UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Organic Geochemical Analyses for 247 Organic-rich-rock and 11 Oil Samples from the Middle Pennsylvanian Cherokee and Marmaton Groups, southeastern Iowa, Missouri, southeastern Kansas, and northeastern Oklahoma

By

Joseph R. Hatch, Ted A. Daws, Sister Carlos M. Lubeck, Mark J. Pawlewicz, Charles N. Threlkeld and April K. Vuletich[1]

Open-File Report 84-160

[1] Denver, Colorado 80225

1984

CONTENTS

ILLUSTRATIONS

Organic Geochemical Analyses for 247 Organic-rich-rock and 11 Oil Samples from the Middle Pennsylvanian Cherokee and Marmaton Groups, southeastern Iowa, Missouri, southeastern Kansas, and northeastern Oklahoma

By

Joseph R. Hatch, Ted A. Daws, Sister Carlos M. Lubeck, Mark J. Pawlewicz, Charles N. Threlkeld and April K. Vuletich

INTRODUCTION

This report presents descriptions and compilations of organic geochemical data for 247 rock and 11 oil samples collected from the Middle Pennsylvanian Cherokee and Marmaton Groups, from 21 locations in southeastern Iowa, Missouri, southeastern Kansas and northeastern Oklahoma. Figure 1 is an index map showing the outcrop-subcrop area of the Middle Pennsylvanian rocks in the midcontinent, major structural features and sampled locations. Rocks from the Cherokee and Marmaton Groups are a complex mixture of coal cyclothem lithologies which record deposition in marine, transitional marine, and nonmarine environments. These samples were collected to document organic geochemical variability and to determine which, or if any, of the various Middle Pennsylvanian lithologies are probable source rocks for the Cherokee oils.

METHODS

Organic carbon determinations are used to characterize the amount of organic matter; Rock-Eval pyrolysis, organic-carbon isotope analyses, and extractable organic matter (EOM) compositions are used to characterize variation in organic-matter type; vitrinite reflectance and Rock-Eval pyrolysis (T_{max}, S_2 peak) are used to characterize the organic matter thermal maturity.

Organic carbon was determined by a wet oxidation method slightly modified from Bush (1970).

Pyrolysis assay was by Rock-Eval 1 using the instrument (Girdel) and methods of Espitalié and others (1977). This method measures contents of volatile hydrocarbons (S_1, mgHC/g rock) pyrolytic hydrocarbons (S_2, mgHC/g rock) and pyrolytic carbon dioxide (S_3, mgCO_2/g rock) and the temperature of maximum hydrocarbon generation (S_2 peak) during pyrolysis (T_{max}). S_1, S_2, S_3, and organic carbon are combined mathematically in the form of various indicies used for hydrocarbon source rock evaluation. These indicies include the genetic potential ($S_1 + S_2$, mgHC/g rock), hydrogen index (HI, S_2/org. C, in mg HC/g org. C), oxygen index (OI, S_3/org. C, in mg CO_2/g org. C), volatile hydrocarbon yield (S_1/org. C, in mgHC/g org. C) and the production index (S_1/S_1+S_2).

Procedures used for measuring vitrinite reflectance (R_o, oil immersion, random orientation) are described in Bostick and Alpern (1977).

Organic carbon $^{13}C/^{12}C$ ratios were determined by standard techniques. An oven-dried (40°C) powdered sample was reacted with 2N HCl to dissolve carbonate. The residue was centrifuged, decanted, washed three times, dried and combusted in oxygen in an apparatus similar to that described by Kaplan, Smith and Ruth, (1970). The resulting CO_2 was purified and isotope ratios were determined with a 6-inch Nier-type double-collecting mass spectrometer equipped with a dual inlet system. Results are reported in the usual δ notation relative to the PDB marine-carbonate standard.

Pulverized samples (<100 mesh) were extracted with chloroform ($CHCl_3$) in a Soxhlet apparatus for 20 to 24 hours to determine the extractable organic matter (EOM) content. Sulfur was removed from the EOM by refluxing with polished copper metal. The filtered EOM, or an aliquot, was evaporated at room temperature under nitrogen to an arbitrarily defined solvent-free point and the weight of the total extract used to calculate the EOM concentration. The EOM isolated was diluted with N-heptane to precipitate the asphaltenes. A concentrate of the solution was separated by column chromatography on silica gel, eluting successively with heptane, benzene and benzene-methanol to collect the saturated hydrocarbons, aromatic hydrocarbons and resin (NSO) fractions, respectively.

The saturated hydrocarbon fractions were analyzed further by gas chromatography on a SE54 bonded phase WCOT column, 30 m x 0.36 mm I.D. temperature programmed from 80 to 300°C at 8°C per minute. Identifications of peaks on the resultant chromatograms were based on relative retention times. Measurements of peak heights above baseline were used to calculate pristane/phytane.

EXPLANATION OF TABLES

Descriptive information for the 247 rock and 11 oil samples and results of the organic geochemical analyses are listed in Tables 1 through 7. Table 1 lists sample numbers, lithologies, locations, sample types and depth interval or thickness for the 247 rock samples. Table 2 lists sample numbers, field names, locations, producing horizon and approximate production depth for 11 oil samples produced from the Middle Pennsylvanian section in southeastern Kansas and northeastern Oklahoma. Table 3 lists organic carbon and Rock-Eval pyrolysis analyses on the rock samples; Table 4 lists vitrinite reflectance for 19 coal samples; Table 5 lists organic carbon $\delta^{13}C$ for 38 samples; Table 6 lists data on the amounts and composition (saturated HC, aromatic HC, resin, asphaltene, saturated HC+ aromatic HC/bitumen, saturated HC/aromatic HC, and pristane/phytane) for the extractable organic matter for 77 rock samples, and Table 7 lists $\delta^{13}C$ of saturated HC and aromatic HC fractions from 18 rock extracts and 6 oil samples.

REFERENCES CITED

Bostick, N. A. and Alpern, B., 1977, Principles of sampling, preparation and constituent selection for microphotometry in measurement of maturation of sedimentary organic matter: Journal of Microscopy, v. 109, pt. 1, p. 41-47.

Bush, P. R., 1970, A rapid method for determination of carbonate carbon and organic carbon: Chemical Geology, v. 6, p. 59-62.

Espitalié, J., Laporte, J. L., Madec, M., Marquis, F., Leplat, P., Paulet, J., and Boutefeu, A., 1977, Méthode rapid de caractérisation des roches méres de leur potentiel pétrolier et de leur degre d'evolution: Revue de I'Inst. Francais de Pétrole, v. 32, n. 1, p. 23-42.

Heckel, P. H., 1977, Origin of phosphatic black shale facies in Pennsylvanian cyclothems of mid-continent North America: American Association of Petroleum Geoloigists Bulletin, v. 61, no. 7, p. 1045-1068.

Kaplan, I. R., Smith, J. W., and Ruth, E., 1970, Carbon and sulfur concentration and isotopic composition in Apollo 11 lunar samples (Proceedings Apollo 11 lunar scientific conferences): Geochimica et Cosmochimica Acta, Supp. 2, p. 1317-1329.

King, P. B., Beckman, H. M., and Edmonston, G. J., 1974, Geologic Map of the United States: U.S. Geological Survey Map, 1:2,500,000.

Vlissides, S. D., and Quirin, B. A., 1964, Oil and gas fields of the United States: U.S. Geological Survey Map, 1:2,500.000

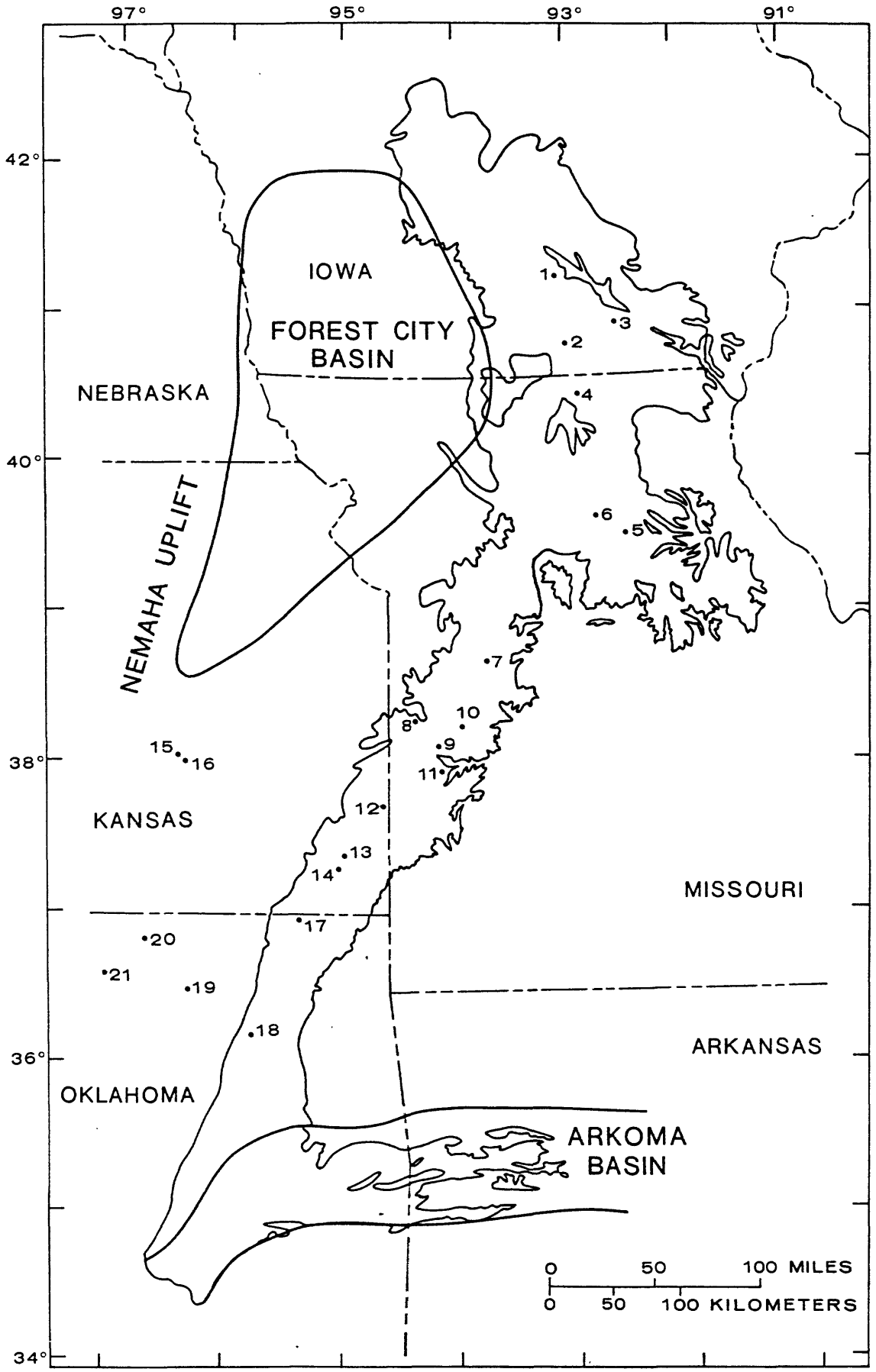

Figure 1. Index map of the midcontinent region shows the outcrop-subcrop of Middle Pennsylvanian rocks, major structural features, and sample locations. Modified from King and others (1974) and Vlissides and Quirin (1964).

