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Number 51



Wyoming State Geological Survey
Gary B. Glass, State Geologist

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WYOMING GEO-NOTES

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Cover: FMC's soda ash refinery west of Green River, Wyoming.

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MINERALS UPDATE

OVERVIEW

Gary B. Glass

State Geologist, Wyoming State Geological Survey

In the second quarter of 1996, it was determined that some of the reports from which Petroleum Information (PI) gets its monthly production figures were incorrect. A major oil and gas producer in Wyoming was inadvertently providing incorrect monthly production reports for at least 14 months, starting in January or February of 1995. Because of this, PI's preliminary oil production figure for 1995 as well as their monthly figures for the first quarter of 1996 are incorrect. While it had looked like 1995 oil production had only declined 1.6% between 1994 and 1995, a revised estimate shows 1995 production at 75 million barrels, rather than the 78.9 million barrels reported earlier. The revised estimate represents a 6.5% decline in production. The reporting error was tracked back to a new computer system implemented by the company in 1995. Each gallon of produced condensate was incorrectly reported as a barrel of condensate, which inflated the production reports for oil. Although the company's corrected monthly reports are expected by August, revised monthly production numbers for the State will take a little longer. The new estimated production figure for 1995 now agrees closely with gross production reported to the Wyoming Department of Revenue.

Table 1 and **Figure 1** reflect the new production figure for 1995 as does **Table 6** on p. 14. Oil production after 1995 has been changed to show an average 5.8% decline in production each year through 2002. The higher prices received for Wyoming crude in 1995 (**Table 2** and **Figures 2** and **3**) and the even higher prices seen in the second quarter of 1996 (**Table 5** on p. 13) should help slow the production decline between 1995 and 1996. For the first quarter of 1996, oil production was an estimated 5.8% below the same quarter of last year, which is the average annual decline seen over the last seven years.

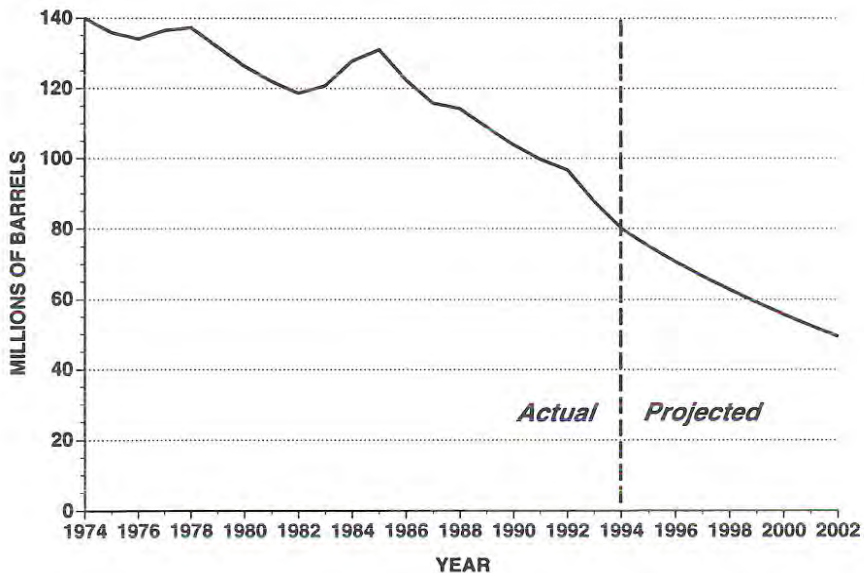
There are some downside risks in this oil forecast. If the Express Pipeline from Canada and(or) the Amoco-Conoco Expansion from Billings are built (see discussions below), prices paid for Wyoming crude will more than likely decline. For example, the Environmental Impact Statement for the Express Pipeline as well as many oil producers expect the bonuses now paid Wyoming producers to cease once Express' pipeline is operational. Lower prices often translate into lower production as marginally economic wells are abandoned or shut in. In addition, the current annual decline in production might also accelerate if these new pipelines capture any of the market share now supplied by Wyoming crude. It is also unclear if both these projects will move forward in competition with one another.

Table 1. Wyoming mineral production (1985-1995) with forecasts to 2002¹.

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	NA	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	96.8	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	*75.0	*987.8	*142.6	*1.07	263.9	18.1	1.3	*1.12
1996	70.7	993.1	142.6	1.07	274.9	18.5	1.8	1.13
1997	66.6	1,010.2	142.6	1.07	287.1	18.5	2.3	1.15
1998	62.7	1,027.5	142.6	1.07	299.9	18.5	2.3	1.17
1999	59.1	1,045.0	142.6	1.07	313.3	18.5	2.3	1.18
2000	55.6	1,062.9	142.6	1.07	321.1	18.5	2.3	1.20
2001	52.4	1,080.9	142.6	1.07	321.1	18.5	2.3	1.22
2002	49.4	1,099.3	142.6	1.07	321.1	18.5	2.3	1.24

*Estimated until official figures are available (July, 1996).

¹Changed somewhat from CREG, Wyoming State Government Revenue Forecast FY96-FY2002, January, 1996; ²Millions of barrels; ³Wyoming Oil & Gas Conservation Commission, 1985-1994; ⁴Billions of cubic feet; ⁵Based on Exxon's estimate that the average helium content in the gas processed at Shute Creek is 0.5%; ⁶Millions of short tons (Wyoming State Inspector of Mines, 1985-1995); ⁷Wyoming State Inspector of Mines, 1986-1995; ⁸Millions of pounds of yellowcake (not available for 1985 and previous years because it was only reported as taxable value); ⁹Millions of short tons.



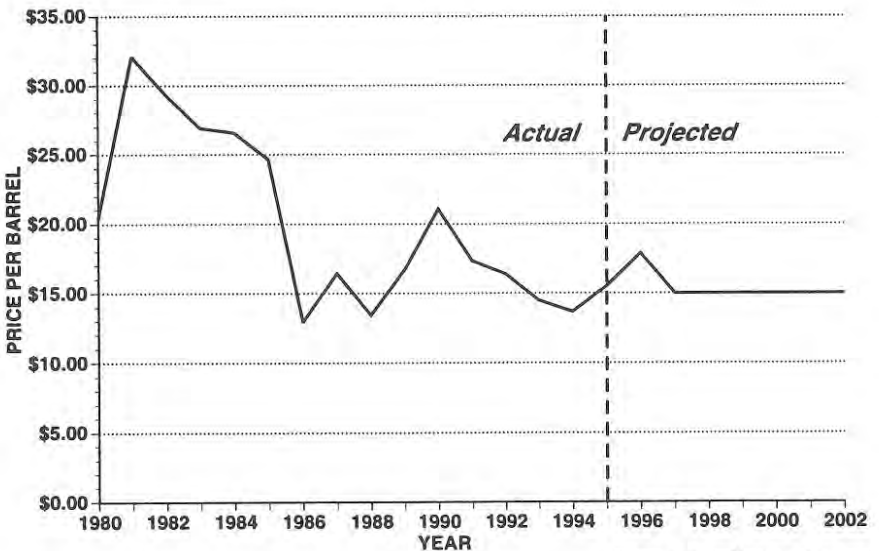
Wyoming State Geological Survey,
Oil and Gas Section, July, 1996

Figure 1. Annual oil production from Wyoming (1974 to 1994) with forecasts to 2002.

Table 2. Average prices paid for Wyoming oil, methane, coal, and trona (1985-1995) with forecasts to 2002¹.

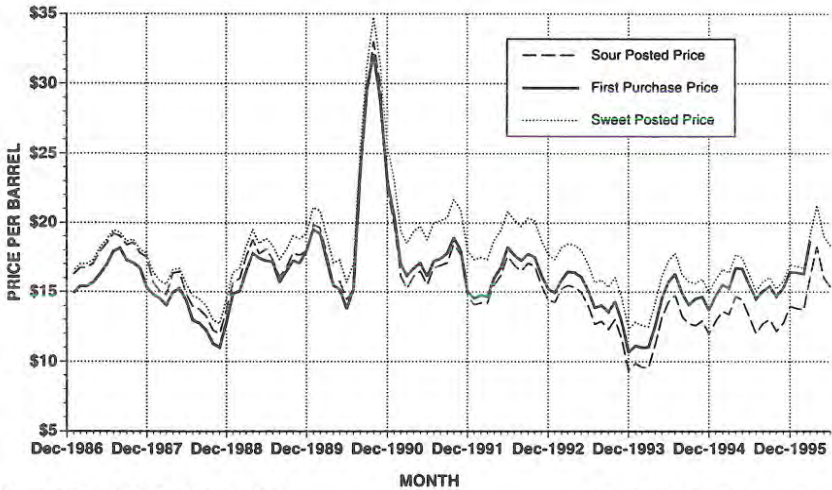
Calendar Year	Oil ²	Methane ³	Coal ⁴	Trona ⁵
1985	24.67	3.03	11.36	35.18
1986	12.94	2.33	10.85	34.80
1987	16.42	1.78	9.80	36.56
1988	13.43	1.43	9.16	36.88
1989	16.71	1.58	8.63	40.76
1990	21.08	1.59	8.43	41.86
1991	17.33	1.46	8.06	44.18
1992	16.38	1.49	8.13	44.50
1993	14.50	1.81	7.12	40.08
1994	13.67	1.63	6.62	38.96
1995	15.50	1.13	6.26	40.70
*1996	17.90	1.10	6.17	42.50
*1997	15.00	1.27	6.09	42.50
*1998	15.00	1.33	5.99	42.50
*1999	15.00	1.40	5.89	42.50
*2000	15.00	1.47	5.72	42.50
*2001	15.00	1.54	5.65	42.50
*2002	15.00	1.62	5.70	42.50

* Estimated until official figures are available (July, 1996).
¹ Changed somewhat from CREG, Wyoming State Government Revenue Forecast FY96-FY2002, January, 1996; ² First purchase price in dollars per barrel (weighted average price for sweet, sour, heavy, stripper, and tertiary oil). Source: Energy Information Administration, 1985-1995; ³ Wellhead price in dollars per thousand cubic feet (MCF). Sources: Wyoming State Land and Farm Loan Office, 1989-1995 (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). Sources: Energy Information Administration, 1985-1990 and derived from Wyoming Department of Revenue, 1991-1994; ⁵ Dollars per ton of trona, not soda ash. Source: Wyoming Department of Revenue, 1985-1994.



Wyoming State Geological Survey,
 Oil and Gas Section, July, 1996

Figure 2. Average prices paid for Wyoming oil (1980 to 1995) with forecasts to 2002.



Source: Unpublished DOE and company data

Wyoming State Geological Survey,
Oil and Gas Section, July, 1996

Figure 3. Wyoming posted Sweet and Sour crude oil prices and first purchase prices averaged by month (1987 to present).

At a special August meeting, the Wyoming Board of Land Commissioners finally approved the easements requested for the controversial Express Pipeline Project. This pipeline could bring 172,000 barrels of Canadian crude oil per day to Casper. The pipeline sought easements to cross about 10 miles of State lands in Big Horn, Hot Springs, Fremont, and Natrona Counties. As a condition to the Board's approval, Express agreed to pay the State at least \$15 million over the next five years, plus a \$70,000 easement fee. There is also a contingency to pay the State up to \$15 million more if it is needed to mitigate adverse effects on the State's severance taxes and royalties caused by the pipeline. As another part of the agreement, the State will appear before the Federal Energy Regulatory Commission in regard to the applications of Express and its subsidiary, Platte Pipeline Company. The State will seek tariffs that are equitable to Wyoming producers.

A spokesman for Express said the 800-mile-long pipeline from Wild Horse, Alberta, to Casper will cost an estimated \$390 million. Express hopes to have the pipeline completed before the end of the year. In late July, the Montana Land Board also approved easements that Express needed to cross Montana state lands.

In the meantime, a competing project, called the Amoco-Conoco Expansion, moved one step closer to fruition when it also received its needed easements from the Montana Land Board in July. This 75-mile-long pipeline project is slated to bring up to 50,000 barrels of Canadian oil per day (about 18

million barrels a year) into Elk Basin Station in the Bighorn Basin of Wyoming. The crude oil from this pipeline will go to refineries in the southern Rocky Mountain states. The combined capacity of this proposed expansion and the Express line is 222,000 barrels a day or about 81 million barrels a year.

In regard to oil prices, we have increased our forecast for the average price paid in 1996 upward to \$17.90 (Table 2 and Figure 2). This is \$2.90 higher than our earlier estimate of \$15.00. The out years we have left at \$15.00.

Estimates of natural gas production for 1995 through 2002 remain unchanged from earlier issues of *Wyoming Geo-notes* (Table 1 and Figure 4). Production in the first quarter of 1996, however, was doing a little better than expected. It was 5.3% above the same quarter of 1994 (Table 7 on p. 16).

On the other hand, the average price paid for Wyoming natural gas in 1995 was reduced by two cents to \$1.13 (Table 2 and Figure 5). This is the lowest average price for any year since the 1970s. The average spot sale price at Opal for the first two quarters of 1996 was not doing any better (Figure 6). It averaged \$1.13 for the first six months, which is a penny less than the same time period last year (Table 8 on p. 17). Because the price is not firming up, we have revised our forecast of the average first purchase price of natural gas in 1996 downward to \$1.10 (Table 2 and Figure 5). This is down from our earlier estimate of \$1.21. Forecast prices for the out years were not changed.

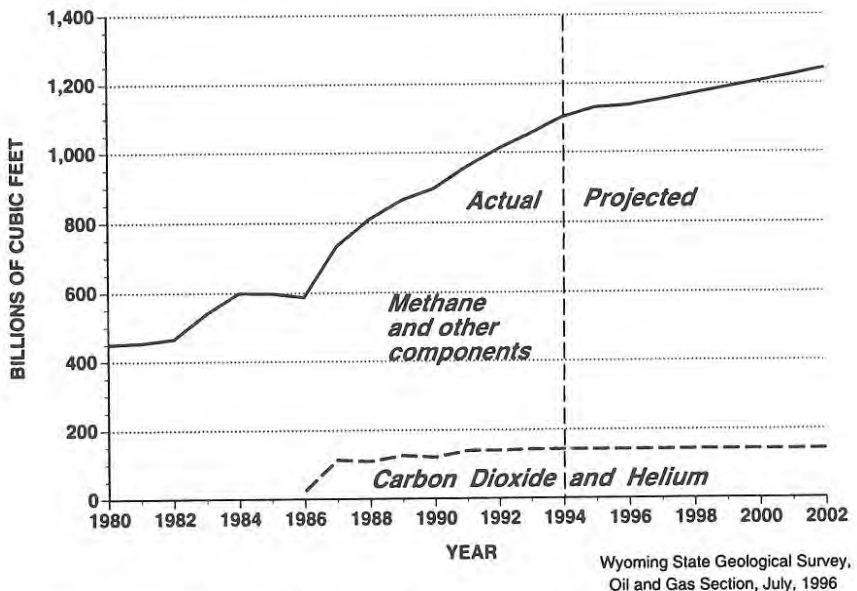


Figure 4. Annual natural gas production from Wyoming (1980 to 1994) with forecasts to 2002.

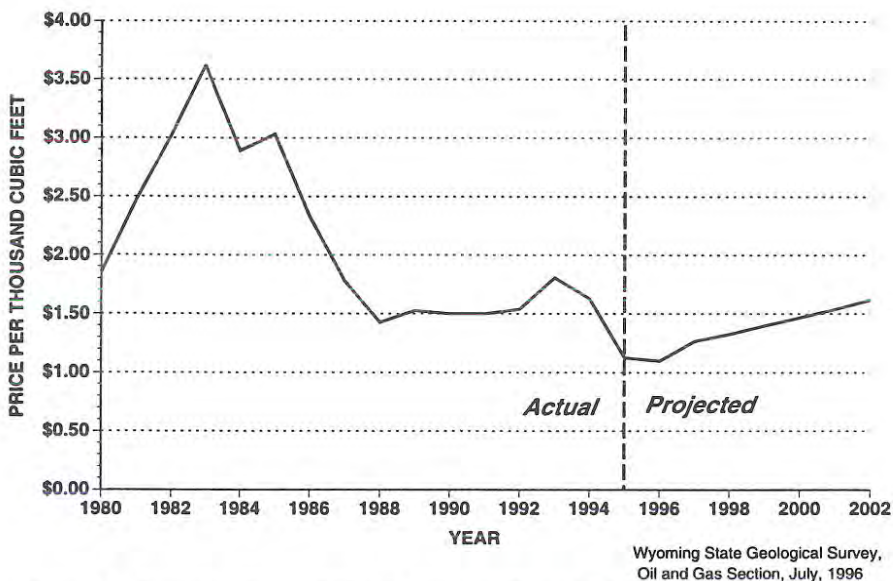


Figure 5. Average prices paid for Wyoming methane (1980 to 1995) with forecasts to 2002.

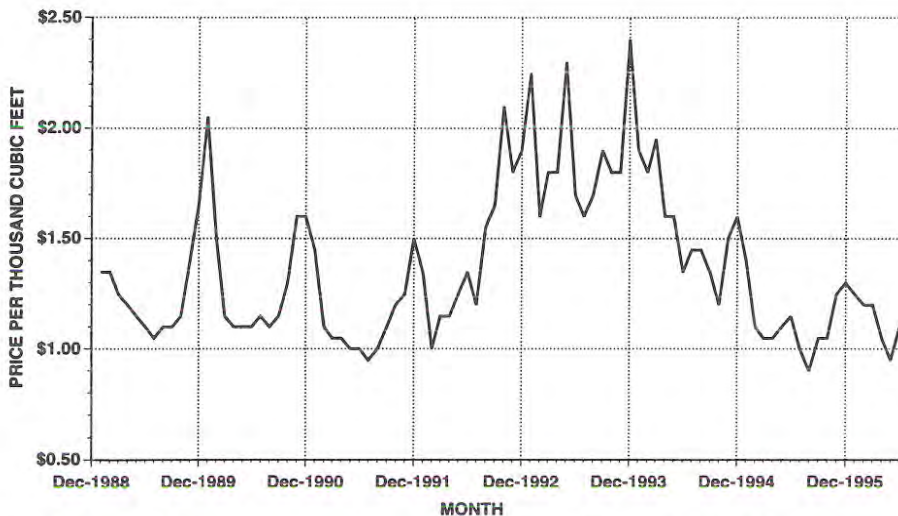


Figure 6. Spot prices for methane at Opal, Wyoming, averaged by month (1989 to present).

