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Gary B. Glass, State Geologist

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WYOMING GEO-NOTES

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Cover: Frances Smith, former Publications Sales Manager, retires (see p. 57).

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MINERALS UPDATE

OVERVIEW

Gary B. Glass

State Geologist, Wyoming State Geological Survey

In February, Guardian American Minerals, Inc. announced the recovery of three diamonds from their newly discovered 'kimberlitic pipes' in the Green River Basin of southwestern Wyoming. This discovery of last November is located in Uinta County. More details are provided on p. 40.

Although official 1995 production figures for oil and natural gas are not yet available from the Wyoming Oil and Gas Conservation Commission, preliminary production figures published by Petroleum Information indicate that both oil and gas production came in slightly higher than the Consensus Revenue Estimating Group's (CREG's) January forecast. Oil production was an estimated 78.9 million barrels, which is a decline of only 1.6% from actual 1994 production (Table 1). Figure 1 shows that the last time oil production flattened out of its relatively steep decline was in 1988. In that year, the price of oil had declined by \$3.00 a barrel (Table 2). The flattening of the decline curve for Wyoming oil production in 1995 has been attributed to an increase in price (about \$1.83 above 1994) as well as to legislative incentives.

Prices for Wyoming crude in the first quarter of 1996 averaged \$16.97 per barrel, compared to the \$15.50 average price in 1995 (Table 2; Figures 2 and 3). And prices remained high at least into May. This would be much greater news if it were not for the proposed Express Pipeline, which plans to bring Canadian oil into Casper to serve Rocky Mountain and Midwestern markets. The Wyoming Independent Producer's Association filed an appeal to the Interior Board of Land Appeals after the U.S. Bureau of Land Management (BLM) approved the pipeline's right-of-way across Federal lands. And the State of Wyoming filed a petition with the Federal Energy Regulatory Commission (FERC) to intervene in Express Pipeline's application for a declaratory order and certain waivers of FERC regulations. Studies by the BLM and others all indicate that at least the bonuses paid for Wyoming crude would decrease or end if this pipeline were put in production. Many observers also see a possibility that the Canadian oil might be sold cheaply enough to capture a greater share of the market, thereby displacing oil now provided by Wyoming producers. There is also still a chance that other Canadian pipelines into the U.S. might saturate the Midwestern market enough to discourage or delay construction of the Express Pipeline (see p.11). Decisions or activities in the second or third quarter of 1996 may well dictate the course this situation will take.

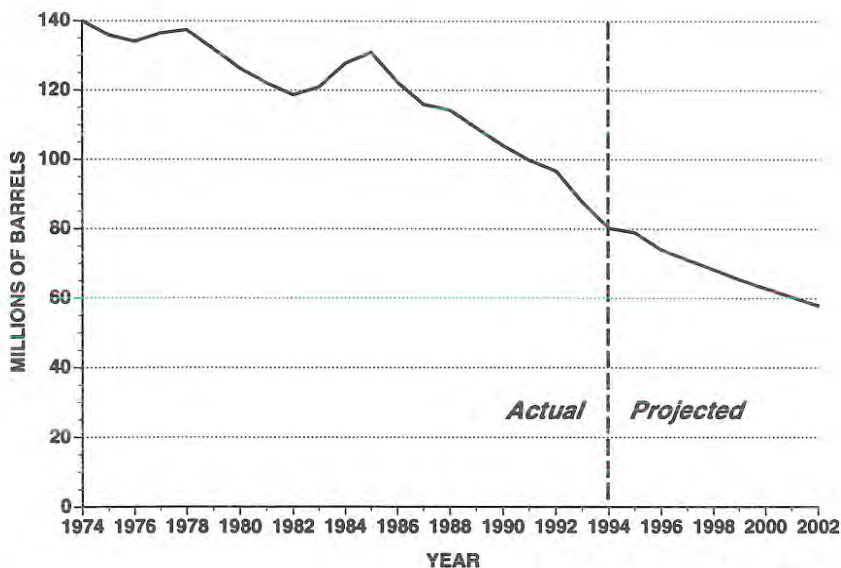
In regard to natural gas, preliminary estimates by Petroleum Information show Wyoming's 1995 production at 1.132 trillion cubic feet or about 2.6%

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	*78.9	*987.8	*142.6	*1.07	263.9	18.1	1.3	*1.12
1996	74.9	993.1	142.6	1.07	274.9	18.5	1.8	1.13
1997	71.9	1,010.2	142.6	1.07	287.1	18.5	2.3	1.15
1998	69.0	1,027.5	142.6	1.07	299.9	18.5	2.3	1.17
1999	66.2	1,045.0	142.6	1.07	313.3	18.5	2.3	1.18
2000	63.6	1,062.9	142.6	1.07	321.1	18.5	2.3	1.20
2001	61.1	1,080.9	142.6	1.07	321.1	18.5	2.3	1.22
2002	58.6	1,099.3	142.6	1.07	321.1	18.5	2.3	1.24

*Estimated until official figures are available.

¹Modified from CREG, Wyoming State Government Revenue Forecast FY96-FY2002, January, 1996; ²Millions of barrels; ³Wyoming Oil & Gas Conservation Commission, 1985-1994; ⁴ Billions 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 [NA] for 1985 because it was only reported as taxable value); ⁹Millions of short tons.



Wyoming State Geological Survey,
Oil and Gas Section, Apr., 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	1.15	*6.26	*40.70
1996	15.00	1.21	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.
¹ Modified 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) and 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; and ⁵ Dollars per ton of trona, not soda ash. Source: Wyoming Department of Revenue, 1985-1994.

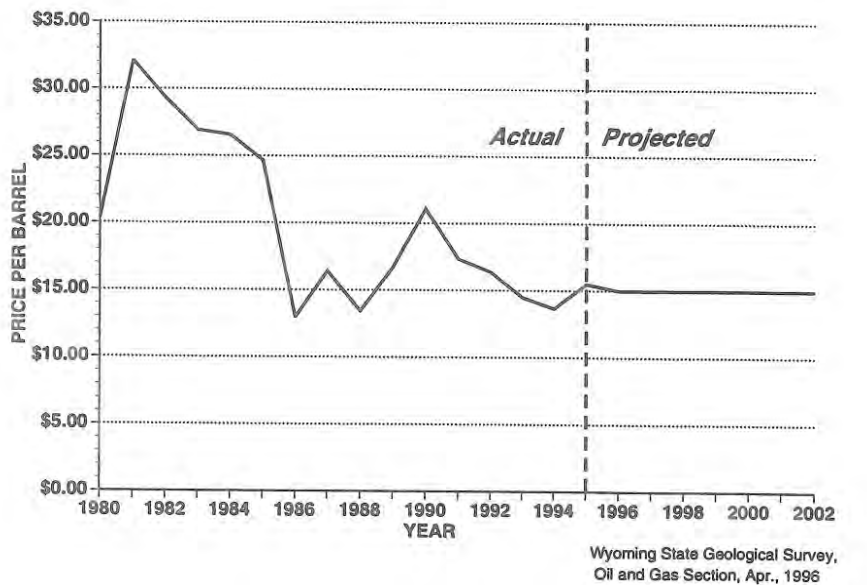
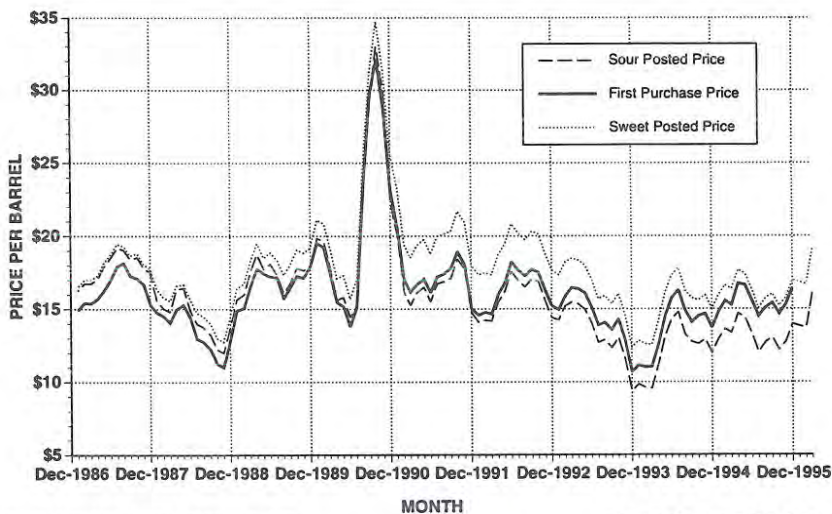


Figure 2. Average prices paid for Wyoming oil (1980 to 1995) with forecasts to 2002.



Source: Unpublished DOE and company data

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

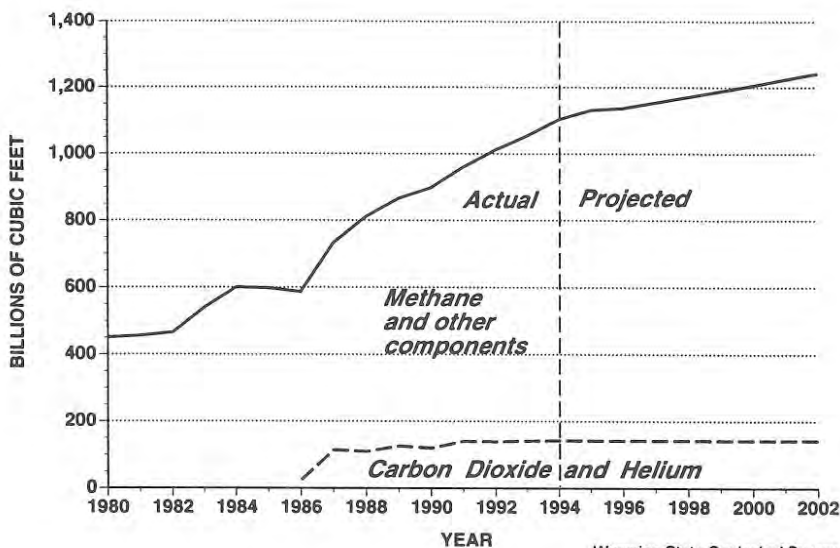
Figure 3. Wyoming posted Sweet and Sour crude oil prices and first purchase prices averaged by month (1987 to present).

above actual production in 1994 (**Table 1; Figure 4**). This increase in production comes at a time when Wyoming gas is selling at an exceptionally low price (an average of \$1.15 per MCF in 1995) (**Table 2; Figures 5 and 6**). The price in Wyoming is 40-50% lower than first purchase prices in other areas of the nation. The lower prices in Wyoming are attributed at least in part to a lack of adequate deliverability. Additional pipeline capacity out of the State could help Wyoming producers get more comparable prices for their natural gas.

KN Energy, Colorado Interstate Gas, and Wyoming Interstate Co. have announced pipeline expansion projects. These projects would increase pipeline capacity by 467-567 million cubic feet a day (170-207 billion cubic feet a year). This is equivalent to 18-21% of last year's methane production. There is a more detailed discussion of these projects on p. 11. The State of Wyoming has filed Motions to Intervene with the Federal Energy Regulatory Commission in support of Colorado Interstate Gas' and Wyoming Interstate's applications.

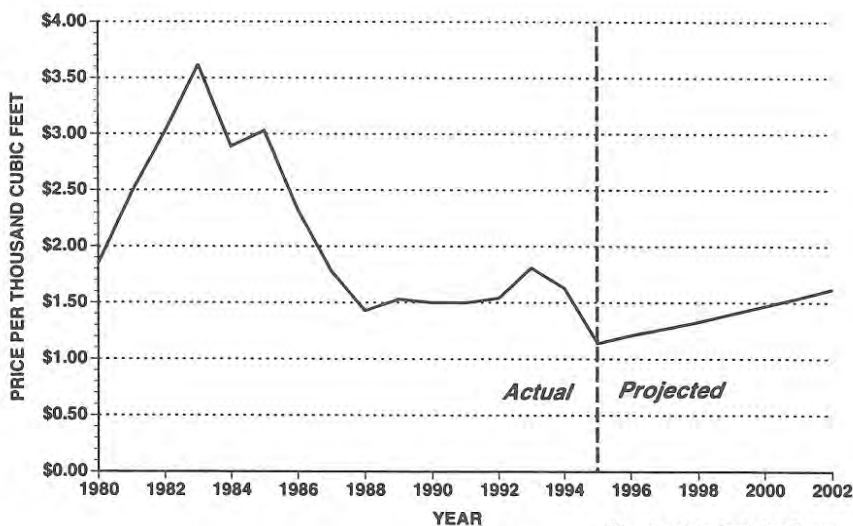
The **Oil and Gas Update** in this issue has added some new tables. There is a table tracking Applications for Permit to Drill (p. 19) and another tracking seismic exploration permits (p. 20). Thanks are due Cynthia Roman and Lori McCoy of the Wyoming Oil and Gas Conservation Commission for providing the data for these tables.

In regard to coal, Wyoming production in 1995 set another record at 263.9 million tons, which is 11.4% greater than 1994 and marks the third year in a row



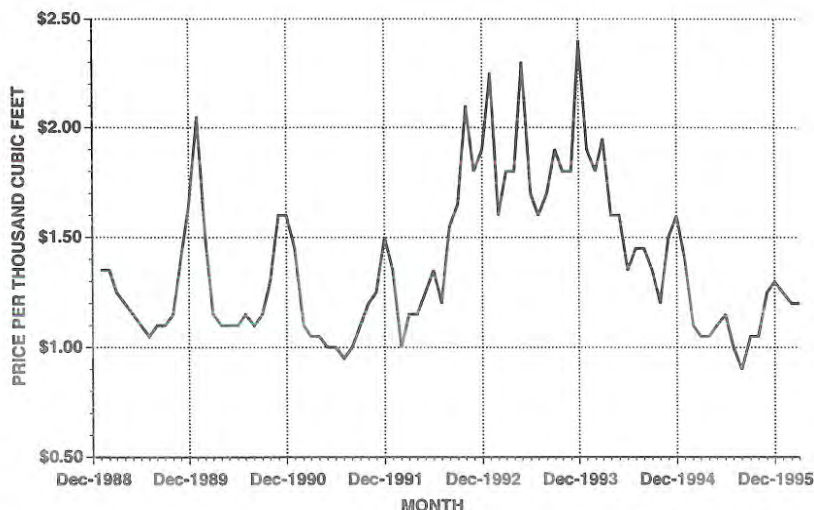
Wyoming State Geological Survey,
Oil and Gas Section, Apr., 1996

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



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

Figure 5. Average prices paid for Wyoming methane (1980 to 1995) with forecasts to 2002 (see Table 1 for sources of data).



Source: American Gas Association

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

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

that production has increased by more than 10% (Table 1; Figure 7). It is also important to note that most of the increase in production in 1995 involved contract sales rather than spot-sale purchases. Spot-sale tonnages were about the same for both 1994 and 1995 (see Figure 13 on p. 28). There is a certain stability implied by a strengthening of contract sales as opposed to spot sales. Although we cannot be certain yet, solicitations asking for multiple-year terms, even for as long as five years, may be on the increase.

On the other hand, the average price paid for Wyoming coal will continue to decline (Tables 2 and 3; Figure 8). While this is expected as lower priced coal from the Powder River Basin becomes a greater percentage of the total, the decline in average price could accelerate somewhat as at least some prices from this basin were still less than \$4.00 per ton in 1995 as well as in the first quarter of this year.

Forecasts for trona and uranium production have been increased over those reported in the last issue of *Wyoming Geo-notes* (Table 1). And the first trona lease sale since 1986 netted the U.S. Bureau of Land Management a total of \$3.67 million in acceptable bids from one of two companies that bid on the tracts. The high bidders on the three offered tracts were General Chemical on two of the tracts and Solvay Minerals on another. The bid by Solvay, however, was rejected by the BLM (see p. 38 for more details). In the case of uranium, the unrestricted spot sale price has almost doubled from what it was in March of 1995 (see p. 39).

This issue of *Wyoming Geo-notes* also includes a 1995 exploration summary for coal, uranium, and other minerals, exclusive of oil and gas (p. 42).

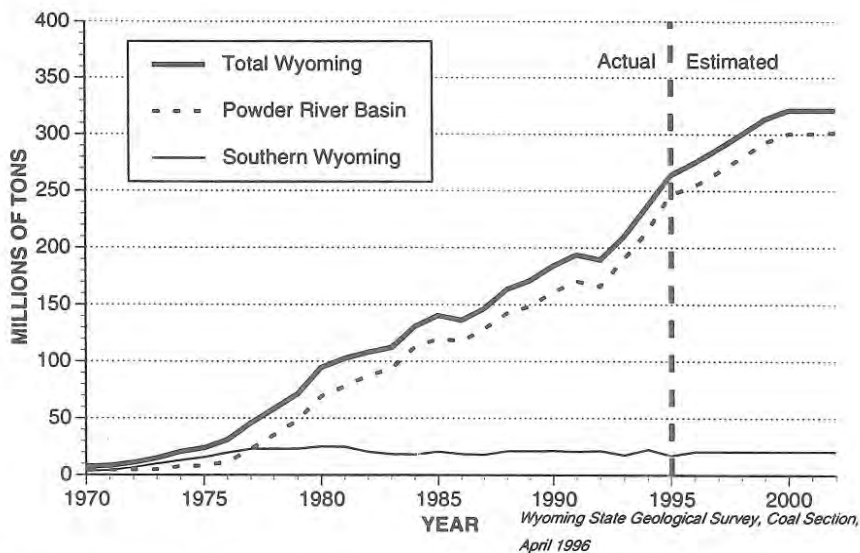


Figure 7. Annual coal production from Wyoming (1970-1995) with forecasts to 2002. Data from Wyoming State Inspector of Mines (1970-1995) and Wyoming Consensus Revenue Estimating Group (1996-2002).