Table 1.--Sample numbers, lithologies, locations, sample types and depth intervals or thickness for 247 rock samples from the Middle Pennsylvanian Cherokee and Marmaton Groups, southeastern Iowa, Missouri, southeastern Kansas, and northeastern Oklahoma

[--, no data; facies nomenclature is from Heckel, 1977, one foot = 0.3048 m.]

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
41-1	Clay shale, N2, phosphatic	Offshore shale	SE 1/4, SW 1/4, sec. 36, T. 75 N., R. 20 W., Marion County, Iowa	1	Core	35.2-36.4	D226878	Excello shale
41-2	Coal, N1, minor pyrite	Nearshore shale	----------do----------	1	---do---	41.9-42.3	--	Mulky coal
41-5	------do------	---do---	----------do----------	1	---do---	69.7-70.5	--	Bever coal
41-8	------do------	---do---	----------do----------	1	---do---	92.3-93.6	--	Wheeler coal
41-13ac	Limestone	Regressive limestone	----------do----------	1	---do---	109.7-110.2+ 111.0-111.5	D226826	
41-13f	Shale, N2, pyritic, calcareous	Nearshore shale	----------do----------	1	---do---	114.7-118.6	D226879	
41-13g	Limestone	Regressive limestone	----------do----------	1	---do---	118.6-119.0	D226827	
41-17	Shale, N1, phosphatic	Offshore shale	----------do----------	1	---do---	119.0-120.9	D226880	Swede Hollow shale (Verdigris shale)
41-18	Coal, N1, minor pyrite	Nearshore shale	----------do----------	1	---do---	120.9-121.9	--	Whitebreast coal (Croweburg coal)
41-23	Shale, N3-N2, ironstone and pyrite	---do---	----------do----------	1	---do---	162.1-162.9	--	
41-24	Coal, N1, pyritic	---do---	----------do----------	1	---do---	162.9-164.5	--	
41-26	Limestone	Regressive limestone	----------do----------	1	---do---	170.1-171.6	D226828	
41-28	------do------	---do---	----------do----------	1	---do---	174.0-175.1	D226829	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
41-31	Shale, N3-N2, phosphatic	Offshore shale	----------do----------	1	---do---	187.6-188.1	D226881	"Seahorne" shale
41-32	Coal, N1, minor pyrite	Nearshore shale	----------do----------	1	---do---	188.1-188.9	--	Tebo coal
41-37a	Shale, N3,	---do---	----------do----------	1	---do---	207.7-209.7	D226882	
41-37b	Shale, N3-N2,	---do---	----------do----------	1	---do---	209.7-211.7	D226883	
41-38	Coal, N1, pyritic	---do---	----------do----------	1	---do---	211.7-212.5	--	
41-46	Shale, N2-N1, pyrite	---do---	----------do----------	1	---do---	231.7-233.5	--	
41-48	Coal, N1, minor pyrite	---do---	----------do----------	1	---do---	277.5-281.7	D192369	
41-51	Coal, N1, pyritic	---do---	----------do----------	1	---do---	297.0-299.3	D192370	
41-53	Shale, N2,	---do---	----------do----------	1	---do---	312.5-316.0	D226884	
41-58	Coal N1, pyritic	---do---	----------do----------	1	---do---	332.2-332.8	D211717	
41-60	------do------	---do---	----------do----------	1	---do---	346.1-347.1	D211718	
41-66	Shale, N2, iron stone and pyrite nodules	---do---	----------do----------	1	---do---	370.2-373.3	D226885	
41-70	Shale, N2	---do---	----------do----------	1	---do---	469.0-495.0	D226886	
22-6c	Limestone	Regressive limestone	SW 1/4, SE 1/4, sec. 36, T. 70 N., R. 19 W., Appanoose County, Iowa	2	Core	134.6-136.6	D226823	
22-6d	Shale N2, phosphatic	Offshore shale	----------do----------	2	---do---	137.1-138.1	D226871	Anna shale

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
22-7	Coal, N1, minor pyrite	Nearshore shale	----------do----------	2	---do---	138.6-141.0	D192373	Mystic coal (Lexington coal)
22-9	Limestone	Regressive limestone	----------do----------	2	---do---	142.5-146.8	D226824	
22-11	Shale, N2, phosphatic	Offshore shale	----------do----------	2	---do---	163.2-165.2	D226872	Little Osage shale
22-14	Shale, N2, phosphatic	---do---	----------do----------	2	---do---	185.2-187.8	D226873	Excello shale
22-17	Coal	Nearshore shale	----------do----------	2	---do---	235.5-236.7	--	Bevier coal
22-19	------do------	---do---	----------do----------	2	---do---	255.1-256.5	--	
22-22c	Shale, N3,	Offshore shale	----------do----------	2	---do---	278.7-283.8	D226874	
22-22e	Shale, N1, phosphatic	---do---	----------do----------	2	---do---	285.3-286.6	D226875	Swede Hollow shale (Verdigris shale)
22-23	Coal	Nearshore shale	----------do----------	2	---do---	287.0-288.0	--	Whitebreast coal (Croweburg coal)
22-30	------do------	---do---	----------do----------	2	---do---	324.2-325.9	--	
22-32a	Shale, N3, pyritic	---do---	----------do----------	2	---do---	339.2-342.3	D226876	
22-32b	Shale, N1, phosphatic	Offshore shale	----------do----------	2	---do---	343.6-344.6	D226877	"Seahorne" shale
22-33	Coal	Nearshore shale	----------do----------	2	---do---	344.6-346.2	--	Tebo coal
22-44	Coal, impure	---do---	----------do----------	2	---do---	395.2-396.3	--	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
22-48	Coal, pyritic	---do---	----------do----------	2	---do---	419.8-422.2	D192374	
21-2	------do------	---do---	NW 1/4, NW 1/4, sec. 18, T. 71 N., R. 14 W., Wapello County, Iowa	3	---do---	76.7-79.6	D176189	Bevier coal(?)
21-4	Shale, N3-N2, pyritic	---do---	----------do----------	3	---do---	117.2-119.9	--	
21-5	Shale, N2, calcareous pyritic	Offshore shale	----------do----------	3	---do---	121.3-129.0	--	
21-7	Shale, N1, pyritic phosphatic	---do---	----------do----------	3	---do---	129.5-131.9	--	Swede Hollow shale (Verdigris shale)
21-8	Coal	Nearshore shale	----------do----------	3	---do---	131.9-133.3	D176190	Whitebreast coal (Croweburg coal)
21-13	Shale, N3, pyritic	---do---	----------do----------	3	---do---	162.1-167.1	--	
21-14	Coal	---do---	----------do----------	3	---do---	167.1-167.9	D176191	
21-15	Shale, N3, pyritic	Offshore shale	----------do----------	3	---do---	167.9-168.8	--	
21-17	------do------	---do---	----------do----------	3	---do---	182.8-183.8	--	
21-18	Coal	Nearshore shale	----------do----------	3	---do---	183.8-186.4	D176192	
21-20	------do------	---do---	----------do----------	3	---do---	191.7-195.3	D176193	
21-21ab	Shale, N3, pyritic	Offshore shale	----------do----------	3	---do---	195.5-196.9	--	"Seahorne" shale
21-22	Coal	Nearshore shale	----------do----------	3	---do---	197.9-199.0	D176194	Tebo coal

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
21-26	------do------	---do---	----------do----------	3	---do---	215.7-217.1	D176195	
21-29	------do------	---do---	----------do----------	3	---do---	243.8-246.2	D176196	
21-31	------do------	---do---	----------do----------	3	---do---	263.0-264.2	D176197	
21-33	Shale, N3, pyritic	---do---	----------do----------	3	---do---	306.5-312.7	--	
21-34	Coal, boney	---do---	----------do----------	3	---do---	316.0-319.5	D176198	
21-36	Coal	---do---	----------do----------	3	---do---	322.0-326.1	D176199	
21-40	------do------	---do---	----------do----------	3	---do---	357.9-358.4	D176200	
Anna	Shale, N1, phosphatic	Offshore shale	SW 1/4, SW 1/4, sec. 23, T. 65 N., R. 18 W., Putnam County, Missouri	4	Channel	2.0	D185643	Anna shale
Lexington	Coal	Nearshore shale	----------do----------	4	---do---	2.8	D179385	Lexington coal
SS-1	Shale, N2, phosphatic	Offshore shale	NW 1/4, NW 1/4, sec. 16, T. 54 N., R. 14 W., Randolph County, Missouri	5	Core	56.0-59.8	D196423	Excello shale
GS-100	Coal	Nearshore shale	----------do----------	5	---do---	59.8-61.1	D193792	Mulky coal
GS-101	------do------	---do---	----------do----------	5	---do---	71.8-76.0	D193793	Bevier coal
GS-102	------do------	---do---	----------do----------	5	---do---	108.8-110.0	D193794	Croweburg coal
SS-8	Shale, N2, phosphatic	Offshore shale	SW 1/4, NW 1/4, sec. 9, T. 54 N., R. 14 W., Randolph County, Missouri	5	Channel	1.8	D196428	Little Osage shale

