC							
3011	WC7464	CC			SH	2		5.03		2.12	27.61	549
3033	XC9381		ORD	BGFK	FORM.TOP							
3040	WC9382	CTG			SH,CALC	24		1.16	1.15	.77	4.62	398
3070	WC9383	CTG			SH,V.CALC							
3100	WC9384	CTG			SH,V.CALC	28		1.05		1.34	3.59	342
3130	WC9385	CTG			SH,V.CALC							
3160	WC9386	CTG			SH,V.CALC	36		.93	1.64	.51	2.44	262
3190	WC9387	CTG			SH,V.CALC							
3220	WC9388	CTG			SH,V.CALC	36		.47	1.95	.47	1.36	289
3250	WC9389	CTG			SH,V.CALC							
3280	WC9390	CTG			SH,CALC	12		.80	1.23	.46	3.06	382
3310	WC9391	CTG			SH,CALC							
3340	WC9392	CTG			SH,V.CALC	27		.55	2.51	1.45	2.16	393
3370	WC9393	CTG			SH,V.CALC							
3400	WC9394	CTG			SH,V.CALC	36		.38	1.46	.43	1.31	345
3430	WC9395	CTG			SH,V.CALC							
3460	WC9396	CTG			SH,V.CALC	45		.39	1.58	.56	1.46	374
3490	WC9397	CTG			SH,V.CALC							
3520	WC9398	CTG			SH,V.CALC	39		.45	1.64	.45	1.38	307
3550	WC9399	CTG			SH,V.CALC							
3580	WC9400	CTG			SH,V.CALC	46		.43	1.46	.43	1.21	281
3610	WC9401	CTG			SH,V.CALC							
3640	WC9402	CTG			SH,V.CALC	35		.58	1.78	.72	2.31	398
3670	WC9403	CTG			SH,V.CALC							
3700	WC9404	CTG			SH,V.CALC	36		.57	1.73	.57	2.09	367
3730	WC9405	CTG			SH,V.CALC							
3760	WC9406	CTG			SH,V.CALC	39		.45	1.37	.42	1.49	331
3790	WC9407	CTG			SH,V.CALC							
3820	WC9408	CTG			SH,V.CALC	42		.52	1.49	.29	1.25	240
3821	XC9408		ORD	WOMB	FORM.TOP							
3850	WC9409	CTG			SH,V.CALC							
3880	WC9410	CTG			SH,V.CALC	20		2.62	2.91	1.71	13.08	499
3910	WC9411	CTG			SH,V.CALC							
3940	WC9412	CTG			SH,V.CALC	10		3.82	3.34	2.49	20.42	535
3970	WC9413	CTG			SH,V.CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2740	.42		35												
2770															
2800	.18		42												
2830															
2860	.16		41												
2890															
2920	.13		47		6.38	1.23	5.15	382	.24						
2950															
2957															
2980	.11	68	56	1	7.94	1.69	6.25	358	.27			.54			
3010															
3011	.07		42		20.91	5.31	15.60	416	.34			.59			
3033															
3040	.14	99	66	1	3.49	.72	2.77	301	.26						
3070															
3100	.27		128		2.99	.67	2.32	285	.29						
3130															
3160	.17	176	55	3											
3190															
3220	.26	415	100	4											
3250															
3280	.13	154	57	3	2.44	.66	1.78	305	.37						
3310															
3340	.40	456	264	2											
3370															
3400	.25	384	113	3								.58			
3430															
3460	.28	405	144	3	.81	.27	.54	208	.49						
3490															
3520	.25	364	100	4											
3550															
3580	.26	340	100	3											
3610												.67			
3640	.24	307	124	2											
3670															
3700	.21	304	100	3	1.43	.43	1.00	251	.43						
3730															
3760	.22	304	93	3											
3790															
3820	.19	287	56	5											
3821															
3850															
3880	.12	111	65	2	10.13	1.83	8.30	387	.22						
3910												.57			
3940	.11	87	65	1	14.61	2.44	12.18	382	.20						
3970												.51			

803816

M. Killgore

H084.0195
C.2

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: M. C. Killgore
SPC Mid-Continent Division
Dallas

November 7, 1984

PGW/110784/RD/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Application of the Sohio PGW Lopatin Modelling Program to the Ouachita Overthrust, Oklahoma -- Report PGW/TM173.

Enclosed are two copies of the subject report (one for C. Titus) for your retention and use. Until a Divisional Geologist is named, we will direct all technical correspondence to your attention.

The modelling exercise described in the attached report has found good agreement between calculated and measured thermal maturities for levels associated with oil and gas generation. Once a thermally spent state was reached, the model was considerably less accurate. It is interesting to note that the Waples calibration curve proved more appropriate for the Ouachita Overthrust than did the PGW preferred calibration.

R. J. Drozd
Acting Supervisor
Petroleum Geochemistry Group

RJD:mlc
Enclosures (2)

cc: H. G. Bassett
C. Titus
G. Cole
Files (0) (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed two (2) reports.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: C. Titus
SPC Mid-Continent Region
Dallas

September 13, 1984

PGW/072784/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Technical Memorandum (PGW/TM173) -- Application of the Sohio PGW Lopatin 1.1 Modelling Program to the Ouachita Overthrust, Oklahoma.

Summary: The PGW Lopatin 1.1 Burial History Thermal Maturity program was used to model four different areas within the Oklahoma portion of the Ouachita Overthrust. These sites were the Campbell 1-24 well, the Octavia Prospect, the Big Cedar Prospect and the Broken Bow Uplift. Two regression methods were used for modelling purposes, the Waples regression and the PGW Preferred regression. Results showed that the Waples regression calculated the maturity more accurately when low maturies were observed, but neither method calculated data favorably when thermally spent maturities (>2.0% R_o) were observed.

1. INTRODUCTION

This report presents the results of an application of burial history modelling using the PGW Lopatin 1.1 Burial History Thermal Maturity program [1] for the Ouachita Overthrust region, Oklahoma.

Burial history data obtained during a duty visit to the Mid-Continent Region (3/12-16/84) for four sites within the Ouachita Overthrust were utilized for this exercise. Sediments of possible source interest were those of the Devonian Arkansas Novaculite and the Ordovician Polk Creek Shale, Bigfork Chert and Womble Shale (Figure 1). The actual modelling was accomplished by using a 40^{o}F surface temperature, an 18°F doubling rate, and a standard 1.0°F/100' geothermal gradient for all sites (but with a secondary gradient increase for certain sites from 230-200 MYBP depending on the proximity to the Broken Bow Uplift). By varying the regression methods, an attempt was made to match observed vitrinite reflectance values (% R_o) to those calculated by the program. By matching the observed R_o values, the thermal conditions to which the sediments were subjected could be approximated. Therefore, a more accurate estimation of the thermal history of the region could be determined and subsequently applied to future wells (sites) of interest.

2. GEOLOGIC PARAMETERS

The geologic burial histories for the four study sites were determined jointly with C. Titus (SPC Dallas, Mid-Continent Region). The burial histories are illustrated in Tables 1-4 for the Campbell 1-24 well site, the Octavia Prospect (Trotter-Dees 1-29 and Weyerhaeuser 1-15 well sites), the Big Cedar Prospect and the Broken Bow Uplift, respectively.

A simplified synopsis of the burial history for the Ouachita Overthrust is as follows:

a. Deposition of the Ouachita facies (including Atoka deposition) from Ordovician through Upper Pennsylvanian times;

b. Uplift and erosion from Permian through Early Cretaceous times. The Broken Bow Uplift occurred about 230-200 MYBP and included a major geothermal heating event which effected each of the four sites differently:

1. Campbell 1-24: no effect.
2. Octavia Prospect: partially effected.
3. Big Cedar Prospect: partially effected.
4. Broken Bow Uplift: fully effected; sediments in this area consist of meta-sediments.

c. Minor deposition during the Middle Cretaceous (up to 2000-3000 feet).

d. Erosion of the Cretaceous cover.

3. GEOTHERMAL GRADIENTS

A constant geothermal gradient of $1.0^{o}F/100'$ was used for all sites with the exception of the increased heating during the Broken Bow Uplift. It was assumed that this event affected the geothermal gradients for the four sites as follows (from 230-200 MYBP):

a.	Campbell 1-24:	no effect.
b.	Octavia Prospect:	increased to $1.25^{o}F/100'$.
c.	Big Cedar Prospect:	increased to $1.30\text{-}1.50^{o}F/100'$ (modelled using $1.30^{o}F/100'$, but could be as high as $1.50^{o}F/100'$).
d.	Broken Bow Uplift:	increased to $2.20^{o}F/100'$.

4. RESULTS:

Tables 1-4 list the respective data input for the burial histories represented by Figures 2-5 using the Waples regression method. Figures 6-9 represent the same conditions in Tables 1-4, but used the PGW Preferred regression method (see Figure 10).

4.1 Campbell 1-24 Well Site:

Figure 2 illustrates the modelled profile using the Waples regression, whereas Figure 6 used the PGW Preferred Method. Comparison of these figures to the actual sediment maturity profile in Figure 11, indicated that the Waples method estimated the maturity more accurately at low maturities. At 2000-2200' the Lower Stanley, Upper Arkansas Novaculite had an R_o value of approximately 0.50%; a 0.50% R_o as calculated by the Waples method occurred at 2000' but at 1000' using PGW Preferred method.

Therefore, at low maturities the Waples regression method appeared to be more applicable for the Ouachitas.

4.2 Octavia and Big Cedar Prospects:

Due to the lack of well control in this area, and therefore no well maturity profiles, it was difficult to evaluate these sites. At present though, the Trotter-Dees 1-29 and Weyerhaeuser 1-15 wells are being drilled. These wells will be useful in evaluating the Octavia Prospect burial history model when the maturity profiles become available. Figure 3 and 4 (Waples) and Figures 7 and 8 (PGW Preferred), illustrate the modelled profiles for these two sites, respectively. The Octavia model was based on the Stanley Group; the Big Cedar model was based on the Jackfork Formation. Comparing the calculated R_o values to outcrop data showed a better correlation using the Waples regressed data than the PGW Preferred. But, as noted in section 4.1, the Waples calculated values were more accurate for maturities (probably) up to 1.0% R_o. The surface R_o values for these two sites are from 0.7 to 1.1-1.2%; therefore a better correlation was obtained using the Waples regression.

4.3 Broken Bow Uplift:

Figures 5 (Waples) and Figure 9 (PGW Preferred) illustrate the modelled profiles for the Broken Bow Uplift. Comparison of these models were to surface R_o data only (no well data). R_o data for the Stanley and Arkansas Novaculite Formations in this area are generally from 4.5 to 5.5%. Calculated R_o data using the Waples regression indicated very high values (>6.0% R_o), whereas, the R_o data calculated by the PGW Preferred indicated excessively low values (<4.0% R_o). From the two regression methods, there was a +20% R_o increase from Waples method and a -20% decrease using the PGW Preferred method. Therefore, a more accurate calculated R_o might be determined by using a regression midway between the Waples and PGW Preferred regression methods.

5. CONCLUSIONS

Since the Lopatin 1.1 Burial History Thermal Maturity program* has been available to PGW for use, two other areas had been modelled.

1. The Gulf Coast region [2] was modelled and indicated a better correlation to the Waples method when comparing calculated to observed R_o data for the HGT (0.6% R_o) and DGGT (1.0% R_o).

2. The Broadmere #1 well [3] (Precambrian age, Australia) used both the Waples and PGW Preferred methods and concluded that reliable R_o (maturity) profiles are needed when modelling. At best, the burial history models should be used as a guide in exploration.

This report showed that the Waples regression compared more favorably to the observed R_o data than the PGW Preferred method for immature to oil generation mature sediments. But when comparing thermally spent sediments (up to 5.0% R_o), neither method calculated the maturity favorably when compared to the observed. Because of this lack of correlation, it may be concluded that the Ouachita Overthrust should use a calibration curve (regression method) similar to Waples when maturity is low, but one which approaches the PGW Preferred for thermally spent sediments.

*The Lopatin 1.2 Burial History Thermal maturity program is now available for modelling purposes. This version utilized a different algorithm for calculating TTI by integrating a shorter time period. Any further modelling will use the Lopatin 1.2 format.

6. REFERENCES

1. Armstrong, E. and Burwood, R. 1984 Lopatin 1.1 PGW Time-Temperature/ Burial History Calculation with Accompanying Graphics Display/ Presentation - PGW Procedures Manual No. 23.

2. Marsek, F. 1984 Application of Sohio Burial History/ Thermal Maturation Modelling Program to 5 Wells in the Destin Dome Area, Eastern Gulf of Mexico - Technical Memorandum (PGW/TM163).

3. Cole, G. 1984 Application of the PGW Burial History/ Thermal Maturation Modelling Program to the Amoco Broadmere #1 Well, Northern Territory, Australia, Provisional Results and Observations - Technical Memoradum (PGW/TM168).

G. A. Cole

GAC:mlc

Enclosures: Tables 1-4
Figures 1-11

cc: H. G. Bassett
E. Luttrell
R. Drozd
Files (0) (2-5)

```
*************************************************************************
*                                                                       *
*                                                                       *
*          LL       OOOO    PPPPP      AA    TTTTTT    II    NN   NN    *
*          LL      OOOOOO   PPPPPP    AAAA   TTTTTT    II    NNN  NN    *
*          LL      OO  OO   PP  PP   AA  AA    TT      II    NNNNNN     *
*          LL      OO  OO   PPPPPP   AAAAAA    TT      II    NN NNN     *
*          LL      OO  OO   PPPPP    AAAAAA    TT      II    NN   NN    *
*          LLLLLL  OOOOOO   PP       AA  AA    TT      II    NN   NN    *
*          LLLLLL   OOOO    PP       AA  AA    TT      II    NN   NN    *
*                                                                       *
*                                                                       *
*************************************************************************
```

L O P A T I N - 1 P G W

VERSION 1.1

10/01/83

TABLE 1

WELL TITLE : CAMPBELL 1-24

DATE : 07/26/84

RUN ID : RUN1

COMMENTS :

WAPLES REGRESSION/1.0 DEG F

LIST OF INPUT VARIABLES

SURFACE TEMPERATURE : 40.0 DEG. F

DOUBLING TEMPERATURE : 18.0 DEG. F

ACTIVATION TEMPERATURE : 0.0 DEG. F

LIST OF GEOTHERMAL GRADIENT INFORMATION

GEOTHERMAL GRADIENT : 1.00 TIME : CONSTANT THICKNESS : CONSTANT

LIST OF BURIAL HISTORY INFORMATION

AGE :	350.0	THICKNESS :	0.0	FORMATION	TOPS :	
AGE :	320.0	THICKNESS :	4500.0	FORMATION	TOPS :	STAN
AGE :	310.0	THICKNESS :	2600.0	FORMATION	TOPS :	JKFK
AGE :	300.0	THICKNESS :	4000.0	FORMATION	TOPS :	ATOK
AGE :	120.0	THICKNESS :	-7800.0	FORMATION	TOPS :	
AGE :	100.0	THICKNESS :	1200.0	FORMATION	TOPS :	
AGE :	.0	THICKNESS :	-2400.0	FORMATION	TOPS :	

THE RO/TTI MATURITY LIMITS

OIL GENERATION RO : .60 TTI : 8.86
GAS GENERATION RO : 1.00 TTI : 65.89

LIST OF OBSERVED RO VALUES

RO : .50 DEPTH : 2000.0

RO : .60 DEPTH : 3800.0

THE REGRESSION METHOD : WAPLES
SLOPE : 3.92805 INTERCEPT : 1.81881

```
**********************************************************************
*                                                                    *
*                                                                    *
*    LL       OOOO    PPPPP     AA     TTTTTT    II    NN   NN       *
*    LL      OOOOOO   PPPPPP   AAAA    TTTTTT    II    NNN  NN       *
*    LL      OO  OO   PP  PP  AA  AA     TT      II    NNNNNN        *
*    LL      OO  OO   PPPPPP  AAAAAA     TT      II    NN NNN        *
*    LL      OO  OO   PPPPP   AAAAAA     TT      II    NN   NN       *
*    LLLLLL  OOOOOO   PP      AA  AA     TT      II    NN   NN       *
*    LLLLLL   OOOO    PP      AA  AA     TT      II    NN   NN       *
*                                                                    *
*                                                                    *
**********************************************************************
```

L O P A T I N - 1 P G M

VERSION 1.1

10/01/83

TABLE 2

WELL TITLE : OCTAVIA PROSPECT

DATE : 05/07/84

RUN ID : RUN1

COMMENTS :

WAPLES REGRESSION

LIST OF INPUT VARIABLES

SURFACE TEMPERATURE : 40.0 DEG. F

DOUBLING TEMPERATURE : 18.0 DEG. F

ACTIVATION TEMPERATURE : 0.0 DEG. F

LIST OF GEOTHERMAL GRADIENT INFORMATION

```
GEOTHERMAL GRADIENT :   1.00     TIME :    350.0     THICKNESS : CONSTANT
GEOTHERMAL GRADIENT :   1.25     TIME :    230.0     THICKNESS : CONSTANT
GEOTHERMAL GRADIENT :   1.00     TIME :    200.0     THICKNESS : CONSTANT
```

LIST OF BURIAL HISTORY INFORMATION

```
AGE :     350.0     THICKNESS :       0.0     FORMATION TOPS :
AGE :     320.0     THICKNESS :   11000.0     FORMATION TOPS :
AGE :     310.0     THICKNESS :    6000.0     FORMATION TOPS :
AGE :     300.0     THICKNESS :    6000.0     FORMATION TOPS :
AGE :     264.0     THICKNESS :   -6000.0     FORMATION TOPS :
AGE :     230.0     THICKNESS :   -1000.0     FORMATION TOPS :
AGE :     200.0     THICKNESS :   -1000.0     FORMATION TOPS :
AGE :     120.0     THICKNESS :   -4000.0     FORMATION TOPS :
AGE :     100.0     THICKNESS :    1000.0     FORMATION TOPS :
AGE :        .0     THICKNESS :   -4000.0
```

THE RO/TTI MATURITY LIMITS

OIL GENERATION RO : .60 TTI : 8.86
GAS GENERATION RO : 1.00 TTI : 65.89
OPTIONAL EVENT OWPL RO : 1.35 TTI : 214.17

THE REGRESSION METHOD : WAPLES
SLOPE : 3.92805 INTERCEPT : 1.81861

```
******************************************************************************
*                                                                            *
*                                                                            *
*        LL       OOOO    PPPPP      AA     TTTTTT    II     NN   NN         *
*        LL      OOOOOO   PPPPPP    AAAA    TTTTTT    II     NNN  NN         *
*        LL      OO  OO   PP  PP   AA  AA     TT      II     NNNNNN          *
*        LL      OO  OO   PPPPPP   AAAAAA     TT      II     NN NNN          *
*        LL      OO  OO   PPPPP    AAAAAA     TT      II     NN   NN         *
*        LLLLLL  OOOOOO   PP       AA  AA     TT      II     NN   NN         *
*        LLLLLL   OOOO    PP       AA  AA     TT      II     NN   NN         *
*                                                                            *
*                                                                            *
******************************************************************************
```

L O P A T I N - 1 P G M

VERSION 1.1

10/01/83

TABLE 3

WELL TITLE : BIG CEDAR PROSPECT

DATE : 05/09/84

RUN ID : RUN1

COMMENTS :

WAPLES REGRESSION
1.2 F

LIST OF INPUT VARIABLES

SURFACE TEMPERATURE : 40.0 DEG. F

DOUBLING TEMPERATURE : 18.0 DEG. F

ACTIVATION TEMPERATURE : 0.0 DEG. F

LIST OF GEOTHERMAL GRADIENT INFORMATION

GEOTHERMAL GRADIENT :	1.00	TIME :	330.0	THICKNESS :	CONSTANT
GEOTHERMAL GRADIENT :	1.20	TIME :	230.0	THICKNESS :	CONSTANT
GEOTHERMAL GRADIENT :	1.00	TIME :	200.0	THICKNESS :	CONSTANT

LIST OF BURIAL HISTORY INFORMATION

AGE :	330.0	THICKNESS :	0.0	FORMATION TOPS :
AGE :	320.0	THICKNESS :	1000.0	FORMATION TOPS :
AGE :	310.0	THICKNESS :	6000.0	FORMATION TOPS :
AGE :	300.0	THICKNESS :	13000.0	FORMATION TOPS :
AGE :	230.0	THICKNESS :	-10000.0	FORMATION TOPS :
AGE :	200.0	THICKNESS :	-2000.0	FORMATION TOPS :
AGE :	.0	THICKNESS :	-7900.0	FORMATION TOPS :

THE RO/TTI MATURITY LIMITS

OIL GENERATION RO :	.60	TTI :	8.86
GAS GENERATION RO :	1.00	TTI :	65.89
OPTIONAL EVENT OMPL RO :	1.35	TTI :	214.17

THE REGRESSION METHOD : WAPLES
SLOPE : 3.92805 INTERCEPT : 1.81881

```
-                                                                                  *
*                                                                                  *
*        LL        OOOO    PPPPP      AA     TTTTTT    II     NN   NN              *
*        LL       OOOOOO   PPPPPP    AAAA    TTTTTT    II     NNN  NN              *
*        LL       OO  OO   PP   PP  AA  AA     TT      II     NNNNNN               *
*        LL       OO  OO   PPPPPP   AAAAAA     TT      II     NN NNN               *
*        LL       OO  OO   PPPPP    AAAAAA     TT      II     NN   NN              *
*        LLLLLL   OOOOOO   PP       AA  AA     TT      II     NN   NN              *
*        LLLLLL    OOOO    PP       AA  AA     TT      II     NN   NN              *
*                                                                                  *
*                                                                                  *
************************************************************************************
```

L O P A T I N - 1 P G M

VERSION 1.1

10/01/83

TABLE 4

WELL TITLE : BROKEN BOW UPLIFT

DATE : 05/15/84

RUN ID : RUN1

COMMENTS :

WAPLES REGRESSION/2.2 DEGREES F
AT 230 MYBP

LIST OF INPUT VARIABLES

SURFACE TEMPERATURE : 40.0 DEG. F

DOUBLING TEMPERATURE : 18.0 DEG. F

ACTIVATION TEMPERATURE : 0.0 DEG. F

LIST OF GEOTHERMAL GRADIENT INFORMATION

GEOTHERMAL GRADIENT :	1.00	TIME :	395.0	THICKNESS :	CONSTANT
GEOTHERMAL GRADIENT :	2.20	TIME :	230.0	THICKNESS :	CONSTANT
GEOTHERMAL GRADIENT :	1.00	TIME :	200.0	THICKNESS :	CONSTANT

LIST OF BURIAL HISTORY INFORMATION

AGE :	395.0	THICKNESS :	0.0	FORMATION TOPS :
AGE :	350.0	THICKNESS :	400.0	FORMATION TOPS :
AGE :	300.0	THICKNESS :	25000.0	FORMATION TOPS :
AGE :	230.0	THICKNESS :	-6400.0	FORMATION TOPS :
AGE :	200.0	THICKNESS :	-10000.0	FORMATION TOPS :
AGE :	120.0	THICKNESS :	-6000.0	FORMATION TOPS :
AGE :	100.0	THICKNESS :	3000.0	FORMATION TOPS :
AGE :	.0	THICKNESS :	-5000.0	FORMATION TOPS :

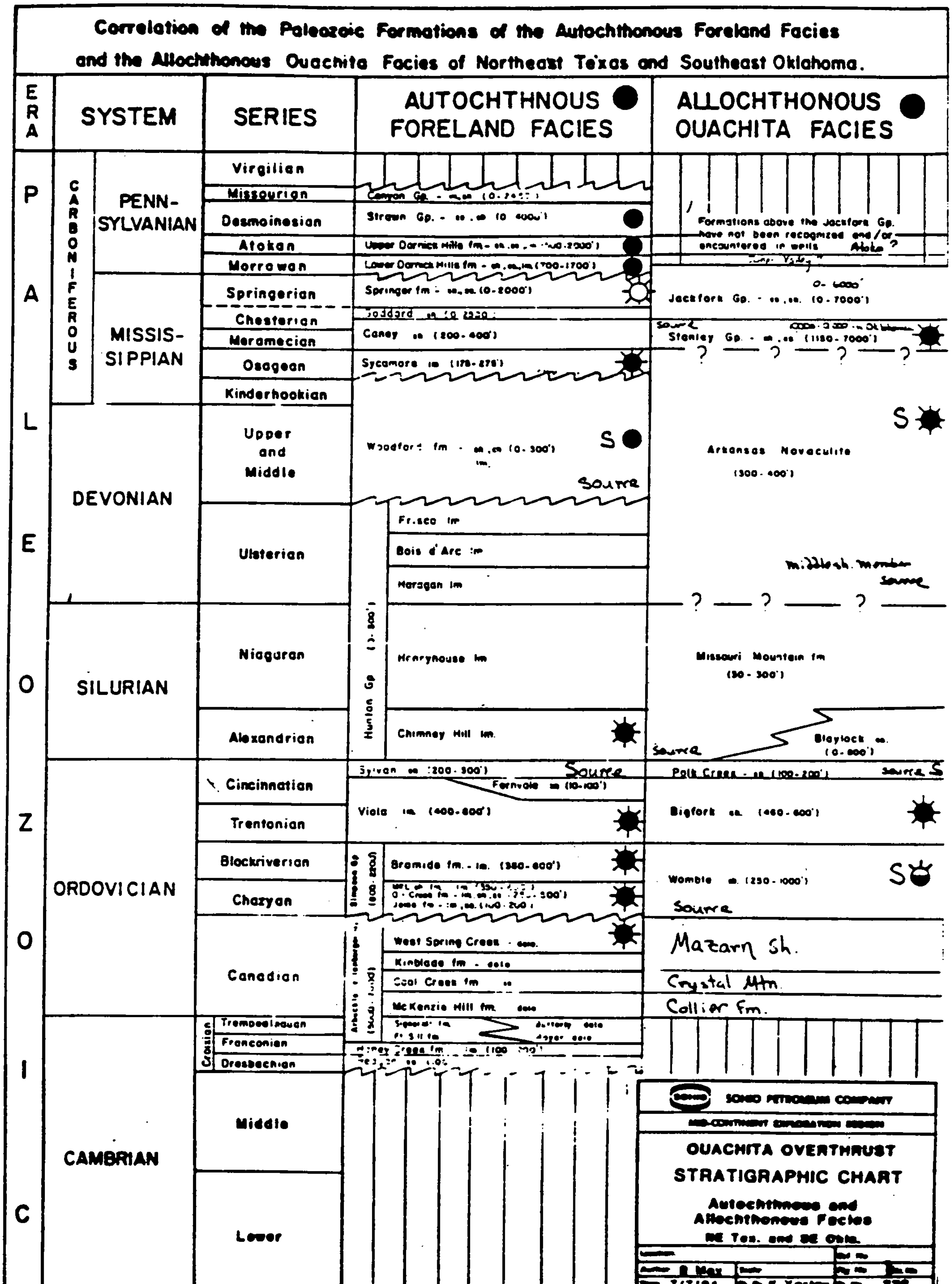
THE RO/TTI MATURITY LIMITS

OIL GENERATION RO :	.60	TTI :	8.86
GAS GENERATION RO :	1.00	TTI :	65.89
OPTIONAL EVENT GPL RO :	4.00	TTI :	*******

LIST OF OBSERVED RO VALUES

RO : 5.00 DEPTH : 1000.0

THE REGRESSION METHOD : WAPLES
SLOPE : 3.92805 INTERCEPT : 1.81881



Correlation of the Paleozoic Formations of the Autochthonous Foreland Facies
and the Allochthonous Ouachita Facies of Northeast Texas and Southeast Oklahoma.
ERA
SYSTEM
SERIES
AUTOCHTHNOUS FORELAND FACIES
ALLOCHTHONOUS OUACHITA FACIES
PALEOZOIC
CARBONIFEROUS
PENN-SYLVANIAN
MISSIS-SIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
Virgilian
Missourian
Desmoinesian
Atokan
Morrowan
Springerian
Chesterian
Meramecian
Osagean
Kinderhookian
Upper and Middle
Ulsterian
Niagaran
Alexandrian
Cincinnatian
Trentonian
Blackriverian
Chazyan
Canadian
Trempealeauan
Franconian
Dresbachian
Croixian
Middle
Lower
Strawn Gp.
Upper Darnick Hills fm
Lower Darnick Hills fm (700-1700')
Springer fm (0-2000')
Caney (200-400')
Sycamore (175-275')
Woodford fm (0-300')
S
Source
Frisco lm
Bois d'Arc lm
Haragan lm
Hunton Gp
Henryhouse lm
Chimney Hill lm.
Sylvan (200-300')
Source
Fernvale (10-100')
Viola (400-600')
Simpson Gp
Bromide fm. - lm. (350-600')
Arbuckle
West Spring Creek - dolo.
Kinblade fm - dolo
Cool Creek fm
McKenzie Hill fm. dolo
Formations above the Jackfork Gp. have not been recognized and/or encountered in wells
Atoka ?
0- 6000'
Jackfork Gp. (0-7000')
Source
Stanley Gp. (1150-7000')
? ? ? ?
S
Arkansas Novaculite
(300-400')
Source
? ? ?
Missouri Mountain fm
(50-300')
Source
Blaylock
(0-800')
Polk Creek (100-200')
Source S
Bigfork (450-600')
Womble (250-1000')
S
Source
Mazarn Sh.
Crystal Mtn.
Collier Fm.
SOHIO PETROLEUM COMPANY
OUACHITA OVERTHRUST
STRATIGRAPHIC CHART
Autochthnous and Allochthonous Facies
NE Tex. and SE Okla.

