Wyoming Geo-notes
Number 80

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Wyoming State Geological Survey
Lance Cook, State Geologist

Laramie, Wyoming
June, 2004

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WYOMING GEO-NOTES: This quarterly digest on the state's geology, mineral resources, and activities of the Wyoming State Geological Survey is available by subscription (four issues for $15.00) or as single copies at $5.00 each. Two-year subscriptions are accepted.

People with disabilities who require an alternative form of communication in order to use this publication should contact the Editor, Wyoming State Geological Survey at (307) 766-2286. TTY Relay operator 1 (800) 877-9975.

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600 copies printed by Pioneer Printing and Stationery Company, Cheyenne, Wyoming.

Front cover: This photograph is from one half of a stereo pair, published by W.I. Marshall of Fitchburg, Massachusetts, negative #54. Marshall obtained his negatives of Yellowstone from J. Crissman, who was one of the very early photographers in Yellowstone Park. This photo was taken in approximately 1873, and shows a group of tourists aboard the second boat that was launched on Yellowstone Lake. Almost immediately upon creation of Yellowstone National Park in 1871, the area became a destination for frontier tourists and wealthy Easterners. From the private collection of Lance Cook, Wyoming State Geologist.

MINERALS UPDATE

Overview

Lance Cook, Wyoming PG-2577

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Mineral production figures for Wyoming are now final for 2003. Natural gas, coal, and trona all showed increases from the previous year while oil and uranium production decreased slightly (**Table 1**). Estimates made by the State of Wyoming's Consensus Revenue Estimating Group (CREG) early in 2003 were only slightly less than the actual production for all commodities except natural gas (compare **Table 1** with Table 1 in *Wyoming Geo-notes No. 79*, March, 2004). For details and analysis of the individual minerals produced in Wyoming in 2003, refer to the update articles in this issue.

Natural gas production (which includes coalbed methane, carbon dioxide, and helium) was even better than expected or forecast for 2003, mainly because of increased conventional methane production in the Pinedale anticline and Jonah gas fields. These two areas plus coalbed methane (CBM) from the Powder River Basin (PRB) accounted for about 38% of all the natural gas produced in Wyoming in 2003. However, not all is well in the industry, as CBM production is dropping off in the PRB (see section below) and regulations and environmental considerations may limit or delay development in the Pinedale anticline and Jonah fields.

The Wyoming State Geological Survey (WSGS) has published another pamphlet on Wyoming's mineral resources. Information Pamphlet 10 entitled *Natural gas in Wyoming* by R.H. De Bruin, is designed to answer common questions about one of the state's most important resources. Similar to the popular pamphlets on CBM and carbon dioxide, our new publication provides information on the origin, occurrence, resources, production, uses, transportation, and importance of natural gas to Wyoming. The new publication is free upon request (one per person); multiple copies can be purchased through the WSGS publications sales office in Laramie.

End-of-year prices for oil and gas were especially strong in 2003, with substantial gains over 2002 (**Table 2**) and exceeded the CREG forecast made early in 2003. Uranium prices were also substantially higher in 2003 than in 2002. Trona prices were only slightly

Table 1. Wyoming mineral production (1987 through 2003) with forecasts to 2008[1].

Calendar Year	Oil[2,3]	Methane[3,4]	Carbon Dioxide[3,4]	Helium[4,5]	Coal[6]	Trona[7]	*In situ* Uranium[8]
1987	115.9	628.2	114.2	0.86	146.5	12.4	0.00
1988	114.3	700.8	110.0	0.83	163.6	15.1	0.09
1989	109.1	739.0	126.1	0.94	171.1	16.2	1.1
1990	104.0	777.2	119.9	0.90	184.0	16.2	1.0
1991	99.8	820.0	140.3	1.05	193.9	16.2	1.0
1992	97.0	871.5	139.2	1.05	189.5	16.4	1.2
1993	89.0	912.8	140.8	1.06	209.9	16.0	1.2
1994	80.2	959.2	142.6	1.07	236.9	16.1	1.2
1995	75.6	987.5	148.8	1.11	263.9	18.4	1.3
1996	73.9	1023.4	149.0	1.10	278.4	18.6	1.6
1997	70.2	1040.7	151.0	1.10	281.5	19.4	2.2
1998	65.7	1072.6	151.0	1.10	315.0	18.6	2.3
1999	61.3	1133.1	161.0	1.10	336.5	17.8	2.8
2000	60.6	1293.3	161.0	1.10	338.9	17.8	2.1
2001	57.5	1437.6	174.0	1.20	368.8	17.7	1.6
2002	54.7	1572.6	174.0	1.20	373.2	17.2	1.4
2003	52.4	1636.9	196.0	1.20	376.6	17.5	1.2
2004	50.4	1602.8	196.0	1.20	380.6	18.0	1.4
2005	50.4	1652.8	196.0	1.20	384.4	18.5	1.4
2006	52.4	1707.8	196.0	1.20	388.3	18.5	1.4
2007	54.5	1765.5	196.0	1.20	392.1	18.5	1.4
2008	57.7	1824.3	196.0	1.20	396.0	18.5	1.4

[1]From CREG's Wyoming State Government Revenue Forecast, October, 2003; [2]Millions of barrels; [3]Wyoming Oil and Gas Conservation Commission, 1987 through 2003; [4]Billions of cubic feet, estimates for methane include coalbed methane; [5]Based on ExxonMobil's estimate that the average helium content in the gas processed at La Barge is 0.5%; [6]Millions of short tons (Wyoming State Inspector of Mines, 1987 through 2003); [7]Millions of short tons (Wyoming Department of Revenue, 1987 through 2003; Wyoming State Inspector of Mines, 2003); [8]Millions of pounds of yellowcake (Wyoming Department of Revenue, 1987 through 1999; Wyoming State Inspector of Mines, 2000 through 2003).

Table 2. Average prices paid for Wyoming oil, methane, coal, and trona (1987 through 2003) with forecasts to 2008[1].

Calendar Year	Oil[2]	Methane[3]	Coal[4]	Trona[5]
1987	16.42	1.78	9.80	36.56
1988	13.43	1.43	9.16	36.88
1989	16.71	1.58	8.63	40.76
1990	21.08	1.59	8.43	43.70
1991	17.33	1.46	8.06	44.18
1992	16.38	1.49	8.13	43.81
1993	14.50	1.81	7.12	40.08
1994	13.67	1.63	6.62	38.96
1995	15.50	1.13	6.38	40.93
1996	19.56	1.46	6.15	45.86
1997	17.41	1.94	5.78	42.29
1998	10.67	1.81	5.41	41.29
1999	16.44	2.06	5.19	38.49
2000	26.87	3.42	5.40	37.28
2001	21.59	3.66	5.75	38.00
2002	22.08	2.09	6.66	38.00
2003	26.63	4.41	6.80	37.40
2004	22.50	3.50	6.00	37.50
2005	20.50	3.25	6.03	37.50
2006	20.50	3.25	6.12	37.50
2007	20.50	3.25	6.24	37.50
2008	20.50	3.25	6.40	37.50

[1]From CREG's Wyoming State Government Revenue Forecast, October, 2003; [2]First purchase price in dollars per barrel (weighted average price for sweet, sour, heavy, stripper, and tertiary oil). Source: Energy Information Administration, 1987-2003; [3]Wellhead price in dollars per thousand cubic feet (MCF), includes coalbed methane. Source: American Association, 1998-2003; Wyoming Office of State Lands and Investments, 1989-2003 (derived from State royalty payments); and Minerals Management Service, 1987-1988 (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, 1987-1990 and derived from Department of Revenue, 1991-2003; [5]Dollars per short ton of trona, not soda ash. Source Wyoming Department of Revenue, 1987-2003.

(1.6%) less in 2003 and coal prices, although not final, are expected to be about 2% higher than in 2002.

Based on fourth quarter, 2003 and first quarter, 2004 trends, the CREG estimates for production and prices that will be made in September promise to be interesting. If the trends for CBM continue through 2004, natural gas production may actually decrease for the first time in at least 25 years. It will probably not make much difference in revenues, however, if the prices for natural gas (as well as coal and oil) continue at their high levels.

As pointed out in the **Coal Update** in this issue of *Wyoming Geo-notes*, improvements in the railroad system are being made to transport Wyoming coal to its markets. As is the case with natural gas produced in the state, it is important that movement of Wyoming coal to its out-of-state markets not be inhibited. It is possible that coal prices, like natural gas prices, are more closely related to the ability of coal suppliers to get their product to the power plants than once thought. We saw an increase in natural gas prices at the wellhead when Wyoming's pipeline capacity expanded to meet producer's needs, and perhaps this could be the case with coal.

We were discouraged to see that the proposed Dakota, Minnesota & Eastern Railroad (DM&E) out of the PRB was delayed by additional regulatory review. Not only will this new railroad increase the capacity for moving coal out of the PRB, it will give mines with captive shippers another transportation choice and will increase competition for better rail rates. Although the current coal transportation system is working quite well, the present system will be stretched beyond its capacity with a few more years of increased coal production in the PRB.

Our proposed STATEMAP projects for 2004 have been funded, although at a level somewhat less than anticipated (see the **Geologic Mapping, Paleontology, and Stratigraphy Update**). Our STATEMAP 2003 projects are winding down and we are already realizing the importance of this work, as the maps produced are being incorporated into some regional projects such as the new 1:250,000–scale map of southwestern Wyoming compilation and the recently completed interactive database for the northern PRB. The STATEMAP projects affect a number of different sections of the WSGS throughout the year, including Publications, Mapping, Industrial Minerals and Uranium, and Metals and Precious Stones, and enable the WSGS to employ a number of contract geologists and GIS specialists.

The Geologic Hazards Section at the WSGS has been working closely with the federal and state emergency management agencies to develop a more realistic way to assess and predict damages and casualties that could result from geologic hazards. The article on HAZUS in this issue of *Wyoming Geo-notes* describes some of this work and shows how actual hazards data collected and compiled for Wyoming can be used to make the general models much more specific to a particular area (e.g., Wyoming or individual counties), and hence, much more useful. This work by the section is on the cutting edge of hazards assessment and mitigation and will be used by the Federal Emergency Management Agency as a model throughout the U.S.

For our visitors and customers, we have some good news about access to our building and payment options. The construction in the parking lot behind (north of) our building has been completed and the WSGS building can once again be accessed through the north door. There are now two 30-minute parking meters in the parking lot for the convenience of our patrons. See the new locations map in the back of this issue of *Wyoming Geo-notes* and the WSGS web site for more information on parking near our building and on the University of Wyoming campus. Finally, we are now able to take credit cards (Visa®/Master Card®) for purchases made over the phone and at our sales desk. We are also developing an online publication and map ordering system, in concert with a new publications list, which will be available in the near future.

Coalbed methane issues

Yearly data on CBM production in the PRB shows steady growth in number of wells and annual volumes, but a recent downturn in daily production rates (**Figure 1**). More detailed production data by month (**Figure 2**) reveals some disturbing trends for future CBM production. While CBM production peaked in October, 2003, at 977 million cubic feet (MMCF) per day and the number of producing wells peaked at 12,270 in February, 2004, the data for March, 2004 leads to some negative projections. Production of 823 MMCF per day in March was a decrease of nearly 16% in the six months from the October, 2003 peak. This is an annual decline rate of 32%. Similarly, the producing-well count declined by 880 in one month as the mature eastern producing areas in the PRB began to lose wells from depletion and as new well completions failed to keep pace with abandonments.

