



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

By Mark J. Pawlewicz and Thomas M. Finn

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By Mark J. Pawlewicz and Thomas M. Finn

## Introduction

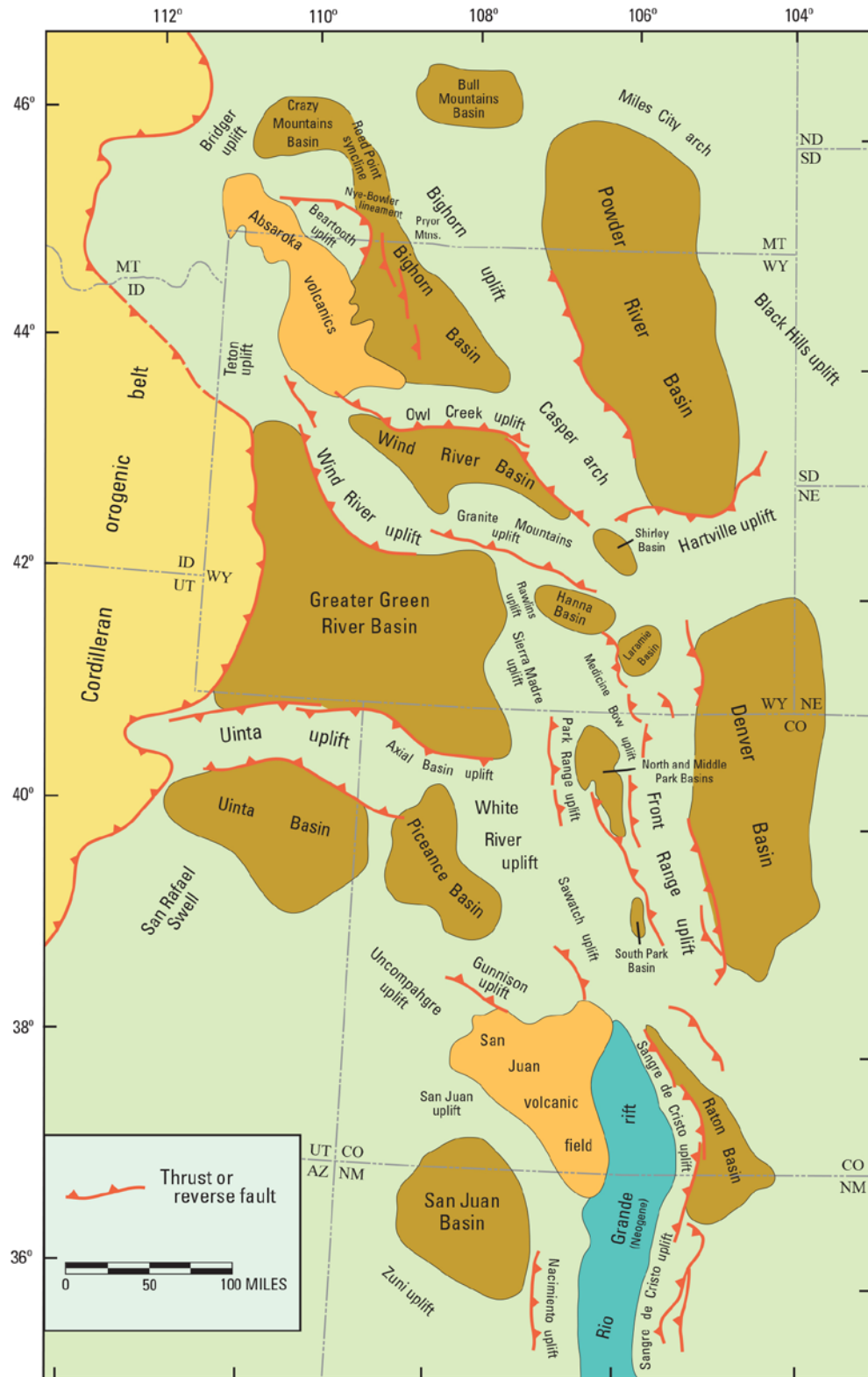
The Wind River Basin is a large Laramide (Late Cretaceous through Eocene) structural and sedimentary basin that encompasses about 7,400 square miles in central Wyoming (fig. 1). The basin is bounded by the Washakie Range and Owl Creek and southern Bighorn Mountains on the north, the Casper arch on the east and northeast, and the Granite Mountains on the south, and Wind River Range on the west (figs. 1 and 2).