FIGURE 1

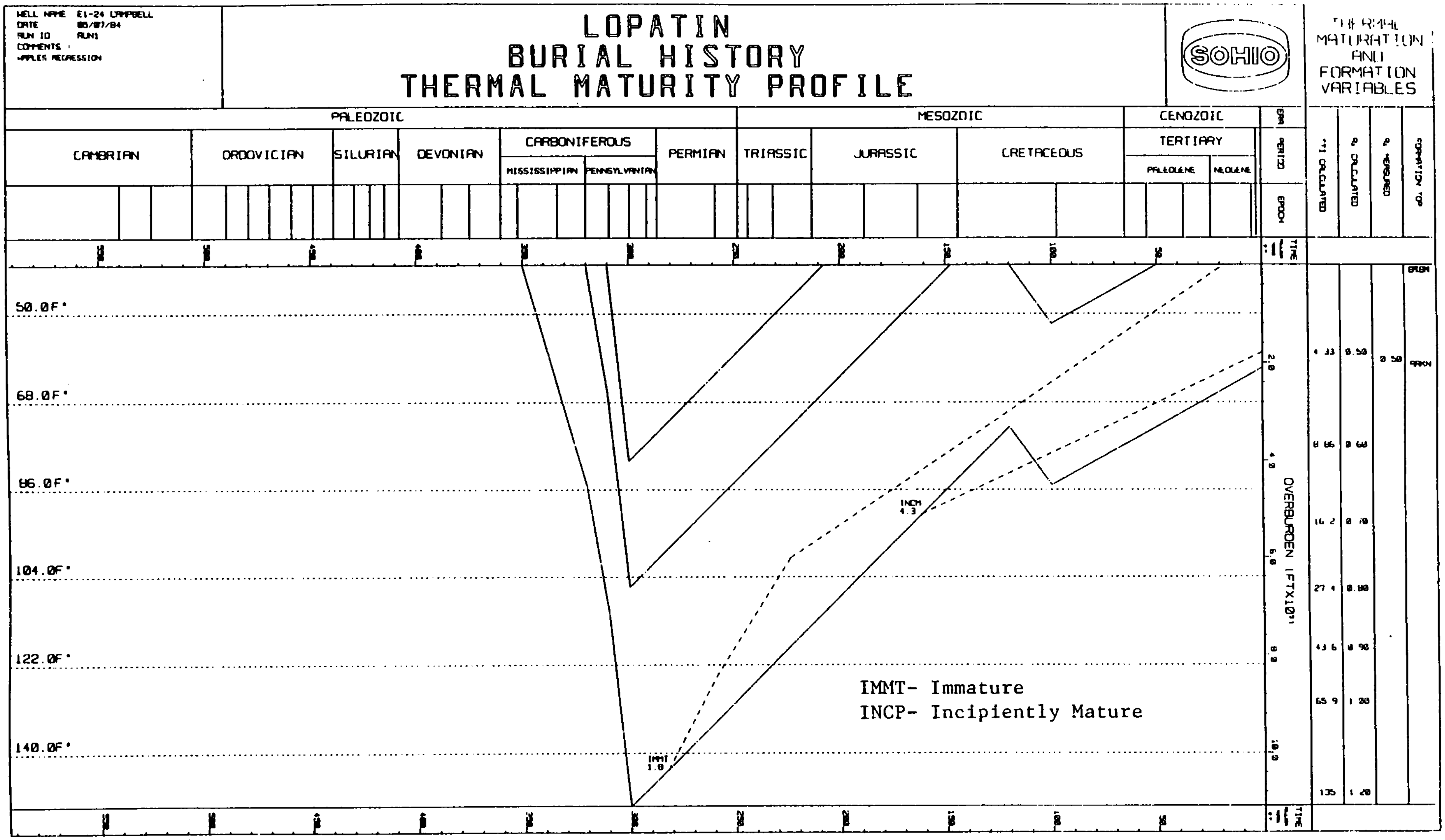

WELL NAME E1-24 CAMPBELL
DATE 05/07/84
RUN ID RUN1
COMMENTS :
WAPLES REGRESSION
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOCENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
Ro CALCULATED
Ro MEASURED
FORMATION TOP
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
OVERBURDEN (FTX10³)
2.0
4.0
6.0
8.0
10.0
INCM 4.3
IMMT 1.0
IMMT- Immature
INCP- Incipiently Mature

FIGURE 2

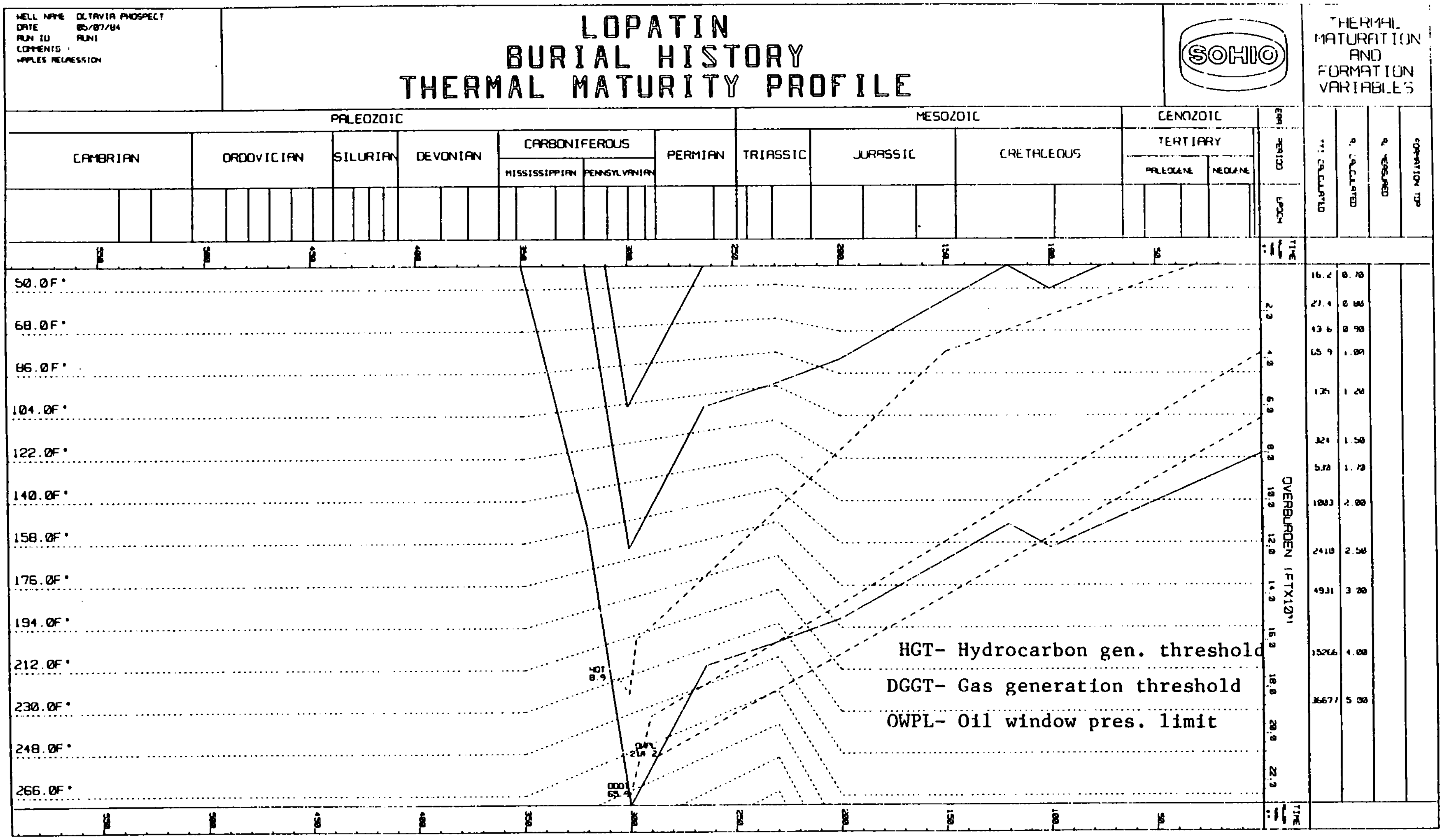

WELL NAME OLTAVIA PROSPECT
DATE 05/07/84
RUN ID RUN1
COMMENTS
WAPLES REGRESSION
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOCENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
R. CALCULATED
R. MEASURED
FORMATION TOP
50.0F
68.0F
86.0F
104.0F
122.0F
140.0F
158.0F
176.0F
194.0F
212.0F
230.0F
248.0F
266.0F
OVERBURDEN (FTX10³)
HGT- Hydrocarbon gen. threshold
DGGT- Gas generation threshold
OWPL- Oil window pres. limit

FIGURE 3

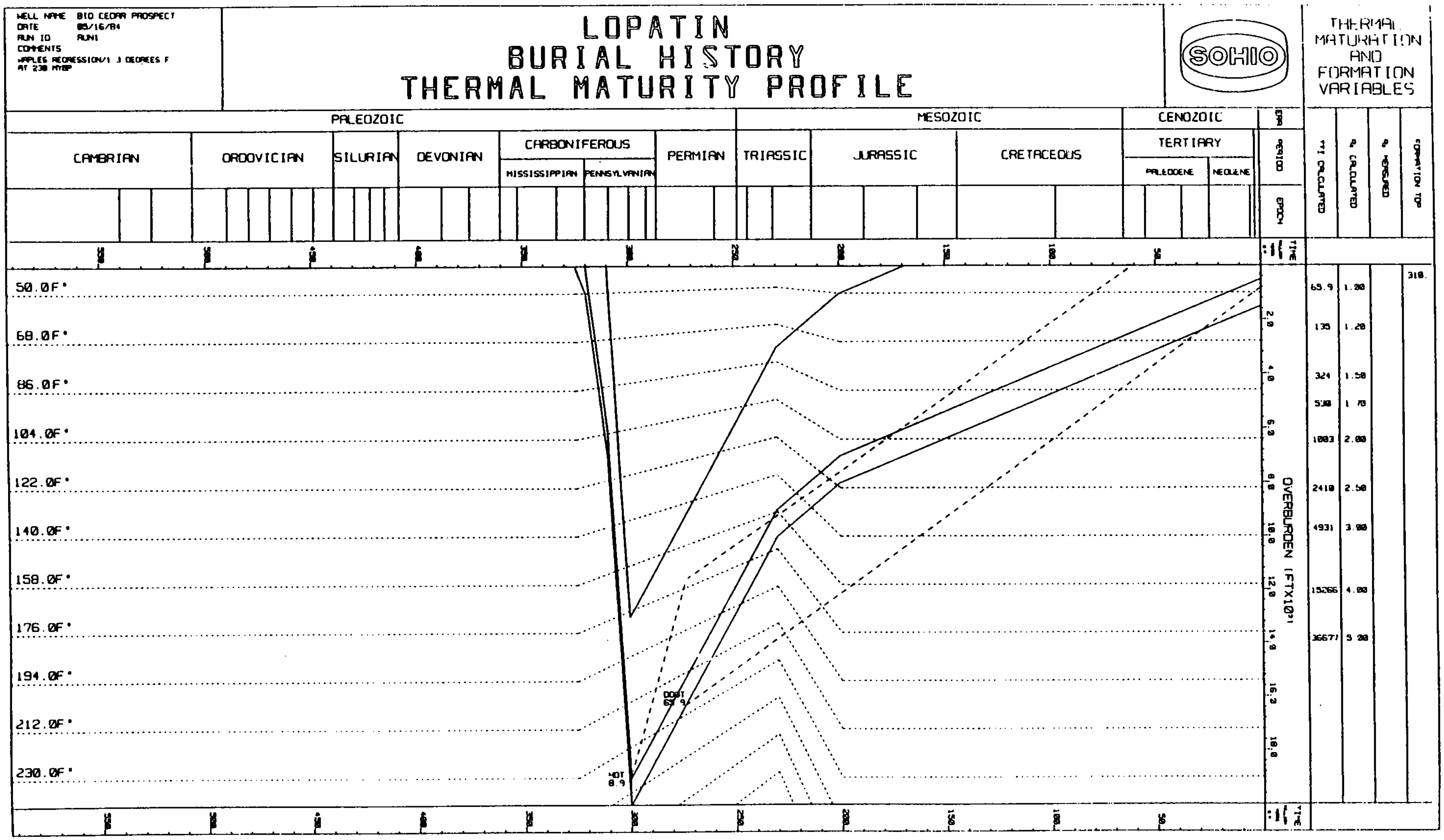
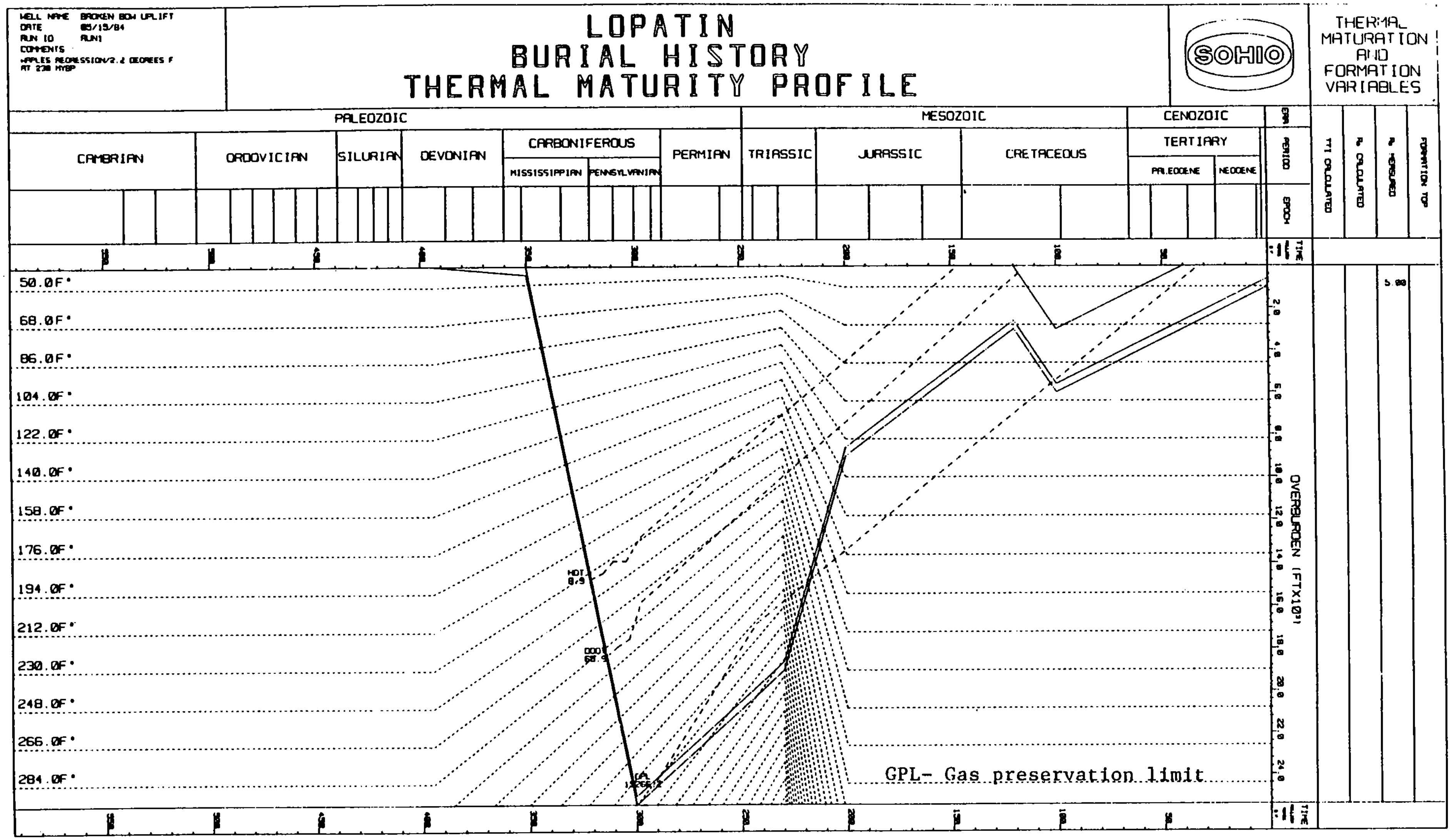
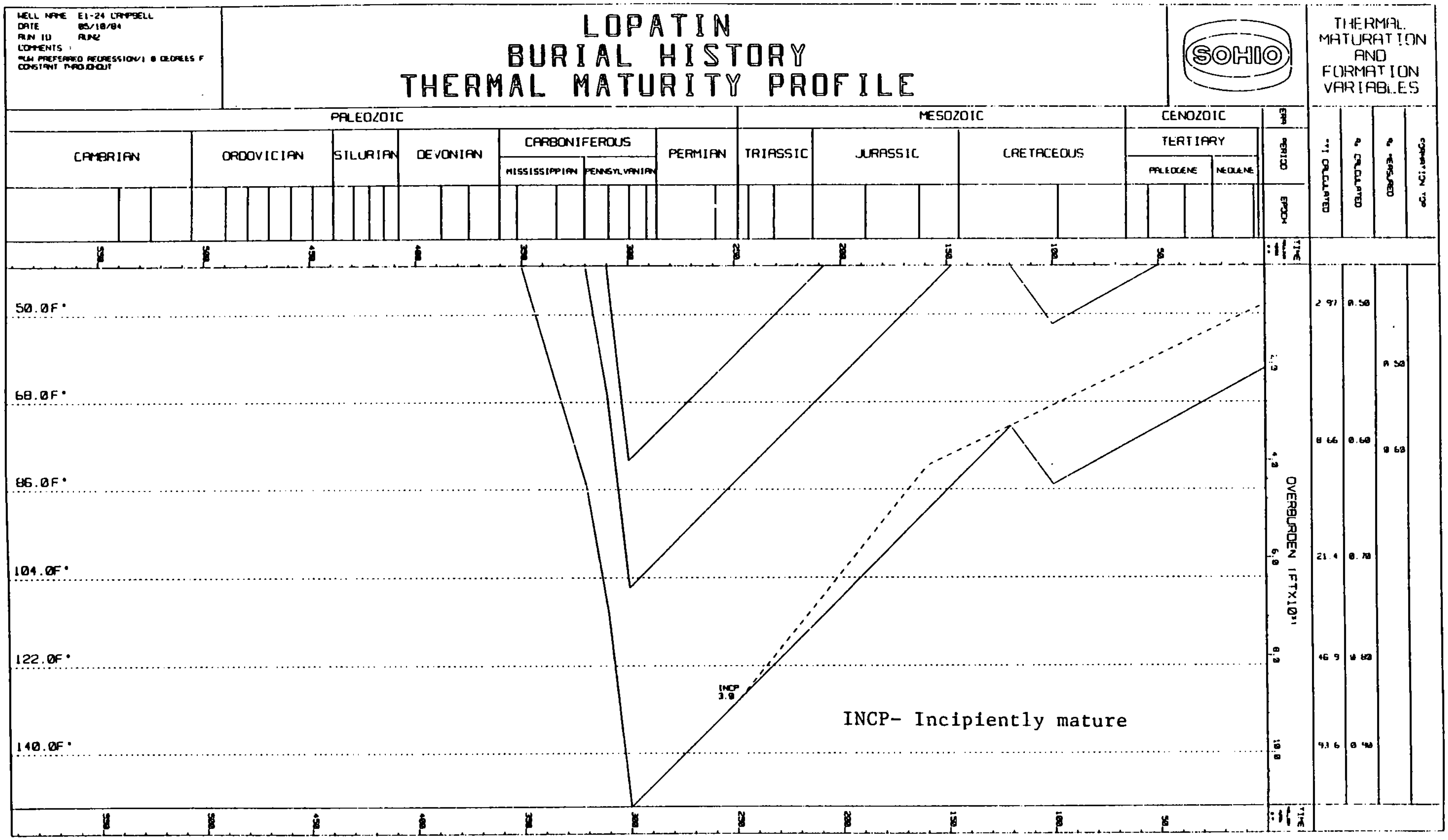

WELL NAME BIO CEDAR PROSPECT
DATE 05/16/84
RUN ID RUN1
COMMENTS
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOCENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
R₀ CALCULATED
R₀ MEASURED
FORMATION TOP
OVERBURDEN (FTX10³)
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
158.0F°
176.0F°
194.0F°
212.0F°
230.0F°
DOOT 65.9
HOT 8.9
310.
65.9 1.00
135 1.20
324 1.50
530 1.70
1003 2.00
2410 2.50
4931 3.00
15266 4.00
36677 5.00
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
550
500
450
400
350
300
250
200
150
100
50

FIGURE 4


WELL NAME BROKEN BOW UPLIFT
DATE 05/15/84
RUN ID RUN1
COMMENTS
WAPLES REGRESSION/2.2 DEGREES F AT 230 MYBP
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOCENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
Ro CALCULATED
Ro MEASURED
FORMATION TOP
5.00
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
158.0F°
176.0F°
194.0F°
212.0F°
230.0F°
248.0F°
266.0F°
284.0F°
OVERBURDEN (FTX10³)
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
24.0
HOT 8.9
GPL- Gas preservation limit
FIGURE 5



WELL NAME E1-24 CAMPBELL
DATE 05/10/84
RUN ID RUN2
COMMENTS :
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOGENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
R₀ CALCULATED
R₀ MEASURED
FORMATION TOP
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
OVERBURDEN (FTX10³)
INCP 3.9
INCP- Incipiently mature

FIGURE 6

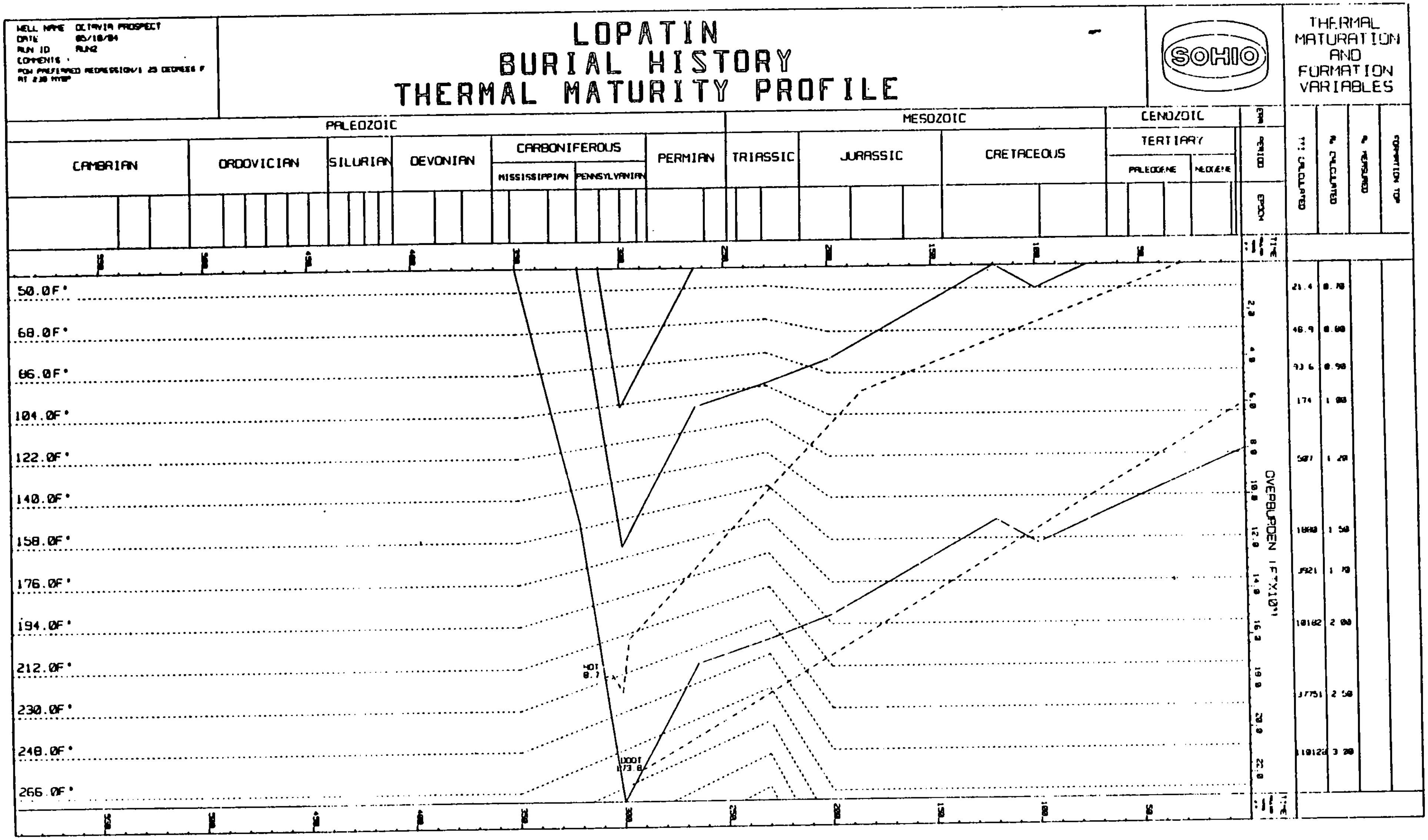
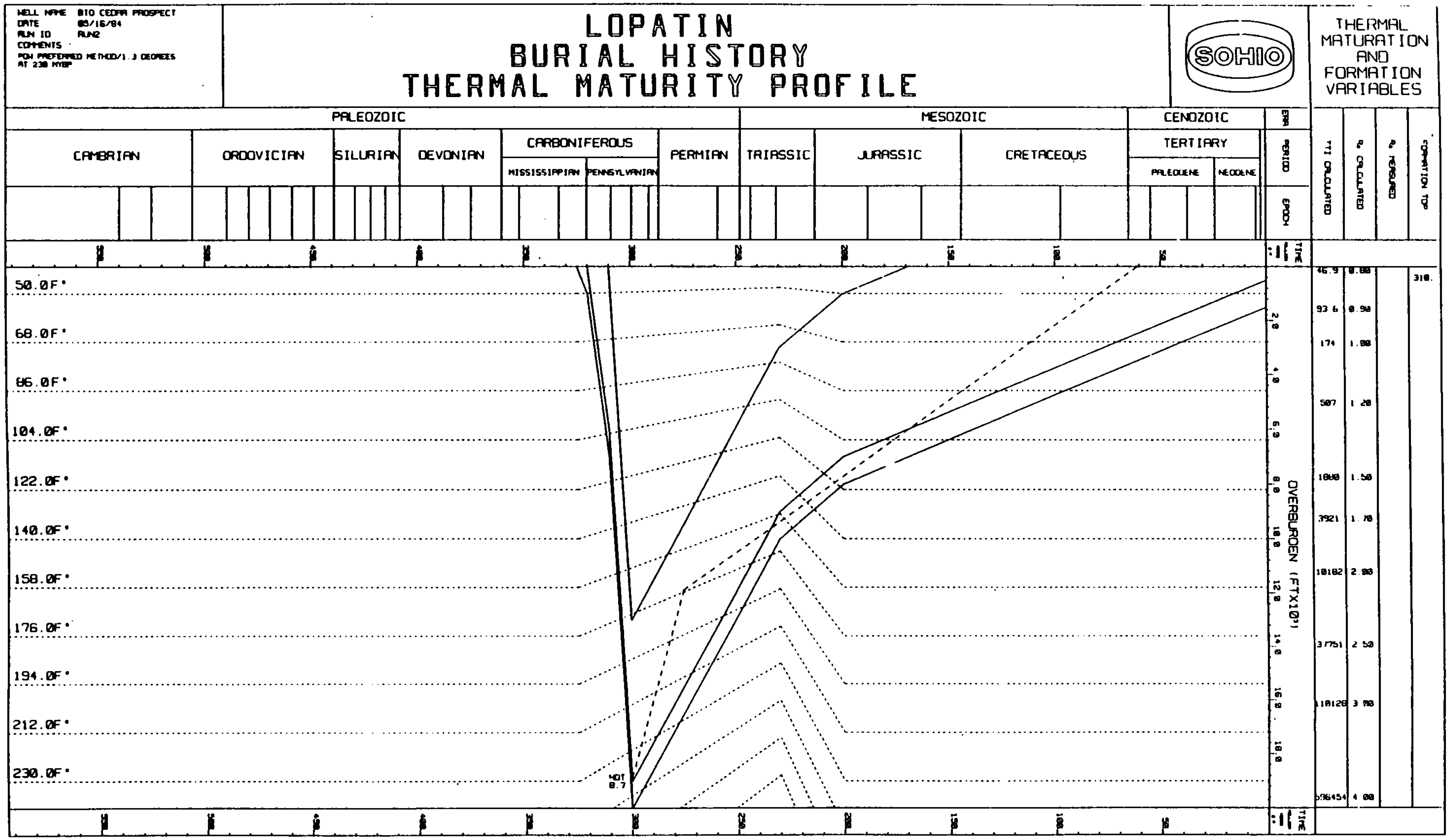

WELL NAME OCTAVIA PROSPECT
DATE 05/10/84
RUN ID RUN2
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOGENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
OVERBURDEN
TTI CALCULATED
Ro CALCULATED
Ro MEASURED
FORMATION TOP
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
158.0F°
176.0F°
194.0F°
212.0F°
230.0F°
248.0F°
266.0F°
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
21.4 0.70
46.9 0.80
93.6 0.90
174 1.00
507 1.20
1880 1.50
3921 1.70
10182 2.00
37751 2.50
110122 3.00
50
100
150
200
250
300
350
400
450
500
550

FIGURE 7



WELL NAME BIO CEDAR PROSPECT
DATE 05/16/84
RUN ID RUN2
COMMENTS
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOCENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
Ro CALCULATED
Ro MEASURED
FORMATION TOP
OVERBURDEN (FTX10³)
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
158.0F°
176.0F°
194.0F°
212.0F°
230.0F°

FIGURE 8

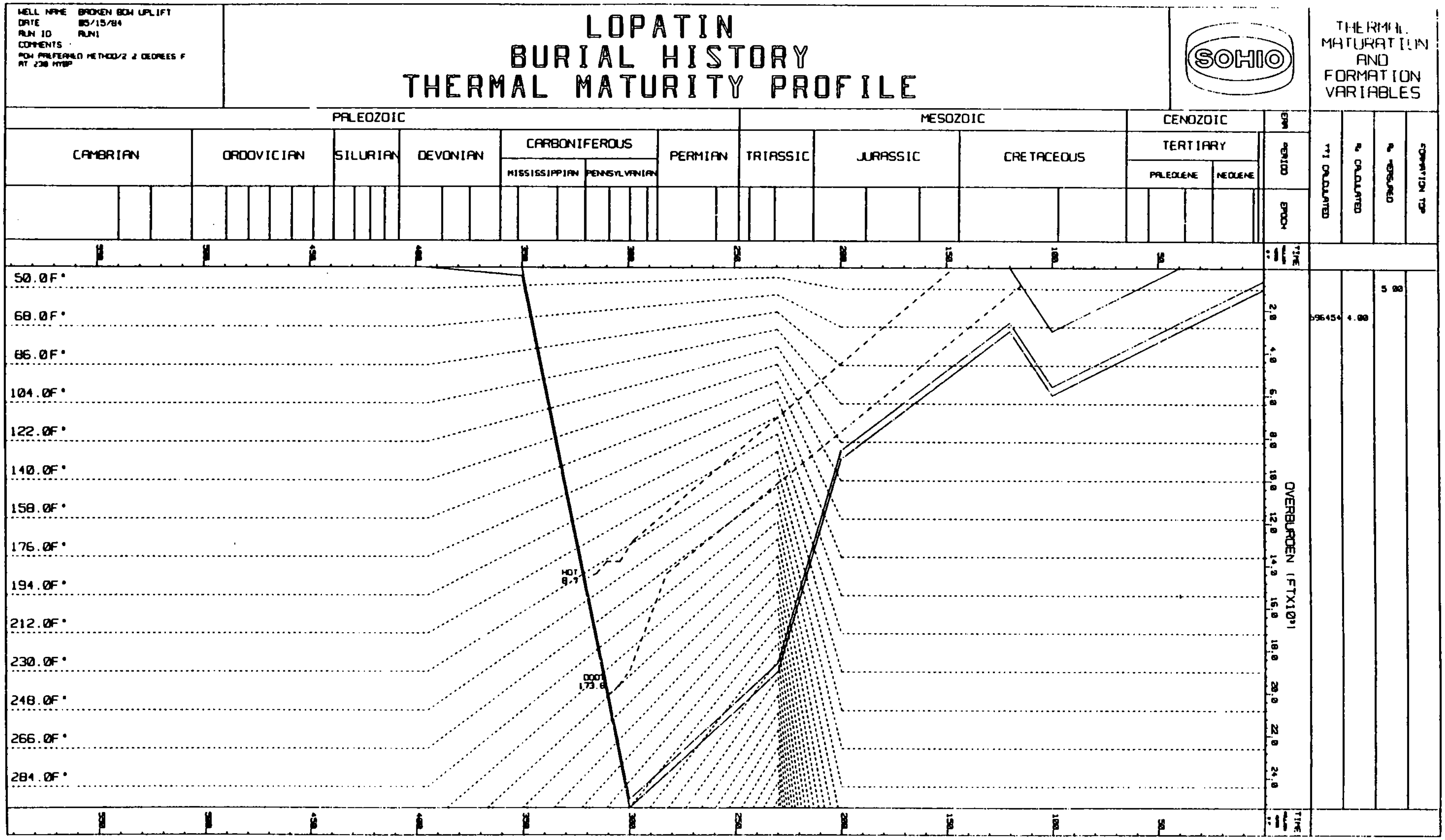

WELL NAME BROKEN BOW UPLIFT
DATE 05/15/84
RUN ID RUN1
COMMENTS
LOPATIN
BURIAL HISTORY
THERMAL MATURITY PROFILE
SOHIO
THERMAL MATURATION AND FORMATION VARIABLES
PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
MISSISSIPPIAN
PENNSYLVANIAN
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
PALEOCENE
NEOGENE
ERA
PERIOD
EPOCH
TIME
TTI CALCULATED
R_o CALCULATED
R_o MEASURED
FORMATION TOP
5.00
4.00
OVERBURDEN (FTX10³)
50.0F°
68.0F°
86.0F°
104.0F°
122.0F°
140.0F°
158.0F°
176.0F°
194.0F°
212.0F°
230.0F°
248.0F°
266.0F°
284.0F°
HOT 8.7
DOOT 173.8