The trends we are seeing are not due to lack of CBM resources. Total cumulative production to date from PRB coals is less than 1.25 trillion cubic feet (TCF), or about 5% of the total recoverable resource. The production trends are driven by the rate at which wells are being drilled, and the

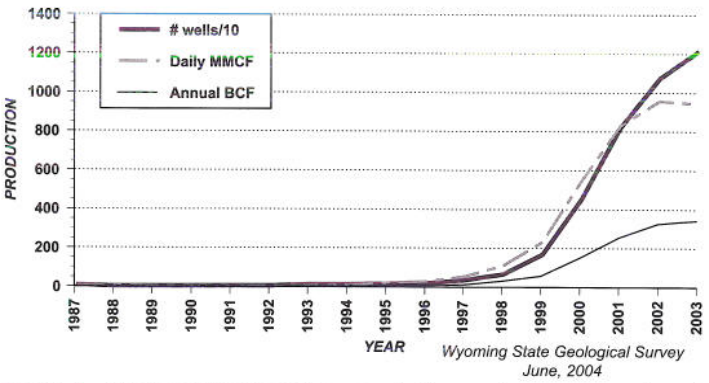

Figure 1. Annual coalbed methane production and average number of producing coalbed methane wells in the Powder River Basin, Wyoming, 1987 through 2003. Annual production is in billion cubic feet (BCF); daily production in millions of cubic feet (MMCF) is averaged for each year. Data from the Wyoming Oil and Gas Conservation Commission.

drilling rate is a function of permitting. Private and state lands were selectively developed while the PRB Oil and Gas Environmental Impact Statement (EIS) for federal lands was being prepared, and operators drilled at an accelerated rate. Because of this, the inventory of appropriate drilling locations has become selectively weighted towards locations on federal lands, and now the pace of development will be largely controlled by the rate of federal permitting by the U.S. Bureau of Land Management (BLM).

In the first six months of federal fiscal year 2004 (starting October 1, 2003), the average rate of permitting has been four wells per day. That equates to roughly 1500 wells per year for the federal mineral estate. During the peak in 2000 and 2001, the drilling rate was 3200 wells per year. As a result of the slowdown in federal permitting, we can expect even further declines in production and correspondingly lower levels of drilling activity. At the rate of 2000 new wells drilled per year, full development will not occur for another 20 years, and production will extend over another 30 years.

We have revised and updated our popular Information Pamphlet 7, *Coalbed Methane in Wyoming*, with new and forecast production data, more complete coverage of CBM activity in areas of Wyoming outside the PRB, and new information on other selected topics. The pamphlet is still free upon request (one per person); multiple copies can also be purchased through the publications sales office at the WSGS.

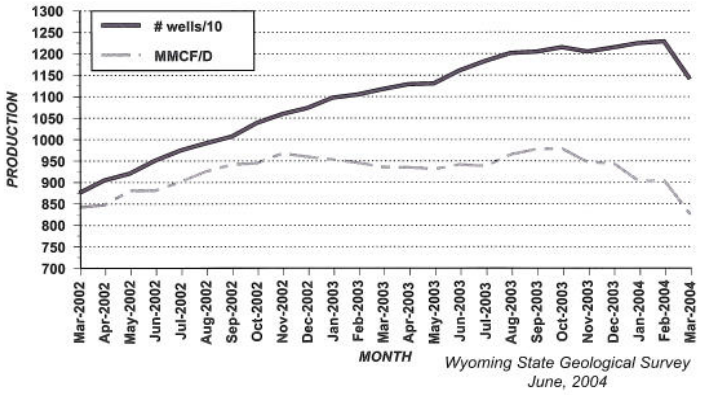

Figure 2. Monthly coalbed methane production and average number of producing wells in the Powder River Basin, Wyoming, March, 2002 through March, 2004. Production is in million cubic feet per day (MMCF/D) averaged for each month. Data from Wyoming Oil and Gas Conservation Commission.

Oil and Gas Update

Rodney H. De Bruin, Wyoming PG-3045

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Wyoming oil and gas producers received much higher prices in 2003 than they received during 2002. Average oil prices for 2003 were up $4.55 per barrel from 2002 prices, while natural gas prices were $2.32 per thousand cubic feet (MCF) higher. Oil production declined 4.2% from 2002 to 2003, while natural gas production increased 5.0% during 2003. Coalbed methane (CBM) production from the Powder River Basin (PRB) accounted for 346.0 billion cubic feet (BCF) or 18.9% of Wyoming's total natural gas production. Increases in gas production from Jonah Field and from wells on the Pinedale anticline accounted for another 353.6 BCF or 19.3% of the total. Cumulative production from Jonah Field exceeded 1.0 trillion cubic feet (TCF) in March, 2004.

Almost $12 million was realized from one state and two federal lease sales in the fourth quarter of 2003. The October state sale brought in nearly $2.0 million. The October federal lease sale brought in over $4.2 million. The December federal sale received high bids that totaled nearly $5.7 million. Federal and state lease sales netted $20 million in 2003.

The number of applications for permit to drill in 2003 remained healthy with 7283 approvals; this is 863 more than in 2002. Thirteen less seismic projects were approved in 2003. The number of conventional seismic exploration miles permitted in 2003 was 1603 less, but the total for 3-D seismic is 747 square miles more. The average daily rig count for the fourth quarter of 2003 was 65 and the average for all of 2003 was 54. These averages are 26 more than for the fourth quarter of 2002 and 14 more than for all of 2002.

Completion of new pipeline capacity out of Wyoming...had a positive effect on the average price of Wyoming gas.

Prices and production

Prices paid to Wyoming oil producers during all of the year 2003 averaged $26.63 per barrel (**Table 3**). The average price for 2003 is $4.55 higher than the average price in 2002 and exceeded the State of Wyoming's Consensus Revenue Estimating Group (CREG) estimates by $0.88 per barrel (**Table 2**; compare to Table 2 in *Wyoming Geo-notes No. 79*, March, 2004). Over the last 52 months, the average monthly price for a barrel of Wyoming crude oil has been over $20 for all but the last three months of 2001 and the first two months of 2002 (**Figure 3** and **Table 3**). Posted sweet and sour crude prices and first purchase price

Table 3. Monthly average price of a barrel of oil produced in Wyoming (2000 through April, 2004).

	2000		2001		2002		2003		2004	
	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative
January	$24.01	$24.01	$24.62	$24.62	$15.70	$15.70	$28.02	$28.02	$28.88	$28.88
February	$26.48	$25.25	$24.82	$24.72	$16.63	$16.17	$31.00	$29.51	$29.40	$29.14
March	$27.24	$25.91	$22.71	$24.05	$20.64	$17.66	$28.92	$29.31	**$31.40**	**$29.89**
April	$22.92	$25.16	$22.85	$23.75	$22.63	$18.90	$24.50	$28.11	**$31.25**	**$30.23**
May	$26.06	$25.34	$23.68	$23.74	$22.86	$19.69	$24.51	$27.39		
June	$28.31	$25.84	$22.99	$23.61	$21.71	$20.03	$26.55	$27.25		
July	$27.12	$26.02	$22.55	$23.46	$23.29	$20.49	$26.37	$27.12		
August	$28.18	$26.29	$23.67	$23.49	$24.27	$20.97	$27.20	$27.13		
September	$30.22	$26.73	$22.02	$23.32	$25.47	$21.47	$24.16	$26.80		
October	$28.75	$26.93	$17.71	$22.76	$24.27	$21.75	$25.71	$26.69		
November	$29.63	$27.17	$16.44	$22.19	$22.66	$21.83	$25.63	$26.60		
December	$23.60	$26.88	$14.86	$21.58	$24.85	$22.08	$26.98	$26.63		
Average yearly price		**$26.88**		**$21.58**		**$22.08**		**$26.63**		

All averages are derived from published monthly reports by the Energy Information Administration, except that averages in bold print in 2004 are estimated from various unpublished bulletins listing posted prices. *Wyoming State Geological Survey, Oil and Gas Section, May, 2004.*

for Wyoming oil averaged by month have been at least as high in 2003 as they were when prices spiked in December, 2000 (**Figure 3**). Estimated crude oil prices will probably be adjusted upward for 2004 and 2005 (**Table 2** and **Figure 4**), at the next CREG meeting since gasoline prices are above all-time highs in mid-2004.

Oil production reported by the Wyoming Oil and Gas Conservation Commission (WOGCC) for 2003 was about 52.4 million barrels (**Table 4**). This production was just 100,000 barrels less than the most recent CREG estimate (see Table 1 in *Wyoming Geo-notes No. 79*, March, 2004) and a decrease of 4.2% from 2002 (**Table 1**). We are still expecting oil production to decline in 2004 and 2005, then rebound slightly in 2006 through 2008 (**Table 1** and **Figure 5**) as the ongoing carbon dioxide floods recover additional oil from the state's fields.

Spot prices for natural gas at Opal, Wyoming averaged $4.41 during 2003. This is $2.32 per MCF higher than the average price for 2002 (**Table 5** and **Figure 6**) and exceeded the CREG forecast by $0.21 (**Table 2**; compare to Table 2 in *Wyoming Geo-notes No. 79*, March, 2004). Prices have held at relatively high levels throughout the year because storage levels at the end of last year's heating season were extremely low and refilling that storage continued through the summer months. The heating season ended with U.S. storage levels significantly higher than last year, but still slightly below the five-year average. The higher storage volumes could result in lower Wyoming natural gas prices this coming summer (2004) than last summer if temperatures are normal or below normal and if industrial demand moderates. Completion of new pipeline capacity out of Wyoming decreased the price differential between Wyoming gas and gas from other areas of the U.S. and had a positive effect on the average price of Wyoming natural gas. The last CREG estimate projected that the average price for Wyoming natural gas will decrease in 2004 (**Table 2** and **Figure 7**), but data received so far in 2004 show prices still over $5.00 per MCF (**Table 5**).

Natural gas production in Wyoming for 2003 was 1834 BCF according WOGCC statistics. This production is up 5.0% from 2002 (**Table 6**) and exceeded the earlier CREG estimate by 34 BCF. CBM production from the PRB accounted for 346.0 BCF or 18.9% of Wyoming's total natural gas production. Increases in gas production from Jonah Field and wells on the Pinedale anticline accounted for 353.6 BCF or 19.3% of the total. Production from Jonah Field alone was 247.9 BCF in 2003 and cumulative production exceeded 1.0 TCF in March, 2004. CBM production rates are once again beginning to decrease; the average daily production for December was 942.7 million cubic feet (MMCF) of gas per day versus 977 MMCF per day in September. Although the CREG estimates for total natural gas production in 2004 and beyond will stay

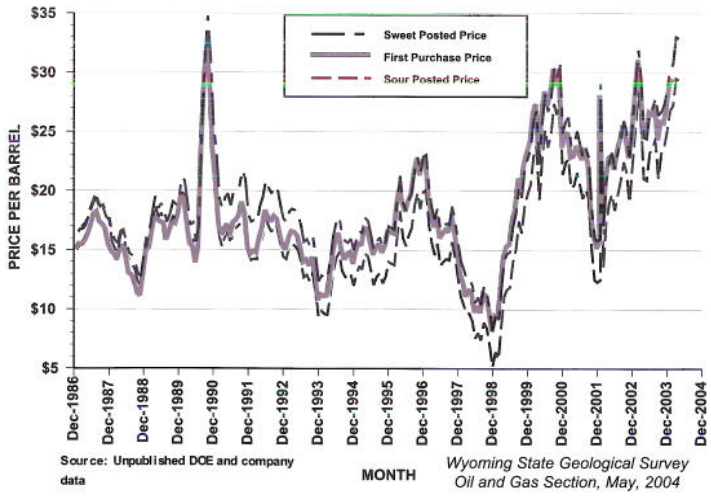


Figure 3. Wyoming posted sweet and sour crude oil prices and first purchase prices, averaged by month (January, 1987 through April, 2004).

