



# **Vitrinite Reflectance Data for the Wind River Basin, Central Wyoming**

By, Thomas M. Finn, Laura N.R. Roberts, and Mark J. Pawlewicz

Open-File Report 2006–1015

**U.S. Department of the Interior**  
**U.S. Geological Survey**

**U.S. Department of the Interior**  
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U.S. Geological Survey, Reston, Virginia: 2006

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Suggested citation:  
Finn, T.M., Roberts, L.N.R., and Pawlewicz, M.J., 2006, Vitrinite reflectance data for the Wind River Basin, central, Wyoming: U.S. Geological Survey Open-File Report 2006-1015.

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# Vitrinite Reflectance Data for the Wind River Basin, Central Wyoming

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## Introduction

The Wind River Basin is a large Laramide (Late Cretaceous through Eocene) structural and sedimentary basin that encompasses about 7,400 mi<sup>2</sup> in central Wyoming (fig. 1). The basin boundaries are defined by fault-bounded Laramide uplifts that surround it, including the Owl Creek and Bighorn Mountains to the north, Wind River Range to the west, Granite Mountains to the south, and Casper Arch to the east (fig. 1). Important conventional oil and gas resources have been discovered and produced from reservoirs ranging in age from Cambrian through Tertiary (Keefer, 1969; Fox and Dolton, 1989, 1996; De Bruin, 1993). In addition, an extensive overpressured basin-centered gas accumulation has also been identified in Cretaceous and Tertiary sandstone reservoirs by numerous researchers including Spencer (1987), Johnson and others (1996), Surdam (1997), and Surdam and others (1997, 2004). The purpose of this report is to present new vitrinite reflectance data to be used in support of the U.S Geological Survey assessment of undiscovered oil and gas resources of the Wind River Basin.

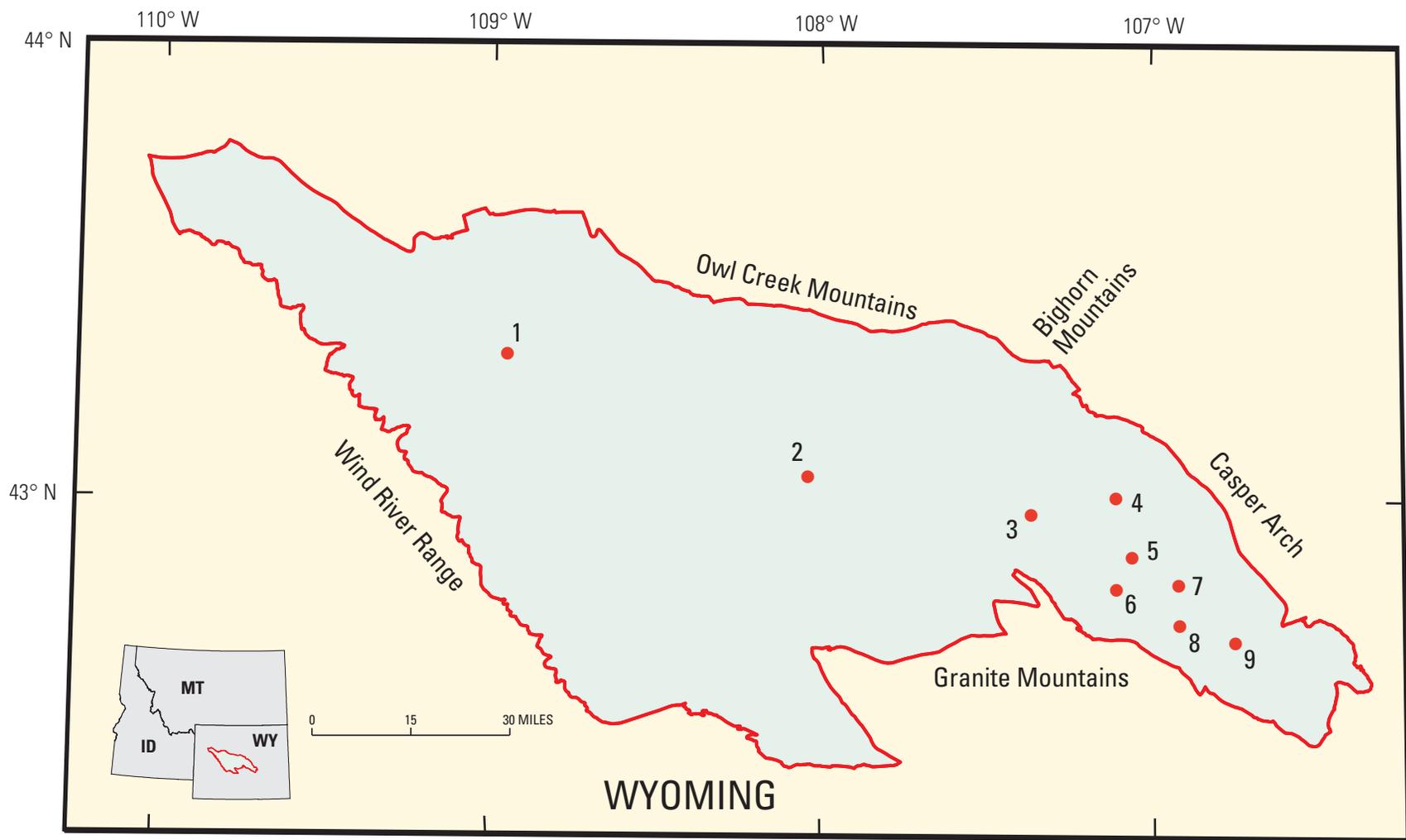
One hundred and nineteen samples were collected from Jurassic through Tertiary rocks, mostly coal-bearing strata (figs. 1, 2), in an effort to better understand and characterize