Important conventional and unconventional oil and gas resources have been discovered and produced from reservoirs ranging in age from Mississippian through Tertiary (Fox and Dolton, 1989; De Bruin, 1993; Johnson and others, 1996, 2007). In recent years, advances and success in horizontal drilling and multistage fracture stimulation have led to an increase in exploration and completion of wells in marine shales in other Rocky Mountain Laramide basins that were traditionally considered hydrocarbon source rocks. Important parameters that control hydrocarbon production from these shales include: reservoir thickness, amount and type of organic matter, and thermal maturity (Milici, 1993; Curtis, 2002). The purpose of this report is to present new vitrinite reflectance data collected mainly from Cretaceous marine shales in the Wind River Basin to better characterize their thermal maturity and hydrocarbon potential. These new data supplement previously published data by Johnson and others (1991), Barker and Crysdale (1993), Katz and Liro (1993), Nuccio and others (1993), Pawlewicz (1993), Nuccio and others (1996), and Finn and others (2006).

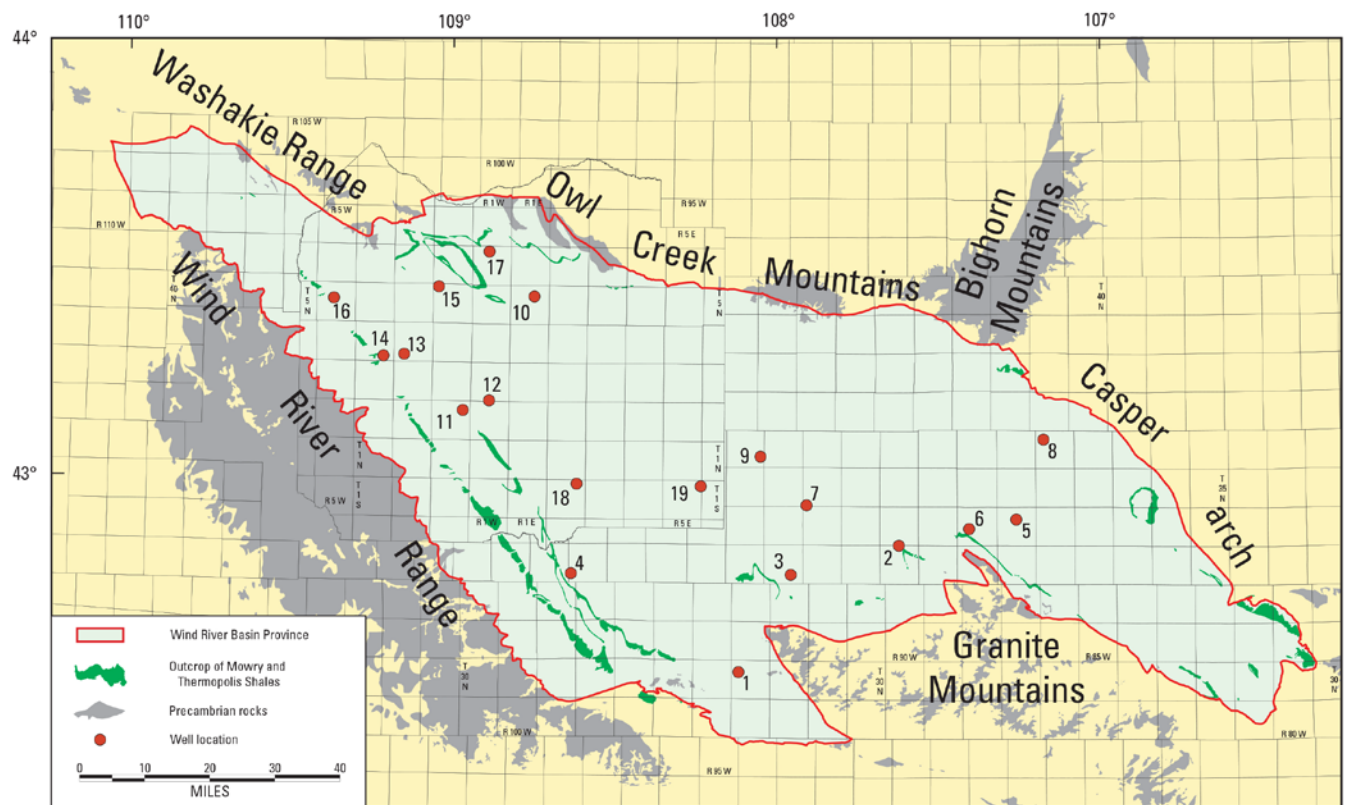
Ninety-nine samples from Cretaceous and Tertiary strata (fig. 3) were collected from well cuttings stored at the U.S. Geological Survey Core Research Center in Lakewood, Colorado. Well sample locations are shown on figure 2. All samples were analyzed for vitrinite reflectance to determine levels of thermal maturation. Preparation of samples for reflectance analysis required (1) crushing the larger 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 and polishing process was implemented that included sanding with progressively finer sandpaper (60 to 600 grit) followed by a two-step polishing process (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 containing sufficiently high 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. Analytical results are given in table 1.

