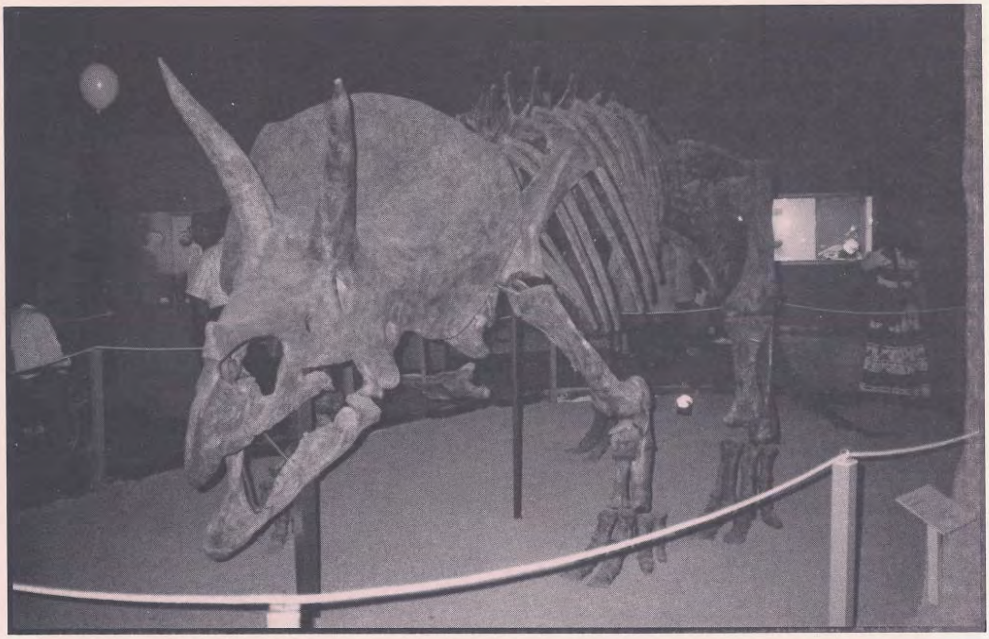
Wyoming Geo-notes

Number 47



Wyoming State Geological Survey
Gary B. Glass, State Geologist

Laramie, Wyoming
August, 1995

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WYOMING GEO-NOTES
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Cover: *Triceratops* is Wyoming's State Dinosaur. The pictured skeleton of *Triceratops*, along with skeltons of many other dinosaurs, is on exhibit at the Wyoming Dinosaur Center at Thermopolis, Wyoming.

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MINERALS UPDATE

OVERVIEW

Gary B. Glass
State Geologist, Wyoming State Geological Survey

As usual, there is some good news and some bad news related to the State's oil and gas industry. The good news is that oil production, at least in the first quarter of 1995, was only 0.5% below first quarter production in 1994. This gives some hope that 1995 production may not decline by the predicted 11.7% indicated in **Figure 1** and **Table 1**.

Similarly, the price paid to Wyoming oil producers for the first six months of 1995 has averaged $2.90 per barrel higher than in the same months in 1994. Since the price forecasts made in January of this year show the average price dropping, there is room for optimism that the average price might be closer to $15.00 per barrel than the forecast of $13.50 in **Figure 2** and **Table 2**. The higher oil prices should help prevent premature abandonment of marginal wells at least for as long as the prices hold. Several legislative incentives and a possible royalty reduction for production of heavy oil (API gravity less than 20 degrees) from Federal leases should also help.

The not so good news for oil producers is that the Express Pipeline Project is back again. This project, if built, would lay an oil pipeline from Alberta to Casper. This pipeline would have the capacity to bring 170,000 barrels of Canadian oil a day into Wyoming, targeting markets now served by Wyoming producers.

Natural gas production was 1.8% higher in the first quarter of 1995 than in the first quarter of 1994. In fact, production of natural gas from Wyoming set an all time record for the State in January and makes it more likely that annual production in 1995 will increase rather than decline slightly as indicated in **Figure 3** and **Table 1**.

This first-quarter increase in production comes at a time when the price of natural gas has fallen substantially. In the first six months of this year, natural gas prices were 56 cents per thousand cubic feet lower than they were in the first half of last year. This is probably best reflected in the spot prices for methane at Opal (**Figure 4**). Based on the first six months of 1995, the average price paid for methane from Wyoming could end up lower than what is shown in **Figure 5** and **Table 2**.

In July, the Altamont pipeline project cleared appeals to its construction, and its builders now hope to begin shipping Canadian gas into southwestern Wyoming by 1997 or 1998. Among Wyoming producers, feelings are still mixed on the effect that this gas would have on Wyoming's gas industry.

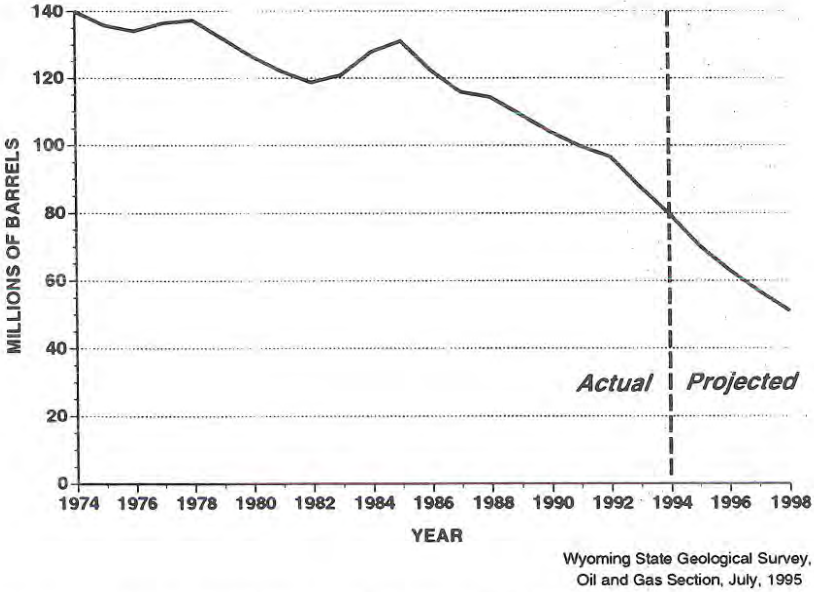


Figure 1. Annual oil production from Wyoming (1974 to 1994) with forecasts to 1998.

Table 1. Wyoming mineral production (1981-1994) with forecasts to 1998[1].

Calendar Year	Oil[2]	Natural Gas[3]	Carbon Dioxide[4]	Helium[5]	Coal[6]	Trona[6]	Mined Uranium[7]	In-situ Uranium[8]	Sulfur[9]
1981	122.1	455.4	—	—	102.7	11.2	4.6	?	0.05
1982	118.7	465.1	—	—	108.0	10.9	2.1	?	0.07
1983	120.9	539.8	—	—	112.2	11.6	3.0	?	0.57
1984	127.8	600.1	—	—	130.7	11.7	1.6	?	0.71
1985	131.0	597.9	—	—	140.4	11.8	0.6	?	0.80
1986	122.4	563.2	23.8	0.15	135.4	13.0	0.2	0.04	0.76
1987	115.9	628.2	114.2	0.86	146.5	13.6	0.2	0.06	1.19
1988	114.3	700.8	110.0	0.83	163.6	14.9	0.3	1.16	1.06
1989	109.1	739.0	126.1	0.94	171.1	16.2	0.1	1.07	1.17
1990	104.0	777.2	119.9	0.90	184.0	16.2	0.2	1.1	1.04
1991	99.8	820.0	140.3	1.05	193.9	16.2	0.4	1.1	1.18
1992	96.8	871.5	139.2	1.05	189.5	16.4	0.1	1.2	1.20
1993	89.0	912.8	140.8	1.06	209.9	16.0	—	1.1	1.14
1994	*79.5	*952.5	*142.5	*1.07	236.9	16.1	—	1.2	*1.20
*1995	70.2	947.8	142.5	1.07	245.5	16.4	—	1.2	1.20
*1996	63.2	969.6	142.5	1.07	256.5	16.8	—	1.2	1.20
*1997	56.9	991.9	142.5	1.07	267.9	17.1	—	1.2	1.20
*1998	51.2	1,014.6	142.5	1.07	279.9	17.1	—	1.2	1.20

*Estimated until official figures are available.
[1]Adapted from CREG, Wyoming State Government Revenue Forecast FY95-FY98, January, 1995. [2]Millions of barrels (Source: Wyoming Oil & Gas Conservation Commission, 1981-1993); [3]Billions of cubic feet (primarily methane with some hydrogen sulfide and nitrogen) (Source: Wyoming Oil & Gas Conservation Commission, 1981-1993); [4] Billions of cubic feet. Source: Wyoming Oil & Gas Conservation Commission, 1986-1993; [5]Billions of cubic feet, based on Exxon's estimate that the average helium content in the gas processed at Shute Creek is 0.5%; [6]Millions of short tons (Source: Wyoming State Inspector of Mines, 1981-1994); [7]Millions of short tons of uranium ore (not yellowcake) (Source: Wyoming Department of Revenue, 1981-1992); [8]Miillions of pounds of yellowcake (U_3O_8) (Source: Wyoming Department of Revenue, 1986-1994; unknown between 1981-1985 because it was only reported as taxable valuation); [9]Millions of short tons (Source: Wyoming Oil & Gas Conservation Commission, 1981-1993).

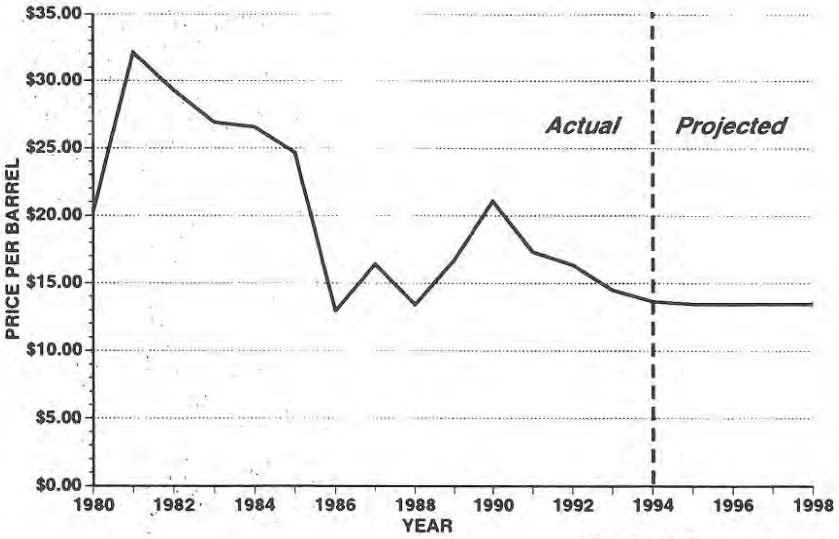


Figure 2. Average prices paid for Wyoming oil (1980 to 1994) with forecasts to 1998.

Table 2. Average prices paid for Wyoming oil, methane, coal, trona, and uranium (1985-1994) with forecasts to 1998[1].

Calendar Year	Oil[2]	Methane[3]	Coal[4]	Trona[5]	Uranium[6]
1985	24.67	3.03	11.36	35.18	36.82
1986	12.94	2.33	10.85	34.80	52.45
1987	16.42	1.78	9.80	36.56	43.55
1988	13.43	1.43	9.16	36.88	25.77
1989	16.71	1.58	8.63	40.76	22.09
1990	21.08	1.59	8.43	41.86	21.16
1991	17.33	1.46	8.09	44.18	-----
1992	16.38	1.49	8.14	44.50	-----
1993	14.50	1.81	7.32	40.08	-----
1994	13.67	1.63	*6.70	*39.00	-----
*1995	13.50	1.56	6.54	40.00	-----
*1996	13.50	1.65	6.43	40.00	-----
*1997	13.50	1.65	6.31	40.00	-----
*1998	13.50	1.65	6.19	40.00	-----

* Estimated until official figures are available.
[1] Adapted from CREG, Wyoming State Government Revenue Forecast FY95-FY98, January, 1995.
[2] First purchase price in dollars per barrel (weighted average price for sweet, sour, heavy, stripper, and tertiary oil). Source: Energy Information Administration, 1985-1994.
[3] Wellhead price in dollars per thousand cubic feet (MCF). Sources: Wyoming State Land and Farm Loan Office, 1989-1994 (derived from State royalty payments); Minerals Management Service, 1985-1988 (derived from Federal royalty payments).
[4] Dollars per short ton (weighted average price for coal mined by surface and underground methods). Source: Energy Information Administration, 1985-1993.
[5] Dollars per ton of trona, not soda ash. Source: Wyoming Department of Revenue, 1985-1993.
[6] Uranium prices in dollars per pound of yellowcake (weighted average price for in-situ and(or) surface-mined uranium). Source: Energy Information Administration, 1985-1990; no estimates available after 1990.

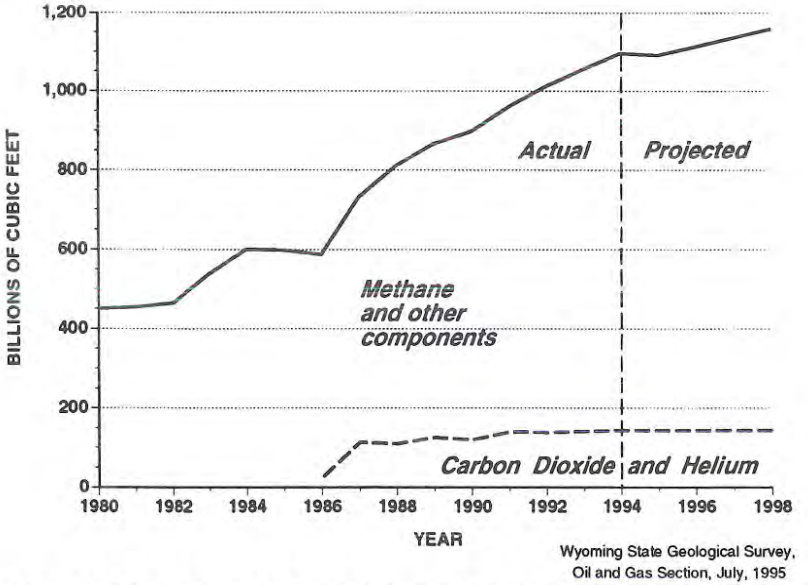


Figure 3. Annual natural gas production from Wyoming (1980 to 1994) with forecasts to 1998.

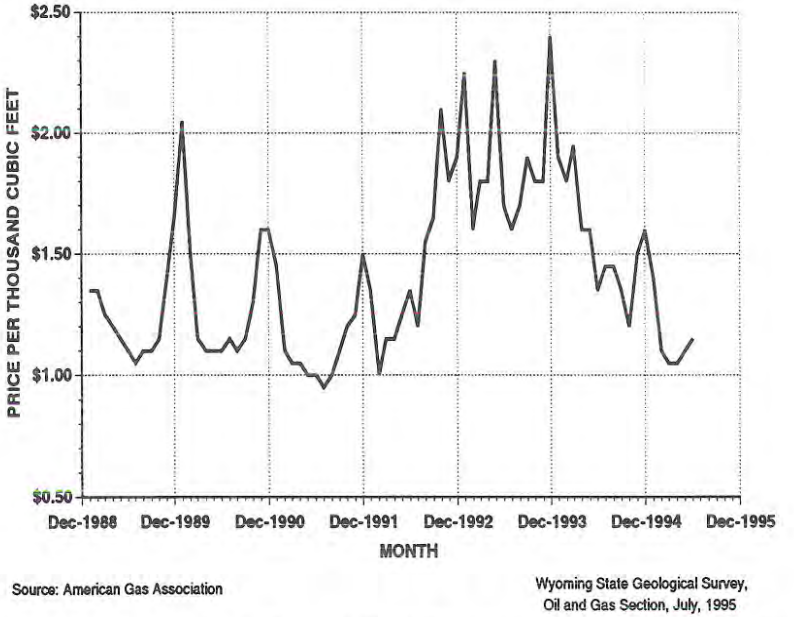


Figure 4. Spot prices for methane at Opal, Wyoming, averaged by month (1989 to present).

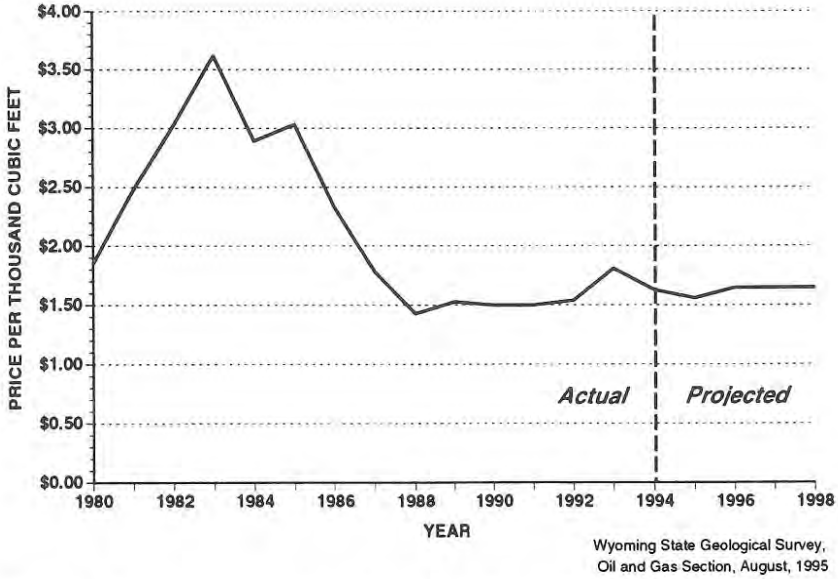


Figure 5. Average prices paid for Wyoming methane (1980 to 1994) with forecasts to 1998.

This issue also includes a summary of 1994 oil and gas exploration in Wyoming (p. 41-45).

Wyoming coal deliveries in the first quarter of 1995 were 15% greater than in 1994. In fact, deliveries for two of the first three months of this year were record setting months for Wyoming producers, and collectively, the first three months set a new record among all the coal-producing states (p. 18 of the **Coal Update**). A continuation of these kinds of deliveries will carry Wyoming's 1995 production over 250 million tons, which is higher than the January forecast shown in **Figure 6** and **Table 1**. Much of the new tonnage is being added by short term contracts rather than spot sales, and some power plants are beginning to burn Powder River Basin coals, while others are changing blends by adding more coal from producers in the Powder River Basin (see **Coal Update**).

In regard to coal prices, there has really not been much information available. However, the fact that revenues are tracking forecasts while production is somewhat higher than projected, suggests that prices are slightly lower than the forecast in **Figure 7** and **Tables 2** and **3**.

Several things have happened in regard to the trona industry. FMC announced price increases for its soda ash; the U.S. Bureau of Land Management (BLM) raised its royalty rate on trona from 5% to 8%; and it looks like the BLM will hold a sodium (trona) lease sale in 1995 or 1996. The Environmental Assessment for the lease sale was released for public comment in June or July.