FIGURE 9

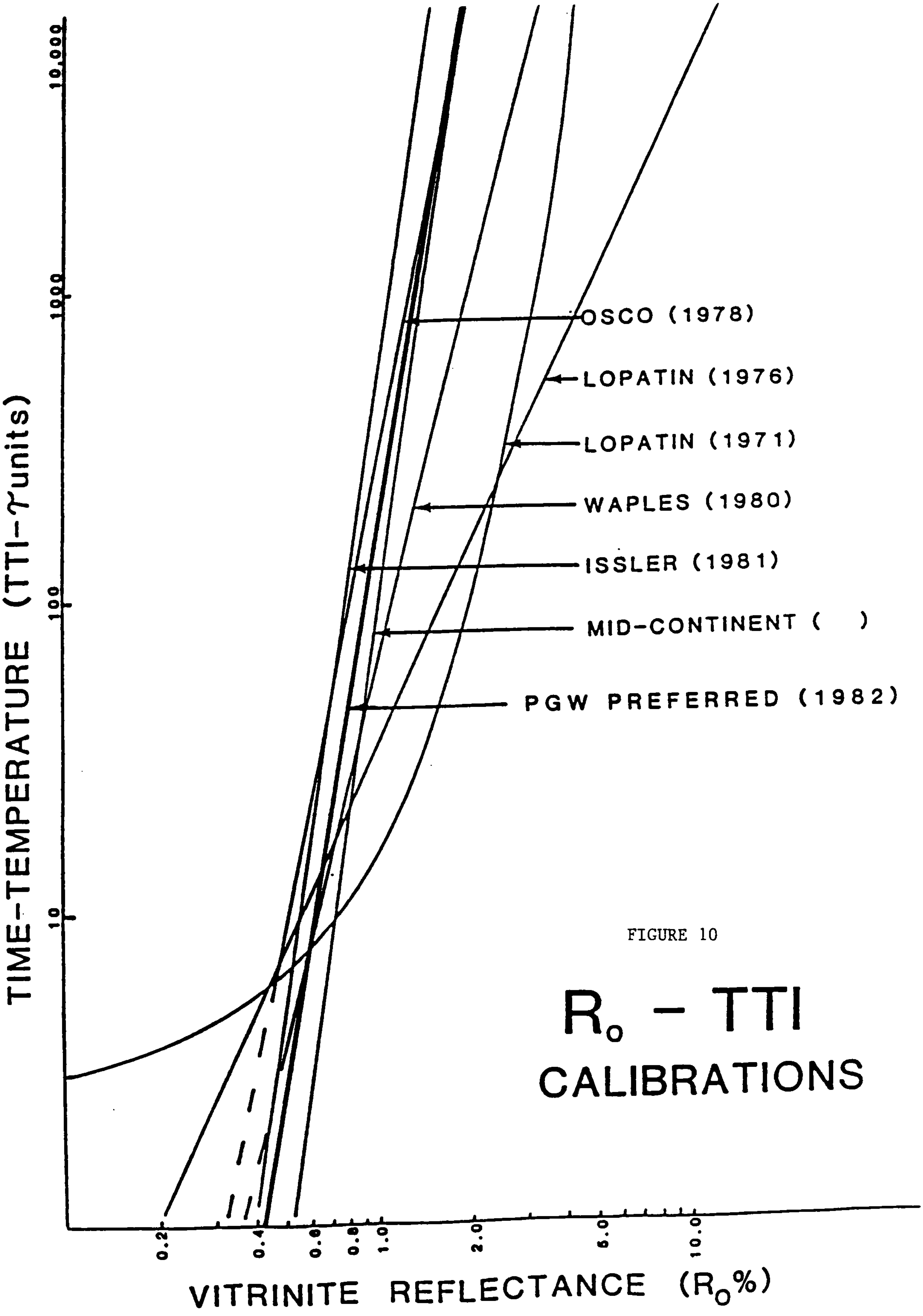


FIGURE 10

R_o – TTI CALIBRATIONS

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

WELL : #1-24 CAMPBELL

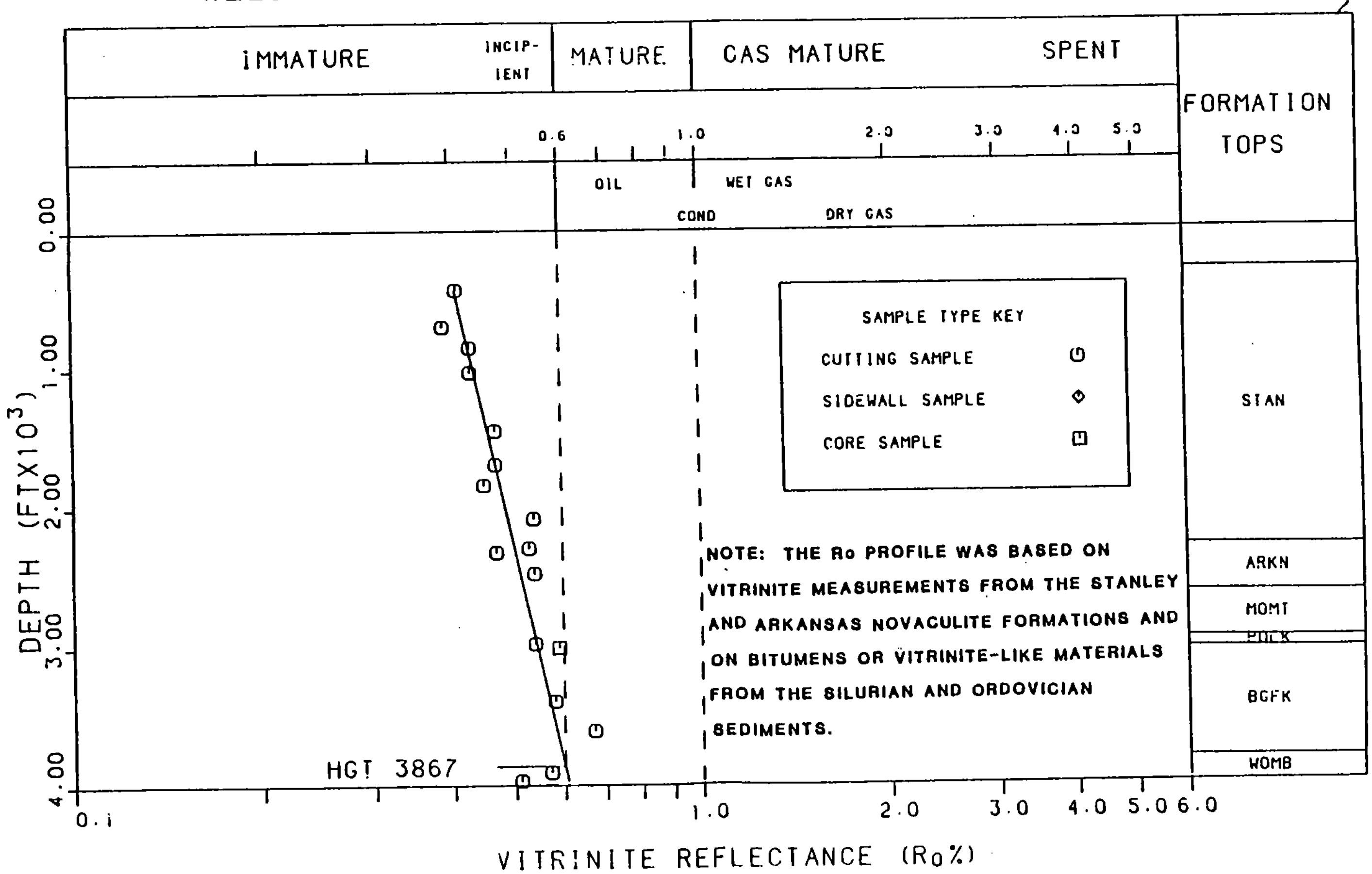


FIGURE 11

G. Cole

HO85.0664

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: M. Killgore
SPC Mid-Continent Region
Dallas

March 4, 1985
PGG/030485/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Issue of "Source Evaluation of the Trotter-Dees 1-29 Well, Pushmataha County, Oklahoma - Technical Memorandum (PGG/TM190".

Enclosed find a copy of the subject report for your use and retention. Individual copies have been forwarded directly to C. Titus, D. Bajak and T. Legg.

The report details the source rock geochemistry for the Trotter-Dees 1-29 well with comparisons to other wells in the Oklahoma Ouachita Overthrust.

85749

R. Drozd / g.a.c.
R. J. Drozd

RJD:mlc
Enclosure

cc: H. G. Bassett
C. Titus
D. Bajak
T. Legg
G. Cole
Files (0) (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed report.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: M. Killgore
SPC Mid-Continent Region
Dallas, Texas

March 1, 1985
PGG/022585/GC/2-5
PGG No.: 83-160

Attn: C. Titus
D. Bajak
T. Legg

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Technical Memorandum (PGG/TM190) -- Source Evaluation of the Sohio Trotter-Dees 1-29 Well, Pushmataha County, Oklahoma.

Summary: A geochemical source quality screen and detailed thermal maturity assessment of the stratigraphic sequence penetrated in the Sohio Trotter-Dees 1-29 well was completed by PGG. The well was spudded in the Pennsylvanian Jackfork Formation and penetrated complete Stanley Group (Mississippian) and Arkansas Novaculite (Devonian) sections. The well attained TD in the Missouri Mountain Formation (Silurian) at 15893'. Except for sporadic good TOC values, the Trotter-Dees 1-29 well was only moderate, at best, in source richness. The well was spudded in oil mature sediments (~0.65-0.70% R_o at surface) and was completed in thermally spent sediments (Arkansas Novaculite had an R_o >3.0%).

1. INTRODUCTION

This report details the source rock geochemistry of the Sohio Trotter-Dees 1-29 well, Pushmataha County, Oklahoma that was drilled to a total depth of 15893'. The well was spudded in the Pennsylvanian Stanley Group, and penetrated the Devonian Arkansas Novaculite and Silurian Missouri Mountain Formations. The well is currently testing above 7000'.

2. MATERIALS AND METHODS

2.1 Materials

A total of five hundred twenty (520) cuttings samples, twenty-seven (27) sidewall cores, and two conventional core samples, were submitted for geochemical source rock evaluation covering the gross well intervals from 50' to 15893'. Samples were analyzed on a screen basis every 60'. Each sample was given a unique PGG well sample number from WD1195-1244, WD2685-2862, WD3824-3874, WD4462-4493, WD5209-5232, WD5277-5339, WD6043-6082, WD7880-7929 and WD8940-8982 for the cuttings samples, WD1509-1514, WD2182-2192, WD2863-2870 and WD3007 for the SWC samples, and WD8128-8129 for the conventional core samples.

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGG methods. Analyses consisted of organic petrographic determinations to establish a thermal maturity profile, rapid screen Rock-Eval pyrolysis and Total Organic Carbon (%TOC - bitumen free) to assess the overall source quality.

The hydrocarbon proneness (oil or gas) of any interval of interest was assessed by means of proprietary pyrolysis gas chromatography (PGC) which established the GOGI ratio (gas-oil generation index).

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the Sohio Trotter-Dees 1-29 well is listed in Table 1 and Figure 1. A Source Evaluation Log is appended as Figure 2.

3.1 Sediment Thermal Maturity Profile (STAMP)

The STAMP for the Trotter-Dees 1-29 well is a graphic representation of the detailed vitrinite reflectance analyses performed on nine (9) SWC, two (2) conventional core, and twenty-seven (27) cuttings samples from the 290'-15623' interval. A linear regression applied to the thirty-eight (38) sample data set indicated a correlation coefficient of 0.98 (r^2=96%). The maturity gradient for this well was 14.2 DOD units/km (4.31 DOD units/1000'). This data implied:

1) the surface R_o, as extrapolated by the regression analysis, was ~ 0.68%.

2) HGT (hydrocarbon generation threshold, 0.6% R_o) would have occurred at approximately 1300' above the surface.

3) DGGT (dominant gas generation threshold, 1.0% R_o) occurred at approximately 3830'.

4) all sediments below 11000' were thermally spent (R_o >2.0%).

The gradients between the Trotter-Dees 1-29 (14.2 DOD units/km), Campbell 1-24 (15.9 DOD units/km) and the 1-25 Weyerhaeuser (14.6 DOD units/km) were similar (Cole, 1984). This would imply that the geothermal gradients throughout most of the Oklahoma Ouachita Overthrust were constant and the differing maturity values between the wells (i.e., Campbell was mostly immature, 1-25 Weyerhaeuser was thermally spent) were caused primarily by different depths of burial.

3.2 Source Quality

The source quality for the Trotter-Dees 1-29 well was determined by using PGG standardized methods for %TOC, pyrolysis (potential productivity), and pyrolysis-gas chromatography (PGC). The source quality data is summarized in Table 2 and will be discussed by formation.

Two points, however, should be discussed regarding contaminants used during the drilling of the well:

1. Oil-based drilling muds were used from approximately 3000' to TD. The clays within the various lithologies absorbed the oil fraction, which in turn, were virtually unextractable using methylene chloride prior to source rock analyses.

   The pyrolysis results, therefore, were abnormally high (both S1 and S2). The GOGI values (gas-oil generation index using PGC methods) were also affected. The effects can be seen particularly well at 9280-9640' where maturity levels indicated gas prone sediments, but GOGI values of 0.13-0.15 indicated immature, oil-prone sediments. Due to this contamination the pyrolysis and PGC results were not considered valid for this well.

2. Throughout the 0-8000' interval of the Trotter-Dees well a coal additive was used during drilling. This coal had an R_o between 0.5-0.8% and was found in varying amounts. Sample number WD2838 (5860') consisted of coaly material resulting in a TOC of 4.36%. Therefore, some of the higher TOC values, high S2 values and gas-prone GOGI values in the upper 8000' of the well could be due to this coal additive.

3.2.1 Jackfork Formation (Pennsylvanian) - 0' to 1100'; oil mature, moderate source richness with an average TOC of 0.69% and ranged from 0.20 to 4.04%.

3.2.2 Stanley Group (Mississippian) - 1100' to 15290', oil mature to thermally spent; moderate source richness with an average TOC of 0.65% and ranged from 0.07 to 4.36%. Sporadic intervals within the Stanley contained good source richness and could be considered possible gas sources.

3.2.3 Arkansas Novaculite (Devonian) - 15290' to 15660'; thermally spent; moderate source richness with an average TOC of 0.61% and ranged from 0.06 to 1.34%. The TOC values did not compare favorably to the values from the Campbell 1-24 well. Values from the Campbell 1-24 ranged from 0.15 to 3.15% with the top 60' being of good to very good source richness and mixed oil/gas proneness. The Trotter-Dees 1-29 did not contain this good source rich (high TOC) zone.

3.2.4 Missouri Mountain (Silurian) - 15660 to TD; thermally spent; moderate source richness with an average TOC of 0.55% and ranged from 0.34 to 0.79%.

4. EXPLORATION SIGNIFICANCE

The Trotter-Dees 1-29 was a wet/dry gas prospect with Arkansas Novaculite and Polk Creek Shale objectives. The well was completed after penetrating the Arkansas Novaculite objective; the Polk Creek was not reached. The low TOC values throughout the well were not generally of sufficient source richness to generate or be considered for commercial amounts of hydrocarbons. The Mississippian Stanley Group, though, did contain limited intervals of good source richness which may have generated some commercial quantities of gas. Examples of these intervals were:

1. 6920-6980' : 1.71% TOC avg.
2. 7400-7530' : 1.51% TOC avg.
3. 8150-8540' : 1.10% TOC avg.
4. 8786-9020' : 1.11% TOC avg.
5. 9520-9580' : 1.21% TOC avg.

The Arkansas Novaculite in the Trotter-Dees 1-29 well did not contain the good source richness encountered in other Ouachita Overthrust wells and could not be considered a good source candidate rock.

5. REFERENCES

Cole, G.A., 1984, Maturity Assessment of the Vierson-Cochran 1-25 Weyerhaeuser well, McCurtain County, Oklahoma: Exploration Brief (PGW/EB211).

Cole, G.A., 1984, Source rock evaluation of the #1-24 Campbell well, Atoka County, Oklahoma: Technical Memorandum (PGW/TM156).

G. A. Cole

GAC:mlc

Enclosures: Figures 1-2
Tables 1-2

cc: H. G. Bassett
R. Drozd
Files (0) (2-5)

Work by: R. Chaikin
C. Cox
R. Lukco
K. Valentine
J. Reymander
J. Lakner

TABLE 2

SUMMARY OF SOURCE QUALITY DATA

FORMATION	TOC % AVG.	TOC % RANGE	MATURITY
Jackfork	0.69	0.20-4.04	Oil Mature
Stanley	0.65	0.07-4.36	Oil Mature to Thermally Spent
Arkansas Novaculite	0.61	0.06-1.34	Thermally Spent
Missouri Mountain	0.55	0.34-0.79	Thermally Spent

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

WELL : TROTTER-DEES 1-29

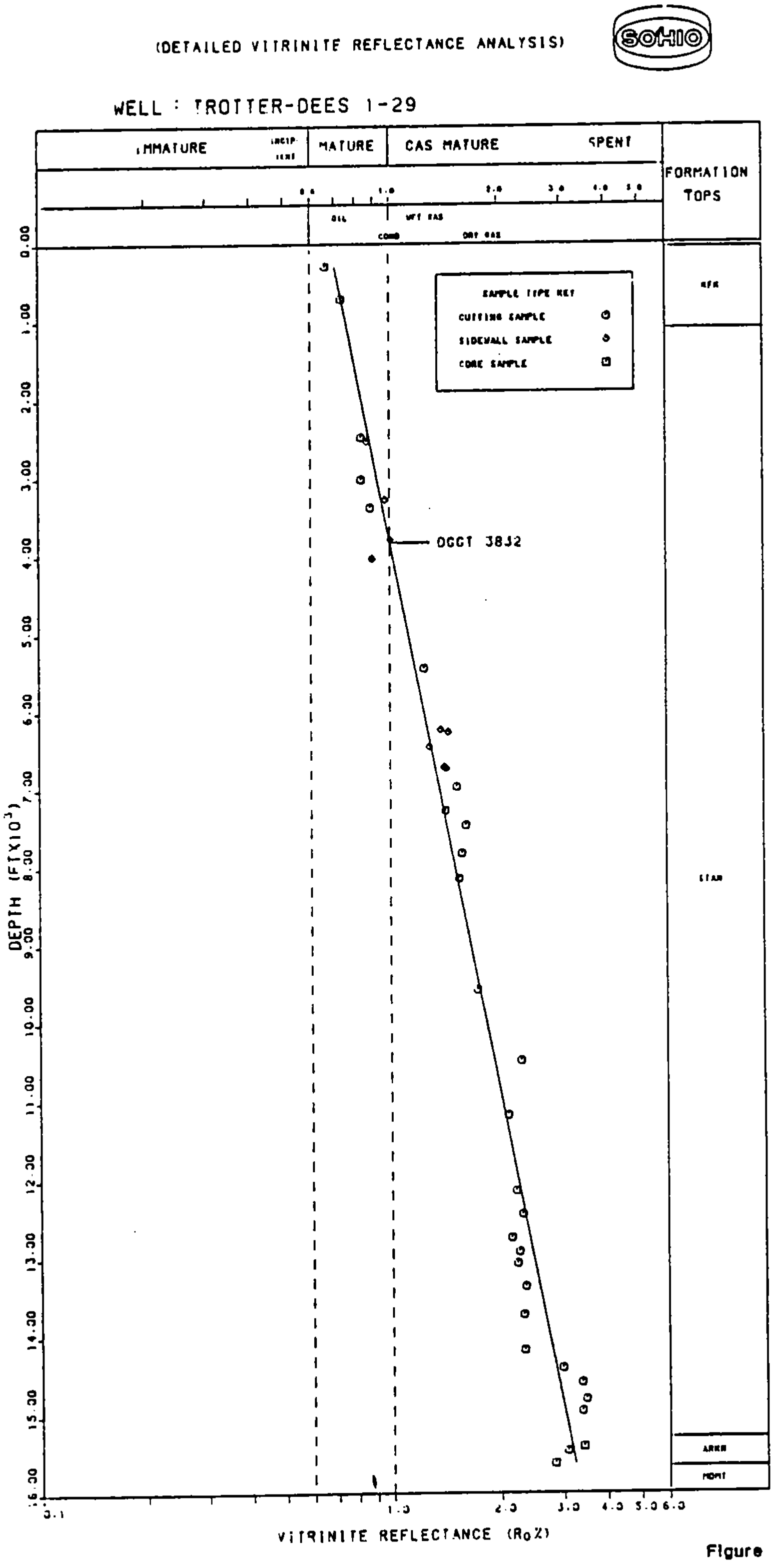


Figure 1

APPENDIX

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH.
LST. } 0-10% qualifying component

SH. CALC
LST. ARG } 11-25% qualifying component

SH. V. CALC
LST. V. ARG } 26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component (CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): %. Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): %. Thermally Distillable Hydrocarbons (Rock Eval @ ≤ 300°C) - Kg/Tn.

S2 (12): %. Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: %. Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

GI (TSE)(14): %. Generation Index. TSE/TOC. Generation intensity based on abundance of Total Soluble Extract.

GI (S1)(15): %. Generation Index. S1/TOC Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): %. Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn. More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) %. Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn. More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): %. Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(O): %. Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

T A B L E S

TABLE 1

S U M M A R Y D A T A F I L E

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC29,T1NR18E
WELL/SITE : TROTTER-DEES 1-29
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
50	WD1195	CTG			SST	8		.41		.01	.01	2
55	XD1195		PENN	JKFK	FORM.TOP							
80	WD1196	CTG			SST							
110	WD1197	CTG			SST	4		.20		.20	.36	180
140	WD1198	CTG			SST							
170	WD1199	CTG			SH	8		.60		.22	.49	82
200	WD1200	CTG			SH							
230	WD1201	CTG			SH	8		.54		.10	.32	59
260	WD1202	CTG			SH							
290	WD1203	CTG			SH	9		.66		.23	.46	70
320	WD1204	CTG			SH							
350	WD1205	CTG			SST	5		.48		0.00	.01	2
380	WD1206	CTG			SST							
410	WD1207	CTG			SST	4		.20		.17	.36	180
440	WD1208	CTG			SST							
470	WD1209	CTG			SST	5		.26		.17	.41	158
500	WD1210	CTG			SST							
530	WD1211	CTG			SST	3		.22		.13	.23	105
620	WD1212	CTG			SST							
650	WD1213	CTG			SH,CALC	10		.69		.16	.39	57
680	WD1214	CTG			SH,CALC							
710	WD1215	CTG			SH	8		.80		.12	.40	50
740	WD1216	CTG			SH							
770	WD1217	CTG			SST	6		.26		.16	.34	131
800	WD1218	CTG			SST							
810	WD1219	CTG			SST	7		.60		.11	.30	50
840	WD1220	CTG			SST							
870	WD1221	CTG			SST	6		.62		.10	.26	42
900	WD1222	CTG			SST							
930	WD1223	CTG			SST	7		.43		.07	.30	70
960	WD1224	CTG			SST							
990	WD1225	CTG			SST	8		.79		.07	.36	46
1020	WD1226	CTG			SST							
1050	WD1227	CTG			SST	7		4.04		.18	2.25	56
1080	WD1228	CTG			SST							
1100	XD1228		MISS	STAN	FORM.TOP							
1110	WD1229	CTG			SST,CALC	10		.86		.10	.46	53

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
50	.50		2												
55															
80															
110	.36		100												
140															
170	.31		37												
200															
230	.24		19												
260															
290	.33		35									.66			
320															
350	0.00		0												
380															
410	.32		85												
440															
470	.29		65												
500															
530	.36		59												
620															
650	.29		23												
680															
710	.23		15									.73			
740															
770	.32		62												
800															
810	.27		18												
840															
870	.28		16												
900															
930	.19		16												
960															
990	.16		9												
1020															
1050	.07		4		3.10	1.02	2.08	77	.49						
1080															
1100															
1110	.18		12												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1140	WD1230	CTG			SST,CALC							
1170	WD1231	CTG			SST	9		.78		.06	.31	40
1200	WD1232	CTG			SST							
1230	WD1233	CTG			SST	7		.42		.08	.27	64
1260	WD1234	CTG			SST							
1290	WD1235	CTG			SH,CALC	10		.49		.07	.42	86
1320	WD1236	CTG			SH,CALC							
1350	WD1237	CTG			SH,CALC	10		.48		.04	.39	81
1380	WD1238	CTG			SH,CALC							
1410	WD1239	CTG			SH,CALC	11		1.05		.11	.46	44
1440	WD1240	CTG			SH,CALC							
1470	WD1241	CTG			SH,CALC	10		.33		.09	.31	94
1500	WD12[illegible]	CTG			SH,CALC							
1530	WD12[illegible]	CTG			SH,CALC							
1560	WD1[illegible]	CTG			SH,CALC							
1580	WD2[illegible]	[illegible]G			SLTST	9		.37		0.00	0.00	0
1610	WD2[illegible]	CTG			SLTST							
1640	WD2687	CTG			SH,CALC	12		.46		0.00	.06	13
1670	WD2688	CTG			SH,CALC							
1700	WD2689	CTG			SH	9		.64		0.00	.13	20
1730	WD2690	CTG			SH							
1737	WD1511	SWC										
1760	WD2691	CTG			SLTST	8		.44		.01	.03	7
1790	WD2692	CTG			SLTST							
1820	WD2693	CTG			SLTST,CALC	10		.56		0.00	.03	5
1850	WD2694	CTG			SLTST,CALC							
1880	WD2695	CTG			SH	8		.84		0.00	.11	13
1910	WD2696	CTG			SH							
1940	WD2697	CTG			SH	9		.46		0.00	.06	13
1970	WD2698	CTG			SH							
2000	WD2699	CTG			SH	9		.63		0.00	.03	5
2030	WD2700	CTG			SH							
2060	WD2701	CTG			SH	8		.73		0.00	.16	22
2090	WD2702	CTG			SH							
2120	WD2703	CTG			SH	9		.65		0.00	.04	6
2130	WD1512	SWC										
2150	WD2704	CTG			SH							
2180	WD2705	CTG			SH,CALC	13		.70		0.00	1.07	153
2210	WD2706	CTG			SH,CALC							
2240	WD2707	CTG			SH,CALC	11		2.64		0.00	1.10	42
2270	WD2708	CTG			SH,CALC							
2300	WD2709	CTG			SH,CALC	13		.34		0.00	.01	3
2330	WD2710	CTG			SH,CALC							
2360	WD2711	CTG			SH	9		.90		.01	.16	18
2390	WD2712	CTG			SH							
2420	WD2713	CTG			SH,CALC	11		.83		0.00	.15	18
2450	WD2714	CTG			SH,CALC							
2480	WD2715	CTG			SLTST	7		1.37		.01	.42	31
2510	WD2716	CTG			SLTST							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1140															
1170	.16		8												
1200															
1230	.23		19												
1260															
1290	.14		14												
1320															
1350	.09		8												
1380															
1410	.19		10												
1440															
1470	.23		27												
1500															
1530															
1560															
1580			0												
1610															
1640	0.00		0												
1670															
1700	0.00		0												
1730															
1737															
1760	.25		2												
1790															
1820	0.00		0												
1850															
1880	0.00		0												
1910															
1940	0.00		0												
1970															
2000	0.00		0												
2030															
2060	0.00		0												
2090															
2120	0.00		0												
2130															
2150															
2180	0.00		0												
2210															
2240	0.00		0		1.75	.82	.93	66	.89						
2270															
2300	0.00		0												
2330															
2360	.06		1												
2390															
2420	0.00		0												
2450															
2480	.02		1									.83			
2510															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2534	WD1513	SWC										
2540	WD2717	CTG			SH,CALC	11		.56		.01	.05	9
2570	WD2718	CTG			SH,CALC							
2600	WD2719	CTG			SH	9		1.16		.01	.43	37
2630	WD2720	CTG			SH							
2660	WD2721	CTG			SLTST	7		.45		0.00	.06	13
2690	WD2722	CTG			SLTST							
2720	WD2723	CTG			SLTST	8		.57		0.00	.13	23
2750	WD2724	CTG			SLTST							
2780	WD2725	CTG			SLTST	8		.48		0.00	.11	23
2810	WD2726	CTG			SLTST							
2840	WD2727	CTG			SLTST	7		.69		.01	.17	25
2870	WD2728	CTG			SLTST							
2877	WD1514	SWC										
2900	WD2729	CTG			SH,CALC	10		.56		.02	.14	25
2930	WD2730	CTG			SH,CALC							
2960	WD2731	CTG			SH	8		.72		0.00	.14	19
2990	WD2732	CTG			SH							
3020	WD2733	CTG			SH	9		1.66		0.00	.75	45
3050	WD2734	CTG			SH							
3080	WD2735	CTG			SH	8		.62		.01	.12	19
3110	WD2736	CTG			SH							
3130	WD1510	SWC										
3140	WD2737	CTG			SLTST	6		.71		.01	.16	23
3170	WD2738	CTG			SLTST							
3200	WD2739	CTG			SH,CALC	11		.56		.06	.15	27
3230	WD2740	CTG			SH,CALC							
3260	WD2741	CTG			SH,CALC	10		.72		.05	.25	35
3279	WD1509	SWC										
3290	WD2742	CTG			SH,CALC							
3320	WD2743	CTG			SH,CALC	12		.62		.06	.15	24
3350	WD2744	CTG			SH,CALC							
3380	WD2745	CTG			SH	8		1.02		.21	.40	39
3394	WD2182	SWC										
3410	WD2746	CTG			SH							
3440	WD2747	CTG			SH	8		.79		.14	.26	33
3480	WD2748	CTG			SH							
3510	WD2749	CTG			SLTST	8		.39		.07	.05	13
3540	WD2750	CTG			SLTST							
3570	WD2751	CTG			SLTST	8		.34		.07	.07	21
3600	WD2752	CTG			SLTST							
3624	WD2183	SWC										
3630	WD2753	CTG			SLTST	8		.37		.04	.01	3
3660	WD2754	CTG			SLTST							
3690	WD2755	CTG			SLTST,CALC	10		.23		.04	0.00	0
3720	WD2756	CTG			SLTST,CALC							
3750	WD2757	CTG			SLTST	8		.36		.01	.02	6
3780	WD2758	CTG			SLTST							
3792	WD2184	SWC										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2534												.86			
2540	.17		2												
2570															
2600	.02		1												
2630															
2660	0.00		0												
2690															
2720	0.00		0												
2750															
2780	0.00		0												
2810															
2840	.06		1												
2870															
2877															
2900	.13		4												
2930															
2960	0.00		0												
2990															
3020	0.00		0									.83			
3050															
3080	.08		2												
3110															
3130															
3140	.06		1												
3170															
3200	.29		11												
3230															
3260	.17		7												
3279												.97			
3290															
3320	.29		10												
3350															
3380	.34		21									.88			
3394															
3410															
3440	.35		18												
3480															
3510	.58		18												
3540															
3570	.50		21												
3600															
3624															
3630	.80		11												
3660															
3690	1.00		17												
3720															
3750	.33		3												
3780															
3792												1.00			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3810	WD2759	CTG			SH	9		.21		.01	.03	14
3840	WD2760	CTG			SH,CALC							
3870	WD2761	CTG			SH,CALC	10		.30		.02	.05	17
3900	WD2762	CTG			SH,CALC							
3930	WD2763	CTG			SH,CALC	11		.24		.02	.06	25
3960	WD2764	CTG			SH,CALC							
3990	WD2765	CTG			SH,CALC	11		.20		.02	.04	20
4010	WD2185	SWC										
4020	WD2766	CTG			SH,CALC							
4034	WD2186	SWC										
4050	WD2767	CTG			SH,CALC	12		.26		.01	.05	19
4080	WD2768	CTG			SH,CALC							
4110	WD2769	CTG			SH,CALC	11		.23		0.00	.03	13
4140	WD2770	CTG			SH,CALC							
4170	WD2771	CTG			SH,CALC	10		.33		0.00	.03	9
4200	WD2772	CTG			SH,CALC							
4230	WD2187	SWC										
4230	WD2773	CTG			SH,CALC	10		.17		.04	.04	24
4270	WD2774	CTG			SH							
4300	WD2775	CTG			SH	9		.11		0.00	0.00	0
4330	WD2776	CTG			SH							
4360	WD2777	CTG			SH	7		.11		0.00	.01	9
4382	WD2188	SWC										
4390	WD2778	CTG			SH							
4420	WD2779	CTG			SH	5		.07		0.00	.01	14
4450	WD2780	CTG			SH							
4480	WD2781	CTG			SH	8		.23		0.00	0.00	0
4510	WD2782	CTG			SH							
4540	WD2783	CTG			SLTST	7		.27		.01	.03	11
4570	WD2795	CTG			SLTST							
4600	WD2796	CTG			SH	8		.22		.01	.03	14
4630	WD2797	CTG			SH							
4660	WD2798	CTG			SH	9		.22		0.00	.03	14
4685	WD2189	SWC										
4690	WD2799	CTG			SH							
4720	WD2800	CTG			SH,CALC	13		.25		.01	.05	20
4750	WD2801	CTG			SH,CALC							
4780	WD2802	CTG			SH,CALC	10		.18		.02	.08	44
4810	WD2803	CTG			SH,CALC							
4840	WD2804	CTG			SH,CALC	11		.20		0.00	.08	40
4851	WD2190	SWC										
4870	WD2805	CTG			SH,CALC							
4900	WD2806	CTG			SH	9		.20		.01	.07	35
4906	WD2191	SWC										
4930	WD2807	CTG			SH							
4960	WD2808	CTG			SH	3		.02		.02	.05	250
4990	WD2809	CTG			SH							
5020	WD2810	CTG			SH,CALC	11		.27		0.00	0.00	0
5050	WD2811	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3810	.25		5												
3840															
3870	.29		7												
3900															
3930	.25		8												
3960															
3990	.33		10												
4010															
4020															
4034												.89			
4050	.17		4												
4080															
4110	0.00		0												
4140															
4170	0.00		0												
4200															
4230															
4230	.50		24												
4270															
4300			0												
4330															
4360	0.00		0												
4382															
4390															
4420	0.00		0												
4450															
4480			0												
4510															
4540	.25		4												
4570															
4600	.25		5												
4630															
4660	0.00		0												
4685															
4690															
4720	.17		4												
4750															
4780	.20		11												
4810															
4840	0.00		0												
4851															
4870															
4900	.13		5												
4906															
4930															
4960	.29		100												
4990															
5020			0												
5050															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5080	WD2812	CTG			SH	9		.14		.03	.07	50
5110	WD2813	CTG			SH							
5140	WD2814	CTG			SH,CALC	11		.15		.01	.01	7
5150	WD2192	SWC										
5170	WD2815	CTG			SH,CALC							
5200	WD2816	CTG			SH,CALC	12		.18		.01	.02	11
5230	WD2817	CTG			SH,CALC							
5260	WD2818	CTG			SH,CALC	12		.29		.01	.07	24
5290	WD2819	CTG			SH,CALC							
5320	WD2820	CTG			SH	9		.15		.05	.03	20
5350	WD2821	CTG			SH							
5380	WD2822	CTG			SH,CALC	10		.36		.03	.06	17
5410	WD2823	CTG			SH,CALC							
5440	WD2824	CTG			SH,CALC	11		.49		.28	.60	122
5470	WD2825	CTG			SH,CALC							
5500	WD2826	CTG			SH,CALC	12		.31		.23	.46	148
5530	WD2827	CTG			SH,CALC							
5560	WD2828	CTG			SH,CALC	11		.45		.10	.15	33
5590	WD2829	CTG			SH,CALC							
5620	WD2830	CTG			SH,CALC	10		.35		.09	.19	54
5650	WD2831	CTG			SH,CALC							
5680	WD2832	CTG			SH	9		.34		.06	.04	12
5710	WD2833	CTG			SH							
5740	WD2834	CTG			SH,CALC	10		.32		.12	.23	72
5770	WD2835	CTG			SH,CALC							
5800	WD2836	CTG			SH	9		.47		.05	.02	4
5830	WD2837	CTG			SH							
5860	WD2838	CTG			SH,CALC	12		4.36		.20	2.63	60
5890	WD2839	CTG			SH,CALC							
5920	WD2840	CTG			SH	9		.07		.09	.26	371
5950	WD2841	CTG			SH							
5980	WD2842	CTG			SLTST,CALC	12		.28		.18	.41	146
6010	WD2843	CTG			SLTST,CALC							
6040	WD2844	CTG			SH	9		.52		.88	.88	169
6058	WD2863	SWC										
6070	WD2845	CTG			SH							
6100	WD2846	CTG			SH,CALC	11		.42		.37	.56	133
6130	WD2847	CTG			SH,CALC							
6147	WD2864	SWC										
6160	WD2848	CTG			SH,CALC	13		.34		.10	.21	62
6190	WD2849	CTG			SH,CALC							
6220	WD2850	CTG			SH,CALC	12		.43		.04	.14	33
6239	WD2865	SWC										
6250	WD2851	CTG			SH,CALC							
6274	WD2866	SWC										
6280	WD2852	CTG			SH,CALC	12		.35		.10	.22	63
6310	WD2853	CTG			SH,CALC							
6340	WD2854	CTG			SH,CALC	11		.32		0.00	0.00	0
6370	WD2855	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5080	.30		21												
5110															
5140	.50		7												
5150															
5170															
5200	.33		6												
5230															
5260	.13		3												
5290															
5320	.63		33												
5350															
5380	.33		8												
5410															
5440	.32		57									1.24			
5470															
5500	.33		74												
5530															
5560	.40		22												
5590															
5620	.32		26												
5650															
5680	.60		18												
5710															
5740	.34		37												
5770															
5800	.71		11												
5830															
5860	.07		5		3.28	1.09	2.19	75	.50						
5890															
5920	.26		129												
5950															
5980	.31		64												
6010															
6040	.50		169												
6058															
6070															
6100	.40		88												
6130															
6147															
6160	.32		29												
6190															
6220	.22		9												
6239												1.38			
6250															
6274												1.45			
6280	.31		29												
6310															
6340			0												
6370															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
6394	WD2867	SWC										
6400	WD2856	CTG			SH	7		.20		0.00	.01	5
6430	WD2857	CTG			SH							
6460	WD3006	SWC										
6480	WD2858	CTG			SH	9		.46		0.00	.01	2
6485	WD2868	SWC										
6510	WD2859	CTG			SH							
6530	WD2860	CTG			SLTST	9		1.72		0.00	.58	34
6534	WD2869	SWC										
6560	WD2861	CTG			SLTST							
6590	WD2862	CTG			SH,CALC	13		.49		.02	.06	12
6620	WD3824	CTG			SH,CALC	10		.61		.01	.04	7
6650	WD3825	CTG			SH,CALC							
6680	WD3826	CTG			SH	8		.20		.01	0.00	0
6710	WD3827	CTG			SH							
6726	WD2870	SWC										
6740	WD3828	CTG			SH	9		.28		.02	0.00	0
6744	WD3007	SWC										
6770	WD3829	CTG			SH							
6800	WD3830	CTG			SH	9		.37		.01	.01	3
6830	WD3831	CTG			SH							
6860	WD3832	CTG			SH	7		.23		0.00	0.00	0
6890	WD3833	CTG			SH							
6920	WD3834	CTG			SH	9		1.17		.01	.18	15
6950	WD3835	CTG			SH							
6980	WD3836	CTG			SH,CALC	12		2.24		.04	1.32	59
7010	WD3837	CTG			SH,CALC							
7040	WD3838	CTG			SH	9		.29		.01	0.00	0
7070	WD3839	CTG			SH							
7100	WD3840	CTG			SST	8		.40		0.00	0.00	0
7130	WD3841	CTG			SST							
7160	WD3842	CTG			SH,CALC	12		.61		.03	.03	5
7190	WD3843	CTG			SH,CALC							
7220	WD3844	CTG			SH,CALC	10		.61		.02	.08	13
7250	WD3845	CTG			SH,CALC							
7280	WD3846	CTG			SH,CALC	11		.96		.02	.08	8
7310	WD3847	CTG			SH,CALC							
7340	WD3848	CTG			SH,CALC	11		.79		.01	.14	18
7370	WD3849	CTG			SH,CALC							
7400	WD3850	CTG			SH,CALC	10		1.35		.07	.39	29
7430	WD3851	CTG			SH,CALC							
7470	WD3852	CTG			SST	7		1.83		.09	.91	50
7500	WD3853	CTG			SST							
7530	WD3854	CTG			SST	8		1.35		.03	.58	43
7560	WD3855	CTG			SST							
7590	WD3856	CTG			SST	9		.92		.02	.29	32
7620	WD3857	CTG			SST							
7650	WD3858	CTG			SH,CALC	11		.61		.02	.02	3
7680	WD3859	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
6394															
6400	0.00		0												
6430															
6460												1.28			
6480	0.00		0												
6485															
6510															
6530	0.00		0												
6534															
6560															
6590	.25		4												
6620	.20		2												
6650															
6680	1.00		5												
6710															
6726												1.41			
6740	1.00		7												
6744												1.43			
6770															
6800	.50		3												
6830															
6860			0												
6890															
6920	.05		1												
6950															
6980	.03		2		2.30	.80	1.50	103	.53			1.53			
7010															
7040	1.00		3												
7070															
7100			0												
7130															
7160	.50		5												
7190															
7220	.20		3												
7250															
7280	.20		2									1.42			
7310															
7340	.07		1												
7370															
7400	.15		5												
7430															
7470	.09		5									1.62			
7500															
7530	.05		2												
7560															
7590	.06		2												
7620															
7650	.50		3												
7680															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
7710	WD3860	CTG			SH	8		.42		.03	.04	10
7740	WD3861	CTG			SH							
7770	WD3862	CTG			SH,CALC	11		.41		.03	.04	10
7800	WD3863	CTG			SH,CALC							
7830	WD3864	CTG			SH	9		1.73		.02	.65	38
7870	WD3865	CTG			SH							
7900	WD3866	CTG			SH,CALC	10		.71		.03	.10	14
7930	WD3867	CTG			SH,CALC							
7960	WD3868	CTG			SH,CALC	12		.42		.03	0.00	0
7990	WD3869	CTG			SH,CALC							
8020	WD3870	CTG			SH,CALC	11		.57		.01	0.00	0
8050	WD3871	CTG			SH,CALC							
8090	WD3872	CTG			SH,CALC	11		.89		0.00	.01	1
8120	WD3873	CTG			SH,CALC							
8150	WD3874	CTG			SH,CALC	10		.91		0.00	.01	1
8180	WD4462	CTG			SH,CALC	15		1.07		0.00	.19	13
8210	WD4463	CTG			SH,CALC							
8240	WD4464	CTG			SH,CALC	12		1.91		0.00	1.24	65
8270	WD4465	CTG			SH,CALC							
[illegible]	[illegible]	[illegible]			SH,CALC	12		.95		.03	.25	26
					[illegible]CALC							
8360	WD[illegible]	[illegible]				15		.90		0.00	.15	17
8390	WD4469	CTG			SH,CALC							
8420	WD4470	CTG			SH,CALC	15		1.21		0.00	.28	23
8450	WD4471	CTG			SH,CALC							
8480	WD4472	CTG			SH,CALC	15					.11	12
8510	WD4473	CTG			SH,CALC							
8540	WD4474	CTG			SH,CALC	14		.92		0.00	.13	14
8570	WD4475	CTG			SH,CALC							
8600	WD4476	CTG			SH,CALC	13		.51		0.00	0.00	0
8630	WD4477	CTG			SH,CALC							
8660	WD4478	CTG			SH,CALC	14		.73		0.00	0.00	0
8690	WD4479	CTG			SH,CALC							
8720	WD4480	CTG			SH,CALC	13		.66		.07	.57	86
8750	WD4481	CTG			SH,CALC							
8780	WD4482	CTG			SH,CALC	14		1.26		.59	1.78	141
8810	WD4483	CTG			SH,CALC							
8840	WD4484	CTG			SH,CALC	13		.97		.22	.86	89
8870	WD4485	CTG			SH,CALC							
8900	WD4486	CTG			SH,CALC	15		1.05		.30	1.78	170
8930	WD4487	CTG			SH,CALC							
8960	WD4488	CTG			SH,CALC	10		1.37		.14	.66	48
8990	WD4489	CTG			SH,CALC							
9020	WD4490	CTG			SH,CALC	14		.92		.23	1.66	180
9050	WD4491	CTG			SH,CALC							
9080	WD4492	CTG			SH,CALC	16		.75		.29	1.27	169
9110	WD4493	CTG			SH,CALC							
9130	WD5209	CTG			SH,CALC							
9160	WD5210	CTG			SH,CALC	13		.61		.19	1.06	174