Table 3. 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.

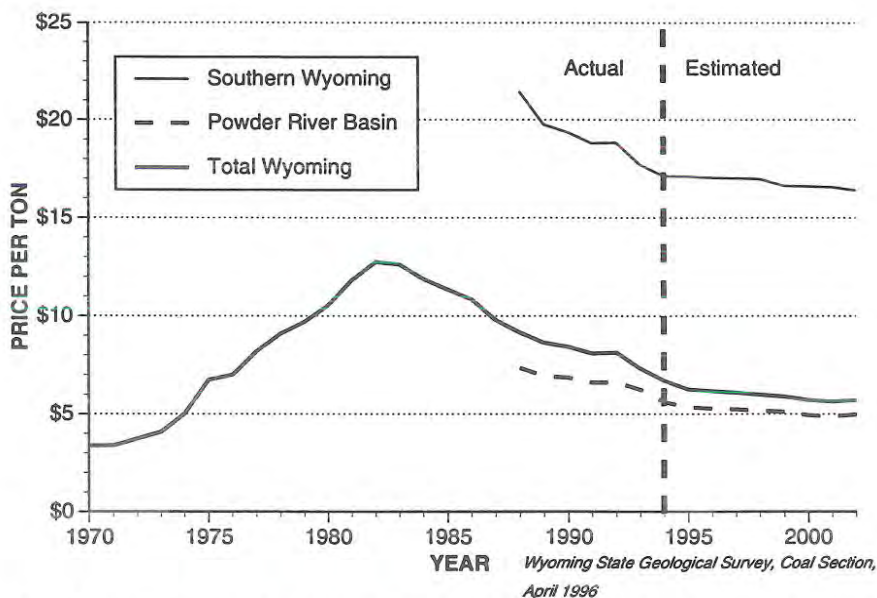


Figure 8. Average prices paid for Wyoming coal (1970 to 1994) with estimates to 2002. Sources: U.S. Energy Information Administration (1970-1990); derived from the Wyoming Department of Revenue (1991-1994); and the Consensus Revenue Estimating Group (1995-2002).

OIL AND GAS UPDATE

Rodney H. De Bruin

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Prices paid to Wyoming oil producers in 1995 averaged \$15.50 per barrel (Table 4), which is the highest yearly average price since 1992 when the average was \$16.38 per barrel (Table 2). The relatively stable and higher oil prices in 1995 had a positive effect on oil production in the State. A preliminary production estimate for Wyoming in 1995, which is derived from Petroleum Information, Inc., is 78.9 million barrels. This is about a 1.6% decline from actual 1994 production of 80.2 million barrels (Table 5). Wyoming's oil production has declined every year since 1985 at an average yearly rate of approximately 5.3% (Figure 1).

The average price for the first quarter of 1996 was an estimated \$16.97 per barrel (Table 4), which is higher than it has been in the last four years. Factors contributing to the higher oil prices in the first quarter were the lowest refinery inventories in the U.S. in over 20 years and colder than average weather throughout most of the country.

Table 4. Monthly average price of a barrel of oil produced in Wyoming (1993 to present).

	1993	1993	1994	1994	1995	1995	1996	1996
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	\$ 15.08	\$ 15.08	\$11.15	\$ 11.15	\$ 14.77	\$ 14.77	\$ 16.25	\$16.25
FEB	\$ 16.00	\$ 15.54	\$11.01	\$ 11.08	\$ 15.55	\$ 15.16	\$ 16.15	\$16.20
MAR	\$ 16.47	\$ 15.85	\$11.04	\$ 11.07	\$ 15.26	\$ 15.19	\$ 18.50	\$16.97
APR	\$ 16.41	\$ 15.99	\$12.59	\$ 11.45	\$ 16.73	\$ 15.58		
MAY	\$ 16.11	\$ 16.01	\$14.53	\$ 12.07	\$ 16.65	\$ 15.79		
JUN	\$ 15.11	\$ 15.86	\$15.73	\$ 12.68	\$ 15.52	\$ 15.75		
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		\$16.97

Source: All averages are 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, April, 1996.

Table 5. Monthly oil production from Wyoming in barrels (1993 to present).

	1992		1993		1994		1995	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	8,527,905	8,527,905	7,616,208	7,616,208	7,115,472	7,115,472	6,711,598	6,711,598
FEB	7,933,484	16,461,389	6,583,954	14,200,162	6,387,147	13,502,619	7,878,752	14,590,350
MAR	8,392,491	24,853,880	7,690,771	21,890,933	6,984,248	20,486,867	6,393,588	20,983,938
APR	8,079,724	32,933,604	7,355,334	29,246,267	6,672,207	27,159,074	6,232,288	27,216,226
MAY	8,235,583	41,169,187	7,533,207	36,779,474	6,847,709	34,006,783	6,476,789	33,693,015
JUN	7,960,645	49,129,832	7,307,445	44,086,919	6,594,914	40,601,697	6,481,062	40,174,077
JUL	8,186,319	57,316,151	7,572,346	51,659,265	6,773,956	47,375,653	6,573,157	46,747,234
AUG	8,108,187	65,424,338	7,370,091	59,029,356	6,685,423	54,061,076	6,443,344	53,190,578
SEP	7,847,059	73,271,397	7,162,224	66,191,580	6,446,719	60,507,795	6,402,917	59,593,495
OCT	7,978,799	81,250,196	7,374,889	73,566,469	6,525,817	67,033,612	6,513,566	66,107,061
NOV	7,728,632	88,978,828	6,897,568	80,464,037	6,257,924	73,291,536	6,274,160	72,381,221
DEC	7,831,601	96,810,429	7,203,163	87,667,200	6,236,204	79,527,740	6,502,617	78,883,838
Total Barrels Reported¹		96,810,429		87,667,200		79,527,740		78,883,838
Total Barrels Not Reported²		169,781		1,233,006		651,400		
Total Barrels Produced³		96,980,210		88,960,236		80,179,140		

¹Monthly production reports from Petroleum Information.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, April, 1996.*

Again using data from Petroleum Information, Wyoming's natural gas production in 1995 was an estimated 1.132 trillion cubic feet, which was an increase of about 2.6% over actual production in 1994 (Table 6). This production gain was accomplished despite very low prices in 1995 (Table 7). The State's natural gas production has increased every year since 1986 (Figure 4).

In an effort to increase the amount of natural gas that can be transported from Wyoming, there were a number of projects proposed or announced this quarter. KN Energy purchased an Amoco oil pipeline and will convert it to a gas pipeline. The pipeline, which extends from Riverton in the Wind River Basin to the Midwest, is capable of transporting 200 million cubic feet per day. With added compression, its capacity could increase to 300 million cubic feet per day. Colorado Interstate Gas will expand the capacity of its Wind River Lateral pipeline to transport an additional 75 million cubic feet per day. The Wind River Lateral extends from the Wind River Basin to Colorado Interstate's compressor station near Rawlins, Wyoming. Wyoming Interstate Co., Williams Natural Gas Co., and Trailblazer Pipeline are also considering a joint venture that would open more Midwestern markets for Wyoming gas. Subsequent to receiving bids for 812 million cubic feet of additional firm capacity from 21 shippers, Wyoming Interstate Co. announced plans to expand the capacity of its pipeline by 192 million cubic feet of gas per day. This will be accomplished by adding compression. Wyoming Interstate is the central segment of the Trailblazer Pipeline System, which extends from southwestern Wyoming, to Beatrice, Nebraska. The Trailblazer Pipeline System is exploring the possibility of connecting with the Williams Natural Gas System in eastern Kansas. Williams provides natural gas transportation and storage services through a 6,300-mile-long pipeline system in Kansas, Oklahoma, Wyoming, Missouri, Colorado, Nebraska, and Texas.

While these projects to increase the deliverability of Wyoming's natural gas are progressing, Altamont Gas Transmission Co., the Canadian firm that has proposed a natural gas pipeline from Canada to Opal, Wyoming, is apparently going to ask the Federal Energy Regulatory Commission (FERC) to extend its routing permit. FERC granted the permit back in 1991, but the permit expires in July of this year unless Altamont is granted an extension. This proposed, 620-mile-long pipeline was originally permitted to help meet demand for gas in California. California demand has since been met by a number of other pipelines.

In Canada, there is a battle shaping up to provide increased crude oil to U.S. markets. Interprovincial Pipeline (IPL) has filed an application for a third expansion of its crude oil pipeline from Edmonton, Alberta, to Chicago. IPL, which has received permission for an expansion of 120,000 barrels per day this year, has already applied for another 120,000-barrel-per-day expansion. IPL completed an expansion of 175,000 barrels per day two years ago and currently transports 1.6 million barrels of crude oil daily to U.S. markets. IPL's expansion plans are in direct response to the Express Pipeline, which plans to transport as

Table 6. Monthly natural gas production from Wyoming in thousands of cubic feet (MCF) (1992 to present).

	1992	1992	1993	1993	1994	1994	1995	1995
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	89,618,649	89,618,649	88,172,339	88,172,339	93,146,775	93,146,775	100,224,249	100,224,249
FEB	81,194,839	170,813,488	80,726,687	168,899,026	85,623,666	178,770,441	86,691,577	186,915,826
MAR	83,058,343	253,871,831	88,920,212	257,819,238	94,388,052	273,158,493	94,344,991	281,260,817
APR	79,387,752	333,259,583	86,208,224	344,027,462	92,362,726	365,521,219	93,929,323	375,190,140
MAY	75,450,024	408,709,607	87,857,947	431,885,409	93,886,923	459,408,142	95,791,327	470,981,467
JUN	80,156,560	488,866,167	74,555,764	506,441,173	81,764,661	541,172,803	92,140,614	563,122,081
JUL	87,913,920	576,780,087	91,832,536	598,273,709	94,998,414	636,171,217	92,796,301	655,918,382
AUG	88,052,852	664,832,939	91,562,051	689,835,760	93,743,790	729,915,007	90,393,416	746,311,798
SEP	83,373,910	748,206,849	90,580,094	780,415,854	88,476,703	818,391,710	92,589,092	838,900,890
OCT	87,308,510	835,515,359	93,388,208	873,804,062	95,232,646	913,624,356	98,386,458	937,287,348
NOV	88,671,889	924,187,248	88,046,821	961,850,883	95,312,491	1,008,936,847	94,939,660	1,032,227,008
DEC	87,579,985	1,011,767,233	90,133,281	1,051,984,164	87,115,084	1,096,051,931	99,314,617	1,131,541,625
Total MCF Reported¹		1,011,767,233		1,051,984,164		1,096,051,931		1,131,541,625
Total MCF Not Reported²		201,080		2,715,623		6,879,705		
Total MCF Produced³		1,011,968,313		1,054,699,787		1,102,931,636		

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, April, 1996.

Table 7. Monthly average spot sale price of a thousand cubic feet (MCF) of natural gas at Opal, Wyoming (1993 to present).

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

Source: American Gas Association's monthly reports

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

much as 170,000 barrels of crude oil per day to U.S. markets in the Rocky Mountain area and to Wood River, Illinois. Express plans to build a pipeline from Wild Horse, Alberta, to Casper, Wyoming, where it will connect with the Platte Pipeline. Express recently purchased the Platte Pipeline, which extends from Casper to Wood River. While several Rocky Mountain refineries support the Express proposal, which would supply them with additional supplies of crude oil, most of the independent petroleum producers in the area and the State of Wyoming oppose the proposal on the grounds that Express will substantially lower the prices received for Wyoming crude.

The U.S. Bureau of Land Management (BLM) issued a final rule that reduces royalties on heavy oil (20 degree gravity or less) produced from at least some Federal leases. Royalties are reduced on a sliding scale from 12.5% for 20 degree gravity crude to 0.5% for 6 degree gravity crude. The rule, which took effect March 8th, currently only applies to California producers. It was not broadened to help producers of heavy oil in Wyoming or other states. The BLM said the rule should encourage California operators to produce more heavy oil and should increase reserves by nearly 96 million barrels. Although the rule will not benefit Wyoming's producers of heavy oil, it may increase the California market for Wyoming natural gas. A major market for gas transported in the Kern River Pipeline from Opal, Wyoming, to California is steam generation for the extraction of heavy oil in southern California's Kern County.

Following action by Wyoming's Board of Land Commissioners, State leases offered at auction will continue to carry the current royalty rate of 16.67%. However, on leases that are not sold, the State Land Office now has the option of offering those leases at a royalty rate of 12.5%. The Board also agreed to cut the royalty rate to 10% for production on newly-auctioned leases that are drilled within 12 months after the lease is auctioned.

The U.S. Environmental Protection Agency (EPA) has proposed some new regulations that may affect the oil and gas industry. According to a press release by the American Petroleum Institute (API), if the Toxic Release Inventory Program (TRIP) is extended to petroleum exploration and production activities, operators of over 40% of the oil and gas wells in the U.S. will have to prepare additional elaborate reports on their discharges to air, water, land, and underground oil and gas reservoirs. Discharge volumes are already reported to other government entities. API estimates that the petroleum industry's potential costs for these proposed discharge inventories would be \$200 million in the first year alone and over 4,700 facilities would be affected. The U.S. Department of Energy estimates that the costs would be even higher.

For the oil and gas industry, produced water would be the main discharge inventoried under TRIP. Most produced water is returned to the formation from which it came and poses no threat to the quality of drinking water. If TRIP is extended to the exploration and production sector of the oil and gas industry, operators may find abandonment of some stripper or other marginally economic wells is more economical than complying with the new reporting requirements,

thereby accelerating the abandonment of these wells. Stripper wells account for about five million barrels of Wyoming's oil production each year.

The Federal Interior Board of Land Appeals has denied an appeal to delay three oil and gas drilling projects in Sweetwater County. BTA Oil Producers can drill up to ten natural gas exploration wells north of Rock Springs, HS Resources and Lario Oil and Gas can drill three exploration wells in the Boars Tusk area north of Rock Springs, and the Greater Wamsutter II project west of Rawlins can begin.

In the Wind River Basin, however, the Bureau of Land Management vacated their earlier Record of Decision approving Barrett Resources Corp.'s Cave Gulch development plan and suspended their Environmental Assessment of Chevron's Waltman project until an Environmental Impact Statement for the Cave Gulch-Bullfrog-Waltman Natural Gas Development Area is prepared and completed. This process could take more than a year. Because there are already many wells and pipelines in the area, the affected companies are asking that development be allowed to continue while the cumulative assessment is being done.

Oil and gas lease sales can give indications of the level of activity as well as the location of future drilling activities. In the first quarter of 1996, companies spent less money for leases and acquired fewer acres than in the first quarters of the last three years (**Table 8**). Leasing at the Bureau of Land Management's (BLM's) February sale (**Figure 9**) was concentrated in the Powder River and Greater Green River basins. Leasing at the State Land and Farm Loan Office's March sale (**Figure 10**) was heaviest in the Powder River Basin.

The BLM's February sale had a high per-acre bid of \$220 made by Michael Armstrong for a 127.03-acre parcel that covers parts of sections 21 and 29, T52N, R69W (location A, **Figure 9**). The lease is within a mile of Minnelusa oil production at Gibbs South Field. Armstrong also paid \$220 per acre for a 405.36-acre lease that covers parts of section 21, T52N, R69W (location A, **Figure 9**). In addition, Armstrong paid \$210 per acre for a 81.64-acre lease that covers parts of sections 7 and 18, T53N, R68W (location B, **Figure 9**). Twenty-two tracts at this sale received per-acre bids of \$50 or more. The Government shutdowns caused the BLM to cancel its April lease sale. The leases for the April sale will be offered at the June 4th sale. BLM will combine lands nominated for the June sale with those nominated for the August 6th sale. In this way, BLM can offer the same number of parcels at five sales that they normally offer at six sales.

