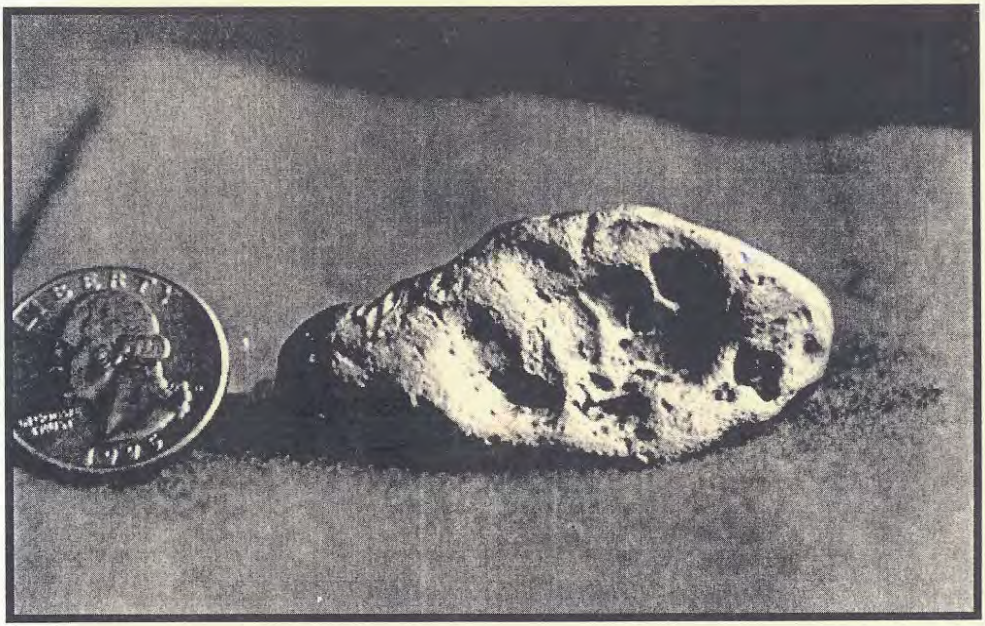
Wyoming Geo-notes

Number 58



Wyoming State Geological Survey
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May, 1998

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WYOMING GEO-NOTES
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Cover: A 7.5-ounce gold nugget found in the region of South Pass. (Photo courtesy of Dave Freeman, 1998).

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MINERALS UPDATE

OVERVIEW

Gary B. Glass
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Since the last issue of *Wyoming Geo-notes*, there have been only a few changes to the production forecasts shown in **Table 1** and **Figures 1-3**, as year-end figures became available. Coal, trona, and uranium production for 1997 are now actual values rather than estimates. In the case of coal, the actual value of 281.5 million short tons agrees with the January 1998 forecast by the State's Consensus Revenue Estimating Group (CREG) (**Table 1**; **Figure 3**). This is again a new production record by coal producers in Wyoming.

Because the Union Pacific/Southern Pacific (UP/SP) railroad was reportedly still experiencing delays in its deliveries in the first quarter of 1998, production may not increase as much as currently forecast for this year. There are; however, no reliable monthly coal production figures yet for 1998.

Trona production on the other hand was 18.2 million short tons in 1997, which is 1.2 million tons below the January CREG forecast of 19.4 million short tons. It is still record setting production as it is 90,000 tons above the previous record set in 1995 (**Table 1**). Because of the weakened export demand from

Table 1. Wyoming mineral production (1985-1997) with forecasts to 2004[1].

Calendar Year	Oil[2,3]	Natural Gas[3,4]	Carbon Dioxide[3,4]	Helium[4,5]	Coal[6]	Trona[6]	In-situ Uranium[7,8]	Sulfur[3,9]
1985	131.0	597.9	—	—	140.4	11.8	N/A	0.80
1986	122.4	563.2	23.8	0.15	135.4	13.0	0.05	0.76
1987	115.9	628.2	114.2	0.86	146.5	13.6	0.00	1.19
1988	114.3	700.8	110.0	0.83	163.6	14.9	0.09	1.06
1989	109.1	739.0	126.1	0.94	171.1	16.2	1.1	1.17
1990	104.0	777.2	119.9	0.90	184.0	16.2	1.0	1.04
1991	99.8	820.0	140.3	1.05	193.9	16.2	1.0	1.18
1992	97.0	871.5	139.2	1.05	189.5	16.4	1.2	1.20
1993	89.0	912.8	140.8	1.06	209.9	16.0	1.2	1.14
1994	80.2	959.2	142.6	1.07	236.9	16.1	1.2	1.10
1995	75.6	987.5	148.8	1.11	263.9	18.1	1.3	1.20
1996	73.9	1,023.4	149.0	1.10	278.4	17.5	1.9	1.22
1997	*70.2	*1,042.0	*149.0	*1.10	281.5	18.2	2.2	*1.20
1998	66.3	1,124.9	149.0	1.10	297.5	20.0	3.0	1.20
1999	62.8	1,150.4	149.0	1.10	314.5	21.1	3.0	1.20
2000	59.5	1,176.4	149.0	1.10	334.6	21.8	3.0	1.20
2001	56.3	1,203.3	149.0	1.10	346.7	22.6	3.5	1.20
2002	53.3	1,230.0	149.0	1.10	350.2	23.5	3.5	1.20
2003	50.5	1,257.6	149.0	1.10	353.7	24.4	3.5	1.20
2004	47.8	1,285.8	149.0	1.10	357.2	25.9	3.5	1.20

*Estimated until official figures are available.
[1]Modified from CREG's Wyoming State Government Revenue Forecast, January, 1998; [2]Millions of barrels; [3]Wyoming Oil & Gas Conservation Commission, 1985-1996; [4] Billions of cubic feet; [5]Based on Exxon's estimate that the average helium content in the gas processed at Shute Creek is 0.5%; [6]Millions of short tons (Wyoming State Inspector of Mines, 1985-1997); [7]Wyoming State Inspector of Mines, 1985-1997; [8]Millions of pounds of yellowcake (not available [N/A] for 1985 and previous years because it was only reported as taxable value); [9]Millions of short tons.

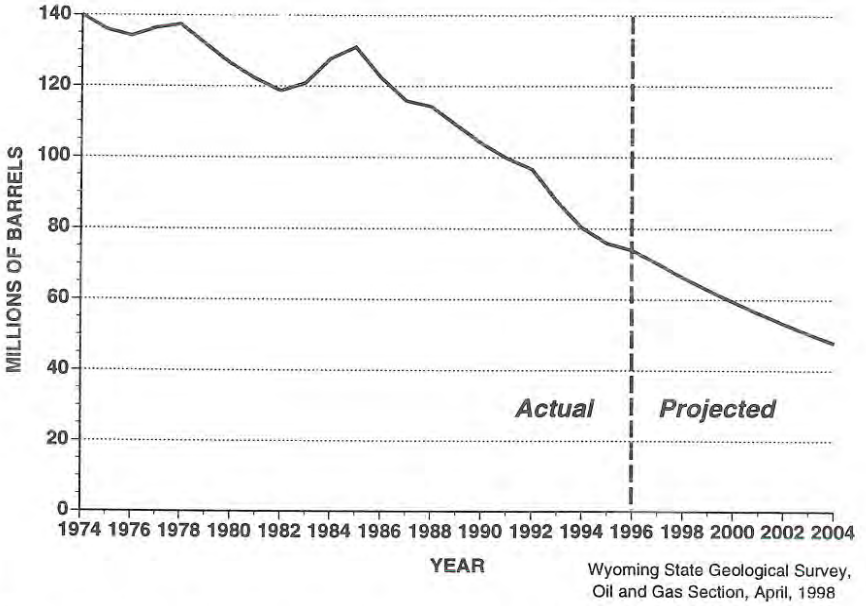

Figure 1. Annual oil production from Wyoming (1974 to 1996) with forecasts to 2004.

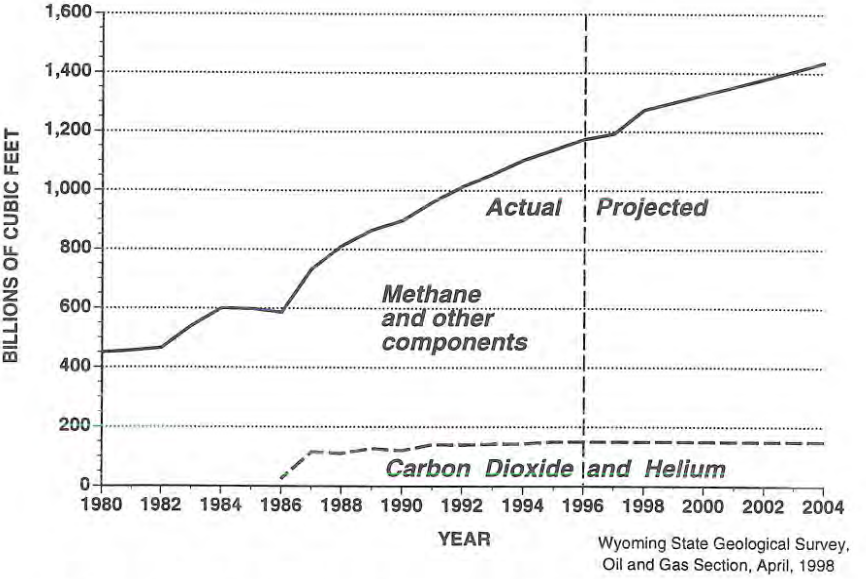

Figure 2. Annual natural gas production from Wyoming (1980 to 1996) with forecasts to 2004.

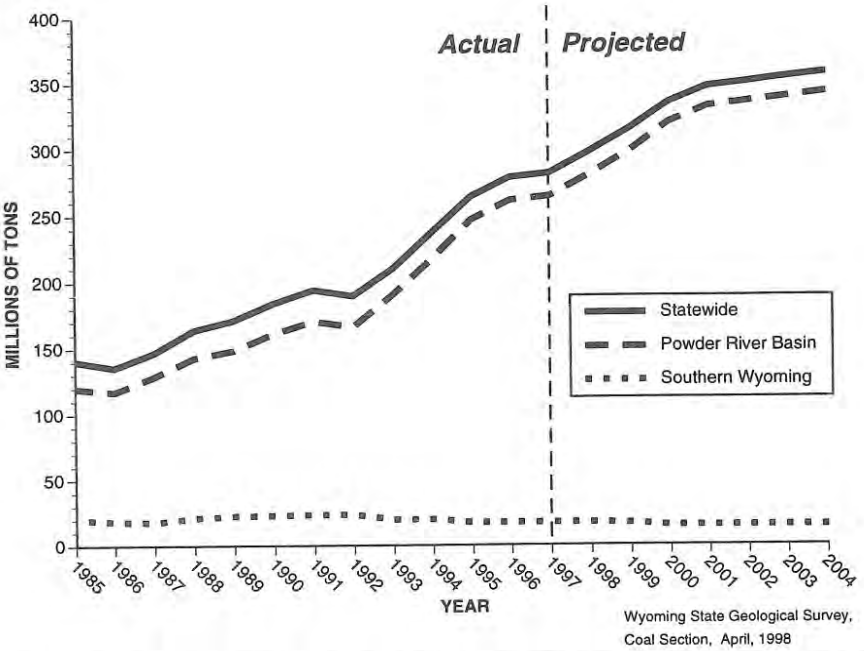

Figure 3. Annual coal production from Wyoming (1985-1997) with forecast to 2004. Data from the Wyoming State Inspector of Mines (1985-1997) and Wyoming Consensus Estimating Group (1998-2004).

Asia, trona production may well decline somewhat in 1998, rather than increase as currently forecast. And it probably will not increase as rapidly as the forecast in this issue suggests. The UP/SP railroad's delivery problems have also affected deliveries of the soda ash produced from the trona mining and refining companies of southwestern Wyoming.

Uranium production, which was 200,000 pounds of yellowcake less than forecast in January, still set a record for annual in-situ production in Wyoming, at 2.2 million pounds (**Table 1**). Our forecast growth in uranium production has been revised downward by 0.5 million pounds for 1998 through 2000. We had previously forecast 3.5 million pounds for each of these years.

Although final production figures for oil and natural gas were not available at the time this issue was prepared, the estimates for 1997 have been increased slightly (**Table 1**; **Figures 1** and 2). In regard to oil, low prices suggest that production could decline somewhat more than currently projected for 1998. And production of natural gas might not increase as much as now projected for this year, because of the relatively mild winter of 1997-1998. Unfortunately, there is not enough production data currently available to quantify these potential declines.

Certainly, if oil prices stay as low as they are now, more production from marginal wells will be shut in and more wells will be abandoned. This would accelerate the annual decline in oil production above the 5.3% decline between 1996 and 1997. In three of the last four years in which Wyoming oil prices dipped below an average of $15.00 per barrel (1986, 1988, 1993, and 1994), production declined between 6.6% and 9.9% (**Table 2**; **Figure 4**). While the decline in oil production did not accelerate in 1988, the steep decline of 1986 was also evidenced in 1987, even though the price averaged $16.42 in that year. The current low prices have also triggered substantial cutbacks in both exploration and development drilling for oil in Wyoming.

With one exception, the price estimates in **Table 2** and **Figures 4-6** have not been changed from CREG's January 1998 estimate. The one exception is the estimated oil price for 1997, which we changed from $17.45 to $17.41 (**Table 2**; **Figure 4**). It does appear that some changes might be necessary later this year when there are more data available. For example, the price for oil in the first quarter of this year has averaged an estimated $12.13 per barrel. When April prices are included, the estimated average price drops to $11.70 per barrel. These low prices are a combination of low world prices related to an oversupply of crude oil, coupled with the loss of bonuses paid for Wyoming crude

Table 2. Average prices paid for Wyoming oil, methane, coal, and trona (1985-1997) with forecasts to 2004[1].

Calendar Year	Oil[2]	Methane[3]	Coal[4]	Trona[5]
1985	24.67	3.03	11.36	35.18
1986	12.94	2.33	10.85	34.80
1987	16.42	1.78	9.80	36.56
1988	13.43	1.43	9.16	36.88
1989	16.71	1.58	8.63	40.76
1990	21.08	1.59	8.43	41.86
1991	17.33	1.46	8.06	44.18
1992	16.38	1.49	8.13	44.50
1993	14.50	1.81	7.12	40.08
1994	13.67	1.63	6.62	38.96
1995	15.50	1.13	6.38	40.93
1996	19.56	1.47	6.15	45.86
1997	*17.41	*1.96	*6.06	*42.62
1998	15.00	1.50	5.97	43.34
1999	15.00	1.50	5.82	42.93
2000	15.00	1.50	5.64	43.25
2001	15.00	1.50	5.55	43.44
2002	15.00	1.50	5.48	43.92
2003	15.00	1.50	5.40	44.24
2004	15.00	1.50	5.32	44.45

* Estimated until official figures are available.
[1] Modified from CREG, Wyoming State Government Revenue Forecast, January, 1998; [2] First purchase price in dollars per barrel (weighted average price for sweet, sour, heavy, stripper, and tertiary oil). Source: Energy Information Administration, 1985-1996; [3] Wellhead price in dollars per thousand cubic feet (MCF). Source: Wyoming Office of State Lands and Investments, 1989-1996 (derived from State royalty payments); Minerals Management Service, 1985-1988 (derived from Federal royalty payments); [4] Dollars per short ton (weighted average price for coal mined by surface and underground methods). Source: Energy Information Administration, 1985-1990 and derived from Department of Revenue, 1991-1996; [5] Dollars per ton of trona, not soda ash. Source: Wyoming Department of Revenue, 1985-1996.

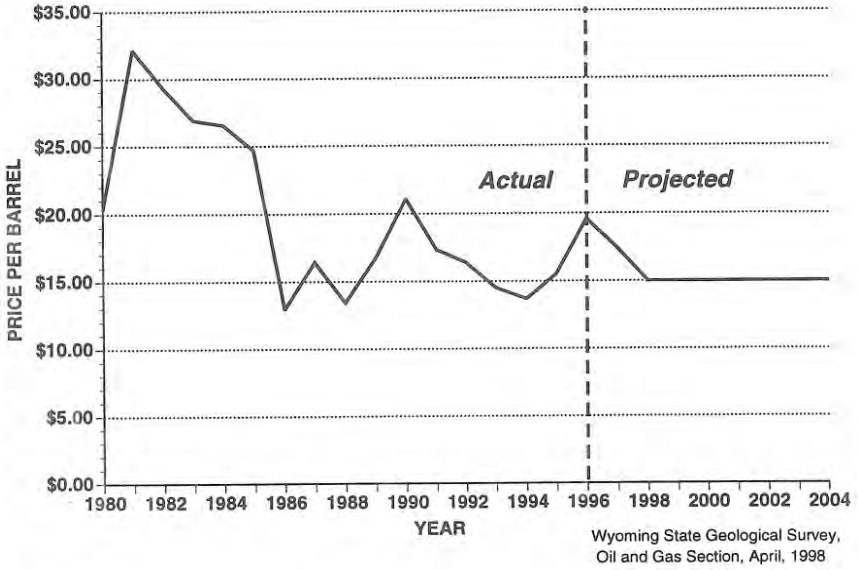

Figure 4. Average prices paid for Wyoming oil (1980 to 1996) with forecasts to 2004.

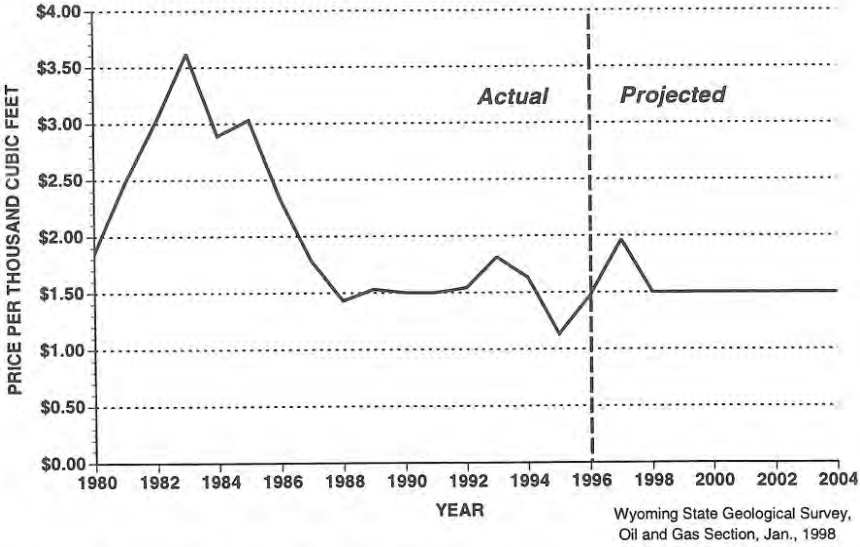

Figure 5. Average prices paid for Wyoming methane (1980 to 1996) with forecasts to 2004.

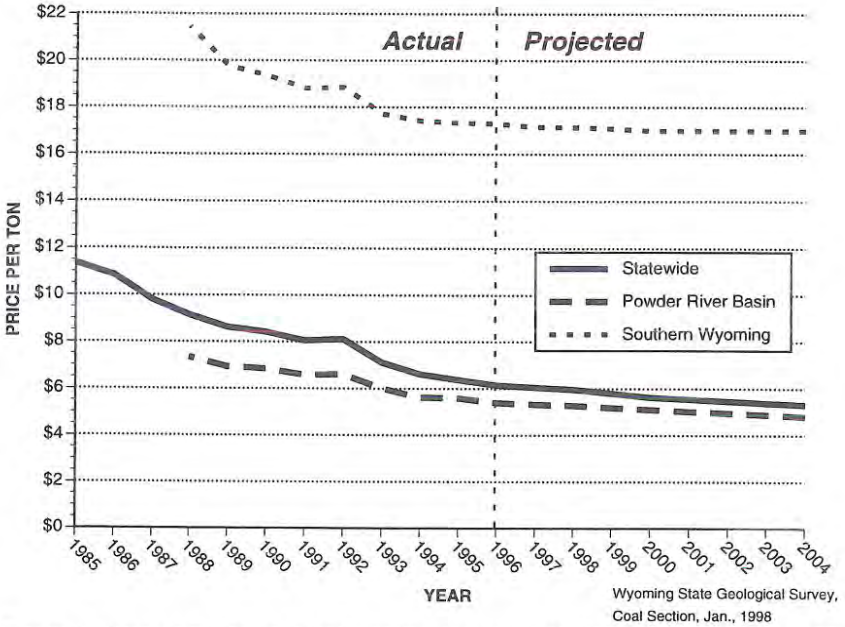

Figure 6. Average prices paid for Wyoming coal (1985 to 1996) with estimates to 2004. Sources: U.S. Energy Information Administration (1985-1990); Wyoming Department of Revenue (1991-1996); and Consensus Revenue Estimating Group (1997-2004).

oils after Canadian oil started to flow into and through the State. CREG's forecast oil price of $15.00 for 1998 might well be too high if prices do not soon increase.

In regard to forecast methane prices, the average for 1998 and hopefully future years may have to be increased from the $1.50 in CREG's estimate of January, 1998, which is shown in **Table 2** and **Figure 5**. Methane prices averaged an estimated $1.88 per thousand cubic feet in the first quarter. Adding in the prices received in April, the average increases to an estimated $1.89 per thousand cubic feet.

The $5.97 average coal price for 1998, which CREG forecast in January, is still looking good (**Table 2**; **Figure 6**). There is still an upside chance that coal prices might flatten out closer to $5.55 after 2001, rather than continue their current forecast decline.

The forecast trona price for 1998 (**Table 2**) might have to be lowered as export demand and price have reportedly softened with the economic crisis in Asia. The price in 1998 may turn out to be closer to the $42.62 estimated for 1997 than the current forecast of $43.34.

There is less optimism that spot sale uranium prices might start back up in 1998. After three years of gradual price increases, the spot sale price of yellowcake fell from $14.00 per pound in 1996 to $12.50 per pound last year. By April of this year, the spot price was reportedly $10.50.