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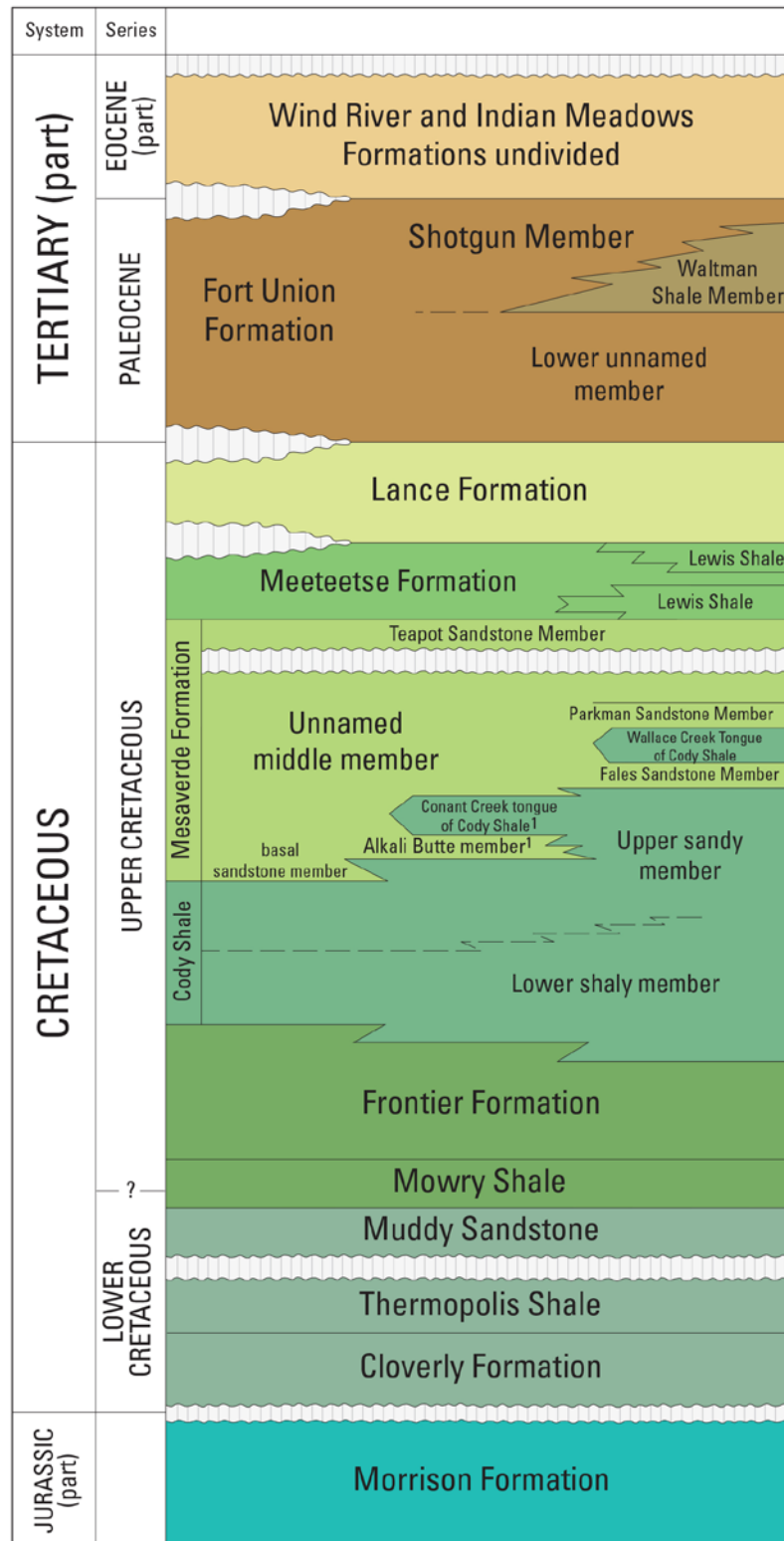
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**Figure 1.** Map of the Rocky Mountain region extending from southern Montana to northern New Mexico showing locations of Laramide sedimentary and structural basins and related features. Modified from Dickinson and others (1988).



