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Vitrinite reflectance suppression in the New Albany Shale, Illinois Basin--Vitrinite reflectance and Rock-Eval data

by

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VITRINITE REFLECTANCE SUPPRESSION IN THE NEW ALBANY SHALE, ILLINOIS BASIN--VITRINITE REFLECTANCE AND ROCK-EVAL DATA

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Modeling the thermal history of the Illinois basin, Illinois, Indiana, and Kentucky (Figure 1) showed that the measured vitrinite reflectance (R_O) of the Upper Devonian-Lower Mississippian New Albany Shale, the main source rock unit used to calibrate the models, was suppressed. That is, measured R_O values (tables 1 and 3) are lower (less mature) than vitrinite reflectance equivalents based on other thermal maturity indicators. Observations indicated that the degree of thermal maturity in R_O profiles (constructed by extrapolating from the Middle Pennsylvanian (Desmoinesian) Herrin coal through the Upper Devonian-Lower Mississippian New Albany Shale) does not always increase with increasing depth of burial. In fact, the R_O of the Middle Pennsylvanian Herrin coal is similar, and in some instances greater than that of the Upper Devonian-Lower Mississippian New Albany Shale, yet the New Albany is up to several thousand feet deeper. The purpose of this report is to present new R_O (table 3) and Rock-Eval data (table 1), and illustrate the amount of suppression of selected New Albany Shale samples. Two Rock-Eval parameters, T_{max} and hydrogen index, are compared with measured R_O data for several New Albany Shale samples from throughout the Illinois basin, and R_O correction contours for the New Albany Shale are estimated (table 1 and Figure 1).

Rock-Eval pyrolysis is used to evaluate rapidly, the petroleum generation potential of rocks, and it provides information on the quantity, type, and thermal maturity of the organic matter in a rock. Pyrolysis is the heating of organic matter in the absence of oxygen to yield organic compounds. Complete details of the Rock-Eval pyrolysis technique and associated problems are given in Espitalie and others (1977) and Peters (1986).

The Rock-Eval pyrolysis technique yields several measurements that determine the thermal maturity and hydrocarbon generation potential of source rocks. Total organic carbon content (TOC) is a useful parameter for evaluating the quantity of organic matter in a potential source rock. Total organic carbon was determined using the Rock-Eval II instrument and is the sum of the carbon in the pyrolyzate plus the carbon from the residual oxidized organic matter. In general (depending on the type of organic matter, and lithology), fine-grained rocks having a total organic carbon content of greater than 0.50 percent are considered a potential hydrocarbon source rock.

Rock-Eval pyrolysis also measures T_{max}, the temperature of maximum hydrocarbon yield. T_{max} can be used as a thermal maturity indicator because the temperature for maximum hydrocarbon yield increases as kerogen matures. Hydrocarbons begin to be generated between T_{max} values of 435°C and 440°C, and thermal cracking to gas and condensate occurs at about 460°C (Tissot and Welte, 1984).

The hydrogen index (HI) is defined as the S2 yield (remaining hydrogen-generating capability of the organic matter) normalized by the total organic carbon content (TOC); in other words, the fraction of the total organic carbon that is generated as hydrocarbons. The hydrogen index is also useful in describing the type of organic matter present in the source rock. The oxygen index (OI) is the quantity of carbon dioxide from the S3 peak (amount of carbon dioxide released by kerogen during pyrolysis) normalized by the total organic carbon content and, if plotted against the HI, yields information about the type of organic matter in the source rock.

Vitrinite reflectance (R_O) was also used to define levels of thermal maturity for the shale samples. Vitrinite, a maceral derived from woody plant material, is common in coal and organic-rich shale. Vitrinite reflectance is a measure of the proportion of light reflected from a polished