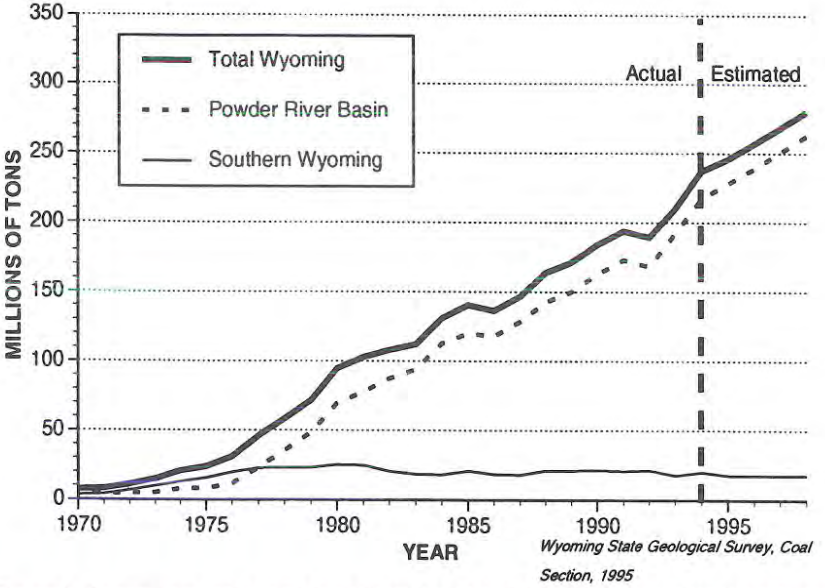


Figure 6. Annual coal production from Wyoming (1970-1994) with forecasts to 1998. Data from the Wyoming State Inspector of Mines (1970-1994) and Wyoming Consensus Revenue Estimating Group (1995-1998).

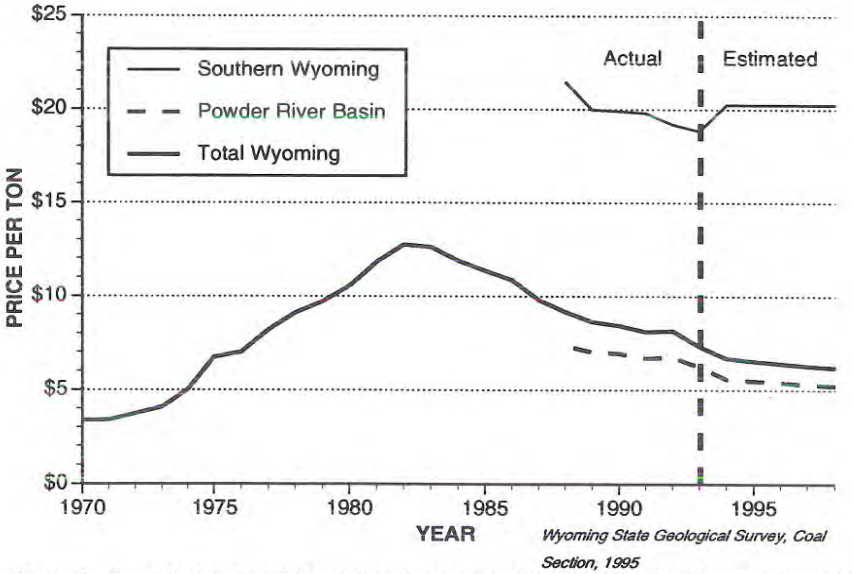


Figure 7. Average prices paid for Wyoming coal (1980 to 1993) with forecasts to 1998. Data from U.S. Energy Information Administration (1980-1993) and the Wyoming Consensus Revenue Estimating Group (1994-1998).

Table 3. Breakdown of average prices paid for coal from northeastern Wyoming, southern Wyoming, and statewide (1988-1993) with forecasts to 1998[1].

YEAR	NORTHEASTERN	SOUTHERN	STATEWIDE
1988	$7.35	$21.45	$9.16
1989	$7.02	$19.97	$8.63
1990	$6.93	$19.90	$8.43
1991	$6.69	$19.80	$8.09
1992	$6.74	$19.19	$8.14
1993	$6.20	$19.53	$7.32
1994	$5.58	$20.45	$6.70
1995	$5.47	$20.45	$6.55
1996	$5.39	$20.45	$6.43
1997	$5.30	$20.45	$6.30
1998	$5.23	$20.45	$6.19

[1]Source of statewide data for 1988-1993 is the Energy Information Administration of the U.S. Department of Energy; forecasts for 1994-1998 are from the Wyoming Consensus Revenue Estimating Group. Regional breakdowns are estimated by the Wyoming State Geological Survey.

The price of yellowcake increased from $9.00 to $11.00 in the second quarter of the year, and the public comment period on the Draft Environmental Impact Statement for the Jackpot underground uranium mine will close in August.

Table 4 includes some new production figures for selected Wyoming mineral commodities.

OIL AND GAS UPDATE

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

Prices paid to Wyoming oil producers for the first six months of 1995 averaged $2.90 per barrel higher than in the comparable period in 1994 (**Figure 8**). The stronger price is an encouraging trend that may, at the very least, lessen the nearly 11% production decline that occurred between 1993 and 1994. Natural gas prices, however, were 56 cents per thousand cubic feet lower in the first half of 1995 than during the same six months in 1994.

According to figures provided by Petroleum Information, Inc., Wyoming's oil production during the first quarter of 1995 was 20.4 million barrels, just under the 20.5 million barrels produced during the first three months of 1994. As mentioned above, the lower than anticipated decline rate in oil production can be attributed in large part to much better prices this year than last year. Milder than average weather in the first quarter of 1995 also probably contributed to the

Table 4. Production history of selected Wyoming mineral commodities[1].

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Bentonite[2]	2.59	1.82	2.16	2.24[6]	2.22[6]	2.43[6]	2.38[6]	2.21[6]	2.53[6]	3.28[6]
Clay[4]	35.9	23.2	1.31	---	---	---	---	---	---	---
Decorative Aggregate[2]	0.09	0.07	0.06	0.07[7]	0.06[6]	0.06[6]	0.07[6]	0.07[6]	0.08[6]	NA[11]
Decorative Stone[10]	---	---	---	---	---	---	24[7]	100[7]	168.0[6]	NA[11]
Dolomite[2]	0.87	0.81	0.46	0.19[6]	0.15[6]	0.21[6]	0.23[6]	0.20[6]	---	---
Gypsum[2]	0.35	0.41	0.35	0.36[6]	0.42[6]	0.44[6]	0.42[6]	0.43[7]	0.36[6]	0.37[6]
Iron Ore	---	---	---	---	40[8]	40[8]	---	---	250[7,9]	---
Leonardite[4]	---	---	---	minor[6]	38.9[6]	41.7[6]	22.9[6]	37.0[6]	39.0[6]	37.1[6]
Limestone[2, 5]	0.32	0.33	0.32	0.64	0.60[6]	0.48[6]	0.49[6]	0.52[6]	0.69[6]	NA[11]
Construction Aggregate[2, 3]	6.40	5.01	4.12	3.15	6.46[6]	7.73[6]	8.62[6]	8.11[6]	10.6[6]	NA[11]
Shale[4]	14.7	9.88	103.2	52.2[6]	15.6[6]	43.5[6]	158.2[6]	113.3[6]	---	---
Sodium Sulfate[4]	2.71	2.03	---	2.10[6]	---	1.9[6]	1.5[6]	1.5[6]	1.5[6]	1.1[6]

Sources: [1]Wyoming Department of Revenue, unless otherwise noted; [2]millions of short tons; [3]includes ballast, scoria, and limestone used for aggregate; [4]thousands of short tons; [5]includes chemical grade limestone used for cement rock, sugar beet refining, and other uses; [6]Wyoming State Inspector of Mines; [7]estimated by Wyoming State Geological Survey; [8]short tons of iron ore used for pigment; [9]short tons of iron ore used as weighting additive in cement; [10] short tons; [11] not available. Prepared by Wyoming State Geological Survey, July, 1995.

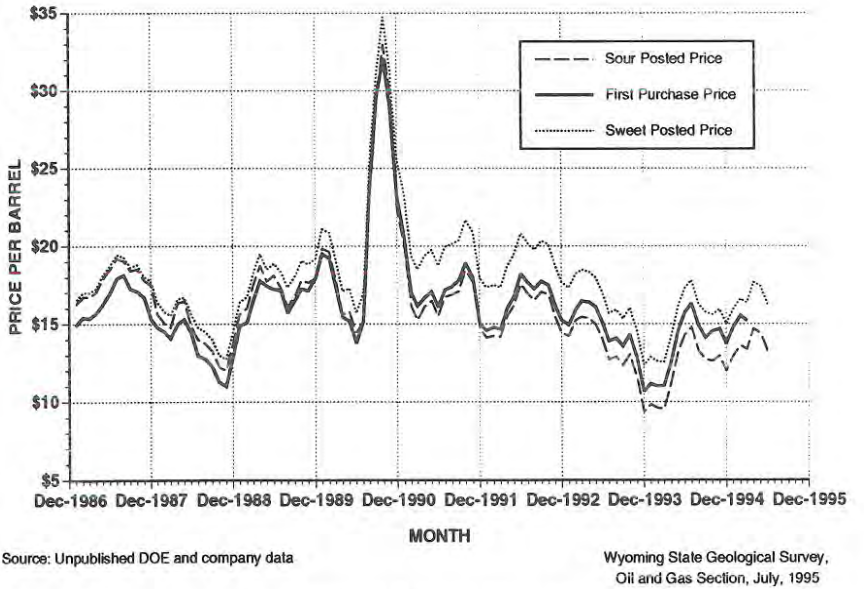


Figure 8. Wyoming posted Sweet and Sour crude oil prices and first purchase prices averaged by month (1987 to present).

shut-in of fewer wells than last year, and tax incentives passed by the Wyoming Legislature may also have helped.

In a related item, the U.S. Bureau of Land Management (BLM) issued a proposed rule to reduce royalty rates for heavy oil production (oil with API gravity less than 20°) on Federal properties. The rule is intended to partially offset the reduced prices paid for low-gravity oil and would hopefully encourage operators of heavy-oil leases to put marginal or uneconomical shut-in wells back into production. The royalty reduction will apply to producing properties rather than individual wells and is based on the weighted average gravity of the oil produced by all wells on the property. The royalty reduction would be terminated if the price of West Texas Intermediate crude oil exceeds $28 per barrel for six consecutive months. The proposed rule would benefit a number of operators in Wyoming, mainly in the Bighorn and Wind River basins.

Plans for the Express Pipeline project were reactivated. The first effort to initiate the Express line failed when Canadian producers supported a rival project. The revived pipeline would start in Alberta, Canada, would parallel the approved route of the Altamont natural gas pipeline through Montana and northern Wyoming, and then would parallel the Platte Pipeline system from Lost Cabin to Casper. The 62-million-barrel-per-year line would target markets in Wyoming, Montana, Colorado, and Utah.

Natural gas production for the first three months of 1995 was 278.0 billion cubic feet, compared to production of 273.2 billion cubic feet for the first quarter of 1994. Strong demand for Wyoming gas and gas liquids boosted first quarter production 1.8% higher than in the first quarter of 1994. These production gains were made despite the low prices producers are currently receiving.

U.S. Senator Nickles from Oklahoma has filed a bill to repeal Section 210 of the 1978 Public Utility Regulatory Policies Act, which requires electric utilities to buy power from cogeneration projects and small power producers. Nickles' bill would only apply to future purchase contracts. The Natural Gas Supply Association testified that this bill would cause as much as a 5% loss in markets for natural gas. The American Gas Association pointed out that 59% of all cogeneration capacity and 75% of independent power producers' cogeneration capacity is fueled by natural gas.

The average daily rig count for the second quarter of 1995 was 22, compared to last year's second quarter average of 32, and a 1995 first quarter average of 20 (**Figure 9**). An examination of drilling statistics for the first five months of this year also indicates that five more wells were drilled than last year despite a lower average weekly rig count. The average well drilled in the first part of 1995, however, was drilled to only 6,860 feet, compared to a five-month average of 8,810 feet in 1994. At least between January and May, 1995, companies were drilling fewer deep gas wells and more shallow oil wells than in the same months of 1994.

Lease sales during the second quarter of 1995 did not bring in as much revenue as the sales in the corresponding quarter of 1994, but the sales did

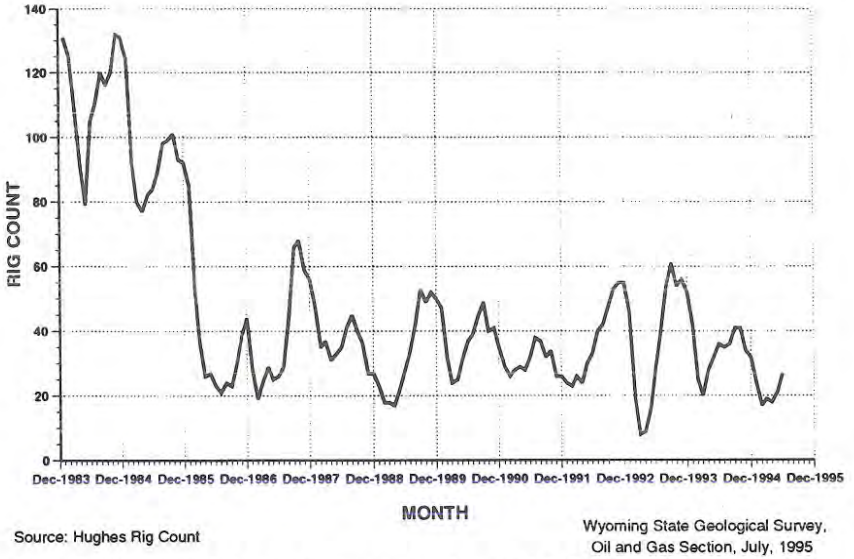


Figure 9. Wyoming daily rig count averaged by month (1984 to present).

bring in more revenue than the sales in the second quarter of 1993 (**Table 5**). The heaviest leasing at the U.S. Bureau of Land Management's (BLM's) April sale was in southwestern Wyoming. Leases in the Bighorn Basin also were in higher demand than usual (**Figure 10**). Most leasing at the May State Land and Farm Loan Board's sale was in the Powder River Basin and in southwestern Wyoming (**Figure 11**). Leases at the BLM's June sale were in demand throughout the State, with the heaviest leasing in southwestern Wyoming and the Powder River Basin (**Figure 12**).

The BLM's April sale had a high per-acre bid of $160. The bid was made by Hanson & Strahn Energy Land Services for a 1,280-acre tract that includes all of sections 14 and 23, T15N, R91W. The tract is on the southern flank of Cherokee Creek Field, which has produced gas and condensate from the Mesaverde, Steele, Shannon, Frontier, and Dakota. The sale's second highest per-acre bid of $112 was made by Donald B. Anderson for a 40-acre tract that covers the NW NE section 22, T26N, R112W. The tract is in an area of Frontier gas and condensate production in Stead Canyon Field. There were only six leases at this sale that drew bids of $50 or more per acre.

The State Land and Farm Loan Office's sale in May had two high per-acre bids of $78. The bids were made by Barlow & Haun, Inc. for a 640-acre lease that includes all of section 16, T20N, R96W, and for a 640-acre lease that includes all of section 36, T21N, R96W. There is no production in either of these townships and the nearest production is in Wamsutter Field, about three miles to the east, where gas is produced from the Lewis and the Almond. Yates Petroleum Corp. made the next highest per-acre bid of $59 for an 80-acre lease

Table 5. Federal and State competitive oil and gas lease sales in Wyoming.

FEDERAL SALES (BUREAU OF LAND MANAGEMENT)

Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
			1991				
TOTAL	$12,934,277	2,815	1,147	2,191,462	675,777	$19.14	$16,000.00
			1992				
TOTAL	$4,778,940	2,122	664	1,434,268	364,478	$13.11	$2,500.00
			1993				
February	$1,637,233	464	246	346,357	155,272	$10.54	$220.00
April	$2,116,184	478	259	351,465	177,989	$11.89	$220.00
June	$1,415,793	463	179	351,130	86,435	$16.38	$390.00
August	$1,877,405	462	262	374,274	208,495	$9.00	$400.00
October	$2,636,127	458	247	367,281	186,274	$14.15	$285.00
December	$3,259,266	444	276	275,435	180,879	$18.02	$320.00
TOTAL	$12,942,008	2,769	1,469	2,065,942	995,344	$13.00	$400.00
			1994				
February	$3,909,085	442	290	374,969	237,761	$16.44	$160.00
April	$4,248,182	498	278	369,657	201,690	$21.06	$275.00
June	$3,759,282	480	270	417,447	233,664	$16.09	$325.00
August	$5,100,550	439	294	323,410	217,157	$23.49	$255.00
October	$4,703,706	492	341	411,117	269,003	$17.49	$11,200.00
December	$5,386,789	617	367	479,930	290,384	$18.55	$390.00
TOTAL	$27,107,594	2,968	1,840	2,376,530	1,449,659	$18.70	$11,200.000
			1995				
February	$3,252,668	533	332	473,177	290,046	$11.21	$425.00
April	$1,591,709	531	206	483,826	189,003	$8.42	$160.00
June	$3,499,604	393	246	384,746	238,863	$14.65	$660.00

STATE SALES (STATE LAND AND FARM LOAN OFFICE)

Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
			1991				
TOTAL	$4,457,885	1,295	1,037	479,975	405,910	$10.98	$401.00
			1992				
TOTAL	$745,738	799	419	277,755	150,613	$4.95	$230.00
			1993				
March	$601,400	200	137	74,940	54,723	$10.99	$400.00
May	$362,840	200	141	82,388	56,770	$6.39	$90.00
September	$505,587	200	141	80,428	56,845	$8.89	$225.00
November	$510,290	200	143	73,517	53,801	$9.48	$155.00
TOTAL	$1,980,017	800	562	311,273	222,139	$8.91	$400.00
			1994				
March	$917,380	200	169	84,571	73,061	$12.56	$170.00
May	$802,688	200	141	75,523	54,199	$14.81	$205.00
September	$586,083	200	149	83,143	61,675	$ 9.50	$190.00
November	$998,001	200	148	88,542	66,217	$15.07	$142.00
TOTAL	$3,304,152	800	607	331,779	255,152	$12.95	$205.00
			1995				
March	$524,165	199	131	89,371	57,702	$9.08	$130.00
May	$452,747	200	125	75,633	49,735	$9.10	$78.00

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

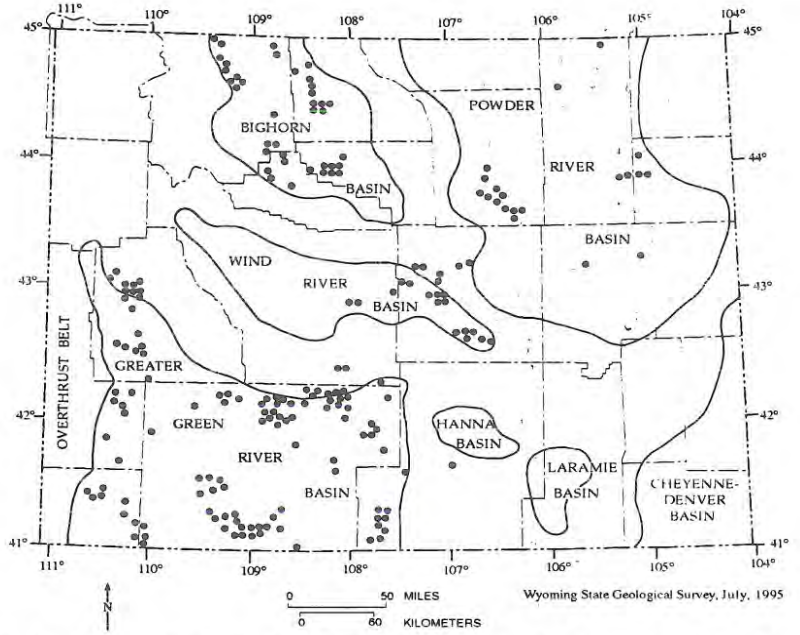


Figure 10. Locations of Federal oil and gas tracts leased by the U.S. Bureau of Land Management at the April, 1995, sale.