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
7710	.43		7												
7740															
7770	.43		7												
7800															
7830	.03		1									1.58			
7870															
7900	.23		4												
7930															
7960	1.00		7												
7990															
8020	1.00		2												
8050															
8090	0.00		0												
8120															
8150	0.00		0									1.55			
8180	0.00		0												
8210															
8240	0.00		0		2.38	.94	1.44	125	.65						
8270															
8300	.11		3												
8330															
8360	0.00		0												
8390															
8420	0.00		0												
8450															
8480	0.00		0												
8510															
8540	0.00		0												
8570															
8600			0												
8630															
8660			0												
8690															
8720	.11		11												
8750															
8780	.25		47		3.00	.93	2.07	238	.45						
8810															
8840	.20		23												
8870															
8900	.14		29		2.80	.45	2.35	267	.19						
8930															
8960	.18		10												
8990															
9020	.12		25		1.54	.36	1.18	167	.31						
9050															
9080	.19		39												
9110															
9130															
9160	.15		31												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
9190	WD5211	CTG			SH,CALC							
9220	WD5212	CTG			SH,CALC	14		.61		.16	1.16	190
9250	WD5213	CTG			SH,CALC							
9280	WD5214	CTG			SH,CALC	15		.87		.38	2.28	262
9310	WD5215	CTG			SH,CALC							
9340	WD5216	CTG			SH,CALC	15		.90		.30	2.49	277
9370	WD5217	CTG			SH,CALC							
9400	WD5218	CTG			SH,CALC	13		1.14		.31	2.61	229
9430	WD5219	CTG			SH,CALC							
9460	WD5220	CTG			SH,CALC	17		.64		.15	1.19	186
9490	WD5221	CTG			SH,CALC							
9520	WD5222	CTG			SH,CALC	17		1.05		.43	3.21	306
9550	WD5223	CTG			SH,CALC							
9580	WD5224	CTG			SH,CALC	9		1.37		.19	1.26	92
9610	WD5225	CTG			SH,CALC							
9640	WD5226	CTG			SH,CALC	17		.79		.48	2.49	315
9670	WD5227	CTG			SH,CALC							
9700	WD5228	CTG			SH,CALC	14		.82		.24	1.94	237
9730	WD5229	CTG			SH,CALC							
9760	WD5230	CTG			SH,CALC	14		1.04		.21	1.13	109
9790	WD5231	CTG			SH,CALC							
9820	WD5232	CTG			SH,CALC	13		.56		.25	1.01	180
9850	WD5277	CTG			SH,CALC							
9890	WD5278	CTG			SH,CALC	13		.61		.27	1.71	280
9920	WD5279	CTG			SH,CALC							
9950	WD5280	CTG			SH,CALC	10		.59		.12	1.45	246
9980	WD5281	CTG			SH,CALC							
10010	WD5282	CTG			SH,CALC	11		.63		.28	2.01	319
10040	WD5283	CTG			SH,CALC							
10070	WD5284	CTG			SH,CALC	10		.56		.28	1.70	304
10100	WD5285	CTG			SH,CALC							
10130	WD5286	CTG			SH,CALC	13		.61		.13	1.21	198
10160	WD5287	CTG			SH,CALC							
10190	WD5288	CTG			SH,CALC	13		.49		.03	.93	190
10220	WD5289	CTG			SH,CALC							
10250	WD5290	CTG			SH,CALC	12		.59		.21	1.19	202
10280	WD5291	CTG			SH,CALC							
10310	WD5292	CTG			SH,CALC	13		.65		.17	1.45	223
10340	WD5293	CTG			SH,CALC							
10370	WD5294	CTG			SH,CALC	12		.68		.19	1.29	190
10400	WD5295	CTG			SH,CALC							
10430	WD5296	CTG			SH,CALC	16		.78		.14	1.02	131
10460	WD5297	CTG			SH,CALC							
10490	WD5298	CTG			SH	9		.91		.04	.62	68
10520	WD5299	CTG			SH							
10550	WD5300	CTG			SH,CALC	12		1.37		.14	1.30	95
10580	WD5301	CTG			SH,CALC							
10610	WD5302	CTG			SH,CALC	17		.79		.19	1.30	165
10640	WD5303	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
9190															
9220	.12		26												
9250															
9280	.14		44		2.82	.37	2.45	324	.15						
9310															
9340	.11		33												
9370															
9400	.11		27		3.10	.40	2.70	272	.15						
9430															
9460	.11		23												
9490															
9520	.12		41		4.38	.50	3.88	417	.13						
9550															
9580	.13		14									1.74			
9610															
9640	.16		61		2.39	.29	2.10	303	.14						
9670															
9700	.11		29												
9730															
9760	.16		20												
9790															
9820	.20		45												
9850															
9890	.14		44												
9920															
9950	.08		20												
9980															
10010	.12		44												
10040															
10070	.14		50												
10100															
10130	.10		21												
10160															
10190	.03		6												
10220															
10250	.15		36												
10280															
10310	.10		26												
10340															
10370	.13		28												
10400															
10430	.12		18												
10460															
10490	.06		4									2.30			
10520															
10550	.10		10												
10580															
10610	.13		24												
10640															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
10670	WD5304	CTG			SH	8		.82		.02	.34	41
10700	WD5305	CTG			SH							
10730	WD5306	CTG			SH,CALC	12		.80		.19	1.53	191
10760	WD5307	CTG			SH,CALC							
10790	WD5308	CTG			SH,CALC	17		.69		.08	.94	136
10820	WD5309	CTG			SH,CALC							
10850	WD5310	CTG			SH,CALC	14		.69		.13	.74	107
10880	WD5311	CTG			SH,CALC							
10910	WD5312	CTG			SH,CALC	11		.54		.11	.69	128
10940	WD5313	CTG			SH,CALC							
10970	WD5314	CTG			SH,CALC	11		.60		.11	.89	148
11000	WD5315	CTG			SH,CALC							
11030	WD5316	CTG			SH	9		.47		.06	.70	149
11060	WD5317	CTG			SH							
11090	WD5318	CTG			SH	7		.32		.08	.50	156
11120	WD5319	CTG			SH							
11150	WD5320	CTG			SH,CALC	11		.56		.21	1.10	196
11180	WD5321	CTG			SH,CALC							
11210	WD5322	CTG			SH,CALC	10		.52		.17	.94	181
11240	WD5323	CTG			SH,CALC							
11270	WD5324	CTG			SH	9		.46		.13	.76	165
11300	WD5325	CTG			SH							
11330	WD5326	CTG			SH	9		.42		.18	.83	198
11360	WD5327	CTG			SH							
11390	WD5328	CTG			SH	8		.48		.20	.97	202
11420	WD5329	CTG			SH							
11450	WD5330	CTG			SH,CALC	12		.76		.29	1.80	237
11480	WD5331	CTG			SH,CALC							
11520	WD5332	CTG			SH,CALC	13		.48		.17	1.02	213
11550	WD5333	CTG			SH,CALC							
11580	WD5334	CTG			SH,CALC	12		.48		.12	.68	142
11610	WD5335	CTG			SH,CALC							
11630	WD5336	CTG			SH,CALC	15		.81		.42	2.03	251
11660	WD5337	CTG			SH,CALC							
11690	WD5338	CTG			SH,CALC	14		.73		.42	1.87	256
11720	WD5339	CTG			SH,CALC							
11750	WD6043	CTG			SH,CALC	12		.34		.02	.44	129
11780	WD6044	CTG			SH,CALC							
11810	WD6045	CTG			SH,CALC	12		.50		.43	1.06	212
11840	WD6046	CTG			SH,CALC							
11870	WD6047	CTG			SH,CALC	13		.41		.04	.27	66
11900	WD6048	CTG			SH,CALC							
11930	WD6049	CTG			SH,CALC	14		.81		.17	1.50	185
11960	WD6050	CTG			SH,CALC							
11990	WD6051	CTG			SH,CALC	13		.75		.29	1.14	152
12020	WD6052	CTG			SH,CALC							
12050	WD6053	CTG			SH,CALC	13		.54		.19	.45	83
12080	WD6054	CTG			SH,CALC							
12110	WD6055	CTG			SH,CALC	10		.44		.19	1.10	250

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
10670	.06		2												
10700															
10730	.11		24												
10760															
10790	.08		12												
10820															
10850	.15		19												
10880															
10910	.14		20												
10940															
10970	.11		18												
11000															
11030	.08		13												
11060															
11090	.14		25												
11120															
11150	.16		37												
11180												2.11			
11210	.15		33												
11240															
11270	.15		28												
11300															
11330	.18		43												
11360															
11390	.17		42												
11420															
11450	.14		38												
11480															
11520	.14		35												
11550															
11580	.15		25												
11610															
11630	.17		52												
11660															
11690	.18		58												
11720															
11750	.04		6												
11780															
11810	.29		86												
11840															
11870	.13		10												
11900															
11930	.10		21												
11960															
11990	.20		39												
12020															
12050	.30		35												
12080															
12110	.15		43												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
12140	WD6056	CTG			SH,CALC							
12170	WD6057	CTG			SH	9		.38		.14	.71	187
12200	WD6058	CTG			SH							
12230	WD6059	CTG			SH	9		.31		.13	.72	232
12260	WD6060	CTG			SH							
12290	WD6061	CTG			SH	9		.25		.19	.36	144
12320	WD6062	CTG			SH							
12350	WD6063	CTG			SH	8		.35		.03	.78	223
12380	WD6064	CTG			SH							
12410	WD6065	CTG			SH	7		.28		.07	.55	196
12440	WD6066	CTG			SH							
12470	WD6067	CTG			SH	9		.24		.06	.29	121
12500	WD6068	CTG			SH							
12530	WD6069	CTG			SH	8		.32		.05	.40	125
12560	WD6070	CTG			SH							
12590	WD6071	CTG			SH	8		.33		.15	.86	261
12620	WD6072	CTG			SH							
12650	WD6073	CTG			SH	9		.33		.18	.97	294
12680	WD6074	CTG			SH							
12710	WD6075	CTG			SH	7		.27		.12	.82	304
12740	WD6076	CTG			SH							
12770	WD6077	CTG			SH	9		.42		.24	1.34	319
12800	WD6078	CTG			SH							
12830	WD6079	CTG			SH	9		.40		.01	.42	105
12860	WD6080	CTG			SH							
12890	WD6081	CTG			SH	7		.33		.05	.62	188
12920	WD6082	CTG			SH,CALC	10		.41		.20	1.09	266
12950	WD7880	CTG			SH,V.CALC	26		.94		6.53	3.19	339
12980	WD7881	CTG			SH,V.CALC							
13010	WD7882	CTG			SH,CALC	16		.75		2.34	2.37	316
13040	WD7883	CTG			SH,CALC							
13070	WD7884	CTG			SH,CALC	18		.64		3.97	3.46	541
13100	WD7885	CTG			SH,CALC							
13130	WD7886	CTG			SH,CALC	19		.81		8.20	7.28	899
13160	WD7887	CTG			SH,CALC							
13190	WD7888	CTG			SH,CALC	19		.84		7.20	2.77	330
13220	WD7889	CTG			SH,CALC							
13250	WD7890	CTG			SH,V.CALC	25		.99		12.33	1.69	171
13280	WD7891	CTG			SH,V.CALC							
13310	WD7892	CTG			SH,V.CALC			.59		3.50	.59	100
13340	WD7893	CTG			SH,V.CALC							
13370	WD7894	CTG			SH			.74		2.39	.82	111
13400	WD7895	CTG			SH							
13430	WD7896	CTG			SH			.49		1.93	.64	131
13460	WD7897	CTG			SH							
13490	WD7898	CTG			SH			.61		3.12	.94	154
13520	WD7899	CTG			SH							
13550	WD7900	CTG			SH			.39		1.64	.31	79
13580	WD7901	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
12140												2.22			
12170	.16		37												
12200															
12230	.15		42												
12260															
12290	.35		76												
12320															
12350	.04		9												
12380															
12410	.11		25												
12440												2.31			
12470	.17		25												
12500															
12530	.11		16												
12560															
12590	.15		45												
12620															
12650	.16		55												
12680															
12710	.13		44												
12740												2.15			
12770	.15		57												
12800															
12830	.02		2												
12860															
12890	.07		15												
12920	.16		49									2.26			
12950	.67		695		3.52	.38	3.14	374	.12						
12980															
13010	.50		312												
13040															
13070	.53		620									2.23			
13100															
13130	.53		1012		1.63	.16	1.47	201	.11						
13160															
13190	.72		857												
13220															
13250	.88		1245												
13280															
13310	.86		593												
13340															
13370	.74		323									2.35			
13400															
13430	.75		394												
13460															
13490	.77		511												
13520															
13550	.84		421												
13580															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
13610	WD7902	CTG			SH			.55		3.07	.25	45
13640	WD7903	CTG			SH							
13670	WD7904	CTG			SH			.81		6.28	.44	54
13700	WD7905	CTG			SH,CALC							
13730	WD7906	CTG			SH,CALC	12		.81		3.28	1.12	138
13760	WD7907	CTG			SH,CALC							
13790	WD7908	CTG			SH,CALC			.79		5.71	.42	53
13820	WD7909	CTG			SH,CALC							
13850	WD7910	CTG			SH,CALC	11		2.25		11.79	2.05	91
13880	WD7911	CTG			SH,CALC							
13910	WD7912	CTG			SH	9		.88		9.88	1.30	148
13940	WD7913	CTG			SH							
13970	WD7914	CTG			SH			.84		3.34	.62	74
14000	WD7915	CTG			SH							
14030	WD7916	CTG			SH			.76		2.02	.93	122
14060	WD7917	CTG			SH							
14090	WD7918	CTG			SH			.50		3.49	.55	110
14120	WD7919	CTG			SH							
14150	WD7920	CTG			SH			.50		2.06	.42	84
14180	WD7921	CTG			SH							
14210	WD7922	CTG			SH			.69		3.04	.36	52
14230	WD7923	CTG			SH							
14260	WD7924	CTG			SH	8		.89		4.19	.87	98
14290	WD7925	CTG			SH							
[illegible]	WD7926	CTG			SH,CALC	17		.74		3.30	1.05	142
[illegible]	[illegible]	CTG			SH,CALC							
14380	[illegible]	[illegible]			SH,CALC	15		.90		6.07	1.40	156
14410	WD7929	[illegible]			SH,CALC							
14440	WD8940	CTG			[illegible]			.60		.59	.66	110
14470	WD8941	CTG										
14500	WD8942	CTG			SH			.61		1.18	.80	131
14590	WD8943	CTG			SH							
14620	WD8944	CTG			SH,CALC	17				[illegible]	1.11	128
14680	WD8945	CTG			SH,CALC							
14710	WD8946	CTG			SH			.35		[illegible]	.65	186
14770	WD8947	CTG			SH							
14800	WD8948	CTG			SH	9		.97		.59	.67	69
14860	WD8949	CTG			SH							
14890	WD8950	CTG			SH			.59		2.72	.94	159
14920	WD8951	CTG			SH							
14950	WD8952	CTG			SH			.73		1.14	.65	89
14980	WD8953	CTG			SH							
15010	WD8954	CTG			SH			.76		1.91	.76	100
15040	WD8955	CTG			SH							
15070	WD8956	CTG			SH,CALC	11		.88		7.92	1.02	116
15100	WD8957	CTG			SH,CALC							
15130	WD8958	CTG			SH,CALC			.48		1.47	.43	90
15160	WD8959	CTG			SH,CALC							
15190	WD8960	CTG			SH,CALC			.27		1.29	.36	133

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
13610	.92		558												
13640															
13670	.93		775												
13700															
13730	.75		405									2.32			
13760															
13790	.93		723												
13820															
13850	.85		524		1.90	.19	1.71	84	.11						
13880															
13910	.88		1123												
13940															
13970	.84		398												
14000															
14030	.68		266												
14060															
14090	.86		698												
14120															
14150	.83		412												
14180												2.33			
14210	.89		441												
14230															
14260	.83		471												
14290															
14320	.76		446												
14350															
14380	.81		674		1.44	.14	1.30	160	.11						
14410												2.98			
14440	.47		98												
14470															
14500	.60		193												
14590												3.37			
14620	.56		160												
14680															
14710	.62		303												
14770															
14800	.47		61									3.46			
14860															
14890	.74		461												
14920															
14950	.64		156									3.37			
14980															
15010	.72		251												
15040															
15070	.89		900												
15100															
15130	.77		306												
15160															
15190	.78		478												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
15220	WD8961	CTG			SH,CALC			.55		4.26	.40	73
15250	WD8962	CTG			SH,CALC			.26		1.18	.61	235
15280	WD8963	CTG			SH,CALC			.28		1.40	.22	79
15290	XD8963			ARKN	FORM.TOP							
15310	WD8964	CTG			SH,CALC			.15		.45	.17	113
15340	WD8965	CTG			SH,CALC	12		.75		2.44	.95	127
15370	WD8966	CTG			SH,CALC	12		.82		1.28	.55	67
15400	WD8967	CTG			SH,CALC			.64		1.08	.33	52
15405	WD8128	CC						1.34		.23	.32	24
15430	WD8968	CTG			SH,CALC			.71		.57	.42	59
15460	WD8969	CTG			SH	6		1.02		1.57	.73	72
15490	WD8970	CTG			SH			.51		.54	.28	55
15520	WD8971	CTG			SH			.50		1.42	.32	64
15580	WD8972	CTG			SH			.58		.94	.38	66
15610	WD8973	CTG			SH			.46		3.78	.24	52
15620	WD8974	CTG			SH			.48		3.57	.48	100
15623	WD8129	CC						.06		.23	.16	267
15650	WD8975	CTG			SH,CALC	14		.52		2.97	1.47	283
15660	XD8975			MOMT	FORM.TOP							
15680	WD8976	CTG			SH,CALC	19		.45		3.66	2.18	484
15710	WD8977	CTG			SH,CALC	17		.58		3.05	2.38	410
15740	WD8978	CTG			SH,CALC	18		.48		4.72	2.02	421
15770	WD8979	CTG			SH,CALC	16		.79		15.15	3.15	399
15800	WD8980	CTG			SH,CALC	17		.68		2.61	3.16	465
15830	WD8981	CTG			SH,CALC	22		.55		3.78	2.05	373
15860	WD8982	CTG			SH,CALC	22		.34		1.27	1.19	350

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
15220	.91		775												
15250	.66		454												
15280	.86		500												
15290															
15310	.73		300												
15340	.72		325												
15370	.70		156												
15400	.77		169												
15405	.42		17									3.41			
15430	.58		80												
15460	.68		154									3.07			
15490	.66		106												
15520	.82		284												
15580	.71		162												
15610	.94		822												
15620	.88		744												
15623	.59		383									2.83			
15650	.67		571												
15660															
15680	.63		813												
15710	.56		526												
15740	.70		983												
15770	.83		1918												
15800	.45		384												
15830	.65		687												
15860	.52		374												

H. G. Bassett

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: M. Killgore
SPC Mid-Continent
Dallas

April 15, 1985
PGG/040985/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Issue of "Source Evaluation of the Sohio Weyerhaeuser 1-15 Well, Pushmataha County, Oklahoma" - Technical Memorandum (PGG/TM195).

Enclosed find a copy of the subject report for your use and retention. Individual copies have been forwarded to C. Titus, D. Bajak and T. Legg.

The report details the source rock geochemistry for the Sohio Weyerhaeuser 1-15 well with comparisons to other Ouachita Overthrust wells. Only Stanley Group sediments were penetrated in this well; results showed that the Stanley was a oil mature to thermally spent shale/minor sandstone sequence with marginal source richness.

R. J. Drozd

RJD:mlc

cc: H. G. Bassett
C. Titus
D. Bajak
T. Legg
G. Cole
Files (0) (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed report.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: M. Killgore
SPC Mid-Continent Region
Dallas

March 21, 1985
PGG/032085/GC/2-5
PGG Job No.: 84-79

Attn: C. Titus

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Technical Memorandum (PGG/TM195) -- Source Evaluation of the Sohio Weyerhaeuser 1-15 Well, Pushmataha County, Oklahoma.

Summary: A geochemical source quality screen and detailed maturity assessment of the stratigraphic sequence penetrated in the Sohio Weyerhaeuser 1-15 well was completed by PGG. The well was spudded in and only penetrated Mississippian Stanley Group strata. The Stanley sediments contained marginal source richness with occasional zones of moderate to good source richness. The well was spudded in oil mature sediments (~0.78% R_o at surface) and was completed in thermally spent sediments (~3.00% R_o at TD). Oil-based drilling muds and coal additives were used during drilling; the oil-based muds affected the pyrolysis data and the coal increased the source richness (%TOC) values for the 2700-2860' interval.

1. INTRODUCTION

This report details the source rock geochemistry of the Sohio Weyerhaeuser 1-15 well, Pushmataha County, Oklahoma that was drilled to a total depth of 13949'. The well was spudded in and only penetrated Mississippian Stanley Group sediments. The well was a dry hole.

2. MATERIALS

2.1 A total of four hundred fifty-three (453) cuttings samples and eleven (11) sidewall cores were submitted for geochemical source rock evaluation covering the gross well interval from 57' to TD. Samples were analyzed on a screen basis every 60'. Each sample was given a unique PGG well sample number from WD4220-4251, WD4397-4429, WD4588-4620, WD7267-7426, WD7546-7606, WD7930-7997, WD9745-9778, and WD9797-9828 for the cuttings samples and WD4451-4461 for the sidewall cores.

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGG methods. Analyses consisted of organic petrographic determinations to establish a thermal maturity profile, rapid screen Rock-Eval pyrolysis and Total Organic Carbon (%TOC-bitumen free and Rock-Eval) to assess the overall source quality.

The hydrocarbon proneness (oil or gas) of any interval of interest was assessed by means of proprietary pyrolysis gas chromatography (PGC) which established the GOGI ratio (gas-oil generation index).

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the Sohio Weyerhaeuser 1-15 well is listed in Table 1 and Figure 1. A Source Evaluation Log is appended as Figure 2.

3.1 Sediment Thermal Maturity Profile (STAMP)

The STAMP for the Weyerhaeuser 1-15 well is a graphic representation of the detailed vitrinite reflectance analyses performed on four (4) SWC and eighteen (18) cuttings samples from the 701' to 13240' interval. A linear regression applied to the twenty-two

(22) sample data set indicated a correlation coefficient of 0.98 (r^2=96%). The maturity gradient for this well was 14.5 DOD units/km (4.43 DOD units/1000'). This data implied:

1) the surface R_o, as extrapolated by the regression analysis, was ~0.78%.

2) HGT (hydrocarbon generation threshold, 0.6% R_o) would have occurred at approximately 2550' above the surface.

3) DGGT (dominant gas generation threshold, 1.0% R_o) occurred at approximately 2460'.

4) all sediments below 9300' were thermally spent (R_o >2.0%).

The gradients for the Weyerhaeuser 1-15 (14.5 DOD units/km), the Trotter-Dees 1-29 (14.2 DOD units/km), Campbell 1-24 (15.9 DOD units/km) and the 1-25 Weyerhaeuser (14.6 DOD units/km) were similar (Cole, 1985). This would imply that the geothermal gradients throughout most of the Oklahoma Ouachita Overthrust were constant and the differing maturity values between the wells (i.e., Campbell was mostly immature, 1-25 Weyerhaeuser was thermally spent) were caused primarily by different depths of burial.

3.2 Source Quality

The source quality for the Trotter-Dees 1-29 well was determined by using PGG standardized methods for %TOC, pyrolysis (potential productivity), and pyrolysis-gas chromatography (PGC).

The only formation penetrated in the Weyerhaeuser 1-15 well was the Stanley. The Stanley Group sediments were lean in source richness with an average TOC of 0.44%. TOC values ranged from 0.05 to 1.04%. Overall, except for an occasional zone of moderate to good source richness, the Stanley Group sediments would have to be considered a non-source.

Two points, however, should be discussed regarding the use of drilling additives in the Stanley cuttings.

1) Oil-based drilling muds were used from approximately 3200' to TD. The clays within the various lithologies absorbed the oil fraction, which could only be partially extracted using methylene chloride prior to source rock analyses. The pyrolysis (both S1 and S2), hydrogen index values, generation index (GI) or any parameters using pyrolysis results would be affected, and therefore, would not be valid for this well. The pyrolysis-gas chromatography (PGC) technique was not used because of this contamination. Oil-prone GOGI values would be expected due to the oil-based mud contamination; results would have been similar to those determined on the Trotter-Dees 1-29 well cuttings (Cole, 1985) where oil-prone GOGI values (i.e. 0.15) were found in gas mature to spent sediments.