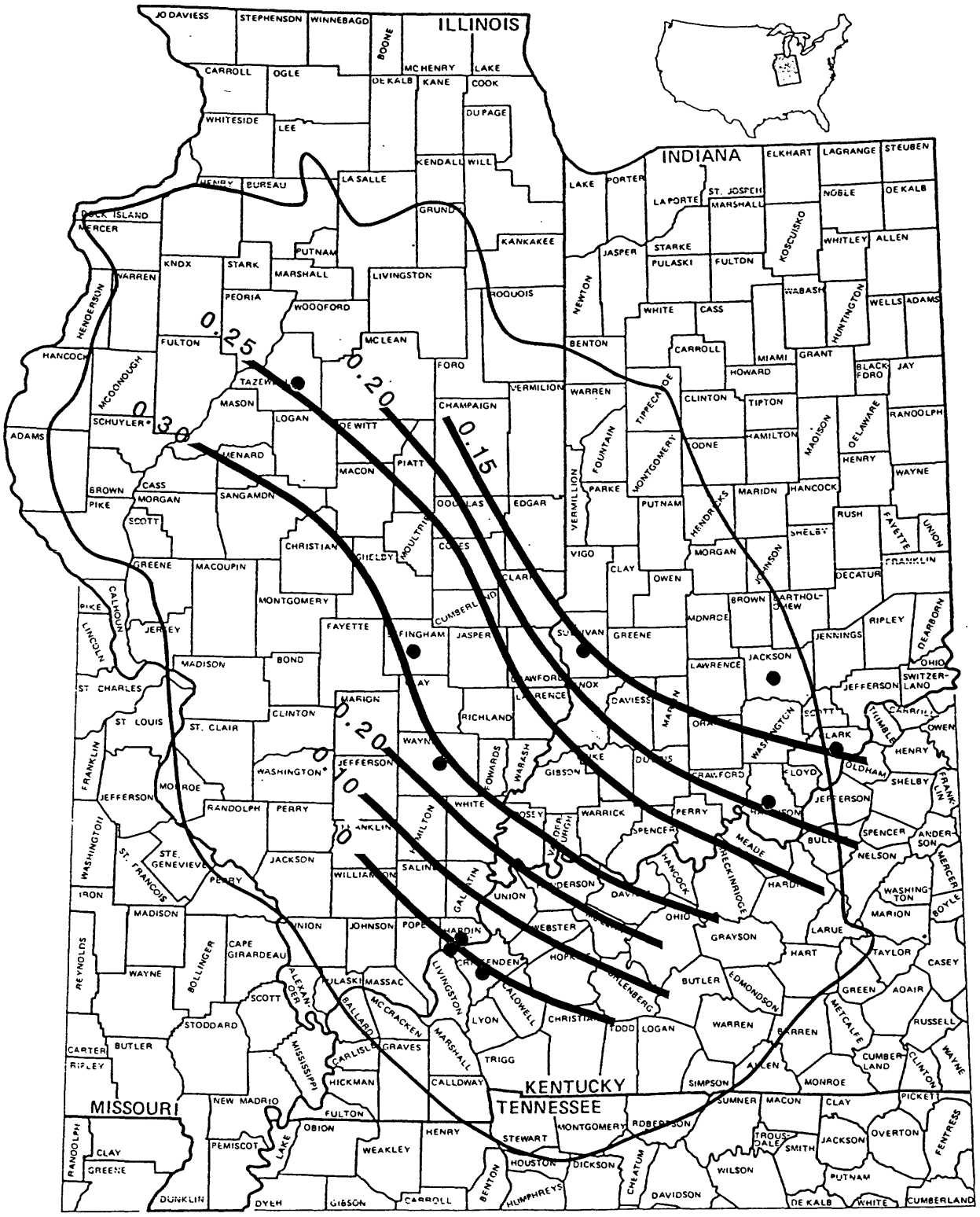

Figure 1.--Index map of the Illinois Basin, Illinois, Indiana, and Kentucky showing the location of samples. The estimated amounts of vitrinite reflectance suppression in the New Albany Shale are shown by contours. More precise sample locations are given in Table 2.

Table 1.-- Measured vitrinite reflectance (R_O), T_{max}, R_O equivalent (based on T_{max}) total organic carbon (TOC), hydrogen index (HI), and oxygen index (OI) data of the Upper Devonian-Lower Mississippian New Albany Shale from wells throughout the Illinois Basin. (---) indicates sample is organically lean or barren. Well name and location for each well is presented in Table 2. * indicates data from Hatch and others (1991). [T_{max}, Temperature at which maximum yield of hydrocarbons occurs during pyrolysis of organic matter (in degrees Celsius); TOC, Total organic carbon (in wt. %); HI, hydrogen Index (mg hydrocarbons/g TOC); OI, oxygen Index (mg CO_2/g TOC)]

Well name	Depth (ft)	R_O measured	T_{max} ° C	R_O equiv.	TOC wt.%	HI	OI
02Il *	3022	0.49	442	0.80	1.8	270	51
	3073	0.42	439	0.70	5.5	475	22
	3096	0.40	447	0.90	5.6	560	41
13Il *	5065	0.64	448	0.95	6.8	280	27
	5116	0.65	445	0.85	5.2	260	22
	5265	0.80	454	1.10	3.7	175	44
11Il *	84	1.14	456	1.15	4.3	120	8
	137	1.22	458	1.18	0.5	40	80
	198	1.33	453	1.10	3.4	65	11
06Il *	1029	0.36	434	0.60	1.3	210	30
	1079	0.41	438	0.66	2.6	320	48
	1129	0.36	436	0.61	1.6	420	26
IN-2 *	145	0.35	428	0.50	9.3	420	30
	195	0.42	434	0.60	3.1	425	49
	237	0.38	432	0.55	6.8	500	37

Table 1. (cont.).