the thermal maturation and burial history of potential source rocks. The results of the analyses are presented in table 1. One sample was from core and the remainder are from well cuttings. These data were collected and analyzed to supplement previously published data by Johnson and others (1991), Barker and Crysedale (1993); Barker and others (1993), Katz and Liro (1993), Nuccio and others (1993), Pawlewicz (1993), Nuccio (1994), and Nuccio and others (1996).

The coal samples were analyzed by vitrinite reflectance to determine levels of thermal maturation. Preparation of the coal for reflectance analysis required (1) crushing the larger coal pieces into 0.25- to 1-millimeter pieces, (2) casting the pieces with epoxy in pre-cut and drilled plugs, and (3) curing the samples overnight. Subsequently, a four-step grinding process was implemented – two with progressively finer sandpaper (60 and 600 grit), and two polishing steps (0.3 and 0.05 micron). Vitrinite reflectance measurements were determined at 500 X magnification using plane-polarized incident white light and a 546-nanometer monochromatic filter in immersion oil. For samples with sufficient quality vitrinite, at least 25 measurements were recorded. For samples of poorer quality, either due to a poor polish or to the presence of mineral or other inorganic material, fewer measurements were recorded.

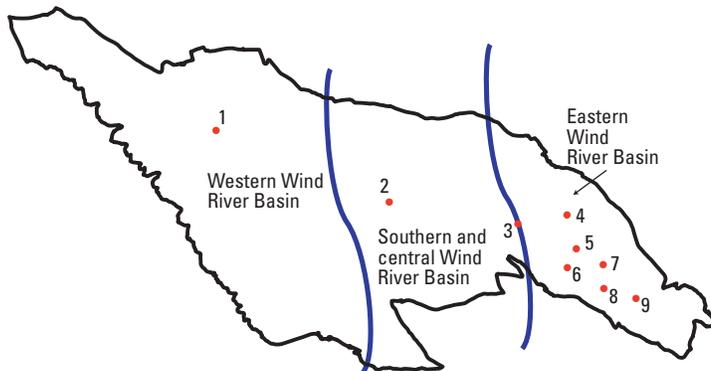
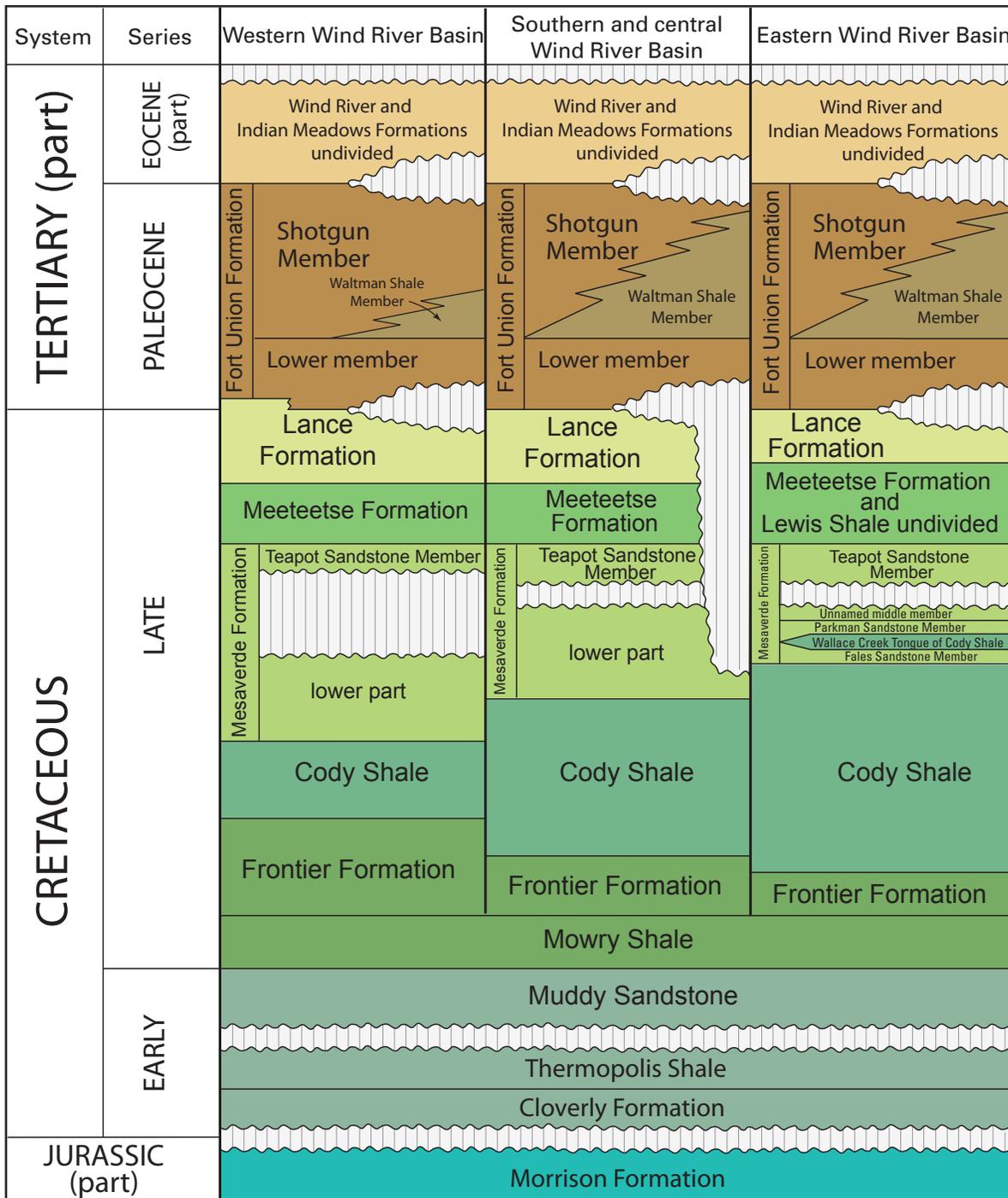
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**Figure 1.** Map showing general outline of the Wind River Basin, central Wyoming, and locations of samples for vitrinite reflectance analysis. Numbers refer to column 1 in table 1.

4 Vitritine Reflectance Data for the Wind River Basin, Wyoming



**Figure 2.** Generalized stratigraphic chart of Jurassic through lower Tertiary rocks in the Wind River Basin, central Wyoming. Inset map shows locations of samples for vitritine reflectance analysis; numbers refer to column 1 in table 1.