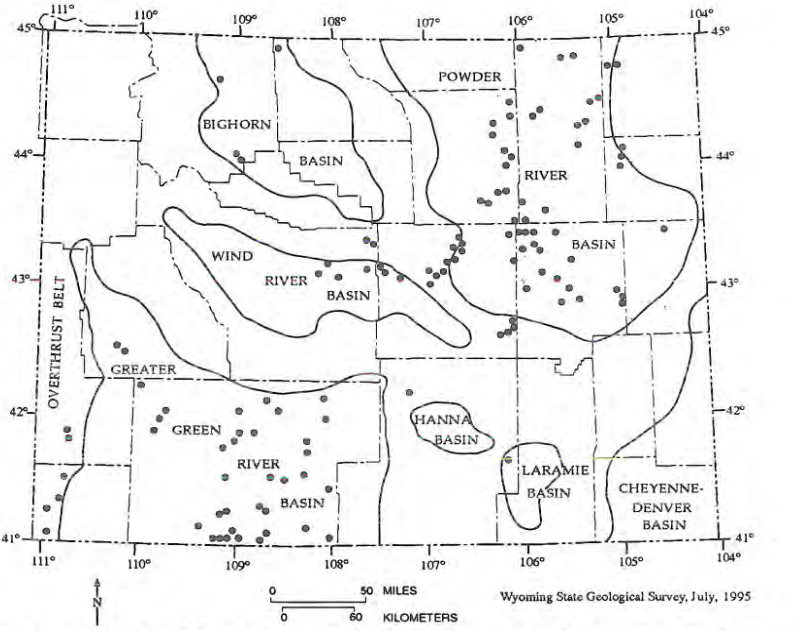


Figure 11. Locations of State oil and gas tracts leased by the State Land and Farm Loan Office at the May, 1995, sale.

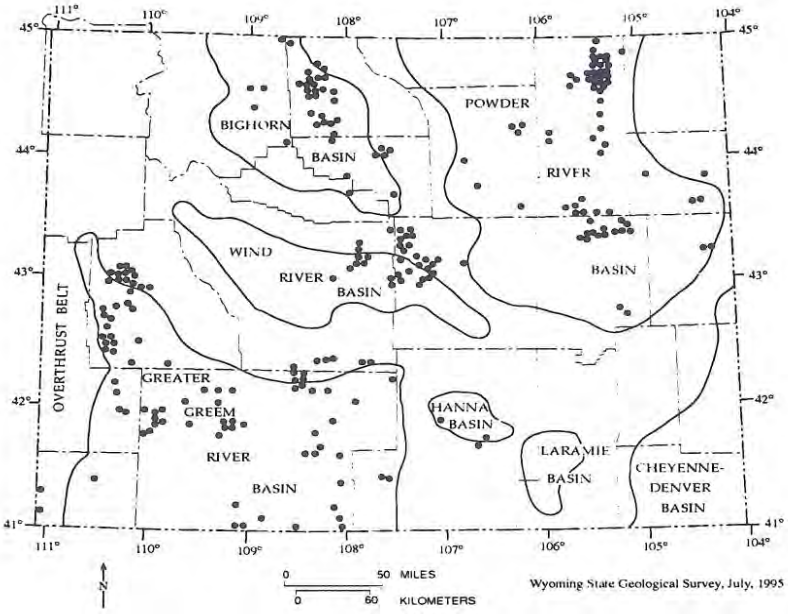


Figure 12. Locations of Federal oil and gas tracts leased by the U.S. Bureau of Land Management at the June, 1995, sale.

that includes W/2 NW section 36, T51N, R75W. The lease is just southeast of Felix Field, which produces from the Muddy. Only these three leases received bids of $50 or more per acre.

The BLM's June sale had a high per-acre bid of $660. The bid was made by High Plains Associates for a 685.5-acre lease that includes parts of sections 19, 20, 29, and 30, T37N, R86W. The lease is about a mile north of Barrett Energy's 1994 sub-thrust Lance gas and condensate discovery. Westech Energy made the sale's second highest per-acre bid of $230 for a lease that includes parts of sections 6, 7, 8, and 17, T38N, R88W. The lease is about one mile east of an apparent Lance discovery in SW NE section 12, T38N, R89W. The third highest per-acre bid of $210 was made by Donald B. Anderson for a 160-acre lease in NE SW, NW SE, and S/2 SE section 18, T23N, R111W. The lease is in an area of Frontier gas and condensate production in Storm Shelter Field. There were 21 tracts that drew bids of $50 or more at this sale.

Exploration and Development

Company data, news releases, and information compiled and published by Petroleum Information indicate the following significant exploration and development events occurred in Wyoming during the second quarter of 1995. The numbers preceding discussions below refer to locations on **Figure 13**.

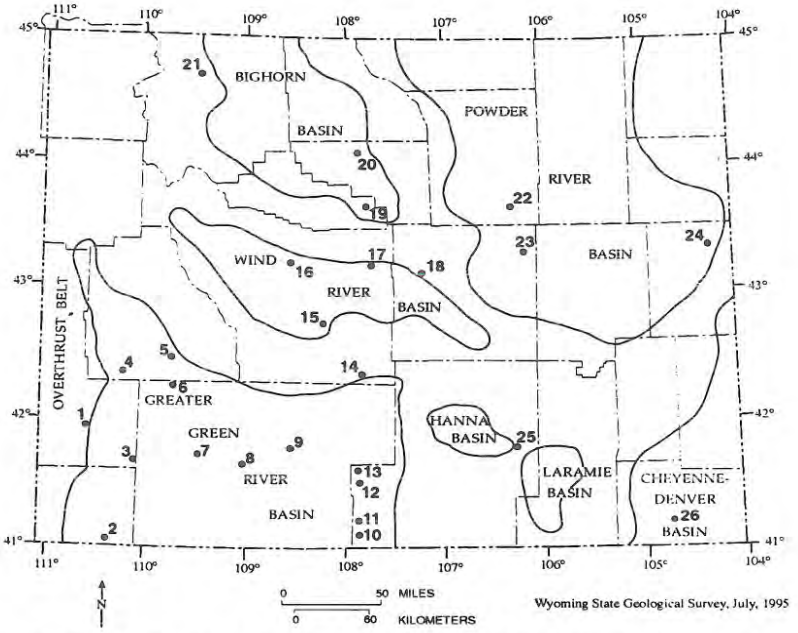


Figure 13. Oil and gas exploration and development activities in Wyoming during the second quarter of 1995 (exclusive of coalbed methane activities).

1. Chevron USA Production is drilling below 2,200 feet at its 1-8 Chevron USA Federal well in NW NW section 8, T23N, R114W. The well will be drilled to 10,100 feet, but the objective has not been disclosed.

2. Union Pacific Resources purchased Oryx Energy's interest in Luckey Ditch Field for $17.5 million. Union Pacific acquired a 50% interest in a gas processing plant, a 15 million cubic feet per day refrigeration plant, gathering and compression facilities, and net reserves of 1.2 million barrels of oil, 20.1 billion cubic feet of gas, and 525,000 barrels of natural gas liquids.

3. Amoco Production drilled its 1 RLP well to 2,000 feet in SE SE section 33, T19N, R112W to test the Green River Formation. There is no Green River production in the area. Amoco has not released any other details on the well.

4. Mobil Oil is planning a horizontal development test of the Frontier at its T33X-16SH Tip Top Unit well. The well will be drilled from a surface location in SE NW section 16, T28N, R113W to a true vertical depth of 7,711 feet.

5. Snyder Oil began drilling its 16-20 Stud Horse Butte well in SE SE section 20, T29N, R108W. The well is projected to the upper Mesaverde and will test the Lance at approximately 8,700 feet. About 1.5 miles to the southeast, Snyder recently completed a gas and condensate discovery in the Mesaverde.

6. Snyder Oil also completed a discovery in the Almond at its 4-10 Sublette Flats well in N/2 NW section 10, T26N, R107W. The well flowed 230,000 cubic feet of gas, four barrels of condensate, and six barrels of water per day during testing of three perforated intervals at 9,978-9,980 feet, 10,183-10,185 feet, and 10,318-10320 feet. Nearest Almond production is more than 20 miles south at Stagecoach Draw Field.

7. Union Pacific Resources began drilling its 1 Stratos-Federal well in C SE section 24, T22N, R107W to test the Frontier and Dakota. The well is projected to 17,000 feet and is about a mile north of abandoned Frontier gas production in Megas Field.

8. Basin Exploration plans to drill four new wells to test the Frontier or Dakota. The 11-1 Greasewood Wash well in NW NW section 1, T22N, R102W is projected to 10,775 feet to test the Dakota. The 21-22 Federal Table Wash well in NE NW section 22, T22N, R102W is projected to 9,215 feet to test the Frontier. The 14-23 Table Wash Creek well in SW SW section 23, T22N, R102W is projected to 9,465 feet to test the Frontier. The 34-33 well in SW SE section 33, T23N, R102W is projected to 10,145 feet to test the Dakota. The tests are about six miles east of Frontier and Dakota production in Leucite Hills and Pine Canyon fields.

9. Union Pacific Resources is preparing to drill its 1 DOC well in SE SE section 16, T22N, R98W to test the Almond. The well is projected to 6,500 feet. Nearest Almond production is about three miles south in Desert Springs Field.

10. Conoco Inc. plans to drill its 1-18 Red Creek wildcat well in SE SE section 18, T13N, R93W to test the Almond. The well is projected to 11,000 feet. Nearest Almond production is nearly three miles north in Robbers Gulch Field.

11. Plains Petroleum completed an Almond discovery with its 1 Snowbank Unit well in SW NW section 31, T15N, R93W. The well produced an average of 1.6 million cubic feet of gas per day during its first two days of production from an undisclosed interval. Nearest Almond production is about four miles to the northwest in Windmill Draw Field.

12. Four new wells were completed in Standard Draw Field. Amoco Production's 1 Champlin 278 Amoco E well in SE SE section 13, T18N, R93W discovered gas and condensate in undisclosed intervals of the Steele and Niobrara. Commingled production from the two formations averaged 214,000 cubic feet of gas and one barrel of condensate during the first 27 days of production. Production from the Steele and Niobrara is the first from these formations in this field. Amoco's 2 Champlin-261 Amoco-H well in NE NE section 9, T18N, R93W flowed an average of 500,000 cubic feet of gas and 108 barrels of water per day from an undisclosed interval in the Almond during its first 18 days of production. Marathon Oil completed its 12-16

Standard Draw well in C NE section 16, T18N, R93W. The well flowed 2.6 million cubic feet of gas and 32 barrels of condensate per day from the Almond between 8,772 and 9,132 feet. Wexpro Co. completed its 22-2 MFS-Creston-Federal well in N/2 NE section 22, T18N, R93W. The well flowed 3.5 million cubic feet of gas from the Almond between 8,654 and 8,670 feet and between 8,794 and 8,810 feet.

13. OXY USA completed a new Almond producer on the northeastern flank of Standard Draw field. Its 2 Federal-BH well in NW NE section 32, T19N, R93W flowed 3.1 million cubic feet of gas, 152 barrels of condensate, and 72 barrels of water per day between 9,022 and 9,270 feet.

14. Wold Oil Properties began drilling its 36-2 Wold-State well in NE SE section 36, T27N, R94W. The well will be drilled to 9,000 feet and will test a number of Tertiary and Cretaceous objectives.

15. CENEX Inc. reached total depth at its horizontally-drilled 3-28H Federal well. The well was drilled from a surface location in NE NW section 28, T33N, R95W to test the Tensleep at an estimated true vertical depth of 10,600 feet.

16. Two new wells were completed in Muddy Ridge Field. Tom Brown Inc. completed its 19-13 Tribal-MR well in NW SE section 19, T4N, R3E flowing 2.0 million cubic feet of gas, 26 barrels of condensate, and seven barrels of water per day from perforations in the Fort Union and Lance between 4,932 and 8,488 feet. Texaco Exploration & Production completed its 18-5 Government-Hornbeck A well in SW NW section 18, T4N, R3E flowing 2.2 million cubic feet of gas, 32 barrels of condensate, and 34 barrels of water per day from the Fort Union and Lance between 7,059 and 8,346 feet.

17. Louisiana Land & Exploration began processing gas at its new plant near Lost Cabin. The plant is designed to process 50 million cubic feet of gas per day from two Madison wells that are the two deepest producing wells in the Rocky Mountain region. Production in both wells is from below 23,500 feet. The company plans to drill a third Madison well later this year. The gas from the Madison is about 70% methane, 20% carbon dioxide, and 10% hydrogen sulfide. The plant produces about 35 million cubic feet of sales gas and over 220 tons of sulfur per day.

18. Barrett Resources Corp. has completed three new Lance/Fort Union producers on its Cave Gulch Unit. The 4 Cave Gulch Unit-Federal well in SW SW section 29, T37N, R86W produced an average of 1.1 million cubic feet of gas, eight barrels of condensate, and 36 barrels of water per day from an undisclosed interval. The 9 Cave Gulch Unit-Federal well in SE SE section 30, T37N, R86W flowed 2.8 million cubic feet of gas, 61 barrels of condensate, and 97 barrels of water per day from undisclosed perforations in a 4,200 feet section of Fort Union and Lance. The 8 Cave Gulch Unit well in SW NW section 32, T37N, R86W flowed 11.9 million cubic feet of gas per day

from perforations between 4,604 and 4,872 feet. The company has plans to drill 14 additional Fort Union/Lance development wells in 1995 and 1996 on the Owl Creek Thrust. Barrett has also acquired 22 square miles of 3-D seismic data and will drill a deep Mesaverde test in the area.

19. Hallwood Petroleum discovered oil in the Phosphoria at its 1 Packsaddle-Federal well in NW NW section 19, T43N, R91W below 3,384 feet. The well pumped 625 barrels of oil and 27,000 cubic feet of gas per day. The discovery is halfway between production in the northwestern and southeastern parts of Lake Ridge Field.

20. JN Exploration & Production will drill a wildcat to test Cretaceous sands at its 41-4 James-Federal well in NE NE section 3, T47N, R93W. The well is projected to 12,000 feet.

21. KGH Operating will test the Madison at its 1 State well in NE SE section 12, T54N, R103W. The well is projected to 5,000 feet and will also test the Greybull and Lakota. Nearest production from the Madison is about 21 miles southeast at Oregon Basin Field.

22. Westech Energy is drilling its 21-4 Big Bend-Federal wildcat in W/2 NE section 4, T43N, R79W to test the Minnelusa (Tensleep). The well is about seven miles north of the nearest Minnelusa (Tensleep) production at Sussex West Field. Projected depth is 15,500 feet.

23. Fluor Daniel Inc. drilled two horizontal Niobrara development tests in Teapot Dome Field. The 73-X-10H NPR#3 well was drilled from a surface location in SE NE section 10, T38N, R78W. The 57-X-14H NPR#3 well was drilled from a surface location in SW SE section 14, T38N, R78W. No other details are yet available.

24. Petrolero Corp. completed a wildcat discovery in the Dakota at its 1-11 Federal well in SE SW section 11, T39N, R63W. The well pumped 84 barrels of oil and 51 barrels of water per day between 5,811 and 5,818 feet. Nearest Dakota production is in Seedy Draw Field about eight miles to the northwest.

25. Sinclair Oil began drilling a Nugget test at its 5-21 UPRC well in SW NW section 21, T21N, R78W. The well is projected to 6,900 feet. There is no Nugget production in the area.

26. Union Pacific Resources' horizontally-drilled wildcat discovered oil in the Niobrara. The 1H Sego Lily 14-5 well drilled from a surface location in SW SW section 5, T14N, R64W produced an average of 71 barrels of oil and nine barrels of water per day during its first 14 days of production. True vertical depth was not disclosed. The well is about five miles south of the nearest Niobrara production in Silo Field.

COAL UPDATE

P. Daniel Vogler
Staff Geologist-Coal, Wyoming State Geological Survey

A review of the first quarter deliveries of Wyoming coal shows a 15% increase over the first quarter for 1994 (**Table 6**). March was another record month with 21,707,320 tons delivered. The first quarter of 1995 also marked the first time in history that Wyoming, or any state, had over 20 million tons of coal delivered for each of three consecutive months. The first quarter is following the same patterns shown in the last two years, albeit considerably higher than past years (**Figure 14**). If previous patterns persist, monthly deliveries in the second quarter are likely to remain around 20 million tons.

The strength of Wyoming's first quarter coal deliveries came from a rise in contract coal. There was minimal change in the spot sales between the first quarters of 1994 and 1995; yet, contract sales have increased by 25% between the same quarters (**Figures 15A** and **15B**). These contract sales are routinely 1- to 3-year contracts, mainly at less than $5.00/ton Freight on Board (FOB). Spot sale agreements usually range from one to three months in duration. Strengthening contract sales are more important to Wyoming's economic stability than spot coal agreements, in which the prices vary more frequently.

If the rest of 1995 keeps pace with the first quarter deliveries, Wyoming could produce over 250 million tons this year, rather than the 245.5 million tons predicted back in January (**Table 7**). At current production rates in the U.S., Wyoming's tonnage could account for over 25% of the total coal produced in the nation.

A review of Wyoming's coal markets has shown some startling changes. While the State delivered nominal quantities of coal to many states outside its core market (mainly 13 states in the Midwest, Colorado, and Wyoming) in 1994, 1995 marked a year where consumers in the core states accounted for over 77% of the increase in deliveries. Increased deliveries to each of these core states averaged 1.2 million tons in 1994 (**Table 8**, **Figures 16** and **17**). This trend looks like it will continue as more plants in the core state area switch to Powder River Basin coals or to other coals from Wyoming (see section on Contracts).

Notable delivery increases occurred in Missouri, Indiana, Illinois, and Georgia (**Table 8**). Indiana and Illinois, prominent coal producers in their own right, are now the 5th and 10th largest customers of Wyoming coal, respectively. Georgia's large delivery increase is due to the Scherer plant, a jointly owned utility near Macon, which increased its consumption of western coal. This plant was specifically designed to either burn western subbituminous coals outright or to blend them with existing feedstocks. At least three new plants in Missouri started burning Powder River Basin coal in 1994, which contributed to this state becoming the 3rd largest consumer of Wyoming coal in 1994.

Table 6. Coal deliveries by month from Wyoming mines.