Well name	Depth (ft)	R_o measured	T_{max} ° C	R_o equiv.	TOC wt.%	HI	OI
SDH308	239.6	0.49	429	0.50	10.8	570	3
Edward	273.2	0.41	438	0.66	5.8	770	11
Knear	315.0	0.49	437	0.65	4.0	655	21
SDH305	76.80	---	---	---	---	---	---
Thelma	92.75	0.56	430	0.50	16.0	620	10
Nehrt	165.50	0.36	431	0.53	2.50	785	34
	203.50	0.43	434	0.60	4.40	680	30
Sheridan	1310.40	1.48	440	0.70	0.80	140	24
Target	1396.40	1.42	449	1.0	5.90	120	1
C-174	1509.60	1.40	452	1.03	5.00	110	3
	1611.40	---	---	---	---	---	---
#1 Pheghly	2509.60	0.54	440	0.70	6.70	450	7
Farms	2586.50	---	---	---	---	---	---
	2590.10	---	---	---	---	---	---
	2622.90	0.52	439	0.70	3.10	490	12
Rose	96.85	1.47	457	1.18	9.60	80	1
Mineral	133.60	1.51	456	1.17	5.40	55	4
Expl.	146.92	---	---	---	---	---	---

Table 2.--Name and location of wells used in this study. Well names correspond to those in Table 1.

Well name	State	County	Location
02Il	Illinois	Effingham	SW, NW, Sec. 31, T. 9 N., R. 4 E.
13Il	Illinois	Wayne	SE, SW, Sec. 17, T. 3 S., R. 8 E.
11Il	Illinois	Hardin	NE, NE, Sec. 36 T. 11 S., R. 7 E.
06Il	Illinois	Tazewell	NE, NW, Sec.8, T. 23 N., R. 2 W.
IN-2	Indiana	Clark	2210'NWL, 1330'SW, Gr. 283, T. 2 N., R. 7 E.
SDH 308 Edward Knear IGS	Indiana	Harrison	SE, NE, NW, Sec. 3, T. 6 S., R. 5 E.
SDH 305 Thelma Nehrt IGS	Indiana	Jackson	NE, SE, SW, Sec. 9 T. 4 N., R. 6 E.
Sheridan Target, C-174	Kentucky=	Crittenden	20-K-16, 1250' FSL, 3100' FEL
#1 Pheghly Farms (01IN) EGS	Indiana	Sullivan	NW, NW, NE, Sec. 14 T. 6 N., R. 10 W.
Rose Mineral Exploration	Illinois	Hardin	SW, SW, Sec. 29, T. 11 S., R. 8 E.

Table 3.--Vitrinite reflectance data. Each data sheet represents the mean random vitrinite reflectance data for an individual sample. The File Name is the project name. The Channel Name is the name of the analyst, and Comments 1 through 6 contain information regarding the quality of the sample. For each sample several vitrinite grains were measured. These are listed on the data sheet in the Pt. column, and correspond to the values in the Meas 1 column. The minimum reading (Min), maximum reading (Max), mean value of all readings (Mean), and standard deviation (StDev) are given. The Mean is the measured R_O value for the sample, and is the value given in Table 1.

File Name: ILLINB
Channel Name: Nuccio
Description: Sheridan Target C174 1310-1310.4
  Comment 1: Vitrinite scarce A few good grains
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.31			
Max:	1.69			
Mean:	1.48			
StDev:	0.18			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.31			
2				1.32			
3				1.69			
4				1.65			
5				1.44			
6							

File Name: ILLINB
Channel Name: Nuccio
Description: Sheridan Target C174 1396-1396.4
  Comment 1: Vitrinite scarce A few good grains
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.23			
Max:	1.60			
Mean:	1.42			
StDev:	0.13			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.38			
2				1.46			
3				1.60			
4				1.23			
5				1.42			
6							

File Name: ILLINB
Channel Name: Nuccio
Description: Sheridan Target C174 1509-1509.6
  Comment 1: Poor sample, grains small and few
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.24			
Max:	1.70			
Mean:	1.40			
StDev:	0.21			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.39			
2				1.70			
3				1.24			
4				1.25			