In regard to other minerals, recent interest in decorative and dimensional stone as well as limestone are noted in the **Industrial Minerals and Uranium Update**. The **Metals and Precious Stones Update** discusses current interest in specimen-grade gold nuggets, diamonds, platinum, palladium, and nickel. The **Rock Hound's Corner** also features diamonds.

Following the **Minerals Update** in this issue, a special article summarizes exploration activities for oil, natural gas, and other mineral exploration in Wyoming in 1997.

In the **Geologic Mapping, Paleontology, and Stratigraphy Update**, there is a discussion of a newly found dinosaur track site in north-central Wyoming near Shell.

In regard to geologic hazards, this issue includes Part I of a special article on Wyoming's study of the sensitivity of its aquifers to contamination (p. 66-68).

OIL AND GAS UPDATE

Rodney H. De Bruin
Staff Geologist-Oil and Gas, Wyoming State Geological Survey

Prices paid to Wyoming oil producers during the first quarter of 1998 averaged $12.13 per barrel (**Table 3**). The average price for the first quarter of 1998 is $7.87 lower than for the first quarter of 1997, and is the lowest first quarter price since 1994. In March, Saudi Arabia, Mexico, and Venezuela announced that they would cut production to alleviate some of the oversupply of crude oil on the world market. If these production cuts occur, they could help somewhat to raise crude oil prices later in the year. **Figure 7** shows the posted Sweet and Sour crude prices and first purchase price for Wyoming oil averaged by month.

Oil production in Wyoming for 1997 was 70.2 million barrels (**Table 4**), according to figures from Petroleum Information/Dwights LLC (PI/D). This production is a drop of about 4.3% from last year's oil production, as reported by PI/D.

Spot prices for natural gas at Opal, Wyoming, averaged $1.88 during the first quarter of 1998 (**Table 5** and **Figure 8**). This is $0.72 lower than last year's first quarter average price of $2.60.

Table 3. Monthly average price of a barrel of oil produced in Wyoming (1995 to present).

	1995 Monthly	1995 Cumulative	1996 Monthly	1996 Cumulative	1997 Monthly	1997 Cumulative	1998 Monthly	1998 Cumulative
JAN	$ 14.77	$ 14.77	$16.38	$16.38	$22.56	$22.56	$12.79	$12.79
FEB	$ 15.55	$ 15.16	$16.28	$16.33	$19.45	$21.01	**$12.20**	**$12.50**
MAR	$ 15.26	$ 15.19	$18.63	$17.09	$17.99	$20.00	**$11.40**	**$12.13**
APR	$ 16.73	$ 15.58	$20.29	$17.90	$16.81	$19.20		
MAY	$ 16.65	$ 15.79	$18.85	$18.08	$17.74	$18.91		
JUN	$ 15.52	$ 15.75	$18.15	$18.10	$15.90	$18.41		
JUL	$ 14.50	$ 15.57	$18.98	$18.22	$16.29	$18.11		
AUG	$ 15.09	$ 15.51	$19.59	$18.39	$16.61	$17.92		
SEP	$ 15.41	$ 15.50	$21.48	$18.74	$16.42	$17.75		
OCT	$ 14.67	$ 15.42	$22.63	$19.13	$17.89	$17.77		
NOV	$ 15.32	$ 15.41	$21.19	$19.31	$16.51	$17.65		
DEC	$ 16.43	$ 15.50	$22.42	$19.56	$14.72	$17.41		
Average yearly price		$ 15.50		$19.56		$17.41		

Source: All averages are derived from published monthly reports by the Energy Information Administration, except that averages in bold print in 1998 are estimated from various unpublished bulletins listing posted prices.

Wyoming State Geological Survey, Oil and Gas Section, April, 1998

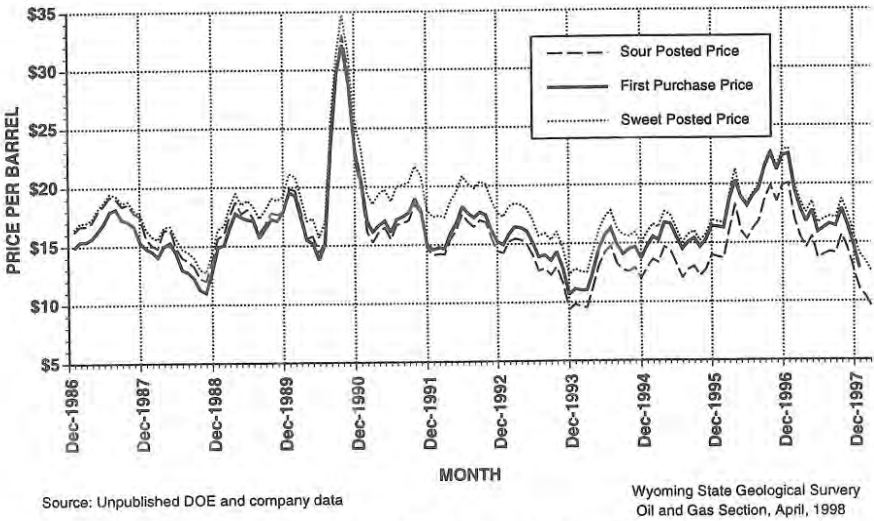

Figure 7. Wyoming posted Sweet and Sour crude oil prices and first purchase prices, averaged by month (January 1987 to March, 1998).

Natural gas production in Wyoming for 1997 was 1,192.1 billion cubic feet, according to production figures from PI/D (**Table 6**). This estimated production is an increase of 2.1% over 1996 production, as reported by PI/D. All of the production gain occurred in the last four months of 1997, because pipeline capacity out of the State increased substantially in September. The increase would have been even larger, if winter had not been milder than normal in the State's market area.

Burlington Resources announced plans to build a second gas processing plant at Lost Cabin. Work on the project began this April, and will continue through June, 1999. Peak employment on the project will be 250 workers. The new plant has a design capacity of 65 million cubic feet per day. In addition, expansion of its existing plant will add another 15 million cubic feet per day capacity, for a total capacity of 130 million cubic feet per day when both plants are on line. The three deep Madison wells in Madden Field will supply natural gas to the plants.

Syntroleum Corp. announced that it signed agreements to develop an 8,000 barrels per day, gas-to-liquids, specialty product plant in Sweetwater County. Enron Capital & Trade Resources Corp., a subsidiary of Enron Corp.; Syntroleum; and SLH Corp. have contributed $3 million to fund detailed engineering studies, land purchases, and other development costs. Subject to certain conditions, Enron Capital & Trade Resources Corp. committed an additional $14.5 million for a minority interest in the plant. The plant would use the Syntroleum Process to convert natural gas into specialty products, including

Table 4. Monthly oil production from Wyoming in barrels (1994 to present).

	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative	1996 Monthly	1996 Cumulative	1997 Monthly	1997 Cumulative
JAN	7,115,472	7,115,472	6,700,000	6,700,000	6,153,037	6,153,037	5,964,848	5,964,848
FEB	6,387,147	13,502,619	6,100,000	12,800,000	5,693,084	11,846,121	5,459,518	11,424,366
MAR	6,984,248	20,486,867	6,300,000	19,100,000	6,176,805	18,022,926	6,014,780	17,439,146
APR	6,672,207	27,159,074	6,200,000	25,300,000	5,977,362	24,000,288	5,729,869	23,169,015
MAY	6,847,709	34,006,783	6,300,000	31,600,000	6,035,505	30,035,793	6,050,971	29,219,986
JUN	6,594,914	40,601,697	6,200,000	37,800,000	5,916,019	35,951,812	5,761,549	34,981,535
JUL	6,773,956	47,375,653	6,300,000	44,100,000	6,076,992	42,028,804	5,964,005	40,945,540
AUG	6,685,423	54,061,076	6,100,000	50,200,000	6,414,850	48,443,654	5,868,789	46,814,329
SEP	6,446,719	60,507,795	6,100,000	56,300,000	6,180,180	54,623,834	5,710,557	52,524,886
OCT	6,525,817	67,033,612	6,300,000	62,600,000	6,186,019	60,809,853	5,949,974	58,474,860
NOV	6,257,924	73,291,536	6,100,000	68,700.000	6,221,912	67,031,765	5,800,811	64,275,671
DEC	6,236,204	79,527,740	6,300,000	75,000,000	6,330,701	73,362,466	5,900,791	70,176,462
Total Barrels Reported[1]		**79,527,740**		**75,000,000**		**73,362,466**		**70,176,462**
Total Barrels Not Reported[2]		**651,400**		**554,113**		**525,957**		
Total Barrels Produced[3]		**80,179,140**		**75,554,113**		**73,888,423**		

[1]Monthly production reports from Petroleum Information/Dwights LLC, except for 1995 which was estimated by the Wyoming State Geological Survey. [2] (Total barrels produced) minus (total barrels reported by Petroleum Information/Dwights LLC).
[3] Wyoming Oil and Gas Conservation Commission.

Wyoming State Geological Survey, Oil and Gas Section, April, 1998.

Table 5. Monthly average spot sale price for a thousand cubic feet (MCF) of natural gas at Opal, Wyoming (1995 to present).

	1995 Monthly	1995 Cumulative	1996 Monthly	1996 Cumulative	1997 Monthly	1997 Cumulative	1998 Monthly	1998 Cumulative
JAN	$ 1.40	$ 1.40	$1.25	$1.25	$3.90	$3.90	$2.05	$2.05
FEB	$ 1.10	$ 1.25	$1.20	$1.23	$2.50	$3.20	$1.70	$1.88
MAR	$ 1.05	$ 1.18	$1.20	$1.22	$1.40	$2.60	$1.90	$1.88
APR	$ 1.05	$ 1.15	$1.05	$1.18	$1.45	$2.31		
MAY	$ 1.10	$ 1.14	$0.95	$1.13	$1.60	$2.17		
JUN	$ 1.15	$ 1.14	$1.10	$1.13	$1.35	$2.03		
JUL	$ 1.00	$ 1.12	$1.20	$1.14	$1.45	$1.95		
AUG	$ 0.90	$ 1.09	$1.25	$1.15	$1.40	$1.88		
SEP	$ 1.05	$ 1.09	$1.20	$1.16	$1.50	$1.84		
OCT	$ 1.05	$ 1.09	$1.30	$1.17	$2.05	$1.86		
NOV	$ 1.25	$ 1.10	$2.45	$1.29	$3.00	$1.96		
DEC	$ 1.30	$ 1.12	$3.50	$1.47	$1.95	$1.96		
Average yearly price		**$ 1.12**		**$1.47**		**$1.96**		

Source: American Gas Association's monthly reports

Wyoming State Geological Survey, Oil and Gas Section, April, 1998

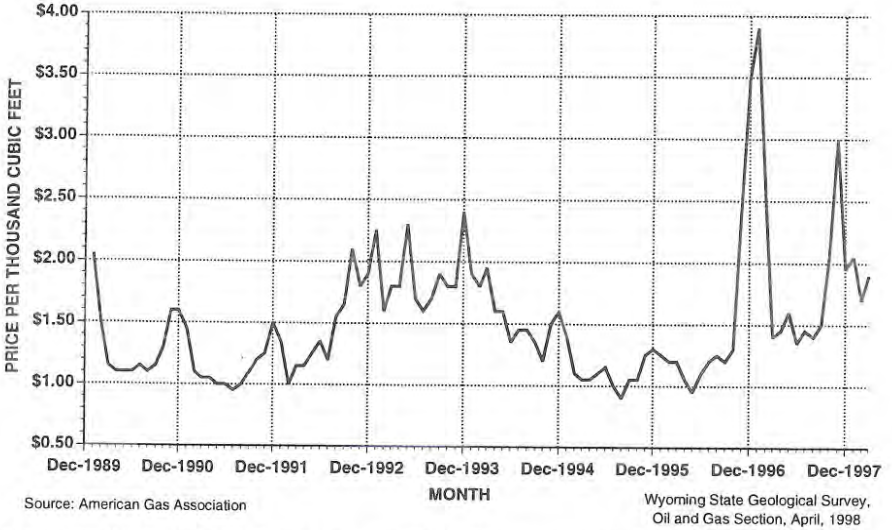

Figure 8. Spot sale price for methane at Opal, Wyoming, averaged by month (January, 1990 to March, 1998).

synthetic lubricants, drilling fluids, and liquid paraffins. The plant would also generate in excess of 50 megawatts of electricity for sale to others.

Snyder Oil entered into an agreement with the University of Wyoming to jointly demonstrate new technologies developed by Snyder and the Institute for Energy Research at the University of Wyoming. Ideally, the new technologies will assist in the discovery and development of gas resources in basin-centered, low-permeability reservoirs. Under the agreement, Snyder and its partner, Belco Oil & Gas, will acquire 45 square miles of 3-D seismic data and perform stimulation tests on low-permeability reservoirs at two exploratory wells. Snyder will be the operator of the $2.8 million project, the Institute for Energy Research will provide project management and new exploration technologies, and the U.S. Department of Energy will provide $1.2 million of the funding. The project is located on the Wind River Reservation in Fremont County.

The U.S. Bureau of Land Management (BLM) will apparently extend its royalty rate reduction for Federal stripper oil properties. The rule that the BLM is extending establishes the conditions under which an operator or owner of a Federal stripper oil property can obtain a reduction from the normal royalty rate of 12.5%. For a stripper oil property to qualify, it must produce an average of less than 15 barrels per day. The regulations provide an incentive for operators to maintain or restart production from marginal or previously uneconomic oil wells.

In a related item, the BLM decided not to grant royalty rate reductions for marginal gas wells. In their opinion, the reductions would not stimulate suffi-

Table 6. Monthly natural gas production from Wyoming in thousands of cubic feet (MCF) (1994 to March, 1998).

	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative	1996 Monthly	1996 Cumulative	1997 Monthly	1997 Cumulative
JAN	93,146,775	93,146,775	100,224,249	100,224,249	101,359,648	101,359,648	99,579,818	99,579,818
FEB	85,623,666	178,770,441	86,691,577	186,915,826	96,303,300	197,662,948	91,766,159	191,345,977
MAR	94,388,052	273,158,493	94,344,991	281,260,817	103,541,127	301,204,075	104,157,578	295,503,555
APR	92,362,726	365,521,219	93,929,323	375,190,140	99,479,609	400,683,684	99,459,039	394,962,594
MAY	93,886,923	459,408,142	95,791,327	470,981,467	97,900,863	498,584,547	101,070,371	496,032,965
JUN	81,764,661	541,172,803	92,140,614	563,122,081	87,069,612	585,654,159	91,905,308	587,938,273
JUL	94,998,414	636,171,217	92,796,301	655,918,382	100,219,275	685,873,434	100,129,497	688,067,770
AUG	93,743,790	729,915,007	90,393,416	746,311,798	99,874,019	785,747,453	97,673,622	785,741,392
SEP	88,476,703	818,391,710	92,589,092	838,900,890	93,510,551	879,258,004	100,028,888	885,770,280
OCT	95,232,646	913,624,356	98,386,458	937,287,348	95,441,022	974,699,026	102,206,875	987,977,155
NOV	95,312,491	1,008,936,847	94,939,660	1,032,227,008	94,015,007	1,068,714,033	100,752,128	1,088,729,283
DEC	87,115,084	1,096,051,931	99,314,617	1,131,541,625	99,141,298	1,167,855,331	103,415,430	1,192,144,713
Total MCF Reported[1]		**1,096,051,931**		**1,131,541,625**		**1,167,855,331**		**1,192,144,713**
Total MCF Not Reported[2]		**6,879,705**		**6,448,396**		**5,663,874**		
Total MCF Produced[3]		**1,102,931,636**		**1,137,990,021**		**1,173,519,205**		

[1] Monthly production reports from Petroleum Information, Inc./Dwights LLC.
[2] (Total MCF produced) minus (total MCF reported by Petroleum Information/Dwights LLC).
[3] Wyoming Oil and Gas Conservation Commission.

Wyoming State Geological Survey, Oil and Gas Section, April, 1998

cient, tax-generating, gas production to offset the government's loss of royalty revenues.

In the first quarter of 1998, there was only one lease sale. Leasing activity at the February U.S. Bureau of Land Management (BLM) sale was concentrated in the Powder River Basin (**Figure 9**). High Plains Associates made the high per-acre bid of $415 for a 480-acre parcel that covers N/2 and SW section 32, T19N, R92W (location A, **Figure 9**). The lease is about a mile from Mesaverde production in Standard Draw Field. Westech Energy paid $390 per acre for a 194.97-acre lease that covers parts of sections 34 and 35, T55N, R68W (location B, **Figure 9**). The lease is within a mile of Minnelusa production at Corral Creek Field. Maurice W. Brown paid $340 per acre for a 907.65-acre parcel that covers parts of sections 9, 20, 24, 30, 31, and 32, T54N, R68W (location C, **Figure 9**). Most of the tract is within two miles of Muddy production at VI Bar Ranch Field. Amirmex paid $270 per acre for a 200-acre lease that covers the SW and SW NW section 28, T48N, R73W (location D, **Figure 9**). The parcel is about a mile west of Minnelusa production at Doe Field. There were 67 tracts at this sale that sold for $50 or more per acre.

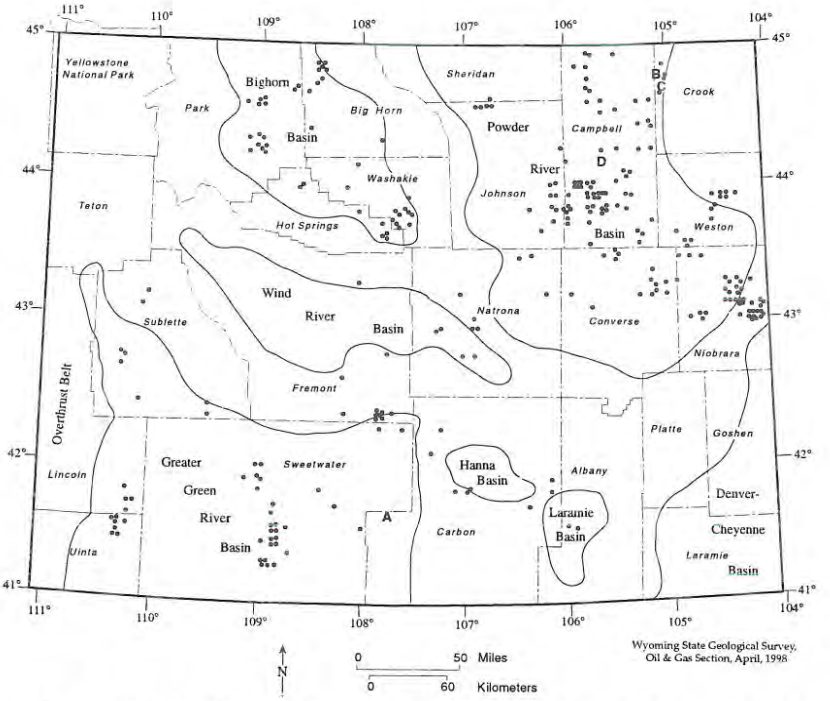

Figure 9. Locations of Federal oil and gas tracts leased by the U.S. Bureau of Land Management at its February, 1998, sale.

The BLM also held a lease sale in early April that brought in $10.3 million. The sale's high per-acre bid of $395 was made by Hanson & Strahn for a 160-acre lease that covers SE section 7, T55N, R72W (location A, **Figure 10**). The lease offsets a new Minnelusa oil pool that is being developed by Trend Exploration. There were 97 tracts at this sale that sold for $50 or more per acre, and 66 of those 97 tracts sold for $100 or more per acre. The majority of leases sold at this sale, and most of the tracts that received bids of $50 or more were in the Powder River Basin. The two BLM lease sales this year have generated almost half as much revenue as the six sales generated in 1997, which was a record year for total sales revenue (**Table 7**).

The Wyoming Office of State Lands and Investments also held an early April lease sale. This sale was the best State sale in several years in terms of total sales revenue (**Table 7**). The sale's high per-acre bid of $320 was made by Amirmex for a 480-acre lease that covers N/2 and SE section 16, T53N, R73W (location A, **Figure 11**). The parcel is about a mile east of oil and gas production from the Muddy Sandstone at Kitty Field. The majority of leases sold at this sale, and most of the 20 parcels that received bids of $50 or more per acre, were in the Powder River Basin.

There were 445 Applications for a Permit to Drill (APDs) in the first quarter of 1998 (**Table 8**). APDs for the first quarter exceeded the number of APDs in the first quarter of 1997 by 147. Campbell County led with over 64% of the total APDs that were approved, and the majority of those were for shallow coalbed methane tests. The APDs approved in Campbell County will drop off next quarter because the BLM placed a drilling moratorium on coalbed methane wells on Federal leases south of Gillette, and is no longer accepting Notices of Staking or APDs for them. The moratorium will be in effect until an Environmental Impact Statement for the new Wyodak Coalbed Methane Area can be completed and a Record of Decision issued.

The number of seismic projects permitted by the Wyoming Oil and Gas Conservation Commission was 11 in the first quarter of 1998 (**Table 9**). Sweetwater and Sublette counties in the Greater Green River Basin accounted for most of the permitted conventional miles and 3-D square miles.

The average daily rig count for the first quarter of 1998 was 42. This average is five less than in the fourth quarter of 1997, but is still the highest first quarter average in the past nine years (**Figure 12**).

Exploration and development

Company data, news releases, and information compiled and published by Petroleum Information/Dwights LLC indicate the following significant exploration and development events occurred in Wyoming during the first quarter of 1998. The numbers preceding discussions below refer to locations on **Figure 13**.