The State Land and Farm Loan Office's sale in March had a high per-acre bid of \$108 made by LB Industries Inc. for a 320-acre lease that covers N/2 section 36, T36N, R90W (location A, **Figure 10**). The tract is about three miles southeast of abandoned Lance and Fort Union gas production at Squaw Butte Field. The sale's second highest per-acre bid of \$60 was made by High Plains Associates for an 80-acre tract that covers W/2 SE section 26, T57N, R73W (location B, **Figure 10**). The lease is a little over a mile north of Muddy

Table 8. 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	Average price per acre leased	High price per acre	Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Average price per acre leased	High price per acre
1992							1992						
TOTAL	\$4,778,940	2,122	664	1,434,268	\$13.11	\$2,500.00	TOTAL	\$745,738	799	419	277,755	\$4.95	\$230.00
1993							1993						
TOTAL	\$12,942,008	2,769	1,469	2,065,942	\$13.00	\$400.00	TOTAL	\$1,980,017	800	562	311,273	\$3.91	\$400.00
1994							1994						
February	\$3,909,085	442	290	374,969	\$16.44	\$160.00	March	\$917,360	200	169	84,571	\$12.56	\$170.00
April	\$4,248,182	498	278	369,657	\$21.06	\$275.00	May	\$802,668	200	141	75,523	\$14.81	\$205.00
June	\$3,759,282	480	270	417,447	\$16.09	\$325.00	September	\$586,063	200	149	83,143	\$9.50	\$190.00
August	\$5,100,550	439	294	323,410	\$23.49	\$255.00	November	\$988,001	200	148	88,542	\$15.07	\$142.00
October	\$4,703,706	492	341	411,117	\$17.49	\$11,200.00	TOTAL	\$3,304,152	800	607	331,779	\$12.95	\$205.00
December	\$5,356,789	617	367	479,930	\$18.55	\$390.00	1995						
TOTAL	\$27,107,594	2,968	1,840	2,376,530	\$18.70	\$11,200.00	March	\$524,165	199	131	89,371	\$9.08	\$130.00
1995							May	\$452,747	200	125	75,633	\$9.10	\$78.00
February	\$3,252,668	553	332	473,177	\$11.21	\$425.00	September	\$431,454	200	134	78,032	\$7.87	\$85.00
April	\$1,591,709	531	206	483,826	\$8.42	\$160.00	November	\$257,862	200	102	80,851	\$6.18	\$52.00
June	\$3,499,604	363	246	384,746	\$14.65	\$660.00	TOTAL	\$1,656,218	799	492	323,867	\$8.17	\$130.00
August	\$1,105,381	468	165	420,169	\$7.41	\$160.00	March	\$308,927	199	96	85,369	\$7.37	\$108.00
October	\$2,761,689	477	227	394,683	\$15.83	\$1,100.00	1996						
December	\$836,195	205	88	180,367	\$12.24	\$316.00	March						
TOTAL	\$13,047,246	2,649	1,284	2,326,988	\$11.76	\$1,100.00							
1996													
February	\$1,635,668	455	192	358,478	\$11.86	\$220.00							

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

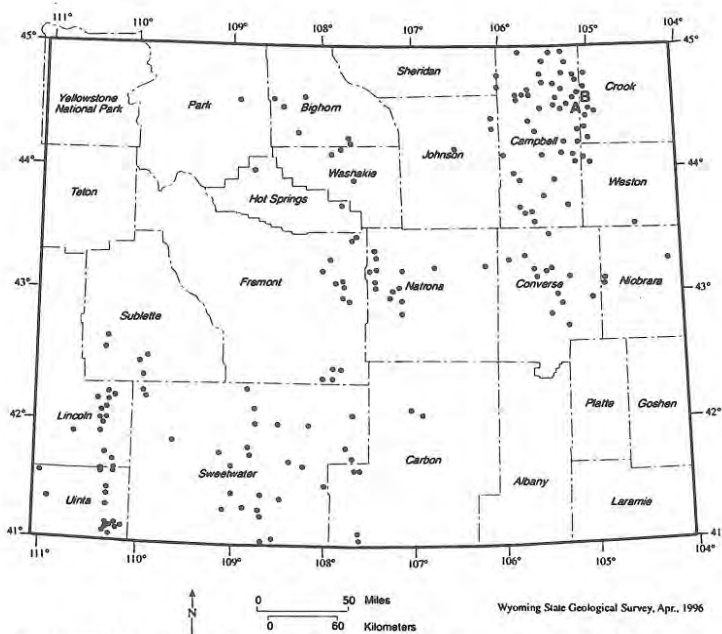


Figure 9. Locations of Federal oil and gas tracts leased by the U.S. Bureau of Land Management at the February, 1996, sale.

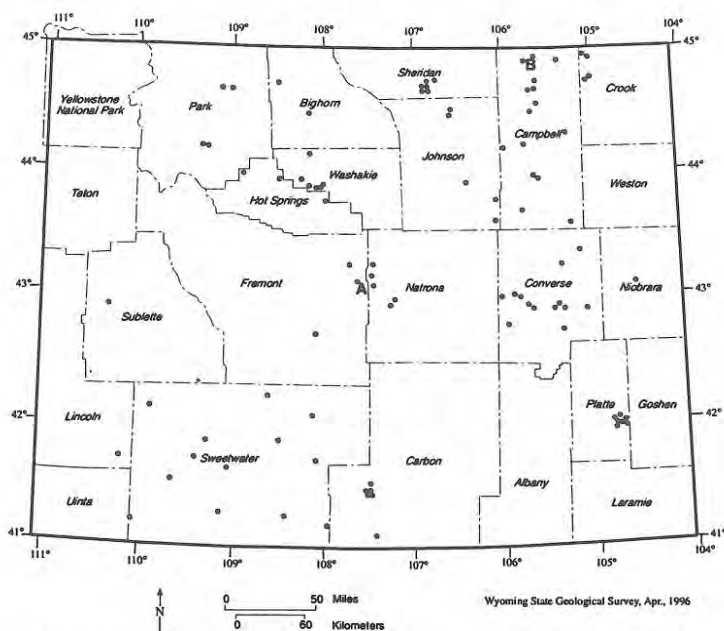


Figure 10. Locations of State oil and gas tracts leased by the State Land and Farm Loan Office at the March, 1996, sale.

Sandstone oil production in Chan Field and a little over a mile south of Muddy and Minnelusa oil production in Sandbar East Field. Only four tracts at this sale received per-acre bids of \$50 or more.

Two other indicators of the level of activity and the location of future drilling are Applications for Permit to Drill (APDs) and permitted seismic projects. In 1995, APDs dropped from the relatively higher levels seen between 1992 and 1994 (Table 9). The number of APDs in the first quarter of 1996 suggests there may be even fewer in 1996. The majority of applications approved by the Wyoming Oil and Gas Conservation Commission in 1995 and the first quarter of 1996 were in counties in the Powder River and Greater Green River basins.

The number of seismic projects permitted by the Wyoming Oil and Gas Conservation Commission has been dropping steadily since 1992 (Table 10). Once again the seismic projects and miles permitted in 1995 were concentrated in counties in the Powder River and Greater Green River basins. One interesting trend between 1992 and 1995 is the decrease in conventional miles and the increase in square miles covered by 3-D seismic. While 3-D seismic is much more expensive to acquire, it is much more accurate in defining drilling targets.

The average rig count for the first quarter of 1996 was less than it was in the last quarter of 1995. Although a decline at the beginning of the year is fairly common (Figure 11), this year's decline is dropping below a very depressed level at the end of 1995.

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 first quarter of 1996. The numbers preceding discussions below refer to locations on Figure 12.

1. Chevron USA plans to drill a horizontal test of the Nugget Sandstone. The 41-18A Painter Reservoir Unit well will be drilled in NE SW section 7, T15N, R119W to a true vertical depth of 12,060 feet. The location is about 11 miles southwest of the only horizontal Nugget producer in the Overthrust Belt, which is in Ryckman Creek Field.
2. Amoco Production completed a new producer in Whitney Canyon-Carter Creek Field. The 3 Champlin 457-B well in NW NW section 31, T18N, R119W flowed 5.4 million cubic feet of gas and 78 barrels of condensate per day from an undisclosed Madison Limestone interval.
3. Enron Oil and Gas has added 1.18 trillion cubic feet of proved undeveloped methane reserves from several Paleozoic formations in the Big Piney field area. The additions were a result of engineering and market evaluation studies. Enron has begun market development studies that include using the methane as a fuel source in generating electricity.

Table 9. Number of Applications for Permit to Drill (APDs) approved by the Wyoming Oil and Gas Conservation Commission (1992 to present).

	1992	1993	1994	1995	1996
County	APDs	APDs	APDs	APDs	APDs
Albany	0	0	0	1	1
Big Horn	13	13	3	16	9
Campbell	247	129	102	151	10
Carbon	26	35	134	50	4
Converse	19	37	75	29	16
Crook	29	29	9	15	3
Fremont	11	16	46	30	3
Goshen	1	0	0	0	0
Hot Springs	14	12	4	13	0
Johnson	4	18	16	6	0
Laramie	21	37	15	10	0
Lincoln	138	136	103	64	3
Natrona	86	36	63	80	7
Niobrara	4	5	4	4	2
Park	23	22	18	20	9
Platte	2	0	2	0	0
Sheridan	6	7	3	0	0
Sublette	40	80	111	61	11
Sweetwater	200	158	205	153	34
Teton	0	0	0	0	0
Uinta	62	49	11	11	3
Washakie	3	17	12	31	1
Weston	29	23	6	10	4
TOTALS	978	859	942	755	120

Source: All data are from the Wyoming Oil and Gas Conservation Commission (numbers for 1996 are for the first quarter only).

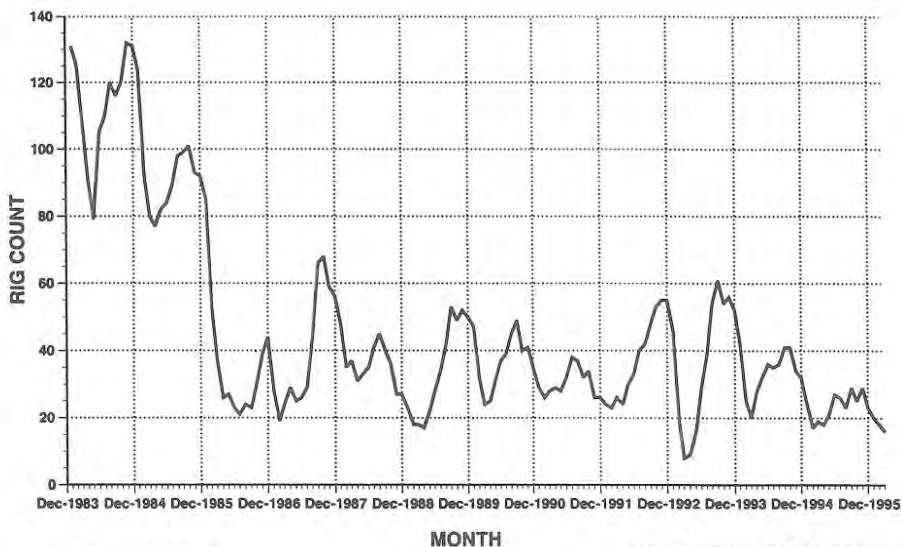
Wyoming State Geological Survey, Oil and Gas Section, April, 1996.

4. Mobil Oil completed a new horizontal development well in Tip Top Field. The 14X-16GH Tip Top Unit well flowed 2.2 million cubic feet of gas per day and was drilled in SW NW section 16, T28N, R113W. The well is producing from the second Frontier between 7,942 and 9,721 feet.
5. Snyder completed two new exploration wells in the Lance. The 7-30-29-108 Stud Horse well in SW NE section 30, T29N, R108W produced an average of 565,000 cubic feet of gas, one barrel of condensate, and two barrels of water per day from an undisclosed depth during its first month on-line. The 16-20 Stud Horse well in SE SE section 20, T29N, R108W produced an average of 1.2 million cubic feet, five barrels of condensate, and 10 barrels of water per day from an undisclosed depth during its first month on-line.

Table 10. Number of seismic projects and miles permitted by the Wyoming Oil and Gas Conservation Commission (1992 to present).

County	1992			1993			1994			1995		
	Permits	Conven- tional Miles	3-D Square Miles	Permits	Conven- tional Miles	3-D Square Miles	Permits	Conven- tional Miles	3-D Square Miles	Permits	Conven- tional Miles	3-D Square Miles
Albany	1	11	0	0	0	0	0	0	0	0	0	0
Big Horn	1	49	0	0	0	0	5	24	4	1	16	0
Campbell	34	190	0	24	134	29	13	17	50	12	24	43
Carbon	3	22	0	8	115	0	11	117	86	1	0	16
Converse	5	103	0	4	26	0	0	0	0	4	39	20
Crook	8	35	0	5	21	0	3	3	2	1	0	5
Fremont	3	48	0	6	38	62	6	12	104	6	32	56
Goshute	1	29	0	0	0	0	0	0	0	0	0	0
Hot Springs	1	14	0	1	0	2	1	9	0	2	70	9
Johnson	2	7	0	1	20	0	0	0	0	1	4	0
Laramie	1	56	0	1	67	0	3	57	0	0	0	0
Lincoln	5	122	0	3	27	50	0	0	0	2	18	110
Natrona	2	6	0	3	20	0	1	0	17	3	27	3
Niobrara	2	9	0	0	0	0	1	0	11	0	0	0
Park	4	114	0	5	54	55	1	0	7	0	0	0
Platte	2	19	0	0	0	0	0	0	0	0	0	0
Sheridan	0	0	0	0	0	0	0	0	0	0	0	0
Sublette	1	2	0	0	0	0	5	4	145	2	0	162
Sweetwater	7	157	0	9	117	187	4	59	0	9	17	497
Teton	0	0	0	0	0	0	0	0	0	0	0	0
Uinta	3	36	0	0	0	0	2	0	89	0	0	0
Washakie	0	0	0	4	17	6	0	0	0	0	0	0
Weston	2	19	0	0	0	0	0	0	0	1	13	0
TOTALS	88	1048	0	74	656	391	56	302	515	45	260	921

Source: All data are from the Wyoming Oil and Gas Conservation Commission.
Wyoming State Geological Survey, Oil and Gas Section, April, 1996.



Source: Hughes Rig Count

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

Figure 11. Wyoming daily rig count averaged by month (1984 to present).

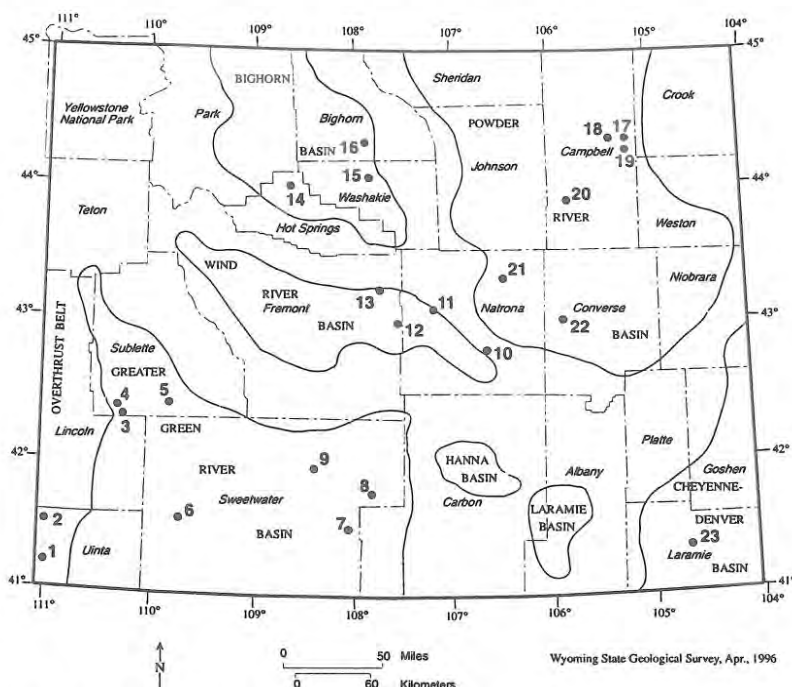


Figure 12. Oil and gas exploration and development activities in Wyoming during the first quarter of 1996 (exclusive of coalbed methane activities).

6. American Methanol Ltd. plans to build a methanol processing plant about 15 miles west of Green River. Construction, which is scheduled to begin in June or July, should be completed sometime late in 1997. The planned capacity of the new plant is about 69 million gallons of methanol per year, and it will employ 25 to 30 permanent workers at completion. Methanol is made by the catalytic reaction of natural gas and steam. The process is enhanced with the addition of carbon dioxide. The company indicated that the low price and abundant local supply of natural gas, the ready access to carbon dioxide from the nearby Exxon Shute Creek gas processing plant, and a local market for methanol were major factors in locating the plant. Locally, methanol is added to natural gas to prevent freezing of water that is produced with the gas.
7. Union Pacific Resources will drill three four-well exploratory projects. Each of the projects will see four wells drilled from a common surface pad. The wells will be drilled in sections 14, 24, and 26, T18N, R94W to the Almond Formation and will range in depth from 10,272 to 10,336 feet. The area is in the gap between Standard Draw Field and Wildrose Field, which both produce from the Almond.
8. Meridian Oil discovered gas at its 32-1 Continental Divide-Federal wildcat in NE SW section 32, T21N, R92W. The company has not released any flow rates for the well, which was completed between 11,192 and 11,279 feet in the Almond.
9. BTA Oil Producers completed its 1 Prima 9410 JV-P wildcat in NE SW section 17, T24N, R96W in the Lewis. The well flowed 544,000 cubic feet of gas and 38 barrels of water per day from between 11,004 and 11,024 feet.
10. Canal Field has a new producing well. Burr Oil and Gas completed its 1-4 Burr-Federal well in SE NW section 4, T32N, R82W in the first Frontier between 2,244 and 2,254 feet. The well flowed 15 barrels of oil and 15,000 cubic feet of gas per day.
11. Three new producing wells were completed in Cave Gulch Field. Barrett Resources completed the 13 Cave Gulch Unit well in SW NW section 32, T37N, R86W in the Meeteetsee between 8,596 and 8,806 feet. The well flowed 10.3 million cubic feet of gas per day. Barrett also completed its 2 Cave Gulch Unit well in SW SE section 30, T37N, R86W in the Lance between 8,119 and 9,510 feet. The well flowed 10.4 million cubic feet of gas, 132 barrels of condensate, and 20 barrels of water per day. Chevron USA completed its 16 Bullfrog Unit well in SW NE section 31, T37N, R86W in unreported Lance and Fort Union intervals. The well produced an average of 20.6 million cubic feet of gas, 11 barrels of condensate, and 52 barrels of water per day from the Lance during its first 20 days on-line and an average of 357 barrels of oil and 26 barrels of water per day from the Fort Union during its first nine days on-line. Barrett and Chevron are the primary developers of the field which has an estimated 450-629 billion cubic feet of gas reserves.