**Table 1.** Vitrinite reflectance data and sample locations for the Wind River Basin; central Wyoming

[All data are from well cuttings except for sample at Map no. 6, which is from core. Map no. refers to numbers plotted in figure 1. Depth range, in feet. Abbreviations: API, well number assigned by American Petroleum Institute; TN, Township North; RW, Range West; Sec., section; R<sub>o</sub>, vitrinite reflectance; N, number of readings per sample; Std. dev., standard deviation; Fm, Formation; Mbr, Member; Lith., lithology; carb sh, carbonaceous shale. Queried (?) where uncertain].

Map no.	API	TN	RW	Sec.	Operator	Well	Depth range	%R <sub>o</sub>	N	Std. dev.	Formation or Member	Lith.	Comments
1	49013209380000	4	2	11	Husky Oil	Tribal 16-11	3330-3340	0.52	30	0.04	Mesaverde Fm	coal	
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	3620-3630	0.46	29	0.02	Mesaverde Fm	coal	
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	3910-3920	0.50	35	0.06	Mesaverde Fm	coal	
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	4220-4270	0.52	25	0.04	Cody Shale	coal	
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	4670-4690	0.59	23	0.06	Cody Shale	coal	poor quality
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	5020-5070	0.56	25	0.05	Cody Shale	coal	
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	8990-9030	0.53	20	0.09	Frontier Fm	coal	
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	10020-10110	0.39	8	0.13	Frontier Fm/Mowry Shale	coal	few pieces to examine
	49013209380000	4	2	11	Husky Oil	Tribal 16-11	10390-10420	0.40	18	0.09	Muddy Sandstone	coal	probably some cavings
2	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	4300-4360	0.58	19	0.01	Fort Union Fm	coal	
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	4900-5000	0.59	21	0.03	Fort Union Fm	coal	
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	5520-5600	0.59	17	0.04	Fort Union Fm	coal	
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	5920-6000	0.62	23	0.03	Fort Union Fm	coal	
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	6360-6400	0.59	23	0.03	Fort Union Fm	coal	low rank coal, bimaceral
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	7560-7620	0.68	15	0.03	Lance Fm	coal	low rank coal, very dirty, bimaceral
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	7660-7760	0.69	21	0.04	Lance Fm	coal	mixed sample, appears to be some mixing of coaly material
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	7860-7960	0.79	18	0.02	Lance Fm	coal	mixed sample, appears to be some mixing of coaly material
	49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	8640-8680	0.63	19	0.04	Mesaverde Fm	coal	mixing of coaly material and oxidized pieces are common
49013205650000	36	94	25	Pancanadian Pet. Co.	Fuller Reservoir II 22-25	9200-9300	0.75	25	0.03	Cody Shale	coal		
3	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	1090-1210	0.46	2	0.00	Fort Union Fm	coal	only a few pieces of poor quality coal
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	1520-1550	0.47	27	0.04	Fort Union Fm	coal	
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	2000-2090	0.45	19	0.04	Fort Union Fm	coal	poor sample, few pieces of poor polish/quality
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	3270-3330	0.48	27	0.04	Lance Fm	coal	fair sample, lower quality coal
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	4140-4230	0.56	21	0.04	Lance Fm	coal	fair sample
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	5000-5030	0.57	27	0.05	Meeteetse Fm	coal	