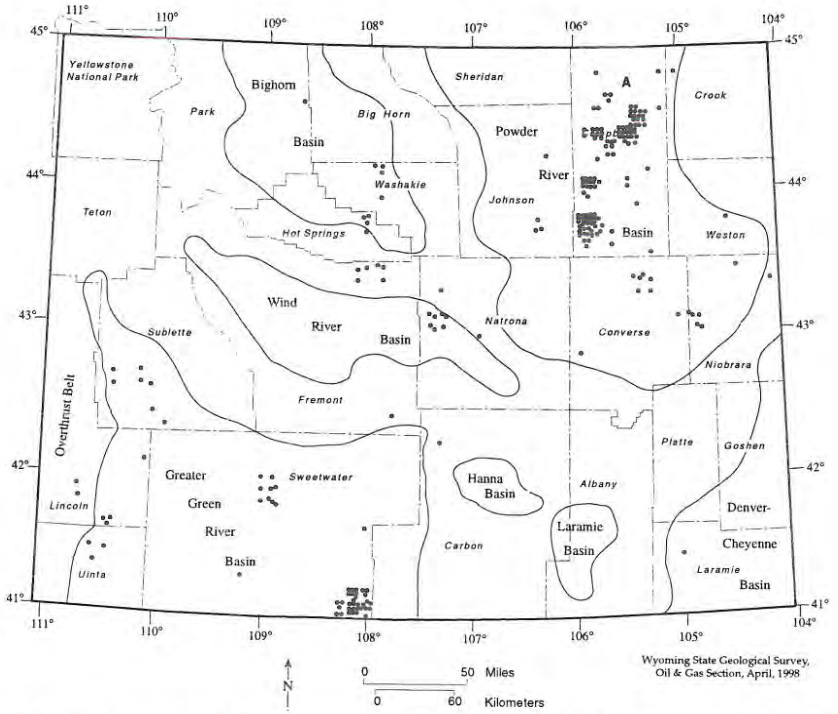

Figure 10. Locations of Federal oil and gas tracts leased by the U.S. Bureau of Land Management at its April, 1998, sale.

1. Chevron USA completed a horizontally-drilled Nugget Sandstone producer in Painter Reservoir East Field. The 12-8A Painter Reservoir Unit well in NE NE section 7, T15N, R119W produced an average of 2,589 barrels of condensate and 11.1 million cubic feet of gas per day during its first month of production. True vertical depth of the well was not reported. The well is a lateral redrilling of a directional development well completed by Chevron in early 1997. Chevron also plans to horizontally-drill the 32-5H Painter Reservoir Unit well in SW NE section 5, T15N, R119W, to an unreported true vertical depth in the Nugget Sandstone.

2. Celsius Energy completed a new exploration well in SW NE section 22, T19N, R113W. The 22-2 Exit Channel well flowed 1.5 million cubic feet of gas and 48 barrels of condensate per day from the Frontier between 11,394 and 11,410 feet and from the Dakota between 12,014 and 12,066 feet. The new producer is a mile southwest of Frontier production at Zieglerís Wash Field and a mile northwest of Frontier and Dakota production at Bruff Field.

3. Marathon Oil set seven-inch liner to a depth of 14,360 feet at its exploratory well in SW NE section 1, T13N, R100W. The 3 Vermillion Creek Deep well will be tested in an open-hole interval in the Nugget Sandstone between

Table 7 . Federal and State competitive oil and gas lease sales in Wyoming.

FEDERAL SALES (BUREAU OF LAND MANAGEMENT)

Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
1995							
TOTAL	$13,047,246	2,649	1,264	2,326,988	1,109,711	$11.76	$1,100.00
1996							
February	$1,635,668	455	192	358,478	137,901	$11.86	$220.00
June	$1,438,325	460	282	337,440	181,338	$ 7.93	$210.00
August	$2,021,488	289	182	261,321	118,267	$17.09	$145.00
October	$3,058,248	363	255	280,434	163,054	$18.76	$270.00
December	$3,333,838	261	214	165,771	138,945	$23.99	$1,450.00
TOTAL	$11,487,567	1,828	1,125	1,403,444	739,505	$15.53	$1,450.00
1997							
February	$2,463,137	267	210	222,486	148,148	$16.63	$250.00
April	$2,612,013	145	137	98,865	90,948	$28.72	$400.00
June	$4,642,113	285	249	313,519	262,682	$17.67	$310.00
August	$4,636,555	426	365	430,213	327,172	$14.17	$600.00
October	$12,133,207	286	227	234,561	169,264	$71.68	$400.00
December	$5,489,578	378	297	279,294	208,428	$26.34	$410.00
TOTAL	$31,976,603	1,787	1,485	1,578,938	1,206,642	$28.50	$600.00
1998							
February	$5,262,908	369	285	366,787	241,654	$21.78	$415.00
April	$10,287,111	247	227	192,561	162,393	$63.35	$395.00

STATE SALES (OFFICE OF STATE LANDS AND INVESTMENTS)

Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
1995							
TOTAL	$1,656,218	799	492	323,887	202,708	$8.17	$130.00
1996							
March	$308,927	199	96	85,369	41,909	$7.37	$108.00
June	$656,177	250	114	103,621	48,638	$13.49	$206.00
October	$663,241	300	134	115,495	54,538	$12.16	$175.00
December	$697,152	300	164	113,626	61,729	$11.29	$86.00
TOTAL	$2,325,497	1049	508	418,111	206,814	$11.24	$206.00
1997							
April	$719,005	300	189	119,436	80,548	$8.93	$170.00
June	$1,008,470	300	185	108,470	62,447	$16.16	$162.00
October	$627,935	300	165	102,802	63,003	$ 9.97	$115.00
December	$795,610	298	165	107,588	57,202	$13.91	$340.00
TOTAL	$3,151,020	1198	704	438,296	263,230	$11.97	$340.00
1998							
April	$1,203,792	300	161	115,646	63,848	$18.85	$320.00

Sources: Wyoming Office of State Lands and Investments, Petroleum Information /Dwights LLC - Rock Mountain Region Report, and U.S. Bureau of Land Mangement.

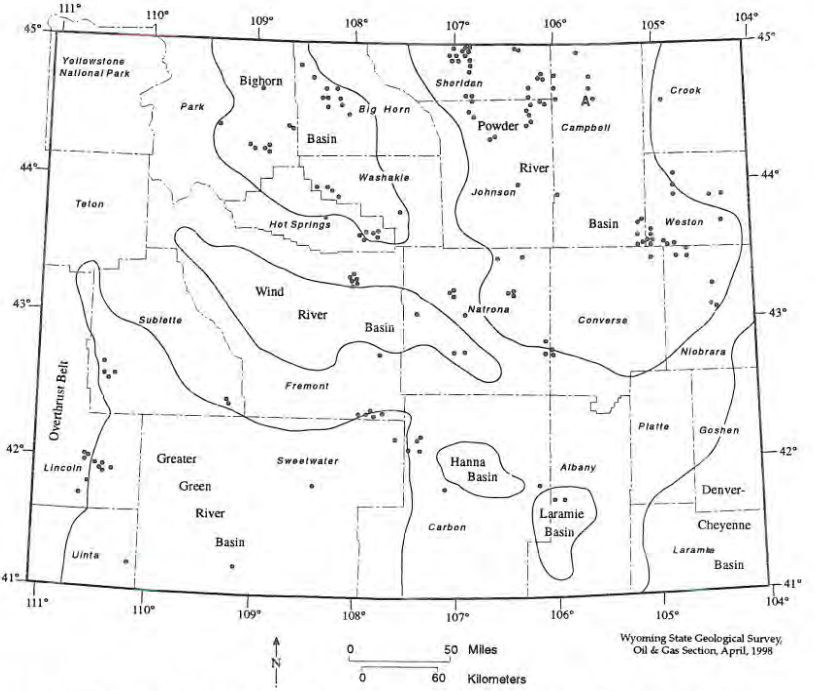

Figure 11. Locations of State oil and gas tracts leased by the Office of State Lands and Investments at its April, 1998, sale.

14,360 and 15,060 feet. The well is a mile north of Marathonís 1 Vermillion Creek Deep discovery well completed in 1997. That well produced 1.7 billion cubic feet of gas from the Nugget and Entrada during its first six months on line and averaged 9.7 million cubic feet of gas per day during December of 1997.

4. OXY USA completed an exploration well in NW NW section 5, T14N, R93W. The 1 Lookout Wash Federal Unit well flowed 8.1 million cubic feet of gas, 120 barrels of condensate, and 16 barrels of water per day from the Almond Formation between 11,200 and 11,219 feet. The new well is a mile southeast of Almond gas production at the discovery well for Snowbank Field.

5. Vessels Oil & Gas completed a well in Sierra Madre Field. The 12-20 Sierra Madre well in NW SW section 20, T13N, R89W pumped 549 barrels of oil and 130,000 cubic feet of gas per day from the Niobrara Formation between 4,420 and 5,400 feet.

6. Yates Petroleum completed an Almond discovery in NW NE section 18, T21N, R95W. The 1 Four Thirty-Federal well was tested in an unreported

Table 8. Number of Applications for Permit to Drill (APD) approved by the Wyoming Oil and Gas Conservation Commission (1994 to present).

County	1994 APDs	1995 APDs	1996 APDs	1997 APDs	1998 APDs
Albany	0	1	1	0	0
Big Horn	3	16	53	59	7
Campbell	105	151	554	941	286
Carbon	135	50	77	84	14
Converse	74	29	20	16	2
Crook	9	15	37	26	2
Fremont	46	30	26	58	14
Goshen	0	0	0	0	0
Hot Springs	4	13	24	42	0
Johnson	16	6	16	6	1
Laramie	15	10	2	3	1
Lincoln	103	64	55	122	22
Natrona	63	80	74	59	4
Niobrara	4	4	7	8	2
Park	18	20	30	25	5
Platte	2	0	0	0	0
Sheridan	3	0	0	2	1
Sublette	113	61	118	179	43
Sweetwater	204	153	136	210	31
Teton	0	0	0	0	0
Uinta	11	11	10	27	4
Washakie	12	31	30	36	6
Weston	6	10	10	5	0
TOTALS	**946**	**755**	**1280**	**1908**	***445**

Source: All data are from the Wyoming Oil and Gas Conservation Commission.
*Number of APDs in the first quarter of 1998.

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interval above 9,650 feet. The well is shut in until it is connected to a pipeline.

7. Texaco Exploration & Production completed two new producers in Stagecoach Draw Field. The 8 Stagecoach Draw Unit well in SW SW section 28, T23N, R107W flowed 1.9 million cubic feet of gas, 20 barrels of condensate, and 15 barrels of water per day from the Almond between 7,958 and 7,961 feet. The 7 Stagecoach Draw Unit well in SE SE section 30, T23N, R107W flowed 2.5 million cubic feet of gas, 69 barrels of condensate, and five barrels of water per day from the Almond between 7,887 and 7,890 feet.

8. Ultra Petroleum will test unreported intervals in the Lance Formation at its 1-8 Radio Tower-Federal wildcat well in C NE section 8, T28N, R107W. The well was cased after log analysis indicated multiple potential pay sands.

Table 9. Number of seismic projects and miles permitted by the Wyoming Oil and Gas Conservation Commission (1995 to present).

	1995			1996			1997			1998		
County	Permits	Conventional Miles	3-D Square Miles	Permits	Conventional Miles	3-D Square Miles	Permits	Conventional Miles	3-D Square Miles	Permits	Conventional Miles	3-D Square Miles
Albany	0	0	0	1	18	0	0	0	0	0	0	0
Big Horn	1	16	0	2	3	66	2	0	45	0	0	0
Campbell	12	24	43	32	56	220	20	52	79	4	9	7
Carbon	1	0	16	2	5	18	3	7	190	0	0	0
Converse	4	39	20	1	4	0	1	5	0	1	12	0
Crook	1	0	5	5	3	20	7	8	18	1	2	0
Fremont	6	32	56	2	5	15	6	43	126	0	0	0
Goshen	0	0	0	0	0	0	2	227	0	0	0	0
Hot Springs	2	70	9	4	17	29	1	8	0	0	0	0
Johnson	1	4	0	0	0	0	2	7	17	0	0	0
Laramie	0	0	0	0	0	0	0	0	0	0	0	0
Lincoln	2	18	110	0	0	0	3	7	116	0	0	0
Natrona	3	27	3	0	0	0	5	14	101	0	0	0
Niobrara	0	0	0	2	0	23	0	0	0	0	0	0
Park	0	0	0	6	20	82	4	56	58	1	16	0
Platte	0	0	0	0	0	0	0	0	0	0	0	0
Sheridan	0	0	0	1	5	0	0	0	0	0	0	0
Sublette	2	0	162	2	21	52	1	0	61	2	1	115
Sweetwater	9	17	497	8	17	670	4	66	296	1	199	0
Teton	0	0	0	0	0	0	0	0	0	0	0	0
Uinta	0	0	0	1	0	40	0	0	0	1	0	42
Washakie	0	0	0	0	0	0	3	36	0	0	0	0
Weston	1	13	0	1	0	16	1	0	17	0	0	0
TOTALS	**45**	**260**	**921**	**70**	**174**	**1251**	**65**	**536**	**1124**	***11**	***239**	***164**

Source: All data are from the Wyoming Oil and Gas Conservation Commission.
*Number of seismic projects and miles permitted during the first quarter of 1998.

Wyoming State Geological Survey, Oil and Gas Section, April, 1998.

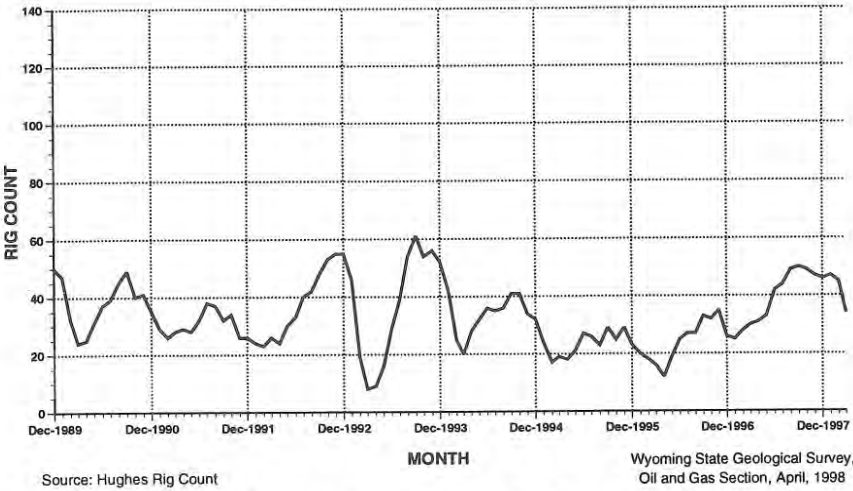


Figure 12. Wyoming daily rig count averaged by month (December, 1989, to March, 1998).

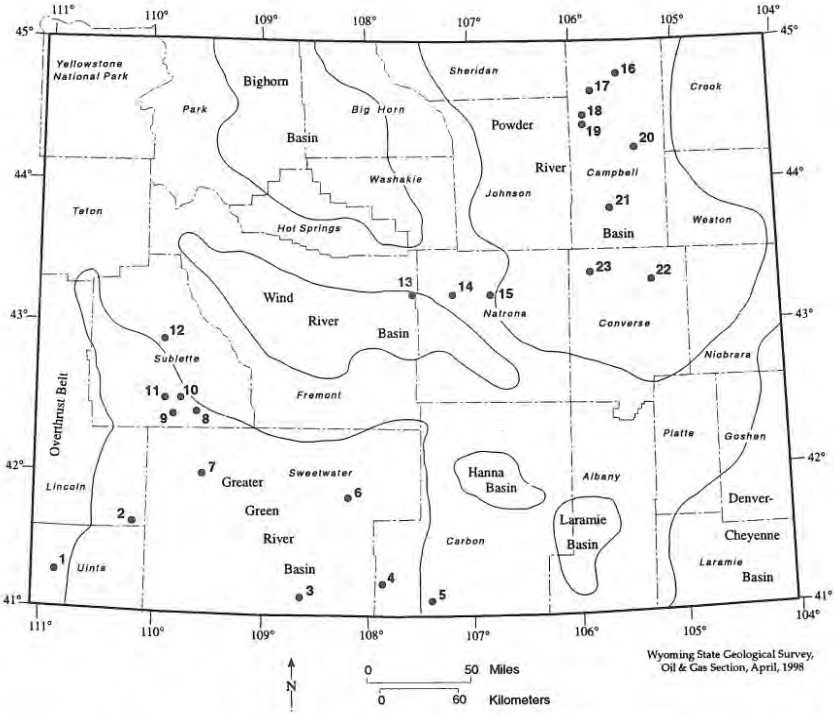


Figure 13. Oil and gas exploration and development activities in Wyoming during the first quarter of 1998 (exclusive of coalbed methane activities).

9. Union Pacific Resources completed a wildcat well in NW NE section 22, T28N, R109W. The 31-22 Tot-Federal flowed 1.5 million cubic feet of gas per day from the Lance Formation above 12,000 feet. The well is three miles southwest of production in Jonah Field.

10. Western Gas Resources completed a new well on the northeastern flank of Jonah Field. The 7-23 Stud Horse Butte-Federal well in SW NE section 23, T29N, R108W is producing 11.2 million cubic feet of gas and 240 barrels of condensate per day from 800 net feet of pay in the Lance between 9,338 and 12,192 feet. Yates Petroleum also completed a Lance producer on the northwestern flank of Jonah Field. During its first month on line, the 1 Gobblers Knob-Federal well in SW SE section 8, T29N, R108W produced an average of 938,000 cubic feet of gas and 27 barrels of water per day from an undisclosed interval.

11. McMurry Oil completed an extension well to Jonah Field. The 7-24-29-109 Corona Unit well in SE NE section 24, T29N, R109W produced an average of 889,000 cubic feet of gas per day from an undisclosed interval in the Lance during its first month on line. The well is about 1.5 miles northwest of Lance production at Jonah Field.

12. Ultra Petroleum signed a letter of intent with Halliburton Energy Services to expand their existing Jonah Field Development Agreement. Under the new agreement, Halliburton will finance six additional wells on the Stud Horse Butte Unit, eight in the Mesa area, and two in an unspecified area. Ultra also agreed to drill two wells on lands owned by HS Resources and others on the Pinedale anticline.

13. Tom Brown completed two new wells in Frenchie Draw Field. The 32 Graham Unit well in SW NW section 16, T37N, R89W flowed 9.5 million cubic feet of gas per day and an undetermined amount of condensate from the Fort Union below 10,000 feet. The 37 Graham Unit well in NE SE section 17, T37N, R89W flowed 6.9 million cubic feet of gas and 42 barrels of condensate per day from the Fort Union below 10,000 feet. In order to meet its drilling schedule planned for the Wind River Basin, Tom Brown recently acquired five drilling rigs, tubular goods, and related assets from W.E. Sauer Companies for $8.1 million. Four of the rigs will be dedicated to that program.

14. Barrett Resources completed a well in Waltman Field. The 1-29 Lak-Cave Gulch-Federal well in NE NW section 29, T37N, R86W is producing about 40 million cubic feet of gas per day from the subthrust Muddy Sandstone at 18,175 feet.

15. BreitBurn Energy completed a wildcat in SW NE section 13, T37N, R83W. The 1 Lost Dome-Federal well pumped 90 barrels of oil and 270 barrels of water per day from perforations in the Tensleep Sandstone between 4,904 and 4,907 feet. The new discovery is in a previously non-producing township on the western flank of the Casper arch. A spokesperson for the

company said that the prospect was generated entirely on surface geology. The nearest Tensleep production is eight miles southeast at Casper Creek North Field.

16. Trend Exploration confirmed its 1997 discovery with the completion of the 7-2 Trend-Jazbo well in SW NW section 7, T55N, R72W. The well offsets Trendís discovery in SE NW section 7, T55N, R72W. The new well pumped 314 barrels of oil and 439 barrels of water per day from the Minnelusa between 8,723 and 8,725 feet.

17. Maxim Drilling & Exploration confirmed its 1996 discovery with the completion of the 34-31 Edna-Federal well in SW SE section 31, T54N, R74W. The well offsets Maximís discovery in NE SE section 31, T54N, R74W. The new well pumped 72 barrels of oil and five barrels of water per day from the Muddy Sandstone at approximately 8,600 feet.

18. Yates Petroleum completed an exploration well in NW SW section 33, T52N, R75W. The 1 Shell Canyon-Federal produced an average of 53 barrels of oil and 273,000 cubic feet of gas per day during its first month on line. The well is producing from the Muddy Sandstone at approximately 9,800 feet.

19. Prima Oil & Gas discovered oil and gas at its 15-6 Cedar Draw-Federal well in SW NE section 15, T51N, R75W. During its first month on line, the well produced an average of seven barrels of oil and 222,000 cubic feet of gas per day. Production is from the Muddy Sandstone at approximately 9,700 feet.

20. Fancher Oil completed a new well in Olsen Field. The 10-2 Pickrel well in NE NW section 10, T49N, R71W, pumped 205 barrels of oil per day from the Minnelusa between 9,546 and 9,558 feet.

21. Devon Energy completed a new well in House Creek Field. The 43-2 House Creek well in SW NE section 5, T44N, R73W, pumped 364 barrels of oil and 196 barrels of water per day from the Sussex between 8,039 and 8,060 feet.

22. Anschutz discovered oil at its 8-14 well in SE NE section 14, T38N, R70W. The well produced an average of 63 barrels of oil per day from an undisclosed interval in the Muddy Sandstone. The new discovery is about 2.5 miles southwest of Muddy production in Haps Draw Field.

23. Vastar Resources completed a discovery in SW SW section 22, T39N, R75W. The 1-22 African Swallow well produced oil at a rate of about 900 barrels per day from the Muddy Sandstone at approximately 14,000 feet. The discovery is about two miles southwest of a Dakota gas well on the western flank of Spearhead Ranch Field. The nearest Muddy production is about four miles to the southwest in Nutcracker Field.

Second Annual Wyoming Natural Gas Fair

The Second Annual Wyoming Gas Fair is set for September 24-26, 1998, at the Snow King Resort in Jackson Hole, Wyoming. This annual event is a joint effort of the Wyoming Natural Gas Pipeline Authority; the Wyoming State Geological Survey; the Science, Technology, and Energy Authority; and the Petroleum Association of Wyoming. The program includes producers, pipeline companies, marketers, end users, Federal officials, representatives of the electric industry, staff of the Wyoming Oil and Gas Conservation Commission, and others.