	1992 Monthly	1992 Cumulative	1993 Monthly	1993 Cumulative	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative
JAN	16,407,150	16,407,150	15,931,150	15,931,150	19,326,770	19,326,770	21,531,910	21,531,910
FEB	14,604,480	31,011,630	14,646,090	30,577,240	17,171,910	36,498,680	20,800,760	42,332,670
MAR	14,429,650	45,441,280	17,112,970	47,690,210	19,178,990	55,677,670	21,707,320	64,039,990
APR	14,063,060	59,504,340	16,259,770	63,949,980	17,839,110	73,516,780		
MAY	14,518,590	74,022,930	16,085,470	80,035,450	18,652,290	92,169,070		
JUN	14,655,600	88,678,530	16,473,920	96,509,370	17,741,480	109,910,550		
JUL	15,592,050	104,270,580	15,296,480	111,805,850	18,213,540	128,124,090		
AUG	16,467,100	120,737,680	16,682,090	128,487,940	20,572,120	148,696,210		
SEP	14,878,150	135,615,830	17,310,330	145,798,270	19,129,450	167,825,660		
OCT	15,122,820	150,738,650	18,300,070	164,098,340	18,189,260	186,014,920		
NOV	14,757,230	165,495,880	18,007,970	182,106,310	18,595,500	204,610,420		
DEC	16,096,150	181,592,030	19,034,530	201,140,840	20,866,710	225,477,130		
Total Tonnage Reported[1]		**181,592,030**		**201,140,840**		**225,477,130**		**64,039,990**
Total Tonnage Not Reported		**7,878,226**		**8,784,986**		**11,430,937**		
Total Tonnage Produced[2]		**189,470,256**		**209,925,826**		**236,908,067**		

[1] COALDAT Marketing Reports by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities

[2] State Mine Inspector's Annual Reports

Wyoming State Geological Survey, Coal Section, July, 1995

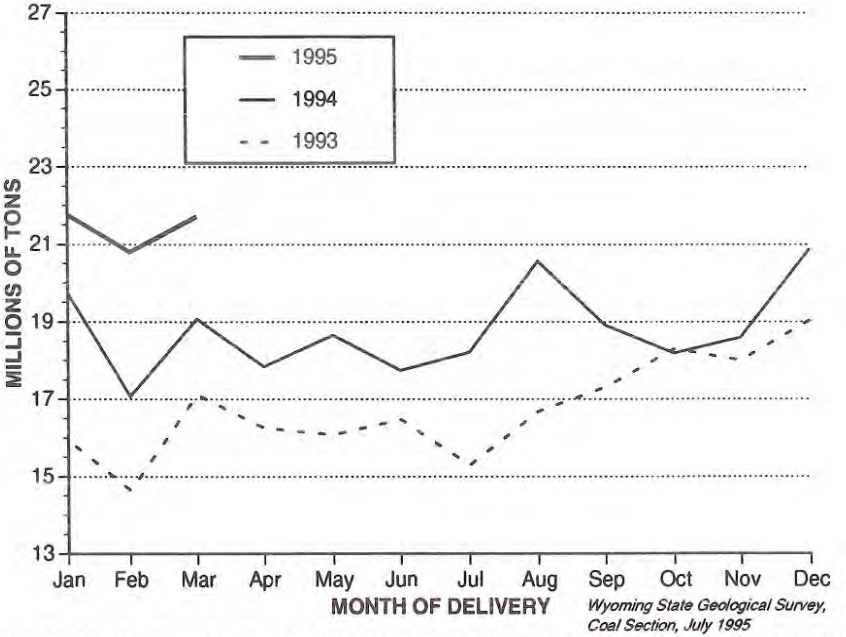


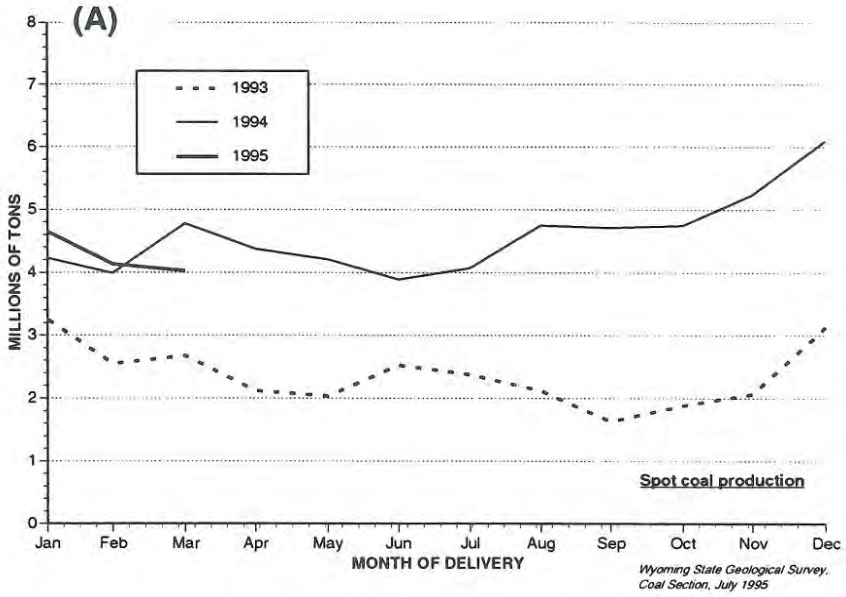
Figure 14. Reported deliveries from Wyoming coal mines (1993 through March, 1995). (From COALDAT Marketing Report by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities.)

Developments in the Powder River Basin

After more than 15 years, Whitney Benefits and Peter Kiewit Co. finally settled their legal battle with the Department of the Interior. The initial dispute was over $60 million worth of coal, which was deemed unminable because it occurred under an alluvial valley floor. The final settlement swelled to $200 million due to interest on the principal over 15 years.

Another train derailment threatened to slow coal deliveries from the Powder River Basin this summer. Eleven Union Pacific cars derailed at the NACCO rail bridge in the southern Powder River Basin on June 7. The accident occurred to a portion of the line that was double tracked. Some sources believe this incident, much like a derailment in the Gillette rail yard last summer, could slow deliveries for about a month.

Burlington Northern (BN) and Union Pacific (UP) railroad stocks are up. Stockholders are optimistic that recent acquisitions by both railroads will broaden the market for Wyoming's low-sulfur coal. Burlington Northern was granted approval of its proposed merger with the Santa Fe Pacific in July. In related news, more than 500 non-union employees have opted to take a buyout offer as a result of UP's takeover of Chicago and Northwestern Transportation



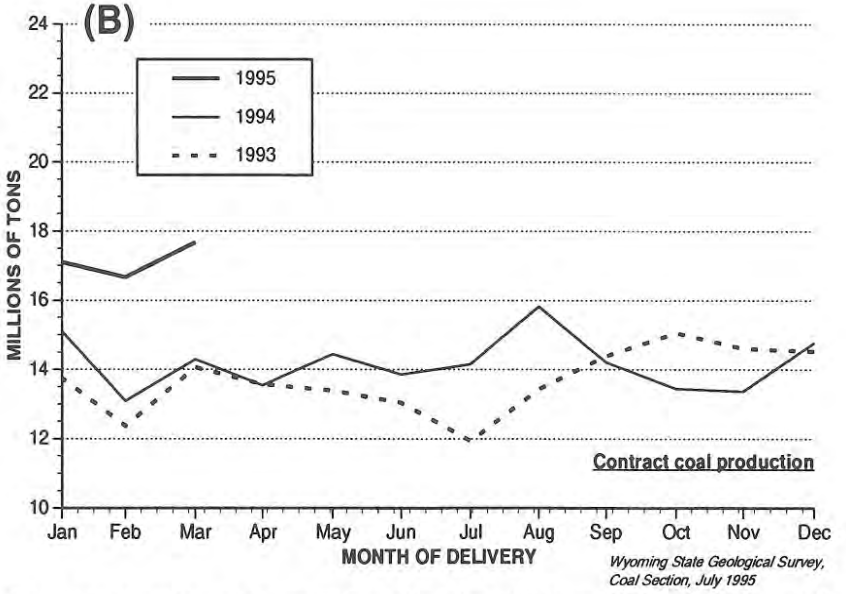


Figure 15. Monthly coal deliveries from Wyoming (1993 through March 1995). (A) Coal sold on the spot market and (B) coal sold on contract. (From COALDAT Marketing Report by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities).

Table 7. Coal production (1985 to 1994) with forecast to 1998 (millions of tons).

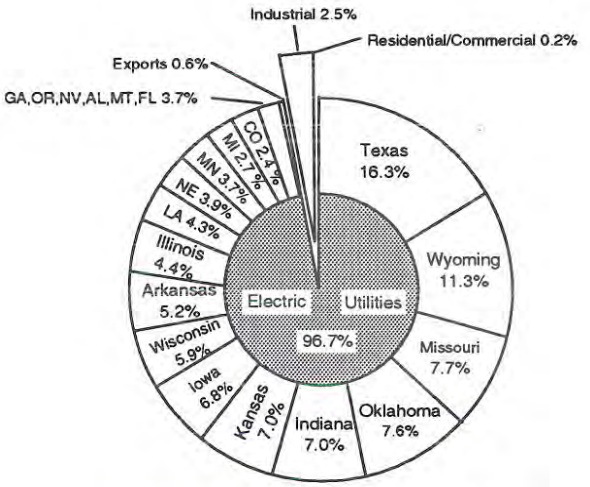
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994[1]	1995[1]	1996[1]	1997[1]	1998[1]
Campbell County	113.9	111.0	122.3	135.7	143.8	154.7	164.9	159.6	181.9	205.2	212.6	222.2	232.1	242.4
Converse County	3.6	4.8	5.1	5.7	6.1	7.9	8.2	8.5	10.2	11.7	12.1	12.7	13.2	13.8
Sheridan County	2.4	1.4	1.2	0.9	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Carbon County	3.3	1.5	2.2	4.1	4.3	4.5	4.7	4.1	4.4	4.4	4.6	4.8	5.0	5.2
Sweetwater County	13.2	12.9	11.8	12.2	12.0	11.9	11.4	12.6	9.2	11.2	11.6	12.1	12.7	13.2
Lincoln County	4.3	4.0	3.8	4.9	4.8	4.7	4.4	4.6	4.1	4.3	4.5	4.7	4.9	5.1
Hot Springs County	M	M	M	M	M	0.1	0.1	M	M	M	M	M	M	M
Total Wyoming	140.7	135.6	146.4	163.5	171.1	183.9	193.9	189.5	209.9	236.9	245.5	256.5	267.9	279.9
Annual Change	7.7%	-3.6%	8.0%	11.7%	4.6%	7.5%	5.4%	-2.3%	10.8%	12.9%	3.6%	4.5%	4.5%	4.5%
Low-priced coal[2]	6%	7%	8%	10%	20%	25%	33%	35%	47%	54%	58%	60%	62%	65%

[1]Forecast by the Wyoming State Geological Survey, January, 1995. [2]Estimated 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).

Table 8. Summary of 1993 and 1994 Wyoming coal production and distribution in short tons[1].

1994 Rank	Coal Deliveries to Power Plants 1993	Coal Deliveries to Power Plants 1994	Percent Difference	Summary of Wyoming Production and Percentage Used for Various Purposes	
1. Texas	37,002,000	38,027,000	2.77	227,826,000	Electrical Plants
2. Wyoming	23,580,000	25,624,000	8.67	0	Coke Plants
3. **Missouri**	**11,690,000**	**17,308,000**	**48.06**	5,829,000	Industrial Plants
4. Oklahoma	16,399,000	17,079,000	4.15	362,000	Residential/Commercial Use
5. **Indiana**	**12,510,000**	**15,772,000**	**26.08**	1,524,000	Exports
6. Kansas	15,855,000	15,762,000	-0.59		
7. Iowa	14,840,000	15,345,000	3.40	235,541,000	Total
8. Wisconsin	12,351,000	13,332,000	7.94		
9. **Arkansas**	**10,754,000**	**11,847,000**	**10.16**		
10. **Illinois**	**7,509,000**	**9,927,000**	**32.20**	96.7%	Power Plants
11. Louisana	9,970,000	9,734,000	-2.37	0.0%	Coke Plants
12. Nebraska	8,696,000	8,835,000	1.60	2.5%	Industrial Plants
13. Minnesota	7,829,000	8,382,000	7.06	0.2%	Residential/Commercial Use
14. **Michigan**	**4,589,000**	**5,497,000**	**19.79**	0.6%	Exports
15. Colorado	5,467,000	5,126,000	-6.24		
16. **Georgia**	**700,000**	**4,831,000**	**590.14**	100.00%	Total
17. **Oregon**	**1,199,000**	**2,123,000**	**77.06**		
18. **Nevada**	**754,000**	**1,012,000**	**34.22**		
19. **Alabama**	**0**	**238,000**			
20. Montana	0	119,000			
21. Florida	0	118,000			
22. North Dakota	5,000	0	-100.00		
23. Massachusetts	7,000	0	-100.00		
24. **Kentucky**	**320,000**	0	**-100.00**		
Total Reported	**202,026,000** [2]	**226,038,000** [2]	**11.89**		
Total Unreported	**2,847,000**	**1,788,000**	**-37.20**		
Total	**204,873,000** [3]	**227,826,000** [3]	**11.20**		

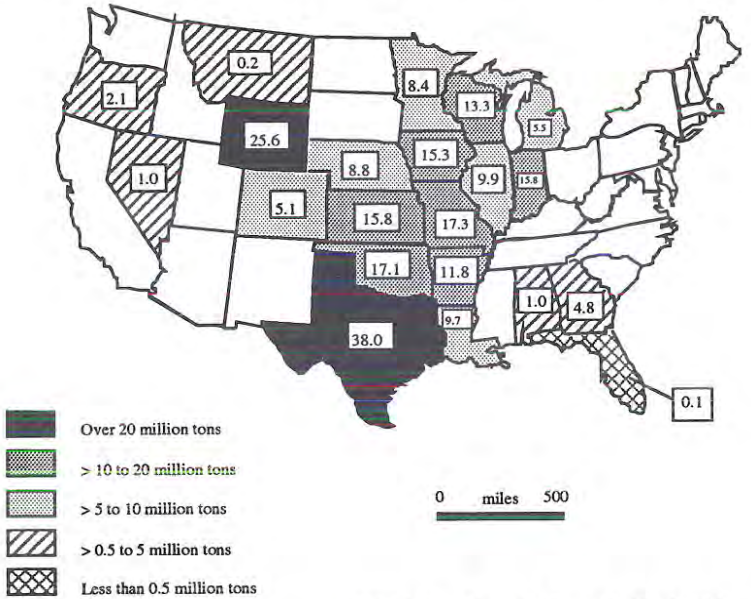
[1]The data for total coal production in this table does not agree with the total coal production reported by the Wyoming State Inspector of Mines (1995); [2]from EIA, 1995a; and [3]from EIA, 1995b.



1994 Coal Production = 236.9 Million Tons

Wyoming State Geological Survey, Coal Section, July , 1995

Figure 16. Utilization of Wyoming coal in 1994 in percent (adapted from EIA, 1995a). Industrial, residential, and commercial usages are not broken down by their destination (EIA, 1995b). The 1994 coal production is from the Wyoming State Inspector of Mines (1995).



Wyoming State Geological Survey, Coal Section, July , 1995

Figure 17. Distribution of Wyoming coal sales to electric generating plants in 1994 in millions of tons (adapted from EIA, 1995a).

Company. Company officials said that between 1,200 and 1,500 people may leave or lose their jobs before the buyout is complete.

Black Hills Power & Light's Neil Simpson No. 2, a small air-cooled, coal-fired plant under construction just east of Gillette, is nearly completed. Officials believe the 80-MW power plant will be ready by September 3rd, months before the original start-up date of December. The opening may also coincide with a rate hike for residents in northeastern Wyoming and southeastern South Dakota. The utility did not have a firm rate increase for Gillette, but it looks like a 9.96% increase for South Dakota users.

Developments in Western and Southwestern Wyoming

Black Butte Coal Company laid off 34 miners in late June. Officials cited the availability of excess hydropower in most of their market area as a reason for the layoffs. In 1994, 37% of Black Butte's production was delivered to the North Valmy plant in Nevada and the Boardman plant in Oregon. Both of these plants are in areas that may be able to tap into surplus hydropower. Earlier in June, the company had reduced hours for nearly 200 employees. Workers were taking eight-hour shifts, three days a week. Workers were also paid for a fourth day even though they were not working that day.

United Mine Workers of America at Pittsburg & Midway's Kemmerer mine have approved a new five-year contract covering 243 employees. There are a total of 308 employees at the Kemmerer mine. In 1994, about 2.4 million tons or two-thirds of the coal mined at this mine were burned at Utah Power and Light's nearby Naughton plant.

Principals in the Carbon County Underground Coal Gasification project near Rawlins are still working to get the project permitted. There is also some opposition to the project.

Arch Minerals may reopen the Seminoe II mine near Hanna. Arch officials are currently looking at permitting issues. The mine would help offset declining production from the Medicine Bow mine.

Contracts

New coal contracts, test burns, solicitations, and spot sales for the second quarter of 1995 are summarized in **Table 9** and **Figure 18**.

In the second quarter, the Cordero mine was awarded a 400,000-ton/year contract with Iowa-Illinois Gas & Electric Co.'s Riverside plant. In the past, this plant mainly used Illinois coal. This contract may indicate the plant's need to comply with Phase I of the Clean Air Act Amendments.

Table 9. Activities involving coal producers in Wyoming during the first quarter of 1995[1].

	Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
1.	Montana Power	Corette	Buckskin	T	100,000 t	2nd Quarter Test.
2.	Springfield (MO) City Utilities	Southwest	North Antelope	C	650,000 t	1 year contract at $5.13 FOB.
3.	Fremont (NE) Dept. of Utilities	Fremont Number 1 & 2	Shoshone	Sp	30,000 t	
4.	Wisconsin Electric Power Co.	Oak Creek	Powder River Basin coal	So	1,500,000 t	Minimum 8,300 Btu/lb.
5.	Lower Colorado River Authority	Fayette Power Project Units 1 & 2	Powder River Basin coal	So	1,500,000 t	1- to 3-year contracts; minimum 8,000 Btu/lb.
6.	Iowa-Illinois Gas & Electric	Riverside	Cordero	C	400,000 t	
7.	Pacific Power & Light	Jim Bridger	Rochelle	C	U	1 year contract.
			Black Butte	C	U	1 year contract.
			Black Thunder	C	U	1 year contract.
			Caballo	C	U	1 year contract.

[1] Data obtained from : Coal Week, trade journals, periodicals, FERC database, and personal contacts.
N.D. =No other data available; C =Contract coal; T =Test burn; Sp =Spot coal; So =Solicitation; U =Undetermined tonnage; t =short ton; t/y =short tons per year.
Wyoming State Geological Survey, Coal Section, July, 1995

Wyoming State Geological Survey, Coal Section, July, 1995

Figure 18. Coal marketing activities related to Wyoming in the second quarter of 1995. [Numbers correspond to those in Table 9].

In the same vein, Wisconsin Electric Power Co.'s Oak Creek plant has solicited 1.5 million tons/year of coal with a minimum of 8,300 Btu/lb . This plant has been using coal from Illinois Basin producers. This solicitation may indicate that this plant is also in need of more western low-sulfur coal in order to achieve compliance with Phase I requirements.

New contract prices for southern Powder River Basin coal seem to be holding steady. Springfield (MO) City Utilities recently awarded a one-year, 650,000-ton contract to Powder River Coal Co.'s North Antelope mine. The FOB contract price was $5.13/ton.

Coalbed Methane

Petrox Resources, Inc., an oil and gas exploration firm from Platteville, Colorado, recently withdrew its application to the Oil and Gas Conservation Commission to "force pool" certain interests in the Fort Union Formation (Wyodak zone coals) in the Powder River Basin. Petrox's coalbed methane venture targeted the Wyodak coal bed in numerous sections of T44-45N and R71-73W.