Despite three consecutive years with greater than 10% growth in production, Wyoming coal production in 1996 is still projected to increase to 274.9 million tons or by an estimated 4.5% (Table 1 and Figure 7). Deliveries to power plants in the first four months of the year are only 3.1 million tons greater than the same period last year (Table 3). This is only a 3.6% increase in deliveries.

While monthly spot sale deliveries have dropped to about 1993 levels, monthly contract deliveries have increased over those seen in 1995 (Figure 8). In March and then again in April, contract deliveries set new records at 19.45 million tons and 20.14 million tons, respectively. Total deliveries in March set a new monthly record at 22.51 million tons, which is almost half a million tons greater than the previous record set in December of 1995 (Figure 9).

Forecast coal prices have not been changed (Tables 2 and 4 and Figure 10). It is notable, however, that coal prices have remained low in the first two quarters of 1996. In fact, there are reports that some of the lower heat value coals in the Powder River Basin (PRB) have sold for less than \$3.00 a ton on the spot market. And some spot sales of the higher heat value PRB coals have reportedly dipped under \$4.00 a ton. While these prices are not unheard of in the PRB, it is unusual for them to stay this low for this long. Slowing demand is likely a major factor in keeping the prices down. Some utilities hoping to

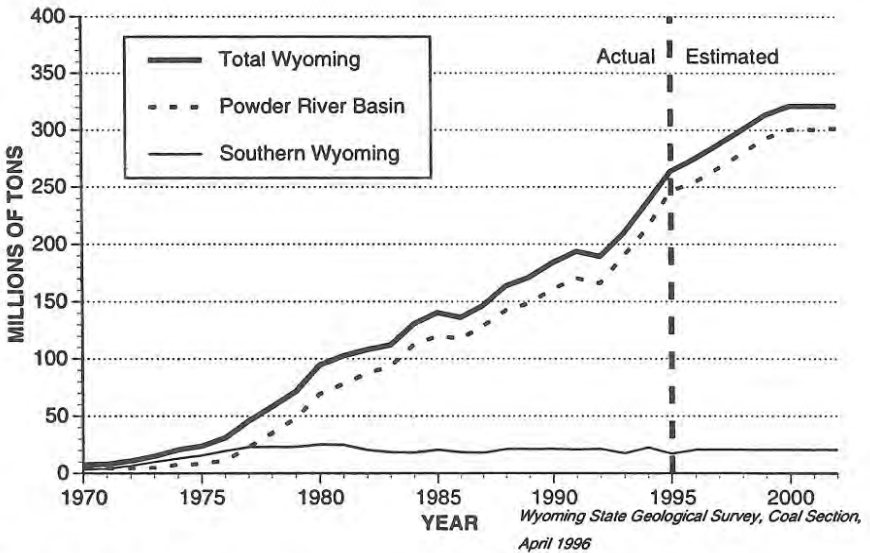


Figure 7. Annual coal production from Wyoming (1970-1995) with forecasts to 2002. Data from Wyoming State Inspector of Mines (1970-1995) and Wyoming Consensus Revenue Estimating Group (1996-2002).

Table 3. Monthly coal deliveries from Wyoming's mines in short tons (1993-1996).

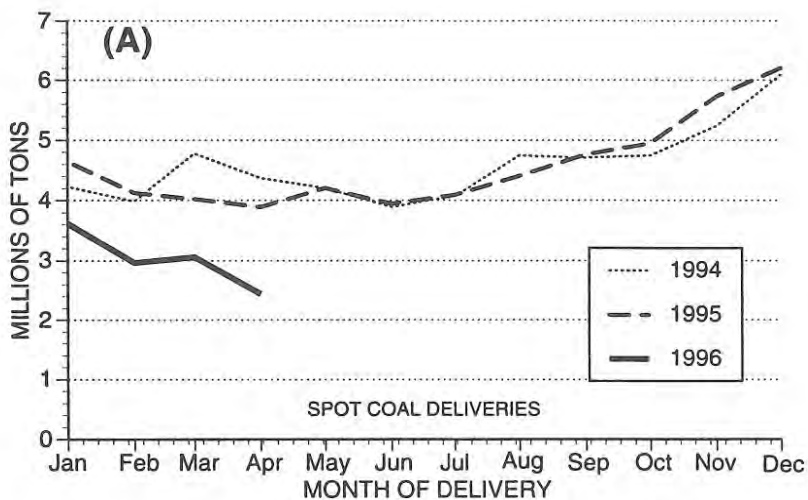
	1993		1994		1995		1996	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	15,931,150	15,931,150	19,326,770	19,326,770	21,586,303	21,586,303	21,793,387	21,793,387
FEB	14,646,090	30,577,240	17,171,910	36,498,680	20,839,926	42,426,229	20,374,055	42,167,442
MAR	17,112,970	47,690,210	19,178,990	55,677,670	21,707,422	64,133,651	22,507,800	64,675,242
APR	16,259,770	63,949,980	17,839,110	73,516,780	20,066,616	84,200,267	22,579,959	87,255,201
MAY	16,085,470	80,035,450	18,652,290	92,169,070	21,509,916	105,710,183		
JUN	16,473,920	96,509,370	17,741,480	109,910,550	18,602,505	124,312,688		
JUL	15,296,480	111,805,850	18,213,540	128,124,090	21,334,608	145,647,296		
AUG	16,682,090	128,487,940	20,572,120	148,696,210	21,356,870	167,004,166		
SEP	17,310,330	145,798,270	19,129,450	167,825,660	21,355,730	188,359,896		
OCT	18,300,070	164,098,340	18,189,260	186,014,920	21,178,610	209,538,506		
NOV	18,007,970	182,106,310	18,595,500	204,610,420	21,042,260	230,580,766		
DEC	19,034,530	201,140,840	20,866,710	225,477,130	22,032,910	252,613,676		
Total Tonnage Reported¹		201,140,840		225,477,130		252,613,676		
Total Tonnage Not Reported²		8,784,986		11,430,937		11,324,347		
Total Tonnage Produced³		209,925,826		236,908,067		263,938,023		

¹ COALDAT Marketing Reports by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities (1993-1995); From bulletin board of the Federal Energy Regulatory Commission in 1996.

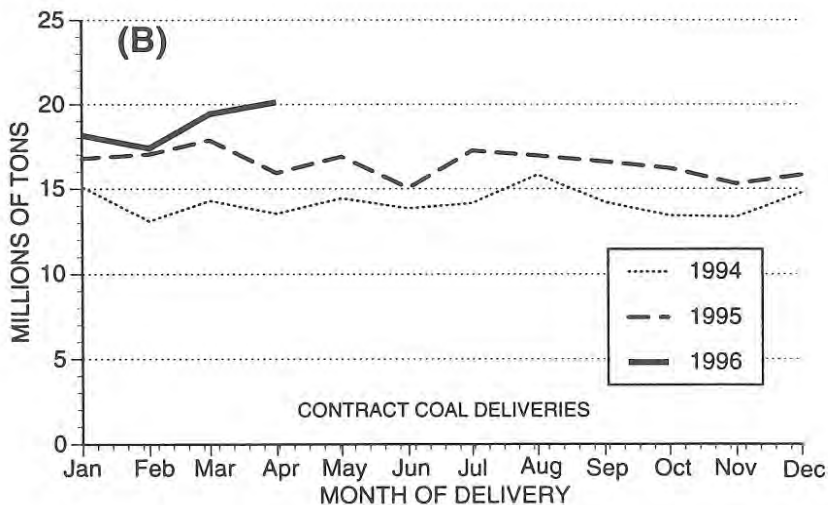
² Includes estimates of residential, industrial, and exported coal, plus tonnages not reported on FERC's 423 forms

³ Wyoming State Mine Inspector's Annual Reports

Wyoming State Geological Survey, Coal Section, July, 1996.

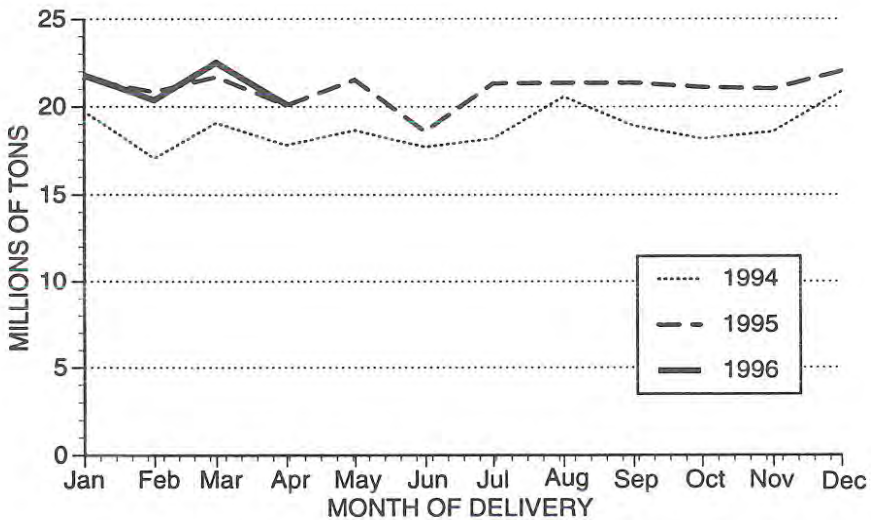


Wyoming State Geological Survey, Coal Section, July 1996



Wyoming State Geological Survey, Coal Section, July 1996

Figure 8. Monthly coal deliveries from Wyoming (1994 through 1996). (A) Coal sold on the spot market and (B) coal sold on contract. (From COALDAT Marketing Report by Resource Data International, Inc. (1994-1995), and from the Federal Energy Regulatory Commission's bulletin board in 1996).



Wyoming State Geological Survey, Coal Section, July 1996

Figure 9. Reported monthly deliveries from Wyoming coal mines (1994 through 1996). From COALDAT Marketing Report by Resource Data International, Inc., (1994 and 1995), and from the Federal Energy Regulatory Commission's bulletin board in 1996.

Table 4. Breakdown of average prices paid for coal from northeastern Wyoming, southern Wyoming, and statewide (1988-1995) with estimates to 2002¹.

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	\$5.51	\$17.13	\$6.62
1995	\$5.35	\$17.12	\$6.26
1996	\$5.28	\$17.05	\$6.17
1997	\$5.24	\$17.02	\$6.09
1998	\$5.17	\$16.99	\$5.99
1999	\$5.11	\$16.64	\$5.89
2000	\$4.94	\$16.61	\$5.71
2001	\$4.87	\$16.57	\$5.64
2002	\$4.98	\$16.41	\$5.70

¹ Statewide data for 1988-1990 are from reports by the U.S. Department of Energy's Energy Information Administration; data for 1991-1994 are derived from Wyoming Department of Revenue information; estimates for 1995-2002 are from the Consensus Revenue Estimating Group's report of January, 1996; and all regional breakdowns are estimated by the Wyoming State Geological Survey.

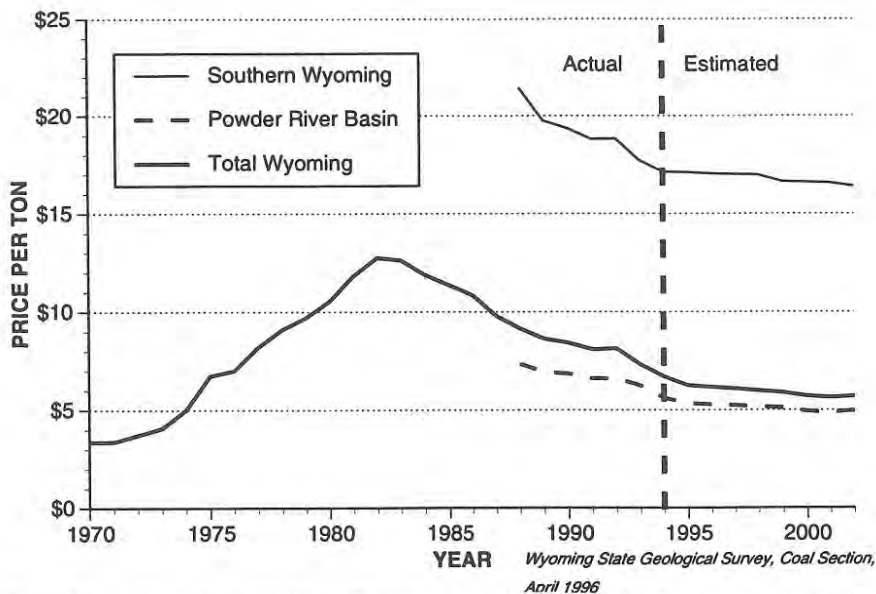


Figure 10. Average prices paid for Wyoming coal (1970 to 1994) with estimates to 2002. Sources: U.S. Energy Information Administration (1970-1990); derived from the Wyoming Department of Revenue (1991-1994); and the Consensus Revenue Estimating Group (1995-2002).

capitalize on the low prices are considering or have put out some wide ranging solicitations and/or) some relatively long-term contracts. For examples, a solicitation by Louisville Gas and Electric in March was for 8,000-14,000 Btu/pound coal, which opened the door to bids from the PRB. And Union Electric Power Co. is soliciting several million tons with 8- to 12-year terms.

Production of trona set a record in 1995 (Table 1). In addition, three of the five existing trona operations have either expanded or are planning expansion of their plant capacities. Production of most of the other industrial minerals or construction materials produced in Wyoming also increased in 1995.

The U.S. Bureau of Land Management (BLM) will hold its second trona (sodium) lease sale this September. It will include tracts totalling about 8,720 acres and holding more than 462 million tons of minable trona. In addition to the companies already mining trona, a number of other companies are reportedly interested in the leases. Many of these tracts are not near existing operations. All the tracts are west of State Highway 350 and south of Green River. This second sale of the year will include the 1,280-acre tract that was bid on in May, but which the BLM rejected as too low a bid (\$332 per acre). This tract contained 60.2 million tons of minable trona.

In the first sale, two 640-acre tracts with a total of 37.7 million tons of minable trona were sold. General Chemical Partners submitted the high bids of \$3,193 per acre for the tract with 19.6 million tons and \$2,437 per acre for the

second tract with 18.1 million tons. The total of the two bonus bids was \$3.67 million.

1995 was a record year for the production of "yellowcake" from in-situ recovery projects. And the spot market price of "yellowcake" inched up to \$14.50 a pound by June.

Exploration for diamonds remained high and should increase even more with the July announcement that some additional diamonds have been found in the Green River Basin. Recent ruby and sapphire discoveries also generated some interest, and exploration for gold and nickel continued.

OIL AND GAS UPDATE

Rodney H. De Bruin

Staff Geologist-Oil and Gas, Wyoming State Geological Survey

Prices paid to Wyoming oil producers in the first half of 1996 averaged an estimated \$18.10 per barrel. If this price holds for the next six months, the average price for 1996 will be the highest since 1990 (Figure 2 and Table 5), when the average price was \$21.08 per barrel. The Gulf War accounted for the high average price in 1990.

The relatively stable and higher oil prices in the first half of 1996 are having a positive effect on oil production from many wells that were only marginally economic at \$15 per barrel. Rather than abandon these wells, operators have chosen to continue production. Although annual production declined an estimated 6.5% between 1994 and 1995, production for the first three months of 1996 is an estimated 18.0 million barrels or only 5.8% below the same quarter of 1995 (Table 6). This table has been revised because of a 14-month-long reporting error by a major oil and gas producing company.

The U.S. Department of Energy (DOE) has contracted with a Colorado firm in Boulder to obtain recommendations and values for various uses of the Naval Petroleum Reserves and Naval Oil Shale Reserves. The contract calls for the company to estimate values the Federal Government would receive under four scenarios: DOE's retention of the reserves, transferral of the reserves to the Department of the Interior for conventional leasing, transferral to other agencies, or the outright sale of the reserves to private industry. The Naval Petroleum Reserves include Teapot Dome Field in Wyoming.

DOE is also co-sponsoring a petroleum conference that will seek solutions to environmental issues. Petroleum companies can discuss their environmentally-related legal, regulatory, and technical issues with senior officials from Federal and State regulatory agencies at the 3rd International Petroleum Environmental Conference on September 24-27 in Albuquerque, New Mexico. DOE will conduct two conference workshops to promote interaction between

Table 5. Monthly average price of a barrel of oil produced in Wyoming (1993 to present).