File Name: ILLINB
Channel Name: Nuccio
Description: Pheghly Farms #1 2509.6
  Comment 1: Pretty good sample. Some nice material
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.36			
Max:	0.74			
Mean:	0.54			
StDev:	0.11			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.36			
2				0.53			
3				0.49			
4				0.51			
5				0.50			
6				0.49			
7				0.69			
8				0.74			
9				0.56			
10				0.51			
11				0.69			
12				0.48			
13				0.44			
14				0.46			
15				0.45			
16				0.67			

File Name: ILLINB
Channel Name: Nuccio
Description: Pheghly Farms #1 2622.9
  Comment 1: Pretty good sample. Some nice material
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.41			
Max:	0.73			
Mean:	0.52			
StDev:	0.09			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.42			
2				0.48			
3				0.58			
4				0.57			
5				0.41			
6				0.51			
7				0.54			
8				0.52			
9				0.49			
10				0.49			
11				0.73			
12				0.65			
13				0.45			
14				0.52			
15				0.46			

File Name: ILLINB
Channel Name: Nuccio
Description: 96.24-96.85 Rose Mineral Exploration
Comment 1: Good sample. Material abundant and large
Comment 2:
Comment 3:
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.23			
Max:	1.78			
Mean:	1.47			
StDev:	0.15			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.54			
2				1.62			
3				1.61			
4				1.23			
5				1.41			
6				1.78			
7				1.61			
8				1.48			
9				1.49			
10				1.32			
11				1.43			
12				1.31			
13				1.63			
14				1.26			
15				1.49			
16				1.42			
17				1.32			
18				1.56			
19				1.32			
20				1.68			
21				1.28			
22				1.41			
23				1.69			
24				1.33			
25				1.33			
26				1.46			
27				1.59			
28				1.75			
29				1.42			

File Name: ILLINB
Channel Name: Nuccio
Description: 133-133.6 Rose Mineral Exploration
  Comment 1: Pretty good sample. Some nice material
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.20			
Max:	1.72			
Mean:	1.51			
StDev:	0.15			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.20			
2				1.63			
3				1.64			
4				1.70			
5				1.53			
6				1.40			
7				1.72			
8				1.47			
9				1.49			
10				1.42			
11				1.46			

File Name: EF3022
Channel Name: nuccio
Description: Effingham, 3022.2
  Comment 1: Vitrinite scarce. Quite a bit of very small recycled OM
  Comment 2: Some low reading amorphous material Ro= .10-.20
  Comment 3: The grains measured were fairly small.
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.35			
Max:	0.67			
Mean:	0.49			
StDev:	0.10			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.55			
2				0.43			
3				0.44			
4				0.48			
5				0.67			
6				0.45			
7				0.41			
8				0.38			
9				0.35			
10				0.57			
11				0.62			
12							

File Name: EF3073
Channel Name: nuccio
Description: Effingham, 3073.2
Comment 1: Vitrinite scarce. Quite a bit of very small recycled OM
Comment 2: Abundant whispy low reading amorphous material Ro= .10-.2
Comment 3: The grains measured were relatively large.
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.35			
Max:	0.47			
Mean:	0.42			
StDev:	0.04			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.43			
2				0.46			
3				0.35			
4				0.46			
5				0.40			
6				0.41			
7				0.43			
8				0.47			
9				0.45			
10				0.35			
11				0.38			
12				0.45			
13				0.45			
14				0.36			
15				0.45			
16				0.44			
17				0.41			

File Name: EF3096
Channel Name: nuccio
Description: Effingham, 3096.2
Comment 1: Vitrinite scarce. Recycled OM very scarce.
Comment 2: Abundant whispy low reading amorphous material Ro= .10-.2
Comment 3: The grains measured were relatively large.
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.32			
Max:	0.59			
Mean:	0.40			
StDev:	0.08			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.35			
2				0.34			
3				0.48			
4				0.39			
5				0.41			
6				0.38			
7				0.35			
8				0.48			
9				0.36			
10				0.33			
11				0.32			
12				0.59			

File Name: WN5065
Channel Name: nuccio
Description: Wayne, 5065.77
  Comment 1: Vitrinite scarce. Recycled OM abundant
  Comment 2: Abundant whispy low reading amorphous material Ro= .10-.2
  Comment 3: The grains measured were relatively large.
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.50			
Max:	0.87			
Mean:	0.64			
StDev:	0.13			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.60			
2				0.57			
3				0.80			
4				0.59			
5				0.51			
6				0.58			
7				0.51			
8				0.72			
9				0.76			
10				0.85			
11				0.51			
12				0.64			
13				0.87			
14				0.50			
15				0.58			