American Oil and Gas is still working on its Lighthouse project in the Powder River Basin. This coalbed methane project also targets the Wyodak coal bed.

References Cited

Wyoming State Inspector of Mines, 1995, Annual report of the State Inspector of Mines of Wyoming for the year ending December 31, 1994: Rock Springs, p. 18-25.

Energy Information Administration, 1995a, Quarterly coal report, October-December 1994: U.S. Department of Energy Report DOE/EIA-0121 (94/4Q), Table 37, p. 65-69. (Data derived from FERC Form 423).

Energy Information Administration, 1995b, Quarterly coal report, October-December 1994: U.S. Department of Energy Report DOE/EIA-0121 (94/4Q), Table 7, p. 18-20. (Data derived from EIA Form 6.)

INDUSTRIAL MINERALS AND URANIUM UPDATE

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Production of industrial minerals and construction materials generally increased in 1994, as did uranium production. **Table 10** compares the 1994 and 1993 production of some commodities and shows the percent increase or decrease between those years. In the following discussions, the locations of most mines, quarries, mills, etc. are shown on **Figure 19**.

Decorative Stone

During the second quarter of 1995, wet weather prevented Sunrise Stone from working at their black granite quarry in Albany County. Fabrication continued, however, using stockpiled blocks from previous quarrying. Georgia Marble quarried white marble west of Wheatland and processed it into various sizes of decorative aggregate. Canyon Creek Stone continues with plans to construct a plant east of Tensleep for processing brown marble. In the meantime, they are producing decorative stone and fieldstone from the property. Moss rock was produced from a site in northwestern Goshen County for possible sale to a buyer in Glenwood Springs, Colorado, who has outlets throughout the western United States. Rocky Mountain Stone, of Longmont, Colorado, leased a site with grey and red sandstone south of Glenrock in Converse County. This stone will be marketed as decorative stone blocks.

Limestone

Limestone, a rock composed primarily of calcium carbonate, is used in several ways. It is a preferred construction aggregate, particularly in highway base and surfacing material. It is also used for its chemical content in the

Table 10. Selected industrial mineral production in Wyoming showing percentage increase or decrease between 1993 and 1994[1].

COMMODITY	1993 PRODUCTION (SHORT TONS)	1994 PRODUCTION (SHORT TONS)	% CHANGE
TRONA	15,966,741	16,079,175	0.70
BENTONITE	2,533,866	3,278,583	22.7
SAND & GRAVEL	5,773,667	6,561,924	12.0
CEMENT	477,827	429,996	-10.0
GRANITE	2,640,234	NOT REPORTED	—
GYPSUM	355,792	368,147	3.36
LEONARDITE	38,999	37,073	-4.9
MARBLE	81,192	NOT REPORTED	—
SODIUM SULFATE	1,521	1,109	-27.1

Source: [1]Wyoming State Inspector of Mines.

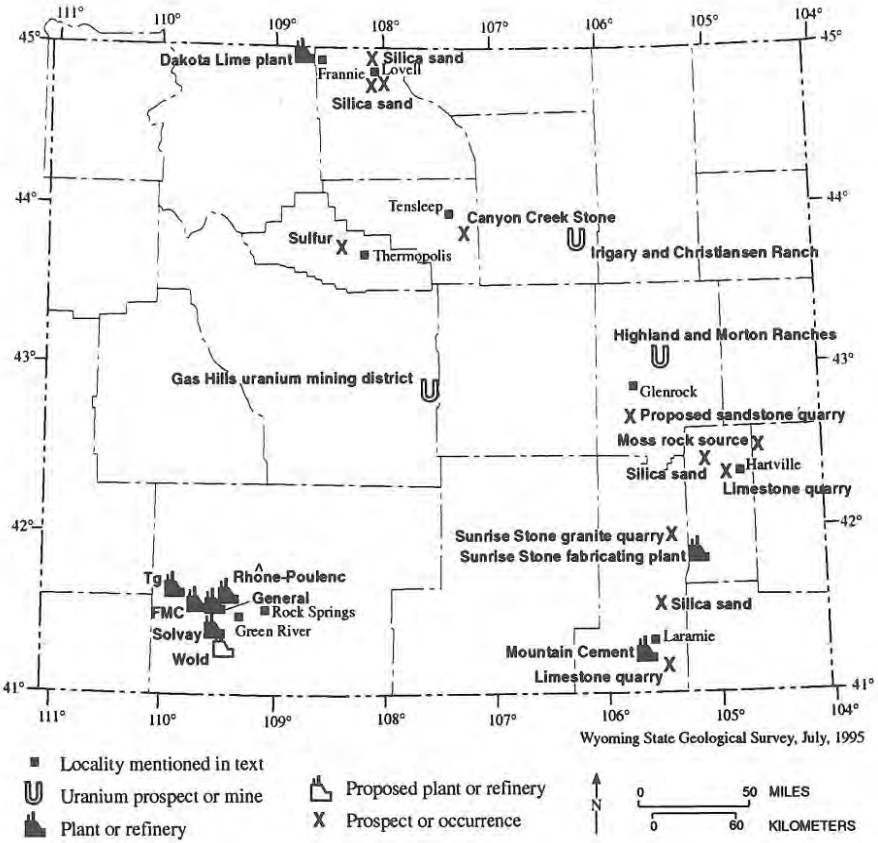

Figure 19. Industrial minerals and uranium activities in Wyoming during the second quarter of 1995.

manufacture of cement, sugar beet processing, and other uses. It is also a source of lime (calcium oxide), which is used in construction, chemicals, and whiteners.

Limestone quarried in Montana is converted to lime at Dakota Lime's plant in Park County, near Frannie, Wyoming. Limestone is mined at the Bass quarry in northeastern Platte County for the control of emissions from the Laramie River coal-fired power plant near Wheatland. Limestone is quarried by Mountain Cement south of Laramie for the chief raw material in cement manufacture. There are also numerous limestone quarries throughout Wyoming from which limestone is quarried for construction aggregate.

During the second quarter of 1995, Colorado Lien of Fort Collins conducted tests and plans to open the Hartville limestone quarry, near Hartville in Platte County, later this summer. Prior to 1960, the Hartville quarry was operated by Great Western Sugar as a source of limestone used in sugar refining. Until 1994, the quarry was operated by Lamb Construction as a source of construction aggregate. Limestone was sold for highway construction projects as far away as central Nebraska, some 200 miles away.

In the second quarter of 1995, Mountain Cement announced plans to open another limestone quarry south of Laramie. According to figures published by the Wyoming State Inspector of Mines, Mountain Cement mined only 26,044 short tons of limestone for cement in 1994 compared to 634,620 short tons in 1993. Cement production decreased from 477,827 short tons in 1993 to 429,996 short tons in 1994, a difference of 47,831 short tons. Apparently, Mountain Cement manufactured most of their cement in 1994 from stockpiled limestone mined in previous years.

Pumice and Pumicite

Wyoming contains resources of pumice and pumicite, a material used primarily as an abrasive, though some pumice rock is sold for landscape rock and other types of decorative aggregate. Most pumice and pumicite is produced in the western United States from Oregon, New Mexico, Idaho, California, Arizona, and Kansas (Bolen, 1995). These pumice deposits consist of pumiceous igneous rock, such as ash falls or near-surface or surficial deposits of pumice rock from volcanic vents. Wyoming pumicite (volcanic ash) deposits are found primarily in northwestern and central Wyoming (Harris and King, 1986). The Leucite Hills near Rock Springs contain deposits of pumice which small operators have mined from time to time. Although there are currently no producing pumicite or pumice deposits in Wyoming, this material represents a possible growth industry, especially for individuals or small operators.

Silica Sand

There is continued interest in Wyoming's silica sand. During the second quarter of 1995, three companies were active in exploration and economic evaluation of silica sand resources in southeastern Wyoming. The Cassa and

the Plumbago Creek silica sand deposits were examined (Harris, 1988a and 1988b). Additionally, two companies were reportedly exploring at least two possible silica sand occurrences south of Lovell, in Big Horn County, as well as the John Blue Canyon occurrence northeast of Lovell (Harris and Warchola, 1992).

Sulfur

An abandoned sulfur mine in Hot Springs County is scheduled for reclamation later this summer, according to officials of the Wyoming Abandoned Mined Lands Program. The Brutch sulfur mine, once Wyoming's largest, is located on private land northwest of Thermopolis. Production of mined sulfur from this mine occurred in the early 1900s, and again in the 1920s. During World War II, the U.S. Bureau of Mines conducted exploratory work on the property and outlined an area of sulfur reserves (Majors, 1946). In the 1980s, the town of Thermopolis conducted additional exploration work, which was funded through a State of Wyoming Economic Development Block Grant. However, the property was never developed.

The mine has been the scene of at least four deaths related to the presence of deadly hydrogen sulfide gas. Because the mine has not been worked since the 1920s, the State is contracting for the reclamation, which will include sealing the portals, contouring the surface, and planting seeds.

Talc and Steatite

The Wyoming State Geological Survey released a report on the occurrence of talc and steatite in Wyoming. The report, Open File Report 95-1, lists thirteen occurrences of talc and steatite in Wyoming, some of which are listed for the first time (Harris, 1995). Talc, mostly known for its use as talcum powder, is primarily used in ceramics, paint, paper coatings, fire-resistant materials, and as sculpturing material. Although Wyoming has never been an important producer of talc, steatite (a compact form of talc) was used by Native Americans to carve bowls and other vessels. In recent years, small amounts of steatite were taken from an area near Sweetwater Gap in southwestern Fremont County for use in sculpture.

Trona

Trona is mined in Wyoming at five locations west of Green River, and processed into soda ash and a variety of sodium-based products at refining plants at the mine sites. A sixth mine and plant facility is under development.

The amount of trona mined in Wyoming in 1994 was 16,079,175 short tons, according to figures recently released by the State Inspector of Mines. This represents an increase of 0.7% over 1994. It was also the fifth highest annual production recorded, following 1992, 1989, 1991, and 1990, respectively.

In June, FMC announced an increase of $15.00/ton for spot purchases of soda ash and $7.00 for long-term contracts. This was the first announced price increase since prices dropped in 1990. As a result, prices changed from $90/ ton to $105/ton of soda ash.

The BLM is planning a competitive sodium lease sale later this summer. Trona is classified by the Federal government as a leasable mineral. The sale will likely include 9,894 acres. A lease sale was proposed in 1993, but was not held because of negotiations regarding increases in the Federal royalty rate. The Environmental Assessment (EA) for the sale is out for public review. Based on this EA, bidders may find that the lease tracts have as many as 53 stipulations or mitigations associated with them.

The Potash Corp. of Canada, purchased Texasgulf, Inc., a major U.S. potash, phosphate, and soda ash producer. Tg Soda Ash, one of the five Wyoming producers of soda ash, is included in the sale. Operations are not expected to change at the Wyoming site.

Uranium

Uranium is mined in Wyoming by in-situ (solution-mining) methods at Comin's operations at the Irigary and Christiansen Ranch properties in Johnson County and at Power Resources operations at the Highland and Morton Ranch properties in Converse County.

During the second quarter of 1995, it was noted that uranium prices had risen from below $9.00 per pound of yellowcake to around $11.00 per pound. There is some optimism that this rise in price could lead to increased domestic production for the first time since the early 1980s. Uranium prices peaked at $42.00 per pound of yellowcake in 1979 (1979 dollars).

Internationally, it has been reported that a 1992 uranium purchase arrangement between the United States and Russia is still being negotiated. According to the original arrangement, the United States was to purchase 500 metric tons of weapons-grade uranium at a price initially set at $12 billion. This is one of the aspects still being negotiated. The weapons-grade uranium, which contains over 90% fissionable ^{235}U, must be diluted with nonfissionable ^{238}U to make fuel-grade uranium, which is around 3% ^{235}U.

Officials of the Wyoming Abandoned Mined Lands Program (AML) announced its plans to reclaim four sites at two abandoned uranium mines in Fremont County. These mines are located in the Gas Hills, one of Wyoming's largest historic uranium districts. The work should be completed in the summer of 1996.

In neighboring Nebraska, uranium is mined by in-situ processes at Crow Butte, near Crawford. Recently, the operating company changed ownership. Crow Butte Resources has replaced Ferret Resources, as the new operator. Crow Butte Resources is a venture primarily controlled by Uranerz USA, the U.S. branch of Uranerz, a German Company; Geomex, a subsidiary of Cameco, headquartered in Canada; and KEPRA, a South Korean nuclear power agency. Cameco has interests in Wyoming and has an office in Casper.

References Cited

Bolen, W.P., 1995, Pumice and pumicite: U.S. Bureau of Mines Mineral Industry Surveys, Annual Review, 1994, 3 p.

Harris, R.E., 1995, Talc, including steatite, in Wyoming: Wyoming State Geological Survey Open File Report 95-1, 14 p.

Harris, R.E., 1988a, The Cassa silica rock deposit, Platte County, Wyoming: Wyoming State Geological Survey Report of Investigations 42, 38 p.

Harris, R.E., 1988b, The Plumbago Creek silica sand deposit, Albany County, Wyoming: Wyoming State Geological Survey Report of Investigations 40, 32 p.

Harris, R.E., and King, J.K., 1986, Pumice, scoria, and pumicite in Wyoming: Wyoming State Geological Survey Open File Report 86-17, 19 p.

Harris, R.E., and Warchola, R.J., 1992, The John Blue Canyon silica sand deposit, Big Horn County, Wyoming: Wyoming State Geological Survey Open File Report 92-3, 26 p.

Majors, F.H. 1946, Exploration of the Brutch sulfur deposits, Hot Springs County, Wyoming: U.S. Bureau of Mines Report of Investigations 3964, 20 p.

METALS AND PRECIOUS STONES UPDATE

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Gold

Mary Ellen Gold Mining Co., Consolidated McKinney, and others continue to explore for gold at South Pass. BHP was reportedly exploring in the southeastern portion of the State, and Royal Gold was apparently working in both the Medicine Bow Mountains and Green River Basin. In addition, Phelps

Dodge and others conducted gold exploration in the Bear Lodge Mountains of northeastern Wyoming. Newmont continued exploration of their gold prospect in the Granite Mountains of central Wyoming. Compass Minerals of Australia reportedly was seeking a joint-venture partner for their Copper King gold-copper prospect in the Laramie Mountains.

In central Wyoming, the Wyoming State Geological Survey initiated a mapping and mineral resource study of the Tin Cup area in the Granite Mountains near Jeffrey City. The Tin Cup area consists of greater than 2.5 billion-year-old volcanic and sedimentary rocks. In addition to gold, the district is known for jade and ruby.

Reconnaissance in the Tin Cup area has identified hematite-bearing shear zones traceable up to a mile in strike length, with massive sulfides and jasperoids. Additional samples collected by the State Survey include nephrite jade.

Diamonds

Since diamonds were first discovered in Wyoming in 1975, dozens of companies have explored for these gems in the Colorado-Wyoming Kimberlite Province. Recently, another company has entered the search for diamonds. Reportedly, the Wyoming State Geological Survey's recovery of chromian diosides and pyrope garnets in stream-sediment samples from Archean cratonic areas in southeastern Wyoming (Hausel and others, 1988) prompted Guardian Enterprises to acquire a mineral lease, which is about 40 miles north of Laramie in Albany County.

In addition to Guardian Enterprises, a partial list of companies that have explored for diamonds since 1979, or continue to explore in this region, include Cominco American Inc., Superior Minerals, Mobile Minerals, Diamet, Royalstar Resources, BHP Minerals, MPH Consulting, Lime Creek, Anglo American, EXMIN, DDI (Diamonds Distributors International), Fleck Resources, First Choice, LAC Minerals, Royal Gold, Rocky Mountain Energy (Union Pacific Resources), Diamond Company, N.L., Colorado Diamond Company, Redaurum Red Lakes, Echo Bay, and Primus Resources.

The Colorado-Wyoming kimberlite province includes more than 100 kimberlite intrusives, one of the largest lamproite fields in the world, and dozens of unexplored geophysical, remote sensing, and heavy mineral anomalies. The province extends many miles north and south of the Colorado-Wyoming State Line (**Figure 20**). Kimberlites have been found as far south as Boulder and Estes Park, Colorado, and as far north as the Iron Mountain and Middle Sybille Creek areas of Wyoming. To date, only the State Line kimberlites have yielded diamonds, although the chemistry of pyrope garnets from the Iron Mountain district suggest those kimberlites also tapped the diamond stability field.

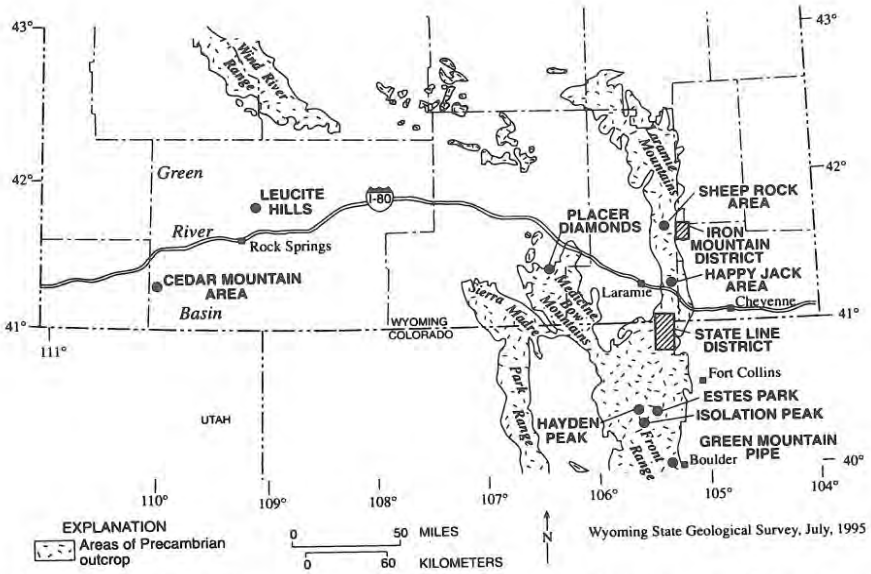

Figure 20. The Colorado-Wyoming Kimberlite Province showing some of the known kimberlite, lamproite, and diamond placer localities.

The Colorado-Wyoming State Line district consists of about 35 early Devonian kimberlite dikes and diatremes (many of which are diamondiferous) (**Figure 21**). Diamond production from the district has totaled more than 120,000 gem and industrial diamonds that range from microdiamonds to a 14.2-carat, flawless, octahedral gemstone. Overall, the gem to industrial quality diamond ratios are very favorable, with some deposits, containing as many as 60% gemstones.

Kimberlites are one of the two principal host rocks known to contain commercial quantities of diamonds. Kimberlites in the State Like district are deeply eroded with as much as 50% of the original pipes already removed. Thus, there is a potential for placer diamonds downstream from the known intrusives.

Kimberlites in the southern portion of the district in northern Colorado, intrude Proterozoic rocks that were cratonized at about 1.7 to 1.9 billion years ago. The intrusives include the Kelsey Lake kimberlites, the George Creek dikes, the Chicken Park kimberlites, the Sloan 1,2,3,4,5, and 6 kimberlites, the Moen intrusive, the Nix kimberlites, the Maxwell pipes, the Diamond Peak kimberlites, and the Park Creek intrusive (Shaver, 1994) (**Figure 21**).