	1993		1994		1995		1996	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	\$ 15.08	\$ 15.08	\$11.15	\$ 11.15	\$ 14.77	\$ 14.77	\$ 16.38	\$ 16.38
FEB	\$ 16.00	\$ 15.54	\$11.01	\$ 11.08	\$ 15.55	\$ 15.16	\$ 16.28	\$ 16.33
MAR	\$ 16.47	\$ 15.85	\$11.04	\$ 11.07	\$ 15.26	\$ 15.19	\$ 18.65	\$ 17.10
APR	\$ 16.41	\$ 15.99	\$12.59	\$ 11.45	\$ 16.73	\$ 15.58	\$ 20.80	\$ 18.03
MAY	\$ 16.11	\$ 16.01	\$14.53	\$ 12.07	\$ 16.65	\$ 15.79	\$ 18.60	\$ 18.14
JUN	\$ 15.11	\$ 15.86	\$15.73	\$ 12.68	\$ 15.52	\$ 15.75	\$ 17.90	\$ 18.10
JUL	\$ 13.91	\$ 15.58	\$16.31	\$ 13.20	\$ 14.50	\$ 15.57		
AUG	\$ 14.08	\$ 15.39	\$14.89	\$ 13.41	\$ 15.09	\$ 15.51		
SEP	\$ 13.57	\$ 15.19	\$14.10	\$ 13.49	\$ 15.41	\$ 15.50		
OCT	\$ 14.23	\$ 15.09	\$14.53	\$ 13.59	\$ 14.67	\$ 15.42		
NOV	\$ 12.92	\$ 14.89	\$14.68	\$ 13.67	\$ 15.32	\$ 15.41		
DEC	\$ 10.66	\$ 14.54	\$13.71	\$ 13.67	\$ 16.43	\$ 15.50		
Average yearly price		\$ 14.54		\$ 13.67		\$ 15.50		

Source: All averages derived from unpublished monthly reports by the Energy Information Administration, except that averages in bold print in 1996 are estimated from various unpublished bulletins listing posted prices.

Wyoming State Geological Survey, Oil and Gas Section, July, 1996.

Table 6. Monthly oil production from Wyoming in barrels (1993 to present).

	1993		1994		1995		1996	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	7,616,208	7,616,208	7,115,472	7,115,472	6,700,000	6,700,000	6,200,000	6,200,000
FEB	6,583,954	14,200,162	6,387,147	13,502,619	6,100,000	12,800,000	5,800,000	12,000,000
MAR	7,690,771	21,890,933	6,984,248	20,486,867	6,300,000	19,100,000	6,000,000	18,000,000
APR	7,355,334	29,246,267	6,672,207	27,159,074	6,200,000	25,300,000		
MAY	7,533,207	36,779,474	6,847,709	34,006,783	6,300,000	31,600,000		
JUN	7,307,445	44,086,919	6,594,914	40,601,697	6,200,000	37,800,000		
JUL	7,572,346	51,659,265	6,773,956	47,375,653	6,300,000	44,100,000		
AUG	7,370,091	59,029,356	6,685,423	54,061,076	6,100,000	50,200,000		
SEP	7,162,224	66,191,580	6,446,719	60,507,795	6,100,000	56,300,000		
OCT	7,374,889	73,566,469	6,525,817	67,033,612	6,300,000	62,600,000		
NOV	6,897,568	80,464,037	6,257,924	73,291,536	6,100,000	68,700,000		
DEC	7,203,163	87,667,200	6,236,204	79,527,740	6,300,000	75,000,000		
Total Barrels Reported¹		87,667,200		79,527,740		75,000,000		75,000,000
Total Barrels Not Reported²		1,233,006		651,400				
Total Barrels Produced³		88,960,236		80,179,140				

¹Monthly production reports from Petroleum Information, except for 1995 and 1996 which are estimated by the Wyoming State Geological Survey.

²(Total barrels produced) minus (total barrels reported by Petroleum Information).

³Wyoming Oil and Gas Conservation Commission.

Wyoming State Geological Survey, Oil and Gas Section, July, 1996.

producers and refiners and officials of the U.S. Environmental Protection Agency and State regulatory agencies. The conference will also feature three days of technical sessions with several presentations that will address technological options for reducing the environmental impacts of oil and gas operations. A more detailed agenda is available on DOE's Fossil Energy World Wide Web Home Page at < <http://www.fe.doe.gov> >.

During the first three months of 1996, Petroleum Information Inc. reported natural gas production in Wyoming as 296.3 billion cubic feet, which is 5.4% higher than production in the first quarter of 1995 (Table 7). This is the highest total ever in a first quarter and bodes well for the year as the State's natural gas production has increased every year since 1986 (Figure 4). In contrast, for the first six months of 1996, the average monthly spot sale price at Opal, was \$1.13, or one cent less than it was in the same period in 1995 (Table 8).

Following completion of the Final Environmental Impact Statement for the expanded Moxa arch area, the U.S. Bureau of Land Management (BLM) approved the drilling of up to 1,325 infill wells in this area of southwestern Wyoming through the year 2005. The BLM's preferred alternative in another recently released environmental impact statement would allow operators in the area of East La Barge, Bird Canyon, Fontenelle II, Lincoln Road, Stagecoach Draw, Jonah, and Big Piney-La Barge fields to drill up to 1,228 new wells through the year 2005.

The Department of the Interior's Board of Land Appeals denied an appeal from three environmental groups to delay Texaco's Stagecoach Draw gas development in southwestern Wyoming. Texaco has plans to drill up to 72 gas wells over the next six to ten years in Stagecoach Draw Field.

The Altamont gas pipeline is once again in the news. The Federal Energy Regulatory Commission (FERC) has given Altamont an additional 15 months to start work on the pipeline after the company showed intent to proceed with the project and identified reasons for the delay. If built, the pipeline will bring Canadian natural gas into the Opal hub in southwestern Wyoming. The route certificate that was originally approved by FERC was to expire July 31, 1996, if work on the pipeline did not begin by then.

A number of Wyoming properties changed hands in the second quarter of 1996. Cross Timbers Oil Co. acquired 81 billion cubic feet of proved gas reserves from Enserch Exploration for \$40 million. The reserves are located in the Fontenelle, Nitchie Gulch, and Pine Canyon fields in the Green River Basin. Cross Timbers said it expects to drill 30 infill wells and increase production from these properties by 50 percent over the next three years. Current net production averages 12.6 million cubic feet of gas per day. Abraxas Petroleum Corp. spent \$47 million for properties in the Great Divide Basin that will add 16.8 million cubic feet of gas equivalent to the company's daily production. Abraxas bought the properties from an undisclosed independent and will acquire a 58% net revenue interest with a net 87 billion cubic feet of gas equivalent. The company also has plans for development drilling on its new properties. Berco Resources Inc.

Table 7. Monthly natural gas production from Wyoming in thousands of cubic feet (MCF) (1993 to present).

	1993		1994		1994		1995		1996	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	88,172,339	88,172,339	93,146,775	93,146,775	100,224,249	100,224,249	101,254,314	101,254,314	101,254,314	101,254,314
FEB	80,726,687	168,899,026	85,623,666	178,770,441	86,691,577	186,915,826	94,747,158	186,915,826	94,747,158	196,001,472
MAR	88,920,212	257,819,238	94,388,052	273,158,493	94,344,991	281,260,817	100,319,834	281,260,817	100,319,834	296,321,306
APR	86,208,224	344,027,462	92,362,726	365,521,219	93,929,323	375,190,140		375,190,140		
MAY	87,857,947	431,885,409	93,886,923	459,408,142	95,791,327	470,981,467		470,981,467		
JUN	74,555,764	506,441,173	81,764,661	541,172,803	92,140,614	563,122,081		563,122,081		
JUL	91,832,536	598,273,709	94,998,414	636,171,217	92,796,301	655,918,382		655,918,382		
AUG	91,562,051	689,835,760	93,743,790	729,915,007	90,393,416	746,311,798		746,311,798		
SEP	90,580,094	780,415,854	88,476,703	818,391,710	92,589,092	838,900,890		838,900,890		
OCT	93,388,208	873,804,062	95,232,646	913,624,356	98,386,458	937,287,348		937,287,348		
NOV	88,046,821	961,850,883	95,312,491	1,008,936,847	94,939,660	1,032,227,008		1,032,227,008		
DEC	90,133,281	1,051,984,164	87,115,084	1,096,051,931	99,314,617	1,131,541,625		1,131,541,625		
Total MCF Reported¹	1,051,984,164	1,051,984,164		1,096,051,931		1,131,541,625		1,131,541,625		
Total MCF Not Reported²		2,715,623				6,879,705				
Total MCF Produced³		1,054,699,787		1,102,931,636		1,138,421,330		1,138,421,330		

¹ Monthly production reports from Petroleum Information

² (Total MCF produced) minus (total MCF reported by Petroleum Information).

³ Wyoming Oil and Gas Conservation Commission.

Wyoming State Geological Survey, Oil and Gas Section, July, 1996.

Table 8. Monthly average spot price of a thousand cubic feet (MCF) of natural gas at Opal, Wyoming (1993 to present).

	1993		1994		1994		1995		1995		1996	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	\$ 2.25	\$ 2.25	\$ 1.90	\$ 1.90	\$ 1.40	\$ 1.90	\$ 1.40	\$ 1.40	\$ 1.25	\$ 1.25	\$ 1.25	\$ 1.25
FEB	\$ 1.60	\$ 1.93	\$ 1.80	\$ 1.85	\$ 1.10	\$ 1.85	\$ 1.10	\$ 1.25	\$ 1.20	\$ 1.20	\$ 1.20	\$ 1.23
MAR	\$ 1.80	\$ 1.89	\$ 1.95	\$ 1.88	\$ 1.05	\$ 1.88	\$ 1.05	\$ 1.18	\$ 1.20	\$ 1.20	\$ 1.20	\$ 1.22
APR	\$ 1.80	\$ 1.87	\$ 1.60	\$ 1.81	\$ 1.05	\$ 1.81	\$ 1.05	\$ 1.15	\$ 1.05	\$ 1.05	\$ 1.05	\$ 1.18
MAY	\$ 2.30	\$ 1.96	\$ 1.60	\$ 1.77	\$ 1.10	\$ 1.77	\$ 1.10	\$ 1.14	\$ 0.95	\$ 1.13	\$ 0.95	\$ 1.13
JUN	\$ 1.70	\$ 1.91	\$ 1.35	\$ 1.70	\$ 1.15	\$ 1.70	\$ 1.15	\$ 1.14	\$ 1.10	\$ 1.13	\$ 1.10	\$ 1.13
JUL	\$ 1.60	\$ 1.87	\$ 1.45	\$ 1.66	\$ 1.00	\$ 1.66	\$ 1.00	\$ 1.12	\$ 1.10	\$ 1.12	\$ 1.10	\$ 1.13
AUG	\$ 1.70	\$ 1.85	\$ 1.45	\$ 1.64	\$ 0.90	\$ 1.64	\$ 0.90	\$ 1.09	\$ 1.20	\$ 1.09	\$ 1.20	\$ 1.13
SEP	\$ 1.90	\$ 1.85	\$ 1.35	\$ 1.61	\$ 1.05	\$ 1.61	\$ 1.05	\$ 1.09	\$ 1.20	\$ 1.09	\$ 1.20	\$ 1.13
OCT	\$ 1.80	\$ 1.84	\$ 1.20	\$ 1.57	\$ 1.05	\$ 1.57	\$ 1.05	\$ 1.09	\$ 1.20	\$ 1.09	\$ 1.20	\$ 1.13
NOV	\$ 1.80	\$ 1.84	\$ 1.50	\$ 1.56	\$ 1.25	\$ 1.56	\$ 1.25	\$ 1.10	\$ 1.20	\$ 1.10	\$ 1.20	\$ 1.13
DEC	\$ 2.40	\$ 1.89	\$ 1.60	\$ 1.57	\$ 1.30	\$ 1.57	\$ 1.30	\$ 1.12	\$ 1.20	\$ 1.12	\$ 1.20	\$ 1.13
Average yearly price		\$ 1.89		\$ 1.57		\$ 1.57		\$ 1.12		\$ 1.12		\$ 1.12

Source: American Gas Association's monthly reports

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bought Amerada Hess' interest in Saddle Rock Field in the Wind River Basin for an undisclosed amount as part of a larger deal that included a number of properties in other states.

At oil and gas lease sales in the second quarter of 1996, the number of acres leased and number of parcels sold were both greater than in the sales held in the first quarter. The average price per acre and total revenue from the State sale was the highest since the November sale in 1994 (Table 9). Leasing at the U.S. Bureau of Land Management's (BLM's) June sale (Figure 11) was concentrated in the Powder River and Greater Green River basins. The BLM had no April sale because of the earlier Federal Government shutdowns. Leases originally planned for the April sale were offered at the June sale. Lands nominated for the June sale were combined with those nominated for the August 6th sale. In this way, the BLM offered the same number of parcels at five sales that normally would have been offered at six sales. Leasing at the State Land and Farm Loan Office's June sale (Figure 12) was heaviest in the Powder River Basin and the Bighorn Basin. At this sale, there were very few leases available in the Greater Green River Basin. The State is now holding its sales the day after the BLM sales. Both the Federal and State sales are held in Cheyenne.

The BLM's June sale had a high per-acre bid of \$210 made by Diversified Title Inc. for a 325.77-acre parcel that covers parts of sections 28, 29, and 30, T53N, R68W (location A, Figure 11). The lease is within a mile of Minnelusa oil production at Cambridge Field. Yates Petroleum paid \$160 per acre for a 320-acre lease that covers N/2 of section 24, T20N, R96W (location B, Figure 11). The lease is within a mile of Almond gas production in Wamsutter Field. High Plains Associates paid \$130 per acre for a 120-acre lease that covers the W/2 NW and SE NW of section 25, T39N, R89W (location C, Figure 11). The lease is about a mile northeast of temporarily abandoned Mesaverde gas production at Badwater Field. There were 10 tracts at this sale that received per-acre bids of \$50 or more.

The State Land and Farm Loan Office's sale in June had a high per-acre bid of \$206 made by Rocky Mountain Exploration for a 640-acre lease that covers section 16, T37N, R87W (location A, Figure 12). The tract is in a non-producing township about five miles northwest of Waltman Field. The sale's second highest per-acre bid of \$150 was made by Yates Petroleum Corp. for a 640-acre tract that covers section 16, T36N, R76W (location B, Figure 12). The lease is a mile west of Frontier, Muddy, and Dakota oil and gas production in Sand Dunes Field. There were seven tracts at this sale that received per-acre bids of \$50 or more.

Applications for Permit to Drill (APDs) in the second quarter of 1996 picked up from the low levels in the first quarter of 1996. The number of APDs for the first half of 1996 was 331 (Table 10). With two more quarters like the second quarter, APDs for 1996 could be nearly as high as they were in 1995.

Because of new 3-D seismic techniques, the total number of miles shot has remained fairly stable since 1992 even though the number of seismic projects

Table 9. Federal and State competitive oil and gas lease sales in Wyoming.

FEDERAL SALES (BUREAU OF LAND MANAGEMENT)							STATE SALES (STATE LAND AND FARM LOAN OFFICE)									
Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre	Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre	
TOTAL	\$12,942,008	2,769	1,469	2,065,942	995,344	\$13.00	\$400.00	TOTAL	\$1,980,017	800	582	311,273	222,139	\$8.91	\$400.00	
			1993								1993					
February	\$3,909,085	442	280	374,969	237,761	\$16.44	\$160.00	March	\$917,380	200	169	84,571	73,061	\$12.56	\$170.00	
April	\$4,248,182	498	278	369,657	201,690	\$21.06	\$275.00	May	\$802,688	200	141	75,523	54,189	\$14.81	\$205.00	
June	\$3,759,282	480	270	417,447	233,664	\$16.09	\$325.00	September	\$386,083	200	149	83,143	61,675	\$9.50	\$190.00	
August	\$5,100,550	439	294	323,410	217,157	\$23.49	\$255.00	November	\$998,001	200	148	88,542	66,217	\$15.07	\$142.00	
October	\$4,703,706	492	341	411,117	269,003	\$17.49	\$11,200.00	TOTAL	\$3,304,152	800	607	331,779	255,152	\$12.95	\$205.00	
December	\$5,386,789	617	367	479,930	290,384	\$18.55	\$390.00									
TOTAL	\$27,107,594	2,968	1,840	2,376,530	1,449,659	\$18.70	\$11,200.00	TOTAL	\$3,304,152	800	607	331,779	255,152	\$12.95	\$205.00	
			1994								1994					
February	\$3,252,668	533	332	473,177	290,046	\$11.21	\$425.00	March	\$524,165	199	131	89,371	57,702	\$9.08	\$130.00	
April	\$1,591,709	531	206	483,826	189,003	\$8.42	\$160.00	May	\$452,747	200	125	75,633	49,735	\$9.10	\$78.00	
June	\$3,499,604	393	246	384,746	238,663	\$14.65	\$660.00	September	\$421,454	200	134	78,032	53,527	\$7.87	\$65.00	
August	\$1,105,381	488	165	420,189	149,025	\$7.41	\$180.00	November	\$257,852	200	102	80,851	41,744	\$6.18	\$52.00	
October	\$2,761,689	477	227	384,683	174,453	\$15.83	\$1,100.00	TOTAL	\$1,656,218	799	482	323,887	202,708	\$8.17	\$130.00	
December	\$836,195	205	88	180,367	66,321	\$12.24	\$316.00									
TOTAL	\$13,047,246	2,649	1,264	2,326,988	1,109,711	\$11.76	\$1,100.00									
			1996								1996					
February	\$1,635,668	455	192	358,478	137,901	\$11.86	\$220.00	March	\$308,927	199	96	85,369	41,909	\$7.37	\$108.00	
June	\$1,438,325	460	282	337,440	181,338	\$7.93	\$210.00	June	\$856,177	250	114	103,621	48,638	\$13.49	\$206.00	

Sources: Wyoming State Land and Farm Loan Office, Petroleum Information Corporation - Rocky Mountain Region Report, and U. S. Bureau of Land Management.