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
SS-11	Shale, N2, phosphatic	---do---	NW 1/4, NW 1/4, sec. 20, T. 54, N., R. 14 W., Randolph County, Missouri	5	---do---	1.2	D196426	Excello shale
BM 2-3	Shale, N2-N3,	Nearshore shale	NW 1/4, NW 1/4, sec. 4, T. 54 N., R. 14 W., Randolph County, Missouri	5	Core	91.1-95.6	D226863	
BM 2-5	Shale, N2, phosphatic	Offshore shale	----------do----------	5	---do---	96.0-98.7	D226864	Verdigris shale
BM 5-1	Limestone, N4,	Regressive limestone	NE 1/4, SE 1/4, sec. 29, T. 55 N., R. 14 W., Randolph County, Missouri	5	---do---	30.0-34.3	D226821	
BM 5-2	Shale, N2,	Offshore shale	---------do----------	5	---do---	34.3-38.1	D226862	Excello shale
GS 105	Coal	Nearshore shale	---------do----------	5	---do---	50.5-53.3	D193796	Bevier coal
BM 5-4	Limestone	Regressive limestone	---------do----------	5	---do---	54.6-58.7	D226822	
BM 14-1	Limestone, N3,	---do---	NW 1/4, NE 1/4, sec. 19, T. 56 N., R. 16 W., Chariton County, Missouri	6	---do---	69.2-71.8	D226820	
BM 14-2	Shale, N2, phosphatic	Offshore shale	---------do----------	6	---do---	71.8-72.8	D226860	Little Osage shale
BM 14-3	Shale, N2-N3	---do---	---------do----------	6	---do---	72.8-76.0	D226861	
BM 14-4	Coal	Nearshore shale	---------do----------	6	---do---	76.0-76.7	D193804	Summit coal
BM 14-6	Shale, N2	Offshore shale	---------do----------	6	---do---	95.5-96.5	--	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
BM 17-1	Coal	Nearshore shale	SE 1/4, SW 1/4, sec. 2, T. 56 N., R. 17 W., Chariton County, Missouri	6	---do---	120.4-122.5	D193803	Bevier coal
BM 17-2	------do------	---do---	---------do----------	6	---do---	130.2-131.6	--	Wheeler coal
BM 17-3	Limestone, shaly, N2-N3	Regressive limestone	---------do----------	6	---do---	136.6-138.1	--	
BM 17-5	Shale, N2	Nearshore shale	---------do----------	6	---do---	138.4-140.1	--	
BM 17-6	Coal	---do---	---------do----------	6	---do---	140.4-140.5	--	
MC 105-1	Limestone, N3, fossiliferous	Regressive limestone	NW 1/4, NW 1/4, sec. 25, T. 46 N., R. 27 W., Johnson County, Missouri	7	---do---	18.3-19.0	D226817	
MC 105-2	Shale, fissle, N2, phosphatic	Offshore shale	---------do----------	7	---do---	19.7-20.5	D226855	Little Osage shale
MC 105-4	Limestone, N5, fossiliferous	Regressive limestone	---------do----------	7	---do---	33.2-35.2	D226818	
MC 105-6	Shale, N2, phosphatic	Offshore shale	---------do----------	7	---do---	36.3-37.5	D226856	Excello shale
MC 86-2	------do------	---do---	SW 1/4, SW 1/4, sec. 9, T. 44 N., R. 26 W., Johnson County, Missouri	7	---do---	31.3-33.8	D226857	Excello shale
MC 86-3	Coal	Nearshore shale	----------do----------	7	---do---	33.8-35.3	D226898	
MC 86-4	Shale N3, fossiliferous	---do---	----------do----------	7	---do---	92.8-93.2	--	
MC 86-5	Shale N3,	---do---	----------do----------	7	---do---	96.2-96.6	D226858	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
MC 86-6	Coal	---do---	----------do----------	7	---do---	97.1-97.8	D226899	
MC 204-2	------do------	---do---	SW 1/4, SE 1/4, sec. 7, T. 45 N., R. 25 W., Johnson County, Missouri	7	---do---	77.2-77.7	--	Wheeler coal
MC 204-3	Limestone, N5	Regressive limestone	----------do----------	7	---do---	78.1-79.8	D226819	
MC 204-5a	Limestone, N3	Transgressive limestone	----------do----------	7	---do---	83.0-84.0	D226859	
MC 204-6	Coal	Nearshore shale	----------do----------	7	---do---	92.1-93.1	D226890	
MC 121-1	Limestone, N3	Regressive limestone	SW 1/4, sec. 1, T. 40 N., R. 32 W., Bates County, Missouri	8	---do---	56.6-61.5	D226813	
MC 121-2	Shale, N2, phosphatic	Offshore shale	----------do----------	8	---do---	62.3-63.1	D226848	Anna shale
MC 121-3	Shale, N2	---do---	----------do----------	8	---do---	63.6-65.1	D226849	
MC 121-4	Coal	Nearshore shale	----------do----------	8	---do---	73.3-73.8	--	Lexington coal
MC 121-5	Shale, N3, fossiliferous	---do---	----------do----------	8	---do---	76.8-81.2	D226850	
MC 121-6	Limestone, N3, fossiliferous	Transgressive limestone	----------do----------	8	---do---	82.7-83.7	D226814	
MC 121-7	Coal	Nearshore shale	----------do----------	8	---do---	83.7-83.9	--	
MC 121-8	Limestone	Regressive limestone	----------do----------	8	---do---	86.9-98.7	D226815	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
MC 142-3	Shale, N2	Nearshore shale	SW 1/4, sec. 29, T. 39 N., R. 30 W., Bates County, Missouri	9	---do---	85.0-88.0	D226851	
MC 142-4	Coal	---do---	----------do----------	9	---do---	88.0-89.4	D226897	Robinson Branch coal
M-7-65	Shale, N2, phosphatic	Offshore shale	NW 1/4, NE 1/4, sec. 30, T. 40 N., R. 27 W., Henry County, Missouri	10	Channel	.5	D185646	"Seahorne" shale
MC 168-4	Shale, N3	Nearshore shale	NE 1/4, SE 1/4, sec. 35, T. 37 N., R. 30 W., Vernon County, Missouri	11	Core	53.3-59.6	D226852	
MC 168-5	Shale, N2, phosphatic	Offshore shale	----------do----------	11	---do---	60.7-62.4	D226853	
MC 168-6	Coal	Nearshore shale	----------do----------	11	---do---	62.6-64.1	--	
MC 168-7	Shale, N3	---do---	----------do----------	11	---do---	80.0-86.5	D226854	
D189091	Coal	Nearshore shale	NW 1/4, SE 1/4, sec. 21, T. 26 S., R. 25 E., Bourbon County, Kansas	12	Channel	1.2	D189091	Mulky coal
D196198	------do------	---do---	NE 1/4, SE 1/4, sec. 2, T. 31 S., R. 22 E., Crawford County, Kansas	13	---do---	1.5	D196198	Bevier coal
6-1	Shale, N2-N1	Offshore shale	SW 1/4, SE 1/4, sec. 8, T. 32 S., R. 22 E., Cherokee County, Kansas	14	Core	44.4-49.6	D226844	Verdigris shale
6-2	Coal	Nearshore shale	----------do----------	14	---do---	52.0-52.7	D226894	Croweburg coal
6-12	Shale	---do---	----------do----------	14	---do---	150.7-152.3	D226845	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
6-13	Coal	---do---	----------do----------	14	---do---	152.3-153.0	D226895	Tebo coal
6-27	Shale	---do---	----------do----------	14	---do---	346.7-348.5	D226846	
6-28	Coal	---do---	----------do----------	14	---do---	348.5-349.3	D226896	
871-3	------do------	---do---	NW 1/4, sec. 31, T. 23 S., R. 10 E., Greenwood County, Kansas	15	---do---	2,062.0-2,062.9	--	
871-12	Shale, N2, phosphatic	Offshore shale	----------do----------	15	---do---	2,095.7-2,097.0	--	Excello shale
349-1	Limestone, N6-N4	Regressive limestone	NW 1/4, SW 1/4, sec. 31, T. 23 S., R. 10. E., Greenwood County, Kansas	15	---do---	2,090.0-2,093.8	--	
349-3	Shale, N2	Offshore shale	----------do----------	15	---do---	2,095.1-2,096.1	--	Excello shale
349-13	Limestone, N4, fossiliferous	Regressive limestone	----------do----------	15	---do---	2,118.5-2,119.2	--	
349-15	------do------	---do---	----------do----------	15	---do---	2,119.7-2,120.0	--	
349-17	Shale, N2	Nearshore shale	----------do----------	15	---do---	2,121.7-2,122.7	--	
349-38	Coal	---do---	----------do----------	15	---do---	2,213.0-2,213.1	--	
349-43	Limestone, N3, argillaceous	Regressive limestone	----------do----------	15	---do---	2,223.2-2,223.8	--	
349-46	Shale, N2-N3	Offshore shale	----------do----------	15	---do---	2,225.0-2,226.4	--	Verdigris shale
349-57	Shale, N2, phosphatic	---do---	----------do----------	15	---do---	2,252.8-2,253.9	--	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
349-69	Shale, N2	---do---	----------do----------	15	---do---	2,288.7-2,289.3	--	
889-44	Shale, N3	---do---	NE 1/4, sec. 6, T. 24 S., R. 10 E., Greenwood County, Kansas	16	---do---	2,368.7-2,374.3	--	
889-61	Coal	Nearshore shale	----------do----------	16	---do---	2,391.2-2,392.1	--	
889-71	Shale, N3, fossiliferous	---do---	----------do----------	16	---do---	2,400.0-2,400.3	--	
889-72	Coal	---do---	----------do----------	16	---do---	2,400.3-2,401.1	--	
1535u-5	Shale, N1-N2	Offshore shale	NE 1/4, SE 1/4, sec. 30, T. 29 N., R. 18 E., Craig County, Oklahoma	17	---do---	95.3-97.1	D227546	Anna shale
1535u-8	Coal	Nearshore shale	----------do----------	17	---do---	98.0-99.0	--	Lexington coal
1535u-23a	Shale, N2, calcareous	Offshore shale	----------do----------	17	---do---	200.7-200.8+ 202.7-202.8	D227547	Shaly partings in Higginsville limestone
1535u-25	Shale, N2	---do---	----------do----------	17	---do---	229.6-235.5	D227548	Little Osage shale
1535-3	Limestone, N4	Regressive limestone	----------do----------	17	---do---	272.9-277.0	--	Fort Scott limestone
1535-7	Shale, N2, phosphatic	Offshore shale	----------do----------	17	---do---	280.1-285.2	D227549	Excello shale
1535-8	Limestone	Transgressive limestone	----------do----------	17	---do---	285.2-295.5	--	Breezy Hill limestone
1535-12	Shale, N2-N3, calcareous, phosphatic	Offshore shale	----------do----------	17	---do---	304.0-306.7	D227550	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1535-13a	Coal	Nearshore shale	----------do----------	17	---do---	307.1-308.0	D227532	Bevier coal
1535-22	Limestone	Regressive limestone	----------do----------	17	---do---	327.3-331.8	--	
1535-23	Shale, N2-N3, phosphatic	Offshore shale	----------do----------	17	---do---	331.8-333.2	D227551	
1535-24	Limestone	Transgressive limestone	----------do----------	17	---do---	333.2-334.6	--	
1535-25	Shale, N2, phosphatic	Offshore shale	----------do----------	17	---do---	334.6-336.1	D227552	Verdigris shale
1535-27	Coal	Nearshore shale	----------do----------	17	---do---	342.3-344.0	--	Croweburg coal, 0.15 ft recovered
1535-47	------do------	---do---	----------do----------	17	---do---	389.1-390.4	D227533	
1535-54	Limestone	Regressive limestone	----------do----------	17	---do---	407.9-408.8	--	
1535-66	Shale, N2, phosphatic	Offshore shale	----------do----------	17	---do---	440.7-441.7	D227553	"Seahorne" shale (?)
1535-69	Coal	Nearshore shale	----------do----------	17	---do---	445.0-446.0	--	Bottom 0.1 ft recovered
1535-78	Shale, N2	---do---	----------do----------	17	---do---	503.0-503.6	D227554	
1535-79	Coal	---do---	----------do----------	17	---do---	503.6-506.7	D227534	Top 0.8 ft recovered
1535-107	Shale, N2-N3	---do---	----------do----------	17	---do---	588.9-600.0	D227555	Bottom 2.5 ft lost
1535-144	Shale, N3	---do---	----------do----------	17	---do---	685.4-690.7	D227556	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1535-146	Coal, shaly	---do---	----------do----------	17	---do---	691.5-692.5	D227535	Top 0.2 and bottom 0.3 ft sampled
1535-150	Coal	---do---	----------do----------	17	---do---	699.3-700.1	D227536	
1535-159	Shale, N2-N3	---do---	----------do----------	17	---do---	711.9-725.5	D227558	
1535-187	Coal, shaly	---do---	----------do----------	17	---do---	765.4-765.7	--	
1615-3	Shale, N2, phosphatic	Offshore shale	SW 1/4, NW 1/4, sec. 23, T. 20 N., R. 14 E., Rogers County, Oklahoma	18	---do---	186.9-189.4	--	Little Osage shale
1615-5	Limestone	Regressive limestone	----------do----------	18	---do---	191.1-208.4	--	Fort Scott limestone
1615-6	Shale, N2, phosphatic	Offshore shale	----------do----------	18	---do---	208.4-210.9	--	Excello shale
1615-7	Limestone, N4, clayey	Transgressive limestone	----------do----------	18	---do---	210.9-213.5	--	
1615-8	Limestone, 5Y,6/1,	---do---	----------do----------	18	---do---	213.5-215.6	--	
1615-12	Coal	Nearshore shale	----------do----------	18	---do---	221.3-221.9	--	
1615-21	Limestone, N6-N4, clayey	Regressive limestone	----------do----------	18	---do---	233.3-235.4	--	
1615-47	Limestone, N4	---do---	----------do----------	18	---do---	288.1-292.9	--	
1615-50	Limestone, N5-N4, fossiliferous	---do---	----------do----------	18	---do---	297.0-298.1	--	
1615-53	Shale, N2-N3	Offshore shale	----------do----------	18	---do---	299.7-301.9	--	Verdigris shale