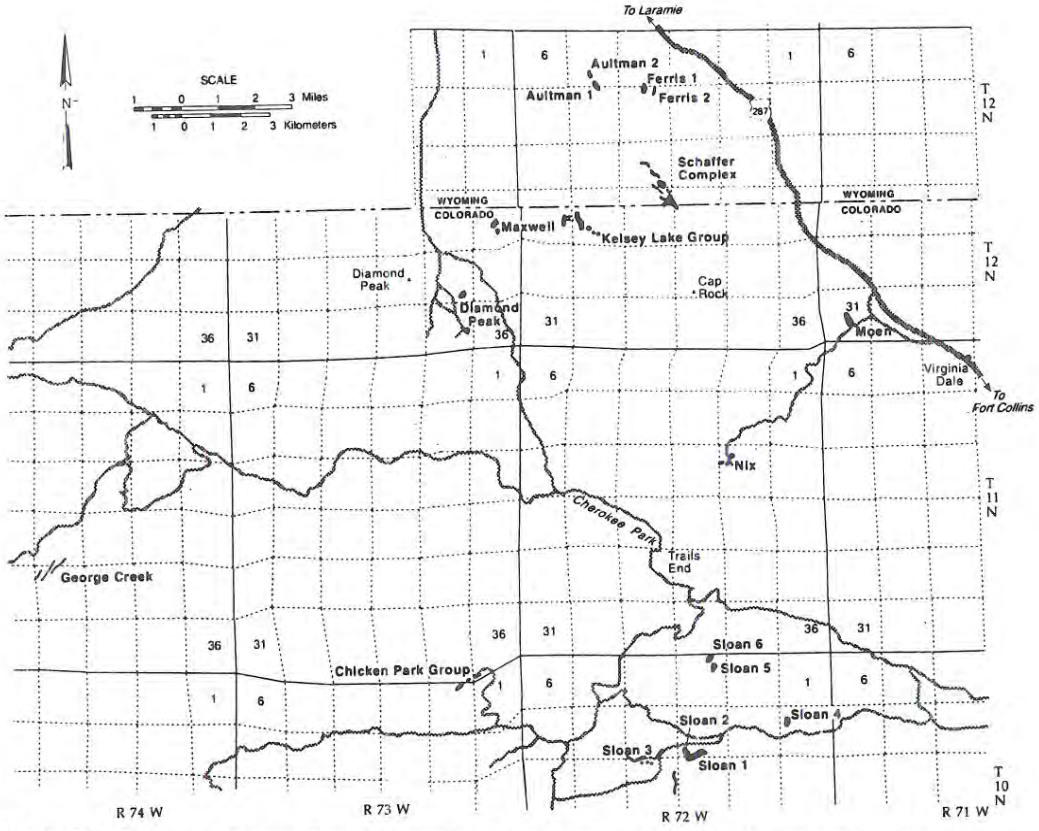

Figure 21. The State Line diamondiferous kimberlite district showing locations of known kimberlites.

The Kelsey Lake kimberlites consist of eight intrusives near the Wyoming border. These intrusives are irregular-shaped pipes or fissures filled with diatreme-facies kimberlite with some zones of hypabyssal-facies and minor crater-facies kimberlite (Coopersmith, 1993). These kimberlites have produced several diamonds larger than one carat. One suite of diamonds recovered from the Kelsey Lake kimberlites and associated alluvium in 1993, yielded 268 diamonds, 25% of which were larger than one carat, and 60% of which were gem quality. The largest was a 6.2-carat gemstone. A more recent test recovered several additional stones, including a 14.2-carat gemstone. Redaurum Red Lake, the company that found this diamond, recently announced plans to build a 140-tonne/hour mill in the summer of 1995 (Howard Coopersmith, pers. comm., 1995).

The George Creek intrusives, southwest of Kelsey Lake, consist of three narrow dikes. These are relatively diamond-rich and yielded more than 86,000 diamonds at an average grade of 136 carats/100 tonnes (the grade of some commercial kimberlites is only 10 to 15 carats/100 tonnes). Nearby, the Chicken Park kimberlites consist of four small intrusives. The largest diamond recovered from these kimberlites was a 2.6-carat, industrial-grade stone.

Farther south and east of George Creek and Chicken Park are the Sloan kimberlites (**Figure 21**). Four of these have been sampled in bulk. The Sloan 1 and 2 consist of hypabyssal- and diatreme-facies kimberlite, and the Sloan 1 has an areal extent of 156 m by 563 m while the Sloan 2 covers an area of 63 m by 625 m. These two pipes have yielded a significant number of subcalcic "G10" harzburgitic pyropes (G10 pyropes have chemistries similar to pyropes found as mineral inclusions in diamond). The $MgO:Cr_2O_3$ ratios of picroilmenite in the pipes suggest the magma was favorable for diamond preservation (McCallum and Waldman, 1991).

The Sloan 1 intrusive contains an estimated resource of 15.3 million tonnes of ore at an average grade of 6.1 carats/100 tonnes. The Sloan 2 is estimated to contain 8.4 million tonnes at an average grade of 17.1 carats/100 tonnes (Oliver, 1990). Cumulative production from these two diatremes is 30,580 diamonds.

Royalstar Resources' recent 3,300-tonne sample of kimberlite from the Sloan 2 intrusive yielded 9,034 diamonds larger than 1 mm with a combined weight of 342.17 carats (Shaver, 1994). The rock was recovered from a 700-foot tunnel and crosscuts driven into the kimberlite. The largest diamond recovered from the tunnel was a 5.51-carat gemstone (Bernie Free, pers. comm., 1994). The ore is processed at the nearby Diamet plant, which is rated at 35 tonnes/day.

A 904-tonne bulk sample taken from the Sloan 5 kimberlite in 1982, yielded 474 diamonds with a total weight of 9.09 carats (average grade of 1.0 carat/100 tonnes). Bulk sampling of the nearby Sloan 6 intrusive resulted in the recovery

of 215 diamonds (total weight of 6.72 carats) from 500 tonnes at a grade of 1.3 carats/100 tonnes.

In total, 20 kimberlite intrusives have been identified in the Wyoming portion of the State Line district. They are known as the Schaffer complex, Aultman 1 and 2, and the Ferris 1 and 2 (**Figure 21**). These intrusives occur as dikes, blows, and diatremes and contain hypabyssal- and diatreme-facies kimberlite (McCallum and Mabarak, 1976; Hausel and others, 1979, and 1981). All of the diatremes that have been tested in the district are diamondiferous.

The bulk samples of the Schaffer and Aultman kimberlites tested by Cominco American yielded diamonds. The largest recovered stone was a 0.86-carat gemstone. Fifty percent of the recovered diamonds were gemstones. The ore grades were low and ranged from 0.5 to 1.0 carat/100 tonnes. There has been no testing of the Ferris 1 and 2 kimberlites.

An airborne geophysical survey over the Wyoming portion of the district identified several conductivity and magnetic anomalies that were not associated with any known kimberlites. One group of prominent magnetic anomalies along the northern edge of the district has been interpreted as the manifestation of undiscovered, buried pipes(Paterson and MacFadyen, 1984). To date, these geophysical anomalies remain unexplored. Several remote sensing anomalies were also outlined in the region (Marrs and others, 1984).

Approximately 40 miles north of the State Line district, fifty-seven kimberlite dikes and blows occur in the Iron Mountain district in the central Laramie Mountains (**Figure 20**). Some of these were tested by Cominco American, but no diamonds were found. Garnets from the intrusives include both G9 and G10 pyropes. Although the presence of G10 pyropes suggests the kimberlites tapped the diamond stability field, ilmenite analyses suggest the kimberlites were emplaced under oxidizing conditions and that diamond preservation was unlikely (McCallum and Waldman, 1991).

Based on stream-sediment samples, it is possible that undiscovered kimberlites lie between the Iron Mountain and State Line districts and continue north of the Iron Mountain area. Nearly 300 kimberlitic heavy mineral anomalies were identified over a 1,200-square-mile area in the Laramie Mountains (Hausel and others, 1988). Heavy mineral anomalies have also been identified in the Seminoe Mountains in central Wyoming, the Medicine Bow Mountains, the Dixon area west of the Sierra Madre, and the Green River Basin of southwestern Wyoming.

Lamproites are the second principal host rocks known to contain commercial diamond deposits. One of the largest lamproite fields in the world is located in southwestern Wyoming. The Leucite Hills north of Rock Springs, include several leucite lamproites and olivine lamproites (**Figure 20**). These volcanic

rocks are dominated by 1- to 3-million-year-old flows with minor volcaniclastics. A few small samples of olivine lamproite breccia (less than one tonne) were tested by the Wyoming State Geological Survey, but no diamonds were found. Adequate diamond testing, however, generally requires thousands of tonnes, so this area needs more thorough sampling.

South of the Leucite Hills, pyrope garnet, clinopyroxene, and orthopyroxene have been recovered from numerous anthills in the vicinity of Cedar and Sage Creek Mountains in the southern Green River Basin (McCandless, 1984). Similar anomalies have been reported as far north as Granger and as far south as the Uinta Mountains near the Wyoming-Utah border. Some indicator minerals have also been found in the basal conglomerate of the Bishop Conglomerate (Oligocene) on Cedar Mountain, Sage Creek Mountain, and in Colorado on Diamond Peak (McCandless and others, 1995). Additionally a few circular structures of unknown origin have also been identified along the western edge of the anomalous areas (Gordon Marlatt, pers. comm., 1994). Four diamonds were reportedly found in the region. One of the diamonds, cut in Germany and mounted in a ring, measures 0.3-inch across (Wayne Sutherland, pers. comm., 1995).

Microdiamonds have been reported in a coal seam near Gillette in the Powder River Basin of northeastern Wyoming (Finkelman and Brown, 1989). In 1977, diamonds were found in a gold placer on Cortez Creek in the northern Medicine Bow Mountains of southeastern Wyoming. The diamonds weighed 0.1 and 0.01 carat (Hausel and others, 1985). A diamond was also reported in the Beaver placers of the South Pass greenstone belt of the southern Wind River Range (Hausel, 1991). A large diamond was found in the vicinity of Tourist Creek west of Gannett Peak in the Wind River Range, and a 7- to 9-carat, blue-white gem diamond was reportedly found in a prospect pit in the Gros Ventre Range (J.D. Love, pers. comm., 1981).

References Cited

Coopersmith, H.G., 1993, Diamondiferous kimberlite at Kelsey Lake, southern Wyoming Archean Province, *in* Mid-Continent diamonds: Geological Association of Canada, Mineral Deposits Division, Symposium, Edmonton, Alberta, p. 85-87.

Finkelman, R.B., and Brown, R.D., 1989, Mineral resource and geochemical exploration potential of coal that has anomalous metal concentrations: U.S. Geological Survey Circular 1035, p. 18-19.

Hausel, W.D., 1991, Economic geology of the South Pass granite-greenstone belt, southern Wind River Range, western Wyoming: Geological Survey of Wyoming Report of Investigations 44, 125 p.

Hausel, W.D., Glahn, P.R., and Woodzick, T.L., 1981, Geological and geophysical investigations of kimberlite in the Laramie Mountains of southeastern Wyoming: Geological Survey of Wyoming Preliminary Report 18, 13 p.

Hausel, W.D., McCallum M.E., and Roberts, J.T., 1985, The geology, diamond testing procedures, and economic potential of the Colorado-Wyoming kimberlite province-a review: Geological Survey of Wyoming Report of Investigations 31, 22 p.

Hausel, W.D., McCallum M.E., and Woodzick, T.L., 1979, Exploration for diamond-bearing kimberlite in Colorado and Wyoming: an evaluation of exploration techniques: Geological Survey of Wyoming Report of Investigations 19, 29 p.

Hausel, W.D., Sutherland, W.M., and Gregory, E.B., 1988, Stream-sediment sample results in search of kimberlite in southeastern Wyoming: Geological Survey of Wyoming Open File Report 88-11, 11 p.

Marrs, R.W., Marks, J.E., Hausel, W.D., and Albert, K.E., 1984, Detection of diamond-bearing kimberlites in the Colorado/Wyoming Province: University of Wyoming Remote Sensing Laboratory Open File Report, 70 p.

McCallum, M.E., and Mabarak, C.D., 1976, Diamond in State Line kimberlite diatremes, Albany County, Wyoming, and Larimer County, Colorado: Geological Survey of Wyoming Report of Investigations 12, 36 p.

McCallum, M.E., and Waldman, M.A., 1991, The diamond resources of the Colorado-Wyoming State Line district: kimberlite indicator mineral chemistry as a guide to economic potential: Wyoming Geological Association 42nd Field Conference Guidebook, p. 77-90.

McCandless, T.E., 1984, Detrital minerals of mantle origin in the Green River Basin, Wyoming: Society of Mining Engineers of AIME Reprint 84-395, 6 p.

McCandless, T.E., Nash, W.P., and Hausel, W.D., in press, Mantle indicator minerals in ant mounds and conglomerates of the southern Green River Basin, Wyoming: Wyoming Geological Association 45th Annual Field Conference Guidebook.

Oliver, D.H., 1990, Prairie Divide Properties Corporation, Sloan Ranch diamond project, Larimer County, Colorado, summary report: unpublished report, 11 p.

Paterson, N.R., and MacFadyen, D.A., 1984, An airborne EM (INPUT)/ magnetometer survey, State Line district, Colorado-Wyoming: Society of Mining Engineers AIME Reprint 84-310, 11 p.

Shaver, K.C., 1994, Phase 1 underground exploration and mill testing of the Sloan Ranch diamondiferous kimberlite complex, Larimer County, Colorado: Royalstar Resources Ltd. report, 39 p.

SUMMARY OF OIL AND GAS EXPLORATION IN WYOMING-1994

Drilling Activities and Completions

Based on preliminary data available from Petroleum Information (1995), there were 524 well completions in Wyoming in 1994, which is a big drop from the more than 750 completions in 1993 (**Figure 22**). Of the 524 well completions in 1994, sixty-one were exploration wells and 463 were development wells. The success rate for exploration wells was 27.9% compared to a success rate of 31.2% for exploration wells in 1993. In all, 451 wells found oil or gas for a success rate of 86.1% compared to a success rate for all wells in 1993 of 80.8%. The higher success rate in 1994 is mainly because there were fewer, higher-risk exploration wells drilled than in 1993.

Based on the Hughes Rig Count, the average daily rig count in 1994 was 34, compared to 37 in 1993 (**Figure 23**). Rigs in Wyoming drilled over 4.3 million feet in 1994, which was a drop of 1.8 million feet from 1993 (**Figure 24**). The average depth of all wells drilled in Wyoming in 1994 was 8,239 feet, which is the deepest average in the last 14 years (**Figure 25**). The average depth of an exploration well in Wyoming in 1994 was 7,179 feet, which was nearly 300 feet deeper than 1993 (**Figure 25**).

Lease Sales

The six Federal lease sales held by the U.S. Bureau of Land Management (BLM) in 1994 grossed over $27 million (**Figure 26**). This is the highest total for Federal sales since 1988. The average price per acre was $18.70 (**Figure 27**). Of the 2.38 million acres that were available for lease, 60.9% were leased. For comparison, the six BLM sales in 1993 grossed $13 million, and only 48.2% of the 2.07 million acres were leased. The average price per acre was $13.00.

Figures 26 and **27** show annual revenue and average price per acre for State Land and Farm Loan sales in recent years, respectively. The four lease sales held by the State Land and Farm Loan Office in 1994 grossed $3.3 million. The average price per acre was $12.95, and 76.8% of the 332,000 acres were leased. For comparison, the four sales in 1993 grossed only $2.0 million. Of the 311,000 acres available for lease that year, 71.4% were leased for an average price of $8.91 per acre.

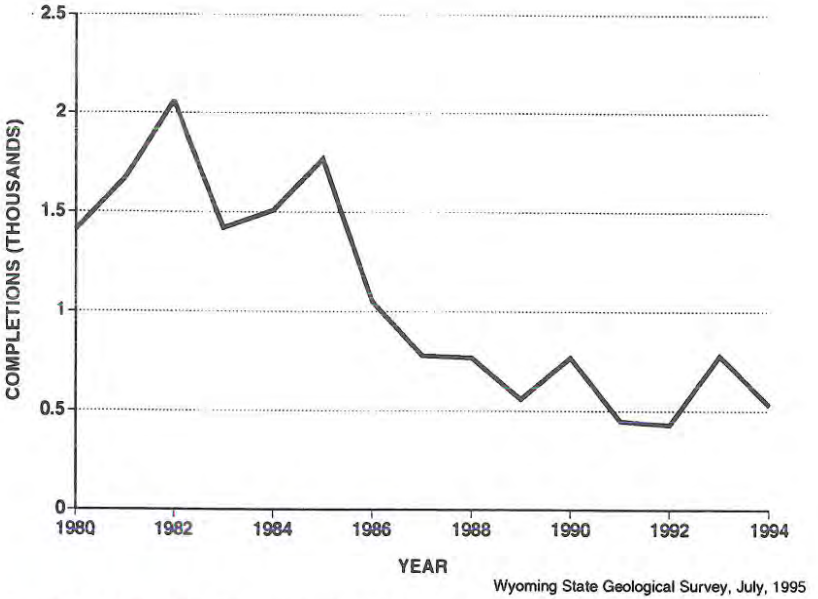

Figure 22. Annual well completions in Wyoming [based on data from Petroleum Information (1980-1994)].

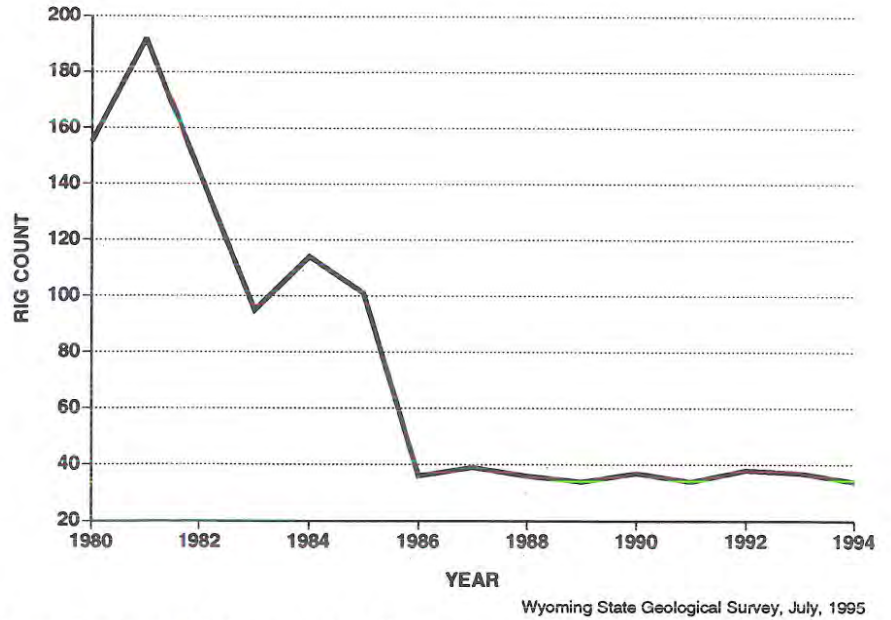

Figure 23. Average daily rig count for Wyoming, averaged by year [based on Hughes Rig Count (1980-1994)].