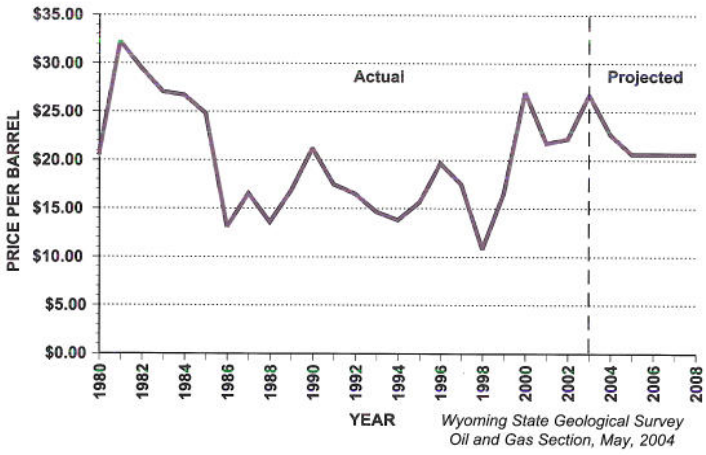


Figure 4. Average prices paid for Wyoming crude oil (1980 through 2003) with forecasts to 2008.

Table 4. Monthly oil production from Wyoming in barrels (1999 through December, 2003).

	1999		2000		2001		2002		2003	
	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative
January	5,333,257	5,333,257	5,187,557	5,187,557	5,003,766	5,003,766	4,711,532	4,711,532	4,617,857	4,617,857
February	4,744,527	10,077,784	4,873,042	10,060,599	4,495,136	9,498,902	4,238,372	8,949,904	4,130,199	8,748,056
March	5,297,674	15,375,458	5,213,721	15,274,320	4,972,168	14,471,070	4,629,468	13,579,372	4,473,585	13,221,641
April	5,065,591	20,441,049	5,014,266	20,288,586	4,804,531	19,275,601	4,565,445	18,144,817	4,345,365	17,567,006
May	5,200,031	25,641,080	5,205,848	25,494,434	4,933,201	24,208,802	4,687,127	22,831,944	4,469,085	22,036,091
June	5,000,039	30,641,119	5,005,008	30,499,442	4,678,672	28,887,474	4,495,524	27,327,468	4,246,526	26,282,617
July	5,164,705	35,805,824	5,083,393	35,582,835	4,854,173	33,741,647	4,595,080	31,922,548	4,413,901	30,696,518
August	5,190,052	40,995,876	5,108,431	40,691,266	4,768,811	38,510,458	4,626,308	36,548,856	4,368,236	35,064,754
September	5,081,384	46,077,260	4,990,825	45,682,091	4,726,876	43,237,334	4,492,324	41,041,180	4,334,149	39,398,903
October	5,163,165	51,240,425	5,165,311	50,847,402	4,834,294	48,071,628	4,623,348	45,664,528	4,436,608	43,835,511
November	5,010,985	56,251,410	4,884,659	55,732,061	4,655,985	52,727,613	4,456,006	50,120,534	4,200,472	48,035,983
December	5,090,959	61,342,369	4,987,669	60,719,730	4,763,863	57,491,476	4,596,150	54,716,684	4,373,237	52,409,220
Total Barrels Reported [1]	**61,342,369**		**60,719,730**		**57,491,476**		**54,716,684**		**52,409,220**	

[1]Monthly production reports are from Wyoming Oil and Gas Conservation Commission. *Wyoming State Geological Survey, Oil and Gas Section, May, 2004.*

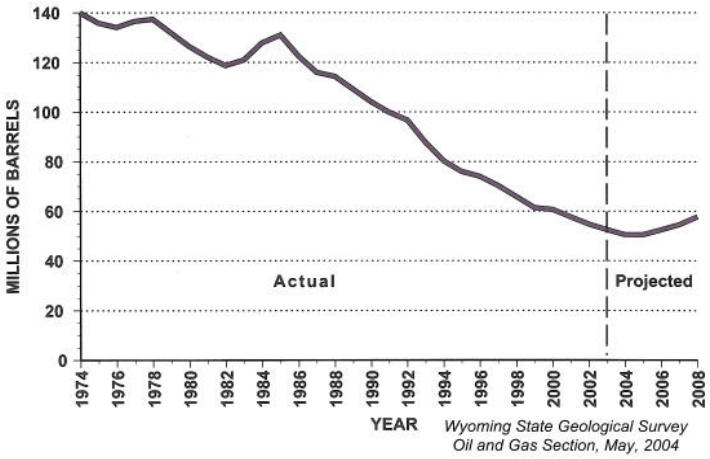


Figure 5. Annual crude oil production from Wyoming (1974 through 2003) with forecasts to 2008.

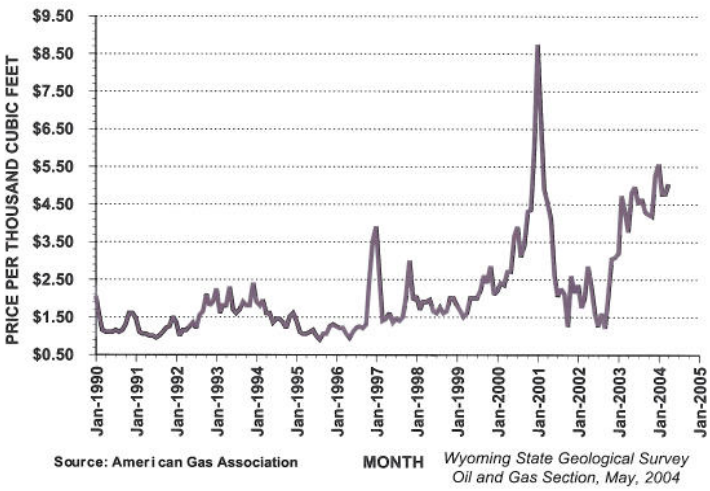


Figure 6. Spot sales prices for methane at Opal, Wyoming, averaged by month (January, 1990 through April, 2004).

the same until the next CREG meeting (**Table 1** and **Figure 8**), we have revised our estimates of CBM production downward from earlier estimates (compare **Figure 8** with Figure 9 in *Wyoming Geo-notes No. 78*, November, 2003).

Reports, projects, and acquisitions

The U.S. Minerals Management Service (MMS) distributed almost $1.1 billion to 36 states in calendar year 2003. This is the states' share of revenues collected from mineral production on federal land within their borders and from federal offshore oil and gas tracts adjacent to their shores. The total is an increase of almost 46% from the $753 million paid out in 2002. Once again, Wyoming led all states in revenue received with more than $503 million as its share. New Mexico was second with over $318 million and Colorado was third with nearly $63 million.

In a related item, reports by the MMS concluded that two royalty-in-kind (RIK) pilot projects conducted with the states of Wyoming and Texas resulted in increased revenues and improved administrative efficiencies. The Wyoming report

Table 5. Monthly average spot sale price for a thousand cubic feet (MCF) of natural gas at Opal, Wyoming (2000 through April, 2004).

	2000		2001		2002		2003		2004	
	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative
January	$2.20	$2.20	$8.75	$8.75	$2.35	$2.35	$3.20	$3.20	$5.57	$5.57
February	$2.40	$2.30	$6.60	$7.68	$1.75	$2.05	$4.73	$3.97	$4.77	$5.17
March	$2.35	$2.32	$4.90	$6.75	$2.00	$2.03	$4.34	$4.09	$4.78	$5.04
April	$2.70	$2.41	$4.55	$6.20	$2.85	$2.24	$3.76	$4.01	$5.04	$5.04
May	$2.70	$2.47	$4.10	$5.78	$2.30	$2.25	$4.81	$4.17		
June	$3.65	$2.67	$2.60	$5.25	$1.60	$2.14	$4.96	$4.30		
July	$3.90	$2.84	$2.05	$4.79	$1.25	$2.01	$4.52	$4.33		
August	$3.10	$2.88	$2.25	$4.48	$1.60	$1.96	$4.65	$4.37		
September	$3.40	$2.93	$2.10	$4.21	$1.20	$1.88	$4.29	$4.36		
October	$4.30	$3.07	$1.25	$3.92	$2.04	$1.89	$4.23	$4.35		
November	$4.35	$3.19	$2.60	$3.80	$3.04	$2.00	$4.18	$4.33		
December	$6.00	$3.42	$2.15	$3.66	$3.08	$2.09	$5.27	$4.41		
Average Yearly Price		**$3.42**		**$3.66**		**$2.09**		**$4.41**		

Source: American Gas Association's monthly reports. Starting in October, 2002, averages calculated from weekly prices posted on Enerfax website. *Wyoming State Geological Survey, Oil and Gas Section, May, 2004.*

Table 6. Monthly natural gas production from Wyoming in thousands of cubic feet (MCF) (1999 through December, 2003).

	1999		2000		2001		2002		2003	
	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative
January	108,524,793	108,524,793	122,320,888	122,078,095	135,998,574	135,998,574	143,510,891	143,510,891	161,162,853	161,162,853
February	94,288,888	202,813,681	112,851,735	235,172,623	123,506,503	259,505,077	132,981,761	276,492,652	145,026,305	306,189,158
March	111,012,987	313,826,668	121,287,580	356,460,203	139,126,687	398,631,764	143,707,799	420,200,451	159,734,697	465,923,855
April	102,363,550	416,190,218	118,886,204	475,346,407	132,684,058	531,315,822	141,016,463	561,216,914	151,047,796	616,971,651
May	104,746,697	520,936,915	118,631,057	593,977,464	138,214,926	669,530,748	146,950,768	708,167,682	143,493,146	760,464,797
June	102,717,295	623,654,210	117,033,775	711,011,239	128,145,994	797,676,742	141,386,350	849,554,032	146,507,531	906,972,328
July	106,733,493	730,387,703	120,838,202	831,849,441	131,752,355	929,429,097	145,796,954	995,350,986	149,789,416	1,056,761,744
August	107,536,099	837,923,802	122,698,001	954,547,442	132,847,188	1,062,276,285	139,407,056	1,134,758,042	149,206,628	1,205,968,372
September	108,200,542	946,124,344	120,166,494	1,074,713,936	131,334,584	1,193,610,869	142,448,905	1,277,206,947	150,567,184	1,356,535,556
October	118,545,893	1,064,670,237	127,682,448	1,202,396,384	137,507,181	1,331,118,050	151,247,991	1,428,454,938	159,308,221	1,515,843,777
November	110,904,046	1,175,574,283	123,108,333	1,325,504,717	136,878,261	1,467,996,311	155,751,286	1,584,206,224	155,178,164	1,671,021,941
December	119,648,215	1,295,222,498	131,474,722	1,456,979,439	144,790,631	1,612,786,942	162,039,833	1,746,246,057	163,090,284	1,834,112,225
Total MCF Reported [1]		**1,295,222,498**		**1,456,979,439**		**1,612,786,942**		**1,746,246,057**		**1,834,112,225**

[1] Monthly production reports are from Wyoming Oil and Gas Conservation Commission. *Wyoming State Geological Survey, Oil and Gas Section, May, 2004.*

concluded that the RIK program reduced the period of time from years to months that it takes MMS to ensure that it has received all royalties due. The report also concluded that RIK royalty receipts in Wyoming exceeded comparable in-value royalties by approximately $810,000 (nearly a 3% increase) and that the process saved administrative costs for both MMS and industry.

The U.S. Geological Survey completed and made public a database that includes over 65,000 records containing chemical analyses of crude oil, natural gas, and rock samples from thousands of worldwide locations. Information within the database includes rock pyrolysis data, organic mass spectrometry, vitrinite reflectance, gas chromatography, column chromatography, stable carbon isotopes, and a number of related petroleum geochemical analyses. The data is available to the public at http://energy.cr.usgs.gov/other/oglab/ogindex.htm.

The Williams Companies completed an expansion of its Opal natural gas-processing plant in early 2004. A fourth cryogenic processing train was constructed at the facility that added 350 MMCF per day of new processing capacity. The project boosts Opal's processing capacity to more than 1.1 BCF of natural gas per day, inlet capacity to 1.5 BCF per day, and ability to recover 56,000 barrels of natural gas liquids per day. The Opal plant can supply gas to the West Coast via connections to Northwest Pipeline and Kern River Pipeline and to the Rockies via Colorado Interstate Pipeline.