2) A coal additive was used from 2700-2860'. The coal had an R_o between 0.5-0.6% R_o and was found in varying quantities. Sample numbers WD4614 at 2790' had a TOC of 12.51% and WD4612 at 2730' had a TOC of 7.87%. These two samples were not used for interpretation purposes.

4. EXPLORATION SIGNIFICANCE

The Sohio Weyerhaeuser 1-15 well was a wet/dry gas prospect with an Arkansas Novaculite (Devonian) objective. The well was completed as a dry hole with TD in the Mississippian Stanley Group. The Arkansas Novaculite objective was not penetrated due to fault splays within the Stanley from 7000' to TD. The Stanley Group, though, did contain limited intervals of moderate source richness (0.5 to 1.04% TOC) which could have generated limited quantities of dry gas.

Also, the good source potential of the Arkansas Novaculite, and Ordovician Polk Creek Shale, Bigfork Chert, or Womble Shale seen in other parts of the Ouachita Overthrust cannot be ruled out as deep gas sources.

5. REFERENCES

Cole, G.A., 1985, Source evaluation of the Sohio Trotter-Dees 1-29 well, Pushmataha County, Oklahoma: PGG Technical Memorandum (PGG/TM190).

G. A. Cole

GAC:mlc

Enclosures: Figures 1-2
Table 1

cc: H. G. Bassett
T. Legg
D. Bajak
R. Drozd
Files (0) (2-5)

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

WELL : WEYERHAEUSER 1-15

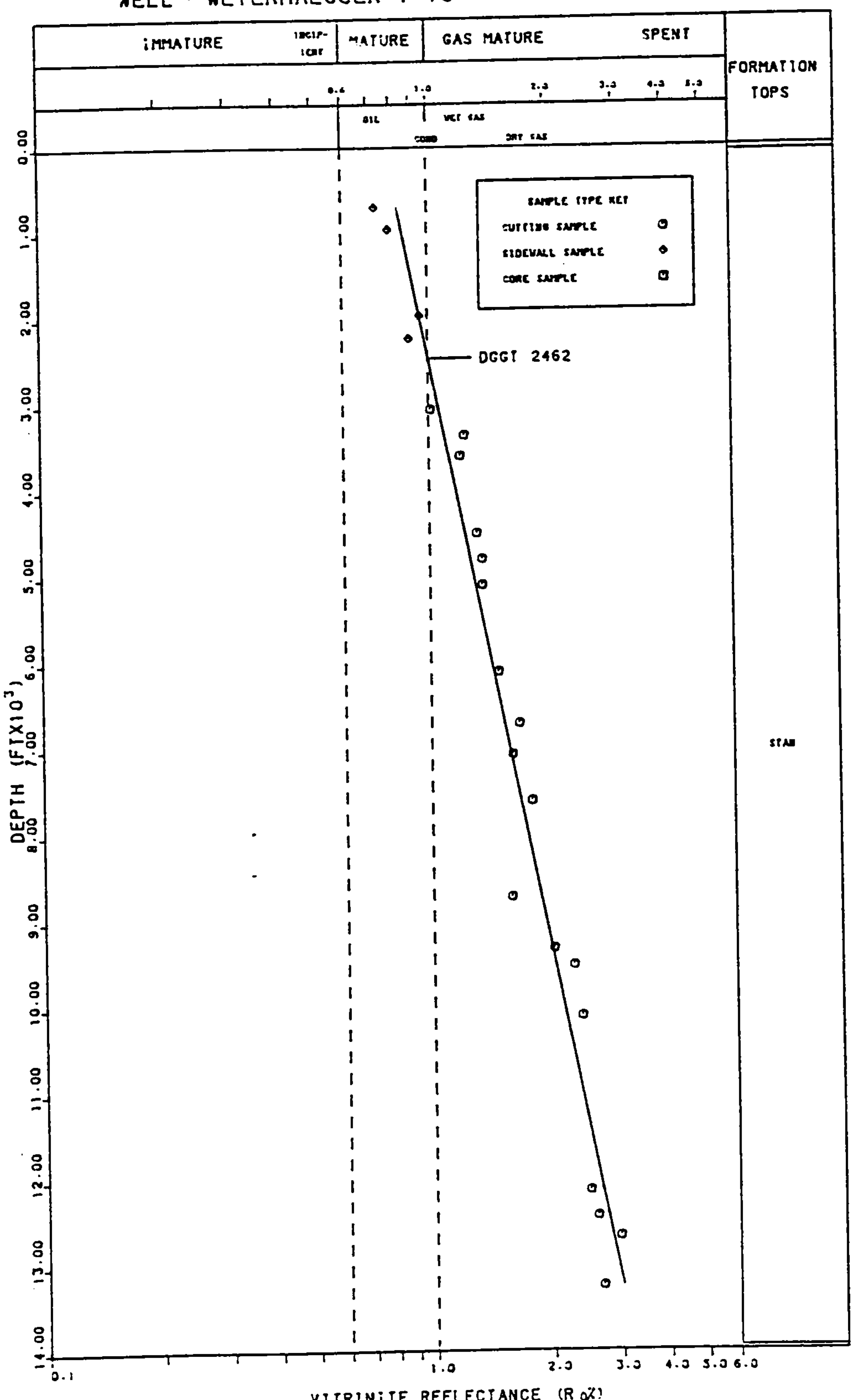


Figure 1

APPENDIX

Key to Source Rock Evaluation Data Report and Graphic Log

This listing is intended as an abbreviated guide to the criteria and parameters used in the subject Data Report and Graphic Log. In that it will routinely be included in evaluation reports, it is of necessity compiled in concise form. Whereas it is intended to constitute a sufficient guide to parameter identification and definition, no attempt is made to provide an interpretative scheme. This will be covered more fully in an Interpretative Guide and Glossary to be issued in Prospectus form later.

Where possible, the format of the key has been arranged in a systematic manner as per the layout of the subject data report and log. Although to be used mostly for well sequences, the layout also handles data from both measured section and random outcrop surveys.

The devised scheme of headings is intended to cover both domestic and foreign situations.

HEADING

Country: Two/three letter abbreviation as per international standard code. Where offshore areas involved, abbreviation compounded with CS (Continental Shelf), eg., CDN CS.

State: Intended for U.S. domestic use. Two letter abbreviation as per Zip-Coded mail system.

County/Region/Prospect: Intended for universal usage, County is applicable to U.S. domestic use and Region/Prospect should provide sufficient scope to cover non-domestic situations.

Location: Giving a more precise location of well or site being Township-Section-Range designation for U.S. domestic or coordinates or seismic line/shot point for non-domestic.

Well/Site: Being the actual name or designation of the well or the outcrop sampling site, eg., measured section identity.

API/OCS: Being the unique designation given to all onshore (API) and offshore (OSC) U.S. domestic wells.

Bracketed number ( ) gives identity of parameters appearing in the Graphic Data Log. Un-numbered parameters appear in Data Report only.

GEOLOGIC DATA (Track 1)

Sample Number: Unique number given to each sample received and inventoried by PGW. Comprise two separate series, being:
W Series (i.e., WA, WB...WX) being Well materials
FS Series (i.e., FSA, FSB...FSX) being Field Survey specimens.

Sample Type: Description as to origin of sediment specimen, being:
- CTG. Ditch Cutting
- SWC. Side Wall Core
- CC. Conventional Core
- OC. Outcrop sample from measured section
- ROC. Random outcrop sample.

Epoch/Age (1): Standard geologic abbreviation (up to six characters) for Epoch (eg., U. CRET) and Age (eg., MISS).

Formation (2): Arbitrary (but consistent) abbreviation (up to four characters) for trivial formation names. A formation legend is included in Data Report and Graphic Log printouts.

Depth (3): Measured in feet/meters BRT and are drill depths. Total Depth (TD) is given as TD in Formation sub-Track.

Lithology (4): (abbreviated) Given by standard geologic abbreviations (up to ten characters) and graphic legend (as per BP Geological Standard Legend) and comprising the gross lithology (eg. SH) and a qualifier (eg. V. CALC.). Usage of qualifier controlled by % content eg:

SH.
LST. } 0-10% qualifying component

SH. CALC
LST. ARG } 11-25% qualifying component

SH. V. CALC
LST. V. ARG } 26-50% qualifying component

Carbonate (5): % Carbonate mineral content by avidimetry. Used to determine % qualifying component.(CALC or ARG) under lithology.

ELECTRIC LOG/WELL DATA (Track 2)

ELOG (6): Will initially consist of a co-plot of the GR Log. Facility to similarly co-plot a combination of FDC, BHC, CNL, etc., logs to be added later.

Casing (7): Casing shoe depths added to log manually. Useful guide in distinguishing caved materials.

Test (8): Standard symbolism manually added for oil, condensate and gas tests and shows.

SOURCE RICHNESS SCREEN (Track 3)

TOC (9): % Total Organic Carbon (bitumen-free)

TSE (10): %. Total Soluble Extract (C_{15+}; sulfur-free) - Kg/Tn.

S1 (11): %. Thermally Distillable Hydrocarbons (Rock Eval @ $\leq 300^\circ C$) - Kg/Tn.

S2 (12): %. Potential Productivity. Thermally Pyrolysable Hydrocarbons (Rock Eval 300-550°C) - Kg/Tn.

HI: %. Hydrogen Index. Pyrolysable Hydrocarbons/Total Organic Carbon - Kg/Tn.

TR: Transformation Ratio $\frac{S1}{S1 + S2}$

Visual Kerogen Description (13)
AL - Algal/Sapropel
AM - Amorphous
HE - Herbaceous
W - Woody
C - Coaly
E - Exinite (Palynomorphs, Cutin, etc.)
M - Major; S - Subordinate; T - Trace.

SOURCE MATURATION (Track 4)

GI (TSE)(14): %. Generation Index. TSE/TOC. Generation intensity based on abundance of Total Soluble Extract.

GI (S1)(15): %. Generation Index. S1/TOC Generation intensity based on abundance of Thermally Distillable Hydrocarbons.

TSE/S1: Ratio of Extractable to Distillable Hydrocarbons. Guide to abundance of heavy, intractable bitumen asphaltene content.

KPI (16): %. Kerogen Pyrolysis Index (Hydrogen Index - Bitumen free basis) K2/TOC Kg/Tn. More accurate version of Rock Eval Screen determined Hydrogen Index characterizing kerogen to hydrocarbon convertibility.

K2 (17) %. Potential Productivity (Analogous to S2 - Bitumen free basis) - Kg/Tn. More accurate version of Rock Eval Screen determined Potential Productivity being exclusive to kerogen content only.

K2(G): %. Potential Productivity - Pyrolytic Hydrocarbon yield as Gas (C_1 - C_5) - Kg/Tn.

K2(O): % Potential Productivity - Pyrolytic Hydrocarbon yield as oil components (C_{5+}) - Kg/Tn.

GOGI (18): Gas-Oil Generation Index. K2(G)/K2(O). Measure of kerogen hydrocarbon type proneness, eg., oil prone (<0.23); mixed oil-gas (0.23<0.50); and gas prone (>0.50). Reflects kerogen assemblage composition and maturity.

DEGREE OF ORGANIC DIAGENESIS (Track 5)

R_o(avg)(19): % Phytoclast Vitrinite Reflectance. Random anistropic readings of autochthonous population.

DOD (20): DOD units being $100[\log(R_o \cdot 10)]$. R_o evaluated from linear regression fit to observed data and quoted in 5 DOD increments. Gradient of Sediment Maturity Profile (Depth vs. log R_o) quoted in DOD units 1000 $ft.^{-1}$ or Km^{-1}.

CPI (21): Carbon Preference Index. Odd to even n-alkane preference ratio.

TAI (22): Thermal Alteration Index. Based on palynomorphs on 1 to 5 scale.

SOURCE POTENTIAL (Track 6)

Sections 23, 24 and 25 are used to complete a manual zonation (24) of the section penetrated and to list both on-structure (23) and off-structure (25) summary annotations as to source potential.

SOURCE CARBON ISOTOPIC DESCRIPTION (Data Report Only)

D 13C(K) $\delta^{13}C$ Kerogen (relative PDB 1)

D 13C(TSE) $\delta^{13}C$ Total Soluble Extract (relative PDB 1)

D 13C(KPY) $\delta^{13}C$ Kerogen Pyrolysate (relative PDB 1)

RB:dlc
9/29/81

TABLES

TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : PUSHMATAHA
LOCATION : SEC15,T1SR20E
WELL/SITE : WEYERHAEUSER 1-15
API/OCS : 35-127-20025

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
57	WD4220	CTG			SH	8		.33		0.00	0.00	0
60	XD4220		MISS	STAN	FORM.TOP							
80	WD4221	CTG			SH							
110	WD4222	CTG			SH	9		.33		0.00	.03	9
140	WD4223	CTG			SH							
170	WD4224	CTG			SH,CALC	12		.21		0.00	0.00	0
200	WD4225	CTG			SH,CALC							
230	WD4226	CTG			SH	8		.05		0.00	0.00	0
260	WD4227	CTG			SH							
290	WD4228	CTG			SH,CALC	13		.16		0.00	0.00	0
320	WD4229	CTG			SH,CALC							
350	WD4230	CTG			SH,CALC	10		.21		0.00	.01	5
380	WD4231	CTG			SH,CALC							
402	WD4451	SWC			SH							
410	WD4232	CTG			SH,CALC	11		.34		.02	.28	82
440	WD4233	CTG			SH,CALC							
470	WD4234	CTG			SH,CALC	15		.30		.02	.15	50
500	WD4235	CTG			SH,CALC							
530	WD4236	CTG			SH,CALC	11		.29		0.00	.06	21
542	WD4452	SWC			SH							
560	WD4237	CTG			SH,CALC							
590	WD4238	CTG			SH	9		.19		.01	.01	5
620	WD4239	CTG			SH							
650	WD4240	CTG			SH,CALC	13		.38		.01	.10	26
680	WD4241	CTG			SH,CALC							
701	WD4453	SWC			SH							
710	WD4242	CTG			SH,CALC	13		.34		.02	.14	41
712	WD4454	SWC			SH							
740	WD4243	CTG			SH,CALC							
770	WD4244	CTG			SH,CALC	12		.43	.44	.03	.36	84
800	WD4245	CTG			SH,CALC							
830	WD4246	CTG			SH,CALC	11		.43	.82	.05	.34	79
860	WD4247	CTG			SH,CALC							
890	WD4248	CTG			SLTST	6		.08	1.10	.02	0.00	0
920	WD4249	CTG			SLTST							
950	WD4250	CTG			SH,CALC	11		.22	.55	.05	.01	5
959	WD4455	SWC			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
57			0												
60															
80															
110	0.00		0												
140															
170			0												
200															
230			0												
260															
290			0												
320															
350	0.00		0												
380															
402															
410	.07		6												
440															
470	.12		7												
500															
530	0.00		0												
542															
560															
590	.50		5												
620															
650	.09		3												
680															
701												.73			
710	.13		6												
712															
740															
770	.08	102	7	15											
800															
830	.13	191	12	16											
860															
890	1.00	1375	25	55											
920															
950	.83	250	23	11											
959												.79			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
980	WD4251	CTG			SH,CALC							
1010	WD4397	CTG			SH	9		.34		.05	.18	53
1040	WD4398	CTG			SH							
1070	WD4399	CTG			SH	9		.16		.19	.10	62
1098	WD4456	SWC			SH							
1100	WD4400	CTG			SH							
1130	WD4401	CTG			SH	7		.22		.21	.23	105
1160	WD4402	CTG			SH							
1190	WD4403	CTG			SH,CALC	14		.28		.10	.36	129
1220	WD4404	CTG			SH,CALC							
1250	WD4405	CTG			SH	9		.33		.04	.09	27
1280	WD4406	CTG			SH							
1298	WD4457	SWC			SH							
1310	WD4407	CTG			SH,CALC	13		.33		.01	.06	18
1340	WD4408	CTG			SH,CALC							
1370	WD4409	CTG			SH,CALC	13		.41		.02	.23	56
1400	WD4410	CTG			SH,CALC							
1430	WD4411	CTG			SH	9		.26		.03	.13	50
1460	WD4412	CTG			SH							
1490	WD4413	CTG			SH	9		.28		.03	.20	71
1520	WD4414	CTG			SH							
1550	WD4415	CTG			SH,CALC	10		.30	.47	.04	.14	47
1580	WD4416	CTG			SH,CALC							
1610	WD4417	CTG			SH,CALC	16		.35		.04	.34	97
1640	WD4418	CTG			SH,CALC							
1670	WD4419	CTG			SH	5		.62		.11	.18	29
1700	WD4420	CTG			SH							
1730	WD4421	CTG			SH,CALC	12		.34		.02	.14	41
1760	WD4422	CTG			SH,CALC							
1790	WD4423	CTG			SH,CALC	14		.32	.31	.02	.20	62
1820	WD4424	CTG			SH,CALC							
1850	WD4425	CTG			SH,CALC	12		.38	.31	.03	.15	39
1880	WD4426	CTG			SH,CALC							
1910	WD4427	CTG			SH,CALC	13		.28	.32	.03	.13	46
1940	WD4428	CTG			SH,CALC							
1966	WD4458	SWC			SH							
1970	WD4429	CTG			SH,CALC	15		.29		.02	.05	17
2000	WD4588	CTG			SH,CALC	10		.41		0.00	0.00	0
2030	WD4589	CTG			SH,CALC							
2060	WD4590	CTG			SH	9		.39		.01	.05	13
2090	WD4591	CTG			SH							
2120	WD4459	SWC			SH							
2120	WD4592	CTG			SH,CALC	11		.39		.01	.01	3
2150	WD4593	CTG			SH,CALC							
2180	WD4594	CTG			SH	9		.39		.03	.07	18
2210	WD4595	CTG			SH							
2231	WD4460	SWC			SH							
2250	WD4596	CTG			SH,CALC	11		.36		.01	.05	14
2280	WD4597	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
980															
1010	.22		15												
1040															
1070	.66		119												
1098															
1100															
1130	.48		95												
1160															
1190	.22		36												
1220															
1250	.31		12												
1280															
1298															
1310	.14		3												
1340															
1370	.08		5												
1400															
1430	.19		12												
1460															
1490	.13		11												
1520															
1550	.22	157	13	12											
1580															
1610	.11		11												
1640															
1670	.38		18												
1700															
1730	.13		6												
1760															
1790	.09	97	6	16											
1820															
1850	.17	82	8	10											
1880															
1910	.19	114	11	11											
1940															
1966												.95			
1970	.29		7												
2000			0												
2030															
2060	.17		3												
2090															
2120															
2120	.50		3												
2150															
2180	.30		8												
2210															
2231												.89			
2250	.17		3												
2280															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2310	WD4598	CTG			SH,CALC	10		.44		.01	.04	9
2340	WD4599	CTG			SH,CALC							
2370	WD4600	CTG			SH,CALC	10		.63		.02	.18	29
2400	WD4601	CTG			SH,CALC							
2412	WD4461	SWC			SH							
2430	WD4602	CTG			SH,CALC	13		.50		.03	.09	18
2460	WD4603	CTG			SH,CALC							
2490	WD4604	CTG			SH,CALC	11		.41		.01	.01	2
2520	WD4605	CTG			SH,CALC							
2550	WD4606	CTG			SH,CALC	10		.45		.02	.01	2
2580	WD4607	CTG			SH,CALC							
2610	WD4608	CTG			SH,CALC	11		.55		.04	.09	16
2640	WD4609	CTG			SH,CALC							
2670	WD4610	CTG			SH	9		.92		.02	.22	24
2700	WD4611	CTG			SH							
2730	WD4612	CTG			SLTST,CALC	12		7.87		.28	6.86	87
2760	WD4613	CTG			SLTST,CALC							
2790	WD4614	CTG			COAL	8		12.51		.48	13.10	105
2820	WD4615	CTG			COAL							
2850	WD4616	CTG			SH,CALC	10		1.04		.14	.39	38
2880	WD4617	CTG			SH,CALC							
2910	WD4618	CTG			SH,CALC	10		.41		.04	.08	20
2940	WD4619	CTG			SH,CALC							
2970	WD4620	CTG			SH	9		.45		.04	.06	13
3000	WD7267	CTG			SH,CALC	12		.99		.05	.22	22
3030	WD7268	CTG			SH,CALC							
3060	WD7269	CTG			SH,CALC	12		.77		.11	.23	30
3090	WD7270	CTG			SH,CALC							
3120	WD7271	CTG			SH,CALC	12		.92		.05	.15	16
3150	WD7272	CTG			SH,CALC							
3180	WD7273	CTG			SH,CALC	12		.99		.15	.26	26
3210	WD7274	CTG			SH,CALC							
3240	WD7275	CTG			SH,CALC	12		.60		2.60	.65	108
3270	WD7276	CTG			SH,CALC							
3300	WD7277	CTG			SH	7		.42		5.97	.43	102
3330	WD7278	CTG			SH							
3360	WD7279	CTG			SH,CALC	12		.59		5.22	.64	108
3390	WD7280	CTG			SH,CALC							
3420	WD7281	CTG			SH,CALC	11		.61		5.64	.66	108
3450	WD7282	CTG			SH,CALC							
3480	WD7283	CTG			SH,CALC	11		.62		5.10	.77	124
3510	WD7284	CTG			SH,CALC							
3540	WD7285	CTG			SH,CALC	13		.61		3.35	.54	89
3570	WD7286	CTG			SH,CALC							
3600	WD7287	CTG			SH,CALC	11		.82		5.18	.90	110
3630	WD7288	CTG			SH,CALC							
3660	WD7289	CTG			SH,CALC	10		.64		6.29	.86	134
3690	WD7290	CTG			SH,CALC							
3720	WD7291	CTG			SH	7		.37		4.83	.48	130

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2310	.20		2												
2340															
2370	.10		3												
2400															
2412															
2430	.25		6												
2460															
2490	.50		2												
2520															
2550	.67		4												
2580															
2610	.31		7												
2640															
2670	.08		2												
2700															
2730	.04		4		6.85	2.65	4.20	87	.63						
2760															
2790	.04		4		12.14	4.41	7.73	97	.57						
2820															
2850	.26		13												
2880															
2910	.33		10												
2940															
2970	.40		9												
3000	.19		5												
3030															
3060	.32		14									1.01			
3090															
3120	.25		5												
3150															
3180	.37		15												
3210															
3240	.80		433												
3270															
3300	.93		1421												
3330															
3360	.89		885									1.23			
3390															
3420	.90		925												
3450															
3480	.87		823												
3510															
3540	.86		549												
3570															
3600	.85		632									1.20			
3630															
3660	.88		983												
3690															
3720	.91		1305												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
3750	WD7292	CTG			SH							
3780	WD7293	CTG			SH,CALC	10		.37		4.28	.35	95
3810	WD7294	CTG			SH,CALC							
3840	WD7295	CTG			SLTST	7		.30		4.10	.21	70
3870	WD7296	CTG			SLTST							
3900	WD7297	CTG			SLTST,CALC	9		.46		4.33	.26	57
3930	WD7298	CTG			SLTST,CALC							
3960	WD7299	CTG			SH,CALC	12		.67		4.22	.64	96
3990	WD7300	CTG			SH,CALC							
4020	WD7301	CTG			SH,CALC	12		.67		4.82	.90	134
4050	WD7302	CTG			SH,CALC							
4080	WD7303	CTG			SH,CALC	12		.65		3.78	.48	74
4110	WD7304	CTG			SH,CALC							
4140	WD7305	CTG			SH,CALC	11		.69		3.68	.65	94
4170	WD7306	CTG			SH,CALC							
4200	WD7307	CTG			SH,CALC	11		.47		4.31	.37	79
4230	WD7308	CTG			SH,CALC							
4260	WD7309	CTG			SST	6		.27		2.97	.13	48
4290	WD7310	CTG			SST							
4320	WD7311	CTG			SST	8		.45		3.40	.20	44
4350	WD7312	CTG			SST							
4380	WD7313	CTG			SH	9		.68		4.55	.53	78
4410	WD7314	CTG			SH							
4440	WD7315	CTG			SH	9		.70		6.26	.79	113
4470	WD7316	CTG			SH							
4500	WD7317	CTG			SH,CALC	11		.74		4.87	.50	68
4530	WD7318	CTG			SH,CALC							
4560	WD7319	CTG			SH	9		.68		7.29	.51	75
4590	WD7320	CTG			SH							
4620	WD7321	CTG			SH	7		.46		5.52	.42	91
4650	WD7322	CTG			SH							
4680	WD7323	CTG			SH,CALC	10		.56		4.48	.54	96
4710	WD7324	CTG			SH,CALC							
4740	WD7325	CTG			SH,CALC	13		.59		3.05	.41	69
4770	WD7326	CTG			SH,CALC							
4800	WD7327	CTG			SH,CALC	12		.71		3.18	.43	61
4830	WD7328	CTG			SH,CALC							
4860	WD7329	CTG			SH,CALC	12		.64		2.70	.43	67
4890	WD7330	CTG			SH,CALC							
4920	WD7331	CTG			SH	9		.73		2.70	.46	63
4950	WD7332	CTG			SH							
4980	WD7333	CTG			SH,CALC	11		.58		3.96	.68	117
5010	WD7334	CTG			SH,CALC							
5040	WD7335	CTG			SH,CALC	12		.72		2.55	.48	67
5070	WD7336	CTG			SH,CALC							
5100	WD7337	CTG			SH,CALC	13		.57		2.81	.32	56
5130	WD7338	CTG			SH,CALC							
5160	WD7339	CTG			SH,CALC	10		.51		4.77	.50	98
5190	WD7340	CTG			SH,CALC							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
3750															
3780	.92		1157												
3810															
3840	.95		1367												
3870															
3900	.94		941												
3930															
3960	.87		630												
3990															
4020	.84		719												
4050															
4080	.89		582												
4110															
4140	.85		533												
4170															
4200	.92		917												
4230															
4260	.96		1100												
4290															
4320	.94		756												
4350															
4380	.90		669												
4410															
4440	.89		894												
4470															
4500	.91		658									1.32			
4530															
4560	.93		1072												
4590															
4620	.93		1200												
4650															
4680	.89		800												
4710															
4740	.88		517												
4770															
4800	.88		448									1.36			
4830															
4860	.86		422												
4890															
4920	.85		370												
4950															
4980	.85		683												
5010															
5040	.84		354												
5070															
5100	.90		493									1.36			
5130															
5160	.91		935												
5190															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5220	WD7341	CTG			SH	7		.45		5.07	.55	122
5250	WD7342	CTG			SH							
5280	WD7343	CTG			SH,CALC	12		.68		2.97	.61	90
5310	WD7344	CTG			SH,CALC							
5340	WD7345	CTG			SH,CALC	13		.70		2.87	.63	90
5370	WD7346	CTG			SH,CALC							
5400	WD7347	CTG			SH,CALC	12		.54		3.58	.61	113
5430	WD7348	CTG			SH,CALC							
5460	WD7349	CTG			SH,CALC	14		.65		2.37	.36	55
5660	WD7350	CTG			SH,CALC							
5690	WD7351	CTG			SH,CALC	11		.64		4.27	.86	134
5720	WD7352	CTG			SH,CALC							
5750	WD7353	CTG			SH,CALC	11		.60		6.27	.83	138
5780	WD7354	CTG			SH,CALC							
5810	WD7355	CTG			SH,CALC	10		.58		5.27	.48	83
5840	WD7356	CTG			SH,CALC							
5870	WD7357	CTG			SH	8		.47		6.53	.73	155
5900	WD7358	CTG			SH							
5930	WD7359	CTG			SH	7		.49		13.79	.44	90
5960	WD7360	CTG			SH							
5990	WD7361	CTG			SH	7		.33		7.52	.47	142
6020	WD7362	CTG			SH							
6050	WD7363	CTG			SH,CALC	11		.76		11.68	1.13	149
6080	WD7364	CTG			SH,CALC							
6110	WD7365	CTG			SH,CALC	11		.50		3.26	.99	198
6140	WD7366	CTG			SH,CALC							
6170	WD7367	CTG			SH,CALC	14		.58		4.84	.63	109
6200	WD7368	CTG			SH,CALC							
6230	WD7369	CTG			SH,CALC	12		.72		7.91	1.18	164
6260	WD7370	CTG			SH,CALC							
6290	WD7371	CTG			SH,CALC	12		.67		5.13	1.34	200
6320	WD7372	CTG			SH,CALC							
6350	WD7373	CTG			SH,CALC	13		.56		6.83	.92	164
6380	WD7374	CTG			SH,CALC							
6410	WD7375	CTG			SH,CALC	12		.71		5.76	.77	108
6440	WD7376	CTG			SH,CALC							
6470	WD7377	CTG			SH,CALC	13		.79		6.60	1.27	161
6500	WD7378	CTG			SH,CALC							
6530	WD7379	CTG			SH,CALC	12		.89		7.98	1.20	135
6560	WD7380	CTG			SH,CALC							
6590	WD7381	CTG			SH,CALC	12		.73		5.48	.24	33
6620	WD7382	CTG			SH,CALC							
6650	WD7383	CTG			SH,CALC	13		.73		6.61	.54	74
6680	WD7384	CTG			SH,CALC							
6710	WD7385	CTG			SH,CALC	13		.59		7.88	1.00	169
6740	WD7386	CTG			SH,CALC							
6770	WD7387	CTG			SH,CALC	13		.54		5.00	1.29	239
6800	WD7388	CTG			SH,CALC							
6830	WD7389	CTG			SH,CALC	12		.76		4.09	.53	70

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5220	.90		1127												
5250															
5280	.83		437												
5310															
5340	.82		410												
5370															
5400	.85		663												
5430															
5460	.87		365												
5660															
5690	.83		667												
5720															
5750	.88		1045												
5780															
5810	.92		909												
5840															
5870	.90		1389												
5900															
5930	.97		2814												
5960															
5990	.94		2279												
6020															
6050	.91		1537												
6080															
6110	.77		6[illegible]2									1.49			
6140															
6170	.88		834												
6200															
6230	.87		1099												
6260															
6290	.79		766												
6320															
6350	.88		1220												
6380															
6410	.88		811												
6440															
6470	.84		835												
6500															
6530	.87		897												
6560															
6590	.96		751												
6620															
6650	.92		905												
6680															
6710	.89		1336									1.48			
6740															
6770	.79		926												
6800															
6830	.89		538												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
6860	WD7390	CTG			SH,CALC							
6890	WD7391	CTG			SH,CALC	13		.65		6.91	.82	126
6920	WD7392	CTG			SH,CALC							
6950	WD7393	CTG			SH,CALC	13		.64		5.22	.86	134
6980	WD7394	CTG			SH,CALC							
7010	WD7395	CTG			SH	9		1.04		5.19	.66	63
7040	WD7396	CTG			SH							
7070	WD7397	CTG			SH,CALC	10		.72		6.04	1.14	158
7100	WD7398	CTG			SH,CALC							
7130	WD7399	CTG			SH	9		.58		4.51	3.17	547
7160	WD7400	CTG			SH							
7190	WD7401	CTG			SH	9		.46		4.52	.95	207
7220	WD7402	CTG			SH							
7250	WD7403	CTG			SH	9		.31		5.22	.64	206
7280	WD7404	CTG			SH							
7310	WD7405	CTG			SH,CALC	10		.51		4.30	1.30	255
7340	WD7406	CTG			SH,CALC							
7370	WD7407	CTG			SH	9		.56		6.28	.70	125
7400	WD7408	CTG			SH							
7430	WD7409	CTG			SH	7		.38		5.30	.95	250
7460	WD7410	CTG			SH							
7490	WD7411	CTG			SH	6		.34		9.15	[illegible]	65
7520	WD7412	CTG			SH							
7550	WD7413	CTG			SH	7		[illegible]		10.17	.36	71
7580	WD7414	CTG			SH							
7610	WD7415	CTG			SH	7		.39		7.86	.41	105
7640	WD7416	CTG			SH							
7670	WD7417	CTG			SH	6		.26		6.69	.16	62
7700	WD7418	CTG			SH							
7730	WD7419	CTG			SH	8		.39		7.78	.42	108
7760	WD7420	CTG			SH							
7790	WD7421	CTG			SH,CALC	10		.69		12.18	.47	68
7820	WD7422	CTG			SH,CALC							
7850	WD7423	CTG			SH,CALC	10		.51		4.55	.42	82
7880	WD7424	CTG			SH,CALC							
7910	WD7425	CTG			SH,CALC	12		.76		9.94	.65	86
7940	WD7426	CTG			SH,CALC							
8000	WD7546	CTG			SH,CALC	20		.44		1 40	.28	64
8030	WD7547	CTG			SH							
8060	WD7548	CTG			SH	8		.30		2.75	.21	70
8090	WD7549	CTG			SH,CALC							
8120	WD7550	CTG			SH,CALC	10		.36		1.95	.57	158
8150	WD7551	CTG			SH,CALC							
8180	WD7552	CTG			SH,CALC	10		.37		2.09	.34	92
8210	WD7553	CTG			SH,CALC							
8240	WD7554	CTG			SH,CALC	10		.29		5.49	.35	121
8270	WD7555	CTG			SH,CALC							
8300	WD7556	CTG			SH	9		.35		3.44	.34	97
8330	WD7557	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
6860															
6890	.89		1063												
6920															
6950	.86		816												
6980															
7010	.89		499												
7040															
7070	.84		839									1.61			
7100															
7130	.59		778												
7160															
7190	.83		983												
7220															
7250	.89		1684												
7280															
7310	.77		843												
7340															
7370	.90		1121												
7400															
7430	.85		1395												
7460															
7490	.98		2691												
7520															
7550	.97		1994												
7580															
7610	.95		2015									1.80			
7640															
7670	.98		2573												
7700															
7730	.95		1995												
7760															
7790	.96		1765												
7820															
7850	.92		892												
7880															
7910	.94		1308												
7940															
8000	.83		318												
8030															
8060	.93		917												
8090															
8120	.77		542												
8150															
8180	.86		565												
8210															
8240	.94		1893												
8270															
8300	.91		983												
8330															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
8360	WD7558	CTG			SH	8		.33		1.39	.16	48
8390	WD7559	CTG			SH							
8420	WD7560	CTG			SH	7		.23		1.60	.54	235
8450	WD7561	CTG			SH							
8480	WD7562	CTG			SH	7		.31		2.26	.14	45
8510	WD7563	CTG			SH							
8540	WD7564	CTG			SH	7		.21		1.89	.05	24
8570	WD7565	CTG			SH							
8600	WD7566	CTG			SH	6		.24		.87	.35	146
8630	WD7567	CTG			SH							
8660	WD7568	CTG			SH	7		.33		1.58	.23	70
8690	WD7569	CTG			SH							
8720	WD7570	CTG			SH,CALC	11		.36		.40	.36	100
8750	WD7571	CTG			SH,CALC							
8780	WD7572	CTG			SH,CALC	12		.44		.77	.31	70
8810	WD7573	CTG			SH,CALC							
8840	WD7574	CTG			SH,CALC	10		.41		1.33	.31	76
8870	WD7575	CTG			SH,CALC							
8900	WD7576	CTG			SH,CALC	24		.19		1.33	.14	74
8930	WD7577	CTG			SH,CALC							
8960	WD7578	CTG			SH	8		.37		.68	.17	46
8990	WD7579	CTG			SH							
9020	WD7580	CTG			SH	5		.20		2.31	.30	150
9050	WD7581	CTG			SH							
9080	WD7582	CTG			SLTST	6		.2[illegible]		1.69	.57	259
9110	WD7583	CTG			SLTST							
9140	WD7584	CTG			SLTST	5		.1[illegible]		2.17	.45	281
9170	WD7585	CTG			SLTST							
9200	WD7586	CTG			SLTST	6		.2[illegible]		2.91	0.00	0
9230	WD7587	CTG			SLTST							
9260	WD7588	CTG			SLTST,CALC	12		.25		2.84	.28	112
9290	WD7589	CTG			SLTST,CALC							
9320	WD7590	CTG			SLTST	7		.27		.78	.33	122
9350	WD7591	CTG			SLTST							
9390	WD7592	CTG			SLTST,CALC	11		.23		1.40	.30	130
9420	WD7593	CTG			SLTST,CALC							
9450	WD7594	CTG			SLTST,CALC	13		.21		1 11	.40	190
9490	WD7595	CTG			SLTST,CALC							
9520	WD7596	CTG			SLTST,CALC	10		.60		1 43	.35	58
9550	WD7597	CTG			SLTST,CALC							
9580	WD7598	CTG			SLTST,CALC	10		.26		.79	.26	100
9610	WD7599	CTG			SLTST,CALC							
9640	WD7600	CTG			SLTST,CALC	11		.19		1.14	.20	105
9680	WD7601	CTG			SLTST,CALC							
9710	WD7602	CTG			SLTST,CALC	10		.27		2.53	.29	107
9750	WD7603	CTG			SLTST,CALC							
9850	WD7604	CTG			SLTST	8		.24		2.49	.30	125
9920	WD7605	CTG			SLTST							
9950	WD7606	CTG			SLTST	9		.31		3.38	.33	106