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	6020-6110	0.55	21	0.04	Mesaverde Fm	coal	fair sample
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	7120-7240	0.59	31	0.04	Cody Shale	coal	fair sample
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	8620-8680	0.56	13	0.04	Cody Shale	coal	fair sample
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	10900-10950	0.56	13	0.06	Cody Shale	coal	poor sample, several populations, higher values probably right
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	11050-11120	0.80	13	0.30	Frontier Fm	coal	poor sample, several populations, higher values probably right
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	11700-11800	0.54	17	0.03	Muddy Sandstone	coal	only a few pieces of coal
	49025209780000	35	88	27	Diamond Shamrock	1-27 Coal Bank	12170-12180	0.58	11	0.05	Thermopolis Shale	coal	poor sample, few pieces of poor polish/quality
4	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	2080-2200	0.44	4	0.04	Shotgun Mbr	carb sh	poor sample
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	2470-2530	0.47	17	0.05	Shotgun Mbr	coal	fair sample
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	2620-2830	0.67	9	0.12	Shotgun Mbr	coal	poor sample, few pieces, and two populations of coal maturity
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	5020-5060	0.54	25	0.05	Lower Fort Union	coal	fair sample
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	6800-6870	0.64	14	0.05	Lower Fort Union	coal	fair sample, mostly carb sh
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	7900-7930	0.67	29	0.06	Lance Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	8820-8910	0.70	25	0.08	Lance Fm	coal	fair sample, wide range of coal color
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	9900-10000	0.53	25	0.02	Lance Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	11260-11280	0.74	31	0.05	Lance Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	11400-11450	0.68	27	0.04	Lance Fm	coal	fair sample, pieces with oxidation rims higher R <sub>o</sub> than other material
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	11600-11620	0.82	29	0.05	Lance Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	11760-11780	0.73	25	0.05	Lance Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	11910-11930	0.72	31	0.05	Meeteetse Fm	coal	fair sample, two populations of coal
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	12140-12180	0.72	19	0.05	Meeteetse Fm	coal	fair sample
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	12430-12460	0.61	31	0.05	Meeteetse Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	12660-12740	0.60	29	0.05	Meeteetse Fm/Teapot Sandstone	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	12820-12890	0.66	27	0.05	Mesaverde Fm	coal	fair sample
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	13110-13150	0.66	5	0.02	Mesaverde Fm	carb sh	poor sample
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	13300-13350	0.57	13	0.05	Mesaverde Fm	carb sh	little vitrinite to measure
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	13650-13740	0.73	17	0.06	Mesaverde Fm	coal	
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	14870-14930	0.89	3	0.06	Cody Shale	carb sh	little organic matter
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	16300-16450	1.25	16	0.26	Cody Shale	shale	whole slide scan, all dispersed organic matter
	49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	18520-18560	1.21	2	0.05	Frontier Fm	coal	one piece present
49025208370000	35	86	11	Union Oil of Calif.	Hells Half Acre 1-K-II	19650-19700	1.40	2	0.04	Muddy Sandstone	coal		