The Federal Energy Regulatory Commission (FERC) will prepare an Environmental Impact Statement (EIS) for a new pipeline in northern Colorado and southern Wyoming. Entrega, an affiliate of EnCana Oil and Gas (USA), plans to construct, own, and operate a new 327-mile-long natural gas pipeline that extends from Meeker, Colorado to new interconnections with Colorado Interstate Gas and Wyoming Interstate Co. lines near Wamsutter. From there the pipeline would extend eastward to the Cheyenne Hub south of Cheyenne. The Meeker to Wamsutter leg would be 36 inches in diameter and the Wamsutter to Cheyenne Hub segment would be 42 inches in diameter. Under maximum compression, the line could add up to 2.0 BCF per day of new capacity. Entrega proposes to place the project into service in two phases; the Meeker to Wamsutter segment would commence service by the fall of 2005 and the Wamsutter to Cheyenne Hub segment one year later. The U.S. Bureau of Land Management (BLM) will assist FERC with the EIS.

A significant exploration project in the poorly explored, but extremely deep Hanna Basin of southeastern Wyoming is now underway. Anadarko Exploration & Production is drilling below 17,700 feet at its 17-2 Durante well in NE NE sec 17, T22N, R82W (see ***Exploration and development***, below). The

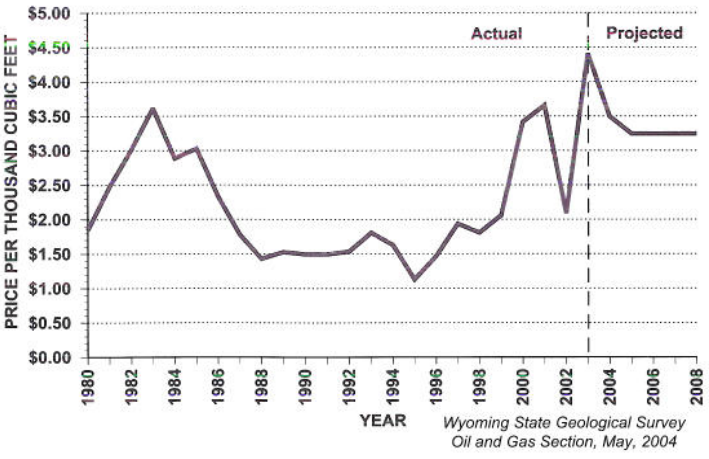


Figure 7. Average prices paid for Wyoming natural gas (1980 through 2003) with forecasts to 2008.

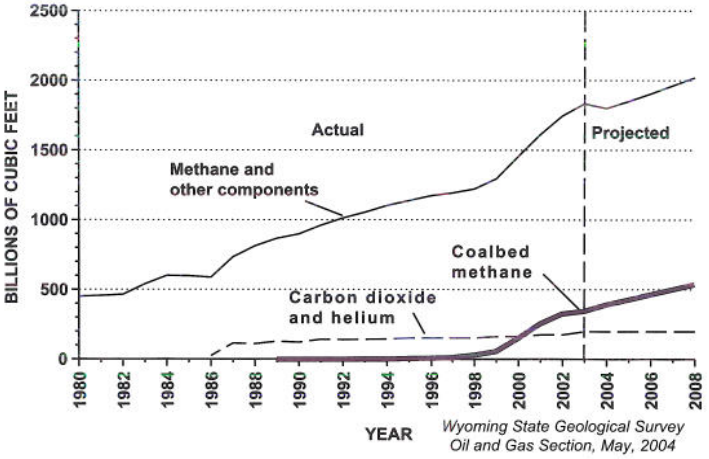


Figure 8. Annual natural gas production from Wyoming (1980 through 2003) with forecasts to 2008.

well has an objective of 23,100 feet and is already the deepest well drilled in the Hanna Basin. The well is designed to test the potential for basin-centered, overpressured natural gas reserves, particularly in sandstones of the Lewis Shale and Mesaverde Formation.

GeoTir Corp. filed a Notice of Intent (NOI) with the BLM to conduct geophysical operations in the Salt Wells Field area in T14N, R102 to 103W. The 3-D seismic project would cover about 4520 acres of federal land, 160 acres of private land, and 480 acres of state land. The project is scheduled to take 60 days and to be completed during the summer of 2004.

Stone Energy filed an NOI to conduct 3-D geophysical operations on about 70 square miles of public, state, and private lands in T39N, R92 to 94W. The project would begin in the summer of 2004 and would take about 45 days to complete. Stone recently completed a discovery in the area (see ***Exploration and development***, below) that flowed 3.8 MMCF of gas, 70 barrels of condensate, and 132 barrels of water per day.

The BLM approved the proposed development of natural gas in Cooper Reservoir Field in the Wind River Basin (WRB). Bill Barrett Corp. submitted a proposal that includes the drilling, completing, testing, producing, and reclaiming of up to 92 additional natural gas wells on 42 additional well pads in an area of 4082 acres. The majority of the development would occur over the next five to 10 years.

Between 30 and 70% of the field's estimated 100 million barrels of oil-in-place may be recoverable using the thermal recovery techniques planned...

Yates Petroleum Corp., Bill Barrett Corp., Tom Brown Inc., and BLM's Reservoir Management Group, all signed the Chinook Development Contract that requires the companies to spend a certain amount of money to study, explore, and develop about 740,000 acres that includes all or parts of 32 townships extending from T34 to 39N, R85 to 94W in the eastern WRB. The agreement exempts the companies from the acreage limitation provisions of the Mineral Leasing Act which prohibits a company from controlling more than 246,000 acres of federal oil and gas leases in a state. The contract has a five-year term and may be extended twice by two years each time. The area includes Waltman, Madden, Cooper Reservoir, Fuller Reservoir, and Frenchie Draw fields.

Also in the eastern WRB, Bill Barrett Corp., Chevron USA, and Prima Energy proposed further development of Cave Gulch, Waltman, and Bullfrog fields to the BLM. Based on current data, the operators estimate that up to 149 additional wells will be needed to fully develop all currently known oil and gas resources within the project area. The operators plan to drill the 149 wells from 105 well pads over a 10-year period. The wells will be spaced at 40-acre, 20-acre, and 10-acre densities. The BLM determined that an Environmental Assessment (EA) is necessary for this project.

In the Greater Green River Basin (GGRB) Tom Brown Inc. proposed infill drilling in Hay Reservoir Field, T23 to 24N, R96 to 97W. The project consists of construction, drilling, completing, and producing up to 25 infill wells over the next three years. Six wells are proposed for 2004, 10 wells for 2005, and nine wells in 2006.

Houston Exploration Co. has plans to explore for natural gas in the Green River Formation, T15N, R111W, in the GGRB. The company has received drilling permits for two wells and has applied for a permit for a third well. The three permits are for depths that range from 2850 to 3030 feet.

The BLM plans to prepare an EA for a natural gas project in the GGRB proposed by Cabot Oil & Gas and GMT Energy. The two companies have notified the BLM that they plan to explore and develop the Wind Dancer Unit that covers about 6400 acres of public land in T24N, R96W. Cabot recently completed a discovery (see ***Exploration and development***, below) and has drilled and cased three other prospects in the area. The project includes drilling, completing, and producing up to 12 natural gas wells and constructing, utilizing, and maintaining related facilities. The drilling and completion of the wells is expected to take less than two years once the project is approved.

Derek Oil & Gas has reached an agreement with Ivanhoe Energy to jointly develop LAK Ranch Field, a steam-assisted gravity drainage project in the eastern PRB. Between 30 and 70% of the field's estimated 100 million barrels of oil-in-place may be recoverable using the thermal recovery techniques planned for the project. The initial development program could grow to over 20 producing wells and oil production could exceed 4500 barrels per day. If more productive acreage is identified, daily production rates could exceed 10,000 barrels per day according to Derek. The oil from the project will be processed by the refinery in Newcastle.

XTO Energy agreed to purchase proved reserves in the Hartzog Draw Unit of the PRB from ExxonMobil. Net daily production from the Shannon Sandstone is about 2300 barrels of oil. XTO also acquired CBM development potential in the Big George coal zone delineated under 12,500 acres of the 35,775-acre unit.

EnCana Corp. agreed to acquire Tom Brown Inc. for a total consideration of $2.7 billion in cash, including debt. Completion of the acquisition is expected to add about 325 MMCF of gas equivalent per day of production, about 1.2 TCF of proved gas equivalent reserves, and about two million net undeveloped acres to EnCana's holdings. Most of Brown's properties were in the WRB and GGRB of Wyoming as well as the Piceance, East Texas, Permian, and Western Canada sedimentary basins.

Lease sales

Leasing activity at the October, 2003 BLM sale was scattered throughout the state (**Figure 9**). The high per-acre bid of $990 was made by Energy West Corp. for a 1915.09-acre lease that covers parts of section 6 and all of sections 20 and 22, T22N, R95W (**location A, Figure 9**). The lease is in the vicinity of Lost Creek Basin and Strike fields where Lewis and Mesaverde reservoirs are being developed. The second high per-acre bid of $450 was made by Strata Oil & Gas for a 240-acre tract that covers S/2 SW section 2 and E/2 E/2 section 10, T17N, R91W (**location B, Figure 9**). The lease is just north of an area of Mesaverde CBM development. The sale generated $4,173,493 and the average per-acre bid was $65.14 (**Table 7**). Twenty parcels at this sale received a bid of $50 or more per acre.

Leasing activity at the October, 2003 sale of the Wyoming Office of State Lands and Investments was concentrated in the PRB (**Figure 10**). CH4 Energy made the sale's high per-acre bid of $2025 for a 640-acre lease that covers all of section 16, T43N, R75W (**location A, Figure 10**). CH4 also made the sale's second highest per-acre bid of $1550 for an 80-acre lease that covers W/2 NW section 36, T45N, R76W (**location B, Figure 10**). Both of these leases are in an area with CBM potential in relatively deep coal beds in the Fort Union Formation. The sale generated $1,978,075 and the average per-acre bid was $53.16 (**Table 7**). There were 11 parcels at this sale that received a bid of $50 or more per acre. Total revenue for the three state lease sales in 2003 was almost $3.4 million, a definite improvement over 2002. The average price per acre leased was also substantially higher in 2003.

Leasing activity at the December, 2003 BLM sale was scattered throughout the state (**Figure 9**). Donald Anderson made the sale's first and second high per-acre bids of $1110 for a 642.8-acre lease that covers section 4, T14N, R92W (**location A, Figure 9**) and $1100 for a 480-acre parcel that covers E/2 and E/2 W/2 section 25, T15N, R92W (**location B, Figure 9**). Both leases are adjacent to producing or abandoned Mesaverde gas wells in Blue Gap Field. This sale generated $5,698,724 and the average per-acre bid was $56.88 per acre (**Table 7**). There were 34 leases at this sale that received bids of $50 or more per acre.

Total revenue from BLM sales in 2003 was about $16.6 million, almost $5 million higher than in 2002, but only about half of the all-time record set in 2001. The average price per acre leased in 2003 was $43.76, substantially higher than the $19.83 average in 2002 (**Table 7**). Revenues for state sales and BLM sales in 2003 were generally lower than in 1999, 2000, and 2001 because most of the highest quality leases have already been sold and there is less total acreage available.