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1615-56	Coal	Nearshore shale	----------do----------	18	---do---	320.0-321.7	--	Croweburg coal
1615-136	Shale, N3, phosphatic	Offshore shale	----------do----------	18	---do---	532.4-533.1	--	
1615-139	Limestone, 5Y 4/1	Transgressive limestone	----------do----------	18	---do---	537.1-539.0	--	
1615-143	------do------	---do---	----------do----------	18	---do---	542.9-545.3	--	
1615-191	Shale, N2, phosphatic	Offshore shale	----------do----------	18	---do---	649.9-652.0	--	1615-191 & 1615-192) combined
1615-193	Shale, N2, fossiliferous	Nearshore shale	----------do----------	18	---do---	652.0-652.4	--	
1615-194	Coal	---do---	----------do----------	18	---do---	652.4-652.9	--	
1615-236	Shale, N3	---do---	----------do----------	18	---do---	766.9-772.0	--	
1615-237	Shale, N2, phosphatic	Offshore shale	----------do----------	18	---do---	772.0-772.4	--	
1615-247	Limestone, 5Y 6/1	Transgressive limestone	----------do----------	18	---do---	783.3-784.3	--	
1615-264	Shale, N3	Nearshore shale	----------do----------	18	---do---	851.4-851.7	--	
1615-265	Shale, N2, phosphatic	Offshore shale	----------do----------	18	---do---	851.7-851.9	--	
1615-267	Coal	Nearshore shale	----------do----------	18	---do---	852.0-852.2	--	
1615-290	Shale, N2, calcareous	Offshore shale	----------do----------	18	---do---	890.9-891.6	--	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1615-292	Coal	Nearshore shale	----------do----------	18	---do---	893.4-894.3	--	
1615-341	------do------	---do---	----------do----------	18	---do---	1,023.0-1,024.4	--	
1615-382	Shale, N3, calcareous	---do---	----------do----------	18	---do---	1,090.9-1,095.7	--	
1615-384	Coal	---do---	----------do----------	18	---do---	1,095.7-1,096.0	--	
1051-9	Shale, N2, phosphatic	Offshore shale	NE 1/4, NW 1/4, sec. 4, T. 23, N., R. 10 E., Osage County, Oklahoma	19	---do---	1,754.9-1,758.6	--	Excello shale
1051-11	Limestone	Transgressive limestone	----------do----------	19	---do---	1,759.0-1,764.7	--	
1051-13	Shale, N2, phosphatic, fossiliferous	Offshore shale	----------do----------	19	---do---	1,764.7-1,766.0	--	
1051-44	Limestone	Regressive limestone	----------do----------	19	---do---	1,816.5-1,818.5	--	
1051-48	Shale, N2, phosphatic	Offshore shale	----------do----------	19	---do---	1,820.9-1,821.4	--	
1051-49	Shale, N3, fossiliferous	---do---	----------do----------	19	---do---	1,821.4-1,822.2	--	
1051-50	Shale, N2, phosphatic	---do---	----------do----------	19	---do---	1,822.2-1,826.9	--	Verdigris shale
1051-62	Shale, N2, fossiliferous	Nearshore shale	----------do----------	19	---do---	1,867.6-1,868.0	--	
1051-63	Shale, N2, papery	Offshore shale	----------do----------	19	---do---	1,868.0-1,868.3	--	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1051-66	------do------	---do---	----------do----------	19	---do---	1,868.8-1,869.1	--	
1051-69	Coal	Nearshore shale	----------do----------	19	---do---	1,871.9-1,872.2	--	
1051-94	Limestone	Regressive limestone	----------do----------	19	---do---	1,924.9-1,933.1	--	
1051-99	Shale, N3	Nearshore shale	----------do----------	19	---do---	1,934.8-1,935.5	--	
1051-100	Shale, N2	---do---	----------do----------	19	---do---	1,935.5-1,936.2	--	
1051-105	Shale, N3, fossiliferous	---do---	----------do----------	19	---do---	1,943.9-1,944.9	--	
1051-106	Shale, N2, phosphatic	Offshore shale	----------do----------	19	---do---	1,944.9-1,947.5	--	
1051-108	Coal	Nearshore shale	----------do----------	19	---do---	1,948.3-1,948.4	--	
1051-115	Shale, N2, phosphatic	Offshore shale	----------do----------	19	---do---	1,957.8-1,959.3	--	
1051-124	Coal	Nearshore shale	----------do----------	19	---do---	1,971.8-1,972.6	--	
1051-155	Shale, N3, fossiliferous	---do---	----------do----------	19	---do---	2,026.7-2,028.7	--	
1044-15	Limestone, 5Y 5/1	Regressive limestone	NW 1/4, NW 1/4, sec. 12, T. 27 N., R. 6 E., Osage County, Oklahoma	20	Core	2,633.1-2,634.3	--	
1044-18	Limestone, 5YR 3/1	---do---	----------do----------	20	---do---	2,641.1-2,643.3	--	
1044-19	Shale, N2	Offshore shale	----------do----------	20	---do---	2,643.3-2,644.9	D227539	Little Osage shale