**Figure 2.** Map showing general outline of the Wind River Basin, bordering mountain ranges, distribution of major rock units, and sample localities. Outcrops from Green and Drouillard (1994). Province boundary from Johnson and others (2007). Numbers refer to column 1 (map no.) on table 1.



<sup>1</sup>informal units

**Figure 3.** Generalized stratigraphic chart of Upper Jurassic, Cretaceous, and lower Tertiary rocks in the Wind River Basin.



**Table 1.** Vitrinite reflectance data and locations for cuttings samples from wells drilled for oil and gas exploration and production in the Wind River Basin, Wyoming. Map no. refers to sample location numbers shown on figure 2.

[API, well number assigned by American Petroleum Institute; Tnsp., township; Rng., range; Sec., section; Lith., lithology; %Ro, vitrinite reflectance measurement; n, number of readings per sample; nr, no reading. Depth is in feet.]

Map no.	API	Tnsp.	Rng.	Sec.	Operator	Well	Top depth	Bottom depth	Formation	Lith.	%Ro	n
1	49013202250000	30N	94W	8	Oil & Gas Futures	Reserve-Govt. 1	2,000	2,010	Mowry	shale	0.94	12
1	49013202250000	30N	94W	8	Oil & Gas Futures	Reserve-Govt. 1	2,200	2,210	Mowry	shale	0.89	12
1	49013202250000	30N	94W	8	Oil & Gas Futures	Reserve-Govt. 1	2,330	2,340	Thermopolis	shale	0.99	17
2	49013057600000	33N	90W	4	Superior Oil	Govt.-Davis 81-4	2,060	2,070	Frontier	shale	0.57	5
2	49013057600000	33N	90W	4	Superior Oil	Govt.-Davis 81-4	2,740	2,770	Frontier	shale	0.82	11
2	49013057600000	33N	90W	4	Superior Oil	Govt.-Davis 81-4	3,000	3,010	Mowry	shale	0.61	9
2	49013057600000	33N	90W	4	Superior Oil	Govt.-Davis 81-4	3,260	3,280	Mowry	shale	0.62	6
2	49013057600000	33N	90W	4	Superior Oil	Govt.-Davis 81-4	3,400	3,410	Thermopolis	shale	1.30	9
3	49013204640000	33N	93W	26	Oil Resources	Govt-Curry 26-12	2,230	2,260	Frontier	shale	0.63	15
3	49013204640000	33N	93W	26	Oil Resources	Govt-Curry 26-12	2,500	2,510	Mowry	shale	0.82	7
3	49013204640000	33N	93W	26	Oil Resources	Govt-Curry 26-12	2,650	2,660	Mowry	shale	0.81	8
3	49013204640000	33N	93W	26	Oil Resources	Govt-Curry 26-12	2,760	2,770	Thermopolis	shale	0.69	10
4	49013211920000	33N	98W	30	R. Klabzuba	1-30 Federal	1,770	1,780	Mowry	shale	0.99	16
4	49013211920000	33N	98W	30	R. Klabzuba	1-30 Federal	2,000	2,020	Mowry	shale	0.70	6
4	49013211920000	33N	98W	30	R. Klabzuba	1-30 Federal	2,200	2,210	Thermopolis	shale	0.96	17
4	49013211920000	33N	98W	30	R. Klabzuba	1-30 Federal	2,340	2,350	Cloverly	shale	1.24	10