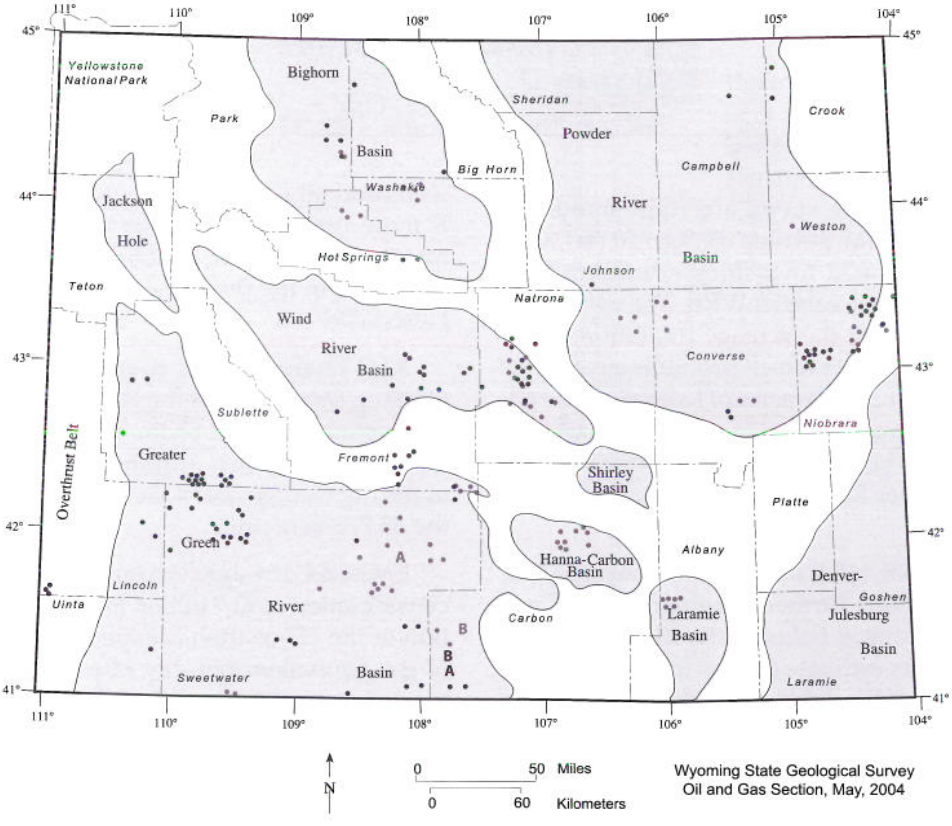


Figure 9. Locations of federal oil and gas tracts leased by the U.S. Bureau of Land Management at its October, 2003 sale (locations in purple) and its December, 2003 sale (locations in black). Locations are approximate and may represent more than one tract.

Table 7. Federal and state competitive oil and gas lease sales in Wyoming (1999 through December, 2003).

Federal Sales (U.S. Bureau of Land Management)								State Sales (Office of State Lands and Investments)							
Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre	Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
			1999								1999				
February	$2,734,442	170	138	157,779	124,880	$21.90	$325.00								
April	$2,121,220	124	116	129,358	121,421	$17.47	$280.00	April	$1,815,526	299	196	123,119	89,194	$20.35	$890.00
June	$8,358,363	179	155	233,599	207,978	$40.19	$32,000.00	June	$1,002,039	300	190	108,310	69,858	$14.34	$400.00
August	$3,294,339	206	197	215,631	208,777	$15.78	$290.00	October	$2,369,527	300	216	109,140	77,261	$30.67	$475.00
October	$4,395,288	214	175	195,827	142,525	$30.84	$580.00	December	$956,113	291	129	115,502	51,674	$18.50	$500.00
December	$5,598,020	176	164	128,480	124,093	$28.99	$410.00								
Total	**$26,501,672**	**1,069**	**945**	**1,060,674**	**929,674**	**$28.51**	**$32,000.00**	**Total**	**$6,143,205**	**1,190**	**731**	**456,071**	**287,987**	**$21.33**	**$890.00**
			2000								2000				
February	$5,497,834	192	180	130,289	120,219	$45.73	$525.00								
April	$3,057,278	189	161	160,712	128,063	$23.87	$440.00	April	$1,475,661	299	191	120,319	71,933	$19.54	$525.00
June	$6,387,887	230	184	260,294	190,306	$33.57	$410.00	June	$2,119,198	300	197	127,798	79,743	$26.58	$775.00
August	$5,213,595	240	222	174,040	154,920	$33.65	$475.00	October	$1,660,315	300	216	117,598	81,603	$20.35	$268.00
October	$5,028,610	147	129	149,934	124,724	$40.32	$510.00	December	$1,240,442	300	192	109,375	62,636	$19.80	$210.00
December	$6,352,525	185	179	182,935	180,380	$35.22	$725.00								
Total	**$31,537,729**	**1,183**	**1,055**	**1,058,204**	**898,612**	**$35.10**	**$725.00**	**Total**	**$6,495,616**	**1,199**	**796**	**475,090**	**295,915**	**$21.95**	**$775.00**
			2001								2001				
February	$9,138,921	202	159	224,225	148,972	$61.35	$1,475.00								
April	$10,976,580	185	184	221,147	221,067	$49.65	$530.00								
June	$3,088,796	158	149	144,738	138,088	$22.37	$360.00	April	$2,250,353	300	212	112,379	82,834	$27.16	$450.00
August	$7,626,362	204	190	260,409	245,116	$31.11	$525.00	June	$1,754,320	300	192	111,507	66,829	$26.25	$650.00
October	$998,308	119	105	127,396	107,880	$9.25	$160.00	October	$679,343	300	129	112,255	53,396	$12.72	$120.00
December	$2,162,599	155	146	125,830	112,159	$9.28	$550.00								
Total	**$33,991,566**	**1,023**	**933**	**1,103,745**	**973,282**	**$34.92**	**$1,475.00**	**Total**	**$4,684,016**	**900**	**533**	**336,141**	**203,059**	**$23.07**	**$650.00**
			2002								2002				
February	$5,137,024	219	164	271,248	177,117	$29.00	$345.00								
April	$2,969,094	142	127	136,864	117,852	$25.19	$375.00								
June	$1,183,222	91	63	82,958	55,808	$21.20	$185.00	April	$465,104	200	90	74,321	35,084	$13.26	$105.00
August	$858,686	124	89	111,462	88,719	$9.68	$205.00	June	$517,143	200	124	74,608	46,481	$11.04	$525.00
October	$578,597	117	86	122,962	72,039	$8.03	$46.00	October	$1,222,823	198	133	70,800	47,436	$25.77	$480.00
December	$866,561	111	95	86,139	73,237	$11.83	$165.00								
Total	**$11,593,184**	**804**	**624**	**811,633**	**584,772**	**$19.83**	**$375.00**	**Total**	**$2,205,070**	**598**	**347**	**219,729**	**129,001**	**$17.09**	**$525.00**
			2003								2003				
February	$170,647	37	27	28,836	19,746	$8.64	$56.00								
April	$1,455,295	98	71	49,521	33,304	$43.70	$310.00								
June	$1,729,660	63	54	46,412	40,177	$43.05	$360.00	April	$812,916	200	92	79,290	30,152	$26.96	$350.00
August	$3,357,650	177	104	233,189	121,515	$27.63	$675.00	June	$583,950	200	121	76,433	43,966	$13.28	$575.00
October	$4,173,493	94	82	70,892	64,072	$65.14	$990.00	October	$1,978,075	199	113	75,614	37,205	$53.16	$2025.00
December	$5,698,724	149	136	117,076	100,188	$56.88	$1110.00								
Total	**$16,585,469**	**618**	**474**	**545,926**	**379,002**	**$43.76**	**$1110.00**	**Total**	**$3,374,941**	**599**	**326**	**231,337**	**111,323**	**$30.32**	**$2025.00**

Sources: Wyoming Office of State Lands and Investments, Petroleum Information/Dwights LLC - Rocky Mountain Region Report, and U.S. Bureau of Land Management.
Wyoming State Geological Survey, Oil and Gas Section, May, 2004.

Permitting and drilling

The WOGCC approved 7283 Applications for Permit to Drill (APDs) in 2003, which is 863 more than in 2002 (**Table 8**). Campbell County again led with 37.7% of the total APDs that were approved in 2003 with Sheridan and Johnson counties combining for another 35.4% of the total. Nearly all of the approved APDs in these three counties were for CBM tests. The increase in approved drilling permits for Sweetwater and Sublette counties since 1999 (**Table 8**) is due to industry emphasis on developing and exploring for natural gas reserves in southwestern Wyoming. The emphasis is in lieu of exploring for and developing oil reserves in the Bighorn and Powder River basins.

The WOGCC permitted 26 seismic projects in 2003, which is 13 less than for 2002. The number of conventional miles permitted in 2003 was 1603 lower, but the square miles total for 3-D seismic is 747 more than in 2002 and 22 square miles more than in 2001 (**Table 9**). Geophysical activity is a good indicator of future exploration and production drilling.

The average daily rig count for the fourth quarter of 2003 was 65, which is 26 more than for the fourth quarter of 2002. The average for all of 2003 was 54 compared to an average of 40 for all of 2002 (**Figure 11**). The rig count does

Table 8. Number of Applications for Permit to Drill (APDs) approved by the Wyoming Oil and Gas Conservation Commission (1997 through December, 2003).

County	1997 APDs	1998 APDs	1999 APDs	2000 APDs	2001 APDs	2002 APDs	2003 APDs
Albany	0	0	0	0	1	1	1
Big Horn	59	13	6	11	23	8	5
Campbell	941	1586	4461	5580	6204	2793	2747
Carbon	84	96	127	174	261	198	278
Converse	16	6	19	70	25	43	86
Crook	26	29	30	47	20	13	52
Fremont	58	76	67	136	149	62	133
Goshen	0	0	0	0	0	1	0
Hot Springs	42	1	8	6	2	9	8
Johnson	6	49	304	769	805	799	1155
Laramie	3	2	0	2	3	3	1
Lincoln	122	105	51	70	87	51	72
Natrona	59	36	51	53	45	49	146
Niobrara	8	8	5	18	15	10	14
Park	25	11	12	18	45	23	56
Platte	0	0	0	0	0	0	0
Sheridan	2	35	416	891	1811	1531	1421
Sublette	179	230	189	338	435	428	486
Sweetwater	210	181	124	335	534	379	591
Teton	0	0	0	0	0	0	0
Uinta	27	26	26	53	35	16	17
Washakie	36	9	0	7	10	1	0
Weston	5	6	4	20	7	2	14
Totals	**1908**	**2505**	**5900**	**8598**	**10,517**	**6420**	**7283**

Source: All data are from the Wyoming Oil and Gas Conservation Commission. *Wyoming State Geological Survey, Oil and Gas Section, May, 2004.*

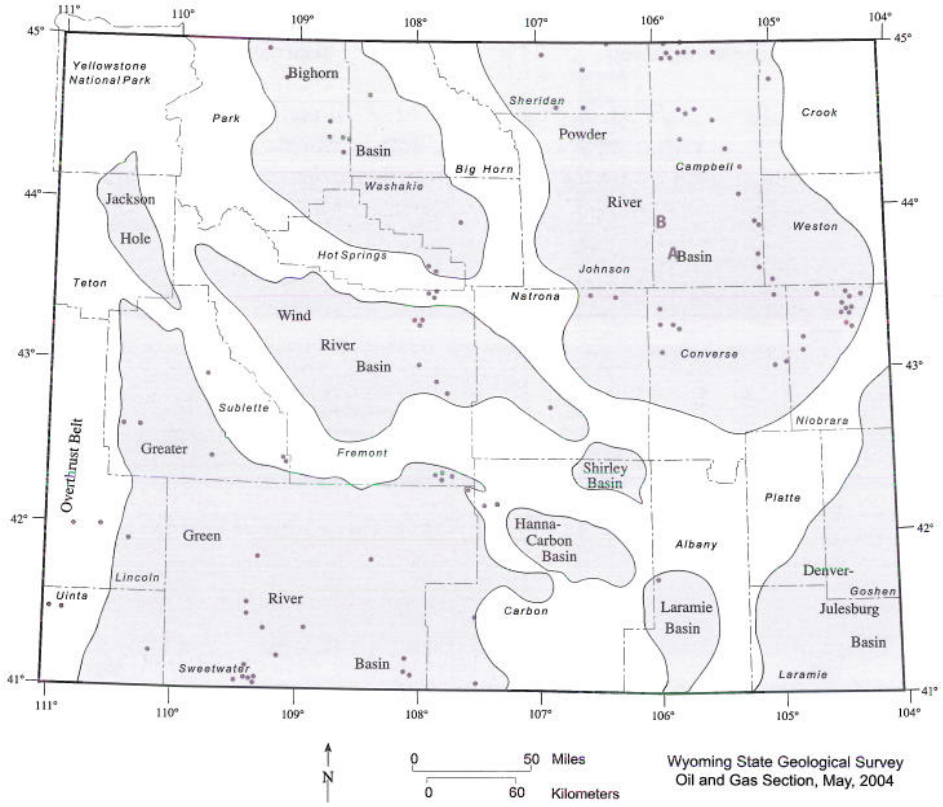


Figure 10. Locations of state oil and gas tracts leased by the Office of State Lands and Investments at its October, 2003 sale. Locations are approximate and may represent more than one tract.