12. Santee Inc. discovered gas at its 8-21 Deer Creek-Federal well in NE NW section 8, T35N, R89W. The well flowed 3.9 million cubic feet of gas and eight barrels of condensate per day from perforations between 6,560 and 7,126 feet in the Lance.
13. Louisiana Land and Exploration Co. has plans to expand the capacity of its Lost Cabin gas processing plant. The plant is currently processing about 50 million cubic feet of gas per day from two deep Madison wells. The company, which is drilling a third deep well, plans to increase the capacity of the plant to 70 million cubic feet per day.
14. Marathon Oil Co. completed a new well in Grass Creek Field. The 112 Mill Iron well in SE section 20, T46N, R98W pumped 593 barrels of oil, 56,000 cubic feet of gas, and 2,973 barrels of water per day from an undisclosed interval in the Tensleep Sandstone.
15. Interenergy is expanding its Hiland sour gas plant at Worland. The \$3 million expansion will quadruple plant production and is necessary because of Bass Enterprises' increased development drilling at Cottonwood Creek Field.
16. KCS Mountain Resources plans to drill at least 19 new development wells in Manderson Field. Ten of the planned wells will be drilled to the Phosphoria and nine will test the "Ooth Louie" sand in the Mowry Shale. KCS has completed the first of its Phosphoria tests. The 34-12P Manderson in SW SE section 12, T50N, R93W flowed 1,200 barrels of oil and 2.5 million cubic feet of gas per day from a depth of approximately 7,500 feet. The nearest current production from the Phosphoria is about three miles south-east of the new well.
17. Swift Energy completed a new well in Little Pine Field. Its 2-15 well in SW SE section 15, T51N, R69W pumped 72 barrels of oil and 25 barrels of water per day from the Minnelusa between 7,912 and 7,924 feet.
18. Kuehne Ranch Field has a new producing well. Samedan Oil completed the 9 Kuehne Ranch well in NE NW section 13, T51N, R70W in the Minnelusa between 7,956 and 7,972 feet. The well pumped 424 barrels of oil and 35 barrels of water per day.
19. Fancher Oil completed a new well in Windmill Field. The 1A Stewart well in SW NE section 4, T50N, R69W pumped 240 barrels of oil and 12 barrels of water per day from the Minnelusa between 8,141 and 8,147 feet. The closest Minnelusa production is nearly a half mile to the northwest.
20. UMC Petroleum completed three Sussex Sandstone producers in House Creek Field. The 21-28 HCNU well in NE NW section 21, T46N, R74W produced an average of 249 barrels of oil, 124,000 cubic feet of gas, and 31 barrels of water per day from an undisclosed interval during its first month on-line. The 23-22 House Creek North Unit well in NE SW section 22, T46N, R74W pumped 249 barrels of oil and 40 barrels of water per day from

between 8,156 and 8,171 feet. The 33-27 House Creek North Unit well in NW SE section 27, T46N, R74W pumped 227 barrels of oil and 20 barrels of water per day from between 8,138 and 8,164 feet.

21. Fluor Daniel completed a new well in Teapot Dome Field. The 73-SHX-10NPR 3 well in SE NE section 10, T38N, R78W pumped 789 barrels of oil and 3,200 barrels of water per day from the Tensleep Sandstone between 5,454 and 5,484 feet.
22. Kerr-McGee completed a new well in Sand Dunes Field. The 21-14 Sand Dunes Muddy Unit well in NE NW section 14, T36N, R76W flowed 1.8 million cubic feet of gas and 118 barrels of oil from the Muddy Sandstone between 13,002 and 13,014 feet.
23. Union Pacific Resources completed two new horizontally-drilled Niobrara producers on the flanks of Silo Field. The 1H Elk Mountain 41-4 well drilled from a surface location in NE NE section 4, T15N, R65W recovered 207 barrels of oil on a 3.5-hour test. The company has not disclosed any other information. The 1H Absaroka 14-29 well drilled from a surface location in SW SW section 29, T16N, R65W produced an average of 221 barrels of oil and 31 barrels of water during its first month on-line. Details on the productive interval were not released.

COAL UPDATE

P. Daniel Vogler

Staff Geologist-Coal, Wyoming State Geological Survey

Wyoming coal production set another record in 1995 at 263.9 million tons (**Table 1** and **Figure 7**). Campbell and Converse Counties, saw the greatest increases in production, although the 2.4-million-ton increase in Converse County was dwarfed by the 27.2-million-ton increase in Campbell County (**Table 11**). While production from Lincoln County also increased slightly, production from Carbon and Sweetwater Counties declined. **Table 12** compares the 1994 and 1995 production for each mine in Wyoming. Black Thunder was the largest mine with production of more than 36.1 million tons. The Rochelle, Jacobs Ranch, and North Antelope mines followed with production of 26.0, 24.6, and 21.2 million tons, respectively.

Although Wyoming coal production increased significantly in 1995 (11.4%), about 74% of that coal was sold at prices below \$5.00/ton F.O.B. the mine (**Table 11**). The Contracts section of this update describes a sale at only \$3.70/ton..

Figure 13 shows that most of the increased production in 1995 came from new contract sales, which remained 2-5 million tons above all monthly contract deliveries in 1994. It is also apparent that spot market sales in 1995 were nearly

Table 11. 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, April, 1996

Table 12. Wyoming coal production and employment by coal field and mine, 1994 and 1995.

Mine Name	Company	1994		1995		Production Difference 1995-1994	Percentage Increase/Decrease
		Employees	- Production (tons)	Employees	- Production (tons)		
POWDER RIVER COAL FIELD							
Antelope	Karnecott Energy, Inc.	119	8,258,590	128	10,866,880	2,608,290	31.58
Belle Ayr	Cyrus-AMAX Coal Co.	239	18,361,866	224	18,771,977	410,111	2.23
Big Horn	Big Horn Coal Co.	17	100,733	17	37,472	-63,261	-62.80
Black Thunder	Thunder Basin Coal Co.	458	31,616,222	449	36,149,282	4,533,060	14.34
Buckskin	Trilon Coal Co.	140	10,955,839	146	11,600,000	644,161	5.88
Caballo	Powder River Coal Co.	322	14,428,600	232	18,357,087	3,928,487	27.23
Caballo Rojo	Kerr-McGee Coal Corp.	182	16,611,485	186	16,808,549	197,064	1.19
Clover Point	Kerr-McGee Coal Corp.	5	202,202	5	408,994	206,792	202.27
Coal Creek	Thunder Basin Coal Co.	59	2,532,889	64	4,199,587	1,666,698	65.80
Cordero	Karnecott Energy, Inc	204	16,413,646	210	14,607,000	-1,806,646	-11.01
Dave Johnston	Glenrock Coal Co.	182	3,159,725	183	3,268,961	109,236	3.46
Dry Fork	Phillips/Western Fuels	51	3,836,228	47	3,603,453	-232,775	-6.07
Eagle Butte	Cyrus-AMAX Coal Co.	201	17,161,000	180	16,942,000	-219,000	-1.28
Fort Union	Fort Union Coal Co.	5	84,122	6	450	-83,672	-99.47
Jacobs Ranch	Kerr-McGee Coal Corp.	349	20,550,847	381	24,645,109	4,094,262	19.92
North Antelope	Powder River Coal Co.	149	14,147,809	241	21,248,991	7,101,182	50.19
North Rochelle	SMC Mining Co.	1	220,909	2	677,409	456,500	206.65
Rawhide	Powder River Coal Co.	176	12,858,787	168	15,355,000	2,496,213	19.41
Rochelle	Powder River Coal Co.	232	22,677,048	276	26,035,555	3,358,507	14.81
Wyodak	Wyodak Resources	52	2,795,942	51	2,984,000	188,058	6.73
TOTAL		3,143	216,974,489	3,196	246,567,756	29,593,267	13.64%
HANNA COAL FIELD							
Medicine Bow	Arch of Wyoming	76	1,838,300	68	1,699,106	-139,194	-7.57
Rosebud	Rosebud Coal Sales Co.	17	Reclamation	16	Reclamation	0	0.00
Seminole No. 2	Arch of Wyoming	4	0	8	113,991	0	100.00
Shoshone No. 1	Cyrus Shoshone Coal Co.	185	2,543,441	141	1,990,114	-553,327	-21.76
TOTAL		282	4,381,741	233	3,803,211	-692,521	-13.20%

Table 12. Wyoming coal production and employment by coal field and mine, 1994 and 1995 (continued).

Mine Name	Company	1994		1995		Production Difference 1995-1994	Percentage Increase/Decrease	
		Employees	Production(tons)	Employees	Production(tons)			
BIGHORN COAL FIELD								
Grass Creek	Northwestern Resources	(surface)	4	5,564	0	0	-5,564	-100.00
TOTAL			4	5,564	0	0	-5,564	-100.00%
HAMS FORK COAL FIELD								
Kemmerer Skull Point	Pittsburg & Midway FMC Wyoming Corp.	(surface) (surface)	307	3,619,259	311	3,624,328	5,069	0.14
			84	670,934	74	820,000	149,066	22.22
TOTAL			391	4,290,193	385	4,444,328	154,135	3.59%
GREEN RIVER COAL FIELD								
Black Butte	Black Butte Coal Co.	(surface)	274	4,029,060	182	2,155,632	-1,873,428	-46.50
Jim Bridger	Bridger Coal Co.	(surface)	392	7,036,084	375	6,967,096	-68,988	-0.98
Pilot Butte	Arch of Wyoming	(deep)	3	0	3	0	0	0.00
Swanson	Cougar Coal Co.	(deep)	82	190,936	0	0	-190,936	-100.00
TOTAL			751	11,256,080	560	9,122,728	-2,133,352	-18.95%
TOTAL UNDERGROUND								
			270	2,734,377	144	1,990,114	-744,263	-27.22%
TOTAL SURFACE								
			4,301	234,173,690	4,230	261,947,909	27,774,219	11.86%
GRAND TOTAL			4,571	236,908,067	4,374	263,938,023	27,029,956	11.41%

Modified from Annual Reports of the Wyoming State Inspector of mines.
Wyoming State Geological Survey, Coal Section, April, 1996.

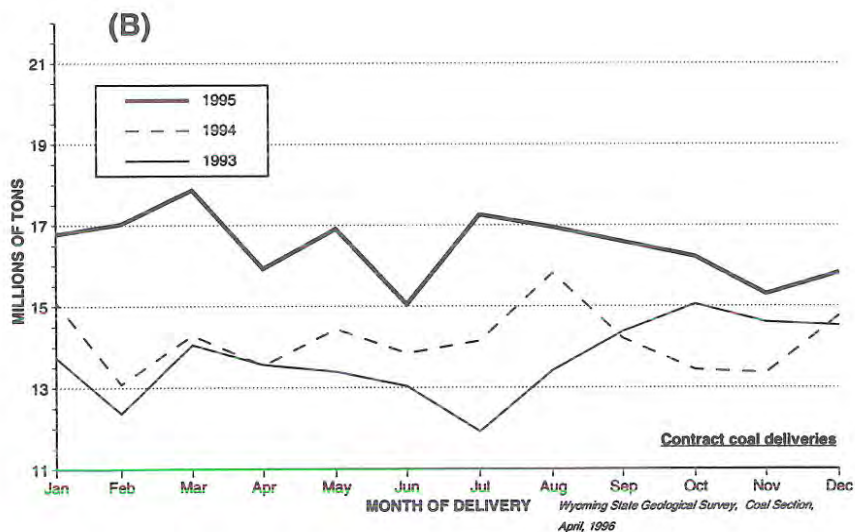
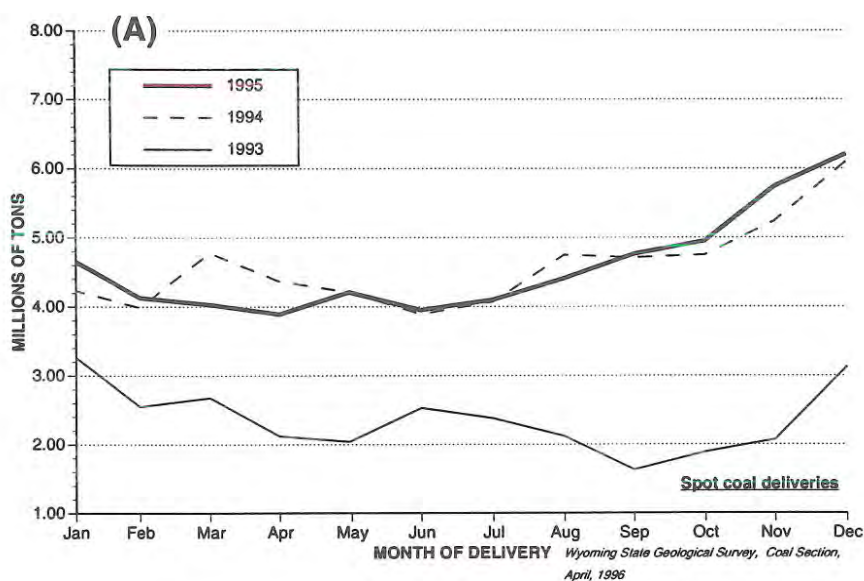


Figure 13. Monthly coal deliveries from Wyoming (1993 through 1995). (A) Coal sold on the spot market and (B) coal sold on contract. (From COALDAT Marketing Report by Resource Data International, Inc., compiled from the FERC Form 423 filed monthly by electric utilities).

the same as those in 1994. Spot deliveries in all of the last three years, however, have increased in the fourth quarter as the weather got colder (**Figure 13**). Spot sales begin to decrease in January or February while contract sales are not as predictable. And the third and fourth quarters of 1995 marked the first time in history that Wyoming's overall reported coal deliveries remained above 21 million tons for six consecutive months (**Table 13** and **Figure 14**). Because there is about 11 million tons of unreported deliveries each year, reported deliveries only need to average 22 million tons per month to reach our production estimate of 274.9 million tons in 1996.

In 1996, the permitted annual capacity of all the coal mines in Wyoming totalled about 446.13 million tons, indicating that production in 1995 was at about 59% of permitted capacity (**Table 14**). By 1997, permitted mine capacity increases to about 466.5 million tons. This permitted annual capacity refers to the level of production that each mine has had approved or permitted by the Air Quality Division of the Wyoming Department of Environmental Quality. A mine's permitted annual capacity is not the same as its current producing capacity because permitted capacity reflects anticipated increases in production capacity. For example, of the 28 producing mines in the State, only five mines produced more than 80% of their permitted capacity in 1995. While another 11 mines produced 50-77% of their permitted capacity, the remaining twelve mines were at less than 50% of theirs.

Collectively, the Antelope, Black Thunder, and North Rochelle mines are currently applying for an additional 41 million tons of annual mine capacity (**Table 14**). If these permits are approved, total annual permitted capacity for Wyoming's coal mines will increase to over 500 million tons per year by 1997.

The Surface Transportation Board, successor to the Interstate Commerce Commission, has received some opposition to the merger of the Union Pacific and Southern Pacific Railways. Reports indicate that while the merger would in all likelihood eliminate over 3,500 jobs in the San Francisco area, it will probably create more than 70 jobs in Wyoming. The Texas Railroad Commission, the Public Service Commission of Colorado, and the Nevada Public Service Commission are the primary opponents to the merger.

In early February, a 66-car train derailment near Bill, Wyoming, caused slowdowns in first quarter coal deliveries. Officials stated that it took about two and one-half weeks to recover from the effects of the accident. This accident occurred near the NACCO rail bridge, the site of a previous train derailment in the Spring of 1995.

The U.S. Environmental Protection Agency's 1996 auction of sulfur dioxide emission credits netted the lowest prices paid to date for emission credits. Enron Power Marketing, which mainly deals in oil and gas, bought more than two-thirds of the 150,000 credits that were offered. Enron paid an average of \$68 per credit for the 107,269 sulfur dioxide credits they purchased. All of the offered 150,000 credits were sold. Many analysts think the \$68 price is the

Table 13 . Monthly coal deliveries from Wyoming's mines in short tons.