There is a lineup of excellent speakers from Union Pacific Fuels, Colorado Interstate Gas, KN Energy, Enron Transportation and Storage, Alliance Pipeline, Barrett Resources, McMurry Oil Co., the Bureau of Land Management, Pacific Corp., the Environmental Protection Agency, the Forest Service, the Gas Research Institute, Mercator Energy, Inc., Kansas City, Enron Capitol and Trade Resources, NICOR Gas, Missouri Gas Energy, North American Transportation, Transmission and Storage, and the Wyoming Oil and Gas Conservation Commission. To get a registration packet for this important event, write to:

Wyoming Natural Gas Fair
P.O. Box 2640
Casper, Wyoming 82602-2640

You can also call (307) 234-7147; fax to (307) 234-5306, or use Email: khutto@missc.state.wy.us to get information. The deadline for pre-registration ($150.00) is August 31, 1998. There is exhibit space within the main building of the resort, which is available on a space-available basis.

COAL UPDATE

Robert M. Lyman
Staff Geologist-Coal, Wyoming State Geological Survey

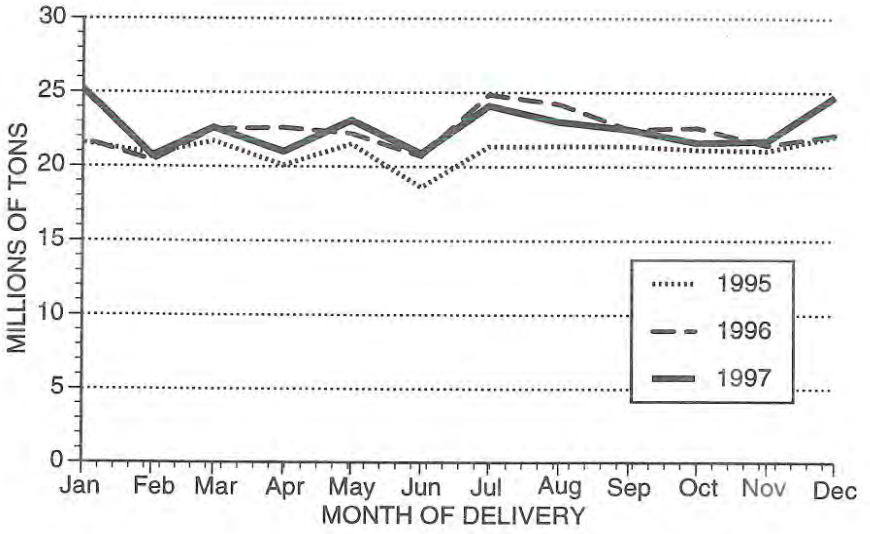
Coal production, as reported by the Wyoming State Inspector of Mines, showed the State's coal producers set a new yearly production record of 281,481,516 short tons. This was a modest increase of 1.1% over the 278,424,956 tons produced in 1996.

Steam coal deliveries, as reported on the Federal Energy Regulatory Commission's Form 423, show that Wyoming led the nation in steam coal deliveries in 1997. Wyoming deliveries last year totaled 270.9 million tons (**Table 10**). The 1997 deliveries only increased by two million tons over the 268.9 million tons delivered in 1996. **Figure 14** shows monthly coal deliveries over the past three years. **Figure 15** breaks these monthly deliveries into what are reported as either spot sales or contract sales.

Table 10. Monthly coal deliveries from Wyoming's mines in short tons (1994 to 1997).

	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative	1996 Monthly	1996 Cumulative	1997 Monthly	1997 Cumulative
JAN	19,326,770	19,326,770	21,586,303	21,586,303	21,793,387	21,793,387	25,165,405	25,165,405
FEB	17,171,910	36,498,680	20,839,926	42,426,229	20,374,055	42,167,442	20,743,224	45,908,629
MAR	19,178,990	55,677,670	21,707,422	64,133,651	22,507,800	64,675,242	22,566,012	68,474,641
APR	17,839,110	73,516,780	20,066,616	84,200,267	22,579,959	87,255,201	20,961,008	89,435,649
MAY	18,652,290	92,169,070	21,509,916	105,710,183	22,216,016	109,471,217	23,102,867	112,538,516
JUN	17,741,480	109,910,550	18,602,505	124,312,688	20,698,814	130,170,031	20,862,610	133,401,126
JUL	18,213,540	128,124,090	21,334,608	145,647,296	24,842,971	155,013,002	24,074,929	157,476,055
AUG	20,572,120	148,696,210	21,356,870	167,004,166	24,421,537	179,434,539	23,002,254	180,478,309
SEP	19,129,450	167,825,660	21,355,730	188,359,896	23,339,792	202,774,331	22,452,566	202,930,875
OCT	18,189,260	186,014,920	21,178,610	209,538,506	22,615,721	225,390,052	21,623,057	224,553,932
NOV	18,595,500	204,610,420	21,042,260	230,580,766	21,421,085	246,811,137	21,695,072	246,249,004
DEC	20,866,710	225,477,130	22,032,910	252,613,676	22,105,530	268,916,667	24,695,740	270,944,744
Total Tonnage Reported[1]		**225,477,130**		**252,613,676**		**268,916,667**		**270,944,744**
Total Tonnage Not Reported[2]		**11,430,937**		**11,324,347**		**9,508,289**		**10,536,772**
Total Tonnage Produced[3]		**236,908,067**		**263,938,023**		**278,424,956**		**281,481,516**

[1] COALDAT Marketing Reports by Resource Data International, Inc. (1994-1995); and from bulletin board of the Federal Energy Regulatory Commission in 1996 and 1997.
[2] Includes estimates of residential, industrial, and exported coal, plus tonnages not reported on FERC's Form 423.
[3] Wyoming State Mine Inspector's Annual Reports.
Wyoming State Geological Survey, Coal Section, April, 1998.



Wyoming State Geological Survey, Coal Section, April, 1998

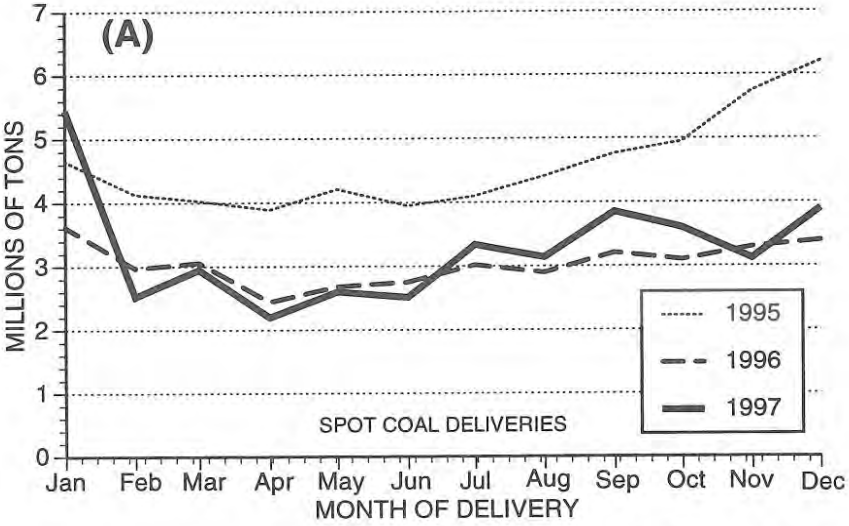
Figure 14. Reported monthly deliveries from Wyoming coal mines (1995 through 1997). From COALDAT Marketing Report by Resource Data International, Inc. in 1995, and from the Federal Energy Regulatory Commission's bulletin board in 1996 and 1997.

Table 11 depicts historic and projected coal production by county. It also provides an estimate of the percentage of Powder River Basin coal that sells for more than $5.00/ton. The tonnage sold at these higher prices is the remaining, older, long-term contracts that had escalation clauses built into them. **Table 12** shows an estimated breakdown of the average prices for coal produced in northeastern Wyoming and southern Wyoming.

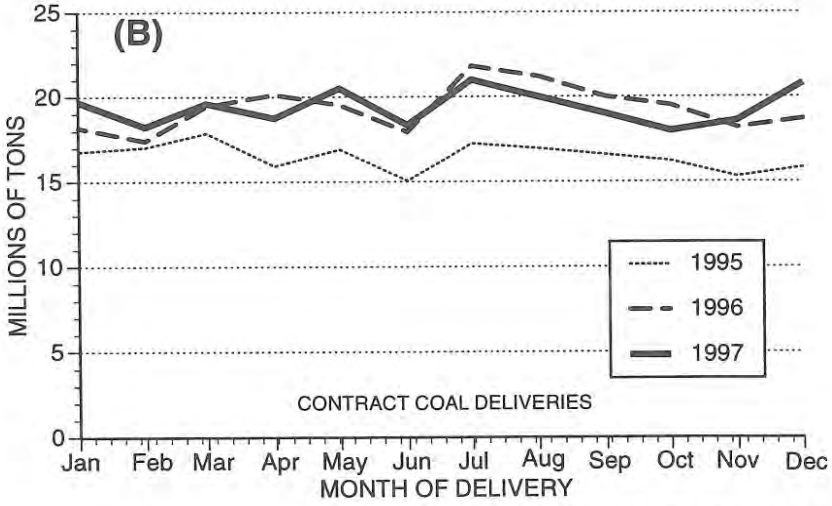
Table 13 is a corrected version of a similar table, which appeared on p. 31 of *Wyoming Geo-notes No. 57*. The table shows the permitted capacity of Wyoming mines, based on permits issued by to the Air Quality Division of the Wyoming Department of Environmental Quality. In *Wyoming Geo-notes 57*, the figures for the Skull Point and Kemmerer mines were inadvertently transposed.

Figure 16 shows the location of the coal mines that were active in 1997, as well as the location of coal-fired power plants and plants that process coal-related products.

As a matter of interest, accidental deaths at the nation's coal mines fell to a record low of 30 in 1997, down from 39 in 1996. Wyoming reported no fatalities in coal mines in 1997, as opposed to one in 1996. The emphasis on safety in Wyoming coal mines and the safe working habits of the coal miners themselves are something the State can be very proud of.



Wyoming State Geological Survey, Coal Section, April, 1998



Wyoming State Geological Survey, Coal Section, April, 1998

Figure 15. Monthly coal deliveries from Wyoming (1995 through 1997). (A) Coal sold on the spot market and (B) coal sold on contract. (From COALDAT Marketing Report by Resource Date International, Inc. in 1995, and from the Federal Energy Regulatory Commission's bulletin board in 1996 and 1997).

Table 11. Wyoming coal production by county (in millions of tons), from 1994 to 1997 with forecasts to 2004.

	1994[1]	1995[1]	1996[1]	1997[1]	1998[2]	1999[2]	2000[2]	2001[2]	2002[2]	2003[2]	2004[2]
Campbell County	205.2	232.4	245.3	246.3	265.3	282.5	304.3	316.4	319.9	323.4	326.9
Converse County	11.7	14.1	15.8	17.8	15.0	15.3	15.3	15.3	15.3	15.3	15.3
Sheridan County	0.1	M	M	M	M	M	M	M	M	M	M
Carbon County	4.4	3.8	4.7	5.0	4.2	3.7	2.0	2.0	2.0	2.0	2.0
Sweetwater County	11.2	9.1	8.2	7.8	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Lincoln County	4.3	4.5	4.4	4.6	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total Wyoming	236.9	263.9	278.4	281.5	297.5	314.5	334.6	346.7	350.2	353.7	357.2
Annual Change	12.9%	11.4%	5.5%	1.1%	5.7%	5.7%	6.4%	3.6%	1.0%	1.0%	1.0%
Higher-priced coal[3]	33%	26%	24%	22%	17%	13%	9%	6%	4%	4%	4%

[1]Tonnages from the Wyoming's State Inspector of Mines, 1994-1997.

[2]County estimates by the Wyoming State Geological Survey, April, 1998; [3]Estimated percentage of Powder River Basin coal production that is sold at prices above $5.00 [older long-term contracts that have not yet expired]. M means minor tonnage (less than 0.1 million tons).

Table 12. Breakdown of average prices paid for coal from northeastern Wyoming, southern Wyoming, and Wyoming as a whole (1988-1996) with forecasts to 2004.

Year	Northeastern	Southern	Statewide
1988	$7.35	$21.45	$9.16
1989	$6.94	$19.76	$8.63
1990	$6.86	$19.36	$8.43
1991	$6.58	$18.81	$8.06
1992	$6.61	$18.84	$8.13
1993	$6.02	$17.72	$7.12
1994	$5.62	$17.42	$6.62
1995	$5.60	$17.35	$6.38
1996	$5.40	$17.30	$6.15
1997	$5.33	$17.21	$6.06
1998	$5.28	$17.17	$5.97
1999	$5.19	$17.10	$5.82
2000	$5.11	$17.00	$5.64
2001	$5.03	$17.00	$5.55
2002	$4.96	$17.00	$5.48
2003	$4.89	$17.00	$5.40
2004	$4.81	$17.00	$5.32

Statewide data for 1988-1990 are from reports by the U.S. Department of Energy's Energy Information Administration; data for 1991-1996 are derived from Wyoming Department of Revenue information; estimates for 1997-2004 are derived from the Consensus Revenue Estimating Group's report of January, 1998; and all regional breakdowns are estimated by the Wyoming State Geological Survey.

Developments in the Powder River Basin (PRB)

"Coal Mine For Sale" was the dominant theme in the Powder River Basin (PRB) during the first quarter of 1998. At one point, mines representing nearly 82% of the coal production in Wyoming's PRB were thought to be for sale or in the process of being sold.

The sale of ARCO Coal Co.'s mines in this country is apparently close to completion, but not to the apparent first buyer. In a press release issued by ARCO on March 2, 1998, the company announced the pending sale of its U.S. coal operations to the Alliance Coal Group (Alliance), an affiliate of the Beacon Group which also owns Mapco Coal. Alliance is also an affiliate of Texas Pacific Group, a private investment firm like the Beacon Group. If the deal was not finalized within two weeks of the press announcement, ARCO said it would reconsider offers from the other bidders.

And the proposed Alliance deal did run into enough of a snag that ARCO reopened the door to the next highest bidder. In a March 23rd press release, ARCO announced they had reached an agreement with Arch Coal on the sale of their domestic coal assets. In the announcement, ARCO said it had agreed to sell its coal holdings to Arch Coal for a transaction valued at $1.14 billion.

Table 13. Permitted capacity of Wyoming coal mines in 1997 (corrected 4-1-98)[1].

Mine	County	Capacity in Million Tons/year
Belle Ayr	Campbell	25.0
Black Thunder	Campbell	55.0
Buckskin	Campbell	24.0
Caballo-Rocky Butte	Campbell	51.0
Coal Creek	Campbell	18.0
Cordero-Rojo	Campbell	60.0
Dry Fork	Campbell	15.0
Eagle Butte	Campbell	35.0
Fort Union	Campbell	9.4
Jacobs Ranch	Campbell	35.0
North Antelope	Campbell	35.0
North Rochelle	Campbell	20.0
Rawhide	Campbell	24.0
Rochelle	Campbell	30.0
Wyodak	Campbell	10.0
	Subtotal =	**446.4**
Cyprus-Shoshone	Carbon	3.5
Medicine Bow	Carbon	4.0
Rosebud	Carbon	1.8
Seminoe II	Carbon	2.1
	Subtotal =	**11.4**
Antelope	Converse	30.0
Dave Johnston	Converse	4.2
	Subtotal =	**34.2**
Kemmerer	Lincoln	4.2
Skull Point	Lincoln	1.5
	Subtotal =	**5.7**
Black Butte	Sweetwater	7.0
Jim Bridger	Sweetwater	7.9
Leucite Hills	Sweetwater	2.5
Lion Coal	Sweetwater	0.3
Pilot Butte	Sweetwater	2.0
	Subtotal =	**19.7**
	Wyoming Total =	**517.4**

[1] From Air Quality Division, Wyoming Department of Environmental Quality

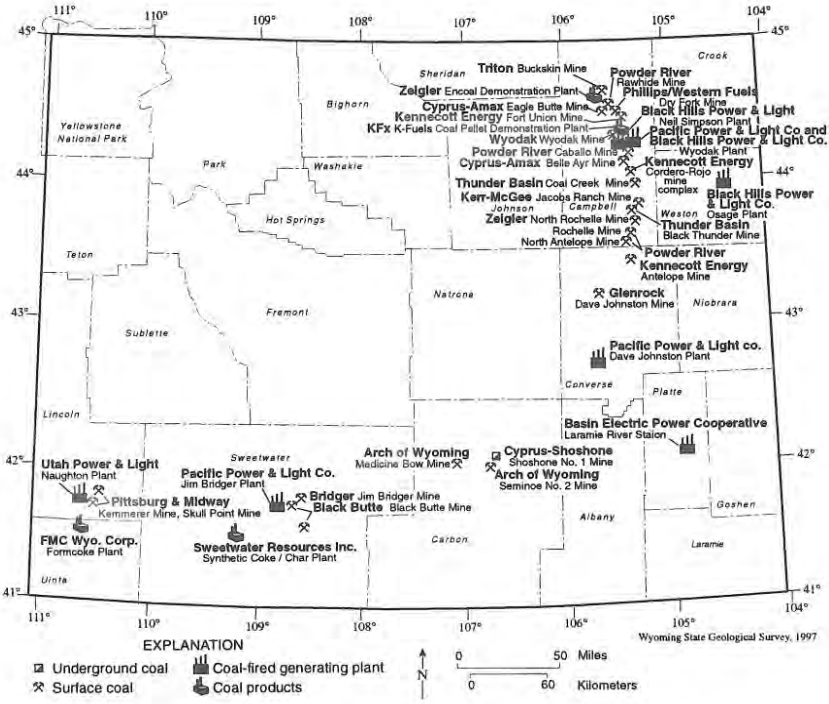


Figure 16. Active coal mines, plants, and products in Wyoming, 1997.

According to *Coal Outlook* (3/30/98), the structure of the acquisition involves two steps. In the first step, Arch will pay ARCO $390 million in cash for Mountain Coal which operates the West Elk mine in Colorado, and for ARCO's 65% interest in Canyon Fuel LLC, formerly Coastal's Utah holdings. ITOCHU Corp. of Japan will retain their portion of the limited liability corporation's three Utah mines.

The second and simultaneous step in the deal involves bringing the newly acquired Utah and Colorado operations, along with Arch's existing Hanna Basin operations in Wyoming, into a new joint venture called Arch Western Resources LLC. ARCO is reportedly contributing their two PRB mines, Black Thunder and Coal Creek, to the venture. ARCO's subsidiary, Thunder Basin Coal Co. currently operates these mines. Arch Coal will own 99% of the new company with ARCO retaining 1%. Arch Western Resources LLC will give ARCO $700 million on a tax-deferred basis. As the final $50 million portion of the price tag, Arch will assume leases on the mining equipment at the Black Thunder mine.

In an interview in *Coal Daily* (3/30/98), Steven Leer of Arch Coal said, "We see ourselves as a strong competitor that will help keep electric cost low." Some competitors in the PRB; however, are concerned that the entrance of a new player into the basin will drive already low prices farther down. While Leer would not divulge Arch's plans, he did indicate that they were not likely "to do anything that would be counterintuitive or destroy value for our shareholders."

In another potential sale, PacifiCorp is no longer the probable purchaser of The Energy Group (TEG), which includes Peabody Coal Group and its subsidiary, Powder River Coal Co. In early February, it looked like PacifiCorp's bid to acquire TEG was near to completion. Then on February 16th, Texas Utilities Co. (TU) released a statement confirming that they were in negotiations with TEG, with a view to making an offer. A bidding war between PacifiCorp and TU apparently followed this announcement. By March, it looked like TU might become the successful bidder. Early in May, the *Casper Star-Tribune* (5/2/98) carried an article indicating a $10.4 billion offer by TU had been accepted by TEG. It was also reported that TU would sell the Peabody Coal Group to Lehman Brothers Merchant Banking Group for about $2 billion. Peabody owns the Caballo, North Antelope, Rochelle, Rawhide, and Rocky Butte coal properties in Wyoming, through their subsidiary, Powder River Coal Co. The sale of TEG apparently still requires some regulatory approvals before it can become final.

Kerr-McGee Coal Corp.'s Jacob Ranch mine is also for sale. Initial bids were due by March 18th. According to *Coal Outlook* (3/30/98), the company selected a short list of bidders from the first offers. Although names were not mentioned, it is rumored that the potential purchasers include at least some of the same companies that were interested in the ARCO sale. Kerr-McGee is hoping to close a deal in time for the new owner to bid on the Federally-owned Thundercloud Lease-by-application (LBA) tract, which is now scheduled to come up for bid sometime in September of this year. The estimated 450 million tons of reserves in that tract would extend the life of the Jacobs Ranch mine by 8-10 years.

Zeigler Coal, the parent company of Triton Coal, is preparing to test the waters for a potential buyer for its coal operations. At the close of 1997, Zeigler retained the services of an investment-banking firm, First Boston Corp., to explore various alternatives to maximize value for shareholders of the company. The alternatives included sale of the entire company. In addition, Zeigler's board of directors has adopted a change-in-control, a severance plan and retention bonus plan for all salaried employees, as well as special incentives for certain key employees.

With the recent sale of some of its eastern operations, Cyprus-Amax may have quieted rumors that it might sell all or a portion of its western coal operations. At the end of February, Cyprus-Amax agreed to sell some of its Appalachian and Midwestern coal properties. In a company news release, Milton H. Ward stated, "This sale is part of our previously disclosed plan to focus our

attention on growing production and markets for our Pennsylvania and Western U.S. operations."

In February, the Final Environmental Impact Statement (FEIS) on the Thundercloud and Powder River LBA tracts was completed. Following the FEIS, the U.S. Bureau of Land Management (BLM) issued Records of Decision to lease both tracts. The sale for the Powder River tract, which is sought by Powder River Coal Co., is now set for June 30th. This tract has an estimated 532 million tons of coal and is located near Powder River's North Antelope mine. As mentioned earlier, the sale for the 450-million-ton Thundercloud LBA, which is adjacent to Kerr-McGee's Jacobs Ranch mine, will not occur until sometime in September of this year.

The Interior Board of Land Appeals reversed the U.S. Bureau of Land Management's (BLM's) 1994 decision that a coal lease exchange sought by Belco Petroleum was not in the public interest (*Coal Outlook*, 2/16/98). Belco is attempting to exchange its coal reserves along Interstate 90 in Johnson County for a portion of the Hay Creek tract in Campbell County. The Hay Creek lease tract is located just north of the Buckskin mine, currently the area's northernmost mine.