**Table 1.** Vitrinite reflectance data and locations for cuttings samples from wells drilled for oil and gas exploration and production in the Wind River Basin, Wyoming. Map no. refers to sample location numbers shown on figure 2.—Continued

[API, well number assigned by American Petroleum Institute; Tnsp., township; Rng., range; Sec., section; Lith., lithology; %Ro, vitrinite reflectance measurement; n, number of readings per sample; nr, no reading. Depth is in feet.]

Map no.	API	Tnsp.	Rng.	Sec.	Operator	Well	Top depth	Bottom depth	Formation	Lith.	%Ro	n
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	4,680	4,710	Mesaverde	coal	0.46	25
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	7,310	7,320	Cody	shale	0.82	10
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	7,660	7,670	Cody	shale	0.53	11
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	9,530	9,540	Cody	shale	0.83	11
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	10,310	10,340	Frontier	shale	0.62	11
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	10,690	10,700	Mowry	shale	0.73	13
5	49025210670000	34N	87W	9	Davis Oil	1 RK Federal	10,820	10,830	Thermopolis	shale	0.53	7
6	49025058260000	34N	88W	20	M.K.M Exploration	1 Wolters-Fed.	1,560	1,570	Mowry	shale	0.64	12
6	49025058260000	34N	88W	20	M.K.M Exploration	1 Wolters-Fed.	1,900	1,920	Mowry	shale	0.55	9
6	49025058260000	34N	88W	20	M.K.M Exploration	1 Wolters-Fed.	2,020	2,030	Thermopolis	shale	0.70	11
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	1,880	1,900	Fort Union	coal	0.68	19
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	3,040	3,060	Meeteetse	coal	0.54	11
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	3,790	3,810	Mesaverde	coal	0.56	27
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	5,030	5,060	Mesaverde	coal	0.54	13
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	8,970	8,980	Cody	shale	0.92	17
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	9,700	9,710	Frontier	shale	1.08	12
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	9,900	9,910	Mowry	shale	0.93	10
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	10,060	10,070	Mowry	shale	1.11	9
7	49013069220000	35N	92W	31	Sun Oil Company	Wolf-Federal 1	10,190	10,200	Thermopolis	shale	1.10	12

**Table 1.** Vitrinite reflectance data and locations for cuttings samples from wells drilled for oil and gas exploration and production in the Wind River Basin, Wyoming. Map no. refers to sample location numbers shown on figure 2.—Continued

[API, well number assigned by American Petroleum Institute; Tnsp., township; Rng., range; Sec., section; Lith., lithology; %Ro, vitrinite reflectance measurement; n, number of readings per sample; nr, no reading. Depth is in feet.]