	1992		1993		1994		1995	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
JAN	16,407,150	16,407,150	15,931,150	15,931,150	19,326,770	19,326,770	21,586,303	21,586,303
FEB	14,604,480	31,011,630	14,646,090	30,577,240	17,171,910	36,498,680	20,839,926	42,426,229
MAR	14,429,650	45,441,280	17,112,970	47,690,210	19,178,990	55,677,670	21,707,422	64,133,651
APR	14,063,060	59,504,340	16,259,770	63,949,980	17,839,110	73,516,780	20,066,616	84,200,267
MAY	14,518,590	74,022,930	16,085,470	80,035,450	18,652,290	92,169,070	21,509,916	105,710,183
JUN	14,655,600	88,678,530	16,473,920	96,509,370	17,741,480	109,910,550	18,602,505	124,312,688
JUL	15,592,050	104,270,580	15,296,480	111,805,850	18,213,540	128,124,090	21,334,608	145,647,296
AUG	16,467,100	120,737,680	16,682,090	128,487,940	20,572,120	148,696,210	21,356,870	167,004,166
SEP	14,878,150	135,615,830	17,310,330	145,798,270	19,129,450	167,825,660	21,355,730	188,359,896
OCT	15,122,820	150,738,650	18,300,070	164,098,340	18,189,260	186,014,920	21,178,610	209,538,506
NOV	14,757,230	165,495,880	18,007,970	182,106,310	18,595,500	204,610,420	21,042,260	230,580,766
DEC	16,096,150	181,592,030	19,034,530	201,140,840	20,866,710	225,477,130	22,032,910	252,613,676
Total Tonnage Reported¹		181,592,030		201,140,840		225,477,130		252,613,676
Total Tonnage Not Reported²		7,878,226		8,784,986		11,430,937		11,324,347
Total Tonnage Produced³		189,470,256		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

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, April, 1996.

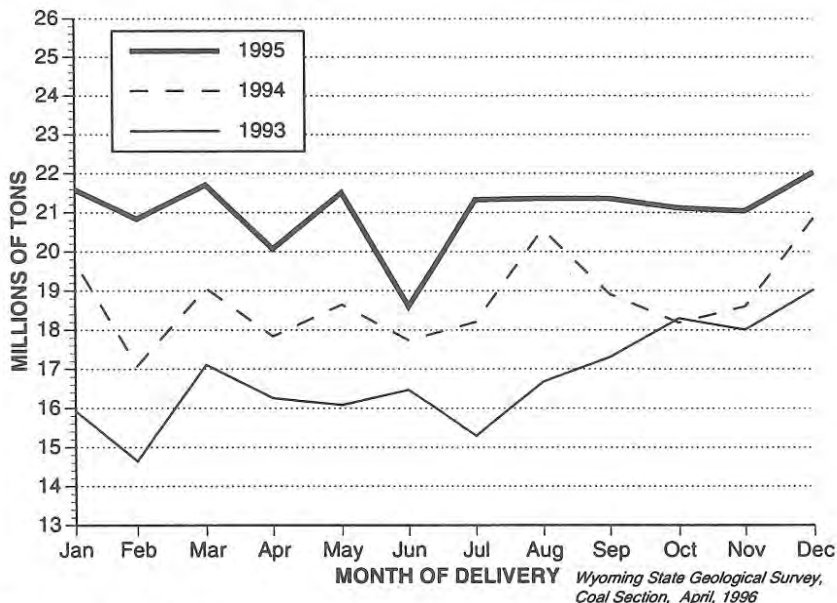


Figure 14. Reported deliveries from Wyoming coal mines (1993 through 1995). From COALDAT Marketing Report by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities).

bottom for the credit market. The depressed prices paid for emission credits stem from a lower than expected demand. This lower demand is attributed to the fact that many major utilities in the East have reached compliance with Phase I of the 1990 Clean Air Act Amendments and do not need credits. Each emission credit is equal to one ton of sulfur dioxide.

Developments in the Powder River Basin

In the Montana portion of the basin, the Bull Mountain mine is in the process of forming a joint venture with Sumitomo, a Japanese firm. It has been suggested that this joint venture could result in an additional one million tons of this low-end, metallurgical-grade coal going to Pacific Rim customers (Montana Coal Council, 1996). Also, Decker Coal Co. obtained two coal agreements, totaling 700,000 tons, for delivery in 1996.

In other Montana news, Unit 3 at the Colstrip power plant was shut down in March. Officials cited excess hydropower as the main reason (Montana Coal Council, 1996). The excess hydropower in the West may affect some of Wyoming's southwestern mines since hydropower is a cheap alternative in some of their market areas.

Two coal beneficiation projects have resumed planning in the Powder River Basin. Construction on the Carbontec plant, which is sited adjacent to the

Table 14. Comparison of Wyoming's 1995 coal production with permitted annual mine capacity, by mine.

Parent Company	Mining Operator	Mine Name	Tonnage ¹	Capacity ²	Capacity used in 1995
Kennecott Minerals	Kennecott Energy, Inc.	Antelope	10,866,880	12.00 ³	90.56%
Cyprus-AMAX	Cyprus-AMAX Coal West	Belle Ayr	18,771,977	25.00	75.09%
Kiewit Mining Group	Big Horn Coal Co.	Big Horn	37,472	4.60	0.81%
Kiewit Mining Group	Black Butte Coal Co.	Black Butte	2,155,632	9.50 ⁴	22.69%
ARCO	Thunder Basin Coal Co.	Black Thunder	36,149,282	44.00 ⁵	82.16%
Zeigler Coal Co.	Triton Coal Co. (SMC Mining Co.)	Buckskin	11,600,000	24.00	48.33%
Peabody Holding Co.	Powder River Coal Co.	Caballo	18,357,067	35.00	52.45%
Drummond, Inc.	Caballo Rojo, Inc.	Caballo Rojo	16,808,549	30.00	56.03%
ARCO	Thunder Basin Coal Co.	Coal Creek	4,199,587	18.00	23.33%
Kerr-McGee Corp.	Kerr-McGee Coal Corp.	Clovis Point	408,994	4.00	10.22%
Kennecott Minerals	Kennecott Energy, Inc.	Cordero	14,607,000	24.00	60.86%
Pacific Power and Light	Glenrock Coal Co.	Dave Johnston	3,268,961	4.23	77.28%
Phillips/Western Fuels	Dry Fork Coal Co.	Dry Fork	3,603,453	15.00	24.02%
Cyprus-AMAX	Cyprus-AMAX Coal West	Eagle Butte	16,942,000	24.00	70.59%
Fort Union Ltd. Partnership	Fort Union Coal Co.	Fort Union	450	9.40	0.00%
Entech Inc. (Montana Power)	Northwestern Resources	Grass Creek	0	0.35 ⁶	0.00%
Kerr-McGee Corp.	Kerr-McGee Coal Corp.	Jacobs Ranch	24,645,109	35.00	70.41%
PacificCorp/Idaho Power	Bridger Coal Co. (Glenrock Coal Co.)	Jim Bridger	6,967,096	7.90	88.19%
Chevron Corp.	Pittsburg & Midway Coal Mining	Kemmerer	3,624,328	4.20	86.29%
Arch Minerals	Arch of Wyoming, Inc.	Medicine Bow	1,699,106	4.00	42.48%
Peabody Holding Co.	Powder River Coal Co.	North Antelope	21,248,991	35.00 ⁷	60.71%
Zeigler Coal Co.	Triton Coal Co. (SMC Mining Co.)	North Rochelle	677,409	8.00 ⁸	8.47%
Arch Minerals	Arch of Wyoming, Inc.	Pilot Butte	0	2.00 ^{6, 9}	0.00%
Peabody Holding Co.	Powder River Coal Co.	Rawhide	15,355,000	24.00	63.98%
Peabody Holding Co.	Powder River Coal Co.	Rochelle	26,035,555	30.00 ⁹	86.79%
Entech Inc. (Montana Power)	Northwestern Resources	Rocky Butte	0	16.00 ¹¹	0.00%
Cyprus-AMAX	Cyprus Shoshone Coal Co.	Shoshone No. 1	1,990,114	3.50	56.86%
Arch Minerals	Arch of Wyoming, Inc.	Seminole 2	113,991	2.10	5.43%
FMC Corp.	FMC Wyoming Corp.	Skull Point	820,000	1.50	54.67%
Cougar Coal Co.	Cougar Coal Co.	Swanson	0	0.25 ⁸	0.00%
Black Hills Corp.	Wyodak Resources	Wyodak	2,984,000	10.00 ¹²	29.84%
Total			263,938,023	466.53 ¹³	56.57%

Compiled by Wyoming State Geological Survey, March 1996

- ¹ Tonnage in short tons from Wyoming State Mine Inspector's Office, Box 1094, Rock Springs, WY, 82902.
- ² Tonnage in millions of tons/year (MMTPY) from the Department of Environmental Quality, Division of Air Quality.
- ³ Application submitted for another 18 MMTPY.
- ⁴ Tonnage and capacity figures include Black Butte and Leucite Hills mines.
- ⁵ Tonnage on a build up schedule from 36 MMTPY in 1994 to 44 MMTPY in 1997, with an application to increase capacity to 55 MMTPY.
- ⁶ Constructed, but mine temporarily closed.
- ⁷ Permitted for 31.5 MMTPY in 1995, 30.6 MMTPY in 1996, 35 MMTPY from 1997 on.
- ⁸ Application submitted for another 12 MMTPY.
- ⁹ Closed 7/10/93; apparently sold to a subsidiary of Union Pacific Corporation.
- ¹⁰ Permitted for 28 MMTPY in 1995, and 30 MMTPY from 1996 on.
- ¹¹ Not constructed yet, permitted for 8 MMTPY for first two years of mine life; 16 MMTPY each following year
- ¹² On a build up schedule to 10 MMTPY.
- ¹³ This tonnage is based on using the highest capacity figures referred to in the footnotes.

Caballo Rojo mine, could start as early as this summer. This plant is expected to produce 2.0 million tons of refined coal (low-sulfur briquettes) a year from a feedstock of 2.8 million tons of subbituminous coal. The other project, a Kfx-clean-coal plant is slated for construction at the Fort Union mine site. K-Fuels expects this plant to produce 500,000 tons of refined product a year from about 700,000 tons of subbituminous coal. K-Fuels hopes to complete construction of this plant in 1996.

Developments In Western And Southwestern Wyoming

Perhaps the biggest first quarter news in southwestern Wyoming was the sale of the underground Pilot Butte mine, located north of Rock Springs. The Pilot Butte mine was sold by Arch Mineral Corporation, to its lessor, a subsidiary of Union Pacific Corporation. No other details of the sale are available.

Contracts

Table 15 and **Figure 15** depict coal marketing activity in Wyoming for the first quarter of 1996. Recent bids in response to coal solicitations indicate that some Powder River Basin coal prices were below \$4.00/ton F.O.B. the mine.

The Lower Colorado River Authority (LCRA) recently finalized its coal supply agreements with Kerr-McGee Coal Corp. The agreement centered around a 350,000-ton sale of coal from the Jacobs Ranch mine at an F.O.B. mine price of \$3.70/ton. LCRA also has an option to buy an additional 400,000 tons at a price of \$3.60/ton.

In other sales, Detroit Edison purchased 1.2 million tons of coal from the Rochelle mine. Also, Cordero sold 1.5 million tons of coal to MidAmerican Power's Council Bluffs, Louisa, and Neal plants. Neither of these sales announcements cited prices.

Coalbed Methane

Since 1992, the U.S. Bureau of Land Management has written Environmental Assessments on three coalbed methane projects in the Powder River Basin: Exxon's three-well, Pistol Point project (approved in October 1992); American Oil and Gas' 40-well, Marquiss project (approved in November 1992); and American Oil and Gas' 200-well, Lighthouse project (approved in June 1995, but still on appeal with the Interior Board of Land Appeals). The appeal was filed by the Powder River Basin Resource Council (PRBRC). Since then, Torch Operating (successor operator of the Marquiss project) has proposed 40 additional wells (63 wells had already been drilled); Western Gas Resources has proposed 60-100 wells in the Lighthouse project area; Petrox Inc. has proposed 35 wells in the Lighthouse area; and Redstone Resources has proposed 100-200 wells north and west of the Buckskin coal mine. Another operator, DCD, Inc., had a coalbed methane project in operation, but all their wells were on fee lands.

Table 15. Activities involving coal producers in Wyoming during the first quarter of 1996¹.

Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
1. Commonwealth Edison	Various plants	Souther Powder River Basin	Sp	150,000 t	
2. Dairyland Power and Electric	Genoa and Alma	North Antelope	C	500,000 t	
3. Detroit Edison	Various plants	Rochelle	C	1,200,000 t	
4. Georgia Power	Scherer	Powder River Basin	So	2,400,000 t	Terms for up to five years.
5. Gulf Power	Various plants	Low-sulfur coal	C	500,000 t	
6. Indiana Michigan Power	Rockport	Powder River Basin	So	Variable	Terms for 3-12 months, 2-5 years, and 5 years are being accepted.
7. Lower Colorado River Authority	Fayette	Jacobs Ranch	Sp	350,000 t	\$3.70/ton F.O.B. mine.
8. MidAmerican Power	Council Bluffs, Louisa, and Neal	Cordero	C	1,500,000 t	
	Neal	Hanna Basin	Sp	600,000 t	
9. Texas Utilities Electric	Monticello	Cordero, Belle Ayr, Black Thunder	C	500,000 t	

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



Wyoming State Geological Survey, Coal Section, April 1996

Figure 15. Coal Marketing activities related to Wyoming in the first quarter of 1996. [Numbers correspond to those in Table 15].

In 1995, because of the number of wells applied for and concerns over possible effects on local water wells, the U.S. Bureau of Land Management stopped issuing Applications for Permit to Drill while they looked into their compliance with the National Environmental Policy Act. Late in 1995, the BLM facilitated a meeting between landowners, industry, the State Engineer's office, and the PRBRC to see if both the landowner's and the industry's concerns could be mitigated. Other facilitated meetings were held in the first quarter of this year. There is some hope that the dialogue between these parties might eliminate the need for a cumulative Environmental Impact Statement dealing with coalbed methane development in the Powder River Basin.

Reference Cited

Montana Coal Council, 1996, Montana Coal Council Newsletter, March, p. 2.

INDUSTRIAL MINERALS AND URANIUM UPDATE

Ray E. Harris

Staff Geologist - Industrial Minerals and Uranium, Wyoming State Geological Survey

For 1995, the U.S. Geological Survey showed Wyoming 14th in nonfuel mineral production, and second in per capita valuation of nonfuel minerals. And Wyoming is eighth among states in industrial minerals production according to the most recently available figures from the now defunct U.S. Bureau of Mines. Wyoming ranks first among states in the value of its trona and bentonite production.

Industrial minerals currently mined in Wyoming include, in alphabetical order:

- Bentonite
- Clay, non-bentonitic (intermittent production)
- Construction aggregate
- Decorative aggregate
- Decorative stone
- Feldspar
- Gypsum
- Leonardite
- Limestone, chemical grade
- Shale
- Sodium sulfate
- Sulfur (recovered)
- Trona

There is also current exploration and development interest in the following five industrial minerals:

- Decorative stone
- Diamond
- Silica sand
- Trona
- Zeolite

Another two industrial materials are manufactured in Wyoming from industrial minerals mined out-of-state.

- Lime
- Perlite (expanded)

Construction Aggregate

An industry official now predicts that construction activity in 1996 will be at about the same level as 1995. In January, Bob Gaukel, Executive Vice President of the Wyoming Contractors' Association, said that the highway construction program is about the same as last year, and that no new heavy construction projects are anticipated. As a result, the production of construction aggregate in Wyoming will likely remain close to the estimated 6 million tons of sand and gravel (river rock) and the 3.5 million tons of crushed rock (granite, limestone, and clinker [baked and fused shale]) quarried in 1995. Earlier, officials had indicated that aggregate production might decline in 1996.

Trona

Trona is mined by underground methods at five locations in Wyoming, and is refined into sodium products at plants near the mines (Figure 16). Table 16 lists the operators and the owners of the five operating trona mines.