File Name: WN5116
Channel Name: nuccio
Description: Wayne, 5116.28
  Comment 1: Vitrinite scarce. Recycled OM very scarce.
  Comment 2: Abundant whispy low reading amorphous material Ro= .10-.2
  Comment 3: The grains measured were relatively large.
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.51			
Max:	0.87			
Mean:	0.65			
StDev:	0.11			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.68			
2				0.64			
3				0.87			
4				0.87			
5				0.60			
6				0.62			
7				0.86			
8				0.65			
9				0.53			
10				0.51			
11				0.52			
12				0.60			
13				0.61			
14				0.57			
15				0.56			
16				0.75			
17				0.71			
18				0.55			
19				0.63			
20				0.66			

File Name: WN5265
Channel Name: nuccio
Description: Wayne, 5265.41
Comment 1: Vitrinite scarce. Some recycled material.
Comment 2: Abundant whispy low reading amorphous material Ro= .10-.2
Comment 3: The grains measured were relatively large.
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.75			
Max:	0.94			
Mean:	0.80			
StDev:	0.08			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.78			
2				0.75			
3				0.78			
4				0.94			
5				0.76			

File Name: HR84
Channel Name: nuccio
Description: Hardin, 84.0
Comment 1: Vitrinite scarce. Some recycled material.
Comment 2: Abundant whispy low reading amorphous material high Rm
Comment 3: The grains measured were relatively large.
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.91			
Max:	1.42			
Mean:	1.14			
StDev:	0.17			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.06			
2				0.98			
3				1.23			
4				1.06			
5				1.03			
6				1.09			
7				1.23			
8				1.42			
9				1.37			
10				0.91			
11				0.95			
12				1.15			
13				1.12			
14				1.41			

File Name: HR137
Channel Name: nuccio
Description: Hardin, 137.0
  Comment 1: Vitrinite scarce.
  Comment 2: Abundant whispy low reading amorphous material high Rm
  Comment 3: The grains measured were relatively large.
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.01			
Max:	1.39			
Mean:	1.22			
StDev:	0.16			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.01			
2				1.12			
3				1.33			
4				1.39			
5				1.26			

File Name: HR198
Channel Name: nuccio
Description: Hardin, 198.0
Comment 1: Vitrinite scarce.
Comment 2: Abundant whispy reading amorphous material high Rm
Comment 3: The grains measured were relatively large.
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	1.11			
Max:	1.51			
Mean:	1.33			
StDev:	0.10			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				1.30			
2				1.28			
3				1.36			
4				1.23			
5				1.39			
6				1.26			
7				1.51			
8				1.48			
9				1.35			
10				1.37			
11				1.29			
12				1.11			
13				1.30			
14				1.39			

Description: Tazwell, 1029.5
Comment 1: Vitrinite scarce. Quite a bit of recycled OM
Comment 2: Some very low reading amorphous material Ro= .10-.20
Comment 3: The grains measured were fairly good and relatively
Comment 4: large.
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.30			
Max:	0.47			
Mean:	0.36			
StDev:	0.05			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.34			
2				0.36			
3				0.30			
4				0.38			
5				0.38			
6				0.43			
7				0.47			
8				0.33			
9				0.35			
10				0.30			
11				0.31			
12				0.35			
13				0.35			

File Name: TZ1079
Channel Name: nuccio
Description: Tazwell, 1079.4
Comment 1: Vitrinite scarce. Quite a bit of very small recycled OM
Comment 2: Quite a lot of low reading amorphous material Ro= .10-.20
Comment 3: The grains measured were fairly good and relatively
Comment 4: large.
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.34			
Max:	0.53			
Mean:	0.41			
StDev:	0.06			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.36			
2				0.37			
3				0.37			
4				0.41			
5				0.52			
6				0.34			
7				0.43			
8				0.45			
9				0.34			
10				0.53			
11				0.38			
12				0.42			

File Name: TZ1129
Channel Name: nuccio
Description: Tazwell, 1129.4
Comment 1: Vitrinite scarce. Quite a bit of very small recycled OM
Comment 2: Quite a lot of low reading amorphous material Ro= .10-.20
Comment 3: The grains measured were fairly good and relatively
Comment 4: large.
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.29			
Max:	0.46			
Mean:	0.36			
StDev:	0.05			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.33			
2				0.33			
3				0.33			
4				0.29			
5				0.33			
6				0.39			
7				0.39			
8				0.45			
9				0.33			
10				0.32			
11				0.46			
12				0.36			
13							