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
8360	.90		421												
8390															
8420	.75		696												
8450															
8480	.94		729												
8510															
8540	.97		900												
8570															
8600	.71		362												
8630															
8660	.87		479												
8690															
8720	.53		111									1.59			
8750															
8780	.71		175												
8810															
8840	.81		324												
8870															
8900	.90		700												
8930															
8960	.80		184												
8990															
9020	.89		1155												
9050															
9080	.75		768												
9110															
9140	.83		1356												
9170															
9200	1.00		1265												
9230															
9260	.91		1136												
9290															
9320	.70		289									2.03			
9350															
9390	.82		609												
9420															
9450	.74		529												
9490															
9520	.80		238									2.28			
9550															
9580	.75		304												
9610															
9640	.85		600												
9680															
9710	.90		937												
9750															
9850	.89		1037												
9920															
9950	.91		1090												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
9990	WD7930	CTG			SH,CALC	11		.31		11.29	.70	226
10020	WD7931	CTG			SH,CALC							
10050	WD7932	CTG			SH	9		.21		9.86	.35	167
10080	WD7933	CTG			SH							
10110	WD7934	CTG			SH			.69		6.08	.31	45
10140	WD7935	CTG			SH							
10170	WD7936	CTG			SH			.33		9.49	.77	233
10200	WD7937	CTG			SH							
10230	WD7938	CTG			SH			.43		12.70	2.34	544
10245	WD7939	CTG			SH							
10260	WD7940	CTG			SH,CALC	13		.44		11.03	1.17	266
10270	WD7941	CTG			SH,CALC							
10300	WD7942	CTG			SH,CALC	13		.47		17.53	1.13	240
10330	WD7943	CTG			SH,CALC							
10360	WD7944	CTG			SH,CALC			.79		6.06	.60	76
10390	WD7945	CTG			SH,CALC							
10420	WD7946	CTG			SH,CALC			.80		6.41	.47	59
10450	WD7947	CTG			SH,CALC							
10480	WD7948	CTG			SH,CALC			.82		6.58	.56	68
10510	WD7949	CTG			SH,CALC							
10540	WD7950	CTG			SH,CALC			.40		8.70	.67	167
10570	WD7951	CTG			SH,CALC							
10600	WD7952	CTG			SH,CALC			.85		6.96	.40	47
10630	WD7953	CTG			SH,CALC							
10660	WD7954	CTG			SH,CALC	12		.34		9.15	.20	59
10690	WD7955	CTG			SH,CALC							
10720	WD7956	CTG			SH,CALC	18		.39		9.82	.11	28
10750	WD7957	CTG			SH,CALC							
10780	WD7958	CTG			SH,CALC			.47		3.09	.23	49
10810	WD7959	CTG			SH,CALC							
10840	WD7960	CTG			SH,CALC	14		.46		11.47	1.08	235
10870	WD7961	CTG			SH,CALC							
10900	WD7962	CTG			SH,CALC	16		.39		7.36	.28	72
10930	WD7963	CTG			SH,CALC							
10960	WD7964	CTG			SH,CALC	17		.43		8.41	.47	109
10990	WD7965	CTG			SH,CALC							
11020	WD7966	CTG			SH,CALC			.73		4.97	.52	71
11050	WD7967	CTG			SH,CALC							
11080	WD7968	CTG			SH,CALC	15		.43		14.40	1.25	291
11110	WD7969	CTG			SH,CALC							
11140	WD7970	CTG			SH,CALC	16		.47		8.72	.50	106
11170	WD7971	CTG			SH,CALC							
11200	WD7972	CTG			SH,CALC	16		.49		9.93	1.20	245
11230	WD7973	CTG			SH,CALC							
11260	WD7974	CTG			SH,CALC	15		.35		4.53	.28	80
11290	WD7975	CTG			SH,CALC							
11320	WD7976	CTG			SH,CALC			.65		4.41	.17	26
11350	WD7977	CTG			SH,CALC							
11380	WD7978	CTG			SH,CALC			.55		3.33	.03	5

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
9990	.94		3642												
10020															
10050	.97		4695												
10080															
10110	.95		881									2.39			
10140															
10170	.92		2876												
10200															
10230	.84		2953												
10245															
10260	.90		2507												
10270															
10300	.94		3730												
10330															
10360	.91		767												
10390															
10420	.93		801												
10450															
10480	.92		802												
10510															
10540	.93		2175												
10570															
10600	.95		819												
10630															
10660	.98		2691												
10690															
10720	.99		2518												
10750															
10780	.93		657												
10810															
10840	.91		2493												
10870															
10900	.96		1887												
10930															
10960	.95		1956												
10990															
11020	.91		681												
11050															
11080	.92		3349												
11110															
11140	.95		1855												
11170															
11200	.89		2027												
11230															
11260	.94		1294												
11290															
11320	.96		678												
11350															
11380	.99		605												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
11410	WD7979	CTG			SH,CALC							
11440	WD7980	CTG			SH,CALC			.77		5.98	.50	65
11470	WD7981	CTG			SH,CALC							
11500	WD7982	CTG			SH,CALC			.67		5.89	.26	39
11530	WD7983	CTG			SH,CALC							
11560	WD7984	CTG			SH,CALC			.60		5.53	.15	25
11590	WD7985	CTG			SH,CALC							
11620	WD7986	CTG			SH,CALC			.26		.87	.12	46
11650	WD7987	CTG			SH,CALC							
11680	WD7988	CTG			SH,CALC			.79		6.73	.34	43
11710	WD7989	CTG			SH,CALC							
11740	WD7990	CTG			SH,CALC			.32		1.90	.13	41
11770	WD7991	CTG			SH,CALC							
11800	WD7992	CTG			SH,CALC			.18		.46	.17	94
11830	WD7993	CTG			SH,CALC							
11860	WD7994	CTG			SH,CALC			.34		1.27	.57	168
11890	WD7995	CTG			SH,CALC							
11920	WD7996	CTG			SH,CALC	14		.47		17.88	.90	191
11950	WD7997	CTG			SH,CALC							
11980	WD9745	CTG			SH			.29		4.43	.55	190
12010	WD9746	CTG			SH							
12040	WD9747	CTG			SH			.31		3.95	.65	210
12070	WD9748	CTG			SH							
12100	WD9749	CTG			SH			.29		4.84	.58	200
12130	WD9750	CTG			SH							
12160	WD9751	CTG			SH			.20		4.97	.25	125
12190	WD9752	CTG			SH							
12220	WD9753	CTG			SH			.14		5.23	0.00	0
12250	WD9754	CTG			SH							
12280	WD9755	CTG			SH			.27		5.17	.24	89
12310	WD9756	CTG			SH							
12340	WD9757	CTG			SH			.20		6.74	.15	75
12370	WD9758	CTG			SH							
12400	WD9759	CTG			SH			.21		4.47	.19	90
12430	WD9760	CTG			SH							
12460	WD9761	CTG			SH			.28		7.01	.44	157
12490	WD9762	CTG			SH							
12520	WD9763	CTG			SH			.38		.28	.90	237
12550	WD9764	CTG			SH							
12580	WD9765	CTG			SH			.19		5.91	.15	79
12610	WD9766	CTG			SH							
12640	WD9767	CTG			SH			.19		9.26	.20	105
12670	WD9768	CTG			SH							
12700	WD9769	CTG			SH			.12		4.76	.06	50
12730	WD9770	CTG			SH							
12760	WD9771	CTG			SH			.12		5.72	0.00	0
12790	WD9772	CTG			SH							
12820	WD9773	CTG			SH			.17		6.63	0.00	0
12850	WD9774	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
11410															
11440	.92		777												
11470															
11500	.96		879												
11530															
11560	.97		922												
11590															
11620	.88		335												
11650															
11680	.95		852												
11710															
11740	.94		594												
11770															
11800	.73		256												
11830															
11860	.69		374												
11890															
11920	.95		3804												
11950															
11980	.89		1528												
12010															
12040	.86		1274												
12070															
12100	.89		1669												
12130												2.48			
12160	.95		2485												
12190															
12220	1.00		3736												
12250															
12280	.96		1915												
12310															
12340	.98		3370												
12370															
12400	.96		2129												
12430												2.59			
12460	.94		2504												
12490															
12520	.24		74												
12550															
12580	.98		3111												
12610															
12640	.98		4874												
12670												2.96			
12700	.99		3967												
12730															
12760	1.00		4767												
12790															
12820	1.00		3900												
12850															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
12880	WD9775	CTG			SH			.17		5.14	.20	118
12910	WD9776	CTG			SH							
12940	WD9777	CTG			SH			.22		3.43	.26	118
12970	WD9778	CTG			SH							
13000	WD9797	CTG			SH			.15		4.81	.41	273
13030	WD9798	CTG			SH							
13060	WD9799	CTG			SH			.14		7.51	.10	71
13090	WD9800	CTG			SH							
13120	WD9801	CTG			SH			.22		6.37	.37	168
13150	WD9802	CTG			SH							
13180	WD9803	CTG			SH			.21		3.81	.32	152
13210	WD9804	CTG			SH							
13240	WD9805	CTG			SH			.33		.37	.65	197
13270	WD9806	CTG			SH							
13300	WD9807	CTG			SH			.28		4.84	.38	136
13330	WD9808	CTG			SH							
13360	WD9809	CTG			SH			.24		4.66	.17	71
13390	WD9810	CTG			SH							
13420	WD9811	CTG			SH			.23		.15	0.00	0
13450	WD9812	CTG			SH							
13480	WD9813	CTG			SH			.34		.45	.71	209
13510	WD9814	CTG			SH							
13540	WD9815	CTG			SH			.26		6.00	.02	8
13570	WD9816	CTG			SH							
13600	WD9817	CTG			SH			.27		6.50	.07	26
13630	WD9818	CTG			SH							
13660	WD9819	CTG			SH			.15		5.09	0.00	0
13690	WD9820	CTG			SH							
13710	WD9821	CTG			SH			.63		1.03	.97	154
13740	WD9822	CTG			SH							
13770	WD9823	CTG			SH			.26		5.82	.18	69
13800	WD9824	CTG			SH							
13830	WD9825	CTG			SH			.30		.19	.58	193
13860	WD9826	CTG			SH							
13890	WD9827	CTG			SH			.31		.20	.64	206
13920	WD9828	CTG			SH			.29		.22	.62	214
13949	XD9828	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
12880	.96		3024												
12910															
12940	.93		1559												
12970															
13000	.92		3207												
13030															
13060	.99		5364												
13090															
13120	.95		2895												
13150															
13180	.92		1814												
13210															
13240	.36		112									2.67			
13270															
13300	.93		1729												
13330															
13360	.96		1942												
13390															
13420	1.00		65												
13450															
13480	.39		132												
13510															
13540	1.00		2308												
13570															
13600	.99		2407												
13630															
13660	1.00		3393												
13690															
13710	.52		163												
13740															
13770	.97		2238												
13800															
13830	.25		63												
13860															
13890	.24		65												
13920	.26		76												
13949															

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To:	M. Killgore SPC Mid-Continent Region Dallas	August 9, 1985 PGG/080985/GC/2-5 PGG Job No.: 85-29
Attn:	C. Titus	
From:	Petroleum Geochemistry Group Warrensville	Classification: RESTRICTED

Technical Memorandum (PGG/TM204) -- Source Evaluation of the Sohio #1-7 Weyerhaeuser Well, McCurtain County, Oklahoma.

Summary: A geochemical source quality screen and detailed maturity assessment of the stratigraphic sequence penetrated in the Sohio #1-7 Weyerhaeuser were completed by PGG. The well was spudded in the Mississippian Stanley Group strata and penetrated Devonian Arkansas Novaculite through Silurian Blaylock SST sediments. The majority of sediments contained marginal source richness, with occasional zones of moderate to good source richness within the Arkansas Novaculite. The well was spudded in thermally spent sediments (>3.50% R_o at surface) and was completed in thermally spent sediments (>5.00% R_o at TD).

1. INTRODUCTION

This report details the source rock geochemistry of the Sohio #1-7 Weyerhaeuser well, McCurtain County, Oklahoma that was drilled to a total depth of 6721'. The well was spudded in Mississippian Stanley Group sediments. The well penetrated two thrust sheets:

1. Upper thrust (0-3050') - penetrated Stanley (Mississippian) through Missouri Mountain (Silurian) sediments.

2. Lower thrust (3050-TD) - penetrated Arkansas Novaculite (Devonian) through Blaylock SST (Silurian) sediments.

2. MATERIALS AND METHODS

2.1 Materials

A total of two hundred twenty-two (222) cuttings samples were submitted for geochemical source rock evaluation covering the gross well interval from 44' to TD. Samples were analyzed on a 30 to 60' screen basis. Each sample was given a unique PGG identification number in the series from WE2820-2895 (44-2310'), WE4246-4285 (2370-3540'), WE3911-3954 (3570-4860'), WE4189-4234 (4890-6230'), and WE4286-4301 (6260' to TD).

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGG methods. Analyses consisted of organic petrographic determinations to establish a thermal maturity profile, rapid screen Rock-Eval pyrolysis and Total Organic Carbon (%TOC-bitumen free and Rock-Eval) to assess the overall source quality.

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the Sohio #1-7 Weyerhaeuser well is listed in Table 1. A Source Evaluation Log is appended as Figure 1.

3.1 Sediment Thermal Maturity

All sediments penetrated in the #1-7 Weyerhaeuser well were thermally spent (considered by PGG to be those sediments with R_o values >2.0%) as determined by whole rock vitrinite (or vitrinite-like) reflectance. Due to the small depth intervals penetrated within the two thrust sheets, it was not possible to apply a linear regression analysis or generate a well profile.

Table 2 lists the R_o ranges for the formations penetrated.

TABLE 2

	Formation	R_o Range
Upper Thrust:	Stanley	3.96-4.87
	Ark. Novaculite	5.31
	Mo. Mountain	No Data
Lower Thrust:	Ark. Novaculite	4.23-5.34
	Mo. Mountain	No Data
	Blaylock SST	4.88-5.75*

*determined on vitrinite-like particles

3.2 Source Quality

The source quality for the #1-7 Weyerhaeuser well was determined by using PGG standardized methods for %TOC (source richness) and pyrolysis (potential productivity based on S2 yield). It should be noted, however, that no S2 yield would be expected from thermally spent sediments.

3.2.1 Upper Thrust Sheet

a. Stanley Group (Mississippian) - 42 samples - thermally spent; source richness was lean with an average TOC of 0.36% and ranged from 0.19 to 0.54%; potential productivity was poor with an average S2 of 0.03 kg/ton.

b. Arkansas Novaculite (Devonian) - 12 samples - thermally spent; source richness was lean with an average TOC of 0.40% and ranged from 0.08 to 1.00% (the interval from 2670-2700' had a TOC of 1.00%); potential productivity was poor with an average S2 of 0.04 kg/ton.

c. Missouri Mountain (Silurian) - 7 samples - thermally spent; source richness was very lean with an average TOC of 0.05% and ranged from 0.02 to 0.11%; potential productivity was poor with an average S2 of 0.01 kg/ton.

3.2.2 Lower Thrust Sheet

a. Arkansas Novaculite (Devonian) - 62 samples - thermally spent; source richness was moderate with an average TOC of 0.55% and ranged from 0.05 to 2.43%; potential productivity was poor with an average S2 of 0.05 kg/ton.

Five zones within the Arkansas Novaculite contained good source richness (>1.0% TOC). These zones were from 3330'-3420', 3480-3540', 3870-3960', 4050'-4200', and 4650'-4740'. Even though these sediments are now thermally spent, these intervals were, at one time, good to excellent source rocks. These same sediments, where less mature (i.e. in the frontals), are considered oil-prone source rocks.

b. Missouri Mountain (Silurian) - 2 samples - thermally spent; poor source richness (TOC averaged 0.29%) and potential productivity (S2 averaged 0.05 kg/ton).

c. Blaylock SST (Silurian) - 59 samples - thermally spent; source richness was lean with an average TOC of 0.16% and ranged from 0.0 to 0.78%; potential productivity was poor with an average S2 of 0.05 kg/ton.

4. EXPLORATION SIGNIFICANCE

The Sohio #1-7 Weyerhaeuser well was a dry gas prospect with an Arkansas Novaculite (Devonian) objective. The well was completed as a dry hole with TD in the Silurian Blaylock SST. The Arkansas Novaculite objective was penetrated in two thrust sheets and contained occasional zones of good source potential, but both sheets were thermally spent. The advanced maturities (generally greater than 4% R_o) may rule out the possibility of gas in this prospect if the gas preservation limit of 4% R_o (as accepted by the industry), is used. At the present time, the true gas preservation limit is unknown. In carbonate rocks, it does not exceed 4% R_o. In clastic rocks, it may be somewhat higher than 4% R_o.

In any case, the good source potential intervals within the Arkansas Novaculite of this well, and known potential of the Ordovician Polk Creek Shale, Bigfork Chert, or Womble Shale seen in other parts of the Ouachita Overthrust, cannot be ruled out as deep gas sources within some parts of the Weyerhaeuser acreage in Oklahoma.

G. A. Cole

GAC:mlc

Enclosures: Table 1

Figure 1

cc: H. G. Bassett

R. Drozd

T. Legg

Files (0) (2-5)

Work by: R. Lukco

R. Chaikin

C. Hodges

TABLE 1

SUMMARY DATA FILE
GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : MCCURTAIN
LOCATION : SEC7,T4SR23E
WELL/SITE : #1-7 WEYERHAEUSER
API/OCS : 35-089-20057

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	XE2820		MISS	STAN								
44	WE2820	CTG			SH			.31		0.00	.01	3
90	WE2821	CTG			SH							
120	WE2822	CTG			SH			.43		0.00	.04	9
150	WE2823	CTG			SH							
180	WE2824	CTG			SH			.38		0.00	.01	3
210	WE2825	CTG			SH							
240	WE2826	CTG			SH			.26		0.00	0.00	0
270	WE2827	CTG			SH							
300	WE2828	CTG			SH			.29		0.00	0.00	0
330	WE2829	CTG			SH							
360	WE2830	CTG			SH			.33		0.00	.01	3
390	WE2831	CTG			SH							
420	WE2832	CTG			SH			.35		.02	.06	17
450	WE2833	CTG			SH							
480	WE2834	CTG			SH			.27		0.00	.01	4
510	WE2835	CTG			SH							
540	WE2836	CTG			SH			.21		0.00	.01	5
570	WE2837	CTG			SH							
600	WE2838	CTG			SH			.23		0.00	.02	9
630	WE2839	CTG			SH							
660	WE2840	CTG			SH			.36		0.00	.03	8
690	WE2841	CTG			SH							
720	WE2842	CTG			SH			.41		.01	.05	12
750	WE2843	CTG			SH							
780	WE2844	CTG			SH			.30		0.00	0.00	0
810	WE2845	CTG			SH							
840	WE2846	CTG			SH			.39		0.00	0.00	0
870	WE2847	CTG			SH							
900	WE2848	CTG			SH			.27		0.00	0.00	0
930	WE2849	CTG			SH							
960	WE2850	CTG			SH			.24		0.00	0.00	0
990	WE2851	CTG			SH							
1020	WE2852	CTG			SH			.39		0.00	0.00	0
1050	WE2853	CTG			SH							
1080	WE2854	CTG			SH			.40		.02	.10	25
1110	WE2855	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
44	0.00		0												
90															
120	0.00		0												
150															
180	0.00		0									3.96			
210															
240			0												
270															
300			0												
330															
360	0.00		0												
390															
420	.25		6												
450															
480	0.00		0									4.08			
510															
540	0.00		0												
570															
600	0.00		0												
630															
660	0.00		0												
690															
720	.17		2												
750															
780			0									4.53			
810															
840			0												
870															
900			0												
930															
960			0												
990															
1020			0												
1050															
1080	.17		5									4.48			
1110															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1140	WE2856	CTG			SH			.39		.03	.07	18
1170	WE2857	CTG			SH							
1200	WE2858	CTG			SH			.33		.01	.03	9
1230	WE2859	CTG			SH							
1260	WE2860	CTG			SH			.48		.02	.02	4
1290	WE2861	CTG			SH							
1320	WE2862	CTG			SH			.37		0.00	.01	3
1350	WE2863	CTG			SH							
1380	WE2864	CTG			SH			.19		0.00	.03	16
1410	WE2865	CTG			SH							
1440	WE2866	CTG			SH			.44		.01	.01	2
1470	WE2867	CTG			SH							
1500	WE2868	CTG			SH			.35		0.00	.01	3
1530	WE2869	CTG			SH							
1560	WE2870	CTG			SH			.36		0.00	0.00	0
1590	WE2871	CTG			SH							
1620	WE2872	CTG			SH			.35		.03	.09	26
1650	WE2873	CTG			SH							
1680	WE2874	CTG			SH			.30		0.00	0.00	0
1710	WE2875	CTG			SH							
1740	WE2876	CTG			SH			.54		.01	.05	9
1770	WE2877	CTG			SH							
1800	WE2878	CTG			SH			.31		0.00	.01	3
1830	WE2879	CTG			SH							
1860	WE2880	CTG			SH			.38		0.00	.03	8
1890	WE2881	CTG			SH							
1920	WE2882	CTG			SH			.31		0.00	.01	3
1950	WE2883	CTG			SH							
1980	WE2884	CTG			SH			.38		0.00	.01	3
2010	WE2885	CTG			SH							
2040	WE2886	CTG			SH			.38		0.00	.01	3
2070	WE2887	CTG			SH							
2100	WE2888	CTG			SH			.52		0.00	0.00	0
2130	WE2889	CTG			SH							
2160	WE2890	CTG			SH			.49		0.00	0.00	0
2190	WE2891	CTG			SH							
2220	WE2892	CTG			SH			.50		.03	.06	12
2250	WE2893	CTG			SH							
2280	WE2894	CTG			SH			.51		0.00	.06	12
2310	WE2895	CTG			SH							
2370	WE4246	CTG			SH			.32		.04	0.00	0
2400	WE4247	CTG			SH			.28		.01	0.00	0
2430	WE4248	CTG			SH			.34		.08	.10	29
2460	WE4249	CTG			SH			.29		.10	.17	59
2467	XE4249		DEV	ARKN								
2490	WE4250	CTG			SH			.29		.02	.02	7
2520	WE4251	CTG			SH			.28		.03	.05	18
2550	WE4252	CTG			SH			.11		0.00	0.00	0
2580	WE4253	CTG			SH			.42		.05	.03	7

WELL/SITE :#1-7 WEYERHAEUSER

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1140	.30		8												
1170															
1200	.25		3												
1230															
1260	.50		4												
1290															
1320	0.00		0												
1350															
1380	0.00		0									4.64			
1410															
1440	.50		2												
1470															
1500	0.00		0												
1530															
1560			0												
1590															
1620	.25		9												
1650															
1680			0									4.87			
1710															
1740	.17		2												
1770															
1800	0.00		0												
1830															
1860	0.00		0												
1890															
1920	0.00		0												
1950															
1980	0.00		0									4.48			
2010															
2040	0.00		0												
2070															
2100			0												
2130															
2160			0												
2190															
2220	.33		6												
2250															
2280	0.00		0									4.65			
2310															
2370	1.00		12												
2400	1.00		4									4.58			
2430	.44		24												
2460	.37		34												
2467															
2490	.50		7												
2520	.38		11												
2550			0												
2580	.63		12												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2610	WE4254	CTG			SH			.42		.05	.03	7
2640	WE4255	CTG			SH			.80		.05	.03	4
2670	WE4256	CTG			SH			1.00		.12	.08	8
2700	WE4257	CTG			SH			.50		.03	.01	2
2730	WE4258	CTG			SH			.27		.01	.03	11
2760	WE4259	CTG			SH			.41		.03	.01	2
2790	WE4260	CTG			SH			.08		.04	.09	112
2820	WE4261	CTG			SH			.25		.33	.04	16
2824	XE4261		SIL	MONT								
2850	WE4262	CTG			SH			.06		0.00	0.00	0
2880	WE4263	CTG			SH			.11		0.00	0.00	0
2910	WE4264	CTG			SH			.03		.02	.02	67
2940	WE4265	CTG			SH			.05		0.00	.03	60
2970	WE4266	CTG			SH			.03		0.00	0.00	0
3000	WE4267	CTG			SH			.02		.01	.05	250
3030	WE4268	CTG			SH			.04		.02	0.00	0
3050	XE4268		DEV	ARKN								
3060	WE4269	CTG			SH			.12		0.00	0.00	0
3090	WE4270	CTG			SH			.05		.06	.11	220
3120	WE4271	CTG			SH			.06		.02	0.00	0
3150	WE4272	CTG			SH			.08		.03	.05	62
3180	WE4273	CTG			SST			.05		0.00	0.00	0
3210	WE4274	CTG			SST			.23		0.00	0.00	0
3240	WE4275	CTG			SH			.45		0.00	0.00	0
3270	WE4276	CTG			SH			.68		0.00	0.00	0
3300	WE4277	CTG			SH			.17		0.00	0.00	0
3330	WE4278	CTG			SH			1.56		.01	.09	6
3360	WE4279	CTG			SH			2.43		.01	.01	0
3390	WE4280	CTG			SH			1.16		0.00	0.00	0
3420	WE4281	CTG			SH			.89		.02	0.00	0
3450	WE4282	CTG			SH			.57		0.00	0.00	0
3480	WE4283	CTG			SH			1.13		.02	.04	4
3510	WE4284	CTG			SH			1.25		.02	.02	2
3540	WE4285	CTG			SH			.26		.01	.01	4
3570	WE3911	CTG			SH			.19		.01	.08	42
3600	WE3912	CTG			SH			.46		.02	.10	22
3630	WE3913	CTG			SH			.18		.01	.03	17
3660	WE3914	CTG			SH			.05		0.00	.03	60
3690	WE3915	CTG			SH			.12		.01	.05	42
3720	WE3916	CTG			SH			.47		.02	.12	26
3750	WE3917	CTG			SH			.25		.02	.09	36
3780	WE3918	CTG			SH			.10		0.00	.01	10
3810	WE3919	CTG			SH			.66		.10	.10	15
3840	WE3920	CTG			SH			.92		.03	.09	10
3870	WE3921	CTG			SH			1.11		.18	.14	13
3900	WE3922	CTG			SH			.15		0.00	.01	7
3930	WE3923	CTG			SH			1.61		.20	.09	6
3960	WE3924	CTG			SH			.79		.11	.09	11
3990	WE3925	CTG			SH			.49		.05	.05	10

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2610	.63		12												
2640	.63		6												
2670	.60		12									5.31			
2700	.75		6												
2730	.25		4												
2760	.75		7												
2790	.31		50												
2820	.89		132												
2824															
2850			0												
2880			0												
2910	.50		67												
2940	0.00		0												
2970			0												
3000	.17		50												
3030	1.00		50												
3050															
3060			0												
3090	.35		120												
3120	1.00		33												
3150	.38		37												
3180			0												
3210			0												
3240			0												
3270			0												
3300			0												
3330	.10		1												
3360	.50		0									5.34			
3390			0									4.24			
3420	1.00		2												
3450			0												
3480	.33		2												
3510	.50		2									5.07			
3540	.50		4									4.23			
3570	.11		5									5.15			
3600	.17		4												
3630	.25		6												
3660	0.00		0												
3690	.17		8												
3720	.14		4												
3750	.18		8												
3780	0.00		0												
3810	.50		15												
3840	.25		3												
3870	.56		16									5.33			
3900	0.00		0												
3930	.69		12												
3960	.55		14												
3990	.50		10												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
4020	WE3926	CTG			SH			.40		.05	.03	7
4050	WE3927	CTG			SH			1.59		.23	.14	9
4080	WE3928	CTG			SH			1.00		.11	.13	13
4110	WE3929	CTG			SH			.49		.01	.01	2
4140	WE3930	CTG			SH			1.51		.15	.08	5
4170	WE3931	CTG			SH			1.44		.15	.05	3
4200	WE3932	CTG			SH			.40		.03	.03	7
4230	WE3933	CTG			SH			.33		.02	0.00	0
4260	WE3934	CTG			SH			.24		.01	.01	4
4290	WE3935	CTG			SH			.14		.01	.02	14
4320	WE3936	CTG			SH,CALC			.08		0.00	0.00	0
4350	WE3937	CTG			SH,CALC			.30		.04	.06	20
4380	WE3938	CTG			SH,CALC			.23		.03	.01	4
4410	WE3939	CTG			SH,CALC			.13		.01	.03	23
4440	WE3940	CTG			SH,CALC			.30		.01	0.00	0
4470	WE3941	CTG			SH,CALC			.12		0.00	0.00	0
4500	WE3942	CTG			SH,CALC			.28		.02	.02	7
4530	WE3943	CTG			SH,CALC			.18		.01	0.00	0
4560	WE3944	CTG			SH,CALC			.15		.01	.08	53
4590	WE3945	CTG			SH,CALC			.16		.01	.05	31
4620	WE3946	CTG			SH,CALC			.49		.04	.02	4
4650	WE3947	CTG			SH,CALC			1.08		.01	.06	6
4680	WE3948	CTG			SH,CALC			1.46		.08	.11	8
4710	WE3949	CTG			SH,CALC			1.54		.12	.18	12
4740	WE3950	CTG			SH,CALC			.57		.04	.07	12
4770	WE3951	CTG			SH,CALC			.38		.02	.10	26
4800	WE3952	CTG			SH,CALC			.20		.01	0.00	0
4830	WE3953	CTG			SH,CALC			.05		0.00	.02	40
4860	WE3954	CTG			SH,CALC			.05		0.00	.09	180
4890	WE4189	CTG			SH			.10		0.00	.18	180
4903	XE4189		SIL	MONT								
4920	WE4190	CTG			SH			.17		.02	.07	41
4950	WE4191	CTG			SH			.41		.02	.02	5
4957	XE4191		SIL	BLAY								
4980	WE4192	CTG			SH			.32		.01	0.00	0
5010	WE4193	CTG			SH			.21		.01	.03	14
5040	WE4194	CTG			SH			.21		0.00	0.00	0
5070	WE4195	CTG			SH			.22		.08	.16	73
5100	WE4196	CTG			SH			.22		.06	.04	18
5130	WE4197	CTG			SH			.16		0.00	0.00	0
5160	WE4198	CTG			SH			.28		0.00	0.00	0
5190	WE4199	CTG			SH			.17		0.00	0.00	0
5220	WE4200	CTG			SH			.20		0.00	0.00	0
5250	WE4201	CTG			SH			.18		.01	0.00	0
5280	WE4202	CTG			SH			.11		.01	0.00	0
5310	WE4203	CTG			SH			.10		.02	.02	20
5340	WE4204	CTG			SH			.12		.01	.01	8
5370	WE4205	CTG			SH			.16		.01	0.00	0
5400	WE4206	CTG			SH			.12		.01	.01	8