**Table 1.** Vitrinite reflectance data and sample locations for the Wind River Basin; central Wyoming.-Continued

Map no.	API	TN	RW	Sec.	Operator	Well	Depth range	%R <sub>o</sub>	N	Std. dev.	Formation or Member	Lith.	Comments
5	49025058080000	34	85	30	True Oil	1 Sun Ranch	3400-3520	0.45	23	0.05	Fort Union Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	3820-4000	0.50	31	0.03	Fort Union Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	5620-5720	0.43	10	0.10	Lance Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	6990-7040	0.56	31	0.06	Lance Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	7290-7370	0.63	33	0.04	Lance Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	7720-7780	0.67	25	0.06	Meeteetse Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	8070-8110	0.64	15	0.06	Meeteetse Fm	coal	lean
	49025058080000	34	85	30	True Oil	1 Sun Ranch	8500-8550	0.64	31	0.03	Mesaverde Fm	coal	
	49025058080000	34	85	30	True Oil	1 Sun Ranch	8600-8630	0.59	31	0.03	Mesaverde Fm	coal	
49025058080000	34	85	30	True Oil	1 Sun Ranch	8970-9020	0.54	33	0.04	Fales Sandstone Mbr	coal		
6	49025220540000	33	86	23	Diamond Shamrock	23-23 N. Grieve	10269	0.52	33	0.02	Muddy Sandstone	coal	core sample
7	49025200590000	33	84	11	Union Oil	WPS Unit 8	5840-6310	0.58	33	0.07	Fort Union Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	6970-7240	0.57	35	0.05	Lance Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	7710-7770	0.62	13	0.05	Lance Fm	coal	poor sample, almost all pieces with oxidation rims, cavings(?)
	49025200590000	33	84	11	Union Oil	WPS Unit 8	7830-7890	0.61	33	0.04	Lance Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	8120-8160	0.67	31	0.04	Lance Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	8490-8520	0.59	31	0.05	Meeteetse Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	9030-9100	0.53	29	0.05	Meeteetse Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	9260-9300	0.58	31	0.06	Mesaverde Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	9600-9660	0.60	31	0.04	Mesaverde Fm	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	10190-10240	0.59	29	0.04	Cody Shale	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	10390-10440	0.60	29	0.08	Cody Shale	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	11030-11090	0.68	25	0.04	Cody Shale	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	11900-11950	0.59	37	0.06	Cody Shale	coal	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	12710-12760	0.59	23	0.06	Cody Shale	coal/shale	
	49025200590000	33	84	11	Union Oil	WPS Unit 8	12970-13040	0.52	33	0.03	Cody Shale	coal/shale	
49025200590000	33	84	11	Union Oil	WPS Unit 8	14130-14280	0.62	8	0.09	Cody Shale/Frontier Fm	coal	very poor sample	
49025200590000	33	84	11	Union Oil	WPS Unit 8	15340-15400	1.25	5	0.04	Muddy Sandstone/Thermopolis Shale	coal/shale	shale whole rock, a few dispersed organic matter particles	
8	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	1240-1270	0.34	25	0.02	(?)	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	1690-1720	0.37	31	0.03	(?)	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	2530-2560	0.46	27	0.04	Lance Fm	coal	oxidation rims
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	3010-3040	0.43	31	0.03	Meeteetse Fm	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	3640-3670	0.45	29	0.06	Teapot Sandstone Mbr	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	4090-4120	0.45	29	0.03	Middle Mbr Mesaverde Fm	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	4600-4630	0.44	31	0.04	Fales Sandstone Mbr	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	5290-5320	0.43	29	0.05	Cody Shale	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	6040-6160	0.46	31	0.05	Cody Shale	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	7190-7280	0.42	25	0.03	Cody Shale	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	7970-8080	0.42	27	0.06	Cody Shale	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	10440-10450	0.43	31	0.04	Frontier Fm	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	10750-10790	0.44	31	0.04	Frontier Fm	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	11530-11600	0.61	25	0.04	Muddy Sandstone (?)	coal	
	49025211460000	32	84	20	Elf Aquitaine	21-20 Grayrock Federal	11760-11800	0.73	23	0.26	Cloverly Fm	coal	mixture of high-rank material, cavings(?), mostly low R <sub>o</sub> vitrinite

**Table 1.** Vitrinite reflectance (R<sub>o</sub>) data and sample locations for the Wind River Basin; central Wyoming.-Continued

Map no.	API	TN	RW	Sec.	Operator	Well	Depth range	%R <sub>o</sub>	N	Std. dev.	Formation or Member	Lith.	Comments
9	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	3640-3720	0.49	3	0.12	Fort Union Fm	coal	very poor sample
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	4100-4160	0.43	4	0.05	Fort Union Fm	coal	lean sample
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	4280-4360	0.41	15	0.04	Fort Union Fm	coal	low quality
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	4710-4740	0.49	19	0.05	Lance Fm	coal	low quality, oxidation rims, cavings or mis-handled heat lamp
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	5400-5420	0.52	27	0.05	Lance Fm	coal	low quality
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	5810-5820	0.55	41	0.03	Meeteetse Fm	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	6070-6080	0.73	17	0.16	Meeteetse Fm	coal	low quality
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	6350-6370	0.56	8	0.03	Meeteetse Fm/Lewis Shale	coal	low quality
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	6650-6680	0.47	9	0.05	Mesaverde Fm	coal	low quality
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	6800-6830	0.58	29	0.05	Mesaverde Fm	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	7120-7130	0.48	25	0.03	Mesaverde Fm/Cody Shale	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	7450-7470	0.51	27	0.05	Fales Sandstone Mbr	coal	low quality
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	7820-7860	0.51	21	0.07	Cody Shale	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	8110-8150	0.45	13	0.04	Cody Shale	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	9100-9130	0.46	21	0.04	Cody Shale	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	9800-9860	0.48	29	0.05	Cody Shale	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	10740-10800	0.48	25	0.04	Cody Shale	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	11750-11830	0.51	31	0.06	Frontier Fm	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	12870-12900	0.48	31	0.04	Muddy Sandstone	coal	
	49025204400000	32	83	34	Union Oil	1-34 Young Ranch	13250-13380	1.15	11	0.14	Morrison Fm	coal	obviously weathered, with abundant inertinite