Developments in southern Wyoming

On March 19th, the BLM began the public comment period on their decision to consider leasing 11,928 acres of land in the Carbon Basin, which is located southeast of the Hanna Basin in south-central Wyoming. The lands contain an estimated 313 million tons of recoverable coal. Arch Coal has applied to lease at least 3,984 of the Federal acres. Because the environmental review of Arch's LBA has not been completed, the BLM could not have a lease sale on the Arch tract before 1999 at the earliest.

While Arch Coal is bullish on the Carbon Basin project, *Coal Outlook* (3/30/98) reported that Arch plans to curtail production at their Hanna Basin operations, beginning this year. The company's Medicine Bow mine, which produced 1.6 million tons in 1997 is reportedly only scheduled to produce 1.9 million tons over the next three years, and their Seminoe II mine, which produced 600,000 tons in 1997, might be idled this year.

Pittsburg & Midway Coal Mining has named Steve Johnson as the new general manager of their Kemmerer mine. Johnson was the production manager at the mine and succeeds Cliff Rice, who has retired.

Transportation

The Dakota, Minnesota, and Eastern Railroad (DM&E) has filed an application with the Surface Transportation Board (STB). DM&E's application is for a new rail line, which is designed to serve coal traffic in the Powder River Basin

(PRB). The railroad has its application on the Internet to encourage public interest and participation. The address is http://www.dmerail.com.

The project, which will cost an estimated $1.4 billion, involves the building of 280 miles of new rail line in Wyoming, South Dakota, and Minnesota as well as the upgrading of 600 miles of trackage in South Dakota and Minnesota. DM&E hopes to complete the project by 2000. Their plans call for the first year of operation to haul 40 million short tons of PRB coal. In year two, this will increase to an expected 60 million tons. Another 10 million tons will be added each year for the next four years, bringing the expected tonnage in year six to 100 million tons.

In the first quarter of 1998, the Union Pacific/Southern Pacific (UP/SP) railroad was reportedly still having its problems making timely deliveries. On top of the problems stemming from the recent merger of the two railroads, March blizzards blocked tracks and froze switches in Wyoming for several days.

On April 1st, the Burlington Northern-Santa Fe (BNSF) railroad shut down its southern route into the PRB until May 10th. The shutdown meant all their coal traffic moving via Guernsey, Wyoming, and north into the PRB would have to be rerouted. The project, which began last January, involved tearing up a single-track tunnel serving the route, removing the tunnel's roof, shoring up the track bed, and adding double tracking. The BNSF also planned to conduct other repairs and maintenance on the closed section of track. The additional work normally would have been spread over the entire year.

Most of the traffic was to be rerouted via the BNSF's northern route through Gillette, then south through Edgemont, South Dakota, and down to the railroad's coal yard at Alliance, Nebraska. The empties were to travel the same route in reverse (*Coal Daily*, 4/1/98).

Texas Utilities Electric will begin construction in May or June on a 25-mile spur to service its Big Brown power plant near Fairfield, Texas. Currently the plant burns lignite, but it is planning to phase in PRB coals starting in the year 2000 because reserves at their lignite mine will be exhausted by 2010. The spur will connect to both the BNSF and UP/SP railroads (*Coal Outlook*, 1/12/98).

Coalbed methane

In its 4th Quarter Report, Western Gas Resources (WGR) showed a $3 million after-tax gain after selling Barrett Resources Corp. a 50% interest in the company's coalbed methane operations (*Wyoming Geo-notes No. 57*, p. 35). In a company press release, Larry Outlaw, WGR President and COO, said, "We have further solidified our strong position in the Powder River coalbed methane play and have sold 50% interest in position to a highly respected industry partner, which will allow us to accelerate the development of the area." WGR's coalbed methane production increased from 27 million cubic feet per day at the beginning of 1997 to 55 million cubic feet per day by year-end.

As mentioned earlier in this issue (p. 15), the U.S. Bureau of Land Management (BLM) is no longer accepting Notices of Staking or Applications for a Permit to Drill coalbed methane wells in certain portions of the Powder River Basin (PRB). The moratorium applies to Federal leases primarily in T40-50N, R70-75W, in Campbell County. The drilling moratorium was instituted because a ceiling on the number of new coalbed methane wells allowed under the current Environmental Impact Statement (EIS) for the Gillette South Area would be exceeded. The moratorium will be in effect until a new EIS is completed, tentatively in May of 1999. The EIS on the new Wyodak Coalbed Methane Area will study the impact of drilling 3,000 more wells south of Gillette and an additional 750 wells north of the town, all between 1999 and 2007 (*Casper Star-Tribune*, 3/26/98). It has been estimated that approximately 800 coalbed methane wells have already been drilled in the Gillette area, including those not on Federal lands. The moratorium does not currently apply to Federal leases covered by the Environmental Assessment for the Gillette North Coalbed Methane Area.

KN Energy has expressed interest in building a new gas pipeline into the PRB as more coalbed methane production becomes available in this corner of the State. Western Gas Resources has already agreed to add additional compressor and transmission facilities to handle new coalbed methane production related to its partnership with Barrett Resources Corp.

Regulatory developments

President Clinton's FY 1999 budget request to Congress includes a repeal of the percentage depletion allowance for minerals mined on present and former Federal lands. This provision of the Administration's budget is opposed by the mining industry, which estimates this tax change would cost the mining industry nearly $500 million through the year 2003.

The Environment Protection Agency (EPA), in a Congressionally mandated report, has identified coal-fired power plants as a major source of harmful emissions of mercury (*Coal Outlook*, 3/2/98). The report said mercury is the toxin of greatest concern, and coal plants are the only fossil-burning plants that omit mercury.

By way of background, mercury is found as a trace element in coal. While published data are limited, the U.S. Geological Survey reported an average mercury concentration of 0.18 parts per million (ppm) in its analyses of 799 samples of U.S. coals (Swanson and others, 1976). Based on the analyses of 54 Wyoming coals, Glass (1975) reported an average mercury content of 0.10 ppm mercury.

The EPA said it hopes to cut mercury emissions by implementing proposed new standards for smog and particulate emissions. The coal and utility industries are concerned that EPA's action will mean the shutdown of a number of coal-fired units or switching them to natural gas. The EPA is also apparently

seeking time to study what technologies there are to reduce mercury emissions.

In early April, the EPA made a proposal for mercury reporting from coal-fired power plants. Titled the Electric Utility Steam Generating Unit Mercury Emissions Information Collection Effort Request (ICR), the request would have utilities submitting weekly reports on the mercury content of their coal. EPA is accepting public comments on its ICR for 60 days and will schedule a public hearing in Washington, D.C., on this proposal (*Coal Daily*, 4/8/98).

As of January 2nd, the Mine Safety and Health Administration (MSHA) began accepting required quarterly data from coal mine operators via the Internet. The form is available on MSHA's homepage at the following address: http://www.msha.gov (*Coal Week*, 1/26/98). Only initial filings are currently acceptable. Amended filings must be mailed or faxed to the agency.

Market developments and opportunities

According to *Coal Daily* (4/6/98), the spot market for Powder River Basin (PRB) coals was slightly softer in the first quarter of 1998 than it was in the last quarter of 1997. Their market observations indicated spot prices were down by 15 to 20 cents, when coal was available. Some buyers are "front-loading" contract coal this year, apparently hoping to find more attractive spot prices later in the year. This indicates that the discipline noted in the PRB market toward the end of last year may be holding up in the early part of 1998. *Coal Daily's* early April, 52-week-range in spot sale price for 8,400-Btu/lb., PRB coal was $3.90 to $3.00 per ton. Their early April 1998 price was estimated at $3.45. Their 52-week-range for 8,800-Btu/lb., PRB coal was $3.95 to $5.15 per ton. Their early April estimate was $4.60 per ton.

Arch Coal may propose fuel switching to certain utilities now using coal out of its eastern and midwestern mines. Pending completion of its ARCO acquisition, Arch will reportedly offer substitute coal out of its new holdings in the PRB. Numerous utilities have used coal from both ARCO and Arch, so they might be prime candidates for this kind of substitution.

Kennecott Energy reportedly sold about one million tons of its PRB coal options for 1999 delivery (*Coal Outlook*, 1/26/98). The sale price was rumored to have been in the upper $3.00 range. Buyers of the options are apparently utility-affiliated power marketers. Zeigler Coal is also rumored to have sold some options on PRB coal.

Coal Daily (3/5/98) reports that Enron Capital & Trade Resource Corp. and Kennecott Energy have formed an alliance. Under the agreement, Kennecott will be Enron's preferred coal provider and Enron will be Kennecott's preferred energy provider.

At a coal-fired power plant in Portage, Wisconsin, ADA Environmental Solutions LLC (ADA-ES), a subsidiary of Earth Sciences Inc., has begun operation of its first commercial air pollution control system. According to ADA-ES, while coals mined in the PRB can reduce sulfur dioxide emissions and fuel costs, some of these coals can produce airborne fly ash that is difficult to collect. The ADA-ES process is designed to overcome this difficulty through the addition of a proprietary chemical.

Central Illinois Light Co. is contemplating the testing of western coal, most likely at the level of a 10-20% blend with other coals.

Colorado Springs Dept. of Municipal Utilities' Nixon plant has successfully completed a 70,000-ton test burn of 100% PRB coal. The plant will finish out the year with a blended burn of 1/3 PRB coal and 2/3 Colorado coal.

Holland [Michigan] Board of Public Works is considering a shift away from eastern Kentucky coal to a blend of PRB coal and petroleum coke. The blend would be for their James DeYoung generating station.

Coal Outlook reports (3/9/98) that the Kincaid power plant in Illinois will be ready to burn 100% PRB coal in June of 1999. The plant was originally built to burn Illinois Basin coal, but was converted to burn western bituminous coal in the early 1990s. Dominion Resources, the parent company of Virginia Power, bought the plant in February from Commonwealth Edison. Dominion is making the further changes needed to burn PRB coal. Commonwealth will remain the fuel buyer for the plant and will purchase the plant's electric generation for the next 15 years. The plan to switch to PRB coal is part of Dominion's plan to reduce emission levels of nitrogen oxide.

Minnesota Power has scheduled a test burn of PRB coal for completion by Labor Day. Traditionally the utility burns northern PRB coal from Montana. This time they have included Wyoming coal from the Black Thunder, Cordero-Rojo, Rochelle, and the North Antelope mines (*Coal Daily*, 4/3/98).

Mississippi Power and St. Joseph [Missouri] Light and Power are both hoping to increase their burn of PRB coal. Mississippi Power may hike the coal blend in their test burn at the Watson plant from 20% PRB to 40% PRB coal (*Coal Outlook*, 2/16/98). St. Joseph hopes to eventually increase their PRB blend from 30% to the 80-90% range.

TVA reportedly is offering to sell coal they don't need (*Coal Daily*, 3/27/98). They are apparently seeking takers for several hundred thousand tons of PRB coal that they do not need in the near future.

Western Fuels Association, which is representing Basin Electric Power Coop., and Tri-State G&T, the co-owners of the Laramie River power plant, is reopening two contracts involving coal from the Rawhide mine. Coal bids will go out this summer with Powder River Coal Co. having the right of first refusal.

Table 14 is a tabulation of some of the contracts, spot sales, tests, and solicitations for Wyoming coal announced during the first quarter of 1998.

References cited

Glass, G.B., 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): Geological Survey of Wyoming Report of Investigations 11, 219 p.

Stauffenberg, D.G., 1998, Annual report of the State Inspector of Mines of Wyoming for the year ending December 31, 1997: Office of the State Inspector of Mines, Rock Springs, 76 p.

Swanson, V.E., and others, 1976, Collection, chemical analysis, and evaluation of coal samples in 1975: U.S. Geological Survey Open File Report 76-468, 503 p.

Table 14. Marketing activities for Wyoming coal producers during the first quarter of 1998[1].

	Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
1.	American Electric Power Service Corp.	System wide	PRB	So	Unknown	Seeking 3- to 12-month supply at a fixed price, and will consider proposals that bundle SO_2 allowances with coal.
2.	Consumers Energy	Cobb	PRB	So	2,300,000 t	1998 delivery on the BNSF.
3.	Fremont Dept. of Utilities	Unspecified	Shoshone/Hanna	Sp	60 cars	Already bought 40 carloads; $29.16/t delivered.
4.	Grand River Dam Authority	Unspecified	Caballo/PRB PRB	C Sp	500,000 t 200,000 t	Delivery in 1998. Delivery in 1998; Electric Clearing House (broker).
5.	Lansing Board of Water & Light	Eckert Units 4-6	PRB	So	Unknown	Delivery in 1999.
6.	Minnesota Power	Boswell/Laskin	PRB	T	Unknown	Leading to contract for 2.5 million t/y; 5-year contract.
7.	Muscatine Power and Water	No. 8 unit	PRB	So	400,000 t	Delivery in 1999; three-year term; converting unit to PRB coal.
8.	Nebraska Public Power	Sheldon	Shoshone/Hanna	Sp	35,000 t	Higher Btu/lb coal to clean out boiler.
9.	Northern Indiana Public Service Co.	Mitchell, Bailly, Michigan City	Jacobs Ranch/PRB	C	1,000,000 t to 1,800,000 t	5-year contracts; Enron Corp. and Power Company of America.
10.	Omaha Public Power District	North Omaha & Nebraska City	PRB PRB	T So	Unknown 2.4-4.8 million t	Test leading to the following solicitation. Over 5 years starting in 1999.
11.	Texas Municipal Power Agency	Gibbons Creek	Cordero Rojo/PRB	C	1,800,000 t/y	Delivery on BNSF; option to decrease by 5% or increase by 15%; 8,450 Btu/lb.

	Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
12.	TUCO Inc., Southwestern Public Services	Tolk	Coal Creek/PRB	Sp	200,000 to 300,000 t	Delivery in 1998.
13.	Tennessee Valley Authority	Allen, Gallatin, & Shawnee	Jacobs Ranch/PRB	C	1,000,000 t/y	Six-year contract with reopener after 3rd year.
14.	Union Electric	Joppa	PRB	So	500,000 to 2,000,000 t/y	1-, 3-, & 5-year terms starting in 1999.
15.	Wisconsin Public Service Corp.	System	PRB	So	up to 15,000,000 t	1- to 5-year terms.

[1]Data obtained from : Coal Week©, Coal Outlook©, Coal Market Bulletin©, FERC database, and personal contacts.
C =contract coal; Sp =Spot coal;So =solicitation; T =Test burn; t =short ton; t/y =short tons per year; PRB =Powder River Basin
Wyoming State Geological Survey, Coal Section, March, 1998.

INDUSTRIAL MINERALS AND URANIUM UPDATE

Ray E. Harris
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Nonfuel mineral production in Wyoming

Wyoming ranked 12th in the value of nonfuel mineral production in the U.S. in 1996, according to figures recently released by the U.S. Geological Survey (Smith, 1998). Wyoming's 1996 nonfuel mineral production was valued at $1.08 billion. Wyoming was 1st in per capita value of nonfuel minerals, and 26th in per acre value. Wyoming's chief products in order of value were soda ash, bentonite, helium, cement, and construction aggregate. The value of nonfuel mineral production in each of the 50 states and their principal products in 1996 is given in **Table 15**.

Bentonite

Bentonite production in Wyoming should continue to increase. There are 10 operating bentonite plants in Wyoming (**Figure 17**). Bentonite, formerly used primarily for oil and gas well drilling fluid, is now used for a variety of products. These include taconite (iron ore) processing, environmental absor-

Table 15. Ranking of states' nonfuel mineral production in 1996 and their principal mineral product.

1	Arizona (copper)	26	South Carolina (cement)
2	Nevada (gold)	27	Montana (gold)
3	California (cement)	28	Iowa (construction aggregate)
4	Florida (phosphate rock)	29	Idaho (phosphate rock)
5	Georgia (kaolin)	30	Kentucky (construction aggregate)
6	Utah (copper)	31	Arkansas (construction aggregate)
7	Texas (cement)	32	Wisconsin (construction aggregate)
8	Minnesota (iron)	33	Louisiana (salt)
9	Michigan (iron)	34	Oklahoma (cement)
10	Missouri (lead)	35	South Dakota (gold)
11	Pennsylvania (construction aggregate)	36	Maryland (construction aggregate)
12	**Wyoming (soda ash)**	37	Oregon (construction aggregate)
13	New Mexico (copper)	38	New Jersey (construction aggregate)
14	Ohio (construction aggregate)	39	Massachusetts (construction aggregate)
15	New York (construction aggregate)	40	West Virginia (construction aggregate)
16	Illinois (construction aggregate)	41	Nebraska (cement)
17	Alabama (cement)	42	Mississippi (construction aggregate)
18	North Carolina (construction aggregate)	43	Hawaii (construction aggregate)
19	Tennessee (construction aggregate)	44	Connecticut (construction aggregate)
20	Indiana (construction aggregate)	45	Maine (construction aggregate)
21	Alaska (zinc)	46	Vermont (construction aggregate)
22	Virginia (construction aggregate)	47	New Hampshire (construction aggregate)
23	Washington (construction aggregate)	48	North Dakota (construction aggregate)
24	Kansas (cement)	49	Rhode Island (construction aggregate)
25	Colorado (construction aggregate)	50	Delaware (magnesium from sea water)

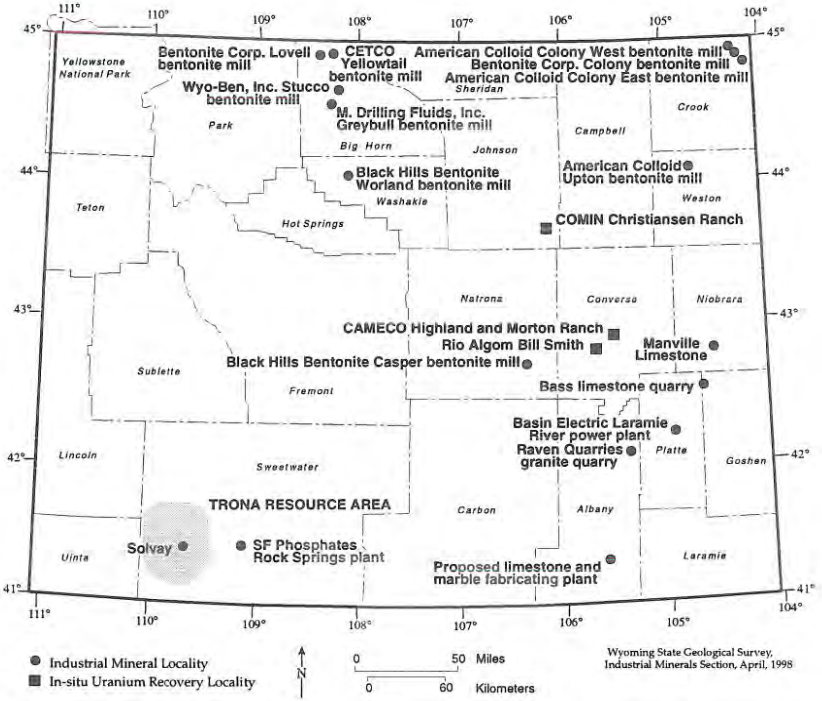

Figure 17. Map of Wyoming industrial mineral and uranium localities of interest, first quarter, 1998.

bents, and molding and casting material. The product that has contributed the most to the recent increase in bentonite production in Wyoming is kitty litter.

Construction aggregate

Construction aggregate is sized sand and gravel and crushed and sized rock. It is mixed with cement to make concrete, used as fill in road and railroad embankments, and is used as a texturing agent in wall coatings and similar material. It can range in size from pieces over five feet in diameter (riprap) to rock flour used as mineral filler in some structural concrete. The national importance of construction aggregate is evident from **Table 15**. Aggregate is the most important nonfuel mineral in many states. In most other states, it ranks either 2nd or 3rd. Reflecting Wyoming's low population and small number of active building projects, construction aggregate is 5th in value.

Decorative and dimensional stone

The Wyoming Science, Technology, and Energy Authority (STEA) awarded Dimensional Stone Exploration, Inc. (DSE) a $125,000 grant to help fund a

geotechnical study of approximately 20 quarry sites in Wyoming. Another $125,000 will be granted DSE after it purchases a building and equipment for a dimensional stone fabricating plant in Wyoming. DSE will use this additional money to continue the geotechnical study of quarry sites in Wyoming. DSE is a Wyoming corporation based in Laramie. It is backed by an Italian stone company with extensive quarrying and processing experience.

Raven Quarries, Inc., formerly Sunrise Stone, continues to quarry black granite and swirled pink granite at its quarry in northeastern Albany County (**Figure 17**). The black granite (geologically an amphibolite) is sold under the product name of "Wyoming Raven". The pink granite (geologically a migmatite) is sold as "Fantastico".

Although the company closed its processing plant on Bluegrass Creek west of Wheatland in Platte County in early 1998, Toby SerVoss of Raven Quarries has said that the Wyoming plant will occasionally process custom orders. Mr. SerVoss also noted that it was less expensive for him to ship quarried blocks to Mexico for finishing than to finish them in Wyoming. The lower labor and equipment costs in Mexico more than make up for the transportation costs from Wyoming to Tijuana, Mexico, and on to markets.

Fertilizer and soil conditioners

In February, SF Phosphates (SF), located southeast of Rock Springs in Sweetwater County (**Figure 17**), announced a projected expansion that will increase their production of soil conditioners by more than 25%. Phosphate rock production from their phosphate mine north of Vernal, Utah, will increase proportionally. The phosphate rock is slurried to the plant from the mine through a pipeline. The plant will also require more sulfur, which it will purchase from Wyoming natural gas refiners. The expanded plant will employ about 12 additional employees. The cost of the expansion is an estimated $36 million.

Limestone (chemical grade)

Basin Electric, the operator of the Laramie River Station, a coal-fired power plant northeast of Wheatland in Platte County (**Figure 17**), is exploring limestone occurrences near the plant. Limestone is used in the plant for emissions control. The Bass quarry, operated by Divide Construction, is the current source of limestone for the plant (**Figure 17**). Basin Electric is seeking high-grade, easy-to-grind, low-silica limestone close to the plant. As of April 1st, no source had been designated.