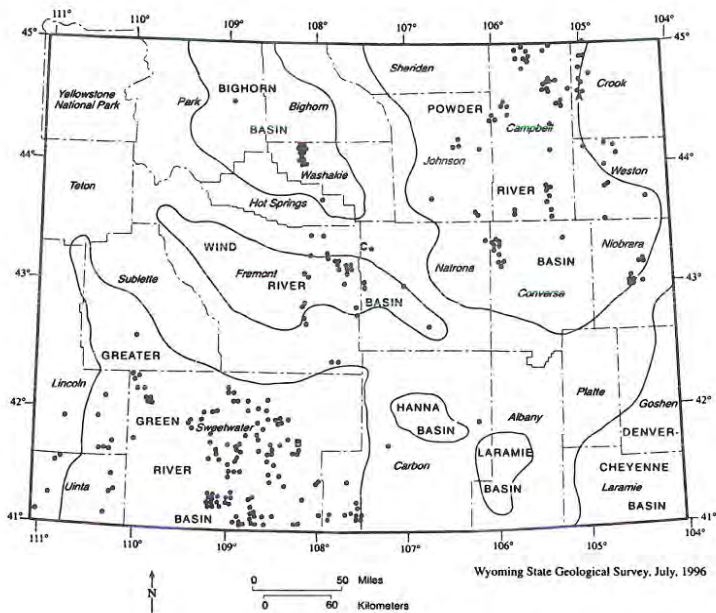


Figure 11. Locations of Federal oil and gas tracts leased by the U.S. Bureau of Land Management at the June, 1996, sale.

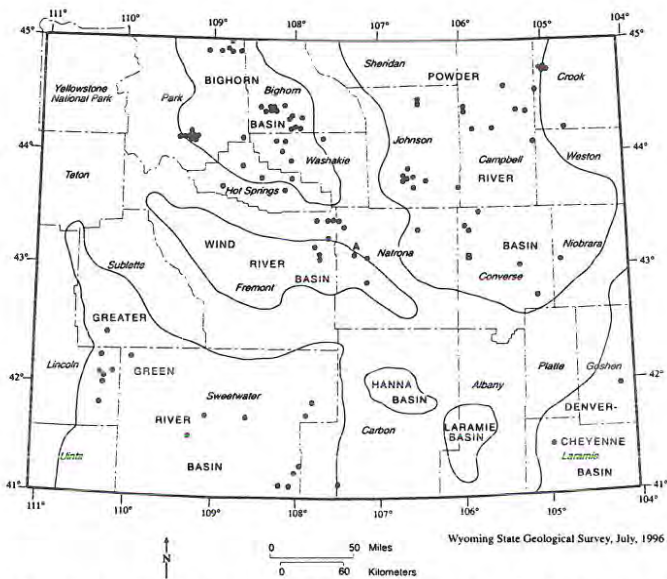


Figure 12. Locations of State oil and gas tracts leased by the State Land and Farm Loan Office at the June, 1996, sale.

Table 10. Number of Applications for Permit to Drill (APD) approved by the Wyoming Oil and Gas Conservation Commission (1993 to present).

	1993	1994	1995	1996 ¹
County	APDs	APDs	APDs	APDs
Albany	0	0	1	1
Big Horn	13	3	16	22
Campbell	129	102	151	62
Carbon	35	134	50	25
Converse	37	75	29	8
Crook	29	9	15	10
Fremont	16	46	30	7
Goshen	0	0	0	0
Hot Springs	12	4	13	0
Johnson	18	16	6	8
Laramie	37	15	10	0
Lincoln	136	103	64	7
Natrona	36	63	80	41
Niobrara	5	4	4	3
Park	22	18	20	16
Platte	0	2	0	0
Sheridan	7	3	0	0
Sublette	80	111	61	34
Sweetwater	158	205	153	62
Teton	0	0	0	0
Uinta	49	11	11	4
Washakie	17	12	31	16
Weston	23	6	10	5
TOTALS	859	942	755	331

Source: All data are from the Wyoming Oil and Gas Conservation Commission.

¹Numbers for 1996 are for the first quarter only.

Wyoming State Geological Survey, Oil and Gas Section, July, 1996.

permitted by the Wyoming Oil and Gas Conservation Commission has been dropping steadily through that same time period (Table 11). Permits did, however, increase substantially in the first half of 1996; so much so, that the number of permits issued in the first half of 1996 already equals the number of permits issued in 1995. Permits for 3-D square miles in 1996 already total only one square mile less than in 1995. Once again the seismic projects and miles permitted so far in 1996 were concentrated in counties in the Powder River and Greater Green River basins.

The average rig count for the second quarter of 1996 started increasing in May from the very low levels seen in the first quarter. By the end of the second quarter, the rig count was running about the same as for the corresponding months in 1995 (Figure 13).

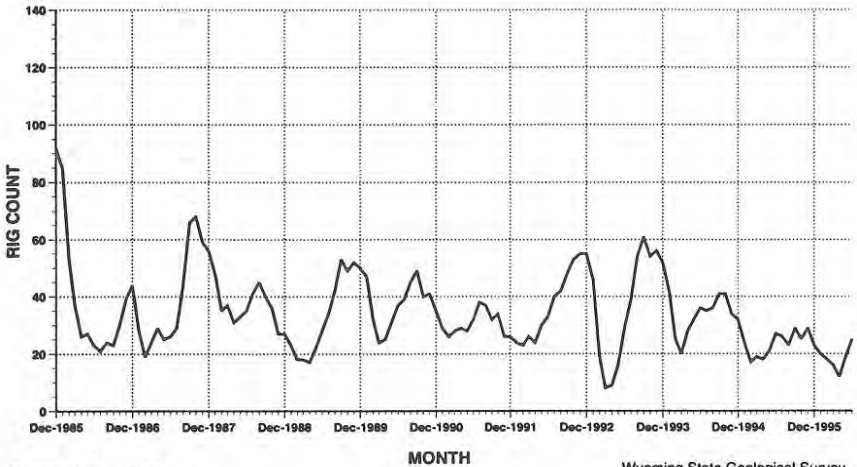
Table 11. Number of seismic projects and miles permitted by the Wyoming Oil and Gas Conservation Commission (1993 to present).

County	1993		1994		1995		1996	
	Permits	Conven- tional Miles	Permits	Conven- tional Miles	Permits	Conven- tional Miles	Permits	Conven- tional Miles
Albany	0	0	0	0	0	0	1	18
Big Horn	0	0	5	24	1	16	1	3
Campbell	24	134	13	17	12	24	24	43
Carbon	8	115	11	117	1	86	2	5
Converse	4	26	0	0	4	39	1	4
Crook	5	21	3	3	1	0	4	0
Fremont	6	38	6	12	6	32	1	5
Goshen	0	0	0	0	0	0	0	0
Hot Springs	1	0	1	9	2	70	4	17
Johnson	1	20	0	0	1	4	0	0
Laramie	1	67	3	57	0	0	0	0
Lincoln	3	27	0	0	2	18	0	0
Natrona	3	20	1	0	3	27	0	0
Niobrara	0	0	1	0	0	0	1	0
Park	5	54	1	0	0	0	0	0
Platte	0	0	0	0	0	0	0	0
Sheridan	0	0	0	0	0	0	0	0
Sublette	0	0	5	4	2	145	0	0
Sweetwater	9	117	4	59	9	17	6	10
Teton	0	0	0	0	0	0	0	0
Ujina	0	0	2	0	0	0	0	0
Washakie	4	17	0	0	0	0	0	0
Weston	0	0	0	0	1	13	0	0
TOTALS	74	656	56	302	45	260	45	105
		391		515		921		920

Source: All data are from the Wyoming Oil and Gas Conservation Commission.

¹Numbers for 1996 are for the first two quarters only.

Wyoming State Geological Survey, Oil and Gas Section, July, 1996.



Source: Hughes Rig Count

Wyoming State Geological Survey,
Oil and Gas Section, July., 1996

Figure 13. Wyoming daily rig count averaged by month (1986 to present).

Exploration and Development

Company data, news releases, and information compiled and published by Petroleum Information indicate the following significant exploration and development events occurred in Wyoming during the second quarter of 1996. The numbers preceding discussions below refer to locations on **Figure 14**.

1. Union Pacific Resources completed a new Phosphoria gas producer in Yellow Creek Field. During its first month of production, the 11-3 Yellow Creek Deep well in NW NW section 11, T14N, R121W produced an average of 7.5 million cubic feet of sour gas, 49 barrels of condensate, and 226 barrels of water per day from a depth of approximately 12,000 feet. The gas, which is processed at Amoco's Whitney Canyon gas plant, is transported through the recently-completed Wahsatch [sic] gathering system.
2. Union Pacific Resources completed a new well in Whitney Canyon-Carter Creek Field. The 25-1 UPRC well in NE NE section 25, T17N, R120W flowed 21.7 million cubic feet of gas per day from the Mission Canyon Limestone between 13,450-13,640 and 13,850-14,370 feet.
3. Marathon Oil Co. completed two new Frontier gas wells in Emigrant Springs Field. The 21-17 Trail well in SW SW section 17, T23N, R112W flowed 3.2 million cubic feet of gas and 31 barrels of condensate per day from between 10,598 and 10,706 feet. The 22-7 Sage well in SE SE section 7, T23N, R112W flowed 2.8 million cubic feet of gas and 28 barrels of condensate per day from between 10,526 and 10,626 feet.

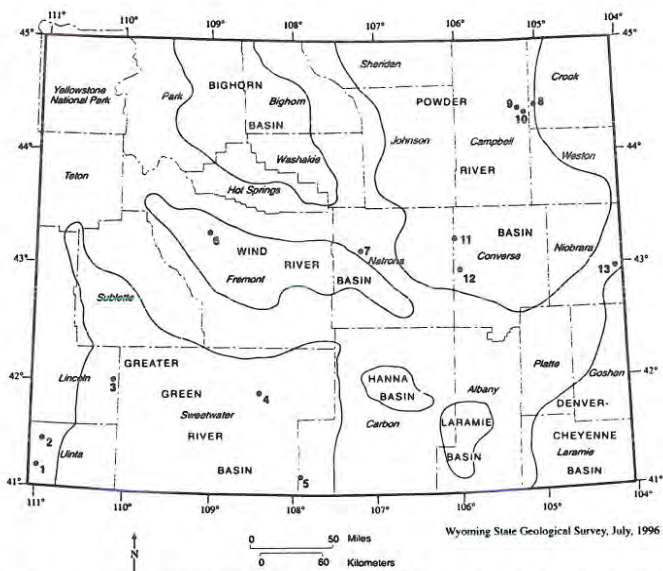


Figure 14. Oil and gas exploration and development activities in Wyoming during the second quarter of 1996 (exclusive of coalbed methane activities).

4. Yates Petroleum set production casing and is waiting on a pipeline connection at its 1 Wabash Cannonball-Federal well in SW NE section 26, T22N, R97W. The 8,700-foot Mesaverde test is a mile northwest of the South Sheep Camp Field discovery well, which produced gas from the Mesaverde before it was abandoned.
5. Conoco Inc. discovered gas at its 1-18 Red Creek well in SE SE section 18, T13N, R93W. Gas flowed at a rate of 462,000 cubic feet with 81 barrels of water per day through perforations in the Almond Formation between 10,898-10,942 and 10,990-11,008 feet. The discovery is about two miles east of McPherson Springs Field, which produces from the Mesaverde and Lewis.
6. Tom Brown Inc. signed an exploration agreement with the Eastern Shoshone and the Northern Arapaho tribes of the Wind River Indian Reservation which will increase Brown's holdings in the Wind River Basin to about one million acres. The new agreement covers over 300,000 acres and allows the company to enter into two exploration options in the next 12 months that would cover a minimum of 100,000 acres and a maximum of 150,000 acres each.
7. Barrett Resources completed another producer in its Cave Gulch Unit. The 7 Cave Gulch Unit well in NW NW section 32, T37N, R86W flowed 5.7 million cubic feet of gas, 61 barrels of condensate, and three barrels of water per day from an undisclosed interval in the Lance. The BLM is allowing Barrett

and other operators in the area to work on 14 existing and new wells this summer while an environmental impact statement is prepared.

8. Flying J Oil and Gas Inc. has an indicated wildcat discovery at its 1-5 Glenn-Federal well in NE NE section 5, T51N, R68W. The well, which was tested between 7,342 and 7,359 feet in the Minnelusa Formation, recovered 1,628 feet of oil and 90 feet of oil-cut mud on a drillstem test. The closest Minnelusa production is about one and a half mile to the northwest at County Line Field.
9. Samedan Oil Corp. completed an oil producer in Kuehne Ranch Field. The 10 Kuehne Ranch well in SW NE section 13, T51N, R70W initially pumped 338 barrels of oil per day from the Minnelusa between 7,958 and 8,011 feet.
10. Conley P. Smith will attempt completion of its 32-3 Charlotte well in NE NW section 32, T51N, R69W. The exploratory well was cased after 6,205 feet of oil was recovered on a drillstem test of the Minnelusa between 8,054 and 8,074 feet. The well is about half a mile north of Minnelusa production at Windmill Field.
11. Yates Petroleum discovered oil in the Frontier at its 1 Catamount Unit well in SW NW section 13, T38N, R77W. Oil was initially pumped at the rate of 26 barrels per day from the First Frontier between 9,492 and 9,695 feet. The well is about a mile north of Bobcat Creek Field, which has produced from the Frontier.
12. Gulf Production completed a discovery in the Muddy Sandstone at its 12-16 Federal well in NW SW section 26, T35N, R76W. The well flowed 211 barrels of oil and 114,000 cubic feet of gas per day between 10,242 and 10,253 feet. The nearest production from the Muddy is in Cole Creek Field, which is about four miles to the southwest.
13. Enserch Exploration set production casing at its 1 Charles-Federal 4-4 well in NW NW section 4, T35N, R60W. The well was permitted as a 4,000-foot test of the Leo.

COAL UPDATE

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According to information recently released by the Energy Information Administration (EIA, 1996), U.S. coal production totaled 1,030 million tons in 1995, slightly below the 1,034 million tons produced in 1994. While production in the Appalachian and Interior coal regions declined 2% and 8%, respectively, production in the Western region increased by almost 5%, with Wyoming

accounting for most of the net increase. Consumption of coal in the U.S., on the other hand, increased by 1.1%, setting a new high of 940.8 million tons, which is 10.6 million tons higher than 1994. Utilities consumed 88% of this coal or 829.2 million tons, which is 2% more than in 1994. At the same time, coal's share of the electric utility market in 1995 declined 1% with nuclear, hydroelectric, and gas-fired generation replacing some coal-fired capacity.

The delivered price of U.S. coal declined in 1995. In fact, the average delivered price to utilities was \$27.01, which is the lowest average in at least the last decade.

Wyoming remained the largest coal-producing state at 263.9 million tons (an 11.4% increase), followed by West Virginia at 164.1 million tons (a 1.4% increase), and Kentucky at 151.1 million tons (a 6.5% decrease). In the West, Colorado production declined very slightly to 25 million tons, Montana production declined by 4.8% to 39.6 million tons, and Utah production increased by 2.6% to 25 million tons (EIA, 1996).

Utilities in at least nineteen states and Canada consumed Wyoming coal in 1995, which compares to 21 states in 1994 (Figure 15). The two additional states in 1994 were Montana and Florida both of which only used very small quantities of Wyoming coal in that year. In addition, overseas exports of Wyoming steam coal increased from about 1.5 million tons in 1994 to 2.2 million tons in 1995. Texas utilities remained the largest users of Wyoming's steam

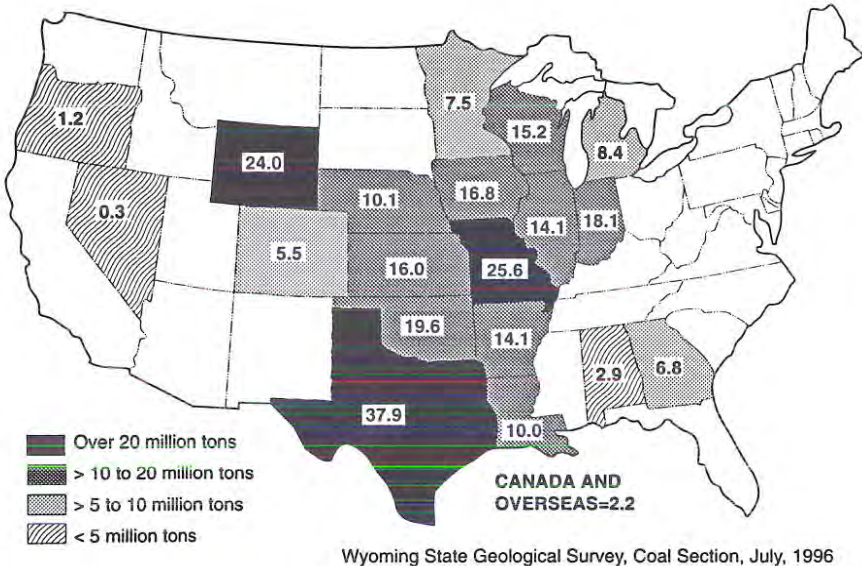
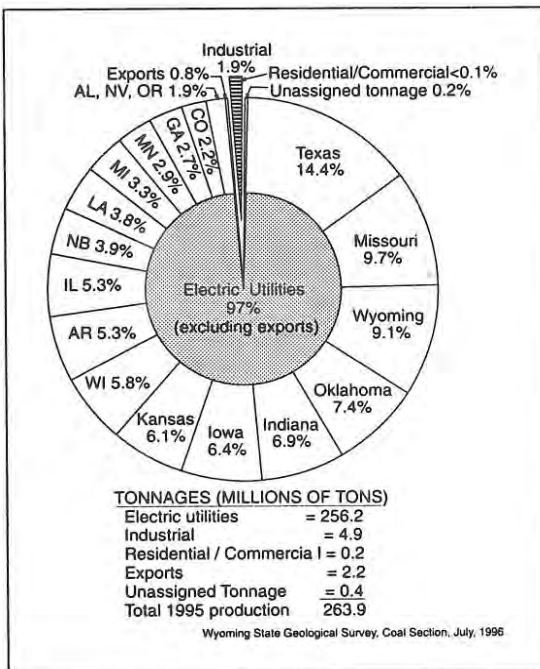


Figure 15. Wyoming coal deliveries to electric generating plants in 1995 in millions of tons (adapted from EIA, 1996).

coal, but Missouri's usage pushed usage in Wyoming to third place in 1995. Domestic utilities used 97.1% of the coal mined in Wyoming last year, which is a 0.4% increase over 1994 (Figure 16). If steam coal exports are included in utility usage, utilities used 97.9%.