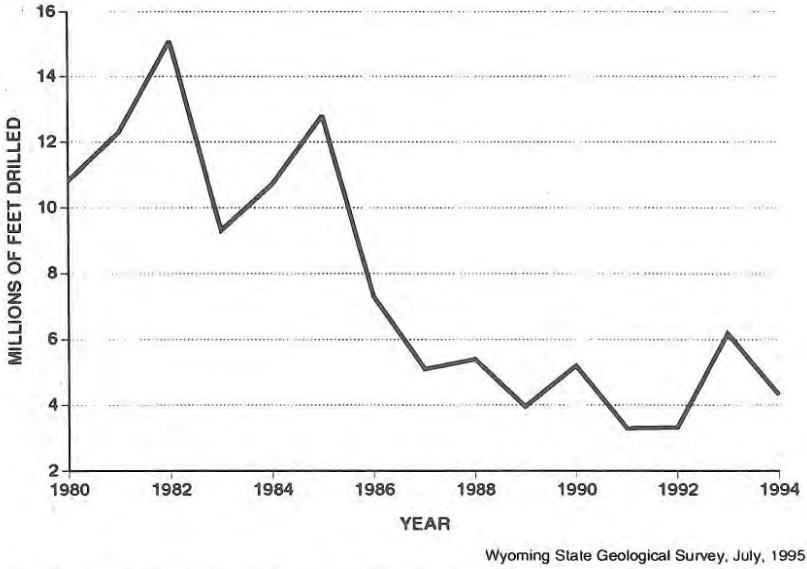

Figure 24. Total feet drilled for oil and gas in Wyoming by year [based on data from Petroleum Information (1980-1994)].

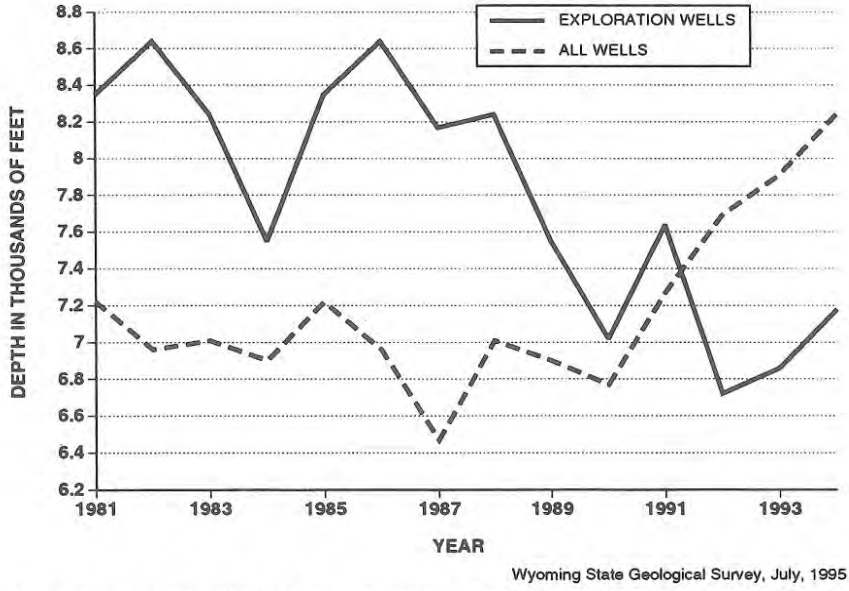

Figure 25. Average depth of wells drilled for oil and gas in Wyoming by year [based on data from Petroleum Information (1981-1994)].

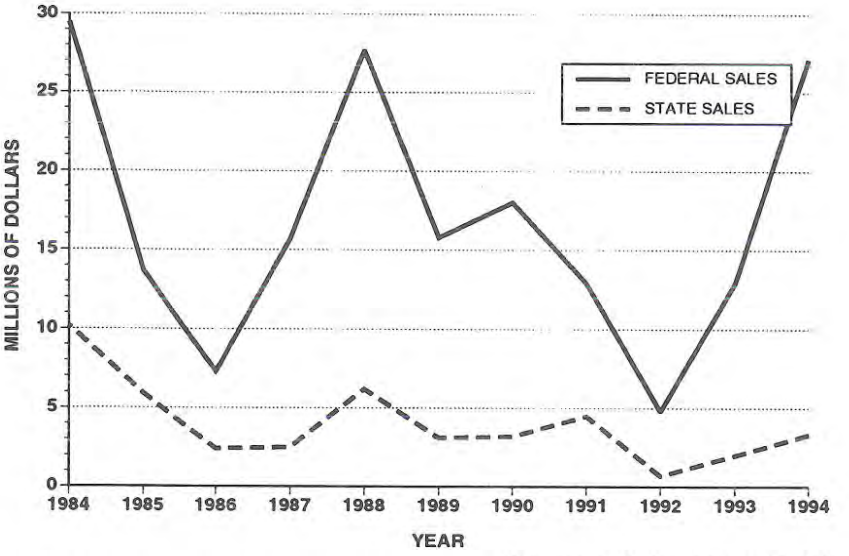

Figure 26. Annual revenue from Federal (U.S. Bureau of Land Management) and from State Land and Farm Loan Office oil and gas lease sales in Wyoming (1984-1994).

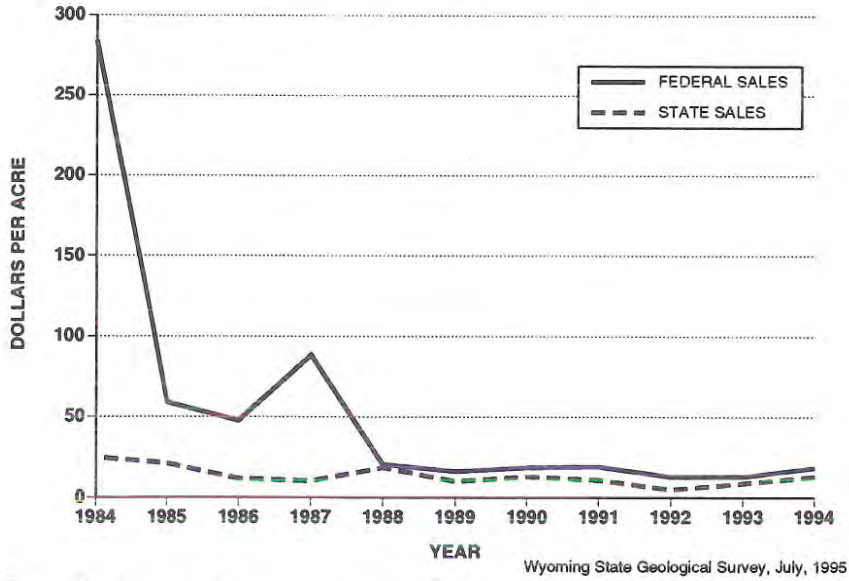

Figure 27. Average price per acre paid for Federal (U.S. Bureau of Land Management) and State Land and Farm Loan Office oil and gas lease sales in Wyoming (1984-1994).

Powder River Basin

In 1994, Campbell County was no longer the leading county in regard to the number of new field wildcats. Campbell County tied for fourth with sixteen new field wildcats, including three oil discoveries. This is the first time in several years that Campbell County was not first in the Nation in new field wildcats. Of the 61 exploratory wells completed in Wyoming in 1994, 49 were in the Powder River Basin.

Wind River Basin

Barrett Resources completed a significant discovery with its 1 Cave Gulch-Federal well in NE NE section 31, T37N, R86W. This 1994 discovery was drilled through the leading edge of the Owl Creek Thrust to a total depth of 6,900 feet in the Lance Formation. The Lance produced an average of 9.7 million cubic feet of gas and 116 barrels of oil per day during its first month of production. The company will drill several more wells in 1995 and 1996 in this area.

Greater Green River Basin

In 1994, most development drilling in Wyoming was for natural gas. There were 291 development gas wells completed in the Greater Green River Basin, which was 89.5% of the total for the State. Drilling in this basin concentrated on the development of gas reserves in the Frontier, Almond, Muddy, and Dakota formations.

Horizontal Drilling

There were 22 horizontal-well completions in Wyoming in 1994, compared to 28 horizontal completions in 1993. Most of the horizontal completions were in the Niobrara in and around Silo Field in the Cheyenne-Denver Basin. There were also horizontal completions in the Powder River, Bighorn, and Greater Green River basins. Only Texas, Alaska, and Montana had more horizontal well completions than Wyoming.

Reference Cited

Petroleum Information, 1995, Resume 1994: Littleton, Colorado, 352 p.

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Technically Recoverable Resources (January 1, 1995)	
Discovered (Includes oil, gas liquids, and condensate)	3.69 billion barrels[1]
Undiscovered	6.18 billion barrels[1]
Total	9.87 billion barrels
Remaining Reserve Base (January 1, 1995)	
Measured reserves (Proved reserves) (Includes oil, gas liquids, and condensate)	1.05 billion barrels[2]
Indicated and inferred reserves (Reserve growth in conventional fields)	2.64 billion barrels[1]
Total	3.69 billion barrels

NATURAL GAS

Remaining Technically Recoverable Resources (January 1, 1995)	
Discovered (Includes 36.2 trillion cubic feet (TCF) of methane[1] and 121.8 TCF of CO_2[3])	158.0 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	329.6 trillion cubic feet
Remaining Reserve Base (January 1, 1995)	
Measured reserves (Proved reserves) (Includes 10.2 TCF of methane[2] and 60.2 TCF of CO_2[3])	70.4 trillion cubic feet
Indicated and inferred reserves (Reserve growth in conventional fields)	26.0 trillion cubic feet
Total	96.4 trillion cubic feet

COAL

Remaining Resources (January 1, 1995)	
Identified and Hypothetical (Discovered)	1,427.8 billion tons[4]
Speculative (Undiscovered)	31.5 billion tons[4]
Total	1,459.3 billion tons
Remaining Reserve Base (January 1, 1995)	
Demonstrated strippable (Measured and indicated reserve base)	26.2 billion tons[5]
Demonstrated underground-minable (Measured and indicated reserve base)	42.5 billion tons[5]
Total	68.7 billion tons

TRONA

Original Resources (1990 estimate)	
Trona	81.0 billion tons[6]
Mixed trona and halite	52.7 billion tons[6]
Total	133.7 billion tons

URANIUM

Remaining Resource (December 31, 1989)	1.99 billion pounds U_3O_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, 1994, U.S. crude oil, natural gas, and natural gas liquids reserves: 1993 Annual Report, 155 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] Modified from Culbertson, W.C., 1983, Genesis and distribution of trona deposits in Wyoming (abstract) in Genesis and exploration of metallic and nonmetallic mineral and ore deposits of Wyoming and adjacent areas: Geological Survey of Wyoming Public Information Circular 19, p. 34.
[7] Energy Information Administration, 1989, Uranium industry annual: U.S. Department of Energy Report DOE/EIA-0478(89), 121 p.
[8] Knutson, C.F., and Dana, G.F., 1982, Developments in oil shale in 1981: American Association of Petroleum Geologists Bulletin, Volume 66, no. 11, p. 2513.

GEOLOGIC MAPPING AND STRATIGRAPHY UPDATE

Alan J. Ver Ploeg
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GEOLOGISTS VOLUNTEER THEIR SERVICE

The Wyoming State Geological Survey has recently solicited the assistance of qualified geologists to accelerate the mapping efforts of its Geologic Mapping Section. The Section is presently working on 1:24,000-scale and 1:100,000-scale mapping, with efforts initially centering around the populated areas of Wyoming. The maps are designed to aid in land-use evaluation and planning, as well as the exploration and development of potential mineral and water resources in these areas.

Due to limited funding and staff, the Section has only been able to produce one or two 1:100,000-scale maps and one or two 1:24,000-scale maps each year. At the current rate of mapping, it would take more than twenty years just to complete 1:100,000-scale coverage of the State. It is hoped that the Survey's mapping efforts can be accelerated by this call for volunteers because recent and projected population growth in many of Wyoming's cities has placed increased pressure on the planning entities in these areas. More timely completion of pertinent geologic maps is critical to good land-use planning.

As a result of these needs, the State Survey has not only begun looking for pertinent, heretofore unpublished, geologic maps, but has also solicited the aid of geologists willing to volunteer their efforts in compiling geologic maps for the Survey. Although most maps will be compiled from acceptable existing maps (especially in the case of 1:100,000-scale maps), some funds may be available to provide volunteers with field money for limited field checking in identified problem areas. There is also a need for geologists willing to review maps prepared for areas they are familiar with.

To date, six individuals have volunteered their assistance in preparing 1:100,00-scale and 1:24,000-scale maps. Proposals to complete seven, 1:100,000-scale geologic maps including the Cody, Carter Mountain, Casper, Thermopolis, Sheridan, Buffalo, and Worland Quadrangles have been submitted to the State Survey. One volunteer proposes to map the Thermopolis 1:24,000-scale quadrangle and has indicated interest in working on others. This response is quite gratifying and very much appreciated. Since the need is great and the opportunities large, anyone else interested in helping is encouraged to contact Alan Ver Ploeg of the Wyoming State Geological Survey at (307) 766-2286.

WHY ARE GEOLOGIC MAPS SO IMPORTANT, AND HOW ARE THEY USED?

Geologic maps are actually quite diverse and are a fundamental source of information for those who use them. Fortunately, much of what is on a geologic map is understandable to both trained and lay users. Geologic maps commonly depict the spatial distribution of bedrock materials such as granite, limestone, sandstone, or shale; surficial materials such as soils and unconsolidated materials deposited by wind, water, and ice; landslides and debris flows; and geologic structures including faults, fractures, and folds. Geologic maps are an invaluable aid in interpreting how all these deposits and structures are related in time and space. And these interpretations are needed to explain the present and predict the future.

Geologic maps are used in the evaluation of geologic hazards, the exploration and development of mineral and energy resources, the preparation of land-use plans, and in helping protect land, water, and air values. In regard to geologic hazards, geologic maps provide information relating to where potential hazards may exist. For examples, mapping may identify an active fault, or it may show the areal extent of geologic materials that could liquify during an earthquake because of ground-shaking. The potential for landslides and other slope failures can be evaluated using information from geologic maps.

Geologic maps directly help in the exploration and development of mineral and energy resources by showing the areal distribution of geologic materials which are hosts for various important minerals or fossil fuels. Indirectly, the information depicted on a geologic map can also provide clues to what occurs in the subsurface far below the earth's land surface.

In land-use planning, geologic maps help the planner determine the best and safest use of lands. Geologic maps also aid in the siting and design of roads, pipelines, mines, wells, buildings, power plants, industrial plants or mills, dams, and other facilities.

Another important use for geologic maps relates to their help in protecting our land, water, and air. Information derived from geologic maps is particularly crucial in siting waste repositories and other potentially contaminating facilities, as well as, in determining the risk of contamination to ground-water resources. Geologic maps provide information on the areal and subsurface distribution of rock or rock materials that store ground water or that serve as recharge areas for aquifers.

The Laramie Quadrangle, a 1:24,000-scale, geologic map recently completed by the Geologic Mapping Section, is a good example of a geologic map with many of the potential uses described above. The map not only depicts

where decorative sandstone, sand and gravel, limestone, and gypsum resources have been or are mined in the Laramie area, but it also provides information that should be helpful for future development of these and other mineral resources. The map shows landslides; unstable wind-blown deposits; and areas of gypsum-rich soils, which are deleterious to concrete foundations. This latter information, in particular, is valuable to local land-use planners, developers, and home owners.

Outcrops of the Casper Formation, which is an important aquifer in the Laramie area, are delineated on the map along with structural information (bed attitudes, folds, and faults). This information is a valuable aid in locating good sites for water wells and in helping the community protect the recharge area for this important aquifer. Faulting in the Laramie area not only accounts for the location of many naturally occurring springs, but faults also have provided good sites for water wells. The accurate location of these faults on the geologic map provides information which will be useful in searching for new water sources in the area. These are only a few examples of the types of important uses for this and other geologic maps.

FELLOWSHIP FUNDS STIMULATE GEOLOGIC FIELD MAPPING IN THE ROCKY MOUNTAIN AREA

Funds totaling $3,500 were recently divided between six students, to aid in financing their field mapping projects in the Rocky Mountain area. The awarded grants were made from the Wyoming Geological Association's J. David Love Field Geology Fellowship in support of field geology projects and in honor of J. David Love, renowned for his distinguished career as a field geologist in Wyoming. Although Dr. Love is now retired from the U.S. Geological Survey, he continues to map and study the State's geology.

Recipients of the fellowship included Susan Dougherty of Montana State University for her mapping project in the Tendoy Range of southwestern Montana; Joe Gregson of Colorado State University for his structural mapping of a portion of the Colorado Plateau; Linda Horn of Purdue University for her glacial mapping and dating project in Wyoming's Sinks Canyon near Lander; Claudia Stewart of the University of Wyoming for her mapping and sampling project in the Wind River Range of Wyoming; Andro Wohlgenant of the University of Wisconsin-Madison for his mapping and structural study in the Absaroka Range of northwestern Wyoming; and Adam Woods of the University of Southern California for his field study of the Dinwoody and Thaynes Formations in Idaho and Wyoming. These projects all represent thesis or dissertation efforts by these respective students.

As noted earlier, field mapping is an important discipline of geology. Unfortunately, its practice has declined at universities and the U.S Geological Survey in recent years. The Wyoming Geological Association, the Wyoming State Geological Survey, and other Wyoming geologists, however, are doing what they can to reverse this trend in Wyoming. The J. David Love Field Geology Fellowship is an excellent part of that effort to encourage geologists to do field geology and specifically field mapping.

LANCE CREEK ACEC DESIGNATION REJECTED

Early in 1994, the U.S. Bureau of Land Management (BLM) proposed making more than 560 square miles in Niobrara County, an Area of Critical Environmental Concern (ACEC). The designation was designed to aid in protecting the paleontologic values in the area (see p. 57, *Wyoming Geo-notes No. 42*, and p. 43, *Wyoming Geo-notes No. 43*). This area is north of Lusk in the southeastern corner of the Powder River Basin. However, the BLM recently announced their decision to reject this designation, electing to continue their existing policy of managing significant fossils on BLM lands in the Lance Creek area, on a case by case basis.

The area had already been designated a National Natural Landmark, and as such has stipulations to protect undiscovered fossils from surface-disturbing activities. The BLM concluded that an ACEC designation would not have provided additional protection for the fossil resources, but would have mandated a costly inventory of the paleontologic resources. The State of Wyoming and others had expressed concern regarding the large size of the proposed ACEC and the potentially high cost of managing and inventorying the area.

GEOLOGIC HAZARDS

James C. Case
Staff Geologist-Geologic Hazards, Wyoming State Geological Survey

RELATIONSHIP BETWEEN WYOMING'S SEISMIC HAZARD AND THE UNIFORM BUILDING CODE

Background

The U.S. Geological Survey and the Federal Emergency Management Agency place the State of Wyoming in a catetgory classified as having a very high seismic hazard (**Figure 28**). In fact, Wyoming's potential for earthquakes is comparable to that of California, Alaska, Nevada, Idaho, and Montana. Wyoming's seismic hazard potential, however, varies across the State. The highest potential is in the western quarter of Wyoming from Yellowstone National Park south into Uinta County. The Teton fault in Teton County, the Star Valley and Rock Creek faults in Lincoln County, and the Bear River fault system in Uinta County are all capable of magnitude 7.0-7.5 events. Wyoming is classified as having a very high seismic hazard in part because of these fault systems.