Timberline Production Co., Inc., of Casper, is proceeding with a study of a limestone deposit south of Manville, Wyoming, in Niobrara County (**Figure 17**). Timberline has leased this limestone from the State. The company will conduct marketing and resource evaluations. The high-grade limestone at the Manville site is chemically suitable for manufacturing lime, refining sugar beets,

and other uses where the purity of the limestone is important. The associated dolomitic limestone is suitable for construction aggregate. Both the limestone and the dolomite are potentially suitable for decorative and dimensional stone. This deposit was initially located by the Wyoming State Geological Survey (Harris, 1987).

Trona

The continuing problems with Asian economies may contribute to a reduction in the amount of trona mined in Wyoming in 1998. According to Dennis Kostick of the U.S. Geological Survey, 46% of domestically produced soda ash is exported. Over half of these exports go to the Far East. Wyoming produces over 90% of all the soda ash manufactured in the U.S. If the Asian economic slowdown continues, orders for Wyoming soda ash will likely decline, resulting in a corresponding decline in the amount of trona mined in Wyoming. Orders for soda ash from this region for the first quarter of 1998 have fallen off considerably. Soda ash prices may also decline.

In February, responding to the Asian situation, Solvay announced an 18-month delay of its permitted $170 million plant expansion (**Figure 17**). This expansion was to have increased Solvay's capacity from 2.3 million short tons of soda ash produced each year to 3.5 million short tons of soda ash per year. The delay will mean that the first increases in production from Solvay will not occur until the first part of 2001, at the earliest.

Another problem afflicting Wyoming's near-term soda ash production is a scheduling shortage of the covered railroad hopper cars that transport soda ash and other products from Wyoming to markets. Soda ash producers have had to slow down production because of the lack of cars at the plants when the refined products need to be shipped.

The Wyoming State Geological Survey published the first of a two-volume set of the *Proceedings of the First International Soda Ash Conference*, held in Rock Springs in June, 1997. This first volume contains papers regarding the marketing, pricing, and future of soda ash production. It is published as Public Information Circular 39. See p. 70-71 for ordering information. Publication of the second volume, containing geological and processing papers presented at the conference, is expected later this year.

Uranium

The price of domestic yellowcake continued a decline in the first quarter of 1998. This decline began in late 1997. As reported by Bob Odell in the March edition of the *Rocky Mountain Scout*, the Feb. 28 price of restricted uranium was $10.75 per pound, down from $12.05 per pound on Dec. 31, 1997 (**Figure 18**). The worldwide demand for yellowcake has also recently decreased.

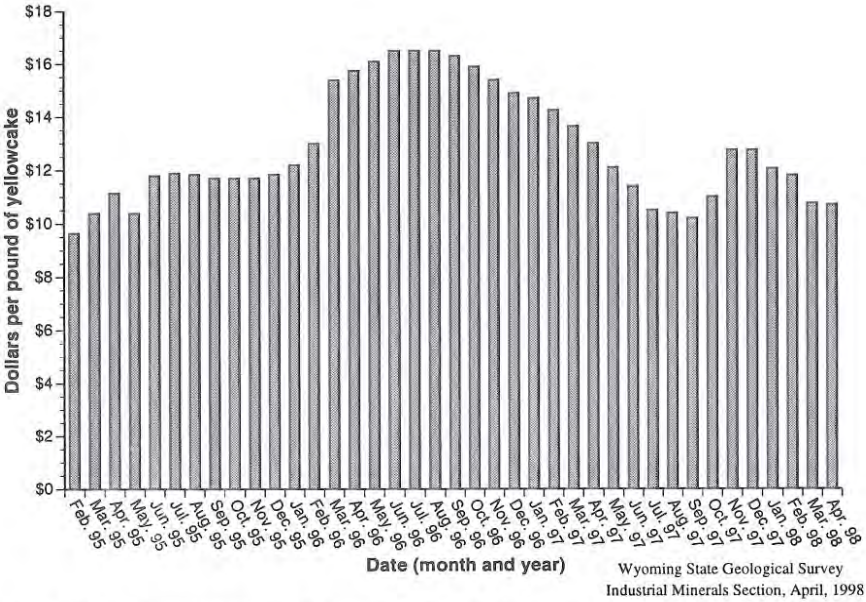

Figure 18. Domestic yellowcake prices, February, 1995, through April, 1998 (from *Rocky Mountain Scout*).

Because of the softening of the uranium market, one of Wyoming's three uranium producers has reduced production. COGEMA Mining (COMIN), which operates the Christiansen Ranch in-situ uranium production facility in Johnson County (**Figure 17**), recently scaled down production and laid off 20% of its work force. The other two Wyoming producers, CAMECO and Rio Algom, continue to produce yellowcake at 1997 rates. CAMECO operates the Highland and Morton Ranch in-situ production facility in central Converse County (**Figure 17**). Rio Algom operates the nearby Bill Smith in-situ production facility (**Figure 17**).

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METALS AND PRECIOUS STONES UPDATE

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Gold nuggets

South Pass is a favorable geological terrane for hosting significant gold mineralization. Based on the geology of the district, South Pass has the highest potential in Wyoming to produce large nuggets.

The South Pass region in the southern Wind River Range of western Wyoming is underlain by an Archean greenstone terrane. Two mining districts are located along either limb of a regional synform formed within the belt. Both districts include several known lode and placer gold deposits (Hausel, 1989, 1991), and many of the lode deposits have sporadic ore shoots that are favorable for hosting significant gold mineralization that may be conducive to yielding specimen-grade gold samples. Placer deposits developed downstream from these ore shoots provide excellent targets for large gold nuggets.

Each year, several ounces of gold, including some nuggets, are found in the South Pass region by hobby prospectors. Much of this gold goes unrecorded, and unfortunately the statistics on gold nuggets from the region are very incomplete. But recently, a relatively large nugget was found in the district by a prospector from Rock Springs, Wyoming. This nugget attracted the interest of the prospecting community, and luckily, information on the discovery was recorded.

Based on the available historical reports, this may be one of the largest nuggets found in the district. The available reports on nuggets from the South Pass region indicate that some of the largest nuggets found in the past included nuggets weighing 630, 24, 5.3, 5.2, 5, 4.5, 3 and 0.75 ounces (Hausel, 1996). In addition to these, another nugget weighing two pounds reportedly ended up in the Los Angeles museum (Ralph Platt, personal communication, 1998).

The nugget that was recently found in the South Pass region is one of the larger found in the district, as well as in Wyoming. According to Toussaint (1998), a prospector from Rock Springs discovered some nuggets while using a metal detector to prospect the tailings in the vicinity of Rock Creek in the central portion of the South Pass-Atlantic City mining district. Initially, the prospector found a small fingernail-size gold nugget with the detector. This was later followed by the discovery of a much larger nugget that was 2.5 inches long and weighed 7.5 ounces. The nugget was reportedly valued at more than $11,000 (Toussaint, 1998; Mattingly, 1998). This nugget is pictured on the cover of this issue of *Wyoming Geo-notes*.

Rock Creek forms a modern placer that has been mined several times during the past. The creek runs across several auriferous shear zones in the vicinity of Atlantic City, which could supply a considerable amount of gold to the placer. The last mining operation on Rock Creek occurred in 1986 and 1987.

Company activities

During the last week of March and the first week of April, the Wyoming State Geological Survey (WSGS) received 50 phone inquiries about the State's diamond potential as well as requests for information about various diamond deposits and prospects in Wyoming. A few companies and consultants also initiated exploration programs, and some of the targets recommended by the WSGS (Hausel and others, 1997) were staked.

The increase in diamond exploration activities in Wyoming is the result of diamonds increasing in value by more than 50% over the past 10 years, and also due to a letter the author sent to the editor of the *Northern Miner* (March 23, 1998), regarding Wyoming's diamond potential. The diamond exploration activity is expected to continue throughout the 1998 field season.

In addition to diamonds, several companies also contacted the WSGS for information and exploration ideas related to platinum, palladium, and nickel deposits. Some companies have already begun exploration activities in the State, and a few reported significant geophysical targets associated with some mafic and ultramafic rocks, possibly related to exploration for platinum-group mineralization. One Canadian company also indicated that they have outlined Wyoming as their exclusive exploration target due to the untapped mineral potential of the State.

In addition, the WSGS also received requests for information on some gold deposits in spite of the current low gold prices.

WSGS activities

The WSGS has several active projects as well as additional projects that are scheduled to begin in the 1998 field season. The following are some of these projects:

(1) Over the past four to five years, the author has accumulated and compiled data on diamonds and potential host rocks throughout the U.S. A Report of Investigations, entitled, *Diamonds and mantle source rocks in the Wyoming craton (with a discussion of other U.S. occurrences)*, is in preparation. It will describe many known diamond occurrences; lamproites, kimberlites, and ultramafic lamprophyres that have been found in the U.S.; and will emphasize that the Wyoming craton has the highest potential for the discovery of commercial diamond deposits in the U.S. Other areas of interest include California, Arkansas, and the Superior Province in the Great Lakes region.

(2) The Wyoming Legislature increased the budget for the WSGS's diamond investigations. During the next two fiscal years, the WSGS will accelerate and expand its efforts to identify potential diamond targets through mapping, stream-sediment sampling, diamond extraction tests, and microprobe geochemical analyses of indicator minerals. The project should generate considerable interest in Wyoming's diamond potential, as the geochemistry of kimberlitic indicator minerals will provide information on which areas in Wyoming are more likely to host diamonds. The generation of such potential targets is necessary to attract exploration dollars, as companies and consultants rely on such information.

(3) The WSGS also received funding for a mapping project in the Barlow Gap area of the Granite Mountains in central Wyoming. The U.S. Geological Survey awarded the WSGS a matching grant to map this region and examine the terrane for mineralization.

The Granite Mountains include a variety of rock types that range from relatively young sedimentary rocks to some very old gneissic rocks (greater than 3.3 billion years old), as well as some jade, ruby, sapphire, uranium, agate, jasper, and gold occurrences. In addition, the Granite Mountains have high potential for the discovery of kimberlite and diamonds, as the region lies in the interior of a craton similar to some of the diamond deposits that are currently mined in South Africa.

(4) The WSGS mapped the Leucite Hills lamproite field in 1997, and is conducting petrographic and geochemical analyses of samples from the volcanic field. The data will be compiled into a final report on this district.

(5) In a related project, the WSGS also sampled the Iron Mountain kimberlite district, and discovered a previously unreported kimberlite in that region. Samples collected during the 1997 field season are currently being processed for indicator minerals and diamonds. Past geochemical studies on some indicator minerals from the kimberlites indicated that some of the Iron Mountain intrusives contained G10 pyropes and Group 1 pyrope-almandines and originated within the diamond stability field.

Speaking engagements

If you are interested in diamonds, other gemstones, or gold, the author will be presenting several talks, field trips, or seminars in the near future. These include:

June 6th, "Wyoming diamond deposits", Natrona County Gem and Mineral Show, Casper.

June 7th, "Wyoming gemstones and semiprecious stones", Natrona County Gem and Mineral Show, Casper.

July 1st, "Wyoming gemstones and semiprecious stones", Rocky Mountain Prospectors and Treasure Hunters Club, Ft. Collins.

July 10th, "Field trip to the Tin Cup district", Rocky Mountain Prospectors and Treasure Hunters Club, Jeffrey City.

July 17th, "Field trip to the South Pass gold district", Rock Springs Mineral Club, Atlantic City.

August 5th, "Geology and mineralization of the South Pass gold district", Rocky Mountain Prospectors and Treasure Hunters Club, Ft. Collins.

August 13-14th, "South Pass gold district field trip", Rocky Mountain Prospectors and Treasure Hunters Club, Atlantic City.

September 9th, "The great 1872 diamond hoax and other mining scams", American Institute of Professional Geologists, Casper.

September 14th, "Diamond potential of the Wyoming craton", Saskatchewan Geological Society.

September 26th, "Diamond prospecting and exploration short course", Rocky Mountain Prospectors and Treasure Hunters Club, Laramie.

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EXPLORATION SUMMARY FOR 1997

Rodney H. De Bruin, Ray E. Harris, W. Dan Hausel, and Robert M. Lyman, Wyoming State Geological Survey

COAL

Coal production in Wyoming in 1997 was 281.5 million short tons compared to production of 278.4 million short tons in 1996. While Wyoming miners were willing and able to once again increase the State's annual coal production, railroad congestion and related delivery problems plagued the coal industry. As a result, production from Wyoming's coal mines was up only 1.1% over that of 1996. Still, 1997 proved to be another record year for Wyoming coal producers, keeping Wyoming ranked as the leading coal producing state in the country.

Reserves at Powder River Coal Co.'s Caballo mine were expanded by 280 million short tons of recoverable coal, with their acquisition of Montana Power's Rocky Butte Federal coal lease. The leased reserves underlie more than 6,800 acres. Powder River Coal is a subsidiary of Peabody Coal Group.

Triton Coal Co. successfully acquired lease rights to the 1,482-acre, North Rochelle LBA coal tract near Wright, Wyoming. After rejecting a July bid of 17 cents/ton, the U.S. Bureau of Land Management accepted Triton's September bid of 19.4 cents/ton. The tract contains an estimated 157.6 million tons of recoverable coal in two minable coal beds within the Wyodak coal zone. Triton Coal Co. is a subsidiary of Zeigler Coal Holding Co.

Arch of Wyoming is going ahead with its feasibility study of the company's plan to go underground at its proposed new Elk Mountain mine in the Carbon Basin of south-central Wyoming. Preliminary plans call for the opening of a surface mine in the year 2000. If exploration and reserve studies show that there is enough coal left for deep mining, Arch may also open an underground mine. Hoping to prove up reserves sufficient to support a 5- to 6-million-ton-per-year operation with a 25-year life, Arch now plans to build a rail spur to the mine.

COALBED METHANE

Chevron USA Production Co. has scheduled a 3,000-foot wildcat well to evaluate the coalbed methane potential of the basal Evanston Formation (Upper Cretaceous) in the Overthrust Belt, three miles east of Evanston, Wyoming. The estimated top of the targeted coal in the Evanston Formation is at a depth of 2,250 feet.

Barrett Resources Corp. (Barrett) and Western Gas Resources (Western) will jointly develop coalbed methane reserves in the northeastern portion of the Powder River Basin. The two partners collectively control over 250,000 acres and currently produce approximately 55 million cubic feet of methane per day. The partner companies have outlined an area of mutual interest (AMI) consisting of 2.1 million acres in an area extending from Gillette south to Wright in Campbell County. Within the AMI, both partners will develop certain specific areas. Barrett will be the principal operator over the next twenty months. Western has agreed to buy all the coalbed gas produced from within the AMI. To handle increases in production, Western also has agreed to install additional compressor and transmission facilities as needed.

INDUSTRIAL MINERALS AND CONSTRUCTION MATERIALS

Several bentonite companies began the development of new pits on new or existing properties. And bentonite production, which has continued to increase in Wyoming, was very near to setting a new production record in 1997. Production was 4.7 million short tons.

In November, Rissler-McMurry received approval of their mining permit for a limestone aggregate quarry two miles west of Guernsey. The limestone will be used for road construction projects in that area.

A stone producer based in Italy acquired several sites to quarry dimensional limestone and dimensional granite in Wyoming. The company is proceeding with plans to construct a limestone fabricating plant as well as a granite fabricating plant in Wyoming.

Mountain Cement received approval of their mining permit for a limestone quarry south of their existing quarry. This new quarry helps assure a continued supply of raw materials for their cement plant at Laramie, Wyoming.

Colorado Lien began production of limestone from their Hartville quarry and drilled to verify reserve estimates. This new quarry is five miles north of Guernsey, Wyoming, in Platte County.

Basin Electric, which operates the coal-fired, Laramie River power plant north of Wheatland, announced they were seeking a nearer source of limestone for emissions control. The existing source, the Bass quarry in northwestern Goshen County, is 40 miles from the plant. Basin Electric and other companies explored for a new site nearer the power plant.

V.A. Resources (VA), of Casper, Wyoming, received approval of a permit to mine limestone at their Plumbago Creek site. This property is 30 miles northeast of Laramie.

VA, which acquired both the Plumbago Creek silica deposit in Albany County and the Cassa silica deposit in Platte County in 1996, also continued working on mining permits for both sites. At year's end, a glass manufacturing company contacted the State of Wyoming and the Wyoming State Geological Survey regarding both the availability of silica from these sites as well as the feasibility of siting a glass plant within the State.

OCI began a major expansion project at its trona mine and soda ash plant in the Green River Basin and is expected to increase its capacity by 33%. Tg Soda Ash continued to develop plans for construction of a new mine at its present site. The new mine will access trona bed 17. The current mine is developed in beds 24 and 25. The sinking of a new shaft at the Solvay mine is on schedule. FMC and General Chemical began operating with expanded capacity following the completion of expansion projects.

Two new publications on the industrial minerals of Wyoming have been published by the Wyoming State Geological Survey (WSGS). The First International Soda Ash Conference, hosted by the U.S. Geological Survey and the Wyoming State Geological Survey with support from the U.S. Bureau of Land Management, was held at Rock Springs, Wyoming, in June, 1997. In March of 1998, Volume 1 of the proceedings for this conference was published by the WSGS as Public Information Circular 39. The second volume is still in preparation.

Late in 1997, the WSGS published the *Proceedings of the 32nd Annual Forum on the Geology of Industrial Minerals* as Public Information Circular 38. The Forum met in Laramie in May of 1996 with technical sessions and field trips. See p. 70-71 for ordering instructions for these and other recent publications.

U.S. Zeolite began mining clinoptilolite southeast of Bitter Creek, in Sweetwater County. The zeolite is shipped to a facility in Utah for refining and shipping to markets. This is the first production of zeolite in Wyoming.

OIL AND NATURAL GAS

Drilling activities and well completions

Based on data available from Petroleum Information/Dwights LLC (PI/D) (1998), there were 790 well completions in Wyoming in 1997, which is a sharp increase from the 372 completions in 1996 (**Figure 19**). Of the 790 completions, 106 were exploration wells and 684 were development wells. The success rate for exploration wells was 35.8% compared to a success rate of 31.4% for exploration wells in 1996. There were 22 new oil discoveries and 16 new gas discoveries in 1997. In all, 640 wells found oil or gas for a success rate of 81.0% compared to a success rate of 77.7% in 1996.

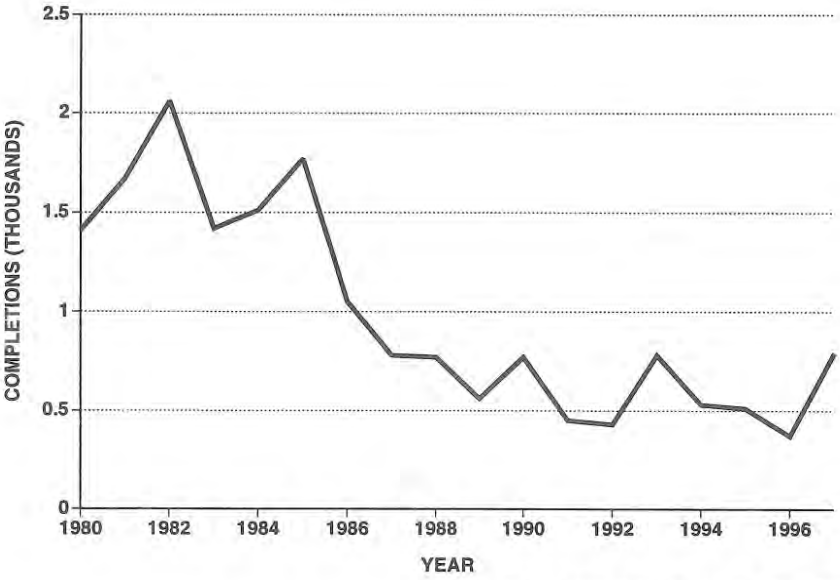

Figure 19. Number of oil and gas well completions by year (1980-1997). From PI/D (1998).

The average daily rig count in 1997, as reported by Hughes Rig Count, was 39. This was an increase of 15 over 1996 and the highest average since 1987 (**Figure 20**). Rigs in Wyoming drilled over 4.8 million feet in 1996, an increase of 2.3 million feet over 1996 (**Figure 21**). The average depth of all wells drilled in Wyoming continued to decline in 1997, reaching 6,090 feet (**Figure 22**). Numerous, shallow, coalbed methane wells drilled in the Powder River Basin played a major role in lowering the average depth of all wells drilled in Wyoming in 1997. The average depth of an exploration well in Wyoming in 1997 was 7,641 feet, which is 447 feet shallower than in 1996 (**Figure 22**).

Lease sales

The six Federal lease sales held by the U.S. Bureau of Land Management (BLM) in 1997 grossed nearly $32 million (**Figure 23**), at an average price per acre of $26.50 (**Figure 24**). In 1996, five Federal sales grossed over $11 million, at an average price per acre of $15.53. Of the 1.6 million acres that were available for lease in 1997, 76.4% were leased. In 1996, 52.7% of the 1.4 million acres available at Federal sales were leased.