Map no.	API	Tnsp.	Rng.	Sec.	Operator	Well	Top depth	Bottom depth	Formation	Lith.	%Ro	n
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	12,680	12,710	Mesaverde	coal	0.57	7
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	13,640	13,650	Cody	shale	1.18	12
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	15,000	15,010	Cody	shale	1.24	9
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	16,000	16,020	Cody	shale	1.54	7
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	17,140	17,160	Cody	shale	1.46	8
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	18,230	18,250	Frontier	shale	1.74	7
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	19,310	19,320	Frontier	shale	nr	
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	19,450	19,460	Mowry	shale	2.01	9
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	19,640	19,650	Mowry	shale	2.41	10
8	49025217680000	36N	86W	8	Coastal Oil & Gas	Bullfrog 3-8-36-86	19,800	19,820	Thermopolis	shale	2.19	10
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	10,800	10,810	Cody	shale	1.33	13
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	12,000	12,040	Cody	shale	1.23	8
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	13,310	13,320	Cody	shale	1.52	17
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	13,850	13,870	Frontier	shale	1.43	13
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	14,130	14,140	Frontier	shale	1.68	15
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	14,350	14,360	Mowry	shale	1.44	11
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	14,560	14,570	Mowry	shale	1.72	12
9	49013205650000	36N	94W	25	Pan Canadian	Fuller Reservoir II	14,650	14,670	Thermopolis	shale	1.70	17
10	49013204400000	5N	1E	10	Continental Oil	Tribal 10-1	7,100	7,110	Cody	shale	0.68	11
10	49013204400000	5N	1E	10	Continental Oil	Tribal 10-1	8,300	8,310	Mowry	shale	0.73	13
10	49013204400000	5N	1E	10	Continental Oil	Tribal 10-1	8,500	8,510	Mowry	shale	0.72	15
10	49013204400000	5N	1E	10	Continental Oil	Tribal 10-1	8,710	8,720	Thermopolis	shale	0.78	15

**Table 1.** Vitrinite reflectance data and locations for cuttings samples from wells drilled for oil and gas exploration and production in the Wind River Basin, Wyoming. Map no. refers to sample location numbers shown on figure 2.—Continued

[API, well number assigned by American Petroleum Institute; Tnsp., township; Rng., range; Sec., section; Lith., lithology; %Ro, vitrinite reflectance measurement; n, number of readings per sample; nr, no reading. Depth is in feet.]

Map no.	API	Tnsp.	Rng.	Sec.	Operator	Well	Top depth	Bottom depth	Formation	Lith.	%Ro	n
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	870	880	Cody	shale	0.89	10
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	1,790	1,800	Cody	shale	0.97	16
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	3,050	3,080	Frontier	shale	1.14	11
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	3,230	3,240	Mowry	shale	0.99	11
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	3,550	3,560	Mowry	shale	0.89	8
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	3,660	3,730	Thermopolis	shale	1.10	14
11	49013061630000	2N	2W	11	Stanolind Oil & Gas	1 Yamba	3,830	3,860	Cloverly	shale	1.28	12
12	49013202830000	3N	1W	33	Norris Oil	Tribal-McBride 1	3,230	3,260	Frontier	shale	0.29	1
12	49013202830000	3N	1W	33	Norris Oil	Tribal-McBride 1	3,440	3,470	Mowry	shale	0.54	11
12	49013202830000	3N	1W	33	Norris Oil	Tribal-McBride 1	3,650	3,670	Mowry	shale	0.51	14
12	49013202830000	3N	1W	33	Norris Oil	Tribal-McBride 1	3,850	3,870	Thermopolis	shale	0.51	11
13	49013213430000	4N	3W	29	Gulf Oil Company	Crowheart Butte SW 1-29-3D	2,100	2,130	Cody	shale	0.67	12
13	49013213430000	4N	3W	29	Gulf Oil Company	Crowheart Butte SW 1-29-3D	3,720	3,750	Mowry	shale	0.79	21
13	49013213430000	4N	3W	29	Gulf Oil Company	Crowheart Butte SW 1-29-3D	4,110	4,140	Mowry	shale	0.99	19
13	49013213430000	4N	3W	29	Gulf Oil Company	Crowheart Butte SW 1-29-3D	4,320	4,330	Thermopolis	shale	0.94	14
14	49013203030000	4N	4W	35	Stoltz & Company	1-35 Tribal	600	610	Mowry	shale	1.10	8
14	49013203030000	4N	4W	35	Stoltz & Company	1-35 Tribal	860	890	Mowry	shale	0.94	6
14	49013203030000	4N	4W	35	Stoltz & Company	1-35 Tribal	1,050	1,060	Thermopolis	shale	0.89	13
14	49013203030000	4N	4W	35	Stoltz & Company	1-35 Tribal	1,200	1,210	Cloverly	shale	1.06	13

**Table 1.** Vitrinite reflectance data and locations for cuttings samples from wells drilled for oil and gas exploration and production in the Wind River Basin, Wyoming. Map no. refers to sample location numbers shown on figure 2.—Continued

[API, well number assigned by American Petroleum Institute; Tnsp., township; Rng., range; Sec., section; Lith., lithology; %Ro, vitrinite reflectance measurement; n, number of readings per sample; nr, no reading. Depth is in feet.]