Although the seismic hazard is less in the rest of the State, magnitude 6.75 earthquakes can occur on faults located along the northern margin of the Wind River Basin and on fault segments extending along the northern flanks of the Seminoe Mountains, Ferris Mountains, Green Mountain, and Crooks Mountain. Earthquakes with magnitudes as large as 6.1 can occur in the rest of Wyoming.

Most loss of life in large earthquakes results from the collapse of buildings and structures, although landslides and other hazards can also lead to the loss of life. The Geologic Hazards Section at the Wyoming State Geological Survey has mapped many of the hazards associated with earthquakes, such as landslides, and supplied the maps to many cities and counties. These local entities have much of the responsibility in ensuring that public buildings and structures in their jurisdictions are designed to withstand earthquakes.

Uniform Building Code

The Uniform Building Code (UBC) is a document prepared by the International Conference of Building Officials. Its stated intent is to "provide minimum standards to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and

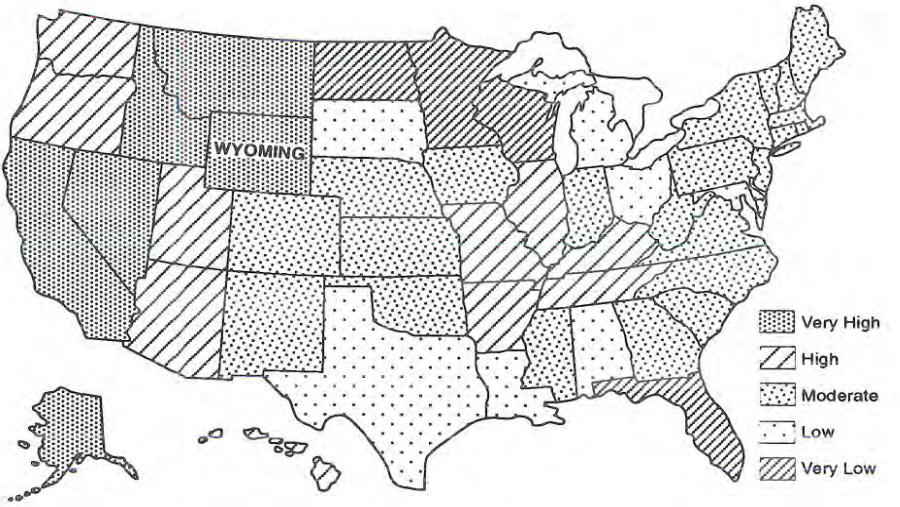

Figure 28. Seismic hazard potential in the United States (source: U.S. Geological Survey and Federal Emergency Management Agency).

occupancy, location and maintenance of all buildings and structures within this jurisdiction and certain equipment specifically regulated herein." The UBC is updated every three years.

The UBC contains information and guidance on designing buildings and structures to withstand seismic events. With safety in mind, the UBC also provides Seismic Zone Maps to help identify which design factors are critical to specific areas of the country. In addition, depending upon the type of building, there is also an "importance factor". The "importance factor" can, in effect, raise the standards that are applied to a building.

The Seismic Zone Map of the UBC, first presented in 1952, is based upon geologic as well as political criteria. The map is used as a guide in designing and constructing buildings, and is used to generally delineate zones of increasing seismic hazard. The map, however, changes through time as better information becomes available. In 1952, four seismic zones were defined, ranging from Zone 0 (low-hazard) to Zone 3 (high-hazard). **Figure 29** shows the three zones that were present in Wyoming in 1952: Zone 0 (no damage expected), Zone 1 (minor damage expected), and Zone 2 (moderate damage expected). The Seismic Zone Map was modified in the 1970 Uniform Building Code. Four

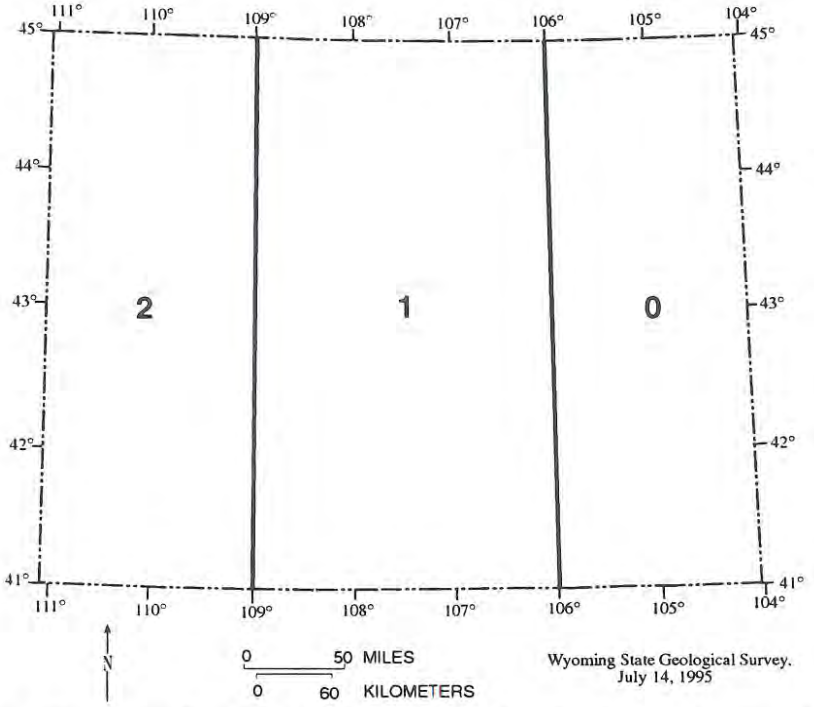

Figure 29. Seismic Zone Map of Wyoming in 1952 (Modified from 1952 version of the Uniform Building Code, International Conference of Building Officials).

seismic zones (0 to 3) were still present in the United States, but Zone 0 was no longer in Wyoming. In 1970, the seismic zones in Wyoming were Zone 1 (minor damage expected; Intensity VI maximum), Zone 2 (moderate damage expected; Intensity VII maximum), and Zone 3 (major damage expected; Intensity VIII and greater) (**Figure 30**). Most recently, the UBC's Seismic Zone Map was upgraded in the 1988 Uniform Building Code. Five seismic zones, ranging from Zone 0 to Zone 4, were present on that map. All of those zones were represented in Wyoming (**Figure 31**). The 1988 revisions to the zone map were defined in part by the probability of having a certain level of ground shaking (horizontal acceleration) in 50 years.

The criteria used for defining boundaries on the map were established by the Seismology Committee of the Structural Engineers Association of California (Building Standards, September-October, 1986). The criteria they developed are as follows:

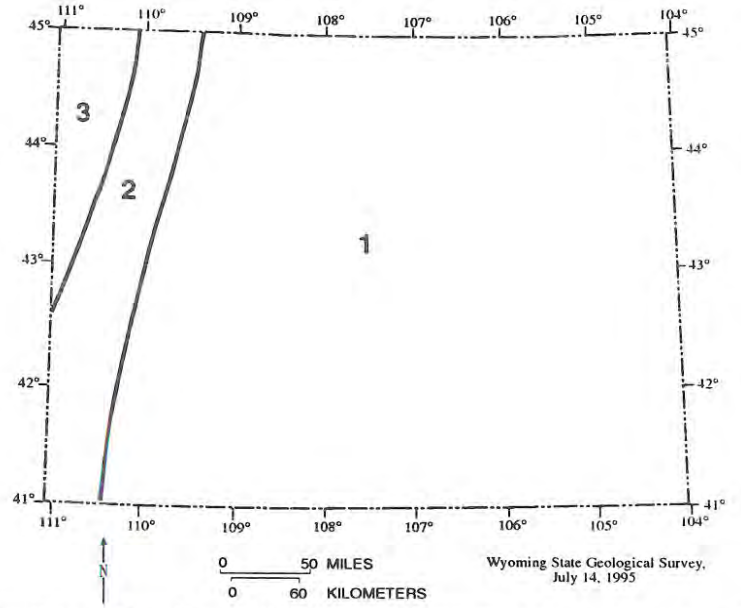

Figure 30. Seismic Zone Map of Wyoming in 1970 (Modified from 1970 version of the Uniform Building Code, International Conference of Building Officials).

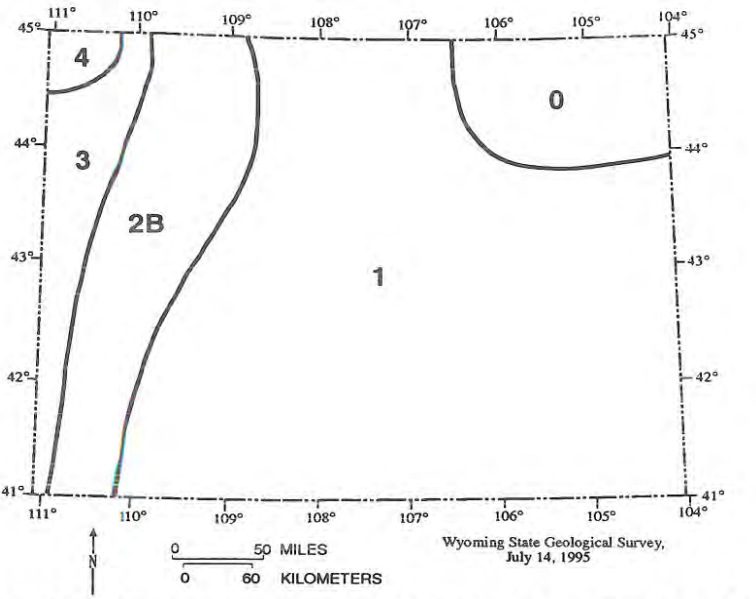

Figure 31. Seismic Zone Map of Wyoming in 1988 (Modified from 1988 version of the Uniform Building Code, International Conference of Building Officials).

Zone	Effective Peak Acceleration, % gravity (g)
4	0.3 and greater
3	0.2 to less than 0.3
2	0.1 to less than 0.2
1	0.05 to less than 0.1
0	less than 0.05

The committee assumed that there was a 90% probability that the above values would not be exceeded in 50 years, or a 100% probability that the values would be exceeded in 475 years.

Future Seismic Zone Maps

Ideally, a seismic zone map will exactly reflect the existing knowledge of the seismic potential of an area. Obviously, knowledge and perceptions change as can observed on **Figures 29** through **31**. For example, in Wyoming, recent investigations have given reason to consider a change to the existing 1988 UBC Seismic Zone Map. In particular, there is some justification for possibly extending Zone 4 south into Teton County. And there may be some justification for extending the zone even as far south as Uinta County. Also, the Zone 2 and Zone 3 boundaries may be shifted to the east in the future, especially in the southwestern portions of the State. The Bear River fault system southeast of Evanston is nearly in Zone 2 on the current Seismic Zone Map. If that fault activates, it could generate accelerations that may qualify it for inclusion in Zone 4.

Summary

Perhaps the most important application of geological and seismological information in any state may be their effect on the Uniform Building Code. Knowing that a fault is capable of generating a magnitude 7.5 earthquake is of little value until building codes are changed to reflect a potential hazard of that size.

Changing the UBC's Seismic Zone Map, however, has other consequences. Buildings that were built "to code" in the past may no longer meet current code requirements because of the changes. This means periodic inspections of buildings are desirable, especially if the buildings are critical facilities such as schools. What it also means is that design and construction costs of new buildings and structures may increase, and older critical buildings may need renovation or even replacement to meet code. Obviously, changes in the UBC's Seismic Zone Map are not made hastily or without substantial documentation of the need for change.

ROCKHOUND'S CORNER

W. Dan Hausel
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The Wyoming State Geological Survey recently initiated field studies for commercially valuable mineral resources in the Tin Cup district of the eastern Granite Mountains. Based on reconnaissance, this district, which is located north of Jeffrey City in central Wyoming, should make an exciting collecting site for any rockhound (**Figure 32**).

The area contains metamorphic rocks intruded by leucogranites. These granites are relatively light colored. In places, they are hydrothermally altered to pink and milky white granite. Some inclusions of mafic (black) schist trapped in these altered granites have been altered to epidote, chlorite, biotite, actinolite, and nephrite jade. There are mining claims on many of the jade localities, which means you cannot collect from these claims without the claimants' permission.

Rubies also occur near some of the jade claims. Specimens of ruby collected by the State Geological Survey occur in porphyroblastic muscovite-chlorite-biotite schist in section 13, T31N, R93W, and in section 18, T31N, R932W. The porphyroblasts consist of 1/4-inch-diameter pale red corundum (ruby) enclosed by greenish reaction rims of sericite. Although most of the rubies are poor quality red corundum, some gem quality rubies have been found.

Some of the more attractive rocks found in the district are found at the Red Boy mine (section 36, T31N, R93W). These include rocks with massive pyrite hosted by either prismatic green and black amphiboles or granites as well as specimens of beautiful red and yellow banded jasperoid.

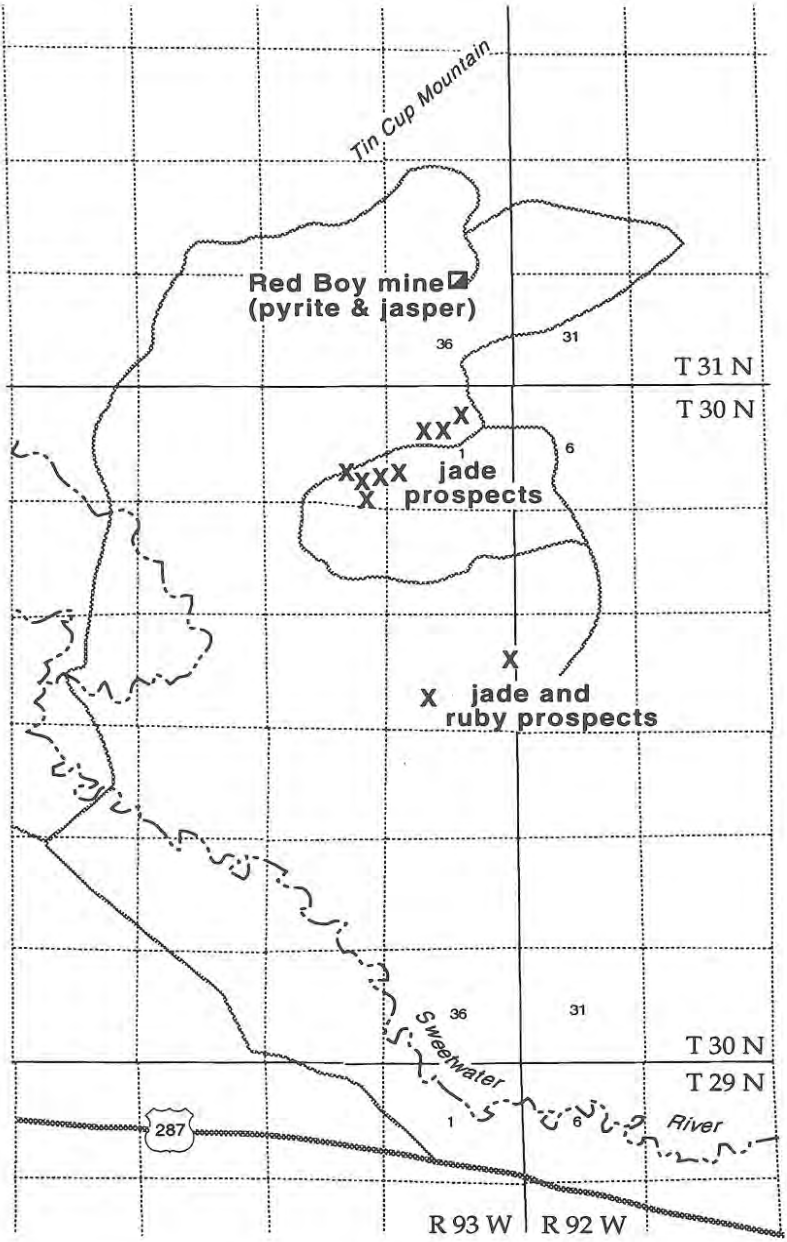

Figure 32. Locality map of the Tin Cup district showing jade, pyrite, jasperoid, and ruby localities.

NEW PUBLICATIONS OF THE WYOMING STATE GEOLOGICAL SURVEY

Bibliography and index of graduate theses and dissertations of the Department of Geology and Geophysics, University of Wyoming (revision and update of 1989 version), by C.S. Boyd, A.J. Ver Ploeg, and others: Information Pamphlet 3, 1995.-$2.00.

Index to geologic mapping in Wyoming from out-of state theses, compiled by A.J. Ver Ploeg and C.M. Boyd: Map Series MS-95, 1995.-$2.50 (xerox copies only).

Talc, including steatite, in Wyoming, by R.E. Harris: Open File Report 95-1, 1995.-$3.00 (xerox copies only).

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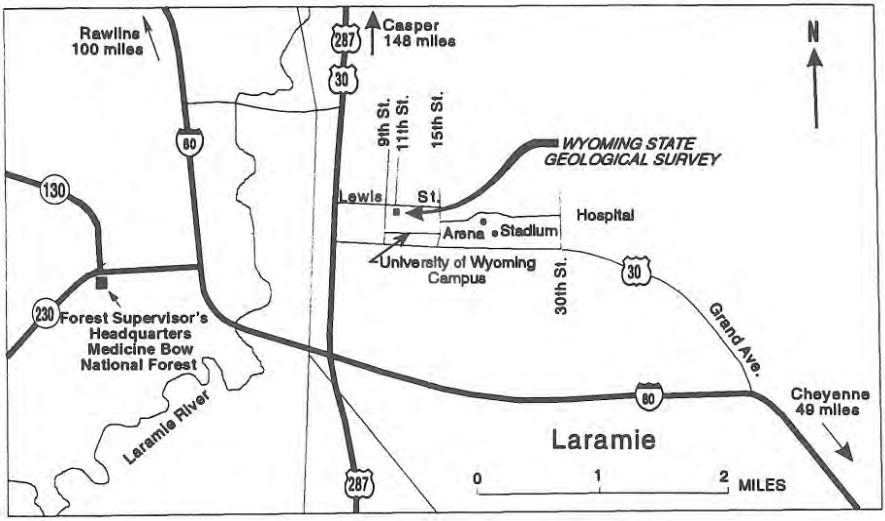

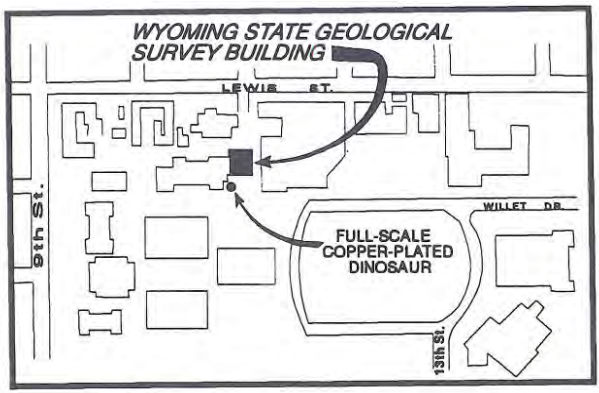

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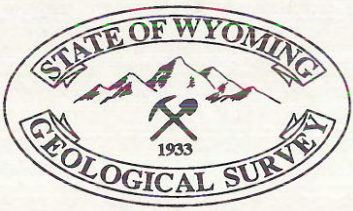
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