Table 9. Number of seismic projects and miles permitted by the Wyoming Oil and Gas Conservation Commission (2000 through December, 2003).

	2000			2001			2002			2003		
County	Permits	Conventional Miles	3-D Square Miles	Permits	Conventional Miles	3-D Square Miles	Permits	Conventional Miles	3-D Square Miles	Permits	Conventional Miles	3-D Square Miles
Albany	0	0	0	0	0	0	1	6	0	0	0	0
Big Horn	1	387	0	1	0	4	0	0	0	0	0	0
Campbell	14	64	132	5	38	3	10	49	3	4	8	3
Carbon	0	0	0	1	500	0	4	419	3	1	0	55
Converse	1	15	0	0	0	0	2	6	47	1	0	75
Crook	7	16	22	4	32	0	1	0	2	3	46	0
Fremont	4	25	116	2	70	15	1	160	0	4	12	717
Goshen	0	0	0	0	0	0	0	0	0	0	0	0
Hot Springs	0	0	0	0	0	0	0	0	0	0	0	0
Johnson	4	35	0	2	4	4	1	16	0	1	25	0
Laramie	0	0	0	0	0	0	1	0	18	0	0	0
Lincoln	0	0	0	1	0	25	0	0	0	0	0	0
Natrona	5	36	135	2	19	63	4	11	72	0	0	0
Niobrara	1	0	25	1	0	16	3	3	52	2	0	42
Park	1	13	0	4	21	20	0	0	0	1	0	6
Platte	0	0	0	0	0	0	0	0	0	0	0	0
Sheridan	0	0	0	2	0	81	0	0	0	0	0	0
Sublette	4	77	44	10	261	374	1	464	0	2	0	238
Sweetwater	13	54	1004	11	129	802	7	348	485	5	1	246
Teton	0	0	0	0	0	0	0	0	0	0	0	0
Uinta	0	0	0	1	259	0	2	196	0	1	0	47
Washakie	0	0	0	0	0	0	1	21	0	1	4	0
Weston	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**55**	**722**	**1478**	**47**	**1333**	**1407**	**39**	**1699**	**682**	**26**	**96**	**1429**

Source: All data are from the Wyoming Oil and Gas Conservation Commission. *Wyoming State Geological Survey, Oil and Gas Section, May, 2004.*

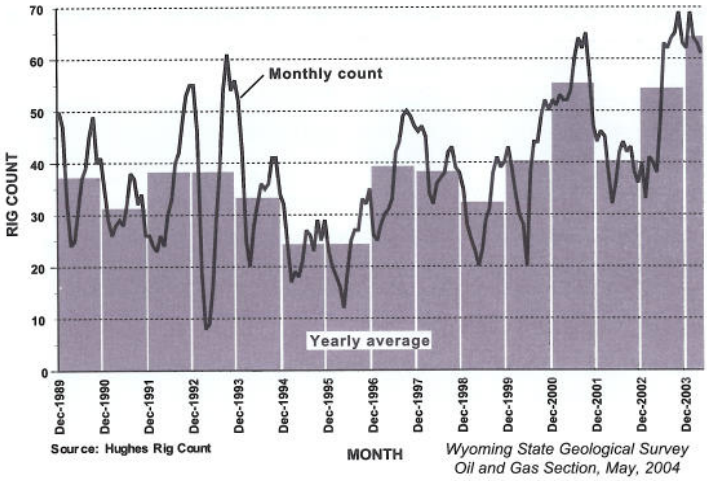


Figure 11. Wyoming daily rig count, exclusive of coalbed methane rigs, averaged by month and year (December, 1989 through April, 2004).

not include rigs drilling for coalbed methane. The higher prices for natural gas, and to a lesser extent higher prices for crude oil, are responsible for the improved rig count. Average monthly prices for natural gas have been above $3.00 per MCF since November, 2002 (**Table 5**) and average monthly oil prices have been above $20.00 per barrel since March, 2002 (**Table 3**).

Exploration and development

Company data, news releases, and information compiled and published by Petroleum Information / Dwights LLC. are used to track oil and gas exploration and development activity in Wyoming. **Table 10** reports the most significant activities exclusive of CBM (see the **Coalbed Methane Update** for development in the industry) during the fourth quarter of 2003. The numbers correspond to locations on **Figure 12**.

Table 10. Significant exploration and development wells in Wyoming, fourth quarter of 2003. Number corresponds to location on Figure 12.

	Company name	Well name/number	Location	Formation tested	Depth(s) interval(s) tested	Tested prod. (per day)	Remarks
1	Chevron Production USA	6-31M Chevron-Federal	NE NE sec 31, T19N, R119W	Madison Ls.	14,276-15,041	9.4 MMCF	New producer on the northern end of Whitney Canyon-Carter Creek Field
2	EnCana Energy Resources	11-1 Reynard Unit	NW SE sec 1, T20N, R113W	Frontier Fm.	11,264-11,270	1.4 MMCF 29 BBL cond 16 BBL H_2O	Wildcat discovery
3	Cabot Oil & Gas	1-33 Mesa	SE NE sec 17, T14N, R93W	Almond Fm.	10,742-10,763 8423-13,810	2.3 MMCF 20 BBL cond 10 BBL H_2O	Southernmost producer in Lookout Wash Field area
4	Yates Petroleum	1 Bitter Creek-State	NW SE sec 16, T16N, R99W	Mesaverde Fm.	11,054-11,494	1.5 MMCF 42 BBL cond 50 BBL H_2O	New producer on northwestern flank of Bitter Creek Field
5	Anadarko Exploration & Production	12 Churchill Federal	SE SE sec 9, T17N, R100W	Dakota Ss.	11,175-11,219	265 MCF	Reestablishes production from the Dakota in Brady North Field
6	Forest Oil	3-16 West Wild Rose-State	NE NW sec 16, T17N, R95W	Almond Fm.	11,680-11,908	746 MCF 7 BBL cond 20 BBL H_2O	Wildcat discovery
7	BP America Production	17-1 Two Rim Unit	SW SW sec 17, T18N, R95W	Mesaverde Fm.	10,792-10,914 10,976-11,070	1.2 MMCF 76 BBL cond 118 BBL H_2O	New discovery in Two Rim Field area
	BP America Production	21-1 Two Rim Unit	SW SW sec 21, T18N, R95W	Mesaverde Fm.	10,770-10,911 11,050-11,125	1.0 MMCF 22 BBL cond 592 BBL H_2O	New discovery in Two Rim Field area
8	Chevron Production USA	124 Table Rock Unit	SE SE sec 3, T18N, R98W	Weber Ss.	Undisclosed interval	6.1 MMCF	New development well in Table Rock Field
9	BP America Production	19-2 Luman	NE NE sec 19, T22N, R95W	Lewis Sh. Mesaverde Fm.	9882-10,578	575 MCF 16 BBL cond 120 BBL H_2O	Wildcat discovery
	BP America Production	33-1 Lost Creek	NE SW sec 33, T23N, R95W	Mesaverde Fm.	10,785-10,936 11,025-11,040	866 MCF 11 BBL cond 48 BBL H_2O	Exploratory test
	BP America Production	4-1 Luman	SW NW sec 4, T22N, R95W	Mesaverde Fm.	10,683-10,886	418 MCF 1 BBL cond 113 BBL H_2O	Exploratory test
10	Cabot Oil & Gas	10-28 Wind Dancer Unit	C NW sec 28, T24N, R96W	Lewis Sh. Almond Fm.	10,884-10,926 10,993-11,038 11,330-11,416 11,482-11,572	3.5 MMCF 22 BBL cond	Wildcat discovery
11	Yates Petroleum	2 Luman Rim-Federal	C NE sec 35, T24N, R98W	Mesaverde Fm.	9349-10,758	2.0 MMCF 105 BBL H_2O	Wildcat discovery
12	Yates Petroleum	1 Merlin Unit	SW NE sec 27, T27N, R107W	Mesaverde Fm.	10,401-10,425	327 MCF	Wildcat discovery
13	Questar Exploration & Production	4-33 Stewart Point	NW NW sec 33, T33N, R109W	Lance Fm. Mesaverde Fm.	8832-14,428 14 intervals	10.6 MMCF 120 BBL cond 528 BBL H_2O	1 of 5 wells drilled from the same well pad on Pinedale anticline
	Questar Exploration & Production	3-33D Stewart Point	NW NW sec 33, T33N, R109W	Lance Fm. Mesaverde Fm.	8914-14,149 12 intervals	9.3 MMCF 168 BBL cond 768 BBL H_2O	2 of 5 wells drilled from the same well pad on Pinedale anticline
	Questar Exploration & Production	1-32D Stewart Point	NW NW sec 33, T33N, R109W	Lance Fm. Mesaverde Fm.	9058-14,162 13 intervals	14.7 MMCF 162 BBL cond 12 BBL H_2O	3 of 5 wells drilled from the same well pad on Pinedale anticline

Table 10 continued. Significant exploration and development wells in Wyoming, fourth quarter of 2003. Number corresponds to location on Figure 12.