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1044-32	Shale, N2, phosphatic	---do---	----------do----------	20	---do---	2,671.9-2,675.3	D227540	Excello shale
1044-35	Limestone	Transgressive limestone	----------do----------	20	---do---	2,676.9-2,686.3	--	Breezy Hill limestone
1044-38	Shale, N3, fossiliferous	Offshore shale	----------do----------	20	---do---	2,690.0-2,694.2	D227541	
1044-40	Coal	Nearshore shale	----------do----------	20	---do---	2,694.2-2,695.4	D227528	
1044-45	Limestone, 5YR-3/1, fossiliferous	Regressive limestone	----------do----------	20	---do---	2,707.3-2,709.7	--	
1044-46	Shale, N2-N3	Offshore shale	----------do----------	20	---do---	2,709.7-2,711.4	D227542	
1044-47	Shale, N2, phosphatic	---do---	----------do----------	20	---do---	2,711.4-2,712.3	D227543	Verdigris shale
1044-48	Coal	Nearshore shale	----------do----------	20	---do---	2,712.3-2,712.7	D227529	Croweburg coal
1044-81	------do------	---do---	----------do----------	20	---do---	2,775.4-2,775.9	D227530	
1044-97	Shale, N3	---do---	----------do----------	20	---do---	2,828.1-2,829.4	D227544	
1044-99	Coal	---do---	----------do----------	20	---do---	2,829.4-2,830.4	D227531	
1044-111	Shale, N3	---do---	----------do----------	20	---do---	2,857.0-2,864.6	D227545	
1044-114	Coal	---do---	----------do----------	20	---do---	2,864.6-2,865.0*	--	
1065-2a	Shale, N3	Offshore shale	NW 1/4, NW 1/4, sec. 34, T. 25 N., R. 3 E., Osage County, Oklahoma	21	Core	3,340.6-3,342.0	D226836	Little Osage shale

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1065-2b	Shale, N2, phosphatic	---do---	----------do----------	21	---do---	3,345.0-3,348.7	D226837	Do.
1065-4	Claystone, calcareous	Nearshore shale	----------do----------	21	---do---	3,351.7-3,370.0	D226809	
1065-5	Limestone	Limestone	----------do----------	21	---do---	3,370.0-3,373.0	D226810	
1065-6a	Shale, N2, phosphatic	Offshore shale	----------do----------	21	---do---	3,373.0-3,374.4	D226834	Excello shale
1065-6b	------do------	---do---	----------do----------	21	---do---	3,374.4-3,376.4	D226835	Do.
1065-7	Limestone, clayey	Transgressive limestone	----------do----------	21	---do---	3,376.4-3,385.0	D226811	
1065-9	Coal	Nearshore shale	----------do----------	21	---do---	3,394.8-3,395.4	D226890	
1065-15	Shale, N2, phosphatic	Offshore shale	----------do----------	21	---do---	3,409.0-3,411.0	D226838	Verdigris shale
1065-17	Coal	Nearshore shale	----------do----------	21	---do---	3,411.5-3,412.0	D226891	Croweburg coal
1065-20	Shale, N3	---do---	----------do----------	21	---do---	3,427.8-3,436.4	D226839	
1065-21b	Limestone	Regressive limestone	----------do----------	21	---do---	3,439.3-3,439.5	D226812	
1065-22b	Shale, N3-N2	Nearshore shale	----------do----------	21	---do---	3,443.0-3,448.0	D226840	
1065-23	Shale, N2, calcareous	---do---	----------do----------	21	---do---	3,448.0-3,450.5	D226841	
1065-24	Coal	---do---	----------do----------	21	---do---	3,450.5-3,450.8	D226892	
1065-34	------do------	---do---	----------do----------	21	---do---	3,488.2-3,489.0	D226893	

Table 1.--Continued

Sample number	Lithology	Facies	Location	Index map number	Sample type	Depth interval or thickness (feet)	USGS analytical laboratory number	Notes
1065-39	Shale, N3	---do---	----------do----------	21	---do---	3,500.0-3,501.0	D226842	
1065-48b	------do------	---do---	----------do----------	21	---do---	3,591.0-3,596.4	D226843	

Table 2.--Sample numbers, field names, locations, producing horizons and approximate depth for 11 oil samples produced from the middle Pennsylvanian section, southeastern Kansas and northeastern Oklahoma
[--- indicates no data]

Sample number	Field	Location	Producing horizon	Depth (feet)	USGS analytical laboratory number
58200C	S. Burbank	NE 1/4, sec. 30, T. 25 N., R. 8 E., Osage County, Oklahoma	Burgess sand	2,470	D239618
58201C	Burden	NE 1/4, sec. 32, T. 31 S., R. 6 E., Cowley County, Kansas	Burbank sand	2,200	D239611
58202C	S. Burbank	NW 1/4, sec. 29, T. 25, N., R. 8 E., Osage County, Oklahoma	-----do-----	---	---
58203C	Simon Lebow	SE 1/4, sec. 19, T. 25 N., R. 9 E., Osage County, Oklahoma	Mississippian chat	2,300	D239616
58204C	Teeter	NW 1/4, sec. 15, T. 23 S., R. 9 E., Greenwood County, Kansas	Burbank sand	2,350	D239612
58206C	Olsen	SW 1/4, sec. 24, T. 26 N., R. 4 E., Osage County, Oklahoma	Squirrel or Prue sand	3,100	D239617
58208C	Haverhill	SE 1/4, sec. 35, T. 28 S., R. 5 E., Butler County, Kansas	Burbank sand	---	D239614
58209C	Pershing	--- sec. 36, T. 25, N., R. 9 E., Osage County, Oklahoma	Bartlesville sand	2,000	D239620
58210C	Sperry	NW 1/4, sec. 24, T. 21 N., R. 12 E., Tulsa County, Oklahoma	Burgess sand	1,218	D239615
64187	Thrall pool	NE 1/4, sec. 6, T. 24 S., R. 10 E., Greenwood County, Kansas	Cherokee sand	---	D239609
64188	Thrall pool	NW 1/4, sec. 12, T. 24 S., R. 9 E., Greenwood County, Kansas	-----do-----	---	D239610
64249	S. W. Bartlesville	--- Washington County, Oklahoma	Bartlesville sand	---	D239619

Table 3.--Organic carbon content and Rock-Eval pyrolysis analysis for rock samples from the Middle Pennsylvanian Cherokee and Marmaton Groups

[HC = hydrocarbons; Org. C = organic carbon]

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
41-1	4.01	0.028	0.37	1.2	438	9	30	0.7	0.07
41-2	46.8	1.4	70	5.3	430	150	11	3.0	.02
41-5	50.9	1.8	99	6.5	435	190	13	3.5	.02
41-8	57.3	.77	95	7.2	432	170	13	1.3	.008
41-13ac	.17	---	---	---	---	---	---	---	---
41-13f	7.89	.17	1.7	.45	444	21	6	2.2	.09
41-13g	.39	.046	.033	.21	---	8	55	12	.6
41-17	24.8	1.6	78	3.1	429	320	12	6.5	.02
41-18	61.8	3.5	170	4.9	423	270	8	5.7	.02
41-23	7.6	.091	2.9	.96	427	39	13	1.2	.03
41-24	55.0	.39	130	5.1	429	230	9	.8	.003
41-26	.17	---	---	---	---	---	---	---	---
41-28	.34	.028	.01	.10	437	3	30	8.2	.7
41-31	5.79	.11	3.5	.41	429	61	7	1.9	.03
41-32	45.3	.28	57	4.4	428	130	10	.6	.005
41-37a	1.66	.079	.83	.51	437	49	30	4.8	.09
41-37b	3.78	.059	1.86	.55	433	49	14	1.6	.03
41-38	46.2	.29	88	5.0	430	190	11	.6	.003
41-46	7.09	.23	7.0	.78	435	99	11	3.2	.03
41-48	65.4	1.9	160	8.2	437	240	13	2.9	.01
41-51	45.6	.67	84	4.3	428	180	9	1.5	.008
41-53	3.31	.20	1.1	.53	439	35	16	6.0	.15
41-58	43.7	1.0	97	3.2	435	220	7	2.3	.01
41-60	47.9	1.1	87	4.9	435	180	10	2.3	.01
41-66	2.55	.051	1.0	.18	436	39	7	2.0	.05
41-70	1.41	.049	.15	.25	431	11	18	3.5	.25
22-6c	0.34	.032	.11	.25	433	33	74	9.4	.2
22-6d	16.4	.81	52	2.6	430	310	16	4.9	.02
22-7	62.3	1.2	86	5.8	424	140	9	1.9	.01
22-9	.09	---	---	---	---	---	---	---	---

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
22-11	18.7	1.8	74	3.8	429	400	20	9.6	0.02
22-14	4.25	.26	.13	1.3	445	3	31	6.1	.65
22-17	54.0	.38	110	6.1	436	200	11	.7	.004
22-19	54.1	.63	87	6.2	434	160	11	1.2	.007
22-22c	4.83	.46	4.9	.97	436	100	20	9.6	.09
22-22e	25.1	2.3	89	4.1	426	350	17	9.2	.03
22-23	63.4	2.5	140	11	422	220	17	3.9	.02
22-30	52.8	.68	100	5.5	433	190	10	1.3	.007
22-32a	1.10	.033	.035	.29	432	3	26	3.0	.5
22-32b	10.6	.28	3.9	.98	436	40	9	2.6	.07
22-33	52.5	2.1	120	8.0	424	230	15	4.0	.02
22-44	34.1	1.0	69	4.9	434	200	14	2.9	.015
22-48	61.5	1.5	125	8.8	432	200	14	2.4	.01
21-2	50.9	1.9	75	5.5	437	150	11	3.7	.02
21-4b	2.8	.15	.94	1.4	432	34	48	5.4	.13
21-5	9.9	.90	11	2.8	433	110	28	9.1	.08
21-7	21.6	2.2	77	2.5	432	360	11	9.8	.01
21-8	41.4	2.2	67	5.4	432	160	13	5.3	.03
21-13	1.3	.052	.25	.75	426	19	58	.04	.17
21-14	67.2	5.0	155	8.7	427	230	13	7.4	.03
21-15	8.0	.31	15	.89	435	180	11	3.9	.02
21-17	7.3	.22	.63	.33	431	9	5	3.0	.26
21-18	61.1	3.0	170	5.1	427	270	8	4.9	.02
21-20	42.3	3.3	96	6.7	431	230	16	7.8	.03
21-21ab	10.7	.63	19	.85	430	180	8	5.9	.03
21-22	42.1	2.1	93	3.3	421	220	8	5.0	.02
21-26	63.5	6.3	190	6.9	428	290	11	9.9	.03
21-29	58.6	2.8	140	4.8	428	240	8	4.8	.02
21-31	64.3	5.1	180	6.0	426	270	9	7.9	.03
21-33	4.6	.14	2.1	.41	424	46	9	3.0	.06