Industrial usage was about 4.9 million tons, down from the 5.8 million tons reported in 1994 (Figure 16). Of this, about 1.6 million tons were used in-state. Residential and commercial usage in 1995 was about 235,000 tons, compared to 362,000 tons in the previous year. One hundred forty-six thousand tons of this coal were used in-state. When EIA's (1996) total production number for 1995 is compared to the total production reported to the Wyoming State Inspector of Mines (1996), there is about a 400,000-ton difference, which was apparently not picked up in EIA's production reports. This is likely a combination of rounding as well as tonnages too small to report to EIA. Since this amount is only 0.15% of Wyoming's total production, the EIA's and the Mine Inspector's totals are very close to one another.



Coal production estimates for 1996 and future years remain the same, with low-price coal edging up to 76% of the total this year (Table 12).

The Clean Air Act Amendments of 1990 (CAAA) set standards for the emission of both sulfur dioxide (SO₂) and nitrogen oxide (NO_x) from power plants. Phase I of the SO₂ standards took effect in 1995, while the NO_x standards

Figure 16. Utilization of Wyoming coal in 1995 in percent (adapted from EIA, 1996). The electric utility total is 258.4 million tons when combined with steam coal exports. The industrial, residential, and commercial usages are not broken down by their destination. The 1995 coal production total is from the Wyoming State Inspector of Mines. All other tonnages are from EIA (1996) except the unassigned tonnage.

Table 12. County coal production in millions of tons, from 1992 to 1995 with forecasts to 2002.

	1992	1993	1994	1995	1996 ¹	1997 ¹	1998 ¹	1999 ¹	2000 ¹	2001 ¹	2002 ¹
Campbell County	159.6	181.9	205.2	232.4	240.1	251.6	263.5	276.2	283.7	283.9	283.9
Converse County	8.5	10.2	11.7	14.1	13.2	13.8	14.9	15.6	16.0	16.3	16.6
Sheridan County	0.1	0.1	0.1	M	M	M	M	M	M	M	M
Carbon County	4.1	4.4	4.4	3.8	4.1	3.8	3.6	3.3	3.0	3.0	3.0
Sweetwater County	12.6	9.2	11.2	9.1	11.5	11.7	12.0	12.2	12.4	12.2	12.2
Lincoln County	4.6	4.1	4.3	4.5	4.6	4.7	4.8	4.8	4.8	4.8	4.8
Hot Springs County	M	M	M	M	M	M	M	M	M	M	M
Total Wyoming	189.5	209.9	236.9	263.9	274.9	287.1	299.9	313.3	321.1	321.1	321.1
Annual Change	-2.3%	10.8%	12.9%	11.4%	4.2%	4.4%	4.5%	4.5%	2.5%	0.0%	0.0%
Low-priced coal ²	57%	64%	67%	74%	76%	78%	83%	87%	91%	94%	94%

¹County estimates by Wyoming State Geological Survey, January, 1996; ²Estimated percentage of total production that is sold on the spot market, through short-term contracts [less than one-year duration], or through renegotiated, longer-term contracts all at prices under \$5.00. M means minor tonnage (less than 0.1 million tons).

Wyoming State Geological Survey, Coal Section, July, 1996

are part of Phase II of the CAAA, and take effect in the year 2000. According to a recent article in *Coal* magazine (Myers, 1996), the use of Powder River Basin coal in non-scrubbed, Phase I, coal-fired power plants increased from less than 15% to about 40% between 1990 and 1995. At the same time, the average price for this coal declined about 10%. As a result, many utilities over-complied with the 1995 Phase I, SO₂ emission standards. This created a surplus of SO₂ allowances and lowered the prices paid for these credits. For example, the quoted price for a credit was \$68 in March (*Wyoming Geo-notes No. 50*, p. 29 and 31). By May, the Emission Credit Corporation reported that the quoted price for 1996 credits was \$79 per credit, down from \$81 in April. The price for year-2000 credits in May was \$75, down from \$77 in April. These rapid swings in price are likely an artifact of the low volume of sales in the second quarter, rather than to any obvious trends in value.

Myers (1996) concluded that switching to Powder River Basin coal prevailed over scrubbing for Phase I compliance. This worked well because SO₂ emissions were the target. But Myers believes that switching will not be as effective in complying with NO_x standards in Phase II of the CAAA. While Powder River Basin (PRB) coals do tend to have lower nitrogen contents than eastern or midwestern coals, switching to PRB coals may not be enough to bring many plants into NO_x compliance. Some utilities will also have to consider redesigning their boilers and modifying firing techniques on a plant by plant basis to meet the new NO_x standards.

In late June, the Union Pacific railroad (UP) shut down its North Platte Subdivision for six days. This 132-mile segment of trackage is the main link to the coal mines in the Powder River Basin. The closure, which was coordinated with both utilities and coal mining companies in the basin, may have been the first use of this type of maintenance scheduled by a major railroad. In this short period, 450 workers and considerable equipment completed what normally would have taken 6 months to do. As a result, this trackage can now handle an additional 100 unit trains over the next 6 months. Some of the coal companies used the down time for maintenance at their mines. UP's track closure was not totally complete as three unit trains a night were allowed to go through, and there was some haulage on the Yoder Subdivision trackage as well.

In early July, the Surface Transportation Board approved the merger of the Union Pacific and Southern Pacific railroads, creating the nation's largest railroad. The merger became official on August 12th. This merger follows the earlier joining of the Burlington Northern and Santa Fe railroads. An estimated 90% of all freight traffic west of the Mississippi River uses one or the other of these newly merged railroads.

The Tongue River railroad proposed for southern Montana remains controversial even though the completed Environmental Impact Statement (EIS) concludes that the rail line will have little environmental consequences. There is still heavy local opposition to the line, making its

fate questionable. Now that the EIS is completed, the Surface Transportation Board is expected to make a decision sometime this year.

In April, the Powder River Basin Regional Coal Team (RCT) met for the first time since 1993. Among other things, they reviewed a report on coal leasing in the southern Powder River Basin that had been prepared by the U.S. Bureau of Land Management (BLM). BLM determined that while the mines in this area had 28 years of remaining reserves under lease in 1995, they would only have 20 years of reserves by 2005. Double digit growth in production over the last three years and mine requests for larger air quality permits were cited as some of the evidence that production is growing fast enough to warrant an increased level of leasing. As a result, BLM concluded that coal operators in the southern Powder River Basin needed about a 30-year reserve to keep up with demand. This would require the leasing of about 540 million tons of Federal coal per year. For comparison, the BLM leased an average of only 220 million tons a year between 1991 and 1995. Pending Federal lease applications equate to a leasing level of 295.5 million tons per year between 1996 and 1999.

In regard to pending Federal coal lease applications in Wyoming, Kennecott Energy's Antelope Lease by Application (LBA) is scheduled for a sale in September of 1996. This LBA is a 617-acre tract with about 60 million tons of recoverable reserves. The BLM is preparing an Environmental Impact Statement on Triton Coal Co.'s North Roundup LBA, which is adjacent to Triton's North Rochelle mine. This LBA is a 1,439-acre tract with an estimated 150 million tons of recoverable reserves. The RCT also recommended the BLM process Powder River Coal Company's North Antelope and Rochelle LBA, which is a 4,020-acre tract with 550 million tons of reserves, and Kerr-McGee's Thundercloud LBA, which is a 3,354-acre tract with about 432 million tons of reserves. BLM still has to decide if these LBAs will require an environmental assessment or an environmental impact statement, and if they will be done separately or together. The companies support separate evaluations. At the very earliest, these LBAs could be ready for a sale next year.

In addition, a New Keeline LBA has been submitted by Evergreen Enterprises, a company headquartered in Casper, Wyoming. This application is for a 7,841-acre tract with an estimated 675 million tons of coal. The tract is north of the Jacobs Ranch mine and overlaps a portion of the old Keeline tract, a leasehold that reverted back to the BLM in 1992. Evergreen hopes to begin production in ten years at 12-15 million tons per year. Evergreen's application must be reviewed by the RCT, which will not meet again until next April or May. In the meantime, the BLM will review the application for completeness.

The Oklahoma legislature has extended its \$2.00/ton tax credits for burning Oklahoma coal. A \$1.00 credit was enacted in 1993, and another \$1.00 credit in 1995. Both credits will remain in effect until at least 1999. Another \$3.00/ton credit is available to any facility burning at least 750,000 tons of Oklahoma coal a year. Despite these tax breaks, the sales of Wyoming coal to Oklahoma increased by 1.5 million tons in 1995. Ohio passed a similar bill in 1991 in which any plant burning 90% or more Ohio coal could qualify for a \$1.00/ton tax credit.

The Alliance for Clean Coal, a group of western railroads and coal companies, has challenged the Ohio law that includes the tax credit and is reviewing the Oklahoma law as well.

In regard to coal beneficiation plants in Wyoming, Southern Company apparently decided against investing in Carbontec Energy's proposed plant, which is slated for construction at Drummond Coal Company's Caballo Rojo railroad loadout facility. But Southern's subsidiary, Georgia Power, has agreed to buy at least one million tons of the plant's high-energy, low-sulfur briquetted fuel. Carbontec, which is building a smaller plant in North or South Dakota, has to have the plants operational by the end of this year to qualify for tax credits.

KFx Inc. and Kennecott Energy have reportedly formed a joint venture in which Kennecott will provide \$1 million in cash and \$4 million in research and development. The venture is called K-Fuel LLC. A K-Fuel plant is under construction at Drummond Coal Co.'s Fort Union mine in the Powder River Basin. Ohio Valley Electric Company has signed up for 0.5 million tons of the plant's upgraded product. KFx Inc. reportedly also has ongoing projects in Turkey, the Czech Republic, and Indonesia.

DEVELOPMENTS IN THE POWDER RIVER BASIN

In June, Peabody Holding Co. began posting information on Internet, advising prospective customers of the availability of short-term subbituminous coal from its North Antelope, Rochelle, Caballo, and Rawhide mines. The information includes the number of tons, period of availability, price, quality, terms, and conditions. Only customers provided with ID numbers and passwords can see the data. Persons interested in this innovative approach to the marketing of excess tonnages of immediately available coal, may call Peabody Holding Co. at (314) 342-7632 to request access. Peabody's home page address is <<http://www.PeabodyGroup.com>>.

Kennecott Energy has announced an expansion of its mining capacity over the next several years through improvements in productivity to include upgraded coal-handling facilities and new mining equipment. For example, they plan to increase the Cordero mine's capacity from its current 14.6 million tons, to 30 million tons. As a part of this effort, they will have a new dragline on line at Cordero in 1998.

Triton Coal Co., a wholly-owned subsidiary of Zeigler Coal Holding Co., has applied to the Wyoming Industrial Siting Division for a revision of its permit for the North Rochelle mine in southern Campbell County. Triton is seeking a revised permit because construction of this mine as originally permitted by Shell Mining Co. is not following the original construction schedule or plan. Triton's mine will cost an estimated \$83.6 million and have a peak work force of 256 employees during the second quarter of 1997. Triton hoped to begin construction on this 18-month project in July. When completed, this 15-million-ton-per-year mine will employ 139 people. The mine currently has a 14-year life although Triton expects to add additional reserves in the future.

Wygen, an independent power producing subsidiary of Black Hills Corp., and Calpine Corp., a Swiss-owned company headquartered in San Jose, CA, are seeking customers for a possible new power plant at the Wyodak mine. If customers are found, the two companies hope to begin construction on a new, air-cooled, 80-megawatt plant in 1997, and have it in production by 1999. This plant would be similar and located adjacent to the 80-megawatt unit of the Simpson plant, which was built in 1995. The capacity of the older unit of the Simpson plant is 22-megawatts. This latter unit was built in the 1970s.

Texaco has relinquished 10,000-acres and some coal reserves in the Lake DeSmet area of Johnson County. The lands and reserves, which reverted back to Northern Wyoming Land Co. and Reynolds Aluminum, were acquired in 1974. Texaco still has other coal holdings in Johnson and Sheridan Counties. According to a Texaco spokesman, the reverted lands and those Texaco still holds collectively contained about 670 million tons of reserves.

DEVELOPMENTS IN WESTERN AND SOUTHWESTERN WYOMING

In June, Arch Minerals Corp. announced the purchase of an 80,000-acre coal property from Edison Development, an affiliate of Commonwealth Edison. The property is in the Carbon Basin, a small subsidiary basin just southeast of the larger Hanna Basin and north of Interstate 80 in the vicinity of Elk Mountain. There is an estimated 100 million tons of reserves in the tract, a large percentage of which is too deep for surface mining. Arch is reportedly negotiating with Union Pacific Resources for an additional six sections of adjacent lands. Arch hopes to begin its environmental assessment this summer and have a surface mine on line in five years. An Arch press release noted that this mining area will come on line about the same time that Arch's Medicine Bow and Seminoe II mines will run out of reserves. Although Arch may seek some Federal leases that Edison Development let lapse, they would move forward with the mine while they sought the leases.

Union Pacific Resources Co. (UPRC) is trying to sell its Corral Canyon property, located in the western part of the Hanna Basin. This 10,000-acre tract is no longer checkerboarded fee and Federal lands as UPRC completed a land swap with the U.S. Bureau of Land Management back in the mid-1980s. The tract has both surface and underground coal reserves.

POWER PLANTS

In May, the Texas Municipal Power Agency (TMPA) tested coal from Kennecott Energy's Cordero mine in their Gibbons Creek plant at Carlos, TX. They will also test coals from Thunder Basin Coal Co.'s Black Thunder and Coal Creek mines. As reported last year, TMPA is switching from Texas lignite to subbituminous coals.

In June, Ohio Edison Co. (OEC) postponed its plans to test Powder River Basin (PRB) coals at its Mansfield plant in PA. They were looking at testing a blend of 30% PRB coal with 70% eastern coal. That was to be followed with a

50% blend. Their existing coal contracts end on December 31, 1999, the day before Phase II compliance with the Clean Air Act Amendments take effect. While the plant has scrubbers, they are old and require large quantities of limestone, creating a major disposal problem. OEC is also considering the testing of PRB coal in the Burger and Sammis plants. However, it now looks like testing is at least on hold until next year.

In June, Centerior Energy arranged for Cleveland Electric Illuminating Co.'s (CEIC's) Lakeshore 18 Unit to test coal from one of Kennecott Energy's Wyoming mines. The test was a blend, but it is not clear what they blended. It may have been blended with Ohio and/or Montana coals. PRB coal may also have been tested at CEIC's Eastlake plant and Toledo Edison Co.'s Bay Shore plant. Eastern coal contracts at some or all of these plants reportedly expire in November of 1996.

Commonwealth Edison (Com Ed) is selling its 1,108-megawatt Kincaid plant at Kincaid, IL, to Dominion Energy, an affiliate of Virginia Power. The plant will reportedly switch to PRB coals after it is retrofit to handle the lower-rank coal. Its current contracts for Utah and Colorado coals expire in the first quarter of next year. Com Ed is also selling its 490-megawatt Stateline plant at Hammond, IN, to Southern Electric International, an affiliate of Southern Co. The sale was for \$64.2 million. This 1929-vintage plant is expected to continue burning both Montana and Wyoming coals. Com Ed will continue to purchase the coal for these plants for at least 15 years, with an option to extend that arrangement another 10 years. They will also buy all the power generated by the two plants. These sales will probably not receive regulatory approvals before early 1997.

Wisconsin Public Service's Power Development Inc. (PDI) has purchased Dairyland Power Cooperative's Stoneman plant at Cassville, WI. This 53-megawatt plant was closed in 1993 because of age and operating costs. Until PDI converts it to a 300-megawatt gas-fired plant, they intend to fire it with PRB coal. The plant is scheduled to come back on line in August, with conversion to gas taking an estimated three years.

In the third quarter of 1996, the Tennessee Valley Authority (TVA) is expected to solicit PRB coal for a test burn in its Gallatin plant at Gallatin, TN. The coal will be blended with Illinois coal. In 1992, Wyoming coal from Thunder Basin Coal Co.'s Black Thunder mine was tested in the Gallatin plant.

Iatan Power Partner's L.P. announced that the construction of their planned 705-megawatt Iatan Unit 2 in Weston, MO, had been postponed until 1998. Because the Iatan Unit 1 burns PRB coal, there is a good chance the new unit will also burn PRB coal.

Central Illinois Public Service (CIPS) spent \$70 million to buy out the remainder of its Cyprus-Amax contract to supply Illinois coal to its Newton No. 1 Unit at Newton, IL. Between August and December, Cyprus-Amax will begin supplying coal from its Shoshone No. 1 mine in the Hanna Basin, instead of the Illinois coal. While coal from the Shoshone No. 1 mine had not previously been

used in Unit 1, 200,000 tons of it were recently burned in Unit 2. Although Cyprus-Amax's original contract went through 2002, there were options for CIPS to buy Colorado coal from Cyprus-Amax or from other suppliers after 1996.