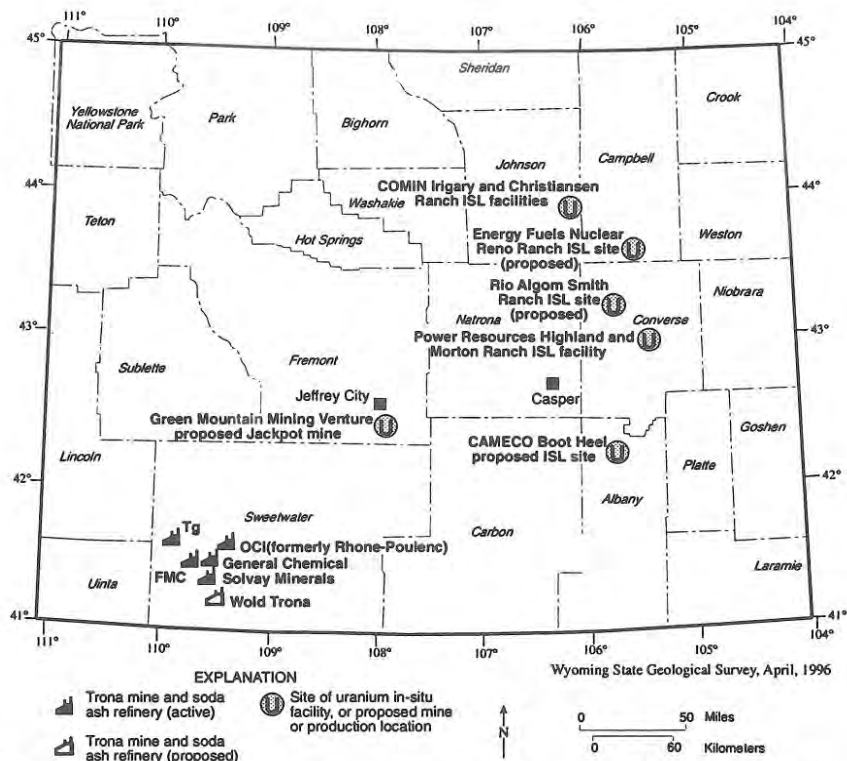


Figure 16. Industrial minerals and uranium activities in Wyoming during the first quarter of 1996. [ISL refers to in-situ leaching of uranium].

Table 16. Wyoming trona producers and ownership.

Producer	Owners/Partners	Country of Partners
FMC (formerly FMC Wyoming)	FMC, Inc. (80%) Nippon Sheet Glass Ltd/ Sumitomo Corp. Joint Venture (20%)	United States Japan
General Chemical Soda Ash Partners, Inc (formerly General Chemical)	General Chemical, Inc. (51%) TOSOH Corp. (49%)	United States Japan
OCI Enterprises (formerly Rhône-Poulenc)	Oriental Chemical Ltd. (51%) Union Pacific Corp. (49%)	S. Korea United States
Solvay Minerals	Solvay S.A. (80%) Asahi Glass Ltd. (20%)	Belgium Japan
Tg Soda Ash	Elf-Aquitaine (100%)	France

According to the Wyoming State Inspector of Mines, trona production in 1995 set a new record at 18.1 million tons, up 2.0 million tons from 1994 (Table 1). Over the previous six years, trona production has been relatively level, ranging between 16.0 and 16.4 million tons. Trona production is expected to flatten out after a relatively slight increase again this year.

In early February, the U.S. Department of the Interior announced increases in the royalty rate on trona produced from Federal leases. The rate will increase from the current 5% to a 6% rate on all lease renewals, effective at the time of renewal. New trona leases will go to 8%.

Also in February, the U.S. Bureau of Land Management (BLM) announced that almost 10,000 acres of Federal trona-bearing lands will be offered by competitive lease sales this year. The last lease of Federal land in the trona resource area was in 1986. High bids at that time were about \$300 per acre. The BLM estimates that collectively there are about 500 million tons of minable trona reserves in the tracts being offered for lease.

Currently, two of the five existing producers, General Chemical and Solvay Minerals, have expressed an interest in some of the leases, along with four companies that do not presently mine trona. These other companies are Church & Dwight, which refines soda ash into baking soda at a plant adjacent to General Chemical; Placer Dome, a Canadian mining company; Unimin, a large domestic industrial minerals company especially prominent in the mining of glass sand; and U.S. Borax, a subsidiary of RTZ, a British worldwide mining company.

The first of these lease sales was held on May 1st in Cheyenne. The second, and larger of the two sales, is planned for late September. The high bids on the three tracts offered in May totalled about \$4.1 million. The BLM rejected

the bid on one tract, dropping the total received for the two other tracts to \$3.67 million. These three tracts, which comprised 2,560 acres, contained an estimated 97.9 million tons of minable trona. The largest of the three tracts (1,280 acres) contains an estimated 60.2 million tons and netted the smallest bid at \$424,960 (\$332 per acre). This bid, which came from Solvay Minerals, was the only bid on this tract and it was the bid that the BLM rejected. General Chemical submitted the high bids on the two 640-acre tracts. They bid about \$2.04 million (\$2,437 per acre) for a tract with 18.1 million tons of trona reserves and about \$1.63 million (\$3,193 per acre) for the other tract with 19.6 million tons of trona. The tract that was not leased will likely be included again in the September sale.

Uranium

According to figures released by the Uranium Exchange, the unrestricted spot market price of yellowcake (the mill product of uranium) has risen from \$7.50 per pound in March, 1995, to \$14.00 per pound as of April 2, 1996. In late February, the *Wall Street Journal* reported that this price increase was the result of greater-than-expected consumption of uranium by North American and Asian nuclear power plants and less-than-expected sales of uranium from the former Soviet bloc nations. Some analysts believe that the price will increase to \$20.00 per pound this year. And some optimistic analysts predict the price going as high as \$40.00 per pound by 1998. This would be close to the record high of \$42.00 per pound of yellowcake set in March, 1979. At that time, there were seventeen operating uranium mines in Wyoming. Today, there are only two in-situ leach (solution mining) operations in production (Figure 16).

As a result of the price increase, uranium production from Wyoming is expected to increase this year. Power Resources announced that it was hiring additional personnel at its Highland-Morton Ranch in-situ leach (ISL) facility and expected to significantly increase production. COMIN, which operates production facilities at the Irigary and Christiansen Ranch sites west of the Pumpkin Buttes, is completing a new, larger production well field. COMIN also constructed new offices at the Christiansen Ranch site, and moved its personnel from the old offices at the Irigary Ranch.

In addition to these expansions of existing operations, five uranium properties are in developmental stages, with the potential of coming into production if the price of yellowcake continues to improve (Figure 16). These are the Smith Ranch ISL project of Rio Algom in the southern Powder River Basin; Energy Fuels Nuclear's Reno Ranch ISL project in the Powder River Basin; Kennecott Minerals' Jackpot underground mine on Green Mountain south of Jeffrey City; and CAMECO Resources (US) Inc. (formerly CAMECO), which has a developmental ISL project at Boot Heel in northern Albany County as well as another project at an undisclosed location in central Wyoming. Also expanding production is Crow Butte Resources at the Crow Butte mine near Crawford, Nebraska. Thanks are due Bob Odell and his *Rocky Mountain Scout* for most of this information on uranium activities.

Kennecott Minerals, which plans to operate the Jackpot mine under a joint venture known as the Green Mountain Mining Venture, has reached a settlement with the Wyoming Outdoor Council (WOC). As a result, the WOC will drop most of its objections to the Environmental Impact Statement (EIS) while the Mining Venture will allow an extended public comment period on the EIS.

METALS AND PRECIOUS STONES UPDATE

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While much of the U.S. is undergoing a significant decline in mineral exploration, Wyoming is seeing an increase in exploration for gemstones, precious metals, and base metals. This interest has been helped by several significant mineral discoveries either made by individuals, companies, or the Wyoming State Geological Survey (WSGS). Based on comments from recent inquirers, the WSGS's publications and talks at national conferences have also played a major role. However, don't expect any new mines in the immediate future. It typically takes up to 20 years from discovery to mine development. But in the meantime, industry is spending exploration dollars, much of which ends up in the local economy.

In the Green River Basin, Guardian American Minerals, Inc. of Reno, Nevada, continued evaluating its November, 1995, discovery of 10 'kimberlitic' diatremes. In February, Guardian American Minerals, which is a wholly-owned subsidiary of Guardian Enterprises Ltd., announced the recovery of diamonds from these diatremes. The discovered pipes and dikes are located in Uinta County in southwestern Wyoming. Two of the diamonds were recovered from a 200-pound core sample. According to Guardian American, they found a 1.07 mm diamond and a 0.13 mm diamond. A company geologist picked a third diamond off the ground adjacent to another pipe. This was a small gem-quality stone approximately 2.2 mm in diameter. While the newly discovered diamonds are small, it should be remembered that the first diamonds found in the State Line district in southeastern Wyoming in 1975 were microscopic. Although it took two decades, the first diamond mine in North America opened on the Colorado side of the State Line district last fall.

In mid-April, the WSGS began grease-table tests on samples from Guardian's 'kimberlitic' diatremes in the Green River Basin. The grease table is designed to extract diamonds from the samples. Also, the WSGS has contracted with the University of Arizona to conduct electron microprobe analysis of indicator minerals from the Green River Basin intrusives. The microprobe will collect geochemical information useful in determining the depth of origin and emplacement conditions of Guardian's Cedar Mountain pipes. These microprobe analyses are critical in identifying the 'kimberlitic' rock, which hosts the diamonds.

Based on the extent of 'kimberlitic' indicator minerals (chromian diopside and pyrope garnet) in the area, other kimberlitic or lamproitic pipes remain to be discovered. Consequently, this summer the Metals and Precious Stones Section of the WSGS plans to conduct geophysical surveys in the Green River Basin over structural anomalies that might indicate the locations of additional, potentially diamondiferous 'kimberlitic' pipes.

At least three other companies will explore for diamonds in southwestern Wyoming this year. In addition, a Canadian company is currently seeking exploration agreements in the Colorado-Wyoming State Line district.

The Colorado-Wyoming State Line diamond district, which contains approximately 35 identified diamondiferous kimberlites as well as several untested geophysical anomalies, has already produced more than 120,000 diamonds, including a 14.2-carat gemstone. So far, commercial production of diamonds has come from the Colorado portion of the district, but there are inadequately tested pipes and untested anomalies in Wyoming that may also yield commercially economic diamonds.

According to the *Northern Miner* (4/1/96), Redaurum Ltd. will have their 200-tonne-per-hour diamond extraction mill on the Kelsey Lake property in Colorado operational in May. A parcel of stones from the mine recently sold at an average price of \$206 per carat.

Several companies have shown interest in other gemstones found in Wyoming and Colorado. Probably one of the more unusual interests is a Pennsylvania-based company, which cuts gemstones from the emerald green mineral called chromian diopside. The company currently imports its material from diamond deposits in Siberia. The company's interest turned to Wyoming after they read in a WSGS publication that several Wyoming diamond deposits have chromian diopside associated with them, and that local collectors had cut some of the material into gemstones. As examples, some chromium diopside material collected from the Sloan kimberlite in Colorado as well as the newly discovered 'kimberlitic' pipes in the Green River Basin of Wyoming have reportedly been cut into gems. Gemstones have also reportedly been cut from garnets found in the Green River Basin.

Following the WSGS's report on gem-quality rubies in the Granite Mountains of central Wyoming, at least two companies have shown exploration interest. A third company, from Cleveland, has requested assistance in their search for high-quality jade deposits.

One of the more exciting developments in the State in recent years followed the WSGS's late-1994 discovery of significant nickel anomalies in the Sierra Madre. After announcing the discovery, dozens of companies and consultants have contacted the WSGS for additional information. Currently, nine different companies have expressed interest in exploring southeastern Wyoming for similar nickel-copper-cobalt-gold-platinum-palladium mineralization. Because

of the worldwide interest in nickel, southeastern Wyoming should see a fair amount of exploration this summer. Two other companies have expressed interest in zinc mineralization in the same region.

A large-tonnage, low-grade, copper-gold deposit west of Cheyenne is receiving some interest by two companies. According to the now defunct U.S. Bureau of Mines, this deposit has a 35-million-ton resource with an estimated 770,000 ounces of gold and 147 million pounds of copper.

There is also some interest in gold mineralization in the Rattlesnake Hills west of Casper and in the Bear Lodge Mountains in northeastern Wyoming. The WSGS detected anomalous gold in the Rattlesnake Hills in 1982, and some recent company drilling identified a large-tonnage, low-grade gold resource. A similar, large-tonnage, low-grade gold deposit was discovered in the Bear Lodge Mountains several years ago by a mining company. Available reports indicate this latter deposit has an estimated resource of at least 8.2 million tons with 172,000 ounces of gold.

On Friday, August 9, 1996, the Metals and Precious Stones Section of the WSGS has scheduled a one-day short course on exploration for gold and diamonds in Wyoming. This course will include discussions of many of the State's gold and diamond deposits. It will be held at the Wyoming State Geological Survey building in Laramie, but will be limited to the first 20 registrants. See the **Rock Hound's Corner** in this issue of *Wyoming Geo-notes* for registration information (p. 56).

SUMMARY OF MINERAL EXPLORATION IN WYOMING - 1995

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Wyoming State Geological Survey

INDUSTRIAL MINERALS

Industrial minerals produced in Wyoming in 1995 included bentonite, construction aggregate, feldspar (for decorative aggregate), granite (for decorative aggregate, decorative stone, and railroad ballast), gypsum (for cement and wallboard), leonardite, limestone (for construction aggregate and control of emissions from power plants), marble (for decorative aggregate), scoria or clinker (baked and fused shale used for construction and decorative aggregate), siliceous shale (used in cement), sodium sulfate, and sulfur produced from the refining of natural gas. Some of the sulfur from Chevron's Carter Creek natural gas processing plant is used in the manufacture of fertilizer at SF Phosphate's fertilizer plant southeast of Rock Springs.

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Technically Recoverable Resources (January 1, 1996)	
Discovered (Includes oil, gas liquids, and condensate)	3.61 billion barrels ¹
Undiscovered	6.18 billion barrels ¹
Total	9.79 billion barrels

Remaining Reserve Base (January 1, 1996)	
Measured reserves (Proved reserves) (Includes oil, gas liquids, and condensate)	0.97 billion barrels ²
Indicated and inferred reserves (Reserve growth in conventional fields)	2.64 billion barrels ¹
Total	3.61 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, 1995)	
Identified and Hypothetical (Discovered)	1,427.5 billion tons ⁴
Speculative (Undiscovered)	31.5 billion tons ⁴
Total	1,459.0 billion tons
Remaining Reserve Base (January 1, 1995)	
Demonstrated strippable (Measured and indicated reserve base)	25.9 billion tons ⁵
Demonstrated underground-minable (Measured and indicated reserve base)	42.5 billion tons ⁵
Total	68.4 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.

In 1995, exploration for industrial minerals centered on bentonite, construction aggregate, decorative stone, limestone, silica sand, and trona. Most bentonite companies continued exploration for new producible deposits. In the Powder River Basin, bentonite in both the Mowry Shale and Frontier Formations near Sheridan was examined for possible production. However, the exploring company did not acquire mineral rights to the deposit.

Exploration and sales of construction aggregate continued. Meridian Aggregates, west of Cheyenne, increased production of their granitic gneiss aggregate, which is used for railroad ballast and other construction aggregate products. A proposed ballast site southwest of Wheatland is for sale. And Rissler-McMurry, a Casper construction company, has acquired a permit to quarry limestone aggregate near Alcova, west of Casper.

Exploration for decorative aggregate and decorative stone continued, as it has for the past three years. Sunrise Stone, which began production of two granitic rocks in 1991, expanded their fabricating plant with the addition of two saws, an engraving machine, and a polishing table. Guernsey Stone, near Guernsey, increased sales of decorative dolomitic marble aggregate. Georgia Marble continued quarrying and processing white marble at its Wheatland plant. Georgia Marble added personnel in 1995, and began development of another quarry on its marble deposit.

Because silica sand, soda ash, limestone, and feldspar are all found or manufactured in Wyoming, the Wyoming State Geological Survey is encouraging companies to consider the feasibility of manufacturing glass within the state. Low tax rates, the presence of large amounts of available low-cost natural gas, and innovative transportation methods may make glass production in Wyoming economically competitive with facilities in the rest of the U.S. At year's end, two silica sand sources, one north of Laramie and one southeast of Glendo, had been acquired by a Casper-based natural gas producer and resource company, which is conducting marketing and feasibility studies.

All five companies that mine bedded trona from the Eocene Green River Formation were constructing or planning plant expansions and improvements. Each of these companies was also considering the proposed Federal trona lease sales, scheduled for 1996. Four other companies (Church & Dwight, Placer Dome, Unimin, and U. S. Borax), which are not presently producing in Wyoming, have also expressed an interest in the leases. Wold Minerals continued with their plans for a sixth trona mine and refinery. Tg is owned by Société Nationale Elf Aquitaine, a French government agency. Rhône-Poulenc was purchased by Oriental Chemical Industry, a South Korean company.

URANIUM

Although there was no exploration for new uranium deposits in Wyoming in 1995, there were several company and property developments. COMIN, a subsidiary of COGEMA, increased production from the Christiansen Ranch

property, while the nearby Irigary Ranch property was placed on standby. Power Resources, which produces yellowcake from in-situ leaching of uranium at its Highland operations, which includes the Highland, Morton Ranch, and other properties in the southern Powder River Basin, announced plans to hire an additional four employees to achieve increased production rates. Energy Fuels Nuclear continued to study the feasibility of an in-situ production facility at its Reno Ranch property. Rio Algom announced that it was proceeding with the development of the Smith Ranch property in the southern Powder River Basin. Rio Algom is planning to use a water, carbon dioxide, and oxygen leaching solution in its in-situ process at the Smith Ranch Property. Kennecott Minerals proceeded with the development of the Jackpot underground uranium mine at Green Mountain south of Jeffrey City, and acquired several necessary mining permits.