The four lease sales held by the Wyoming Office of State Lands and Investments in 1997 grossed over $3.1 million (**Figure 23**), equating to an average price per acre of $11.97 (**Figure 24**). Of the 438,000 acres available for lease in 1997, 60.1% were leased. For comparison, the four sales in 1996

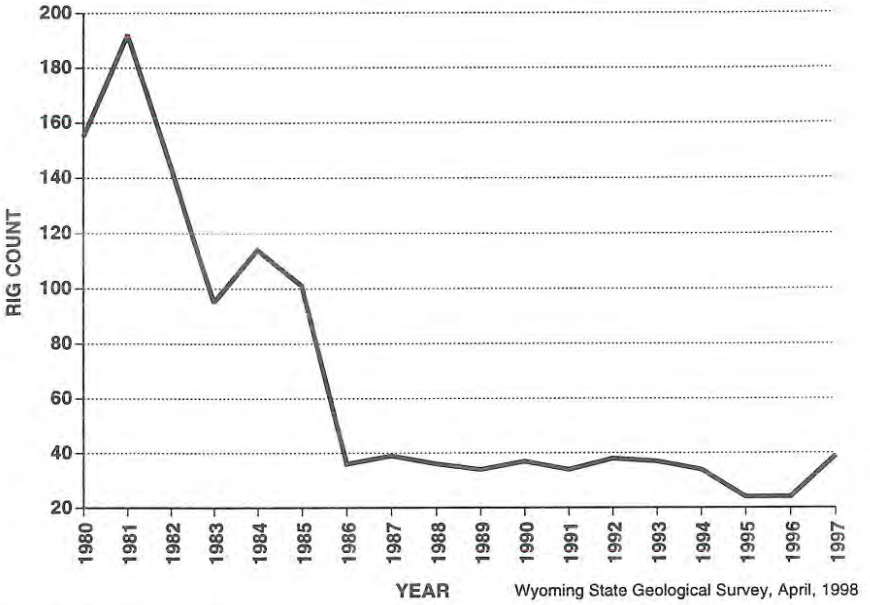

Figure 20. Average daily rig count by year (1980-1997). From Hughs Rig Count.

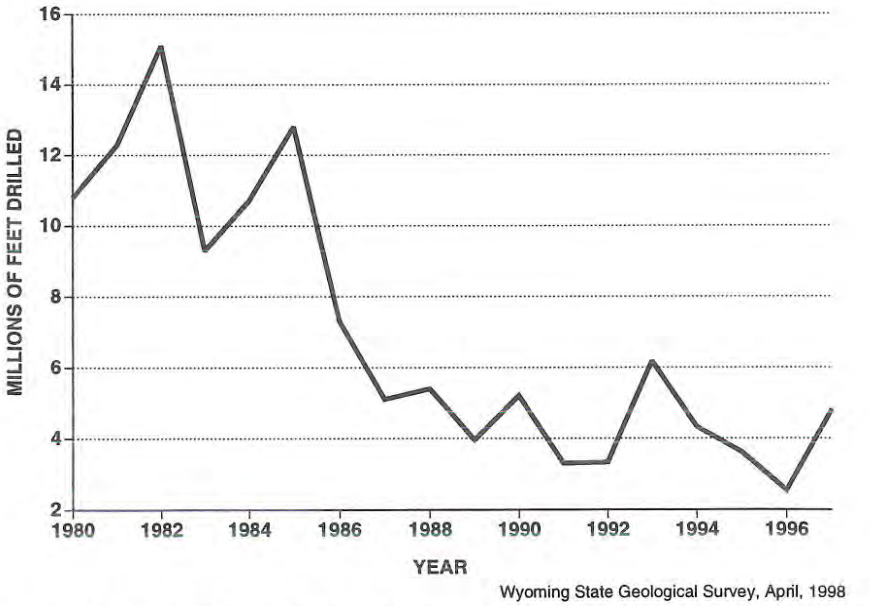

Figure 21. Millions of feet drilled for oil and gas by year (1980-1997). From PI/D (1998).

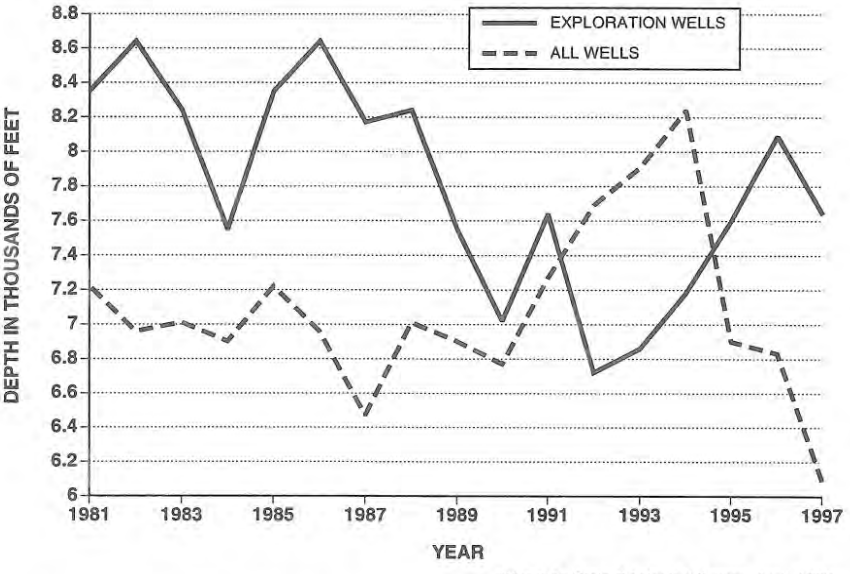

Figure 22. Average depth of oil and gas exploration wells and all oil and gas wells drilled by year (1980-1997). From PI/D (1998).

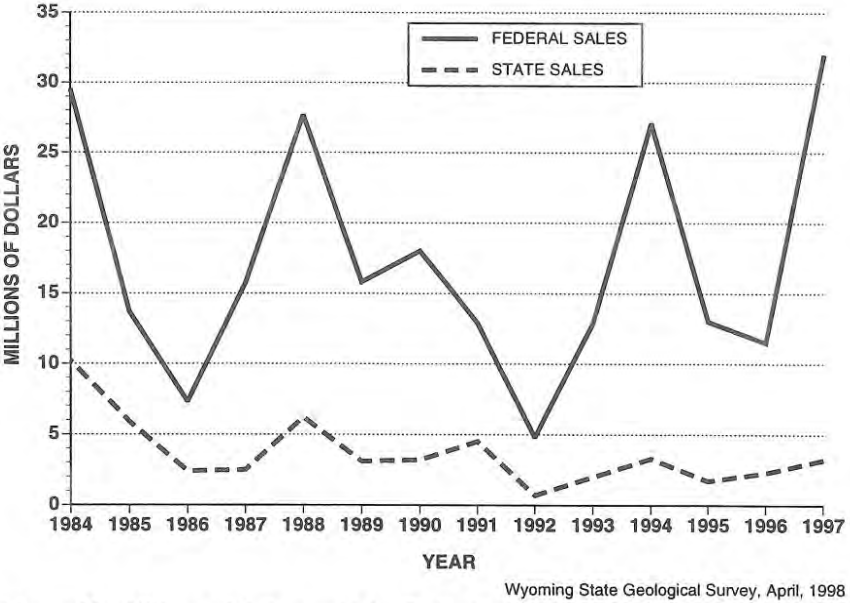

Figure 23. Millions of dollars paid for Federal and State oil and gas leases by year (1984-1997).

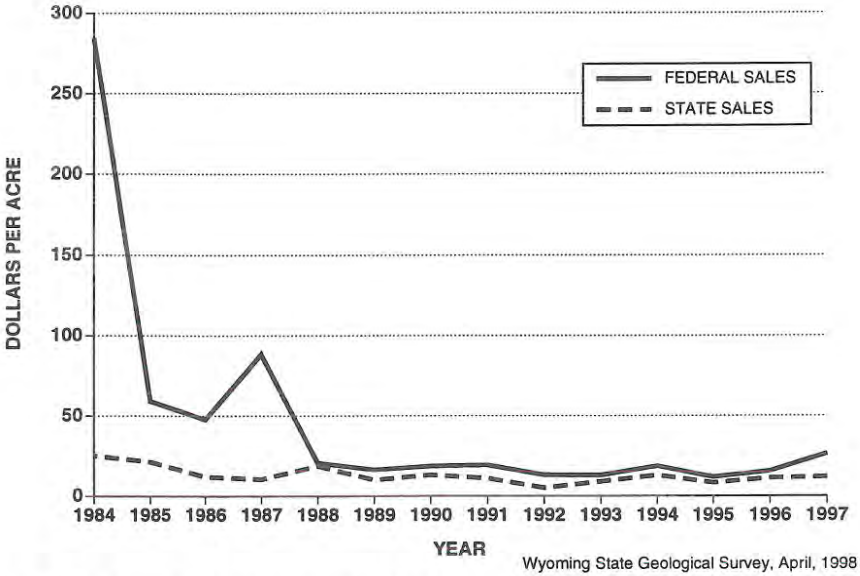

Figure 24. Average price per acre paid for Federal and State oil and gas leases by year (1984-1997).

grossed over $2.3 million. Of the 418,000 acres available for lease that year, 49.5% were leased, at an average price of $11.24 per acre.

The Wyoming Board of Land Commissioners extended its drilling window, which provided reduced royalty rates for discoveries drilled on primary State leases between July 6, 1996, and September 30, 1997. The drilling window now expires July 5, 1998. The reduced rate of 10% will apply to all wells drilled on a qualifying lease and will be effective for as long as commercial production exists from those wells. The 10% royalty rate will; however, return to a rate of 16-2/3% if a producer receives more than $22 per barrel for oil and more than $2 per thousand cubic feet of gas, averaged over any six-month period.

Applications for permit to drill

The Wyoming Oil and Gas Conservation Commission approved 1,908 applications for a permit to drill (APDs) in 1997 (**Figure 25**). This was an increase of 628 over the number approved in 1996 and the largest total in the last six years.

Seismic exploration

During 1997, the Wyoming Oil and Gas Conservation Commission issued seismic exploration permits for 536 conventional miles and 1,124 3-D square miles. While the 3-D square miles decreased slightly from 1996, the conventional miles were the most in the last four years (**Figure 26**).

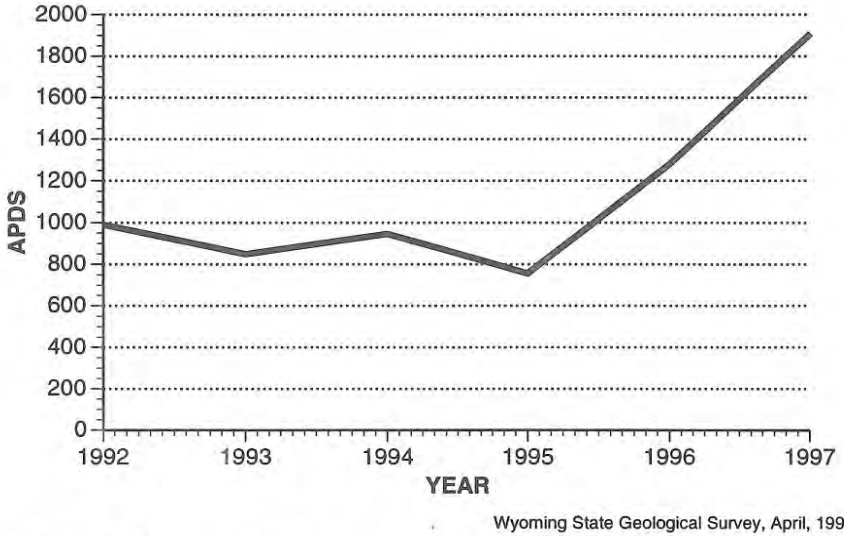

Figure 25. Applications for Permit to Drill approved by the Wyoming Oil and Gas Conservation Commission by year (1992-1997).

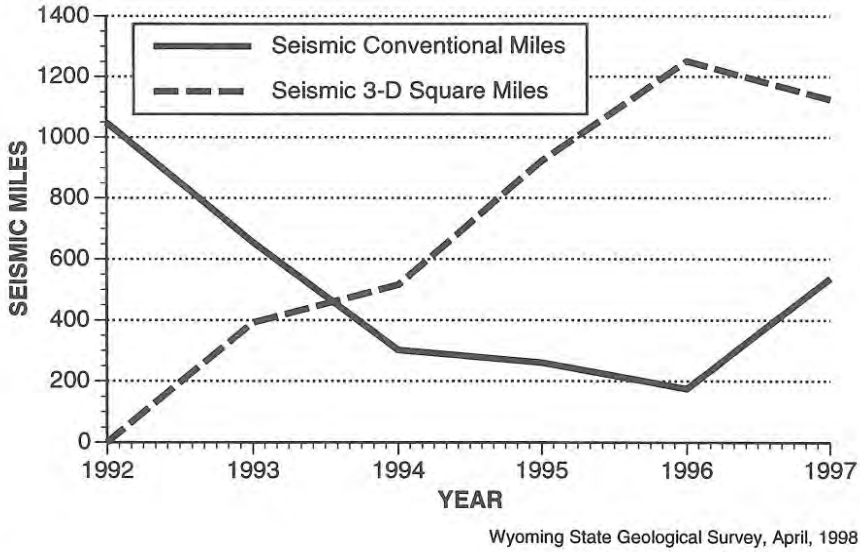

Figure 26. Number of seismic conventional miles and 3-D square miles permitted by the Wyoming Oil and Gas Conservation Commission by year (1992-1997).

Powder River Basin

With 30 new field wildcat wells, Campbell County was the leading county in the U.S. Seven of these wildcat wells found oil and three found gas. Crook County tied for the second leading county in the Rocky Mountain region with 12 new field wildcats. Only one of these wildcat wells found oil. Campbell County was also the leading county in the Rocky Mountain region and the fourth leading county in the U.S. in the number of all wells completed, with 281. Among the 281 completions, 56 were oil wells and 149 gas wells. Most of the gas wells were completed in Fort Union coals, as activity in the coalbed methane play in the Powder River Basin accelerated. Most of the new oil discoveries in the basin were completed in the Muddy Sandstone or the Minnelusa Formation.

Greater Green River Basin

Sweetwater County tied for fifth spot in the number of new field wildcats among counties in the Rocky Mountain region. There were nine wildcat wells completed in the county, with one finding oil and four finding gas. Sweetwater County was the seventh leading county in the Rocky Mountain region for the total number of well completions, with 103. Of the 103 well completions, 4 found oil and 92 found gas. Most of the activity in Sweetwater County was committed to development drilling for gas from the Mesaverde Formation or the Lewis Shale in the eastern part of the basin, and to development drilling for gas from the Frontier Formation or Dakota Sandstone on the Moxa arch.

Sublette County ranked eighth in the Rocky Mountain region for the total number of well completions, with 99. Of the 99 well completions, 37 found oil and 51 found gas. A good deal of the activity in Sublette County was development drilling in the Lance Formation. This drilling was concentrated in the Jonah Field/Pinedale anticline area.

Wind River Basin

KN Energy signed a long-term agreement to process 100 million cubic feet of gas per day from the Cave Gulch/Waltman area. There were a number of development wells drilled in this area during 1997, with significant production from the Fort Union, Lance, Meeteetse, Mesaverde, Frontier, Muddy, Lakota, Morrison, and Sundance formations. In December of 1997, 40 wells in this area produced 152.9 million cubic feet of gas and 566 barrels of condensate per day. Total production from the area in 1997 was 47.1 billion cubic feet of gas and 191,000 barrels of condensate.

Louisiana Land & Exploration completed a third ultra-deep well in the Madison Limestone in Madden Field. The 4-36 Bighorn well was drilled to 24,600 feet in SW NE section 36, T39N, R91W, and had a calculated absolute open flow potential of 240 million cubic feet of gas per day. The company increased its estimate of gross proved and probable recoverable gas reserves in the Madison at Madden Field to over one trillion cubic feet.

Bighorn Basin

Seneca Resources, Texaco Exploration & Production, Kirkwood Oil and Gas, and Loma Energy formed a joint venture to explore 165,000 acres in the Bighorn Basin. Drilling operations are scheduled to begin in 1998. Texaco will be the operator and will hold 40% of the interest in the joint venture. Seneca will hold 35%, Kirkwood will hold 15.6%, and Loma will hold 9.4%.

Overthrust Belt

Amoco Production completed a Madison, Darby, Bighorn, and Cambrian well in Whitney Canyon-Carter Creek Field, which flowed a total of 28.6 million cubic feet of gas and 164 barrels of condensate per day from the four zones. This well establishes the first production from the Cambrian in the Overthrust Belt.

Reference cited

Petroleum Information/Dwights LLC, 1998, 1997 Annual review, Rocky Mountain Region: Rocky Mountain Region Report, v. 71, no. 56, p.17-60.

PRECIOUS STONES AND METALS

At least three companies continued to explore for diamonds in the Green River Basin in southwestern Wyoming. One of these companies, Guardian Enterprises, reported finding another cryptovolcanic breccia pipe 0.5 mile north of their 1996 discovery near Cedar Mountain. The company has now found a total of 11 pipes. One of these, the DK pipe, reportedly yielded three gem-quality diamonds during drilling in 1996 (Guardian Enterprises, 11/25/97). Farther north, Guardian (9/24/96) reported finding 48 diamonds in alluvium. Guardian also identified several circular to elongate magnetic anomalies northeast of the Cedar Mountain pipes, which suggest the presence of a second cluster of pipes. The Wyoming State Geological Survey is currently conducting petrographic and geochemical investigations on the host rock of the pipes, but has not verified the presence of diamonds.

At the Kelsey Lake diamond mine in the State Line district in northern Colorado and southeastern Wyoming, Redaurum recovered some large diamonds including a 28.18-carat gemstone. This diamond was cut into a 16.8-carat gem (*Denver Post*, 9/25/97).

In a surprise development, Redaurum placed its two African diamond mines, as well as the Kelsey Lake mine in Colorado, up for sale (*Northern Miner*, 12/22-28/97). Kelsey Lake has reportedly been producing 65% gemstones (about 50% weighing greater than one carat).

In central Wyoming, a cryptovolcanic structure was drilled in the Seminoe Mountains, and some exploration was reported along the flank of the Bighorn Mountains where G10 (diamond-inclusion) pyropes have been reported. Other diamond exploration activities were reported in the Iron Mountain district and Eagle Rock area of the Laramie Mountains, the Black Hills, and the Granite Mountains.

During 1997, the Wyoming State Geological Survey discovered gem-quality olivine (peridot) associated with olivine lamproite in the Leucite Hills of the Green River Basin. More than 10,000 carats of olivine were recovered from two anthills in this volcanic field.

Gold exploration was reported at a few locations in the State. In the Rattlesnake Hills in central Wyoming, company drilling reportedly identified a 250,000-ounce resource with potential for 1,000,000 ounces. Stratmore Resources currently controls this property. Mineralization in the district occurs in exhalites, breccias, stockworks, and in Tertiary alkalic volcanics.

Several companies also conducted cursory exploration following the Wyoming State Geological Surveyís discovery of significant Ni-, Co-, Au-, Pt-, Pd-, and Cu-mineralization in the Puzzler Hill ultramafic complex in the Sierra Madre. In addition, exploration for titanium was reported in the Laramie Mountains anorthosite complex. The Strong Creek deposit, containing an estimated 300-million-ton, low-grade, titaniferous magnetite resource, is currently being explored.

URANIUM

Uranium exploration increased in 1997 as uranium prices continued higher than the years between 1980 and 1995. Rio Algom began in-situ production of yellowcake at its Bill Smith site in the southern Powder River Basin northeast of Glenrock.

Uranium is recovered by solution mining (in-situ) methods at Comin's operations at the Christiansen Ranch property in Johnson County. CAMECO announced the purchase of Power Resources' in-situ operations at the Highland and Morton Ranch properties in Converse County, where production continued to increase. Wyoming was the leading producer of yellowcake in 1997, and should continue to lead the nation in 1998.

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Technically Recoverable Resources (January 1, 1997)
- Discovered (Includes oil, gas liquids, and condensate) ..... 3.54 billion barrels[1]
- Undiscovered ..... 6.18 billion barrels[1]
- Total ..... 9.72 billion barrels

Remaining Reserve Base (January 1, 1997)
- Measured reserves (Proved reserves) (Includes: 0.605 billion barrels of oil and 4.15 billion barrels of gas liquids and condensate) ..... 0.95 billion barrels[2]
- Indicated and inferred reserves (Reserve growth in conventional fields) ..... 2.61 billion barrels[1]
- Total ..... 3.56 billion barrels

NATURAL GAS

Remaining Technically Recoverable Resources (January 1, 1997)
- Discovered (Includes 36.6 trillion cubic feet (TCF) of methane[1] and 121.6 TCF of CO_2[3]) ..... 158.2 trillion cubic feet
- Undiscovered (Includes 14.72 TCF of conventional methane[1]; 5.43 TCF of coalbed methane; 119.3 TCF of methane in tight gas sands in the Green River Basin; and 31.2 TCF of CO_2[3]) ..... 170.6 trillion cubic feet
- Total ..... 328.8 trillion cubic feet

Remaining Reserve Base (January 1, 1997)
- Measured reserves (Proved reserves) (Includes 11.2 TCF of methane[2] and 59.9 TCF of CO_2[3]) .... 71.1 trillion cubic feet
- Indicated and inferred reserves (Reserve growth in conventional fields) ..... 25.0 trillion cubic feet
- Total ..... 96.1 trillion cubic feet

COAL

Remaining Resources (January 1, 1998)
- Identified and Hypothetical (Discovered) ..... 1,426.6 billion tons[4]
- Speculative (Undiscovered) ..... 31.5 billion tons[4]
- Total ..... 1,458.1 billion tons

Remaining Reserve Base (January 1, 1998)
- Demonstrated strippable (Measured and indicated reserve base) ..... 25.0 billion tons[5]
- Demonstrated underground-minable (Measured and indicated reserve base) ..... 42.5 billion tons[5]
- Total ..... 67.5 billion tons

TRONA

Original Resources
- Trona ..... 76.0 billion tons[6]
- Mixed trona and halite ..... 51.0 billion tons[6]
- Total ..... 127.0 billion tons

URANIUM

Remaining Resource (December 31, 1989) ..... 1.99 billion pounds U_3O_8[9]

Remaining Reserve Base (December 31, 1989)
- Uranium oxide recoverable at $30.00 per pound ..... 66 million pounds[7]

OIL SHALE

Original Resources (January 1, 1981)
- Identified (Discovered) ..... 320 billion barrels of shale oil[8]

[1] Modified from U.S. Geological Survey National Oil and Gas Resource Team, 1995, 1995 National Assessment of United States oil and gas resources: U.S. Geological Survey Circular 1118, 20 p.
[2] Modified from Energy Information Administration, 1997, U.S. crude oil, natural gas, and natural gas liquids reserves: 1996 Annual Report, 131 p.
[3] De Bruin, R.H., 1991, Geological Survey of Wyoming Open File Report 91-6, 20 p.
[4] Modified from Wood, G.H., Jr. and Bour W.V., III, 1988, Coal map of North America: U.S. Geological Survey Special Geologic Map, 1:5,000,000-scale (color) and 44 p. pamphlet.
[5] Modified from Jones, R.W., and Glass, G.B., 1992, Demonstrated reserve base of coal in Wyoming as of January 1, 1991: Geological Survey of Wyoming, Open File Report 92-4, 26 p.
[6] Wiig, S.V., Grundy, W.D., and Dyni, J.R., 1995, Trona resources in the Green River Basin in southwest Wyoming: U.S. Geological Survey Open File Report 95-476, 88 p.
[7] Energy Information Administration, 1989, Uranium industry annual: U.S. Department of Energy Report DOE/EIA-0478(89), 121 p.
[8] Knutson, C.F., and Dana, G.F., 1982, Developments in oil shale in 1981: American Association of Petroleum Geologists Bulletin, Volume 66, no. 11, p. 2513.