File Name: CL145
Channel Name: nuccio
Description: Clark, 145.0
  Comment 1: Vitrinite scarce but good quality and large
  Comment 2: Some very low reading whispy amorphous material
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.30			
Max:	0.44			
Mean:	0.35			
StDev:	0.04			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.31			
2				0.37			
3				0.35			
4				0.37			
5				0.30			
6				0.34			
7				0.33			
8				0.33			
9				0.40			
10				0.40			
11				0.44			
12				0.39			
13				0.31			
14				0.31			
15				0.33			
16				0.31			
17				0.32			

File Name: CL195
Channel Name: nuccio
Description: Clark, 195.0
  Comment 1: Vitrinite scarce but good quality and large
  Comment 2: Some very low reading whispy amorphous material
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.28			
Max:	0.52			
Mean:	0.42			
StDev:	0.08			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.40			
2				0.28			
3				0.50			
4				0.40			
5				0.42			
6				0.41			
7				0.49			
8				0.37			
9				0.52			
10				0.51			
11				0.51			
12				0.42			
13				0.34			
14				0.44			
15				0.32			
16				0.52			
17				0.32			
18				0.39			
19				0.35			

File Name: CL237
Channel Name: nuccio
Description: Clark, 237
  Comment 1: Vitrinite scarce but good quality and large
  Comment 2: Some very low reading whispy amorphous material
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.28			
Max:	0.46			
Mean:	0.38			
StDev:	0.05			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.38			
2				0.37			
3				0.41			
4				0.43			
5				0.39			
6				0.41			
7				0.39			
8				0.28			
9				0.46			
10				0.43			
11				0.38			
12				0.32			
13				0.36			
14				0.36			
15				0.29			

File Name: ILLINB
Channel Name: Nuccio
Description: SDH308 Edward Knear 314.62-315
  Comment 1: The best sample in this well
  Comment 2: Some good fairly large grains
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.36			
Max:	0.66			
Mean:	0.49			
StDev:	0.08			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.47			
2				0.43			
3				0.44			
4				0.45			
5				0.56			
6				0.38			
7				0.52			
8				0.64			
9				0.58			
10				0.53			
11				0.44			
12				0.46			
13				0.46			
14				0.41			
15				0.40			
16				0.54			
17				0.36			
18				0.66			
19				0.51			

File Name: ILLINB
Channel Name: Nuccio
Description: SDH308 Edward Knear 238.3-238.6
Comment 1: A good sample. Material abundant and large.
Comment 2: Whole Rock
Comment 3:
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.40			
Max:	0.59			
Mean:	0.49			
StDev:	0.05			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.56			
2				0.49			
3				0.43			
4				0.59			
5				0.40			
6				0.45			
7				0.47			
8				0.51			
9				0.48			
10				0.52			
11				0.45			
12				0.42			
13				0.50			
14				0.51			
15				0.54			
16				0.45			
17				0.52			
18				0.54			
19				0.57			
20				0.46			

File Name: ILLINB
Channel Name: Nuccio
Description: SDH308 Edward Knear 272.8-273.2
  Comment 1: Some good material
  Comment 2:
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.34			
Max:	0.45			
Mean:	0.41			
StDev:	0.04			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.45			
2				0.45			
3				0.34			
4				0.39			
5				0.39			
6				0.41			
7				0.39			
8				0.43			

File Name: ILLINB
Channel Name: Nuccio
Description: SDH305 Thelma Nehrt 92.3-92.75
  Comment 1: Lots of recycled and fusinite grains
  Comment 2: A few low reading vitrinite grains
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.41			
Max:	0.80			
Mean:	0.56			
StDev:	0.13			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.61			
2				0.51			
3				0.47			
4				0.80			
5				0.52			
6				0.71			
7				0.48			
8				0.41			

File Name: ILLINB
Channel Name: Nuccio
Description: SDH305 Thelma Nehrt 165.15-165.5
  Comment 1: Poor sample, some material but too small to read.
  Comment 2: A few low reading vitrinite grains
  Comment 3:
  Comment 4:
  Comment 5:
  Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.33			
Max:	0.39			
Mean:	0.36			
StDev:	0.03			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.37			
2				0.37			
3				0.33			
4				0.39			

File Name: ILLINB
Channel Name: Nuccio
Description: SDH305 Thelma Nehrt 203.1-203.5
Comment 1: The best sample in this well
Comment 2: Some good fairly large grains
Comment 3:
Comment 4:
Comment 5:
Comment 6:

	Meas1	Meas2	Ratio	Conc.
Min:	0.36			
Max:	0.53			
Mean:	0.43			
StDev:	0.05			

Pt.	X-Pos	Y-Pos	Z-Pos	Meas1	Meas2	Ratio	Conc.
1				0.44			
2				0.50			
3				0.40			
4				0.53			
5				0.45			
6				0.41			
7				0.41			
8				0.46			
9				0.42			
10				0.36			
11				0.42			
12				0.39			

vitrinite grain. It is related to the degree of metamorphism of the vitrinite grain and can be related to other thermal maturity indicators. The samples were prepared by concentrating the kerogen from the shale, mounting in epoxy, planing off when hardened, and polishing. The mean random vitrinite reflectance (from randomly oriented indigenous vitrinite grains) was determined using plane-polarized incident white light and a 546-nm monochromatic filter, in immersion oil, on a reflected light microscope with a nonrotating stage (Bostick, 1979; Bustin, 1986).

Vitrinite reflectance values have been correlated with oil and gas generation for potential source rocks (Dow, 1977; Waples, 1985). For example, Waples (1985) stated that depending on the type of kerogen oil generation begins over a range of R_O values; onset of oil generation ranges from about 0.45 percent R_O to 0.50 percent R_O for high-sulfur kerogen, to 0.60 percent R_O for marine kerogen, to 0.65 percent R_O for terrestrial kerogen. The end of oil generation also occurs over a range of vitrinite reflectance values, but 1.35 percent R_O is commonly accepted as the value at which oil begins to break down into shorter chain hydrocarbons. Dow (1977) stated that oil generation by liptinitic-rich source rocks occurs between 0.50 and 1.35 percent R_O. Wet gas is generated from mixed lacustrine-marine-terrestrial organic matter and from the thermal cracking of oil between R_O values of 0.80 and 2.0 percent. Thermogenic methane is generated from humic organic matter and from the breakdown of wet gas between R_O values of about 1.0 percent and 3.0 percent. Biogenic gas can be generated at levels of maturity as low as those for peat (0.20 percent R_O).

The level of vitrinite reflectance suppression for the New Albany Shale is variable throughout the basin, depending on the quality of the organic matter and level of maturation (Nuccio, 1994). For example, measured R_O values are consistently lower than R_O equivalents based on T_{max} up to a T_{max} of approximately 455°C, at which point measured R_O and R_O equivalents based on T_{max} seem to converge. A plot of hydrogen index versus R_O (Figure 2) for New Albany Shale samples shows little change in R_O until hydrogen indicies are <300 mg/g. This relation suggests that the high hydrogen contents of the New Albany are contributing to the vitrinite suppression. Figure 1 shows the location of samples and the estimated amount of vitrinite suppression by contours, throughout the basin.

Identifying vitrinite reflectance suppression in the New Albany Shale in the Illinois basin has some important consequences when determining the basin's maximum temperature and potential for petroleum generation. The corrected R_O values indicate that the New Albany was mature enough to generate oil over a larger area in the Illinois basin than previously thought. Oil found in the central to northern part of the basin may have been generated in place, and not necessarily deposited by long-range migration from the southern part of the basin as has been thought.