METALS AND PRECIOUS STONES

During 1995, Wyoming received numerous inquiries for information and assistance on diamonds, rubies, gold, copper, nickel, zinc, titanium, iron, and other metals and precious stones.

Diamonds

Exploration activity for diamonds continued with much of the interest centered in the Colorado-Wyoming State Line district, 25 miles south of Laramie, and in the Green River Basin south of Rock Springs. More than 120,000 diamonds have been produced from the Colorado-Wyoming State Line district, to date. The district has 35 discovered kimberlite intrusives, nearly all of which are diamondiferous with reported grades ranging from 0.5 to 135.1 carats/100 tonnes.

In the Wyoming portion of the district, 20 kimberlites were mapped by the Wyoming State Geological Survey (WSGS) several years ago, but no activity was reported on these intrusives in 1995. Past production, however, included 50% gemstones. Several years ago, some geophysical anomalies were identified in this area by Paterson and Associates. Although these anomalies were interpreted as blind diatremes, none of these anomalies have been drilled.

Immediately south of the Wyoming border, the Kelsey Lake diamond mill was scheduled for start-up in December, 1995. The mill is rated at 250,000 tonnes/year (*Northern Miner*, 8/21/95). The *Casper Star-Tribune* (12/30/95) reported that Redaurum Ltd. will recover about 25,000 carats of diamonds in its first year of operation and will increase mill capacity to 1.5 million tonnes/year between 1996 and 1997. The increase in capacity is expected to bring production to about 150,000 carats/year. A 14.2-carat octahedral diamond recovered from the property was reportedly valued at \$250,000 (*Casper Star-Tribune*, 12/30/95).

Other activity in the Colorado part of the district included Anvil Resources' acquisition of four kimberlite 'blows' in the Chicken Park area. The property has

produced 306 diamonds at a grade of 6.67 carats/100 tonnes from kimberlite breccia. The recovered diamonds include a 2.5-carat stone. The company was reportedly drilling on the property in August (Anvil Resources Ltd. company report, 1995).

East of Chicken Park, Royalstar Resources dropped their interest in the Sloan 1 and 2 kimberlites after driving a 725-foot tunnel into the Sloan 2 intrusive and recovering several diamonds. Royalstar processed a 3,000-tonne bulk sample, which yielded 9,034 diamonds with a combined total weight of 342.17 carats. The grade of the bulk sample was 12.68 carats/100 tonnes. The largest diamond recovered was a 5.51-carat gemstone. Cumulative production from these two kimberlites totals about 40,000 diamonds.

Early in 1995, First Choice was exploring a highly anomalous region in the Eagle Rock area several miles north of the State Line district in the Laramie Mountains. The area's potential was initially identified by the WSGS. According to the *Northern Miner* (12/26/94), First Choice detected magnetic and resistivity anomalies, but was unable to intersect kimberlite during the drilling program. The company had plans to continue stream-sediment sampling in the area to search for the source of the kimberlitic indicator minerals. At another undisclosed location, detrital diamonds were reportedly found by a separate company as a follow-up to some other anomalies identified by the WSGS.

In November, Guardian American Minerals, Inc., announced the discovery of a group of 10 'kimberlitic' diatremes and several associated dikes in the Green River Basin of southwestern Wyoming. Although 'kimberlitic indicator minerals' had been known in the Cedar Mountain and Butcherknife Draw region for many years, the source of the minerals was unknown, but were postulated to be undiscovered kimberlites. The discovery is in Uinta County. Based on the geology of the area, the pipes are Tertiary in age as opposed to the Early Devonian age for the State Line kimberlites (Richard Kuchera, pers. comm., 1995). The WSGS is currently conducting petrographic and geochemical studies on the host rocks and processing a 1.5-ton bulk sample provided by Guardian American. Based on the distribution of indicator minerals, the newly discovered pipes can only explain a portion of the anomalies. Early in 1996, Guardian American reported three diamonds had been found on the property. Two were found in a core sample and a third diamond was found adjacent to another pipe.

To the north, near Rock Springs, Royal Gold continued to search for diamonds in the Leucite Hills lamproites. The WSGS also received an inquiry from a gem-cutting center for a source of gem-quality chromian diopside, one of the common indicator minerals found in kimberlite.

Gold

Royal Gold drilled a large 30-square-mile silicified zone on Quaking Asp Mountain, south of Rock Springs in the Green River Basin. This zone was

initially identified by the WSGS. The epithermal deposit contains some secondary kaolinite, alunite, travertine, free sulfur, banded chert, and jasperoid. Drilling results reported by Royal Gold were unfavorable. There have, however, been several other silicified zones recently identified in this structurally complex Tertiary basin (Gordon Marlatt, pers. comm., 1996).

In the Laramie Mountains east of Laramie, Compass Minerals continued to hold the Copper King prospect in the Silver Crown district. The property is described by the WSGS as a low-grade, Proterozoic-age, Au-Cu porphyry target. Exploration and drilling by the company extended the mineralized zone for more than a mile along strike.

Newmont reportedly terminated their interest in the Rattlesnake Hills gold deposit, 50 miles west of Casper. Based on work by the WSGS, the Rattlesnake Hills is a fragment of a greenstone belt, consisting of refolded Archean metamorphic rocks intruded by several Tertiary alkalic plugs and dikes. Gold mineralization was identified in stratabound exhalites, breccia veins, stockworks, and in Tertiary volcanics. There are rumors that Canyon Resources' drilling in the area has outlined a low-grade disseminated gold deposit with a resource of more than 250,000 ounces.

The Golden Clover mine in the Big Creek district of the Medicine Bow Mountains was briefly examined by the WSGS in 1995. The mine was developed by two, 100-foot shafts on a 2,000-foot-long, 0.6- to 6-foot-wide, quartz vein in sheared quartzofeldspathic gneiss. The vein contains free gold and auriferous pyrite. The values increase where the vein pinches, and some sheared wallrocks also yield gold values. Float samples collected in the area, as well as samples from a nearby vein discovered in a roadcut along Highway 230, have also yielded anomalous gold. Assay certificates from the mine range from 0.2 to 20 ounces per ton (opt) Au (Ralph Platt, pers. comm., 1995). The WSGS collected a grab sample of milky quartz with goethite after pyrite from the property. The sample yielded 0.323 opt Au and 14.9 parts per million (ppm) Ag.

Placer gold was recovered from several localities in Wyoming in 1995. One of the more interesting reports described a prospector who found 27 ounces of gold in Strawberry Creek in the South Pass mining district. Another prospector reported finding several ounces of gold and some pyrope garnets in Douglas Creek in the Medicine Bow Mountains.

Base Metals

In response to company inquiries, the WSGS completed a 197-page summary on copper, lead, zinc, and molybdenum (Mineral Report MR95-1). Some copper and zinc exploration by major mining companies was reported in the Hartville uplift and the Sierra Madre.

Nickel-copper-cobalt-precious Metals

The WSGS's recent reconnaissance of the Puzzler Hill area in the Encampment district of southeastern Wyoming resulted in the discovery of significant Cu-Ni-Co-precious metal mineralization hosted by a layered mafic complex. Samples from the massif yielded 0.01 to 4.43% Cu, 66 ppm to 3.72% Ni, 14 ppb to 9.86 ppm Au, <5 to 828 ppb Pt, 5 ppb to 4.04 ppm Pd, <0.1 to 6.6 ppm Ag, 21 ppm to 831 ppm Co, 64 ppm to 294 ppm Cr, and a trace of Pb, and Zn.

Tin Cup District

The WSGS investigated the Tin Cup district in the Granite Mountains of central Wyoming, for gold and other minerals in 1994 and 1995. The district is underlain by amphibolite-grade Archean gneiss, schist, and amphibolite, intruded by 2.6 Ga granite. In the northern portion of the district, three prominent faults that exhibited brittle deformation were mapped. The structures have a combined length of nearly seven miles. All three were prospected in the historic past. The southernmost structure was penetrated by two shafts. One of the shafts exposed massive sulfides.

Although no valuable metals were found in the district, numerous samples of massive jasper, banded agate, jade, rubies, lapidary materials and some massive pyrite were found. In the southern portion of the district, a ruby gneiss was traced along strike for 4,000 feet with widths of 20 to 50 feet. The gneiss contains common ruby porphyroblasts and fuchsite pseudomorphs after ruby. The stones range from 2 inches across to millimeter size and include both industrial stones and some of gem character.

Several jade prospects also occur in the area. At one locality, jade samples of nephrite pseudomorphs after hexagonal quartz were recovered. Some of the other jade prospects in the area contain common narrow veins and veinlets of nephrite jade.

COAL

Of three Federal coal lease applications that were carried over into 1995, only one was awarded. The 1,059-acre Eagle Butte Lease by Application (LBA) was sold to Cyprus-AMAX Corporation for approximately \$18 million or \$0.11/short ton. The tract contains approximately 166.4 million short tons of recoverable coal and is adjacent to the Eagle Butte mine north of Gillette.

In regard to the two pending applications, an Environmental Assessment has been released on the Antelope LBA, which was nominated by Kennecott Energy (KE). This 617.2-acre tract is adjacent to KE's Antelope mine and contains an estimated 57 million tons of recoverable coal.

A public scoping meeting on the second or North Roundup LBA was held in 1995. This tract, which covers 1,439 acres and contains approximately 150 million tons of recoverable coal, was nominated by Zeigler Coal. The U.S.

Bureau of Land Management plans to prepare an Environmental Impact Statement for it. This tract could be a very competitively bid LBA, since it is adjacent to two active mines.

In addition, two new tracts were nominated in 1995. The smaller of these two LBAs is the Thundercloud tract, which was nominated by Kerr-McGee Coal Corporation. This tract covers 4,000 acres and is adjacent to the Black Thunder (ARCO Coal Corporation) and the Jacobs Ranch (Kerr-McGee Coal Corp.) mines. This tract was jointly drilled by ARCO, Kennecott Energy, Kerr-McGee, and others in 1995 and contains an estimated 432 million tons of recoverable coal. This tract is also adjacent to two active mines.

The second LBA, nominated by Powder River Coal Co., is a 4,020-acre tract adjacent to the present North Antelope mine. The tract contains about 555 million tons of recoverable coal. Combined, the estimated tonnages in these two tracts comprise between 3 and 4% of the total mineable coal reserves in the Wyoming portion of the Powder River Basin.

Entech, a subsidiary of Montana Power, put its two Wyoming mines up for sale in 1995. The two mines, Grass Creek and Rocky Butte, represent over 620 million tons of recoverable coal. The Grass Creek mine, located 10 miles northwest of Thermopolis, is the only developed property of the two, with an estimated 10 million tons of recoverable coal (Vogler and others, 1995). Based on public documents, the Rocky Butte mine contains over 610 million tons of recoverable coal.

References cited

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GEOLOGIC MAPPING, STRATIGRAPHY, AND PALEONTOLOGY UPDATE

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MAJOR FAULT IN THE BIGHORN MOUNTAINS REDEFINED

The Wyoming State Geological Survey (WSGS) recently completed work on a report describing the northern portion of the Big Trails fault system, as it occurs in the southern Bighorn Mountains (Figure 17). This study is a spin-off of the southern Bighorn Mountains mapping project of the late 1980s and early 1990s. Evidence uncovered during this mapping points toward a right-lateral

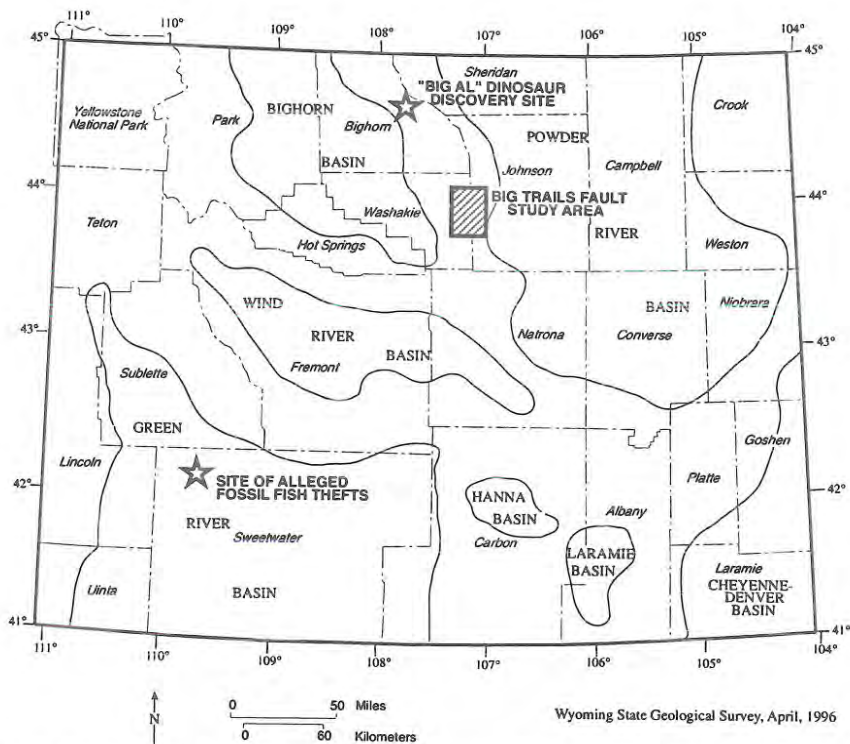


Figure 17. Index to selected reports, maps, or activities related to Wyoming geology.

oblique-slip fault, i.e., movement on the fault is primarily in a horizontal direction. This interpretation varies from traditional interpretations of the structure in the area, but does account for the character and orientation of surface structures adjacent to the fault. Application of this interpretation could be significant for the petroleum industry in searching for and predicting the occurrence of subsurface structures on both flanks of the southern Bighorn Mountains and into the adjacent Powder River and Bighorn basins. Several cross sections, a regional structural index map, and a revised geologic map (1:100,000-scale) are included in the report. In addition, evidence is presented for extending the fault to the north, considerably beyond previous interpretations.

A pre-publication version of the report entitled, "Evidence for right-oblique-slip on a northern segment of the Big Trails fault system, southern Bighorn Mountains, Wyoming", is on file at the WSGS offices in Laramie.

PALEONTOLOGICAL ACTIVITY

Representative Tim Johnson of South Dakota and co-sponsor Representative Joe Skeen of New Mexico have proposed some new legislation (H.R. 2943) entitled the "Fossil Protection Act of 1996". This bill is similar to the one Representative Johnston introduced in 1995 and would allow for commercial fossil collection on Federal lands (the 1995 bill was discussed in *Wyoming Geo-notes No. 48*, p. 40). The more significant changes in the newer bill include: a) its provision allowing for commercial collection of fossils on Federal lands (subject to fees and royalty payments); b) creation of a seven member National Fossil Council to administer the permitting, compliance, and determination of scientifically unique fossils; c) the definition of two types of collecting, e.g., reconnaissance and quarrying, and d) the definition of three types of permits, e.g., educational, scientific, and commercial. Current regulations allow for collection of invertebrate fossils on Federal lands by scientists and by hobbyists, for personal use only. Collection of vertebrate fossils on Federal lands is currently limited to scientists, and requires a permit. H.B. 2943 was referred to the House Subcommittee on Water Resources and Environment on February 15, 1996, and is currently in that committee. Anyone interested in seeing a copy of the proposed bill may contact Alan Ver Ploeg at the Wyoming State Geological Survey by calling (307) 766-2286 or by e-mail: alan_verploeg@wsgs.uwyo.edu

"Big Al" is the nickname given to the juvenile *Allosaurus* discovered northeast of Greybull in the 145+ million-year-old Jurassic Morrison Formation. The dinosaur was found near the old Howe quarry in 1991 on land administered by the U.S. Bureau of Land Management (BLM) (Figure 17). The skeleton was excavated, preserved, and restored through a cooperative effort by the University of Wyoming's Geological Museum, the BLM, and the Museum of the Rockies at Montana State University in Bozeman. A cast of this meat-eating dinosaur was made at the Museum of the Rockies and recently delivered to Laramie. Brent Breithaupt, director of the Geological Museum, and Bob Harmon, chief preparator of the Museum of the Rockies, have reassembled a cast of the fossil in the museum. A formal dedication of the new exhibit was held January 26 at the Geological Museum.

The Tate Geological Museum recently announced a June conference in Casper. The theme of this conference, which is scheduled for June 21-23, is "Paleoenvironments of the Jurassic". The conference will include an icebreaker and presentation by Robert T. Bakker on the 21st; papers dealing with paleoenvironments of the Jurassic and their relationship to various dinosaur species on the 22nd; and a field trip to examine outcrops of the Jurassic Morrison and Sundance Formations on the 23rd. For further information on the conference and registration, contact Alison Hunter at (307) 268-2447; FAX: (307) 268-2514; or e-mail: ahunter@acad.cc.wy.edu

On a related note, organizers have begun planning for the 6th Annual Paleontology Symposium, sponsored by the Worland Office of the BLM and the Washakie County Museum. This symposium is scheduled for July 13-14 in

Worland. Papers relating to paleontologic research in the Bighorn Basin area, as well as across Wyoming, are being solicited. The second day of the symposium is set aside as an "open house" at several archaeological and paleontological research sites. One site is the Big Cedar Ridge fossil area south of Tensleep, noted for its Cretaceous paleobotanical significance. For more information on this symposium, contact Jerry Hansen at (307) 347-4102.