GEOLOGIC MAPPING, PALEONTOLOGY, AND STRATIGRAHY UPDATE

Alan J. Ver Ploeg
Senior Staff Geologist-Geologic Mapping, Wyoming State Geological Survey

NEW GEOLOGIC MAP COMPLETED FOR GILLETTE AREA

The Wyoming State Geological Survey recently completed a new, color, geologic map covering the central portion of Campbell County (**Figure 27**). The new map covers approximately 1,800 square miles and was compiled from existing maps of various scales with some new mapping to fill in gaps or replace outdated mapping. This map is one of a new series of maps at 1:100,000-scale specifically designed to aid city and county planners, industrial and mineral developers, as well as the general public by making regional geologic mapping available for the more populated areas in the State. These 1:100,000-scale maps are intended to complement the more detailed 1:24,000-scale maps,

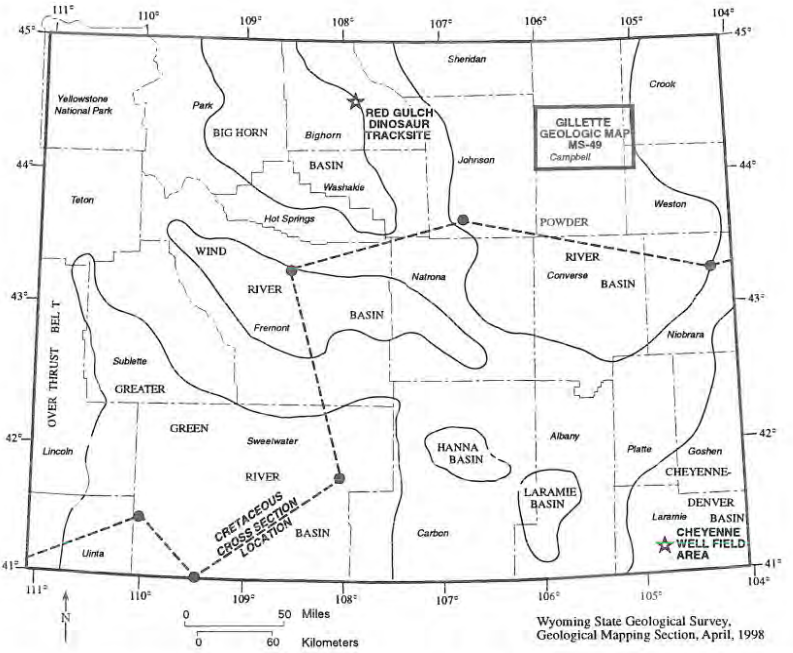

Figure 27. Index to selected paleontologic activities and recently released maps and reports in Wyoming.

which the Wyoming State Geological Survey is doing for the cities in Wyoming. Seven 1:100,000-scale maps have already been completed by either the Wyoming State Geological Survey or the U.S. Geological Survey. These are the Gillette, Cheyenne, Nowater Creek, Recluse, Kinney Rim, Evanston, and Kemmerer Quadrangles.

The new map is titled: *Geologic map of the Gillette 30' X 60' Quadrangle, Campbell, Crook, and Weston Counties, northeastern Wyoming*, and is designated Map Series 49. It includes a written overview summarizing the general geology, mineral activity, ground-water characteristics, and geologic hazards occurring on the quadrangle. See p. 70-71 for price and ordering instructions.

DINOSAUR TRACKS DISCOVERED

The Worland District Office of the U.S. Bureau of Land Management (BLM) recently announced the discovery of dinosaur footprints on public lands near Shell, Wyoming (**Figure 27**). Referred to as the Red Gulch dinosaur track site, this is a significant discovery that could lead to reinterpretation of traditional views of the paleoenvironment of the Middle Jurassic Period (160 to 180 million years ago). Scientists traditionally interpreted the Middle Jurassic Sundance Formation as deposited in a marine environment. Fossilized oyster shells (*Gryphaea*) and squid-like creatures (*Belemnitella*) are commonly found in outcrops of the green glauconitic shales, sandstones, and limestones of the Sundance Formation.

Eric Kvale, a research geologist from the Indiana Geological Survey; however, has also discovered theropod (meat-eating) dinosaur tracks in ripple-marked shoreline sandstones of the Sundance Formation on the Red Gulch road south of Shell. Track sites such as these in the Middle Jurassic are rare throughout the world and very little is known about dinosaurs of this time period. Brent Breithaupt, Director of the University of Wyoming's Geology Museum, along with researchers from the Smithsonian Institute, the Indiana Geological Survey, Dartmouth College, and the BLM will study the site, beginning this spring. This 40-acre site should provide an excellent opportunity for paleontology and geology students and researchers to study a little known part of the paleontologic record. There is the possibility of finding tracks or other evidence of additional types of animals including lizards, crocodiles, pterosaurs, mammals, and birds, as well as expanding the size of the track site.

The BLM's concern with protecting and managing the Red Gulch track site and the desire of the scientific community to study the site has prompted a planning review of the discovery area. The BLM's planning review will consider management options for public education, interpretation, scientific research, and recreation in the area and will allow for public participation in the planning process. The BLM plans to conduct public meetings and will accept

written comments on the approach to management of the area. Comments can be sent to the following address:

U.S. Bureau of Land Management
Worland District Office
P.O. Box 119
Worland, WY 82401-0119

SPRING PALEONTOLOGIC CONFERENCE

The Tate Museum has announced its Spring Paleontologic Conference for this year. The conference will take place June 5-7 and will include a seminar with a full program of research papers on various paleontologic topics, emphasizing life in the Late Cretaceous. Dr. Robert Bakker, Dr. Kraig Derstler, and Dr. Kirk Johnson will be featured speakers. In addition, there will be an opportunity for some first-hand field experience with a one-day field trip to some Late Cretaceous outcrops.

Registration for adults is $60 and includes an icebreaker, participation in the seminar, transportation to field sites, and lunch/beverages on Saturday and Sunday. Students, aged 10-17, can register for $40 but must be accompanied by a registered adult. A block of rooms at the rate of $42/night is reserved at the Parkway Plaza Hotel in Casper (1-800-270-7829). Call the Tate Museum for more information on registration (307-268-2447).

OCTOBER 11-17 IS EARTH SCIENCE WEEK

Earth Science Week, which will be an annual celebration, is one of the American Geological Institute's (AGI's) most ambitious 50th anniversary initiatives, and it offers the geoscience community new opportunities to demonstrate the importance of the earth sciences. In support of this event, AGI will provide a clearinghouse for ideas, activities, and special events, and it will provide support materials that make it easy for geoscientists to participate.

Earth Science Week activities and events are designed to show how geology and the earth sciences relate to society and to our quality of life. An understanding of geology and the earth sciences can help citizens make wise decisions for land management and use, is crucial to addressing environmental and ecological issues, and provides the basis for preparing for and mitigating natural hazards.

Many Earth Science Week activities will focus on education. AGI has recently published a colorful 18" x 24" poster on Geoscience Careers, and will

produce a second poster in time for Earth Science Week. The first module of Earth Works, a set of middle-school student and teacher activities on soils, will be available in time for Earth Science Week, as will a general interest booklet on soils that is part of AGI's Environmental Awareness Series.

For geoscientists, leading a field trip, visiting a classroom, talking to a community group, writing an article, hosting an open house, working with a Scout or other youth group, and planning an earth science event or exhibit at a library, nature center, or museum are just a few of the possibilities for celebrating Earth Science Week. AGI is preparing a booklet of ideas and guidelines for volunteer activities. If you would like to help make Earth Science Week a success, contact Julie Jackson at AGI headquarters or register on the World Wide Web at www.earthsciweek.org. AGI's address is: 4220 King Street, Alexandria, VA 22302-1502. Phone: (703) 379-2480. FAX: (703) 379-7563.

NEW PUBLICATIONS ON WYOMING GEOLOGY

The U.S. Geological Survey (USGS) recently published two new publications relating to Wyoming geology and(or) hydrology. Ogle and Jordan (1997) indexed 55 manuscripts in a new report released in a cooperative effort between the Cheyenne Board of Public Utilities, the University of Wyoming, and the U.S. Geological Survey. The bibliography includes papers relating to geologic formations, structural geology, aquifer characteristics, water levels, water demand projections, and water quality for the area in and around the Cheyenne municipal well field (**Figure 27**). The bibliographic citations are annotated.

Merewether and others (1997) recently published a new cross section illustrating the latest interpretations and correlations of Cretaceous stratigraphy in Wyoming and the adjacent northeastern corner of Utah and western South Dakota. The cross section runs from Coalville, Utah, across Wyoming to White River, South Dakota (**Figure 27**).

References cited

Merewether, E.A., and others, 1997, Cretaceous stratigraphy in a northeast-trending transect, northern Utah to south-central South Dakota: U.S. Geological Survey Geologic Investigations Map I-2609, 2 sheets.

Ogle, K.M., and Jordan, B.J., 1997, Annotated bibliography of selected publications, through 1996, Cheyenne municipal well-field areas, Cheyenne, Wyoming: U.S. Geological Survey Open File Report 97-228, 33p.

PART I: STUDY OF THE SENSITIVITY OF AQUIFERS TO CONTAMINATION

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This is the first part of a continuing discussion of this important study, which is ongoing in Wyoming.

Approximately 47% of the water that supplies public water supply systems in Wyoming is from ground water. A public water supply is defined by the U.S. Environmental Protection Agency (EPA) as a public or private water system that furnishes water to at least 25 people or that has a minimum of 15 hookups. Approximately 95% of the water that supplies private domestic systems is from ground water. Considering the extensive use of ground water in Wyoming, it is important to characterize and protect this valuable resource from contamination.

In 1987, the EPA developed an approach for characterizing the groundwater pollution potential of an area or state. The EPA approach; however, has been modified by Wyoming researchers to more precisely characterize the variety of conditions present in this State. The approach taken in Wyoming is to characterize aquifer sensitivity to contamination introduced on or near the surface. Aquifer sensitivity is defined as the "relative ease with which a contaminant applied on or near the land surface can migrate to the aquifer of interest" (EPA, 1993).

BACKGROUND

In 1987, the EPA published a report titled, *DRASTIC: A standardized system for evaluating ground-water pollution potential using hydrogeologic settings* (Aller and others, 1987). DRASTIC was designed as an easy-to-use model that would allow a user with a basic knowledge of hydrogeology to assess the relative potential for ground-water contamination in various hydrogeologic settings. A hydrogeologic setting is a composite description of all the major geologic and hydrologic factors that affect and control ground-water movement into, through, and out of an area. It is defined as a mappable unit with common hydrogeologic characteristics and common vulnerability to contamination by introduced pollutants.

EPA defined a series of generalized hydrogeologic settings for each of thirteen distinct parts of the country. In Wyoming, EPA defined hydrogeologic settings for the western mountain ranges, the nonglaciated central region, the

high plains, the Colorado Plateau, and the Wyoming Basin. For example, in the Wyoming Basin, which includes most of central, southern, and southwestern Wyoming, EPA defined five hydrogeologic settings. The settings are resistant ridges, consolidated sedimentary rocks, river alluvium, alluvium and dune sand, and swamp/marsh.

The DRASTIC manual defined seven mappable factors that control the ground-water pollution potential in a hydrogeologic setting. The DRASTIC factors, with the letters that form the acronym capitalized and bolded, are **D**epth to water, net **R**echarge, **A**quifer media, **S**oil media, **T**opography (slope), **I**mpact of the vadose zone media, and hydraulic **C**onductivity of the aquifer. EPA assigned each factor a relative weight, which ranged from 1 (least significant) to 5 (most significant).

EPA also defined a series of elements or ranges of values for each factor. For example, under the aquifer media factor, EPA defined eight elements or media. The media ranged from massive shale, at one end, to karst limestone at the other. All elements, media, or ranges of values for each factor were assigned a sensitivity rating, with the ratings ranging from 1 to 10. The higher a rating, the greater the potential that contaminants could be transmitted into an aquifer. For example, under the aquifer media factor, a massive shale media was assigned a sensitivity rating of 1-3, while a karst limestone media was assigned a sensitivity rating of 9-10.

The overall pollution potential of a hydrogeologic setting is determined by multiplying the 1-10 sensitivity rating for each factor by the factor weight, and then adding the weighted ratings for all factors together into a DRASTIC index. The DRASTIC indices can be compared to one another, with the highest indices having the greatest relative pollution potential.

OVERVIEW OF WYOMING'S AQUIFER SENSITIVITY ANALYSIS

In 1992, the Wyoming Department of Environmental Quality/Water Quality Division (DEQ/WRD), in cooperation with the Wyoming Department of Agriculture and the Wyoming Water Resources Center (WWRC), elected to undertake an aquifer sensitivity study for the agricultural areas within Wyoming. As a result, the WWRC received an EPA Section 319 non-point-source pollution grant to begin a pilot study to map ground-water vulnerability to contamination from agricultural pesticides in Goshen County, Wyoming. In 1993, the project was expanded to include sensitivity mapping across the State. An Aquifer Sensitivity to Contamination Work Group was established to define an approach to the sensitivity mapping, and to acquire and generate the necessary data and maps. The principal members of the Work Group were from the WWRC; the DEQ/WRD; the Wyoming State Geological Survey (WSGS); the University of Wyoming's Departments of Renewable Resources, Civil and Architectural En

gineering, Geography and Recreation, and Geology and Geophysics; and EPA Region VIII.

Although EPA's DRASTIC model was used as a basis for the Wyoming approach, it was significantly modified. The DRASTIC concept of using a limited number of hydrogeologic settings to characterize the State was determined to be too generalized for a State as geologically and hydrologically complex as Wyoming. Also, instead of having the seven weighted factors that control the ground-water pollution potential of a hydrogeologic setting (DRASTIC), six equally weighted factors or mappable characteristics that control the ground-water pollution potential of the entire State were utilized in Wyoming.

The factors used in Wyoming are depth to ground water, net aquifer recharge, geohydrologic setting sensitivity, soil, land surface slope, and vadose zone sensitivity. These six factors, rather than the seven used in DRASTIC, are used because the aquifer media and aquifer hydraulic conductivity factors used in DRASTIC are combined into a single factor called geohydrologic setting sensitivity. There were not enough hydraulic conductivity values for geologic formations or aquifer systems in Wyoming to justify a separate factor classification. Sensitivity ratings similar to those used in DRASTIC and ranging from 1-10 were applied to discreet elements within each factor.

In the Wyoming study, each factor is represented by a digital map. For example, the soils factor is composed of a soils map. Each soil unit received a distinct sensitivity rating. Using Geographic Information System (GIS) methodologies, the sensitivity ratings for all factors were added together, resulting in a final aquifer sensitivity map and interpretation. The summed sensitivity ratings were organized in ranges of values that are as follows: 12-25 (lowest sensitivity), 26-30, 31-36, 37-42, and 43-59 (highest sensitivity).

Part II of the description of this study will include a detailed discussion of the six factors. It will be published in the next issue of *Wyoming Geo-notes*.

ROCK HOUND'S CORNER

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Wyoming State Geological Survey

How much are diamonds worth? Most people have no idea! Many diamonds have such a high value that a person could easily carry a king's ransom in diamonds in a shirt pocket. For comparison, people tend to think of gold as being a very high-value commodity, but it would take an armored truck to carry enough gold of similar value to a handful of gem-quality diamonds.

One fingernail-size, gem-quality diamond recently recovered from the State Line district, just south of the Wyoming State line, weighed slightly more than

28 carats and produced a cut stone of 16.8 carats (or about 0.1 ounce) with an estimated value of $300,000. It would take about 1,000 ounces of gold to yield a similar value. Imagine trying to carry that in your shirt pocket! Some other diamonds mined in Australia, known as 'Argyle pinks', have sold for as much as $1,000,000 a carat. An equivalent value of gold would weigh 3,400 ounces!

Diamonds are a billion-dollar industry. *The Economist* (12/20/97) recently reported that 1996 sales of gem diamonds amounted to $52 billion. And while most mined commodities have declined in price, diamonds have shown a 50% increase from 1986 to 1996. In fact, much of the current interest in diamonds around the world is due to diamonds being one of the few commodities that have an intrinsic value. Most other mined commodities are so undervalued that there is currently little exploration interest for anything other than gemstones, and in particular for diamond.

Thus, when diamonds were recently discovered in the Northwest Territories of Canada, one of the largest claim-staking rushes in history followed, and is continuing today. Virtually millions of acres have been staked in Canada, over several provinces. Capital investments for the mines currently under development total more than $800 million, which will result in a tremendous boost to the Canadian economy. And a major offshoot to the diamond exploration in Canada was the discovery of a world-class nickel-cobalt deposit in Voisey Bay, Labrador, by a company searching for diamonds.

There are dozens of companies searching for diamonds in Canada, and several have also contacted the Wyoming State Geological Survey (WSGS) for information on diamond deposits in Wyoming. While some of these companies have already staked as many as five million acres of land in Alberta and Saskatchewan, they are curious about Wyoming because of its geology and the continued discoveries of new kimberlites and lamproites (the only known host rocks for commercial quantities of diamond).

Much of Wyoming is underlain by rocks similar to large portions of Canada, as well as to South Africa and Australia (two major diamond producers). The WSGS and others have already discovered and(or) mapped many kimberlites and lamproites in Wyoming. In addition, the WSGS has identified numerous kimberlitic indicator mineral anomalies, which could lead to undiscovered diamond deposits. It is also interesting to note that the WSGS recently discovered a significant nickel-cobalt occurrence in southeastern Wyoming.

With declining production of oil in Wyoming, a diamond industry could help offset declining revenues. But it takes considerable time and effort to find, identify, and develop diamond deposits.

Unfortunately Wyoming will probably not see a rush on the same scale as Canada. This is not because Wyoming does not have the potential to host major diamond deposits. Wyoming is every bit as favorable, but the Canadian government is providing exploration incentives, something the U.S. govern-

ment is not doing. With so much of the mineral estate in Wyoming owned by the Federal government, incentives could make the difference. However, there is optimism that significant diamond discoveries in Wyoming will attract the attention of the diamond industry. Already, the Wyoming-Colorado State Line district south of Laramie has produced several of the largest diamonds found in North America, including diamonds of 2.6, 5.51, 6.2, 9.4, 10.5, 11.85, 14.2, 16.9, 28.18 and 28.3 carats. Diamond discoveries have also been reported in several other regions of the State.

NEW PUBLICATIONS OF THE WYOMING STATE GEOLOGICAL SURVEY

Teddy Creek gold prospect, Red Mountain Quadrangle, Encampment mining district, Sierra Madre, southeastern Wyoming, by W.D. Hausel, 1997: Mineral Report MR 97-3 - $1.50.

Field reconnaissance of the Palmer Canyon corundum-kyanite-cordierite deposit, Laramie Mountains, Wyoming, by W.D. Hausel, 1998: Mineral Report MR 98-1 - $1.50.

Field reconnaissance of the Leucite Hills peridot (olivine) occurrence, Rock Springs uplift, Wyoming, by W.D. Hausel, 1998: Mineral Report MR 98-2 - $1.50.

Preliminary geologic map of the Poker Butte Quadrangle, Johnson County, Wyoming, by A.J. Ver Ploeg, 1998: Preliminary Geologic Map PGM 98-1 - $4.00.

Preliminary geologic map of the Hole-in-the-Wall Quadrangle, Johnson County, Wyoming, by A.J. Ver Ploeg, 1998: Preliminary Geologic Map PGM 98-2 - $4.00.

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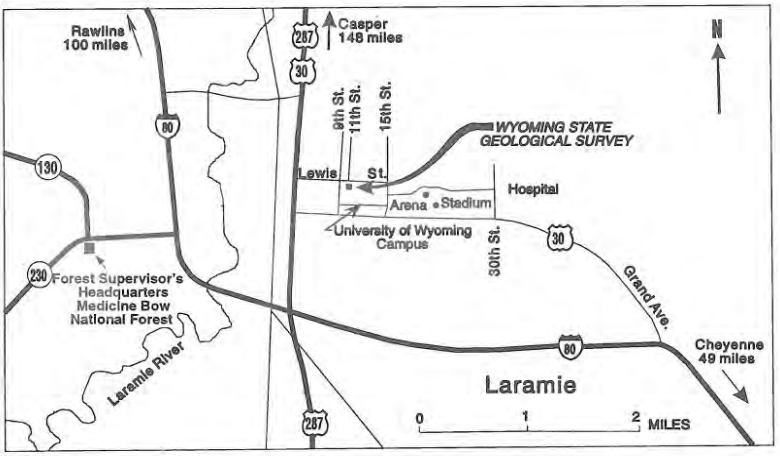

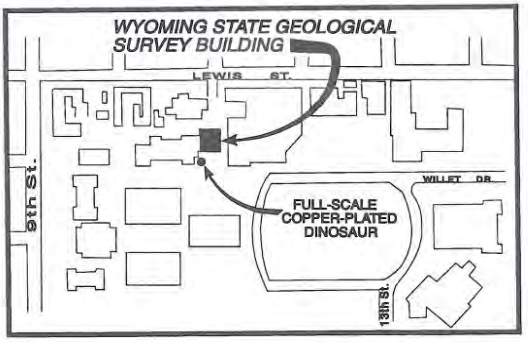

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