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
21-34	50.4	5.0	140	7.3	426	280	14	9.9	0.03
21-36	64.8	6.4	200	6.1	425	300	9	9.9	.03
21-40	45.4	2.1	130	3.8	426	300	8	4.6	.02
Anna	26.3	2.0	110	4.3	430	410	18	8.6	.02
Lexington	71.7	9.8	190	2.8	434	270	4	14	.05
SS-1	13.7	2.0	45	1.8	433	330	13	15	.04
GS-100	58.6	.82	110	6.6	426	190	11	1.4	.007
GS-101	60.4	3.8	150	6.6	429	240	11	6.3	.03
GS-102	67.5	5.5	170	6.6	427	250	10	8.1	.03
SS-8	19.5	.57	42	3.6	436	220	18	2.9	.02
SS-11	19.5	1.2	47	4.2	435	240	21	6.2	.01
BM2-3	5.2	.08	.91	.47	441	18	9	1.5	.08
BM2-5	21.2	.91	56	1.8	433	260	8	4.3	.02
BM5-1	.13	---	---	---	---	---	---	---	---
BM5-2	13.9	.61	21	2.1	432	150	15	4.4	.03
GS-105	54.7	3.9	130	9.8	424	240	18	7.1	.03
BM5-4	.13	---	---	---	---	---	---	---	---
BM14-1	.26	---	---	---	---	---	---	---	---
BM14-2	23.1	2.2	85	2.8	431	370	12	9.5	.02
BM14-3	15.0	.54	27	.80	430	180	5	3.6	.02
BM14-4	65.7	2.1	140	5.1	428	220	8	3.2	.01
BM14-6	5.1	.054	.23	.47	432	5	9	1.1	.19
BM17-1	48.4	2.6	130	4.7	429	260	7	5.4	.02
BM17-2	51.3	3.5	160	4.6	431	320	5	4.9	.02
BM17-3	1.8	.11	1.7	.99	427	96	56	6.1	.06
BM17-5	4.3	.054	2.3	.62	428	54	14	1.2	.02
BM17-6	43.6	1.3	88	4.3	430	200	10	3.0	.01
MC105-1	.25	---	---	---	---	---	---	---	---
MC105-2	9.6	.27	9.8	1.1	440	100	12	2.8	.03
MC105-4	.17	---	---	---	---	---	---	---	---

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
MC105-6	3.8	0.27	0.31	0.53	433	8	14	7.1	0.07
MC86-2	9.2	.21	5.4	1.1	437	58	12	2.3	.04
MC86-3	64.1	1.1	100	9.2	436	160	14	1.5	.01
MC86-4	6.5	.37	4.8	1.5	431	74	23	5.7	.07
MC86-5	2.9	.098	.50	.84	430	17	29	3.4	.16
MC86-6	64.8	2.1	98	7.5	428	150	12	3.2	.02
MC204-2	60.7	2.9	94	9.6	430	160	16	4.8	.03
MC204-3	.28	---	---	---	---	---	---	---	---
MC204-5a	2.6	.20	3.3	.55	428	130	21	7.7	.06
MC204-6	41.4	3.5	97	4.6	431	230	11	8.5	.03
MC121-1	.69	.23	.74	.21	437	110	30	33	.24
MC121-2	19.7	3.8	79	1.3	439	400	7	19	.05
MC121-3	9.9	1.5	21	.69	441	220	7	15	.07
MC121-4	61.0	6.7	140	3.3	436	230	5	11	.04
MC121-5	1.7	.089	.28	.27	436	17	16	5.2	.24
MC121-6	1.1	.15	.51	.23	435	48	22	14	.22
MC121-7	50.4	3.1	120	3.9	441	250	8	6.1	.02
MC121-8	.25	---	---	---	---	---	---	---	---
MC142-3	6.0	.26	1.3	.7	433	21	12	4.3	.17
MC142-4	76.6	3.1	160	6.7	435	210	9	4.0	.02
M-7-65	20.1	2.2	59	3.6	441	290	18	11	.04
MC168-4	2.4	.13	.67	1.2	442	28	49	5.4	.16
MC168-5	18.0	2.3	42	1.4	443	230	8	13	.05
MC168-6	74.3	6.9	230	4.1	430	310	6	9.3	.03
MC168-7	1.7	.13	.41	.53	442	25	32	7.6	.24
D189091	69.6	3.6	210	3.8	440	310	5	5.2	.02
D196198	72.2	10	160	3.4	440	220	5	14	.06
6-1	9.4	1.8	18	.36	444	190	4	19	.09
6-2	40.9	2.1	100	1.7	438	250	4	5.1	.02
6-12	8.5	.78	10	.39	446	120	5	9.2	.07

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
6-13	66.0	2.5	190	2.3	450	280	3	3.8	0.01
6-27	3.0	.28	1.9	.53	440	62	17	9.1	.13
6-28	65.5	5.3	190	2.0	449	290	3	8.1	.03
871-3	59.5	5.6	110	3.7	440	190	6	9.4	.05
871-12	18.9	4.3	58	1.2	442	310	6	23	.07
349-1	.35	.17	.25	.26	434	70	74	49	.40
349-3	21.6	4.0	60	1.3	440	280	6	19	.06
349-13	.11	---	---	---	---	---	---	---	---
349-15	.10	---	---	---	---	---	---	---	---
349-17	4.5	.25	.63	.50	450	14	11	5.5	.29
349-38	47	6.1	110	3.4	445	230	5	13	.05
349-43	.70	.10	.24	.51	438	34	73	14	.30
349-46	14.9	2.3	39	1.6	449	260	11	15	.05
349-57	8.1	1.4	14	1.1	446	170	14	18	.09
349-69	9.0	1.6	16	1.9	447	170	21	18	.09
889-44	3.7	.51	3.7	.46	452	100	13	14	.12
888-61	68.6	8.5	190	2.9	438	270	4	12	.04
889-71	2.8	.15	.53	.18	447	19	7	5.3	.21
889-72	67.7	6.9	130	2.6	443	190	4	10	.05
1535u-5	9.5	1.3	23	.71	443	240	8	14	.05
1535u-8	39.9	4.1	120	2.2	439	290	6	10	.03
1535u-23a	7.6	2.7	21	.32	441	270	4	36	.11
1535u-25	11.0	1.7	25	.66	445	230	6	15	.06
1535-3	.09	---	---	---	---	---	---	---	---
1535-7	14.8	1.8	38	1.1	447	260	8	12	.05
1535-8	.69	.32	1.1	.13	444	160	18	46	.23
1535-12	4.7	.77	6.2	.33	449	130	7	16	.11
1535-13a	73.0	1.5	160	7.2	442	210	10	2.1	.01
1535-22	.11	---	---	---	---	---	---	---	---
1535-23	7.2	1.0	8.8	.36	444	120	5	14	.11

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
1535-24	0.70	0.15	0.50	0.14	444	72	20	21	0.23
1535-25	14.6	3.0	42	.97	448	290	7	21	.07
1535-27	35.3	.55	56	2.3	445	160	6	1.6	.01
1535-47	65.9	7.6	160	3.9	447	240	6	12	.05
1535-54	.21	---	---	---	---	---	---	---	---
1535-66	7.9	1.4	12	.93	437	150	12	18	.11
1535-69	61.1	10	150	2.5	452	240	4	16	.06
1535-78	10.3	.58	5.2	1.0	444	50	10	6	.10
1535-79	68.4	.43	120	4.1	446	180	6	.6	.003
1535-107	2.7	.28	1.2	2.3	446	46	87	10	.18
1535-144	1.7	.11	.22	.60	449	12	35	6.3	.33
1535-146	33.4	2.9	44	1.1	445	130	3	8.7	.06
1535-150	55.6	3.9	69	3.8	453	120	7	7.0	.05
1535-159	2.7	.23	.78	2.5	450	29	93	8.5	.22
1535-187	42.4	6.6	88	2.0	453	210	5	16	.07
1615-3	17.2	3.7	48	.78	448	280	5	21	.07
1615-5	.45	.26	.35	.26	440	78	61	58	.42
1615-6	15.7	2.4	46	.74	438	290	5	16	.05
1615-7	1.9	.50	3.0	.50	440	160	27	26	.14
1615-8	.21	---	---	---	---	---	---	---	---
1615-12	69.6	.62	190	3.3	443	280	5	.9	.003
1615-21	.83	.14	.37	.72	447	45	87	17	.27
1615-47	.29	.047	.13	.28	452	45	95	16	.26
1615-50	.25	---	---	---	---	---	---	---	---
1615-53	12.4	2.4	32	.76	444	260	6	19	.07
1615-56	76.1	.22	130	4.1	452	170	5	.3	.002
1615-136	7.3	2.0	19	0.80	443	260	11	27	.09
1615-139	.48	.078	.21	.40	449	43	84	16	.27
1615-143	.08	---	---	---	---	---	---	---	---
1615-191	10.1	1.9	23	.70	448	230	7	18	.07