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
4020	.63		12												
4050	.62		14												
4080	.46		11												
4110	.50		2												
4140	.65		10												
4170	.75		10									5.22			
4200	.50		7												
4230	1.00		6												
4260	.50		4												
4290	.33		7												
4320			0												
4350	.40		13												
4380	.75		13												
4410	.25		8												
4440	1.00		3												
4470			0												
4500	.50		7												
4530	1.00		6												
4560	.11		7												
4590	.17		6												
4620	.67		8												
4650	.14		1												
4680	.42		5												
4710	.40		8												
4740	.36		7												
4770	.17		5												
4800	1.00		5												
4830	0.00		0												
4860	0.00		0												
4890	0.00		0												
4903															
4920	.22		12												
4950	.50		5												
4957															
4980	1.00		3												
5010	.25		5												
5040			0												
5070	.33		36												
5100	.60		27									5.75			
5130			0												
5160			0												
5190			0												
5220			0												
5250	1.00		6												
5280	1.00		9												
5310	.50		20												
5340	.50		8												
5370	1.00		6												
5400	.50		8									5.09			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5430	WE4207	CTG			SH			.11		.01	0.00	0
5460	WE4208	CTG			SH			.06		.04	.07	117
5490	WE4209	CTG			SH			.08		.01	0.00	0
5520	WE4210	CTG			SH			.12		.04	.08	67
5550	WE4211	CTG			SH			.03		0.00	0.00	0
5580	WE4212	CTG			SH			.06		.01	.01	17
5610	WE4213	CTG			SH			.04		0.00	0.00	0
5640	WE4214	CTG			SH			.02		0.00	0.00	0
5670	WE4215	CTG			SH			.04		.03	.06	150
5700	WE4216	CTG			SH			.04		0.00	.02	50
5730	WE4217	CTG			SH			.02		0.00	0.00	0
5750	WE4218	CTG			SH			.02		0.00	0.00	0
5780	WE4219	CTG			SH			.03		.02	.06	200
5810	WE4220	CTG			SH			.03		.04	.04	133
5840	WE4221	CTG			SH			.15		.09	.16	107
5870	WE4222	CTG			SH			.34		.08	.13	38
5900	WE4223	CTG			SH			.39		.08	.12	31
5930	WE4224	CTG			SH			.31		0.00	0.00	0
5960	WE4225	CTG			SH			.31		.03	.01	3
5990	WE4226	CTG			SH			.22		0.00	0.00	0
6020	WE4227	CTG			SH			.07		.02	.04	57
6050	WE4228	CTG			SH			.08		.02	.02	25
6080	WE4229	CTG			SH			.09		.04	.06	67
6110	WE4230	CTG			SH			.16		.02	0.00	0
6140	WE4231	CTG			SH			.18		.02	0.00	0
6170	WE4232	CTG			SH			.27		.02	0.00	0
6200	WE4233	CTG			SH			.31		.04	.07	23
6230	WE4234	CTG			SH			.26		.06	.09	35
6260	WE4286	CTG			SH			.16		.02	0.00	0
6290	WE4287	CTG			SH			.11		.04	.02	18
6320	WE4288	CTG			SH			.17		.07	.17	100
6350	WE4289	CTG			SH			.10		.05	.10	100
6380	WE4290	CTG			SH			.09		.06	.12	133
6410	WE4291	CTG			SH			.13		.04	.10	77
6440	WE4292	CTG			SH			.10		.02	.04	40
6470	WE4293	CTG			SH			.02		.01	.06	300
6500	WE4294	CTG			SH			0.00		0.00	.02	
6530	WE4295	CTG			SH			.01		.02	.08	800
6560	WE4296	CTG			SH			.22		.22	.11	50
6590	WE4297	CTG			SH			.13		.10	.15	115
6620	WE4298	CTG			SH			.78		.23	.32	41
6650	WE4299	CTG			SH			.26		.11	.11	42
6680	WE4300	CTG			SH			.19		.13	0.00	0
6710	WE4301	CTG			SH			.09		.07	0.00	0

WELL/SITE :#1-7 WEYERHAEUSER

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5430	1.00		9												
5460	.36		67												
5490	1.00		12												
5520	.33		33												
5550			0												
5580	.50		17												
5610			0												
5640			0												
5670	.33		75												
5700	0.00		0												
5730			0												
5750			0												
5780	.25		67												
5810	.50		133												
5840	.36		60												
5870	.38		24												
5900	.40		21												
5930			0												
5960	.75		10												
5990			0									5.49			
6020	.33		29												
6050	.50		25												
6080	.40		44												
6110	1.00		12												
6140	1.00		11												
6170	1.00		7												
6200	.36		13												
6230	.40		23									4.88			
6260	1.00		12												
6290	.67		36												
6320	.29		41												
6350	.33		50												
6380	.33		67												
6410	.29		31												
6440	.33		20												
6470	.14		50												
6500	0.00														
6530	.20		200												
6560	.67		100												
6590	.40		77												
6620	.42		29												
6650	.50		42												
6680	1.00		68												
6710	1.00		78												

TM 213

H086,0090
c. 3

SOHIO PETROLEUM COMPANY
Petroleum Geochemistry Group

To: M. Killgore
SPC Continental Division
Dallas

January 10, 1986
PGG/011086/GC/2-5

From: Petroleum Geochemistry Group
Warrensville

Subject: Issue of "Source Evaluation of the Shell #1-26 Arivett Well, Pike County, Arkansas" - Technical Memorandum PGG/TM213.

Enclosed find a copy of the subject report for your use and retention. Individual copies have been forwarded to C. Titus and T. Krancer.

This report details the source rock geochemistry for the Shell #1-26 Arivett well. All sediments except for a 120' interval within the Arkansas Novaculite contained poor source richness. The section penetrated was dry gas mature to thermally spent and would have to be considered a dry gas prospect, only.

R. J. Drozd

RJD:mlc

cc: M. Howe
T. Krancer
C. Titus
G. Cole
Files (0) (2-5)

Transmittal of Reports, Etc.

Please sign and return the duplicate copy of this document upon receipt of the enclosed report.

Received by: Date:

Comments:

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: M. Killgore
SPC Mid-Continent Region
Dallas

January 9, 1986
PGG/010786/GC/2-5
PGG Job No.: 85-103

Attn: C. Titus

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Technical Memorandum (PGG/TM213) -- Source Evaluation of the Shell #1-26 Arivett Well, Pike County, Arkansas.

Summary: A geochemical source quality screen and detailed maturity assessment of the stratigraphic sequence penetrated in the Shell #1-26 Arivett were completed by PGG. The well was spudded in the Mississippian Stanley Group strata and penetrated Devonian Arkansas Novaculite through Silurian Blaylock SST sediments. The majority of sediments contained marginal source richness, with occasional zones of moderate to good source richness within the Arkansas Novaculite. The well was spudded in gas mature sediments (>1.60% R_o at surface) and was completed in thermally spent sediments (>4.00% R_o at TD).

1. INTRODUCTION

This report details the source rock geochemistry of the Shell #1-26 Arivett well, Pike County, Arkansas, that was drilled to a total depth of 10570'. The well was spudded in the Mississippian Stanley Group and penetrated Devonian Arkansas Novaculite, Silurian Missouri Mountain Shale, and Silurian Blaylock Sandstone. The well was a dry hole.

2. MATERIALS

2.1 A total of three hundred fifty-one (351) cuttings samples and one (1) conventional core were submitted for geochemical source rock evaluation covering the gross well interval from 40' to TD. Samples were analyzed on a screen basis every 60'. Each sample was given a unique PGG well sample number from WE6021-WE6216 and WE6320-WE6471 for the cuttings samples and WE6472 for the conventional core.

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGG methods. Analyses consisted of organic petrographic determinations to establish a thermal maturity profile, rapid screen Rock-Eval pyrolysis and Total Organic Carbon (Rock-Eval) to assess the overall source quality.

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the Shell #1-26 Arivett well is listed in Table 1 and Figure 1. A Source Evaluation Log is appended as Figure 2.

3.1 Sediment Thermal Maturity Profile (STAMP)

The STAMP for the #1-26 Arivett well is a graphic representation of the detailed vitrinite reflectance analyses performed on twenty-three (23) cuttings samples (Table 2) from the 1400' to 9890' interval. A linear regression applied to the twenty-three sample data set indicated a correlation coefficient of 0.96 (r^2=92%). The maturity gradient for this well was 13.3 DOD units/km (4.06 DOD units/1000'). This data implied:

1) The surface R_o as extrapolated by the regression analysis was ~1.65%.

2) HGT (hydrocarbon generation threshold, 0.6% R_o) would have occurred at approximately 10900' above the surface.

3) DGGT (dominant gas generation threshold, 1.0% R_o) occurred at approximately 5400' above the surface.

Source quality analyses showed:

1) Mississippian Stanley Group: 0-8532': gas mature to thermally spent; source richness was poor with an average TOC of 0.16% (ranged from 0 to 0.36%).

2) Devonian Arkansas Novaculite: 8532-9950': thermally spent; source richness was poor overall with an average TOC of 0.34%, but the interval from 8960-9080 had an average TOC of 1.18% (ranged from 0.75 to 1.98%) and would be considered a good source rock.

3) Silurian Missouri Mountain: 9950-10114'; thermally spent; source richness was extremely poor with an average TOC of 0.06% (ranged from 0.04 to 0.09%).

4) Silurian Blaylock Sandstone: 10114' to TD; thermally spent; source richness was extremely poor with an average TOC of 0.06% (ranged from 0 to 0.37%).

The source quality data from the #1-26 Arivett compared favorably to data from other parts of the Ouachita Overthrust. Cole and Titus (1986) have concluded that only the "starved basin" sediments contained sustained source potential. The units of major importance are the Devonian Arkansas Novaculite and the Ordovician Polk Creek Shale, Bigfork Chert, and Womble Shale. Only the Arkansas Novaculite was penetrated in this well and contained a 120' interval of good source richness. These sediments can be rated as good source rocks because of their TOC contents even though they were thermally spent. Though not penetrated, the Ordovician sediments cannot be ruled out as potential source rocks in this region.

I. EXPLORATION SIGNIFICANCE

The Shell #1-26 Arivett well was a dry gas prospect with a Blaylock Sandstone (Silurian) objective. The well was completed as a dry hole with TD in the Blaylock Sandstone. The Arkansas Novaculite objective was penetrated from 8532-9950' and contained a 120' interval of good source richness. All other sediments contained poor source quality. Maturities exceeding 2.0% R_o limit this area as dry gas prospective.

Also, the good source potential of the Ordovician Polk Creek Shale, Bigfork Chert, or Womble Shale seen in other parts of the Ouachita Overthrust cannot be ruled out as deep gas sources.

5. REFERENCES

Cole, G.A., 1985, Source Evaluation of the Sohio Weyerhaeuser 1-15 Well, Pushmataha County, Oklahoma: PGG/TM195.

Cole, G.A., 1985, Geochemical Evaluation of Nine Shot-point Samples from Shell Shot-line 2343, Weyerhaeuser Acreage, Arkansas: PGG/EB334.

Cole, G.A. and Titus, C.A.O., 1986, Source Rock Potential and Thermal Maturity Trends of the Ouachita Facies of the Ouachita Overthrust Southeast Oklahoma: in preparation.

G. A. Cole

G. A. Cole

GAC:mlc

Enclosure: Tables 1,2
Figures 1-3

cc: R. Drozd
T. Krancer
M. Howe
Files (0) (2-5)

SEDIMENT THERMAL MATURITY PROFILE

(DETAILED VITRINITE REFLECTANCE ANALYSIS)

WELL : #1-26 ARIVETT

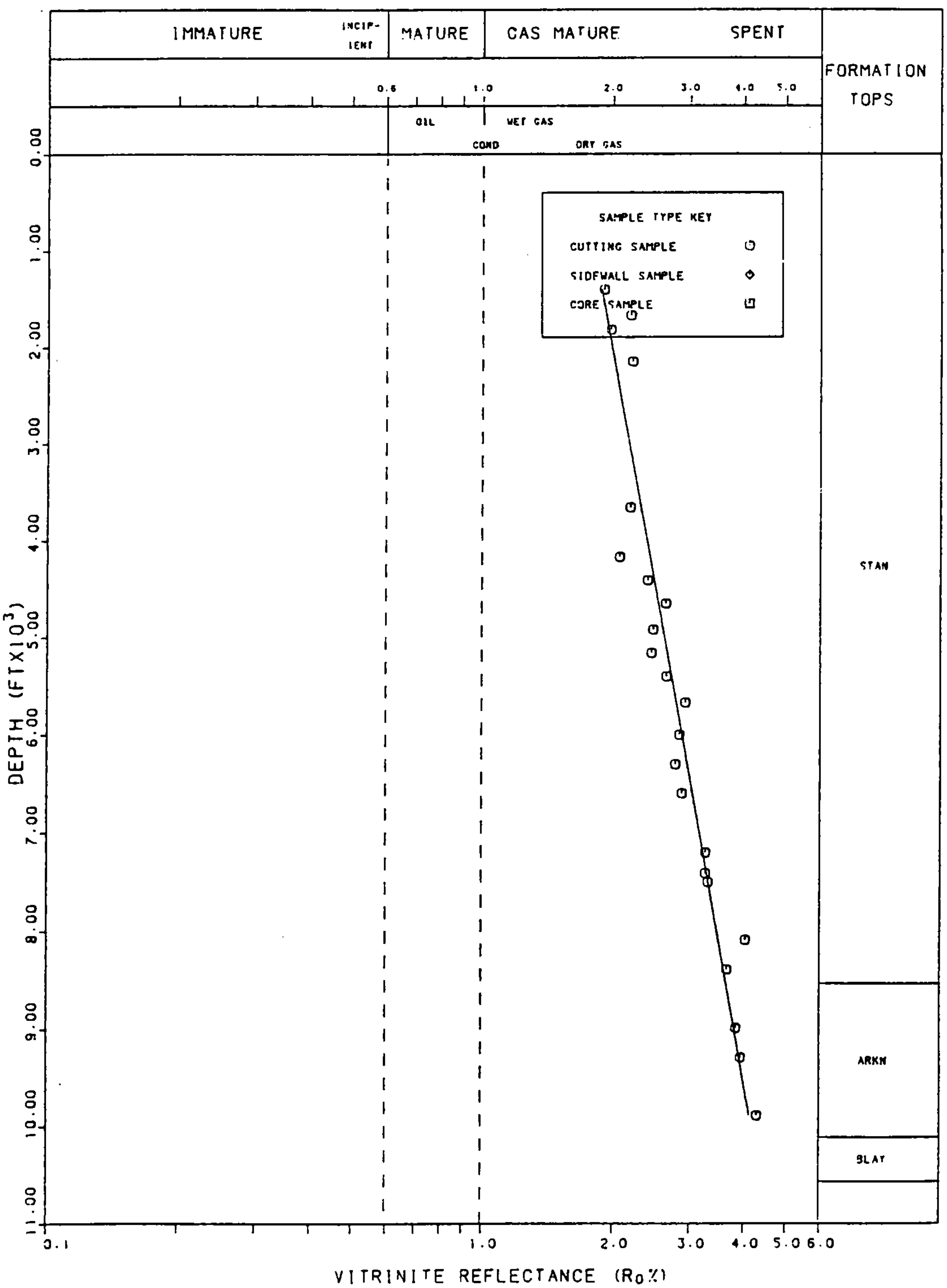


FIGURE 1

TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : AR
COUNTY/REGION/PROSPECT : PIKE
LOCATION : -
WELL/SITE : #1-26 ARIVETT
API/OCS : -

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	XE6021		MISS	STAN								
40	WE6021	CTG			SH							
70	WE6022	CTG			SH							
100	WE6023	CTG			SH							
130	WE6024	CTG			SH							
160	WE6025	CTG			SH							
190	WE6026	CTG			SH							
220	WE6027	CTG			SH			.28		.29	.23	82
250	WE6028	CTG			SH							
270	WE6029	CTG			SH			.02		.03	.01	50
300	WE6030	CTG			SH							
330	WE6031	CTG			SH			.02		.02	0.00	0
360	WE6032	CTG			SH							
390	WE6033	CTG			SH			.07		.04	.05	71
420	WE6034	CTG			SH							
460	WE6035	CTG			SH			.09		.08	.12	133
480	WE6036	CTG			SH							
510	WE6037	CTG			SH			.04		.01	0.00	0
540	WE6038	CTG			SH							
570	WE6039	CTG			SH			.14		.02	.04	29
600	WE6040	CTG			SH							
630	WE6041	CTG			SH			.22		.09	.18	82
660	WE6042	CTG			SH							
690	WE6043	CTG			SH			.13		.02	.03	23
710	WE6044	CTG			SH							
740	WE6045	CTG			SH			.25		.02	.02	8
770	WE6046	CTG			SH							
800	WE6047	CTG			SH			.14		.02	.01	7
830	WE6048	CTG			SH							
860	WE6049	CTG			SH			.14		.02	.01	7
890	WE6050	CTG			SH							
920	WE6051	CTG			SH			.18		.16	.20	111
950	WE6052	CTG			SH							
990	WE6053	CTG			SH			.11		.08	.12	109
1010	WE6054	CTG			SH							
1040	WE6055	CTG			SH			.17		.13	.17	100
1070	WE6056	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
40															
70															
100															
130															
160															
190															
220	.56		104												
250															
270	.75		150												
300															
330	1.00		100												
360															
390	.44		57												
420															
460	.40		89												
480															
510	1.00		25												
540															
570	.33		14												
600															
630	.33		41												
660															
690	.40		15												
710															
740	.50		8												
770															
800	.67		14												
830															
860	.67		14												
890															
920	.44		89												
950															
990	.40		73												
1010															
1040	.43		76												
1070															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1100	WE6057	CTG			SH			.17		.08	.05	29
1130	WE6058	CTG			SH							
1160	WE6059	CTG			SH			.14		.14	.19	136
1190	WE6060	CTG			SH							
1220	WE6061	CTG			SH			.13		.04	0.00	0
1250	WE6062	CTG			SH							
1280	WE6063	CTG			SH			.18		.03	0.00	0
1310	WE6064	CTG			SH							
1340	WE6065	CTG			SH			.13		.13	.11	85
1370	WE6066	CTG			SH							
1400	WE6067	CTG			SH			0.00		.04	0.00	
1430	WE6068	CTG			SH							
1460	WE6069	CTG			SH			0.00		0.00	0.00	
1490	WE6070	CTG			SH							
1520	WE6071	CTG			SH			.26		.03	.01	4
1550	WE6072	CTG			SH							
1580	WE6073	CTG			SH			.16		.02	.01	6
1610	WE6074	CTG			SH							
1640	WE6075	CTG			SH			.12		.12	.10	83
1670	WE6076	CTG			SH							
1700	WE6077	CTG			SH			.08		.01	0.00	0
1730	WE6078	CTG			SH							
1760	WE6079	CTG			SH			.17		.04	.02	12
1790	WE6080	CTG			SH							
1820	WE6081	CTG			SH			.36		.01	.04	11
1850	WE6082	CTG			SH							
1880	WE6083	CTG			SH			.09		.04	.02	22
1910	WE6084	CTG			SH							
1940	WE6085	CTG			SH			.11		.10	.13	118
1970	WE6086	CTG			SH							
2000	WE6087	CTG			SH			.12		.06	.06	50
2030	WE6088	CTG			SH							
2060	WE6089	CTG			SH			.24		.02	.04	17
2090	WE6090	CTG			SH							
2120	WE6091	CTG			SH			.18		.05	.03	17
2150	WE6092	CTG			SH							
2180	WE6093	CTG			SH			.26		.02	.05	19
2210	WE6094	CTG			SH							
2240	WE6095	CTG			SH			.12		.04	0.00	0
2270	WE6096	CTG			SH							
2300	WE6097	CTG			SH			.02		.02	0.00	0
2330	WE6098	CTG			SH							
2360	WE6099	CTG			SH			.07		.05	.01	14
2390	WE6100	CTG			SH							
2420	WE6101	CTG			SH			.13		.04	.04	31
2450	WE6102	CTG			SH							
2490	WE6103	CTG			SH			.02		.07	.08	400
2510	WE6104	CTG			SH							
2540	WE6105	CTG			SH			.12		.07	.10	83

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1100	.62		47												
1130															
1160	.42		100												
1190															
1220	1.00		31												
1250															
1280	1.00		17												
1310															
1340	.54		100												
1370															
1400	1.00											1.90			
1430															
1460															
1490															
1520	.75		12												
1550															
1580	.67		12												
1610															
1640	.55		100												
1670												2.19			
1700	1.00		12												
1730															
1760	.67		24												
1790															
1820	.20		3									1.97			
1850															
1880	.67		44												
1910															
1940	.43		91												
1970															
2000	.50		50												
2030															
2060	.33		8												
2090															
2120	.63		28												
2150												2.21			
2180	.29		8												
2210															
2240	1.00		33												
2270															
2300	1.00		100												
2330															
2360	.83		71												
2390															
2420	.50		31												
2450															
2490	.47		350												
2510															
2540	.41		58												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2570	WE6106	CTG			SH							
2600	WE6107	CTG			SH			.19		.06	.12	63
2630	WE6108	CTG			SH							
2660	WE6109	CTG			SH			.23		.08	.12	52
2690	WE6110	CTG			SH							
2720	WE6111	CTG			SH			.13		.03	.01	8
2750	WE6112	CTG			SH							
2780	WE6113	CTG			SH			.23		.07	.18	78
2810	WE6114	CTG			SH							
2840	WE6115	CTG			SH			.12		.05	.03	25
2870	WE6116	CTG			SH							
2900	WE6117	CTG			SH			.05		.10	.16	320
2930	WE6118	CTG			SH							
2960	WE6119	CTG			SH			.07		.04	.06	86
2990	WE6120	CTG			SH							
3010	WE6121	CTG			SH			.18		.01	.02	11
3050	WE6122	CTG			SH							
3080	WE6123	CTG			SH			.02		.05	.09	450
3110	WE6124	CTG			SH							
3140	WE6125	CTG			SH			.04		.05	.10	250
3170	WE6126	CTG			SH							
3200	WE6127	CTG			SH			.07		.05	.08	114
3230	WE6128	CTG			SH							
3260	WE6129	CTG			SH			0.00		.04	.06	
3290	WE6130	CTG			SH							
3300	WE6131	CTG			SH			.36		.02	.04	11
3320	WE6132	CTG			SH							
3340	WE6133	CTG			SH			.13		.04	.07	54
3350	WE6134	CTG			SH							
3390	WE6135	CTG			SH			.05		.05	.08	160
3410	WE6136	CTG			SH							
3500	WE6473	CTG			SH							
3530	WE6474	CTG			SH							
3560	WE6475	CTG			SH							
3600	WE6137	CTG			SH			.20		.47	.33	165
3630	WE6138	CTG			SH							
3660	WE6139	CTG			SH			.14		.07	.11	79
3690	WE6140	CTG			SH							
3720	WE6141	CTG			SH			.28		.11	.18	64
3750	WE6142	CTG			SH							
3780	WE6143	CTG			SH			.17		.04	.04	24
3810	WE6144	CTG			SH							
3840	WE6145	CTG			SH			.07		.01	0.00	0
3870	WE6146	CTG			SH							
3900	WE6147	CTG			SH			.06		.01	0.00	0
3930	WE6148	CTG			SH							
3960	WE6149	CTG			SH			.07		.06	.12	171
3990	WE6150	CTG			SH							
4020	WE6151	CTG			SH			.09		.12	.09	100

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2570															
2600	.33		32												
2630															
2660	.40		35												
2690															
2720	.75		23												
2750															
2780	.28		30												
2810															
2840	.63		42												
2870															
2900	.38		200												
2930															
2960	.40		57												
2990															
3010	.33		6												
3050															
3080	.36		250												
3110															
3140	.33		125												
3170															
3200	.38		71												
3230															
3260	.40														
3290															
3300	.33		6												
3320															
3340	.36		31												
3350															
3390	.38		100												
3410															
3500															
3530															
3560															
3600	.59		235												
3630															
3660	.39		50												
3690															
3720	.38		39												
3750															
3780	.50		24												
3810															
3840	1.00		14												
3870															
3900	1.00		17												
3930															
3960	.33		86												
3990															
4020	.57		133												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
4050	WE6152	CTG			SH							
4080	WE6153	CTG			SH			.20		.01	.03	15
4110	WE6154	CTG			SH							
4140	WE6155	CTG			SH			.27		.02	.03	11
4170	WE6156	CTG			SH							
4200	WE6157	CTG			SH			.36		.02	.07	19
4230	WE6158	CTG			SH							
4260	WE6159	CTG			SH			.21		.08	.15	71
4290	WE6160	CTG			SH							
4320	WE6161	CTG			SH			.24		.02	.02	8
4350	WE6162	CTG			SH							
4380	WE6163	CTG			SH			.11		.02	.01	9
4410	WE6164	CTG			SH							
4440	WE6165	CTG			SH			.20		.18	.26	130
4470	WE6166	CTG			SH							
4500	WE6167	CTG			SH			.12		.01	.03	25
4530	WE6168	CTG			SH							
4560	WE6169	CTG			SH			.07		0.00	.01	14
4590	WE6170	CTG			SH							
4620	WE6171	CTG			SH			.03		.03	.05	167
4650	WE6172	CTG			SH							
4680	WE6173	CTG			SH			.07		0.00	.01	14
4710	WE6174	CTG			SH							
4740	WE6175	CTG			SH			.04		.01	0.00	0
4770	WE6176	CTG			SH							
4800	WE6177	CTG			SH			.06		.02	.02	33
4830	WE6178	CTG			SH							
4860	WE6179	CTG			SH			.09		.02	0.00	0
4890	WE6180	CTG			SH							
4920	WE6181	CTG			SH			.27		.01	.05	19
4950	WE6182	CTG			SH							
4980	WE6183	CTG			SH			.07		0.00	0.00	0
5010	WE6184	CTG			SH							
5040	WE6185	CTG			SH			.09		.01	.02	22
5070	WE6186	CTG			SH							
5100	WE6187	CTG			SH			.06		0.00	.04	67
5130	WE6188	CTG			SH							
5160	WE6189	CTG			SH			.04		0.00	0.00	0
5190	WE6190	CTG			SH							
5220	WE6191	CTG			SH			.09		0.00	0.00	0
5250	WE6192	CTG			SH							
5280	WE6193	CTG			SH			.09		0.00	.01	11
5310	WE6194	CTG			SH							
5340	WE6195	CTG			SH			.10		.01	.03	30
5370	WE6196	CTG			SH							
5400	WE6197	CTG			SH			.07		.01	.01	14
5430	WE6198	CTG			SH							
5460	WE6199	CTG			SH			.10		.04	.05	50
5490	WE6200	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
4050															
4080	.25		5												
4110															
4140	.40		7												
4170												2.07			
4200	.22		6												
4230															
4260	.35		38												
4290															
4320	.50		8												
4350															
4380	.67		18												
4410												2.40			
4440	.41		90												
4470															
4500	.25		8												
4530															
4560	0.00		0												
4590															
4620	.38		100												
4650												2.64			
4680	0.00		0												
4710															
4740	1.00		25												
4770															
4800	.50		33												
4830															
4860	1.00		22												
4890															
4920	.17		4									2.47			
4950															
4980			0												
5010															
5040	.33		11												
5070															
5100	0.00		0												
5130															
5160			0									2.45			
5190															
5220			0												
5250															
5280	0.00		0												
5310															
5340	.25		10												
5370															
5400	.50		14									2.65			
5430															
5460	.44		40												
5490															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5520	WE6201	CTG			SH			.31		.01	0.00	0
5550	WE6202	CTG			SH							
5580	WE6203	CTG			SH			.23		.03	.06	26
5610	WE6204	CTG			SH							
5640	WE6205	CTG			SH			.10		0.00	.02	20
5670	WE6206	CTG			SH							
5700	WE6207	CTG			SH			.28		.31	.37	132
5730	WE6208	CTG			SH							
5760	WE6209	CTG			SH			.05		.01	0.00	0
5790	WE6210	CTG			SH							
5820	WE6211	CTG			SH			.08		.05	.05	62
5850	WE6212	CTG			SH							
5880	WE6213	CTG			SH			.08		.02	.01	12
5910	WE6214	CTG			SH							
5940	WE6215	CTG			SH			0.00		.03	.04	
5970	WE6216	CTG			SH							
6000	WE6320	CTG			SH			.20		0.00	0.00	0
6030	WE6321	CTG			SH							
6060	WE6322	CTG			SH			.30		.01	0.00	0
6090	WE6323	CTG			SH							
6120	WE6324	CTG			SH			.33		.01	0.00	0
6150	WE6325	CTG			SH							
6180	WE6326	CTG			SH			.29		.01	0.00	0
6210	WE6327	CTG			SH							
6240	WE6328	CTG			SH			.28		0.00	0.00	0
6270	WE6329	CTG			SH							
6300	WE6330	CTG			SH			.29		0.00	0.00	0
6330	WE6331	CTG			SH							
6360	WE6332	CTG			SH			.28		0.00	0.00	0
6390	WE6333	CTG			SH							
6420	WE6334	CTG			SH			.23		0.00	0.00	0
6450	WE6335	CTG			SH							
6480	WE6336	CTG			SH			.31		0.00	0.00	0
6510	WE6337	CTG			SH							
6540	WE6338	CTG			SH			.19		0.00	.01	5
6570	WE6339	CTG			SH							
6600	WE6340	CTG			SH							
6630	WE6341	CTG			SH			.25		.01	.03	12
6660	WE6342	CTG			SH							
6690	WE6343	CTG			SH			.29		0.00	0.00	0
6720	WE6344	CTG			SH			.32		0.00	0.00	0
6750	WE6345	CTG			SH							
6780	WE6346	CTG			SH			.30		0.00	.02	7
6810	WE6347	CTG			SH							
6840	WE6348	CTG			SH							
6870	WE6349	CTG			SH							
6900	WE6350	CTG			SH							
6930	WE6351	CTG			SH							
6960	WE6352	CTG			SH			.17		0.00	.01	6