Texas Utilities Electric (TUE) is expected to solicit up to 1.5 million tons of PRB coal for 1997, and perhaps 1998, for its Monticello plant at Mt. Pleasant, TX. For 1996, TUE has already purchased a total of 420,000 tons of coal from the Black Thunder, Belle Ayr, and Cordero mines in the Powder River Basin. This PRB coal is replacing lignite. TUE's purchases are presently limited by the capacity of their train sets. PRB coal has also been successfully tested at the Big Brown and Martin Lake plants, but there is presently not an adequate rail line into either of these plants. TUE expects to have a rail line into the Big Brown plant by 1998. They began working on the line in April.

There are indications that the Kansas City Board of Public Utilities may switch some or all of their coal contracts from Illinois coal to coal from the Hanna Basin. They will probably test some coals from the PRB as well.

Louisville Gas and Electric's (LG&E's) wide ranging March solicitation for 8,000-14,000 Btu/pound coal with up to 4.25 pounds of sulfur/million Btu elicited 40 responses, two of which came from the PRB. Although LG&E did not select a PRB supplier for this solicitation, they are reportedly considering a switch to PRB coal in their Cane Run plant at Louisville.

The Archer Daniels Midland industrial plant at Lincoln, NB, recently reverted back to PRB coal. It has a contract for 100,000 tons a year from an undisclosed PRB supplier. The plant had been using natural gas.

On the other hand, Holnam Cement Co. in Ft. Collins, CO, switched from PRB coal to gas for at least the summer. They may solicit coal again late this year or early next year.

It is looking like Florida Power and Light will not solicit any long-term contracts for PRB coal for use in its Scherer plant at Macon, GA. Southern Co. has been supplying two of Scherer's four, 880-megawatt units with spot coal from the PRB.

Powder River Coal Co.'s North Antelope and Rochelle mines have a 3-million-ton-per year contract with Indiana and Michigan Power Co.'s Rockport plant at Rockport, IN. This contract expires in 2004. Powder River also has another 4.75-million-ton-per-year contract with this plant that comes from their Caballo and Rawhide mines. This latter contract runs through 2014, assuming price negotiations are successful every five years.

Table 13 and Figure 17 depict coal marketing activity in Wyoming for the second quarter of 1996. Prices for Wyoming coals have remained low for the first two quarters of 1996.

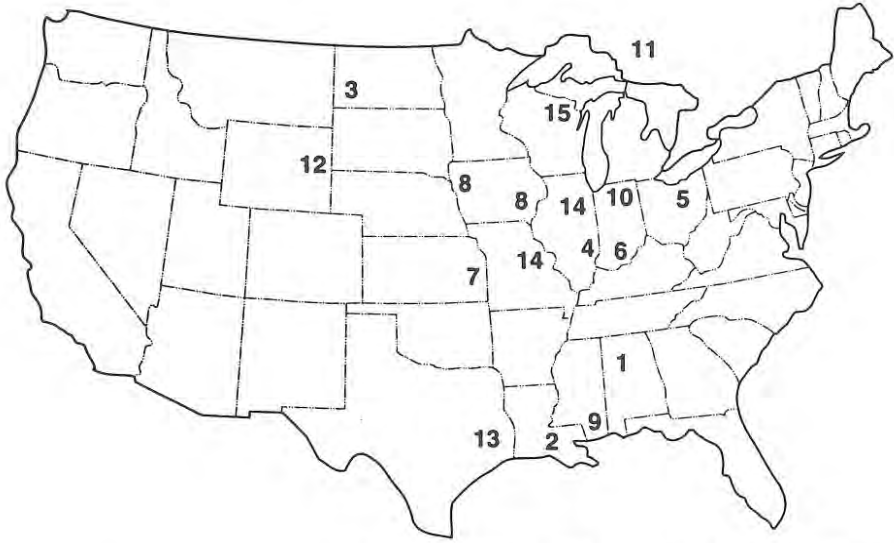
Table 13. Activities involving coal producers in Wyoming, second quarter of 1996¹.

Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
1. Alabama Power Co.	Miller	BelleAyr	C	unknown	Three-year contract began in December 1995; 0,224 million t of 8,525 Btu/lb coal delivered in January 1996 @ \$18.87/t delivered. 8,753 Btu/lb coal delivered at \$19.87/t.
2. Cajun Electric Power Coop.	Big Cajun 2	North Rochelle	T	50,000-100,000 t	Coals trucked to the loadout at the Buckskin mine; 8,800 Btu/lb and 0.2% sulfur.
3. Carbontec beneficiation plant	Feedstock for	Powder River Basin	So	0.675-0.750 million t/yr	For 2-3 years: plant is under construction.
4. Central Illinois Public Service	Newton No. 1	Shoshone No. 1	C	unknown	Between August and December 1996; replacing a contract for Illinois coal.
5. Cleveland Electric Illuminating Co.	Lakeshore 18 Unit	A Kennebec Energy mine in WY	T	unknown	Apparently, testing a blend of different coals; might also have been tested at Cleveland Electric's Eastlake plant and Toledo Edison Co.'s Bay Shore plant.
6. Indiana and Michigan Power Co.	Rockport	Belle Ayr and/or Eagle Butte North Antelope	C	0.51 million t	For last half of 1996.
7. Kansas City Power and Light Co.	LaCygne	Powder River Basin	So	0.335 million t	For second half of 1996.
8. MidAmerican Resources	Probably the George Neal and Louisa plants	Powder River Basin	So	up to 1.0 million t	For delivery in 1997; 8,200 Btu/lb or greater.
			So	Up to 1.0 million t	Over 16 months beginning in July or August.
			So	0.5 million t	For 1996.
			So	4.0 million t	Spot coal in 1997.
			So	4.0-8.0 million t/yr	For an open term.

Table 13. Activities involving coal producers in Wyoming, second quarter of 1996¹ (continued).

Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
9. Mississippi Power Co.	Daniel	Subbituminous and bituminous coal	So	3.3 million t of subbituminous and 2.5 million t of bituminous coal	Decker Coal Co. has been providing coal in all but the summer, using Colorado coal in the summer, with deliveries between 1997-1999. For second half of 1996.
10. Northern Indiana Public Service Co.	Unspecified plants	Powder River Basin as well as IL, OH, and WV coals	So	As needed, low-sulfur coal	
11. Ontario Hydro	Three of its eastern plants	Antelope Rochelle or North Antelope	T T	65,000 t 60,000 t	
12. PacifiCorp Electrical Generation	Dave Johnston	Powder River Basin	So	1.0 million t	For delivery over fifteen months, starting in October, 1996.
13. Texas Municipal Power Agency	Gibbons Creek	Cordero Black Thunder Coal Creek	T T T	Unknown Unknown Unknown	No other details on these tests.
14. Union Electric Co.	Labadie, Sioux, Rush Island, and Joppa	Southern Powder River Basin	Sp	1.0-3.0 million t	Reportedly went to one of Powder River Coal Co.'s mines, for 1997 delivery.
	Labadie, Sioux, Rush Island, and Joppa	Southern Powder River Basin	C	1.0-4.0 million t	Reportedly went to Cordero and one of Powder River Coal Co.'s mines, for delivery 1998-2000.
	Labadie, Sioux, Rush Island, and Joppa	Southern Powder River Basin	So	Several million t	Looking for 8- to 12-year terms, with deliveries starting in 1998. Existing contracts with Belle Air, North Antelope, and Caballo Riojo expire at the end of 1997.
15. Wisconsin Electric Power Co.	Presque Isle	Powder River Basin	So	0.30-0.45 million t	For delivery in 1997.

¹Data obtained from: Coal Week[®], Coal Outlook[®], trade journals, periodicals, FERC database, and personal contacts. C=Contract coal; Sp=Spot coal; So=Solicitation; T=Test burn; t=short ton; ly=tons per year. Wyoming State Geological Survey, Coal Section, April, 1996.



Wyoming State Geological Survey, Coal Section, July, 1996

Figure 17. Coal marketing activities related to Wyoming in the second quarter of 1996 [numbers correspond to those in Table 13].

Coalbed Methane

The U.S. Bureau of Land Management (BLM) has decided to do an Environmental Impact Statement (EIS) for the coalbed methane projects south of Gillette (Figure 18). Although EAs for the Marquiss and Lighthouse projects in this area were already completed, there have been more holes drilled than were anticipated in those EAs. The original EAs considered the drilling of only 245 wells. Now, 150-200 more wells have been proposed. A draft of the EIS is slated for completion in September.

The BLM is also at least going to do an Environmental Assessment (EA) for the coalbed methane area north of Gillette (Figure 18). In that area, there are proposals to drill 130-230 wells.

In July, the Wyoming Oil and Gas Conservation Commission held a special hearing on coalbed methane operations. The Commission is concerned about the protection of shallow aquifers used domestically and for stock. While the Commission did not adopt any permanent new policies for coalbed methane drilling in these areas, they are at least temporarily requiring operators to permit all their wells as gas tests, rather than stratigraphic tests. Gas tests require a surface casing, while stratigraphic tests do not. The Commission will hear additional testimony in August before they decide if this interim policy should be a permanent requirement when drilling wells for coalbed methane. Operators

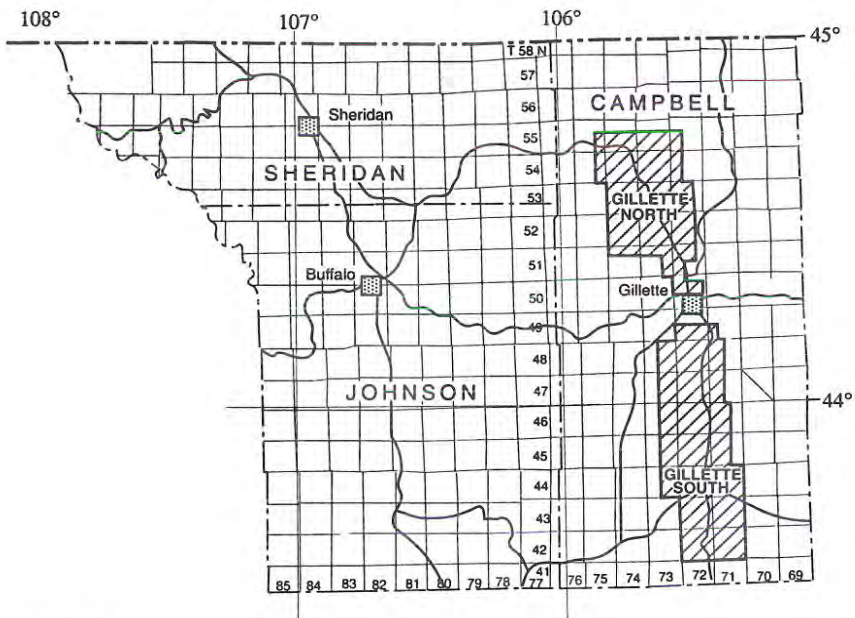


Figure 18. Development areas for coalbed methane in the Powder River Basin, Wyoming.

were invited to provide the Commission with any suggestions that might help assure the protection of shallow aquifers in coalbed methane fields. In addition to requiring surface casing, the Commission is reviewing plugging techniques as well.

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INDUSTRIAL MINERALS AND URANIUM UPDATE

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The Wyoming State Inspector of Mines (1996) has published the State's 1995 production figures. His report shows increases in production for nearly every industrial mineral or construction material produced in the State, as well as an increase in uranium production.

See Figure 19 for the location of the mines, quarries, and plants discussed below.

Bentonite

Wyoming's bentonite industry has recovered from its slump in the 1980s. Bentonite production increased to 4,227,040 tons, which is almost 30% more than in 1994. This makes 1995 the third highest production year, behind only 1981 and 1979, respectively. Most of the increased production is due to non-traditional and innovative uses for bentonite, such as molding clay for foundry

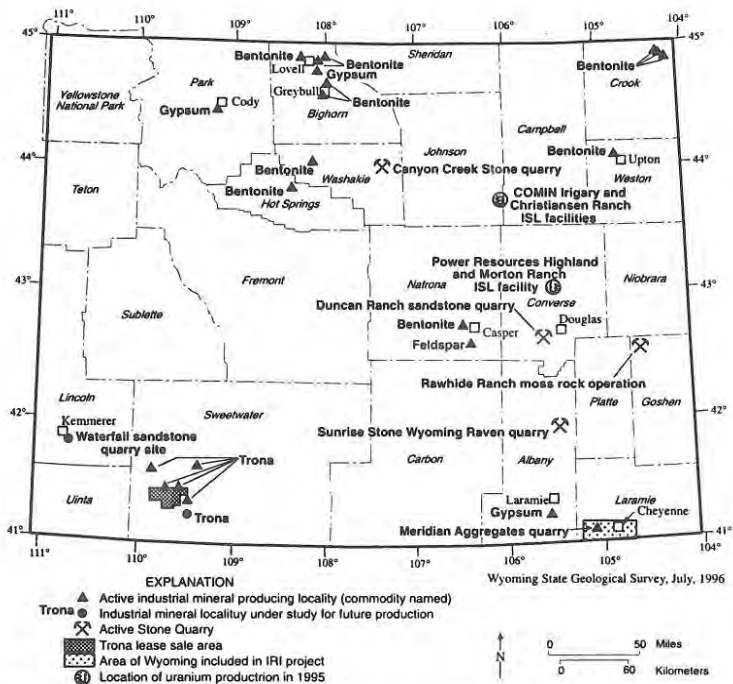


Figure 19. Industrial minerals and uranium activities in Wyoming the second quarter of 1996.

casts, as a binder in taconite pellets, as a material for containing or absorbing environmentally sensitive wastes, and in the control of animal waste. Entire plants in Wyoming are devoted to the latter, most of which is made into kitty litter. Before the mid-1980s, most bentonite was used in drilling muds used by the oil and gas industry. Currently, there are ten active bentonite processing plants in Wyoming.

Construction aggregate

The Wyoming State Geological Survey (WSGS) is participating in a regional study organized by the U.S. Geological Survey. The study is looking at both the geology and mineral resources impacted by the urbanization of the Colorado Front Range. This study, called the Infrastructure Resources Initiative (IRI), includes an area from south of Pueblo, Colorado, north to Cheyenne, Wyoming. In Wyoming, the area may go as far west as the Laramie Basin. A major emphasis of the study is the availability of construction aggregate. There are indications that Wyoming may well become a major supplier of construction aggregate to the Colorado Front Range. For example, Meridian Aggregates' quarry west of Cheyenne supplied one-tenth of the material used in runway construction at the Denver International Airport, or one million tons of construction aggregate. The WSGS will provide information regarding construction aggregates as well as other pertinent mineral and energy resources in the Wyoming portion of the study area.

Decorative and dimensional stone

Apparently, the WSGS' decorative stone initiative, which was started in 1989, continues to have some success in revitalizing this old industry in Wyoming. In July, Sunrise Stone, Soderburg Brothers, Canyon Creek Stone, and Front Range Stone all had stone quarries operational in Wyoming. Prior to the first of these operations starting up in 1991, stone had not been quarried in the State since 1965 when the University of Wyoming closed its stone quarry near Laramie.

Sunrise Stone has continued to increase production from its Wyoming Raven quarry on the Kennedy Ranch in Albany County. This quarry opened with limited production in 1991. Sunrise not only processes stone at their plant southwest of Wheatland in Platte County, but they also ship some stone to Dakota Granite in Milbank, South Dakota, where it undergoes additional processing. Soderburg Brothers recover moss rock from the Rawhide Ranch in Goshen County for sale to dealers along the Colorado Front Range. Canyon Creek Stone quarries decorative stone near Tensleep in Washakie County. In Converse County, Front Range Stone quarries sandstone, which it processes and sells from its finishing plant at Mead, Colorado.

The City of Portland in Oregon has contracted for the renovation of its City Hall. The stone for this building came from a quarry at Waterfall, Wyoming, just southeast of Kemmerer in Lincoln County. The contractor considered reopening this location to match the original stone used on the building. However, the

original quarry site has been subdivided, and houses and small industries have been developed on that site. Although the same sandstone is available northeast of the original site, there are additional expenses needed to open a new quarry. The WSGS is assisting the contractor and mineral owners in the area in evaluating the feasibility of developing a new quarry for this purpose.

Feldspar

During summer months, Pacer Corporation of Custer, South Dakota, mines small quantities of potassium feldspar on Casper Mountain. Although feldspar is a very common mineral, the Casper Mountain deposit is of exceptional quality (very low in iron and other metallic impurities). High quality feldspar is a fairly high-cost industrial mineral with specialized uses: Pacer ships Wyoming feldspar to their plant on the southern edge of Custer, where it is hand-sorted, crushed, pulverized, and bagged for shipment to manufacturers of porcelain glazes, such as used on bathtubs, sinks, and other appliances. The feldspar from Casper Mountain is of such high quality that it is often mixed with lower quality feldspar to meet the specifications required by various manufacturers of ceramic glazes. Pacer gets its lower quality feldspar from the Custer area.

In Wyoming, feldspar has also been produced in past years from the Laramie Mountains both southwest of Cheyenne and south and southeast of Laramie, and from Copper Mountain north of Bonneville in Fremont County. Pacer's quarry is currently the only active site.

Gypsum

Gypsum production in Wyoming set a new record at nearly 470,000 short tons in 1995. This is slightly more than the previous high set in 1990. Gypsum is mined and processed into wallboard (sheet rock) at two locations in the Bighorn Basin. It is also mined south of Laramie for use as a retardant in the manufacture of cement in Mountain Cement's plant at Laramie. Gypsum production for wallboard has been running at or near plant capacity since 1985. Ninety-two percent or 433,000 tons of the gypsum mined last year was used for this purpose. While the amount of gypsum mined for wallrock only varies slightly from year to year, Mountain Cement's usage varies more significantly because they generally only mine gypsum every other year. In between, the plant works from stockpiled gypsum.

Trona

Trona is mined by underground methods in Wyoming at five locations. It is refined into sodium products at plants near the mines. Trona production also set a record in 1995. The five operators mined a total of 18,171,257 tons of trona, up two million short tons from 1994.