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
1615-193	3.9	0.55	2.5	0.47	453	65	12	14	0.18
1615-194	57.5	8.1	160	3.4	446	270	6	14	.05
1615-236	1.2	.13	.32	.32	445	26	26	10	.28
1615-237	14.9	3.4	31	1.0	445	210	7	23	.10
1615-247	.23	---	---	---	---	---	---	---	---
1615-264	2.0	.24	.90	.61	449	45	30	12	.21
1615-265	12.5	2.4	32	.92	448	260	7	19	.07
1615-267	56.2	3.4	77	1.8	447	140	3	6.0	.04
1615-290	21.0	4.0	51	1.2	448	240	6	19	.07
1615-292	62.7	4.8	160	2.1	447	250	3	7.7	.03
1615-341	66.7	1.2	160	2.4	454	240	4	1.8	.008
1615-382	4.1	.42	2.3	1.1	449	57	27	10	.15
1615-384	44.1	3.9	120	1.8	448	270	4	8.8	.03
1051-9	12.2	2.4	23	.31	449	190	3	20	.10
1051-11	.64	.69	.62	.24	447	96	38	110	.53
1051-13	5.3	1.2	4.5	.42	453	86	8	22	.21
1051-44	.55	.087	.11	.40	444	19	73	16	.45
1051-48	8.9	2.2	9.5	.55	452	110	6	25	.19
1051-49	3.0	.55	3.0	.47	449	100	16	19	.15
1051-50	11.9	2.9	18	.42	456	150	4	25	.14
1051-62	3.9	.61	1.3	.44	447	33	11	16	.32
1051-63	10.8	2.3	7.1	.70	456	65	6	21	.25
1051-66	9.5	2.1	8.0	.66	461	84	7	22	.21
1051-69	58.5	11	120	1.4	462	210	2	18	.08
1051-94	.55	.10	.11	.30	449	20	55	18	.48
1051-99	.88	.10	.04	.33	464	5	38	11	.71
1051-100	7.0	.53	1.0	.70	450	15	10	7.6	.34
1051-105	3.8	.77	1.8	.58	448	48	15	20	.30
1051-106	10.4	3.0	11	.49	452	100	5	29	.22
1051-108	45.7	8.9	95	.99	454	210	2	26	.11

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
1051-115	12.4	2.9	12	0.53	453	100	4	24	0.19
1051-124	55.1	7.2	110	1.6	454	190	3	13	.06
1051-155	3.2	.40	.70	.76	453	21	24	12	.36
1044-15	.32	.073	.019	.18	452	6	56	23	.79
1044-18	.35	.013	.034	.15	443	10	42	3.7	.27
1044-19	3.5	1.3	3.3	.33	448	92	9	36	.28
1044-32	9.9	3.9	17	.57	455	170	6	39	.18
1044-35	.35	.24	.21	.19	442	62	56	69	.53
1044-38	4.1	1.1	4.0	.40	454	97	10	28	.22
1044-40	56.7	12	130	2.9	464	220	5	21	.09
1044-45	.25	---	---	---	---	---	---	---	---
1044-46	5.5	.72	3.2	.48	458	57	9	13	.19
1044-47	15.2	2.6	15	.50	457	100	3	17	.15
1044-48	62.4	5.9	150	2.2	468	240	4	9.4	.04
1044-81	61.2	4.1	110	3.0	464	190	5	6.7	.03
1044-97	4.7	.40	1.7	1.0	467	37	21	8.5	.19
1044-99	64.3	3.3	100	3.1	460	160	5	5.1	.03
1044-111	2.0	.091	.18	1.5	466	9	75	4.6	.34
1044-114	36.0	2.9	49	1.4	470	140	4	8.1	.06
1065-2a	2.4	1.3	3.6	.75	444	150	31	54	.26
1065-2b	7.3	3.5	9.7	.56	453	130	8	48	.26
1065-4	.98	.094	.28	.69	443	28	70	9.6	.25
1065-5	.73	.090	.15	.49	443	21	67	12	.38
1065-6a	8.1	2.6	11	.40	458	130	5	32	.19
1065-6b	11.6	3.4	14	.53	458	120	5	29	.20
1065-7	.33	.14	.16	.33	451	47	99	42	.46
1065-9	72.4	9.4	130	1.6	457	180	2	13	.06
1065-15	10.0	2.2	11	.70	457	110	7	22	.17
1065-17	63.0	12	150	1.7	455	240	3	19	.07
1065-20	1.3	.10	.22	.63	460	18	50	8.3	.32

Table 3.--Continued

Sample number	Organic[a] carbon (percent)	S_1[b] mgHC/g sample	S_2[c] mgHC/g sample	S_3[d] mg CO_2/g sample	Temperature of[e] maximum yield (^oC)	Hydrogen[f] index mg HC/g Org.C	Oxygen[g] index mg CO_2/g Org.C	S_1/Org.C mg HC/g Org.C	Production[h] index
1065-21b	0.28	---	---	---	---	---	---	---	---
1065-22b	1.5	.15	.23	.48	458	15	32	9.7	.39
1065-23	3.5	.51	1.4	.48	451	39	14	15	.27
1065-24	50.5	6.0	100	1.5	457	200	3	12	.05
1065-34	35.0	2.5	52	.99	458	150	3	7.1	.05
1065-39	1.1	.083	.004	.66	474	<1	60	7.5	.95
1065-48b	1.2	.042	.060	.58	467	5	49	3.5	.41

a. air-dried basis.
b. mg volatile HC/g sample: Rock-Eval analysis.
c. mg pyrolyzable HC and HC like compounds/g sample: Rock-Eval analysis.
d. mg CO_2/g sample: Rock-Eval analysis.
e. Temperature at which the yield of pyrolysis products (S_2) is a maximum (T_{max}): Rock-Eval analysis.
f. S_2/Org.C.
g. S_3/Org.C.
h. $S_1/S_1 + S_2$.

Table 4.--Vitrinite reflectance for 19 coal samples from the Middle Pennsylvanian Cherokee and Marmaton Groups

Sample number	Vitrinite reflectance[a] (% R_o)			Number of measurements	Quality[c] PASLV+PGH
	Median	Range[b]	Standard deviation		
41-24	0.43	0.30-.53	0.04	125	46699-313
41-60	.53	.40-.65	.05	75	64488-422
22-7	.48	.39-.55	.04	100	57789-115
22-30	.46	.40-.57	.04	125	46699-413
22-48	.52	.43-.59	.04	96	48689-213
GS-105	.45	.35-.57	.04	125	67699-213
BM14-4	.43	.32-.55	.04	125	76699-312
MC204-2	.51	.45-.65	.03	125	97669-314
MC168-6	.53	.42-.61	.03	125	99699-911
D189091	.65	.54-.75	.03	125	97799-313
D196198	.70	.59-.83	.03	127	97699-214
889-72	.68	.55-.79	.05	139	87699-513
1513-13A	.57	.48-.66	.03	125	97699-213
1513-27	.63	.47-.75	.05	125	97799-313
1535-79	.73	.58-.82	.04	125	97799-313
1535-146	.80	.66-.91	.05	125	75599-512
1044-40	.87	.75-1.06	.06	132	97699-213
1044-81	.99	.80-1.12	.06	125	87799-313
1044-99	.97	.83-1.09	.05	125	97699-514

a) Reflectance of vitrinite grains at random orientation, oil immersion objective.
b) Range of values, first-cycle vitrinite constituent group.
c) Operator subjective evaluation (scale 1 to 9 of increasing quality or abundance) of polish, abundance (in the preparation), size, ease of picking "low-gray" or first cycle vitrinite, assurance that it is vitrinite, + pyrite in organic grains, organic groundmass, and "high-gray" seen but not included in the measurements (inertinite in coals).

Table 5.--Organic carbon $\delta^{13}C$ analyses for 38 rock samples from the Middle Pennsylvanian Cherokee and Marmaton Groups

Sample number	Organic[a] carbon (percent)	$\delta^{13}C$[b]	Facies[c]
41-2	46.8	-24.9	Nearshore shale (coal)
41-18	61.8	-25.6	Do. (coal)
41-32	45.3	-24.6	Do. (coal)
41-53	3.3	-24.3	Do.
22-22e	25.1	-26.4	Do.
22-23	63.4	-25.3	Nearshore shale (coal)
22-33	52.5	-24.6	Do. (coal)
21-36	64.8	-25.1	Do. (coal)
Anna	23.3	-26.1	Offshore shale
Lexington	71.7	-25.4	Nearshore shale (coal)
BM 14-2	23.1	-27.2	Offshore shale
BM 14-3	15.0	-24.9	Do.
MC121-2	19.7	-25.7	Do.
MC121-3	9.9	-24.7	Do.
MC121-4	61.0	-24.6	Nearshore shale (coal)
MC142-3	6.0	-23.9	Do.
D189091	69.6	-25.3	Do. (coal)
1535-12	4.7	-24.3	Offshore shale
1535-13a	73.0	-24.8	Nearshore shale (coal)
1535-23	7.2	-24.3	Offshore shale
1535-25	14.6	-26.1	Offshore shale
1535-78	10.3	-24.5	Nearshore shale
1535-79	68.4	-24.8	Do. (coal)
1535-144	1.7	-24.3	Do.
1535-146	33.4	-24.5	Do. (coal)
1615-237	14.9	-25.6	Offshore shale
1615-290	21.0	-24.8	Do.
1615-292	62.7	-24.9	Nearshore shale (coal)
1044-32	9.9	-26.4	Offshore shale
1044-38	4.1	-25.1	Do.
1044-40	56.7	-24.4	Nearshore shale (coal)
1044-46	5.5	-24.5	Offshore shale
1044-47	15.2	-26.1	Do.
1044-48	62.4	-25.8	Nearshore shale (coal)
1044-97	4.7	-24.3	Do.
1044-99	64.3	-24.3	Do. (coal)
1051-115	12.4	-26.1	Offshore shale

a. Air-dried basis.
b. Results are relative to the PDB marine carbonate standard.
c. Facies nomenclature is from Heckel (1977).