Efforts to deter "poaching" of fossil fish continue in southwestern Wyoming with the recent indictment of five Wyoming residents for allegedly taking over \$5,000 worth of fossil fish. The fossils were allegedly removed last summer from outcrops of the Green River Formation on Federal lands west of Farson, Wyoming (Figure 17). If convicted, the defendants could face up to 10 years in prison and a \$250,000 fine.

HISTORICAL SEISMICITY IN SOUTHWESTERN WYOMING

James C. Case

Staff Geologist-Geologic Hazards, Wyoming State Geological Survey

Figure 18 shows that earthquakes have occurred throughout southwestern Wyoming. At first glance, however, it appears that more earthquakes have occurred in Uinta and Lincoln Counties than in Sweetwater County. While this may be the case, there is another possible explanation. Smaller seismic events are better detected and more accurately located the closer they are to a seismic station. As a result, the greater number of plotted earthquakes in the western part of the area may be a function of their closer proximity to the seismic stations in Utah.

Earthquakes have been recorded in southwestern Wyoming for over 100 years. Some have caused damage, although most have simply alarmed residents. And none of the historic earthquakes have been as large as those that have been projected for the area. Last quarter, an analysis of the earthquake potential in southwestern Wyoming was provided (*Wyoming Geo-notes No. 49*, p. 43-48). The article in this issue addresses historical seismicity in that part of the State.

Because many of the recorded earthquakes in southwestern Wyoming have not caused any significant damage, only those that have disturbed residents or caused damage are discussed here. As it turns out, a number of these earthquakes may be related to mining activities or seismic exploration. Considering the total number of earthquakes that have been reported in southwestern Wyoming, however, most of the earthquakes in this area have been related to

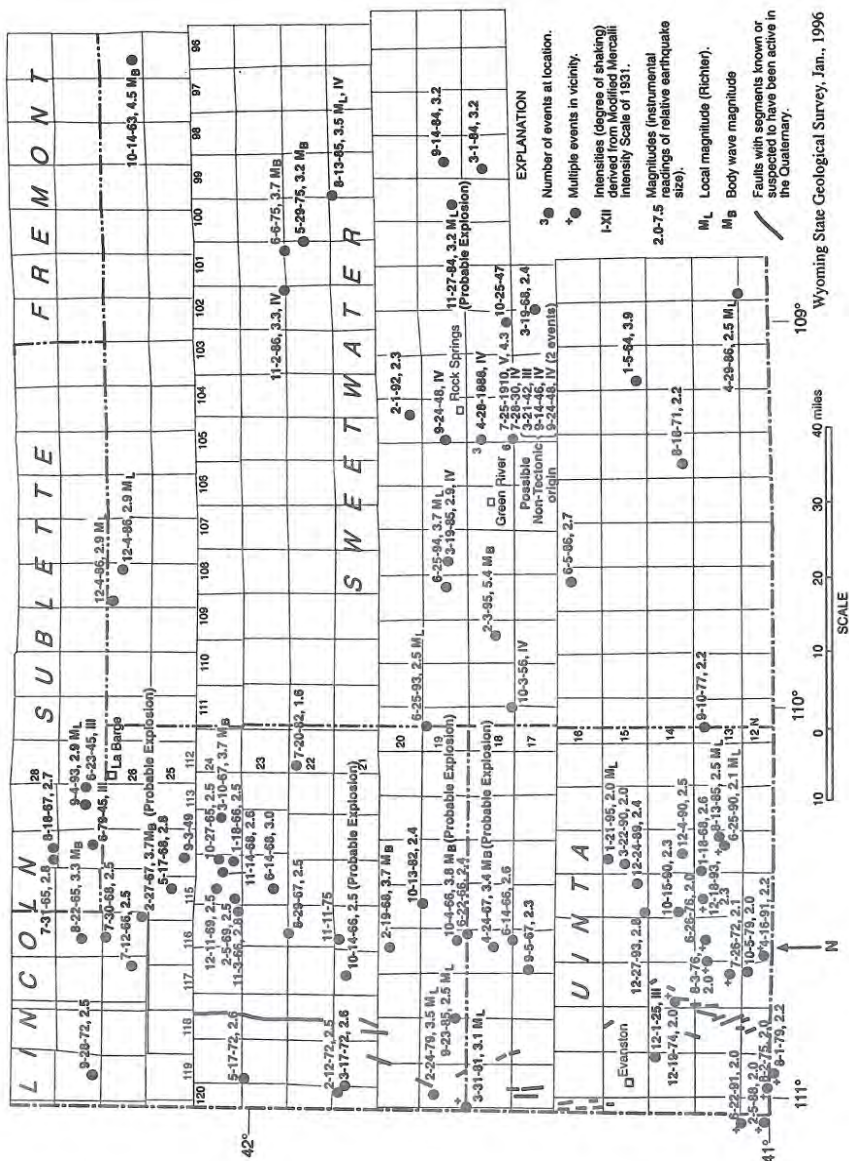


Figure 18. Earthquake epicenters and active faults with surficial expression in southwestern Wyoming.

movements on faults that are not exposed at the surface. The ensuing discussions are organized under four geographic areas: Rock Springs, Green River, Evanston, and La Barge.

ROCK SPRINGS AREA

The first earthquake that was felt and reported in southwestern Wyoming occurred on April 28, 1888. That intensity IV earthquake, which originated near Rock Springs, did not cause any appreciable damage.

Other earthquakes have also occurred in the Rock Springs area, some of which may have been caused by roof collapses in old coal mines. On July 25, 1910, for example, an intensity V earthquake occurred in the area at the same time that the Union Pacific No. 1 mine in Rock Springs partially collapsed (*Cheyenne State Leader*, July 26, 1910). It is not known if the mine collapse generated the earthquake or if an earthquake with a tectonic source caused the mine to collapse. On July 28, 1930, an intensity IV earthquake, with an epicenter near Rock Springs, was felt in Rock Springs and Reliance (*Casper Daily Tribune*, July 28, 1930). Many residents were awakened by the earthquake, and merchandise on store shelves was disrupted. A portion of a coal mine near Reliance caved in during the disturbance. Again, it was never determined whether the earthquake was due to the cave-in or to movement on a fault.

On March 21, 1942, a non-damaging intensity III earthquake was felt in the area. This was followed on September 14, 1946, and September 24, 1948, by two other intensity IV earthquakes, which both rattled dishes in parts of Rock Springs (*Casper Tribune-Herald*, September 27, 1948).

Many things can generate seismic waves that are felt as an earthquake. For examples, the movement on a fault, volcanic activity, an explosion, or a mine collapse can all generate seismic waves. Today, seismologists can usually determine which of these caused an earthquake. Unfortunately, that was not the case for the earthquakes described above. As a result, there will always be some uncertainty as to the cause of these early earthquakes in the Rock Springs area.

GREEN RIVER AREA

On February 3, 1995, one of the largest historic earthquakes in southwestern Wyoming occurred near Little America, Wyoming. A magnitude 5.3, intensity V earthquake was associated with the collapse of a 3,000-foot-wide by 7,000-foot-long portion of a trona mine operated by Solvay Minerals, Inc. One miner lost his life as a result of the collapse. Minor damage was reported at a school administration building in Green River and at a maintenance shop at Little America. The earthquake was felt in Rock Springs and in Salt Lake City. An indisputable triggering mechanism for the mine collapse has not been determined, although the U.S. Mine Safety and Health Administration (1996) feels that the most likely cause was "the degradation of the strength of the pillar-floor system over a long period of time".

A few other historic earthquakes have occurred in the vicinity of Green River. On March 19, 1985, a magnitude 2.9, intensity IV earthquake occurred approximately nine miles northwest of Green River. No damage was reported. On June 25, 1994, the University of Utah Seismograph Stations detected a magnitude 3.7 earthquake centered approximately 12 miles west northwest of Green River. No significant damage was reported. Since these two events occurred in the near- vicinity of mining operations, it is uncertain if they were related to tectonic or mine-related activities.

EVANSTON AREA

Although many earthquakes have been detected in Uinta County, few have been felt. One of the earlier reported earthquakes in southwestern Wyoming did occur near Evanston, however. On December 1, 1925, an intensity III earthquake reportedly occurred approximately five miles southeast of Evanston. There were reports of doors swinging and a sound similar to the passing of a fast train (Neumann, 1927).

LA BARGE AREA

Although quite a few earthquakes have occurred west and southwest of La Barge, there have been few reports of them being felt. In June, 1945, there were two intensity III earthquakes that were felt, although no damage was reported (*Casper Tribune-Herald*, June, 1945). Camp buildings reportedly creaked as a result of the earthquakes.

OTHER EARTHQUAKES

Between 1975 and 1987, four magnitude 3.2-3.7 earthquakes occurred between Superior and Point of Rocks (Case and others, 1995). Of that group, a magnitude 3.5, intensity IV earthquake was felt at Point of Rocks on August 13, 1985. No significant damage was reported. The earthquakes do not appear to be associated with historic or current mining activities.

Between 1965 and 1969, a series of earthquakes occurred in a north-to-south-trending band in the Wyoming Overthrust Belt. A few of the earthquakes, whose magnitudes were from 2.3 to 3.7, have been attributed to explosions (U.S. Geological Survey, 1994). While the rest have not been attributed to such a source, that possibility cannot be dismissed. The sources of the explosions are not known, although some could be related to seismic exploration. A few other earthquakes between 1949 and 1982 have also occurred in the region.

In summary, the historic record shows that southwestern Wyoming is seismically active. Although some of the earthquakes have been associated with mining or exploration, most of the seismic events were related to movement on buried faults. Many earthquakes associated with buried faults in southwestern Wyoming were not discussed in this article because they did not cause damage or were not felt. Because there has been significant historic and some

recent underground mining activity in southwestern Wyoming, however, there is the possibility that other mining-related seismic events will occur.

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ROCK HOUND'S CORNER

W. Dan Hausel

Senior Economic Geologist, Wyoming State Geological Survey

SHORT COURSE ON GOLD AND DIAMONDS OFFERED

A one-day seminar on the identification of gold- and diamond-bearing rocks, and how and where to find these kinds of deposits is being offered by the Wyoming State Geological Survey in Laramie. The course is scheduled for Friday, August 9, 1996, from 1 to 5 p.m. at the Wyoming State Geological Survey Building on the University of Wyoming campus.

Participants will have the opportunity to examine dozens of gold- and diamond-ore samples, and slide presentations will show a variety of deposits and occurrences. A tour of the Survey's diamond-extraction lab is included in the short course.

Because of limited space, only the first 20 registrants will be accepted. The cost of the course is \$25, which will pay for two publications (the Wyoming State Geological Survey's Open File Report OFR 90-9 and Bulletin 68). To register, send a check made out to the "Wyoming State Geological Survey" to the

attention of W. Dan Hausel, WSGS, P.O. Box 3008, Laramie, WY 82071. Be sure to include your name, address, and a phone number along with the check. Questions? Contact W. Dan Hausel at (307) 766-2286).

FRANCES SMITH RETIRES

Our Publications Sales Manager, Frances Smith, has retired after more than 15 years of loyal, distinguished service (see cover photo). "Fran" was often the first contact a person had with the Survey, especially if one was interested in our publications or a topographic map.

She excelled at customer service: there were few questions that she could not answer, and if she could not answer them, she could direct a customer to someone who could. Many of those who ordered our publications were pleasantly surprised when their items appeared within a day or two.

Fran was noted within the Survey for running a "tight ship" in our publication sales section, and it paid dividends in a high degree of customer satisfaction and courteous, efficient service. We estimate that from the time Fran started work for the Survey in February, 1981, she has handled over a million publications. Her co-workers and friends here at the Survey and those in industry, government, and the public will all miss her.

Fran plans on a full and active life in her retirement. Fran's husband retired from the University of Wyoming last year, and they are planning to travel extensively throughout the West as well as pursue their favorite hobbies here in Laramie.

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, scale 1:500,000, 1996.-\$15.00.

*Geological map of Yellowstone National Park, published by Department of Earth Sciences, Montana State University: scale 1 inch equals about 3.75 miles, 1989.-\$5.00.

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) 766-2605; or use the e-mail addresses included below]:

W. Dan Hausel - Metals and precious stones
[e-mail: dan_hausel@wsgs.uwyo.edu]

James C. Case - Geologic hazards
[e-mail: jim_case@wsgs.uwyo.edu]

Rodney H. De Bruin - Oil and gas [e-mail: rod_debruin@wsgs.uwyo.edu]

Ray E. Harris - Industrial minerals and uranium
[ray_harris@wsgs.uwyo.edu]

Alan J. Ver Ploeg - Geologic mapping and stratigraphy
[alan_verploeg@wsgs.uwyo.edu]

Gary B. Glass - Coal [gary_glass@wsgs.uwyo.edu]

SECTION REPORTS RECENTLY MADE AVAILABLE INCLUDE:

*A review of Wyoming's coal mines and markets: 1994, by P.D. Vogler, L.L. Larson, and K.I. Mehring: Coal Report No. 95-1, 1995.-\$15.00

*Garnet in Wyoming, by R.E. Harris: Industrial Minerals Report IM-95-1, 1995.-\$2.00 (xerox copies only).

*Asbestos and serpentine in Wyoming, by R.E. Harris: Industrial Minerals Report IM-95-2, 1995.-\$2.00 (xerox copies only).

*Reconnaissance of the Charter Oak mine and Cu-Ni-Au-Ag-Pt-Pd mineralization associated with the Puzzler Hill layered mafic-ultramafic complex, Encampment district, Sierra Madre, Wyoming, by W.D. Hausel: Mineral Report MR-95-2, 1995.-\$2.00 (xerox copies only).

*Mineral reports available from the Wyoming State Geological Survey, by W.D. Hausel: Mineral Report MR-95-2, 1995.-\$2.00 (xerox copies only).

*Preliminary geologic map of the Laramie Quadrangle, Albany County, Wyoming, by A.J. Ver Ploeg: Preliminary Geologic Map PGM-95-1, 1995.-\$4.00 (xerox copies only).

*Preliminary geologic map of the Red Buttes Quadrangle, Albany County, Wyoming, by A.J. Ver Ploeg: Preliminary Geologic Map PGM-95-2, 1995.- \$4.00 (xerox copies only).

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

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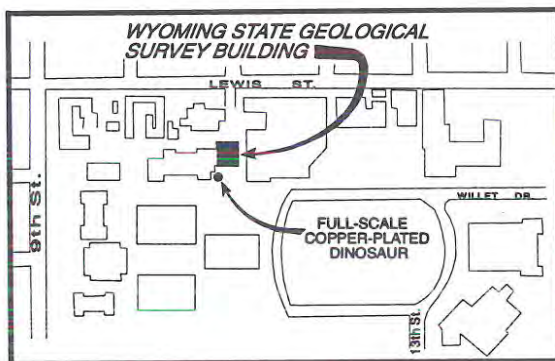
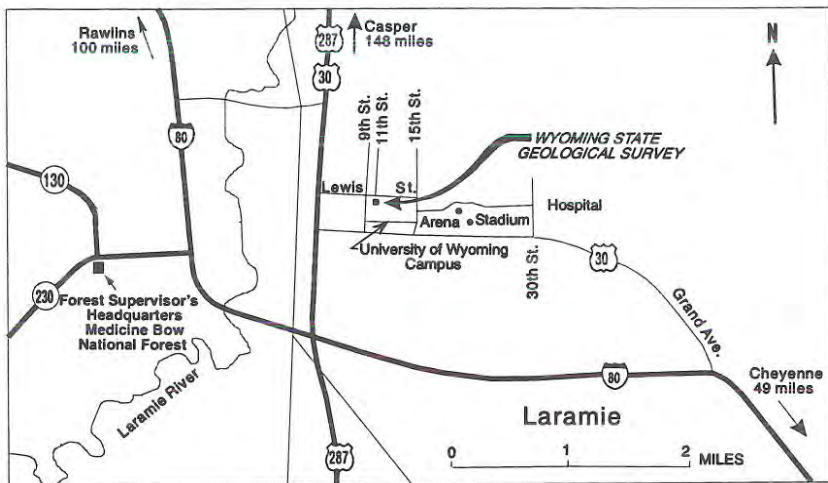
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The Wyoming State Geological Survey now carries Bureau of Land Management (BLM) Surface Management Status maps for the 1:100,000-scale metric topographic quadrangles in Wyoming.-\$5.50 each. Coverage may be limited for specific areas; please call for map availability.

In addition, we now carry the *Recreational map of Wyoming*, published by GTR Mapping. This folded, glove-compartment-style map is available for \$3.95. This map is an ideal companion to the *Geological highway map of Wyoming*, which is also available at the Wyoming State Geological Survey for \$7.00.

These maps (plus other topographic maps of Wyoming) are available over-the-counter at the Survey offices in Laramie or by mail. Sales tax of 6% must be added for Wyoming addresses and postage and map tube charges for rolled maps will be added on when appropriate.

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