Anticipating continued increases in sales, three of the five producers have completed or announced plant construction that will increase their capacity. FMC just completed their construction, increasing their plant capacity to 3.5

million tons of soda ash per year. Their plant capacity had been 2.8 million tons. In the second quarter of this year, OCI announced that it plans to increase its current capacity of 2.3 million tons to "between 2.9 and 3.3 million tons of soda ash per year". Solvay Minerals also announced plans to increase their plant capacity from its current 2.3 million tons of soda ash per year to 3.5 million tons. Solvay's capacity would then equal that of FMC, historically the largest producer.

The U.S. Bureau of Land Management has scheduled a second trona lease sale for September of this year (see **Minerals Overview** in this issue, p. 11).

Uranium

The amount of yellowcake produced in Wyoming in 1995 was 1,301,800 pounds, a record year for the in-situ production (solution mining) of uranium in Wyoming. And in-situ uranium production is expected to increase again in 1996. While this in-situ production is still far short of historical yellowcake production from Wyoming in the 1980s, it does represent something of a recovery for the uranium industry. In the 1970s and 1980s, Wyoming's mills were producing yellowcake from conventionally mined ore, rather than by in-situ methods. Production at that time was reported in millions of tons of uranium ore, not yellowcake, making it difficult to compare the record 7.5 million tons of ore mined in 1980 with the 1.3 million pounds of yellowcake produced in 1995. Suffice to say that 7.5 million tons of uranium ore produced substantially greater yellowcake than today's in-situ production.

According to figures released by the Uranium Exchange and reported by Bob Odell in the *Rocky Mountain Scout*, the unrestricted spot market price of yellowcake (the mill product of uranium) had risen from \$14.00 per pound on April 2, 1996, to \$14.50 per pound on June 4, 1996. The continued increase in price is a result of greater-than-expected consumption of uranium by North American and Pacific Rim nuclear power plants and less-than-expected sales of uranium from the former Soviet bloc nations.

On a worldwide basis, the amount of electricity produced by nuclear power plants continues to increase. According to figures released by the Organization for Economic Cooperation and Development (OECD), nuclear power plants produced 24.0% of all of the electricity generated in the world in 1994, and this percentage increased to 24.4% in 1995. OECD also reported that the percentage of electricity produced by nuclear power plants in the U.S. increased slightly, from 19.6% in 1994, to 19.9% in 1995. France continued to lead the world in nuclear power generation, with 76% of its electricity generated by nuclear fuel.

Forum on the Geology of Industrial Minerals

The Wyoming State Geological Survey hosted the 32nd Annual Forum on the Geology of Industrial Minerals, May 19-22, 1996. The technical sessions were held on the University of Wyoming campus in Laramie. There were 161

registered attenders, and about 40 additional participants, who attended as guest speakers, exhibitors, and others. Pre- and post-meeting field trips visited the following industrial mineral and other producing sites throughout Wyoming and adjacent states:

American Colloid's Colony East bentonite plant and mine, Black Hills (WY)
Cominco's Sloan diamond property, State Line district (CO)
Cyprus-Amox's Eagle Butte coal mine and clinker pit, Powder River Basin (WY)
FMC's Westvaco trona mine and processing plant, Green River Basin (WY)
General Chemical's trona mine and plant, Green River Basin (WY)
Georgia Marble's white marble aggregate quarry and plant, Wheatland (WY)
Georgia-Pacific Gypsum Co.'s mine and wallboard plant, Lovell (WY)
Guernsey Stone's aggregate quarry, Guernsey (WY)
Meridian Aggregates' Granite Cañon aggregate quarry, Laramie
Mountains (WY)
Mountain Cement's gypsum quarry and cement plant, Laramie (WY)
OCI's Big Island trona mine and processing plant, Green River Basin (WY)
Pacer Corporation's feldspar processing plant, Custer (SD)
Sunrise Stone's dimensional stone plant, Laramie Mountains (WY)

Next year's Forum will be held in Québec, P.Q., Canada. Persons interested in attending the 1997 Forum, may contact:

A. James McCann
33rd Annual Forum on the Geology of Industrial Minerals
SOQUEM 2600, Boul. Laurier
Tour Belle Cour
Bureau 2500, 5^e étage
Sainte-Foy (Quebec)
G1V 4M6 CANADA

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Wyoming State Inspector of Mines, [1996], Annual report of the State Inspector of Mines of Wyoming for the year ending December 31, 1995: Rock Springs, Wyoming, 73 p.

METALS AND PRECIOUS STONES UPDATE

W. Dan Hausel

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Exploration for diamonds in the State Line district and Green River Basin is on the increase. Following the opening of Redaurum's Kelsey Lake diamond mine, which is located immediately south of the Colorado-Wyoming border in the Colorado-Wyoming State Line district, several companies began contacting the Wyoming State Geological Survey for information and assistance in identifying additional targets.

Ringold's (2/14/96) reported that Redaurum Ltd. plans to market the Kelsey Lake diamonds in late December as "home-grown" American stones. The mine is expected to produce 25,000 carats of diamonds this year and increase to 150,000 carats per year in the future. According to this article, the mine is expected to have a life of about 12 years, and reach a maximum depth of 575 feet. The Northern Miner (6/24/96) reported that the Kelsey Lake mine has diamond reserves totalling more than \$150 million.

The U.S. Diamond Corporation recently acquired several diamond properties in the State Line district. According to a release from the Hemisphere Group out of Vancouver, B.C., U.S. Diamond recently acquired the George Creek, Pearl Creek, and Sand Creek properties within the district.

In the Green River Basin of southwestern Wyoming, the Wyoming State Geological Survey (WSGS) conducted reconnaissance geophysical surveys over two subtle circular geomorphic anomalies at the request of Primus Minerals. These features are located west of Guardian's diamond-bearing breccia pipes in the vicinity of Cedar Mountain. Although the geophysical surveys were inconclusive, both targets yielded unexplained EM and magnetic anomalies [see Hausel and Roberts (1996) in the following list of reports]. At least four companies were reportedly conducting field investigations in this region in the second quarter of 1996.

Guardian's July announcement that they had recovered additional diamonds in the Green River Basin will likely cause additional exploration in this area of Wyoming. The new diamonds reportedly were not from the same locality as the 1995 discoveries.

The WSGS stepped up its exploration for other gemstone deposits in Wyoming, following the identification of a significant ruby and sapphire deposit in the Granite Mountains of central Wyoming. A second ruby and sapphire deposit was identified in the Laramie Mountains. This deposit contains abundant ruby, some white sapphire, and other potential gemstones.

According to the Northern Miner (6/24/96), Mountain Lake Resources signed a letter of intent to form a joint venture with Compass Minerals on the Copper King gold-copper property, which is located 18 miles west of Cheyenne.

Compass Minerals reportedly identified proven and probable reserves of 25.7 million tons of 0.024 ounce/ton (opt) Au and 0.19% Cu within a larger resource. Three other prospective anomalies were identified within a two-mile radius of the property.

Some 1996 WSGS reports on precious metals or gemstones are:

Hausel, W.D., 1996, Mineral reports available from the Wyoming State Geological Survey: Wyoming State Geological Survey Mineral Report MR96-1, 8 p.

Hausel, W.D., 1996, Jade, jasper, and rubies in the Tin Cup district, western Granite Mountains, central Wyoming: Wyoming State Geological Survey Mineral Report MR96-2, 5 p.

Hausel, W.D., 1996, Geology and gold mineralization of the Rattlesnake Hills, Granite Mountains, Wyoming: Wyoming State Geological Survey Mineral Report MR96-3, 34 p. (1 plate).

Hausel, W.D., 1996, Overview of the Sloan 1 and 2 diamondiferous kimberlites, Colorado-Wyoming State Line district: 1996 Industrial Minerals Forum Field Trip: Wyoming State Geological Survey Mineral Report MR96-4, 16 p.

Hausel, W.D., and Gregory, R.W., 1996, Geophysical reconnaissance of the Lonetree circular topographic anomalies in the southern Green River Basin, Uinta County, Wyoming: Wyoming State Geological Survey Mineral Report MR96-5, 11 p.

Hausel, W.D., 1996, Diamond exploration potential of the Wyoming craton, western U.S.: Society of Mining Engineers Preprint 96-27, 10 p.

Hausel, W.D., Vogler, P.D., and Harris, R.E., 1996, Wyoming exploration summary [1995]: Mining Engineering, v. 48, no. 5, p. 83-85.

Hausel, W.D., 1996, The Tin Cup district, central Wyoming- a rock hound's paradise: International California Mining Journal, v. 65, no. 8, p. 65-68.

Hausel, W.D., 1996, Ruby and sapphire: International California Mining Journal, v. 65, no. 11, p. 25-26.

Hausel, W.D., 1996, Exploration and prospecting interest on the increase in Wyoming: International California Mining Journal, v. 65, no. 11, p. 5-8.

Hausel, W.D., Kucera, R.E., McCandless, T.E., and Gregory, R.W., 1996, Diamondiferous breccia pipes in the southern Green River Basin, Wyoming [abs.]: 32nd Annual Forum on the Geology of Industrial Minerals Abstracts with Programs, p. 23-25.

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Technically Recoverable Resources (January 1, 1996)	
Discovered (Includes oil, gas liquids, and condensate)	3.62 billion barrels ¹
Undiscovered	6.18 billion barrels ¹
Total	9.78 billion barrels

Remaining Reserve Base (January 1, 1996)	
Measured reserves (Proved reserves) (Includes oil, gas liquids, and condensate)	0.98 billion barrels ²
Indicated and inferred reserves (Reserve growth in conventional fields)	2.64 billion barrels ¹
Total	3.62 billion barrels

NATURAL GAS

Remaining Technically Recoverable Resources (January 1, 1996)	
Discovered (Includes 36.2 trillion cubic feet (TCF) of methane ¹ and 121.8 TCF of CO ₂ ³)	157.0 trillion cubic feet
Undiscovered (Includes 15.72 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)	171.6 trillion cubic feet
Total	328.6 trillion cubic feet

Remaining Reserve Base (January 1, 1996)	
Measured reserves (Proved reserves) (Includes 9.2 TCF of methane ² and 60.1 TCF of CO ₂ ³)	69.3 trillion cubic feet
Indicated and inferred reserves (Reserve growth in conventional fields)	26.0 trillion cubic feet
Total	95.3 trillion cubic feet

COAL

Remaining Resources (January 1, 1996)	
Identified and Hypothetical (Discovered)	1,427.2 billion tons ⁴
Speculative (Undiscovered)	31.5 billion tons ⁴
Total	1,458.7 billion tons

Remaining Reserve Base (January 1, 1995)	
Demonstrated strippable (Measured and indicated reserve base)	25.6 billion tons ⁵
Demonstrated underground-minable (Measured and indicated reserve base)	42.5 billion tons ⁵
Total	68.1 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 ₃ O ₈ ⁷
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, 1995, U.S. crude oil, natural gas, and natural gas liquids reserves: 1994 Annual Report, 153 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, STRATIGRAPHY, AND PALEONTOLOGY UPDATE

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GEOLOGIC MAP OF THE HOWELL QUADRANGLE COMPLETED

As part of an ongoing State and Federal mapping initiative (STATEMAP) administered by the U.S. Geological Survey, the Wyoming State Geological Survey completed a geologic map of the Howell Quadrangle. This quadrangle, which is located north of Laramie, includes several new housing subdivisions. A black and white version of this map was released late in July as Preliminary Geologic Map PGM-96-1. This is the third, 1:24,000-scale map of the Laramie area completed as part of STATEMAP (Figure 20). The Laramie and Red Buttes Quadrangles were completed in 1995.

While this mapping effort is geared toward aiding land-use planners and land developers in more populated areas of the State, the maps are also helpful in locating construction materials, in siting water wells, in protecting aquifers,

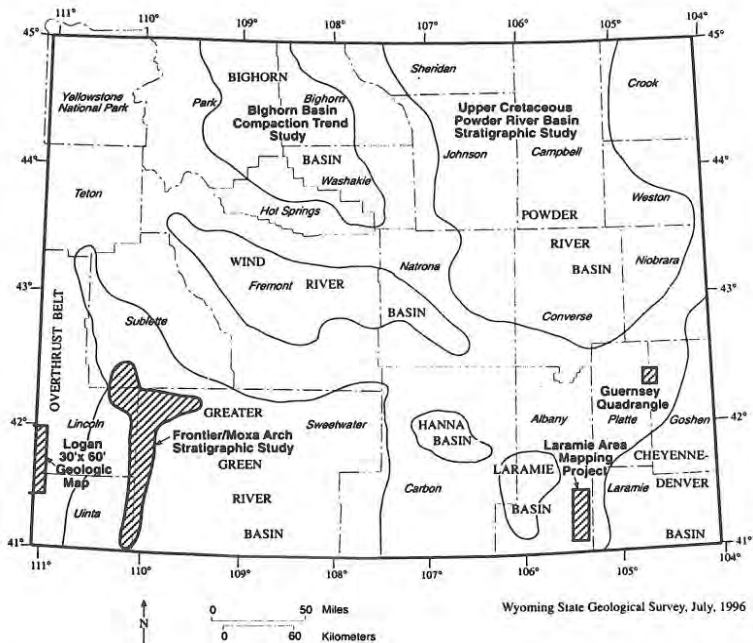


Figure 20. Index to selected reports, maps, or activities related to Wyoming geology.

and in mineral exploration. The maps, which show bedrock and surficial geology, also include an explanatory pamphlet outlining the basic information on the maps and explaining how the maps might be used.

Work on the Guernsey 7.5-minute Quadrangle (**Figure 20**) was initiated this summer as a continuation of this program. This map will be completed in the summer of 1997. Other planned STATEMAP projects are the Casper, Gillette, Thermopolis, Worland, Cody, Sheridan, and Buffalo Quadrangles. Volunteers are helping with some of these compilations.

LISTING OF GEOLOGIC FIELD TRIP GUIDEBOOKS PUBLISHED

The American Geological Institute (AGI) recently published the sixth edition of the *Union list of geologic field trip guidebooks of North America*. This updated reference source lists 11,312 field trip guidebooks, generally prepared for field conferences, professional meetings, or class trips. The 1,030 different organizations that published these guidebooks, include state geological surveys, scientific societies, educational institutions, Federal agencies, and commercial organizations.

Each reference begins with the name of an organization, followed by a chronological list of guidebooks used at its conferences. A list of libraries holding the guidebooks appears at the bottom of the entry. The entries are cross-referenced with a geographic index and a stratigraphic index.

The list was compiled and edited by the Guidebook Committee of the Geoscience Information Society. It is available from the AGI Publications Center, P.O. Box 205, Annapolis Junction, MD 20701. Phone:(301) 953-1744. Fax: (301) 953-2838. The price is \$60, plus shipping (\$5 within the U.S.).

PALEONTOLOGICAL ACTIVITIES

A new exhibit featuring the official state dinosaur, *Triceratops*, is now on display at the Geological Museum at the University of Wyoming. *Triceratops* is known for the three prominent horns on its head. The exhibit includes the 7-foot skull of this plant-eating dinosaur which roamed Wyoming during the Upper Cretaceous (65-70 million years ago). Also included in the exhibit is the original artwork for a color poster of the dinosaur produced as a cooperative effort between the Geological Museum and the Wyoming State Geological Survey. Phyllis Ranz of the Wyoming State Geological Survey painted the scene depicting a herd of *Triceratops*.

One of the predators which fed on *Triceratops* was *Tyrannosaurus rex*. A skull of this gigantic meat eater is also on display at the museum.

NEW GEOLOGIC REPORTS PUBLISHED

Four new reports on the geology and stratigraphy of Wyoming have been published. Each is described below and depicted on **Figure 20**.

Hamlin (1996) describes the stratigraphy of the Frontier Formation, an important gas producer in southwestern Wyoming. Well log correlations and core studies were used to develop a stratigraphic framework for the Frontier Formation on and adjacent to the Moxa arch. Variations in depositional thickness and erosional truncation are noted along depositional strike, giving a clue to the tectonic events influencing the depositional history of the Frontier Formation.

Heasler and Kharitonova (1996) developed an improved exponential model of sonic transit time data as a function of depth, which takes into account the physical range of rock sonic velocities. This model provides a geologically realistic way to predict compaction trends used in basin analysis. The model is applied to the Bighorn Basin in the calculation of erosion estimates.

Dover (1995) completed a color geologic map for the 1:100,000-scale Logan Quadrangle. This map includes portions of Cache and Rich Counties in Utah, and Lincoln and Uinta Counties in Wyoming.

Merewether (1996) discusses the stratigraphy and tectonic history of Upper Cretaceous rocks in the Powder River Basin in a new report, which is part of the U.S. Geological Survey's Evolution of Sedimentary Basins Project. The report provides descriptions of the formations between and including the Cody Shale and the Lance Formation.

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- Merewether, E.A., 1996, Stratigraphy and tectonic implications of Upper Cretaceous rocks in the Powder River Basin, northeastern Wyoming and southeastern Montana: *U.S. Geological Survey Bulletin* 1917-T, 92 p.

HISTORICAL SEISMICITY OF NORTHEASTERN AND EAST-CENTRAL WYOMING

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Although most residents of Wyoming are aware of the earthquake potential in western Wyoming, especially in the Jackson Hole and Yellowstone National Park areas, fewer are aware of the earthquake potential in northeastern and east-central Wyoming. While the seismic hazard in these areas of the State does not compare to the hazard in western Wyoming, it is, nonetheless, a very real hazard. Each county in northeastern and east-central Wyoming has had an earthquake occur within its boundaries over the last 120 years.