	Company name	Well name/number	Location	Formation tested	Depth(s) Interval(s) tested	Tested prod. (per day)	Remarks
13	Questar Exploration & Production	14-28D Stewart Point	NW NW sec 33, T33N, R109W	Lance Fm. Mesaverde Fm.	9130-13,882 10 intervals	10.8 MMCF 216 BBL cond 672 BBL H_2O	4 of 5 wells drilled from the same well pad on Pinedale anticline
	Questar Exploration & Production	13-28D Stewart Point	NW NW sec 33, T33N, R109W	Lance Fm. Mesaverde Fm.	9000-14,098 14 intervals	13.9 MMCF 180 BBL cond 432 BBL H_2O	5 of 5 wells drilled from the same well pad on Pinedale anticline
	Questar Exploration & Production	12-21D Mesa	NW SW sec 21, T32N, R109W	Lance Fm. Mesaverde Fm.	8728-14,185 14 intervals	10.8 MMCF 48 BBL cond	New producer on Pinedale anticline
	Questar Exploration & Production	13-21D Mesa	SW SW sec 21, T32N, R109W	Lance Fm. Mesaverde Fm.	8866-13,827 14 intervals	11.5 MMCF 60 BBL cond	New producer on Pinedale anticline
	Questar Exploration & Production	14-21D Mesa	SE SW sec 21, T32N, R109W	Lance Fm. Mesaverde Fm.	8804-14,153 14 intervals	10.5 MMCF 24 BBL cond	New producer on Pinedale anticline
	Shell Rocky Mountain Production	8-3D Riverside	SE NE sec 3, T31N, R109W	Lance Fm. Mesaverde Fm.	8463-13,206 18 intervals	34.3 MMCF 126 BBL cond 227 BBL H_2O	New producer on Pinedale anticline; one of the Rocky Mountain region's highest flow rates in recent years
	Shell Rocky Mountain Production	13-3 Riverside	SW SW sec 3, T31N, R109W	Lance Fm. Mesaverde Fm.	8349-13,245 12 intervals	2.8 MMCF 41 BBL cond 51 BBL H_2O	New producer on Pinedale anticline
	Shell Rocky Mountain Production	2-24 Riverside	NW NE sec 24, T31N, R109W	Lance Fm. Mesaverde Fm.	8410-12,236 10 intervals	11.9 MMCF 114 BBL cond 939 BBL H_2O	New producer on Pinedale anticline
	Shell Rocky Mountain Production	5-33 Mesa	SW NW sec 33, T32N, R109W	Lance Fm. Mesaverde Fm.	7982-13,980 20 intervals	3.0 MMCF 36 BBL cond 473 BBL H_2O	New producer on Pinedale anticline
	Wexpro Co	14-6D Mesa Unit	SW SE sec 6, T32N, R109W	Lance Fm. Mesaverde Fm.	9132-14,671 12 intervals	12.4 MMCF 24 BBL cond	New producer on Pinedale anticline
	Wexpro Co	16-6D Mesa Unit	SE SE sec 6, T32N, R109W	Lance Fm. Mesaverde Fm.	8952-14,376 13 intervals	7.3 MMCF 72 BBL cond	New producer on Pinedale anticline
	Wexpro Co	14-17D Mesa Unit	SE SW sec 20, T32N, R109W	Lance Fm. Mesaverde Fm.	9230-14,229 13 intervals	10.0 MMCF 36 BBL cond	New producer on Pinedale anticline
	Wexpro Co	2-20 Stewart Point	NW NE sec 20, T33N, R109W	Lance Fm. Mesaverde Fm.	8503-13,561 10 intervals	8.6 MMCF 72 BBL cond	New producer on Pinedale anticline
	Ultra Petroleum	16-3 Riverside	SE SE sec 3, T31N, R109W	Lance Fm.	8227-12,886 17 intervals	10.8 MMCF 77 BBL cond 240 BBL H_2O	New producer on Pinedale anticline
	Ultra Petroleum	15-12 Riverside	SW SE sec 12, T31N, R109W	Lance Fm. Mesaverde Fm.	8252-13,098 18 intervals	10.6 MMCF 95 BBL cond 343 BBL H_2O	New producer on Pinedale anticline
	Ultra Petroleum	13-30 Rainbow	SW SW sec 30, T30N, R107W	Lance Fm. Mesaverde Fm.	8868-13,554 13 intervals	8.2 MMCF 85 BBL cond 1042 BBL H_2O	New producer on Pinedale anticline, Warbonnet area
14	Bill Barrett Corp	1-27 Federal	SW NW sec 27, T36N, R87W	Lance Fm.	6617-8620 7 intervals	804 MCF 45 BBL H_2O	Stepout in Cooper Reservoir Field
15	Bill Barrett Corp	38 Cave Gulch Unit	SE SE sec 30, T37N, R86W	Lance Fm.	5812-8916 10 intervals	9.9 MMCF 63 BBL cond 62 BBL H_2O	New producer in Waltman Field (Cave Gulch Unit)
	Bill Barrett Corp	30 Cave Gulch Unit	SE NE sec31, T37N, R86W	Lance Fm.	6856-8886 8 intervals	1.6 MMCF 135 BBL cond 120 BBL H_2O	New producer in Waltman Field (Cave Gulch Unit)
	Chevron Production USA	69 Waltman	NW NE sec 13, T36N, R87W	Lance Fm.	6788-8790 4 intervals	4.2 MMCF 84 BBL cond 81 BBL H_2O	New producer in Waltman Field
16	Burlington Resources	9-4 Big Horn	NW NE sec 4, T38N, R90W	Madison Ls.	23,910-24,190	57.0 MMCF 547 BBL H_2O	New producer of ultra-deep gas in Madden Field
17	Stone Energy Corp	1-18 Owl Creek-Federal	NW NE sec 18, T39N, R93W	Fort Union Fm. Lance Fm.	6840-6864 10,572-12,074 5 intervals	3.8 MMCF 70 BBL cond 132 BBL H_2O	Wildcat discovery, well has produced 152.9 MMCF of gas and 2166 barrels of condensate in its first four months of production[1]
18	Voyager Exploration	77-33 Silver Tip Unit	SE SE sec 33, T58N, R100W	Frontier Fm.	6041-6147	312 BBL oil 619 MCF 15 BBL H_2O	New producer in Silver Tip Field
19	Anadarko Exploration & Production	17-2 Durante	NE NE sec 17, T22N, R82W	Lewis Sh. Mesaverde Fm.	17,700		Testing potential for basin-centered, overpressured gas; expected total depth of 23,100

Abbreviations include: MCF=thousands of cubic feet of natural gas; MMCF=millions of cubic feet of natural gas; BBL=barrels; cond=condensate; H_2O=water; Ss.=Sandstone; Ls.=Limestone; Fm.=Formation; Sh.=Shale; Gp.=Group. [1]This is the obligation well for the Owl Creek Exploratory Unit, which comprises 3649 acres. *Wyoming State Geological Survey, May, 2004.*

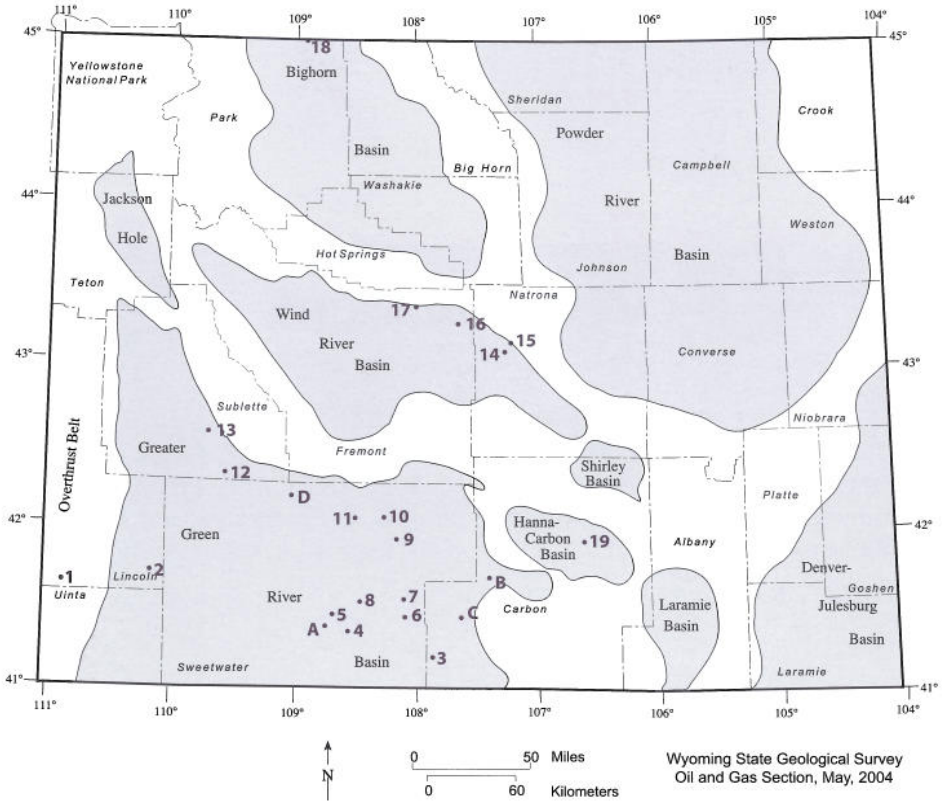


Figure 12. Oil and gas exploration and development activities in Wyoming during the fourth quarter of 2003. Numbers are those used in Table 10. Letters indicate coalbed methane developments described in the Coalbed Methane Update. Locations are approximate and may represent more than one well location or project.

Coal Update

Robert M. Lyman, Wyoming PG-656

Staff Geologist–Coal, Wyoming State Geological Survey

The year 2003 ended with yet another record for Wyoming coal, as about 376.6 million short tons were produced. The year 2004 promises to be very interesting and busy for the Wyoming coal industry. Coal prices continue to show a stable to rising tendency, and the current cost of other fossil fuels indicates that price softening for coal should not be a problem in 2004.

Healthy capital improvement budgets have been announced for several large coal mines in Wyoming's Powder River Basin (PRB); some needed improvements in the railroad joint line are also being addressed. In southern Wyoming, plans continued for developing underground coal reserves at the Bridger mine. Bridger Coal Company applied for additional coal in a federal coal lease tract with plans to mine the coal using a longwall mining system.

The fourth quarter of 2003 saw a number of coal-related activities that will carry over into the new year. The final environmental impact statement (FEIS) for federal coal lease tracts in the southern PRB was released for review, with a lease sale planned for 2004. The proposed acquisition of Triton Coal Company properties by Arch Coal came under fire from the Federal Trade Commission (FTC) at the end of 2003 and it appears that a lawsuit will be filed to block the transaction. Approval of the proposed new railroad from the PRB across South Dakota and Minnesota was delayed further in the fourth quarter as an earlier decision by the federal Surface Transportation Board (STB) was vacated by an appeals court and will require another round of regulatory review.

Production and prices

Wyoming mines produced a record of 376.6 million short tons of coal in 2003. This represented a modest increase statewide of 0.9% over 2002's production. Coal mines from the PRB produced about 363.7 million short tons or 96.6% of the total. Campbell County production only increased by about 0.4% from 2002 to 2003 while Converse County production increased about 10.2%. Overall production from the PRB was about 1.1% more than in 2002 (**Table 11**). Production was down in all areas of southern Wyoming, with a drop of almost

CALENDAR OF EVENTS

Talks

PROSPECTING FOR GEMSTONES IN WYOMING - WHERE AND HOW TO FIND AND RECOGNIZE THEM - W. Dan Hausel: Rocky Mountain Prospectors and Treasure Hunters Club: Ft. Collins, Colorado: July 7, 2004.

GEMSTONES IN THE GREEN RIVER BASIN–*W. Dan Hausel*: Rocky Mountain Prospectors and Treasure Hunters Club field trip, July 9, 2004.

DARE TO BE DIFFERENT—TALES OF GOLD SCAMS, LOST MINES, AND PROSPECTORS–*W. Dan Hausel*: Rocky Mountain Prospectors and Treasure Hunters Club, Fort Collins, Colorado, August 4, 2004.

Meetings, conferences, exhibits, etc.

2004 ROCKY MOUNTAIN SECTION AAPG MEETING AND ROCKY MOUNTAIN NATURAL GAS STRATEGY CONFERENCE AND INVESTMENT FORUM–*R.H. De Bruin, A.J. Ver Ploeg, and R.W. Jones*: Colorado Convention Center, Denver, Colorado, August 9-11, 2004.

FIRST ANNUAL COALBED NATURAL GAS RESEARCH, MONITORING, AND APPLICATIONS CONFERENCE–*various WSGS staff*: Wyoming Union, University of Wyoming, Laramie, Wyoming, August 17-19, 2004.

37TH ANNUAL DENVER GEM AND MINERAL SHOW–*various WSGS staff*: Denver Merchandise Mart, 451 E. 58th Ave, Denver, Colorado, September 17-19, 2004.

WYOMING NATURAL GAS FAIR–*R.H. De Bruin*: Snow King Resort, Jackson, Wyoming, September 23-24, 2004.

ASSOCIATION OF EARTH SCIENCE EDITORS (AESE) ANNUAL MEETING–*R.W. Jones*: The Stanley Hotel, Estes Park, Colorado, November 3-6, 2004.

THE GEOLOGICAL SOCIETY OF AMERICA (GSA) ANNUAL MEETING AND EXPOSITION–*R.W. Jones and other WSGS staff*: Colorado Convention Center, Denver, Colorado, November 7-10, 2004.

Courses and field trips

INTRODUCTION TO ArcGIS® *I*, ESRI® CERTIFIED COURSE–*J.M. Huss*: University of Wyoming, Laramie, Wyoming, August 18-19, 2004.

GOLD MINING AND GEOLOGY OF WYOMING'S PRINCIPAL GOLD DISTRICT–*W. Dan Hausel*: On this trip, we will look at classical lode (shear zone and vein), placer, and paleoplacer gold deposits and their characteristics. Rocky Mountain Prospectors and Treasure Hunters Field trip (see http://www.jymis.com/RMPTH), South Pass, Wyoming, Saturday, August 21, 2004.