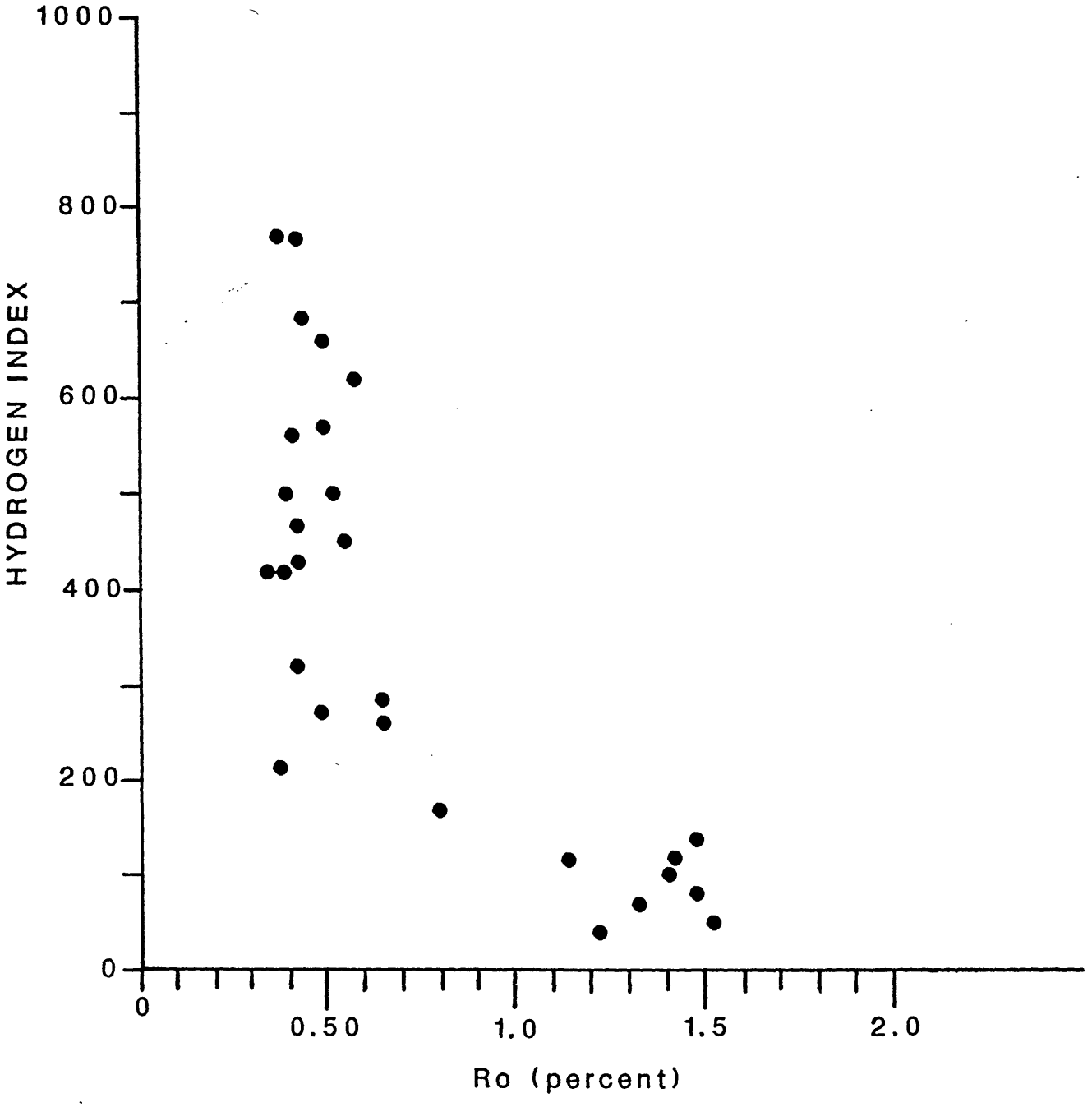

Figure 2.--Plot of hydrogen index (HI) versus measured vitrinite reflectance (R_O) of New Albany Shale samples. The data suggest that the high hydrogen content of the New Albany Shale is contributing to the vitrinite reflectance suppression. Data points correspond to those in Table 1.

REFERENCES

Bostick, N.H., 1979, Microscopic measurements of the level of catagenesis of solid organic matter in sedimentary rocks to aid in exploration for petroleum and to determine former burial temperatures--A review, *in* Scholle, P.A., and Schluger, P.R., eds., Aspects of diagenesis: Society of Economic Paleontologists and Mineralogists Special Publication 26, p. 17-43.

Bustin, R.M., 1986, Organic maturity of Late Cretaceous and Tertiary coal measures, Canadian Arctic Archipelago: International Journal of Coal Geology, v. 6, p. 71-106.

Dow, W.G., 1977, Kerogen studies and geological interpretations: Journal of Geochemical Exploration, v. 7, p. 79-99.

Espitalie, J., Laporte, J.L., Madec, M., Marquis, F., Leplat, P., Paulet, J., and Boutefeu, A., 1977, Rapid method for source rock characterization and for evaluating their petroleum potential and their degree of evolution: Institut Francais du Petrole, v. 32, p. 23-42.

Hatch, J.R., Risatti, J.B., and King, J.D., 1991, Geochemistry of Illinois basin oils and hydrocarbon source rocks, *in* Leighton, M.W., Kolata, D.R., Oltz, D.F., and Eidel, J.J., eds., Interior Cratonic Basins: American Association of Petroleum Geologists Memoir 51, Chapter 24, p. 403-423.

Nuccio, V.F., 1994, Thermal history modeling in the Illinois Basin: *in* Proceedings of the Illinois Basin Energy and Mineral Resources Workshop, September 12-13, 1994, Evansville, Indiana, p. 28-29.

Peters, K.E., 1986, Guidelines for evaluating petroleum source rock using programmed pyrolysis: American Association of Petroleum Geologists Bulletin, v. 70, p. 318-329.

Tissot, B.P., and Welte, D.H., 1984, Petroleum formation and occurrence, (2nd ed.): Berlin, Springer-Verlag, 699 p.

Waples, D.W., 1985, Geochemistry in petroleum exploration: Boston, International Human Resources Development Corporation, 232 p.