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5520	1.00		3												
5550															
5580	.33		13												
5610															
5640	0.00		0												
5670												2.93			
5700	.46		111												
5730															
5760	1.00		20												
5790															
5820	.50		62												
5850															
5880	.67		25												
5910															
5940	.43														
5970															
6000			0									2.84			
6030															
6060	1.00		3												
6090															
6120	1.00		3												
6150															
6180	1.00		3												
6210															
6240			0												
6270															
6300			0									2.78			
6330															
6360			0												
6390															
6420			0												
6450															
6480			0												
6510															
6540	0.00		0												
6570															
6600												2.88			
6630	.25		4												
6660															
6690			0												
6720			0												
6750															
6780	0.00		0												
6810															
6840															
6870															
6900															
6930															
6960	0.00		0												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
6990	WE6353	CTG			SH							
7020	WE6354	CTG			SH			.21		.02	.05	24
7050	WE6355	CTG			SH							
7080	WE6356	CTG			SH			.16		0.00	.02	12
7110	WE6357	CTG			SH							
7140	WE6358	CTG			SH			.25		.01	.02	8
7170	WE6359	CTG			SH							
7200	WE6360	CTG			SH			.21		0.00	.02	10
7230	WE6361	CTG			SH							
7260	WE6362	CTG			SH			.27		0.00	.01	4
7290	WE6363	CTG			SH							
7320	WE6364	CTG			SH			.22		.01	.01	5
7350	WE6365	CTG			SH			.28		0.00	0.00	0
7380	WE6366	CTG			SH							
7410	WE6367	CTG			SH			.24		0.00	0.00	0
7440	WE6368	CTG			SH							
7470	WE6369	CTG			SH			.21		0.00	0.00	0
7500	WE6370	CTG			SH							
7530	WE6371	CTG			SH			.28		.02	.04	14
7560	WE6372	CTG			SH							
7600	WE6373	CTG			SH			.34		.07	.12	35
7630	WE6374	CTG			SH							
7660	WE6375	CTG			SH			.30		.01	0.00	0
7690	WE6376	CTG			SH							
7720	WE6377	CTG			SH			.18		.02	.01	6
7750	WE6378	CTG			SH							
7780	WE6379	CTG			SH			.28		.15	.14	50
7810	WE6380	CTG			SH							
7840	WE6381	CTG			SH			.10		.03	0.00	0
7860	WE6382	CTG			SH							
7880	WE6383	CTG			SH			.18		.01	0.00	0
7910	WE6384	CTG			SH							
7940	WE6385	CTG			SH			.25		.01	.01	4
7970	WE6386	CTG			SH							
8000	WE6387	CTG			SH			.20		.01	0.00	0
8030	WE6388	CTG			SH			.24		.01	0.00	0
8060	WE6389	CTG			SH							
8090	WE6390	CTG			SH			.16		.01	0.00	0
8120	WE6391	CTG			SH							
8150	WE6392	CTG			SH			.19		.01	0.00	0
8180	WE6393	CTG			SH							
8210	WE6394	CTG			SH			.16		.01	0.00	0
8240	WE6395	CTG			SH							
8270	WE6396	CTG			SH			.02		0.00	0.00	0
8300	WE6397	CTG			SH							
8330	WE6398	CTG			SH			.20		.03	.01	5
8360	WE6399	CTG			SH							
8390	WE6400	CTG			SH			.14		0.00	0.00	0
8420	WE6401	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
6990															
7020	.29		10												
7050															
7080	0.00		0												
7110															
7140	.33		4												
7170															
7200	0.00		0									3.26			
7230															
7260	0.00		0												
7290															
7320	.50		5												
7350			0												
7380															
7410			0									3.26			
7440															
7470			0												
7500												3.31			
7530	.33		7												
7560															
7600	.37		21												
7630															
7660	1.00		3												
7690															
7720	.67		11												
7750															
7780	.52		54												
7810															
7840	1.00		30												
7860															
7880	1.00		6												
7910															
7940	.50		4												
7970															
8000	1.00		5												
8030	1.00		4												
8060															
8090	1.00		6									4.04			
8120															
8150	1.00		5												
8180															
8210	1.00		6												
8240															
8270			0												
8300															
8330	.75		15												
8360															
8370			0									3.66			
8420															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
8450	WE6402	CTG			SH			.16		.05	.04	25
8480	WE6403	CTG			SH							
8510	WE6404	CTG			SH			0.00		0.00	0.00	
8532	XE6404		DEV	ARKN								
8540	WE6405	CTG			SH							
8570	WE6406	CTG			SH			.08		.02	0.00	0
8600	WE6407	CTG			SH							
8630	WE6408	CTG			SH			.17		.01	0.00	0
8660	WE6409	CTG			SH							
8690	WE6410	CTG			SH			.12		.02	0.00	0
8720	WE6411	CTG			SH							
8750	WE6412	CTG			SH			.10		0.00	0.00	0
8780	WE6413	CTG			SH			0.00		0.00	0.00	
8810	WE6414	CTG			SH							
8840	WE6415	CTG			SH			.25		.03	0.00	0
8870	WE6416	CTG			SH							
8900	WE6417	CTG			SH			.40		.02	.03	7
8930	WE6418	CTG			SH							
8960	WE6419	CTG			SH			.75		.01	.25	33
8990	WE6420	CTG			SH							
9020	WE6421	CTG			SH			.80		.01	.24	30
9050	WE6422	CTG			SH							
9080	WE6423	CTG			SH			1.98		.08	.35	18
9110	WE6424	CTG			SH							
9140	WE6425	CTG			SH			.60		.01	.05	8
9170	WE6426	CTG			SH							
9200	WE6427	CTG			SH			.37		.01	0.00	0
9230	WE6428	CTG			SH							
9260	WE6429	CTG			SH			.44		.03	.01	2
9290	WE6430	CTG			SH							
9320	WE6431	CTG			SH			.29		.01	0.00	0
9380	WE6432	CTG			SH			.25		.01	.01	4
9410	WE6433	CTG			SH							
9440	WE6434	CTG			SH			.44		.15	.05	11
9470	WE6435	CTG			SH			.24		.02	.01	4
9500	WE6436	CTG			SH							
9530	WE6437	CTG			SH			.28		0.00	0.00	0
9560	WE6438	CTG			SH							
9590	WE6439	CTG			SH			.18		.02	0.00	0
9620	WE6440	CTG			SH							
9650	WE6441	CTG			SH			.05		.01	.02	40
9680	WE6442	CTG			SH							
9710	WE6443	CTG			SH			.02		.02	0.00	0
9740	WE6444	CTG			SH							
9770	WE6445	CTG			SH			.07		.01	0.00	0
9800	WE6446	CTG			SH							
9830	WE6447	CTG			SH							
9860	WE6448	CTG			SH							
9890	WE6449	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
8450	.56		31												
8480															
8510															
8532															
8540															
8570	1.00		25												
8600															
8630	1.00		6												
8660															
8690	1.00		17												
8720															
8750			0												
8780															
8810															
8840	1.00		12												
8870															
8900	.40		5												
8930															
8960	.04		1												
8990												3.84			
9020	.04		1												
9050															
9080	.19		4												
9110															
9140	.17		2												
9170															
9200	1.00		3												
9230															
9260	.75		7												
9290												3.94			
9320	1.00		3												
9380	.50		4												
9410															
9440	.75		34												
9470	.67		8												
9500															
9530			0												
9560															
9590	1.00		11												
9620															
9650	.33		20												
9680															
9710	1.00		100												
9740															
9770	1.00		14												
9800															
9830															
9860															
9890												4.31			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
9920	WE6450	CTG			SH							
9950	WE6451	CTG			SH							
9950	XE6451		SIL	MOMT								
9980	WE6452	CTG			SH							
10010	WE6453	CTG			SH			.06		0.00	0.00	0
10040	WE6454	CTG			SH							
10070	WE6455	CTG			SH			.04		0.00	0.00	0
10100	WE6456	CTG			SH							
10114	XE6456		SIL	BLAY								
10130	WE6457	CTG			SH			.05		0.00	0.00	0
10160	WE6458	CTG			SH							
10190	WE6459	CTG			SH			.01		0.00	.07	700
10220	WE6460	CTG			SH			.03		.01	.04	133
10250	WE6461	CTG			SH							
10280	WE6462	CTG			SH							
10310	WE6463	CTG			SH			0.00		0.00	.07	
10340	WE6464	CTG			SH							
10370	WE6465	CTG			SH			.04		0.00	.12	300
10400	WE6466	CTG			SH							
10430	WE6467	CTG			SH			.03		0.00	.15	500
10460	WE6468	CTG			SH							
10490	WE6469	CTG			SH			.04		.04	.13	325
10520	WE6470	CTG			SH							
10525	WE6472	CC			SLTST							
10550	WE6471	CTG			SH			.01		0.00	.02	200
10570	XE6472	TD										

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
9920															
9950															
9950															
9980															
10010			0												
10040															
10070			0												
10100															
10114															
10130			0												
10160															
10190	0.00		0												
10220	.20		33												
10250															
10280															
10310	0.00														
10340															
10370	0.00		0												
10400															
10430	0.00		0												
10460															
10490	.24		100												
10520															
10525															
10550	0.00		0												
10570															

TABLE 2: R_o Values

SAMPLE #	DEPTH (FT.)	AVE. R_o (%)	# DATA POINTS
WE6067	1400	1.90 ?	2
WE6076	1670	2.19 ?	7
WE6081	1820	1.97 ?	3
WE6092	2150	2.21 ?	9
WE6139	3660	2.19	6
WE6156	4170	2.07	4
WE6164	4410	2.40	12
WE6172	4650	2.64	23
WE6181	4920	2.47	6
WE6189	5160	2.45	8
WE6197	5400	2.65	12
WE6208	5670	2.93	13
WE6320	6000	2.84	18
WE6330	6300	2.78	16
WE6340	6600	2.88	22
WE6360	7200	3.26	25
WE6367	7410	3.26	15
WE6370	7500	3.31	28
WE6390	8090	4.04	6
WE6400	8390	3.66	10
WE6420	8990	3.84	11
WE6430	9290	3.94	14
WE6449	9890	4.31	2

SOHIO PETROLEUM COMPANY

Petroleum Geochemistry Group

To: M. Killgore
SPC Mid-Continent Region
Dallas

August 9, 1985
PGG/080985/GC/2-5
PGG Job No.: 85-29

Attn: C. Titus

From: Petroleum Geochemistry Group
Warrensville

Classification: RESTRICTED

Technical Memorandum (PGG/TM204) -- Source Evaluation of the Sohio #1-7 Weyerhaeuser Well, McCurtain County, Oklahoma.

Summary: A geochemical source quality screen and detailed maturity assessment of the stratigraphic sequence penetrated in the Sohio #1-7 Weyerhaeuser were completed by PGG. The well was spudded in the Mississippian Stanley Group strata and penetrated Devonian Arkansas Novaculite through Silurian Blaylock SST sediments. The majority of sediments contained marginal source richness, with occasional zones of moderate to good source richness within the Arkansas Novaculite. The well was spudded in thermally spent sediments (>3.50% R_o at surface) and was completed in thermally spent sediments (>5.00% R_o at TD).

1. INTRODUCTION

This report details the source rock geochemistry of the Sohio #1-7 Weyerhaeuser well, McCurtain County, Oklahoma that was drilled to a total depth of 6721'. The well was spudded in Mississippian Stanley Group sediments. The well penetrated two thrust sheets:

1. Upper thrust (0-3050') - penetrated Stanley (Mississippian) through Missouri Mountain (Silurian) sediments.

2. Lower thrust (3050-TD) - penetrated Arkansas Novaculite (Devonian) through Blaylock SST (Silurian) sediments.

2. MATERIALS AND METHODS

2.1 Materials

A total of two hundred twenty-two (222) cuttings samples were submitted for geochemical source rock evaluation covering the gross well interval from 44' to TD. Samples were analyzed on a 30 to 60' screen basis. Each sample was given a unique PGG identification number in the series from WE2820-2895 (44-2310'), WE4246-4285 (2370-3540'), WE3911-3954 (3570-4860'), WE4189-4234 (4890-6230'), and WE4286-4301 (6260' to TD).

2.2 Methods

Samples were analyzed for source richness and maturity using standardized PGG methods. Analyses consisted of organic petrographic determinations to establish a thermal maturity profile, rapid screen Rock-Eval pyrolysis and Total Organic Carbon (%TOC-bitumen free and Rock-Eval) to assess the overall source quality.

3. RESULTS

A summary of source rock evaluation data for the sediments penetrated by the Sohio #1-7 Weyerhaeuser well is listed in Table 1. A Source Evaluation Log is appended as Figure 1.

3.1 Sediment Thermal Maturity

All sediments penetrated in the #1-7 Weyerhaeuser well were thermally spent (considered by PGG to be those sediments with R_o values >2.0%) as determined by whole rock vitrinite (or vitrinite-like) reflectance. Due to the small depth intervals penetrated within the two thrust sheets, it was not possible to apply a linear regression analysis or generate a well profile.

Table 2 lists the R_o ranges for the formations penetrated.

TABLE 2

	Formation	R_o Range
Upper Thrust:	Stanley	3.96-4.87
	Ark. Novaculite	5.31
	Mo. Mountain	No Data
Lower Thrust:	Ark. Novaculite	4.23-5.34
	Mo. Mountain	No Data
	Blaylock SST	4.88-5.75*

*determined on vitrinite-like particles

3.2 Source Quality

The source quality for the #1-7 Weyerhaeuser well was determined by using PGG standardized methods for %TOC (source richness) and pyrolysis (potential productivity based on S2 yield). It should be noted, however, that no S2 yield would be expected from thermally spent sediments.

3.2.1 Upper Thrust Sheet

a. Stanley Group (Mississippian) - 42 samples - thermally spent; source richness was lean with an average TOC of 0.36% and ranged from 0.19 to 0.54%; potential productivity was poor with an average S2 of 0.03 kg/ton.

b. Arkansas Novaculite (Devonian) - 12 samples - thermally spent; source richness was lean with an average TOC of 0.40% and ranged from 0.08 to 1.00% (the interval from 2670-2700' had a TOC of 1.00%); potential productivity was poor with an average S2 of 0.04 kg/ton.

c. Missouri Mountain (Silurian) - 7 samples - thermally spent; source richness was very lean with an average TOC of 0.05% and ranged from 0.02 to 0.11%; potential productivity was poor with an average S2 of 0.01 kg/ton.

3.2.2 Lower Thrust Sheet

a. Arkansas Novaculite (Devonian) - 62 samples - thermally spent; source richness was moderate with an average TOC of 0.55% and ranged from 0.05 to 2.43%; potential productivity was poor with an average S2 of 0.05 kg/ton.

Five zones within the Arkansas Novaculite contained good source richness (>1.0% TOC). These zones were from 3330'-3420', 3480-3540', 3870-3960', 4050'-4200', and 4650'-4740'. Even though these sediments are now thermally spent, these intervals were, at one time, good to excellent source rocks. These same sediments, where less mature (i.e. in the frontals), are considered oil-prone source rocks.

b. Missouri Mountain (Silurian) - 2 samples - thermally spent; poor source richness (TOC averaged 0.29%) and potential productivity (S2 averaged 0.05 kg/ton).

c. Blaylock SST (Silurian) - 59 samples - thermally spent; source richness was lean with an average TOC of 0.16% and ranged from 0.0 to 0.78%; potential productivity was poor with an average S2 of 0.05 kg/ton.

4. EXPLORATION SIGNIFICANCE

The Sohio #1-7 Weyerhaeuser well was a dry gas prospect with an Arkansas Novaculite (Devonian) objective. The well was completed as a dry hole with TD in the Silurian Blaylock SST. The Arkansas Novaculite objective was penetrated in two thrust sheets and contained occasional zones of good source potential, but both sheets were thermally spent. The advanced maturities (generally greater than 4% R_o) may rule out the possibility of gas in this prospect if the gas preservation limit of 4% R_o (as accepted by the industry), is used. At the present time, the true gas preservation limit is unknown. In carbonate rocks, it does not exceed 4% R_o. In clastic rocks, it may be somewhat higher than 4% R_o.

In any case, the good source potential intervals within the Arkansas Novaculite of this well, and known potential of the Ordovician Polk Creek Shale, Bigfork Chert, or Womble Shale seen in other parts of the Ouachita Overthrust, cannot be ruled out as deep gas sources within some parts of the Weyerhaeuser acreage in Oklahoma.

G. A. Cole

GAC:mlc
Enclosures: Table 1
Figure 1

cc: H. G. Bassett
R. Drozd
T. Legg
Files (0) (2-5)

Work by: R. Lukco
R. Chaikin
C. Hodges

TABLE 1

SUMMARY DATA FILE

GEOCHEMICAL SOURCE ROCK POTENTIAL EVALUATION

COUNTRY : US
STATE : OK
COUNTY/REGION/PROSPECT : MCCURTAIN
LOCATION : SEC7,T4SR23E
WELL/SITE : #1-7 WEYERHAEUSER
API/OCS : 35-089-20057

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
0	XE2820		MISS	STAN								
44	WE2820	CTG			SH			.31		0.00	.01	3
90	WE2821	CTG			SH							
120	WE2822	CTG			SH			.43		0.00	.04	9
150	WE2823	CTG			SH							
180	WE2824	CTG			SH			.38		0.00	.01	3
210	WE2825	CTG			SH							
240	WE2826	CTG			SH			.26		0.00	0.00	0
270	WE2827	CTG			SH							
300	WE2828	CTG			SH			.29		0.00	0.00	0
330	WE2829	CTG			SH							
360	WE2830	CTG			SH			.33		0.00	.01	3
390	WE2831	CTG			SH							
420	WE2832	CTG			SH			.35		.02	.06	17
450	WE2833	CTG			SH							
480	WE2834	CTG			SH			.27		0.00	.01	4
510	WE2835	CTG			SH							
540	WE2836	CTG			SH			.21		0.00	.01	5
570	WE2837	CTG			SH							
600	WE2838	CTG			SH			.23		0.00	.02	9
630	WE2839	CTG			SH							
660	WE2840	CTG			SH			.36		0.00	.03	8
690	WE2841	CTG			SH							
720	WE2842	CTG			SH			.41		.01	.05	12
750	WE2843	CTG			SH							
780	WE2844	CTG			SH			.30		0.00	0.00	0
810	WE2845	CTG			SH							
840	WE2846	CTG			SH			.39		0.00	0.00	0
870	WE2847	CTG			SH							
900	WE2848	CTG			SH			.27		0.00	0.00	0
930	WE2849	CTG			SH							
960	WE2850	CTG			SH			.24		0.00	0.00	0
990	WE2851	CTG			SH							
1020	WE2852	CTG			SH			.39		0.00	0.00	0
1050	WE2853	CTG			SH							
1080	WE2854	CTG			SH			.40		.02	.10	25
1110	WE2855	CTG			SH							

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
0															
44	0.00		(												
90															
120	0.00		(												
150															
180	0.00		(									3.96			
210															
240			(												
270															
300			(												
330															
360	0.00		(												
390															
420	.25		(												
450															
480	0.00		(									4.08			
510															
540	0.00		(												
570															
600	0.00		(												
630															
660	0.00		(												
690															
720	.17		2												
750															
780			(									4.53			
810															
840			(												
870															
900			(												
930															
960			(												
990															
1020			(												
1050															
1080	.17		5									4.48			
1110															

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
1140	WE2856	CTG			SH			.39		.03	.07	18
1170	WE2857	CTG			SH							
1200	WE2858	CTG			SH			.33		.01	.03	9
1230	WE2859	CTG			SH							
1260	WE2860	CTG			SH			.48		.02	.02	4
1290	WE2861	CTG			SH							
1320	WE2862	CTG			SH			.37		0.00	.01	3
1350	WE2863	CTG			SH							
1380	WE2864	CTG			SH			.19		0.00	.03	16
1410	WE2865	CTG			SH							
1440	WE2866	CTG			SH			.44		.01	.01	2
1470	WE2867	CTG			SH							
1500	WE2868	CTG			SH			.35		0.00	.01	3
1530	WE2869	CTG			SH							
1560	WE2870	CTG			SH			.36		0.00	0.00	0
1590	WE2871	CTG			SH							
1620	WE2872	CTG			SH			.35		.03	.09	26
1650	WE2873	CTG			SH							
1680	WE2874	CTG			SH			.30		0.00	0.00	0
1710	WE2875	CTG			SH							
1740	WE2876	CTG			SH			.54		.01	.05	9
1770	WE2877	CTG			SH							
1800	WE2878	CTG			SH			.31		0.00	.01	3
1830	WE2879	CTG			SH							
1860	WE2880	CTG			SH			.38		0.00	.03	8
1890	WE2881	CTG			SH							
1920	WE2882	CTG			SH			.31		0.00	.01	3
1950	WE2883	CTG			SH							
1980	WE2884	CTG			SH			.38		0.00	.01	3
2010	WE2885	CTG			SH							
2040	WE2886	CTG			SH			.38		0.00	.01	3
2070	WE2887	CTG			SH							
2100	WE2888	CTG			SH			.52		0.00	0.00	0
2130	WE2889	CTG			SH							
2160	WE2890	CTG			SH			.49		0.00	0.00	0
2190	WE2891	CTG			SH							
2220	WE2892	CTG			SH			.50		.03	.06	12
2250	WE2893	CTG			SH							
2280	WE2894	CTG			SH			.51		0.00	.06	12
2310	WE2895	CTG			SH							
2370	WE4246	CTG			SH			.32		.04	0.00	0
2400	WE4247	CTG			SH			.28		.01	0.00	0
2430	WE4248	CTG			SH			.34		.08	.10	29
2460	WE4249	CTG			SH			.29		.10	.17	59
2467	XE4249		DEV	ARKN								
2490	WE4250	CTG			SH			.29		.02	.02	7
2520	WE4251	CTG			SH			.28		.03	.05	18
2550	WE4252	CTG			SH			.11		0.00	0.00	0
2580	WE4253	CTG			SH			.42		.05	.03	7

WELL/SITE :#1-7 WEYERHAEUSER

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
1140	.30		8												
1170															
1200	.25		3												
1230															
1260	.50		4												
1290															
1320	0.00		0												
1350															
1380	0.00		0									4.64			
1410															
1440	.50		2												
1470															
1500	0.00		0												
1530															
1560			0												
1590															
1620	.25		9												
1650															
1680			0									4.87			
1710															
1740	.17		2												
1770															
1800	0.00		0												
1830															
1860	0.00		0												
1890															
1920	0.00		0												
1950															
1980	0.00		0									4.48			
2010															
2040	0.00		0												
2070															
2100			0												
2130															
2160			0												
2190															
2220	.33		6												
2250															
2280	0.00		0									4.65			
2310															
2370	1.00		12												
2400	1.00		4									4.58			
2430	.44		24												
2460	.37		34												
2467															
2490	.50		7												
2520	.38		11												
2550			0												
2580	.63		12												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
2610	WE4254	CTG			SH			.42		.05	.03	7
2640	WE4255	CTG			SH			.80		.05	.03	4
2670	WE4256	CTG			SH			1.00		.12	.08	8
2700	WE4257	CTG			SH			.50		.03	.01	2
2730	WE4258	CTG			SH			.27		.01	.03	11
2760	WE4259	CTG			SH			.41		.03	.01	2
2790	WE4260	CTG			SH			.08		.04	.09	112
2820	WE4261	CTG			SH			.25		.33	.04	16
2824	XE4261		SIL	MOMT								
2850	WE4262	CTG			SH			.06		0.00	0.00	0
2880	WE4263	CTG			SH			.11		0.00	0.00	0
2910	WE4264	CTG			SH			.03		.02	.02	67
2940	WE4265	CTG			SH			.05		0.00	.03	60
2970	WE4266	CTG			SH			.03		0.00	0.00	0
3000	WE4267	CTG			SH			.02		.01	.05	250
3030	WE4268	CTG			SH			.04		.02	0.00	0
3050	XE4268		DEV	ARKN								
3060	WE4269	CTG			SH			.12		0.00	0.00	0
3090	WE4270	CTG			SH			.05		.06	.11	220
3120	WE4271	CTG			SH			.06		.02	0.00	0
3150	WE4272	CTG			SH			.08		.03	.05	62
3180	WE4273	CTG			SST			.05		0.00	0.00	0
3210	WE4274	CTG			SST			.23		0.00	0.00	0
3240	WE4275	CTG			SH			.45		0.00	0.00	0
3270	WE4276	CTG			SH			.68		0.00	0.00	0
3300	WE4277	CTG			SH			.17		0.00	0.00	0
3330	WE4278	CTG			SH			1.56		.01	.09	6
3360	WE4279	CTG			SH			2.43		.01	.01	0
3390	WE4280	CTG			SH			1.16		0.00	0.00	0
3420	WE4281	CTG			SH			.89		.02	0.00	0
3450	WE4282	CTG			SH			.57		0.00	0.00	0
3480	WE4283	CTG			SH			1.13		.02	.04	4
3510	WE4284	CTG			SH			1.25		.02	.02	2
3540	WE4285	CTG			SH			.26		.01	.01	4
3570	WE3911	CTG			SH			.19		.01	.08	42
3600	WE3912	CTG			SH			.46		.02	.10	22
3630	WE3913	CTG			SH			.18		.01	.03	17
3660	WE3914	CTG			SH			.05		0.00	.03	60
3690	WE3915	CTG			SH			.12		.01	.05	42
3720	WE3916	CTG			SH			.47		.02	.12	26
3750	WE3917	CTG			SH			.25		.02	.09	36
3780	WE3918	CTG			SH			.10		0.00	.01	10
3810	WE3919	CTG			SH			.66		.10	.10	15
3840	WE3920	CTG			SH			.92		.03	.09	10
3870	WE3921	CTG			SH			1.11		.18	.14	13
3900	WE3922	CTG			SH			.15		0.00	.01	7
3930	WE3923	CTG			SH			1.61		.20	.09	6
3960	WE3924	CTG			SH			.79		.11	.09	11
3990	WE3925	CTG			SH			.49		.05	.05	10

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
2610	.63		12												
2640	.63		6												
2670	.60		12									5.31			
2700	.75		6												
2730	.25		4												
2760	.75		7												
2790	.31		50												
2820	.89		132												
2824															
2850			0												
2880			0												
2910	.50		67												
2940	0.00		0												
2970			0												
3000	.17		50												
3030	1.00		50												
3050															
3060			0												
3090	.35		120												
3120	1.00		33												
3150	.38		37												
3180			0												
3210			0												
3240			0												
3270			0												
3300			0												
3330	.10		1												
3360	.50		0									5.34			
3390			0									4.24			
3420	1.00		2												
3450			0												
3480	.33		2												
3510	.50		2									5.07			
3540	.50		4									4.23			
3570	.11		5									5.15			
3600	.17		4												
3630	.25		6												
3660	0.00		0												
3690	.17		8												
3720	.14		4												
3750	.18		8												
3780	0.00		0												
3810	.50		15												
3840	.25		3												
3870	.56		16									5.33			
3900	0.00		0												
3930	.69		12												
3960	.55		14												
3990	.50		10												

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
4020	WE3926	CTG			SH			.40		.05	.03	7
4050	WE3927	CTG			SH			1.59		.23	.14	9
4080	WE3928	CTG			SH			1.00		.11	.13	13
4110	WE3929	CTG			SH			.49		.01	.01	2
4140	WE3930	CTG			SH			1.51		.15	.08	5
4170	WE3931	CTG			SH			1.44		.15	.05	3
4200	WE3932	CTG			SH			.40		.03	.03	7
4230	WE3933	CTG			SH			.33		.02	0.00	0
4260	WE3934	CTG			SH			.24		.01	.01	4
4290	WE3935	CTG			SH			.14		.01	.02	14
4320	WE3936	CTG			SH,CALC			.08		0.00	0.00	0
4350	WE3937	CTG			SH,CALC			.30		.04	.06	20
4380	WE3938	CTG			SH,CALC			.23		.03	.01	4
4410	WE3939	CTG			SH,CALC			.13		.01	.03	23
4440	WE3940	CTG			SH,CALC			.30		.01	0.00	0
4470	WE3941	CTG			SH,CALC			.12		0.00	0.00	0
4500	WE3942	CTG			SH,CALC			.28		.02	.02	7
4530	WE3943	CTG			SH,CALC			.18		.01	0.00	0
4560	WE3944	CTG			SH,CALC			.15		.01	.08	53
4590	WE3945	CTG			SH,CALC			.16		.01	.05	31
4620	WE3946	CTG			SH,CALC			.49		.04	.02	4
4650	WE3947	CTG			SH,CALC			1.08		.01	.06	6
4680	WE3948	CTG			SH,CALC			1.46		.08	.11	8
4710	WE3949	CTG			SH,CALC			1.54		.12	.18	12
4740	WE3950	CTG			SH,CALC			.57		.04	.07	12
4770	WE3951	CTG			SH,CALC			.38		.02	.10	26
4800	WE3952	CTG			SH,CALC			.20		.01	0.00	0
4830	WE3953	CTG			SH,CALC			.05		0.00	.02	40
4860	WE3954	CTG			SH,CALC			.05		0.00	.09	180
4890	WE4189	CTG			SH			.10		0.00	.18	180
4903	XE4189		SIL	MONT								
4920	WE4190	CTG			SH			.17		.02	.07	41
4950	WE4191	CTG			SH			.41		.02	.02	5
4957	XE4191		SIL	BLAY								
4980	WE4192	CTG			SH			.32		.01	0.00	0
5010	WE4193	CTG			SH			.21		.01	.03	14
5040	WE4194	CTG			SH			.21		0.00	0.00	0
5070	WE4195	CTG			SH			.22		.08	.16	73
5100	WE4196	CTG			SH			.22		.06	.04	18
5130	WE4197	CTG			SH			.16		0.00	0.00	0
5160	WE4198	CTG			SH			.28		0.00	0.00	0
5190	WE4199	CTG			SH			.17		0.00	0.00	0
5220	WE4200	CTG			SH			.20		0.00	0.00	0
5250	WE4201	CTG			SH			.18		.01	0.00	0
5280	WE4202	CTG			SH			.11		.01	0.00	0
5310	WE4203	CTG			SH			.10		.02	.02	20
5340	WE4204	CTG			SH			.12		.01	.01	8
5370	WE4205	CTG			SH			.16		.01	0.00	0
5400	WE4206	CTG			SH			.12		.01	.01	8

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
4020	.63		12												
4050	.62		14												
4080	.46		11												
4110	.50		2												
4140	.65		10												
4170	.75		10									5.22			
4200	.50		7												
4230	1.00		6												
4260	.50		4												
4290	.33		7												
4320			0												
4350	.40		13												
4380	.75		13												
4410	.25		8												
4440	1.00		3												
4470			0												
4500	.50		7												
4530	1.00		6												
4560	.11		7												
4590	.17		6												
4620	.67		8												
4650	.14		1												
4680	.42		5												
4710	.40		8												
4740	.36		7												
4770	.17		5												
4800	1.00		5												
4830	0.00		0												
4860	0.00		0												
4890	0.00		0												
4903															
4920	.22		12												
4950	.50		5												
4957															
4980	1.00		3												
5010	.25		5												
5040			0												
5070	.33		36												
5100	.60		27									5.75			
5130			0												
5160			0												
5190			0												
5220			0												
5250	1.00		6												
5280	1.00		9												
5310	.50		20												
5340	.50		8												
5370	1.00		6												
5400	.50		8									5.09			

DEPTH FT BRT	SAMPLE NO.	SAMPLE TYPE	EPOCH /AGE	FORM	LITHOLOGY (ABR.)	CO3 %	VISUAL KEROGEN DESCRIPTION	TOC %	TSE KG/TN	S1 KG/TN	S2 KG/TN	HI KG/TN
5430	WE4207	CTG			SH			.11		.01	0.00	0
5460	WE4208	CTG			SH			.06		.04	.07	117
5490	WE4209	CTG			SH			.08		.01	0.00	0
5520	WE4210	CTG			SH			.12		.04	.08	67
5550	WE4211	CTG			SH			.03		0.00	0.00	0
5580	WE4212	CTG			SH			.06		.01	.01	17
5610	WE4213	CTG			SH			.04		0.00	0.00	0
5640	WE4214	CTG			SH			.02		0.00	0.00	0
5670	WE4215	CTG			SH			.04		.03	.06	150
5700	WE4216	CTG			SH			.04		0.00	.02	50
5730	WE4217	CTG			SH			.02		0.00	0.00	0
5750	WE4218	CTG			SH			.02		0.00	0.00	0
5780	WE4219	CTG			SH			.03		.02	.06	200
5810	WE4220	CTG			SH			.03		.04	.04	133
5840	WE4221	CTG			SH			.15		.09	.16	107
5870	WE4222	CTG			SH			.34		.08	.13	38
5900	WE4223	CTG			SH			.39		.08	.12	31
5930	WE4224	CTG			SH			.31		0.00	0.00	0
5960	WE4225	CTG			SH			.31		.03	.01	3
5990	WE4226	CTG			SH			.22		0.00	0.00	0
6020	WE4227	CTG			SH			.07		.02	.04	57
6050	WE4228	CTG			SH			.08		.02	.02	25
6080	WE4229	CTG			SH			.09		.04	.06	67
6110	WE4230	CTG			SH			.16		.02	0.00	0
6140	WE4231	CTG			SH			.18		.02	0.00	0
6170	WE4232	CTG			SH			.27		.02	0.00	0
6200	WE4233	CTG			SH			.31		.04	.07	23
6230	WE4234	CTG			SH			.26		.06	.09	35
6260	WE4286	CTG			SH			.16		.02	0.00	0
6290	WE4287	CTG			SH			.11		.04	.02	18
6320	WE4288	CTG			SH			.17		.07	.17	100
6350	WE4289	CTG			SH			.10		.05	.10	100
6380	WE4290	CTG			SH			.09		.06	.12	133
6410	WE4291	CTG			SH			.13		.04	.10	77
6440	WE4292	CTG			SH			.10		.02	.04	40
6470	WE4293	CTG			SH			.02		.01	.06	300
6500	WE4294	CTG			SH			0.00		0.00	.02	
6530	WE4295	CTG			SH			.01		.02	.08	800
6560	WE4296	CTG			SH			.22		.22	.11	50
6590	WE4297	CTG			SH			.13		.10	.15	115
6620	WE4298	CTG			SH			.78		.23	.32	41
6650	WE4299	CTG			SH			.26		.11	.11	42
6680	WE4300	CTG			SH			.19		.13	0.00	0
6710	WE4301	CTG			SH			.09		.07	0.00	0

DEPTH FT BRT	TR	GI (TSE)	GI (S1)	TSE /S1	K2 KG/TN	K2(G) KG/TN	K2(O) KG/TN	KPI KG/TN	GOGI	CPI	TAI	RO %	D-13C (K) -%.	D-13C (TSE) -%.	D-13C (KPY) -%.
5430	1.00		9												
5460	.36		67												
5490	1.00		12												
5520	.33		33												
5550			0												
5580	.50		17												
5610			0												
5640			0												
5670	.33		75												
5700	0.00		0												
5730			0												
5750			0												
5780	.25		67												
5810	.50		133												
5840	.36		60												
5870	.38		24												
5900	.40		21												
5930			0												
5960	.75		10												
5990			0									5.49			
6020	.33		29												
6050	.50		25												
6080	.40		44												
6110	1.00		12												
6140	1.00		11												
6170	1.00		7												
6200	.36		13												
6230	.40		23									4.88			
6260	1.00		12												
6290	.67		36												
6320	.29		41												
6350	.33		50												
6380	.33		67												
6410	.29		31												
6440	.33		20												
6470	.14		50												
6500	0.00														
6530	.20		200												
6560	.67		100												
6590	.40		77												
6620	.42		29												
6650	.50		42												
6680	1.00		68												
6710	1.00		78												