The historical earthquakes presented below are organized by region. The area encompassed by this discussion includes the Wyoming portion of the Powder River Basin, the Black Hills, and the Bighorn Mountains, and extends as far south as Casper, Douglas, and Lusk. Only those earthquakes that were felt and(or) caused concern or damage are described.

CASPER AREA

Two of the earliest recorded earthquakes in Wyoming occurred near Casper. The first was on June 25, 1894, and it had an estimated intensity of V. In residences on Casper Mountain, dishes rattled to the floor and people were thrown from their beds. Water in the Platte River changed from fairly clear to reddish, and became thick with mud due to the river banks slumping into the river during the earthquake (Mokler, 1923).

On November 14, 1897, an even larger event was felt. An intensity VI-VII earthquake, one of the largest recorded in central and eastern Wyoming, caused considerable damage to a few buildings. As a result of the earthquake, a portion of the Grand Central Hotel was cracked from the first to the third story. The crack was from two to four inches wide. Some of the ceilings in the hotel were also severely cracked. In another part of Casper, a person that was sitting in a chair was thrown to the floor (Mokler, 1923).

On October 25, 1922, an intensity IV earthquake was reported in the Casper area. The event was felt in Casper; at Salt Creek, 50 miles north of Casper; and at Bucknum, 22 miles west of Casper. Dishes were rattled and hanging pictures were tilted near Salt Creek. No significant damage was reported at Casper (Casper Daily Tribune, October 26, 1922). On December 11, 1942, an intensity IV earthquake was recorded north of Casper. Although no damage was reported, the event was felt in Casper, Salt Creek, and Glenrock (Casper Tribune-Herald, December 12, 1941). On August 27, 1948, another intensity IV earthquake was reported in the Casper area. No damage was reported (Casper Tribune-Herald, August 27, 1948).

In the 1950s, two earthquakes caused some concern among Casper residents. On January 24, 1954, the intensity IV earthquake near Alcova did not result in any reported damage. One area resident reported that he thought that an intruder in the attic of his house had fallen down (Casper Tribune-Herald, January 24, 1954). On August 19, 1959, an intensity IV earthquake was felt in Casper (Reagor, Stover, and Algermissen, 1985). It is uncertain if this earthquake actually occurred in the Casper area, as it coincides with the Hebgen Lake, Montana, earthquakes that initiated on August 17, 1959.

Of historical note, the U.S. Geological Survey located an 1873 earthquake approximately 37 miles west-northwest of Casper (Reagor, Stover, and Algermissen, 1985). The December 10, 1873, intensity III earthquake was reported to have been felt at Camp Stambaugh. A recent check with the Wyoming State Archives, however, indicated that Camp Stambaugh was located approximately 3.5 miles southeast of Atlantic City in Fremont County, and not 37 miles west-northwest of Casper in Natrona County. As a result, earthquake epicenter maps, including those prepared by the Wyoming State Geological Survey, will have to be modified to reflect this change in the location of the 1873 earthquake.

DOUGLAS AREA

There have been a series of earthquakes recorded in the Douglas, Esterbrook, and northern Albany County areas. On April 14, 1947, an intensity V event was felt near La Prele Creek southwest of Douglas. The earthquake was felt by everyone in a ranch house, and by a few outdoors. Windows were rattled, chairs were moved, and buildings shook (Murphy, 1950). Many of the earthquakes that have been felt in Douglas originated near Esterbrook. On August 22, 1952, an intensity IV earthquake was reported near Esterbrook. It was felt by several people in the area, and was reportedly felt 40 miles to the southwest (Murphy and others, 1954).

In the 1980s, there were a series of relatively significant earthquakes in northern Albany County which were felt in Douglas. On February 13, 1983, a magnitude 4.0, intensity IV event was located approximately 40 miles southwest of Douglas. That non-damaging earthquake was felt in Laramie, Casper, Wheatland, and Medicine Bow (Laramie Daily Boomerang, February 15, 1983). The most significant earthquake to occur in the area, a magnitude 5.5, intensity VI event, occurred on October 18, 1984. That earthquake, with an epicenter located approximately 21 miles south of Esterbrook, was felt in Wyoming, South Dakota, Nebraska, Colorado, Utah, Montana, and Kansas. Stover (1985) reports that cracks were found in the exterior brick walls of the Douglas City Hall and a public school in Medicine Bow. Chimneys were cracked at Casper, Douglas, Guernsey, Lusk, and Rock River. This earthquake was one of the largest felt in eastern Wyoming.

In 1993, there were a series of earthquakes recorded in the Douglas to Esterbrook areas. On June 30, 1993, a magnitude 3.0 earthquake was located

approximately fifteen miles north of Douglas. No damage was reported. This event was followed by a magnitude 3.7, intensity IV earthquake on July 23, 1993. The second earthquake, located approximately 25 miles southwest of Douglas, was felt as far away as Laramie. On December 13, 1993, another earthquake occurred approximately 33 miles south of Douglas. This non-damaging event had a magnitude of 3.5.

LUSK AREA

Lusk has had an interesting earthquake history, especially when considering that most Wyoming residents consider the area to be seismically inactive. On February 25, 1942, an intensity V earthquake, with an epicenter approximately 18 miles south of Lusk, caused no damage (Casper Tribune-Herald, February 27, 1942). On October 3, 1954, an intensity IV earthquake was reported near Guernsey, approximately 38 miles south-southwest of Lusk. Although the event was felt from Douglas to Wheatland, no damage was reported. Train traffic between Douglas and Wheatland was temporarily halted until it was determined that the tracks had not been damaged (Laramie Republican-Boomerang, October 4, 1954).

In the 1960s, there were two earthquakes in the Lusk area. On March 28, 1964, there was an intensity V earthquake with an epicenter approximately 21 miles southeast of Lusk. No significant damage was reported (Casper Star-Tribune, March 29, 1964). On October 22, 1964, there was a magnitude 4.5, intensity V earthquake recorded with an epicenter approximately 17 miles northwest of Lusk. Much of the town was attending a concert in the town's new high school building. When the attendees felt the tremor, they thought that the furnace had blown up (Wyoming State Tribune, August 23, 1964). Fortunately, no significant damage was reported.

In the 1990s, there were a few earthquakes in the Lusk area. On November 1, 1992, a magnitude 3.0, intensity V earthquake occurred just a few miles southeast of Lusk. Although the earthquake was felt throughout Lusk, little damage was reported (Casper Star-Tribune, November 4, 1992). In 1996, there were two earthquakes in the Lusk area. The first occurred on April 8, 1996. It was a magnitude 3.7, intensity III event, and was located approximately 26 miles northeast of Lusk. Although the earthquake was felt in Lusk, no damage was reported. Another earthquake occurred on May 3, 1996. This earthquake, which was located in the southwestern corner of South Dakota, had a magnitude of 3.1. No damage was reported.

NEWCASTLE AREA

A few earthquakes have occurred in the Newcastle area, although none have caused significant damage. The earliest reported event occurred on May 1, 1926, about 15 miles north-northwest of Newcastle, near Osage. That intensity VI earthquake was felt by several individuals, and there were reports of dishes shifting and objects moving (Neumann, 1928). Most recently, on

February 6, 1996, a magnitude 3.7, intensity V earthquake was recorded near Hill City, South Dakota. Residents living twenty-two miles north of Newcastle reported that dishes were shaken off a shelf.

SUNDANCE AREA

One of the first recorded earthquakes in northeastern Wyoming occurred near Sundance on February 3, 1897. The intensity IV-V earthquake severely shook the Shoher school on Little Houston Creek southwest of Sundance. The residents of Sundance heard three loud reports resembling the explosion of a boiler or a great blast. The noise was heard by many in town. There was no doubt among town residents that an earthquake had occurred (Sundance Gazette, February 5, 1897).

GILLETTE AREA

In the 1980s, the Gillette area was host to some of the largest earthquakes that have occurred in the Powder River Basin. Prior to the 1980s, however, there were only a few recorded earthquakes. On February 18, 1972, a magnitude 4.3 earthquake occurred approximately 18 miles east of Gillette. No damage was reported.

On May 29, 1984, a magnitude 5.0, intensity V earthquake occurred approximately 24 miles west-southwest of Gillette. The earthquake was felt in Gillette, Sheridan, Buffalo, Casper, Douglas, Thermopolis, and Sundance. A rancher, living 35 miles west of Gillette, reported that he could see the ground shaking, and he heard a loud noise similar to a sonic boom. Pictures were shaken from the walls of the ranch house, but no other damage occurred at the ranch (Casper Star-Tribune, May 30, 1984). Surprisingly, all other reports only indicated that dishes rattled.

On September 7, 1984, a magnitude 5.6, intensity V earthquake occurred approximately 27 miles west of Gillette. Although the earthquake was closer to Gillette, it was felt more strongly at Buffalo, Casper, Kaycee, Linch, and Midwest. It was felt throughout northeastern Wyoming and in parts of southeastern Montana. As with the earthquake on May 29th, no significant damage was reported (Laramie Daily Boomerang, September 8, 1984).

KAYCEE AND MIDWEST AREAS

A few earthquakes have occurred in the Kaycee and Midwest areas, although none have caused any significant damage. On June 3, 1965, a magnitude 4.7 earthquake occurred approximately 12 miles south of Kaycee, and on May 11, 1967, a magnitude 4.8 earthquake occurred approximately 25 miles northeast of Midwest. No damage was reported for either event.

On September 2, 1976, a magnitude 4.8, intensity IV-V earthquake was felt in Kaycee. The event was located approximately 33 miles northeast of Kaycee. No damage was reported. No additional earthquake activity was reported in the region until the 1990s. On August 30, 1992, a magnitude 3.6, intensity IV earthquake occurred near Mayoworth, approximately 22 miles northwest of Kaycee. The earthquake was felt in Barnum and Kaycee. No damage was reported. On March 10, 1993, a magnitude 3.2 earthquake was recorded 17 miles west of Midwest. No damage was reported.

SHERIDAN AND BUFFALO AREAS

One of the first earthquakes in the Sheridan and Buffalo areas occurred on October 24, 1922. Reagor, Stover, and Algermissen (1985) located the earthquake near Buffalo, and classified the event as an intensity II earthquake. Based upon a description of the earthquake in the October 27, 1922, edition of the Sheridan Post, however, the location and assigned intensity may be in error. The Sheridan Post reported that at Cat Creek, eight miles east of Sheridan, houses were shaken and dishes were rattled. In addition, the October 26, 1922, edition of the Sheridan Post reports that only a slight earthquake shock was felt in Sheridan. Based upon this information, it seems reasonable to locate the earthquake eight miles east of Sheridan, and to assign an intensity IV-V to the event.

The 1922 earthquake was followed by an intensity III event on January 17, 1923. This event was located approximately eight miles southwest of Sheridan. No damage was reported. On September 6, 1943, an intensity IV earthquake was felt in the Sheridan area, although Reagor, Stover, and Algermissen (1985) located the epicenter near Buffalo. Beds and chairs were reported "to sway" in the Sheridan area (Casper Tribune-Herald, September 7, 1943). On April 26, 1953, an intensity IV earthquake was reported in the Sheridan area. Some beds were rocked, dishes were rattled, and some electric wires swayed (Murphy and Cloud, 1955). On March 24, 1977, a magnitude 3.6, intensity IV earthquake was reported near Big Horn. No damage was reported. Most recently, on February 22, 1992, a magnitude 2.9 earthquake was recorded approximately 18 miles east of Buffalo. As expected with such a small earthquake, no damage was reported.

TEN SLEEP AND HYATTVILLE AREAS

There have been a few earthquakes of note in the Ten Sleep and Hyattville areas. The first reported earthquake occurred on November 17, 1925. The intensity V earthquake was located approximately 11 miles north-northeast of Hyattville. The event was felt from Ten Sleep to Sheridan. A ranch located 10 miles west of Sheridan reported that windows rattled and that pictures on walls moved. Near Dome Lake, approximately 20 miles southwest of Sheridan, there was a report of a cabin shaking "like an aspen leaf in the wind" (Sheridan Post-Enterprise, November 18, 1925). The Sheridan Post-Enterprise also reported that the earthquake rumbled for about two minutes near Dome Lake. In

Sheridan, the shock was reported to have lasted a few seconds, and resulted in pictures being moved. Two separate shocks, several seconds apart, were reported from the Veterans Hospital at Fort Mackenzie (Sheridan Post-Enterprise, November 18, 1925). On November 18, 1925, another earthquake occurred in the same area. It was not felt in Sheridan and caused no damage (Sheridan Post-Enterprise, November 19, 1925).

In the 1970s, two earthquakes were recorded near Ten Sleep. On December 12, 1970, a magnitude 4.9 earthquake occurred approximately 8 miles southwest of Ten Sleep. No damage was reported. On September 19, 1974, a magnitude 4.4, intensity V earthquake occurred approximately six miles north-northwest of Ten Sleep. Residents reported that shock waves were felt in the Ten Sleep Canyon area (Casper Star-Tribune, September 21, 1974). No damage was reported.

Most recently, on November 16, 1993, a magnitude 3.5 earthquake occurred 10 miles south of Ten Sleep. No damage was reported.

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ROCK HOUND'S CORNER

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Wyoming may be an important province for corundum, as large portions of the State have been subjected to intense metamorphism during the geological past. Many gneisses in central Wyoming were subjected to pressures and temperatures high enough to produce corundum, an aluminum oxide. For those of you who are rock hounds, this means there are good possibilities of discovering some significant ruby and sapphire deposits in Wyoming. Prospecting for these gemstones could lead to a profitable weekend hobby. The best places to look for these gemstones are in mica schists, serpentinites, and quartzofeldspathic gneisses.

Ruby and sapphire, which are translucent to transparent forms of corundum, are second only to diamond in hardness. Corundum is 9, whereas diamond is 10 on Moh's hardness scale. Ruby, in particular, has the general appearance of garnet, and many people mistake it for garnet. The next time you examine garnet in your rock samples or gold pans, you might want to take a closer look.

Corundum occurs principally as six-sided (hexagonal) prismatic crystals that are frequently barrel-shaped; whereas garnet typically occurs as equidimensional, isometric grains with dodecahedral habit. The crystal habits of corundum include tabular, prismatic, or pyramidal crystals with tapering hexagonal pyramids. Most crystal faces are smooth with the basal planes containing regular, triangular, striations known as partings (you will never see these partings in garnet).

Because of the weight of corundum (specific gravity=3.94-4.08), detrital corundum may be found in placer deposits trapped with other minerals of relatively high to high specific gravity such as garnet, gold, black sands, etc. In fact, several years ago the Wyoming State Geological Survey discovered several tiny sapphires and rubies in the Laramie Range of southeastern Wyoming, while searching for 'kimberlitic' indicator minerals.

Host rocks for ruby and sapphire include metamorphic rocks such as mica schist, gneiss, and crystalline limestone. It may also be found in some silica-poor igneous rocks such as syenites, nepheline syenites, and in serpentinites and related altered ultramafic rocks. Some of the more famous ruby deposits in the world occur in altered limestone.

Large rubies and sapphires are extremely rare. One extremely large sapphire found in North Carolina weighed 312 pounds and contained several small clear areas of deep blue color. The largest known ruby was found in Tibet and weighed 2,000 carats, but was not perfectly transparent. The author recently found some rubies in Wyoming that measured up to 2 inches across,

making them some of the largest found in the world! However, these large stones were unfortunately of poor quality.

So while you are rock hounding and prospecting, keep an eye out for rubies and sapphires.

NEW EMPLOYEES JOIN THE PUBLICATIONS SECTION

The publications section of the Wyoming State Geological Survey recently hired two new employees: Janet Van Nuys, as our Editorial Assistant, and Kathy Hastreiter, as our Publications Sales Manager. Janet joined us in March of this year and Kathy joined us in June. The Survey welcomes both Janet and Kathy.

NEW PUBLICATIONS OF THE WYOMING STATE GEOLOGICAL SURVEY

Structural geology of the Laramie Mountains, southeastern Wyoming and northeastern Colorado, by D.L. Blackstone, Jr.: Report of Investigations 51, 1996.-\$8.00.

Industrial minerals and construction materials map of Wyoming, by Ray E. Harris: Map Series MS-47.-\$15.00 (scale 1:500,000).

*Oil and gas map of Wyoming, by R.H. De Bruin: Map Series MS-48.-\$15.00 (scale 1:500,000).

*Evaluation of coal resources on the Wind River Indian Reservation, Fremont and Hot Springs Counties, Wyoming: Reprint R-62.-Price varies; Black and white copies reproduced on demand. Write or call for list of available materials.

*Geology and gold mineralization of the Rattlesnake Hills, Granite Mountains, Wyoming, by W.D. Hausel: Report of Investigations RI-52.-\$7.00.

Each geologic section of the Survey now releases some of its own numbered reports and maps. Please contact the following Staff Geologists for coverage, availability, prices, or further information on specific commodities or topics [Phone: (307) 766-2286; FAX: (307) 766-2606; or use the E-Mail addresses included below]:

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SECTION REPORTS RECENTLY MADE AVAILABLE INCLUDE:

*Preliminary geologic map of the Howell Quadrangle, Albany County, Wyoming, by A.J. Ver Ploeg: Preliminary Geologic Map PGM-96-1, 1996.-\$4.00 (copies reproduced on demand).

*New releases since the last issue of *Wyoming Geo-notes*.

Order these and other publications and topographic maps from: Wyoming State Geological Survey, P.O. Box 3008, Laramie, Wyoming 82071-3008. Phone: (307) 766-2286; Fax (307) 766-2605; and E-Mail: sales@wsgs.uwyo.edu. An order form is also included in back of this issue of *Wyoming Geo-notes*. Many of these publications are also available over-the-counter at the Wyoming Oil and Gas Conservation Commission (Basko Building) in Casper, Wyoming. A free list of publications is available on request.

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