Table 6.--Chloroform extractable organic matter composition for 77 rock samples from the Middle Pennsylvanian Cherokee and Marmaton Groups

[---, no data, EOM = extractable organic matter, HC = hydrocarbons, Org. C = organic carbon]

Sample number	Organic[a] carbon (percent)	Chloroform Extracts EOM (ppm)	Saturated HC (ppm)	Aromatic HC (ppm)	Resins (ppm)	Asphaltenes (ppm)	EOM / Org. C mg/g	Saturated HC+ Aromatic HC / EOM	Saturated HC / Aromatic HC	Resins / Asphaltenes	Pristane[b] / Phytane
41-2	46.8	10,300	1,400	3,400	2,600	3,400	22	0.44	0.41	0.76	3.4
41-8	57.3	9,100	1,000	3,300	2,100	2,300	16	.49	.30	.91	5.8
41-13f	7.9		Core box wax contamination				---	---	---	---	1.3
41-17	24.8	5,800	900	1,200	2,300	260	23	.45	.75	8.8	.8
41-18	61.8	19,000	1,700	5,400	5,300	2,500	31	.48	.31	2.1	3.6
41-32	45.3	4,600	630	1,900	1,200	890	10	.55	.33	1.3	6.2
41-53	3.3		Core box wax contamination				---	---	---	---	3.4
22-6c	.34		----------do----------				---	---	---	---	2.2
22-7	62.3	20,000	3,000	5,800	4,200	4,600	32	.50	.52	.91	6.6
22-22c	4.8		Core box wax contamination				---	---	---	---	1.6
22-22e	25.1	6,000	1,000	1,700	2,600	400	24	.45	.59	6.5	.9
22-23	63.4	17,000	1,000	5,200	3,900	2,600	27	.49	.19	1.5	2.4
22-30	52.8	8,700	1,100	2,800	1,700	2,400	16	.50	.40	.71	6.4
22-33	52.5	11,400	2,100	3,900	2,000	3,400	22	.53	.54	.59	5.6
22-44	34.1	5,700	520	2,200	1,400	1,200	17	.51	.24	1.2	6.7
21-26	63.5	30,000	1,900	9,700	5,200	13,000	47	.40	.20	.40	8.7
21-36	64.8	36,000	1,600	8,800	4,900	12,000	56	.38	.18	.41	8.0
Anna	26.3	10,200	1,200	2,200	4,000	1,900	38	.37	.55	2.1	.9
Lexington	71.7	32,000	1,800	8,500	2,300	15,000	45	.38	.21	.15	8.1
GS 102	67.5	35,000	2,200	10,000	5,100	12,000	52	.42	.22	.43	8.5
BM 2-3	5.2		Core box wax contamination				---	---	---	---	2.5
BM 2-5	21.2	3,100	700	890	860	64	15	.63	.78	13	1.1
BM 5-2	13.9	2,500	650	760	800	81	18	.62	.86	9.9	1.3
GS 105	54.7	17,000	1,500	5,600	2,500	7,000	31	.43	.27	.36	10.6
BM 14-2	23.1	8,800	1,500	1,900	3,500	1,300	38	.41	.79	2.7	1.2

Table 6.--Continued

Sample number	Organic[a] carbon (percent)	Chloroform Extracts: EOM (ppm)	Saturated HC (ppm)	Aromatic HC (ppm)	Resins (ppm)	Asphaltenes (ppm)	EOM / Org. C mg/g	Saturated HC+ Aromatic HC / EOM	Saturated HC / Aromatic HC	Resins / Asphaltenes	Pristane[b] / Phytane
BM 14-3	15.0	3,000	330	920	810	960	20	0.41	0.36	0.84	4.4
BM 17-5	4.3	570	60	200	180	130	13	.46	.30	1.4	3.5
MC 86-4	6.5	1,300	150	340	470	300	20	.39	.44	1.6	3.3
MC 121-1	.69	Core box wax contamination					---	---	---	---	1.4
MC 121-2	19.7	6,700	2,400	2,300	1,600	370	34	.70	1.0	4.3	1.4
MC 121-3	9.9	2,000	560	660	420	100	20	.70	.85	4.2	1.8
MC 121-4	61.0	9,400	1,100	4,700	1,500	1,800	15	.64	.23	.83	6.7
MC 121-6	1.1	Core box wax contamination					---	---	---	---	5.3
MC 142-3	6.0	----------do----------					---	---	---	---	4.6
M-7-65	20.1	5,100	1,500	1,600	1,500	360	25	.63	.94	4.2	1.4
MC 168-4	2.4	Core box wax contamination				---	---	---	---	4.4	
MC 168-5	18.0	4,300	1,600	1,300	1,100	460	24	.64	1.2	2.4	1.5
MC 168-6	74.3	25,000	2,400	10,000	4,400	5,400	34	.56	.24	.82	6.6
D189091	69.6	17,200	2,700	6,000	2,300	5,300	25	.53	.45	.43	1.8
349-3	21.6	6,300	1,600	1,600	1,500	620	29	.60	1.0	2.4	1.7
349-46	14.9	3,800	1,200	1,100	940	280	26	.65	1.1	3.4	1.9
349-57	8.1	2,800	730	920	680	440	34	.60	.79	1.5	2.0
889-44	3.7	530	100	210	110	100	14	.60	.48	1.1	4.5
1535u-25	11.0	3,500	1,300	1,100	1,000	160	32	.67	1.2	6.3	1.5
1535-7	14.8	3,100	1,000	1,100	870	170	21	.67	.91	5.1	1.7
1535-8	0.69	550	220	120	130	90	80	.61	1.8	1.4	1.3
1535-12	4.7	1,200	490	310	260	140	26	.67	1.6	1.9	2.4
1535-13a	73.0	13,000	1,400	4,900	2,100	4,100	18	.50	.29	.51	6.5
1535-23	7.2	1,500	710	440	330	51	21	.75	1.6	6.5	2.0
1535-25	14.6	5,300	2,200	1,500	1,100	140	36	.75	1.5	7.9	1.6
1535-47	65.9	7,800	960	2,700	910	2,100	12	.55	.36	.43	8.6
1535-78	10.3	2,500	420	1,100	440	490	24	.62	.38	.90	5.2
1535-79	68.4	9,300	1,900	4,400	1,500	1,600	14	.67	.43	.94	7.5
1535-107	2.7	620	210	130	140	40	23	.65	1.6	3.5	3.0
1535-144	1.7	450	180	90	100	26	26	.68	2.0	3.8	2.9

Table 6.--Continued

Sample number	Organic[a] carbon (percent)	Chloroform Extracts: EOM (ppm)	Saturated HC (ppm)	Aromatic HC (ppm)	Resins (ppm)	Asphaltenes (ppm)	EOM / Org. C mg/g	Saturated HC+ Aromatic HC / EOM	Saturated HC / Aromatic HC	Resins / Asphaltenes	Pristane[b] / Phytane
1535-146	33.4	2,800	500	1,300	450	510	8.4	0.65	0.38	0.88	5.2
1615-3	17.2	5,500	2,300	1,400	1,300	150	32	.72	1.6	8.6	1.6
1615-6	15.7	4,300	1,100	1,100	1,000	250	27	.64	1.0	4.0	1.6
1615-53	12.4	4,700	1,400	1,300	1,200	280	38	.65	1.1	4.3	1.7
1615-56	76.1	5,800	510	1,500	1,200	2,000	7.6	.39	.34	.6	5.8
1615-237	14.9	5,800	2,400	1,600	1,200	200	38	.74	1.5	6.0	2.0
1615-290	21.0	3,300	760	1,200	550	460	16	.66	.63	1.2	4.6
1615-292	62.7	7,400	750	3,000	1,200	840	12	.65	.25	1.4	5.1
1051-50	11.9	5,800	2,400	1,400	1,100	200	49	.75	1.7	5.5	1.7
1051-106	10.4	5,300	2,900	1,200	930	230	51	.78	2.4	4.0	1.8
1051-108	45.7	3,800	700	1,400	610	690	8.3	.61	.5	.88	2.2
1051-115	12.4	4,500	2,100	1,000	870	150	36	.75	2.1	5.8	1.8
1051-124	55.1	4,900	1,100	1,700	660	580	8.9	.69	.65	1.1	4.1
1044-32	9.9	5,900	3,000	1,300	930	180	60	.79	2.3	5.2	2.1
1044-35	.35	560	320	110	100	35	160	.76	2.9	2.9	.75
1044-38	4.1	1,400	520	420	230	160	34	.71	1.2	1.4	3.4
1044-40	56.7	4,600	1,100	2,000	540	1,000	8.1	.67	.55	.54	4.5
1044-46	5.5	1,200	660	260	210	90	22	.75	2.5	2.3	2.4
1044-47	15.2	3,200	1,400	850	550	230	21	.74	1.6	2.4	2.5
1044-48	62.4	5,900	610	2,400	660	2,100	9.5	.52	.25	.55	2.6
1044-97	4.7	480	100	170	80	130	10	.56	.60	.62	2.7
1044-99	64.3	6,800	410	3,400	890	1,200	11	.65	.12	.74	4.9

a. Air dried basis.
b. Ratios determined from relative peak heights above baseline.

Table 7.-- $\delta^{13}C$ analyses of saturated HC and aromatic HC fractions of the extractable organic matter for 18 rock and 6 oil samples from the Middle Pennsylvanian Cherokee and Marmaton Groups.

[HC = hydrocarbons]

Sample number	$\delta^{13}C$[a] saturated HC	$\delta^{13}C$[a] aromatic HC	Facies[b]
		Rocks	
41-32	-27.9	-26.0	Nearshore shale (coal)
22-33	-27.2	-25.9	Do. (coal)
Lexington	-28.9	-25.7	Do. (coal)
MC121-4	-26.6	-24.9	Do. (coal)
D189091	-28.6	-26.6	Do. (coal)
349-3	-27.4	-27.6	Offshore shale
1535u-25	-28.7	-28.0	Do.
1535-12	-26.8	-26.0	Do.
1535-13a	-26.8	-25.6	Nearshore shale (coal)
1535-23	-26.5	-26.2	Offshore shale
1535-25	-28.3	-27.4	Do.
1615-6	-29.0	-28.7	Do.
1051-50	-28.1	-27.3	Do.
1044-32	-28.0	-27.4	Do.
1044-38	-27.4	-25.4	Do.
1044-40	-27.5	-24.9	Nearshore shale (coal)
1044-97	-27.7	-27.5	Do.
1044-99	-25.9	-24.4	Do. (coal)
		Oils	
58200	-30.6	-29.2	
58204	-30.2	-29.4	
58206	-29.2	-28.2	
58208	-30.3	-29.0	
58209	-29.5	-28.7	
64249	-30.4	-29.0	