Map no.	API	Tnsp.	Rng.	Sec.	Operator	Well	Top depth	Bottom depth	Formation	Lith.	%Ro	n
15	49013065670000	5N	2W	6	Empire State Oil	Tribal 1	1,780	1,800	Cody	shale	0.84	12
15	49013065670000	5N	2W	6	Empire State Oil	Tribal 1	2,800	2,820	Mowry	shale	0.66	13
15	49013065670000	5N	2W	6	Empire State Oil	Tribal 1	3,400	3,410	Mowry	shale	0.68	9
15	49013065670000	5N	2W	6	Empire State Oil	Tribal 1	3,650	3,660	Thermopolis	shale	0.64	7
16	49013208510000	5N	5W	16	Helmerich & Payne	1-16 Tribal	440	460	Mowry	shale	1.01	9
16	49013208510000	5N	5W	16	Helmerich & Payne	1-16 Tribal	750	760	Mowry	shale	0.85	10
16	49013208510000	5N	5W	16	Helmerich & Payne	1-16 Tribal	900	910	Thermopolis	shale	0.84	12
16	49013208510000	5N	5W	16	Helmerich & Payne	1-16 Tribal	1,100	1,110	Cloverly	shale	0.92	6
17	49013067400000	6N	1W	4	British-American Oil	Tribal 1	720	770	Frontier	coal	0.50	25
17	49013067400000	6N	1W	4	British-American Oil	Tribal 1	1,010	1,050	Mowry	shale	0.81	20
17	49013067400000	6N	1W	4	British-American Oil	Tribal 1	1,320	1,330	Mowry	shale	0.95	8
17	49013067400000	6N	1W	4	British-American Oil	Tribal 1	1,500	1,530	Thermopolis	shale	0.93	5
18	49013206120000	1S	2E	2	Exxon Corporation	1 Shoshone-Arapahoe 534	6,210	6,240	Cody	shale	0.47	17
18	49013206120000	1S	2E	2	Exxon Corporation	1 Shoshone-Arapahoe 534	7,600	7,610	Cody	shale	0.93	4
18	49013206120000	1S	2E	2	Exxon Corporation	1 Shoshone-Arapahoe 534	8,450	8,460	Frontier	shale	0.91	9
18	49013206120000	1S	2E	2	Exxon Corporation	1 Shoshone-Arapahoe 534	8,850	8,860	Mowry	shale	0.89	10
18	49013206120000	1S	2E	2	Exxon Corporation	1 Shoshone-Arapahoe 534	9,060	9,070	Thermopolis	shale	1.03	12

**Table 1.** Vitrinite reflectance data and locations for cuttings samples from wells drilled for oil and gas exploration and production in the Wind River Basin, Wyoming. Map no. refers to sample location numbers shown on figure 2.—Continued

[API, well number assigned by American Petroleum Institute; Tnsp., township; Rng., range; Sec., section; Lith., lithology; %Ro, vitrinite reflectance measurement; n, number of readings per sample; nr, no reading. Depth is in feet.]

Map no.	API	Tnsp.	Rng.	Sec.	Operator	Well	Top depth	Bottom depth	Formation	Lith.	%Ro	n
19	49013060040000	1S	5E	1	Continental Oil	1 Tribal	6,880	6,890	Cody	shale	0.85	10
19	49013060040000	1S	5E	1	Continental Oil	1 Tribal	8,210	8,220	Cody	shale	0.86	16
19	49013060040000	1S	5E	1	Continental Oil	1 Tribal	9,790	9,800	Frontier	shale	1.01	19
19	49013060040000	1S	5E	1	Continental Oil	1 Tribal	10,450	10,470	Frontier	shale	1.01	15
19	49013060040000	1S	5E	1	Continental Oil	1 Tribal	10,850	10,860	Mowry	shale	1.19	13
19	49013060040000	1S	5E	1	Continental Oil	1 Tribal	11,000	11,020	Thermopolis	shale	1.17	13