GOLD, PLATINUM, PALLADIUM AND SILVER IN WYOMING–*W. Dan Hausel*: Rocky Mountain Prospectors and Treasure Hunters Club, Fort Collins, Colorado, October, 2004.

INTRODUCTION TO ArcGIS® *I*, ESRI® CERTIFIED COURSE–*J.M. Huss*: Laramie County GIS Coop, Cheyenne, Wyoming, November 12-13, 2004.

INTRODUCTION TO ArcGIS® *I*, ESRI® CERTIFIED COURSE–*J.M. Huss*: University of Wyoming, Laramie, Wyoming, November 17-18, 2004.

Table 11. Wyoming coal production by county[1,2] (in millions of short tons), from 1997 to 2003 with forecasts to 2008.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Powder River Basin												
Campbell County	246.3	274.1	294.3	299.5	329.5	332.8	334.1	337.5	340.3	343.9	347.3	350.2
Converse County	17.8	23.4	25.6	23.6	24.6	26.8	29.5	29.0	30.0	30.0	30.0	30.0
Sheridan County	M	M	M	M	0.0	0.0	0.0	M	M	M	M	M
Subtotal	264.1	297.5	319.9	323.1	354.1	359.6	363.6	366.5	370.3	373.9	377.3	380.2
Southern Wyoming												
Carbon County	5	3.5	2.7	2.0	0.5	0.7	0.3	0.3	0.3	0.5	1.0	2.0
Sweetwater County	7.8	9.2	9.4	10.0	9.5	8.6	8.5	9.0	9.0	9.0	9.0	9.0
Lincoln County	4.6	4.7	4.3	3.7	4.5	4.2	4.1	4.5	4.5	4.5	4.5	4.5
Subtotal	17.4	17.4	16.4	15.7	14.5	13.5	12.9	13.8	13.8	14.0	14.5	15.5
Total Wyoming[3]	**281.5**	**314.9**	**336.5**	**338.9**	**368.6**	**373.1**	**376.5**	**380.3**	**384.1**	**387.9**	**391.8**	**395.7**
Annual Change	**1.1%**	**11.9%**	**6.9%**	**0.7%**	**8.8%**	**1.2%**	**0.9%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**

[1]Reported tonnage from the Wyoming State Inspector of Mines (1997 through 2003). [2]County estimates by the Wyoming State Geological Survey, May, 2004 for 2004 through 2008. Totals may not agree because of independent rounding. [3]Estimate from CREG's Wyoming State Government Revenue Forecast, October, 2003. M=minor tonnage (less than a million short tons). *Wyoming State Geological Survey, Coal Section, May, 2004.*

5% from 2002 to 2003. Carbon County showed a dramatic 61.4% decline, moving from 0.7 million short tons produced in 2002 to only 0.3 million short tons in 2003. Lincoln County produced 4.1% less coal than in 2002, as production dropped from 4.2 to 4.1 million short tons. Sweetwater County's 2003 production was 8.5 million short tons, only 54,587 short tons less than in 2002.

Of the 13 mines or mining complexes in the PRB, almost half of them reported less production in 2003 than in 2002 (**Table 12**). Production from the Caballo mine was 3.2 million short tons less, the Black Thunder mine reported 2.5 million short tons less, and the Cordero Rojo complex reported 2.1 million short tons less. Production gains of 5.2, 4.3, and 2.7 million short tons were reported by the North Antelope/Rochelle complex, Jacobs Ranch, and Antelope mines, respectively. Both mines in the Hanna Basin experienced large percentage decreases in production from 2002 to 2003.

Table 12. Wyoming's coal production by mine for 2002 and 2003*.

	Mine	2002	2003	% change
Powder River Basin				
Converse County	Antelope	26,808,504	29,533,072	10.16%
Campbell County	Caballo	25,965,042	22,700,000	-12.57%
	Rawhide	3,484,619	3,632,940	4.26%
	Cordero Rojo Complex	38,231,961	36,083,745	-5.62%
	Jacobs Ranch	31,728,341	35,981,571	13.41%
	North Antelope/Rochelle Complex	74,792,642	80,083,444	7.07%
	Belle Ayr	17,452,445	17,853,928	2.30%
	Eagle Butte	24,888,124	24,549,824	-1.36%
	Black Thunder	65,125,564	62,620,297	-3.85%
	Buckskin	18,334,186	17,539,156	-4.34%
	North Rochelle	23,883,760	23,923,145	0.17%
	Dry Fork	4,891,403	4,363,683	-10.79%
	Wyodak	4,052,374	4,812,346	18.75%
	Campbell County subtotal	332,830,461	334,144,079	0.39%
	Powder River Basin subtotal	**359,638,965**	**363,677,151**	**1.12%**
Hanna Basin				
Carbon County	Medicine Bow	455,872	139,038	-69.50%
	Seminoe II	258,705	136,866	-47.01%
	Hanna Basin subtotal	**714,577**	**275,904**	**-61.39%**
Green River Basin				
Sweetwater County	Black Butte	2,817,419	2,940,330	4.36%
	Bridger Coal	5,782,014	5,604,516	-3.07%
	Green River Basin subtotal	**8,599,433**	**8,544,846**	**-0.63%**
Hams Fork Area				
Lincoln County	Kemmerer	4,242,456	4,067,346	-4.13%
Total Production		**373,195,431**	**376,565,247**	**0.90%**

*Data from 2002 and 2003 Annual Reports of the State Inspector of Mines of Wyoming. *Wyoming State Geological Survey, Coal Section, June, 2004.*

Our projected coal production for 2004 continues another modest increase of approximately 1% (**Table 11**). While some analysts are predicting stronger growth in 2004, capital projects scheduled at many of the larger PRB mines and construction scheduled on the joint railroad line out of the PRB should slow some of the anticipated growth in production until 2005. However, we are conservatively forecasting only a 1% annual growth rate from 2004 to 2008 (**Figure 13**).

As expected, monthly coal deliveries to utility companies in the fourth quarter of 2003 were about as high as they have been all year (**Table 13** and **Figure 14**), but the big surge in spot coal that was expected at the end of the year did not materialize (**Figure 15**). Contract coal deliveries did pick up the slack, remaining at high levels throughout the quarter as utility companies prepared for the winter. The usual decrease in coal deliveries in early fall did not occur in 2003 (**Figure 15**).

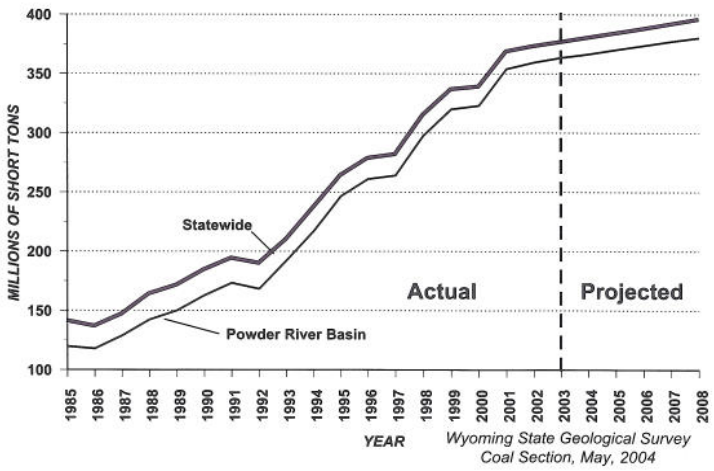


Figure 13. Annual coal production from Wyoming and the Powder River Basin (1985 through 2003) with forecasts to 2008. Sources: Wyoming State Inspector of Mines (1985 through 2003), CREG (2004 through 2008), and the Wyoming State Geological Survey.

Table 13. Estimated monthly coal deliveries from Wyoming's mines in short tons (1999 through December, 2003).

	1999		2000		2001		2002		2003	
	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative
January	27,105,791	27,105,791	27,773,610	27,773,610	27,743,000	27,743,000	28,406,666	28,406,666	31,450,642	31,450,642
February	25,803,390	52,909,181	25,594,109	53,367,719	27,827,000	55,570,000	30,041,748	58,448,414	28,113,877	59,564,519
March	28,222,743	81,131,923	28,262,696	81,630,415	33,739,000	89,309,000	33,409,797	91,858,211	30,310,040	89,874,559
April	25,965,867	107,097,791	25,549,039	107,179,454	27,302,000	116,611,000	27,534,057	119,392,268	30,656,600	120,531,159
May	28,698,498	135,796,288	26,222,515	133,401,969	27,752,000	144,363,000	34,704,299	154,096,567	31,631,441	152,144,600
June	24,753,829	160,550,118	25,085,516	158,487,485	33,968,000	178,331,000	26,674,488	180,771,055	30,797,925	182,942,525
July	28,266,458	188,816,576	28,881,862	187,369,348	29,200,000	207,531,000	27,885,210	208,656,265	31,608,733	214,551,258
August	28,346,757	217,163,333	29,075,295	216,444,642	27,662,000	235,193,000	35,670,535	244,326,800	32,402,820	246,954,078
September	27,373,417	244,536,749	25,865,389	242,310,032	35,369,000	270,562,000	32,234,471	276,561,271	32,169,561	279,123,639
October	26,837,296	271,374,045	26,441,615	268,751,646	29,869,000	300,431,000	26,101,957	302,663,228	32,983,610	312,107,249
November	26,843,021	298,217,066	27,400,246	296,151,892	29,308,000	329,739,000	32,767,619	335,430,847	31,132,084	343,239,333
December	26,834,927	325,051,993	28,300,773	324,452,665	29,984,000	359,723,000	26,476,240	361,907,087	32,362,439	375,601,772
Total Utility Tonnage[1]		**325,051,993**		**324,452,665**		**359,723,000**		**361,907,087**		**375,601,772**
Total Tonnage Other[2]		**11,407,945**		**14,399,483**		**8,955,135**		**11,288,344**		**963,475**
Total Tonnage Produced[3]		**336,459,938**		**338,852,148**		**368,678,135**		**373,195,431**		**376,565,247**

[1]From Federal Energy Regulatory Commission (FERC) Form 423 for 1998; FERC Form 423 as modified by WSGS for 1999 through October, 2003. [2]Includes estimates of a residential, industrial, and exported coal. [3]Wyoming State Mine Inspector's Annual Reports. *Wyoming State Geological Survey, Coal Section, May, 2004.*

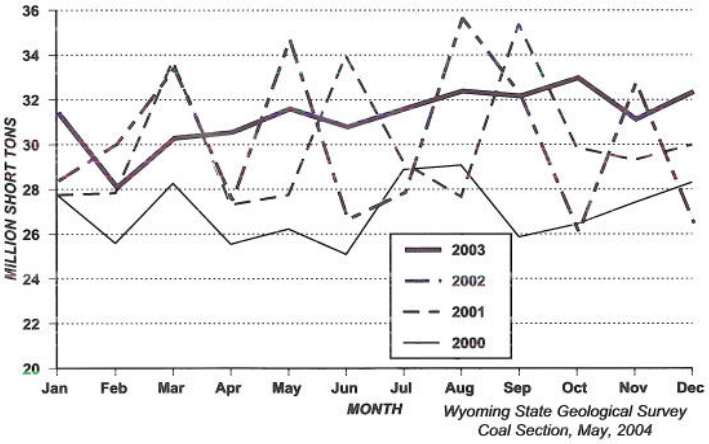


Figure 14. Reported monthly deliveries from Wyoming coal mines (January, 2000 through December, 2003). From Form 423 of the Federal Energy Regulatory Commission (FERC) as modified by the Wyoming State Geological Survey.

Spot market prices for 8400-Btu coal began 2003 selling for $5.05 per ton. By mid-year, the price had leveled out to $5.00 per ton, and finished the year at approximately $5.41 per ton (**Figure 16**). By the end of March, 2004, the lower-Btu spot product was moving at $5.70 per ton, up from $5.16 per ton at the same time a year ago. Average spot prices for 8800-Btu PRB coal began 2003 at $6.07 per ton and averaged $6.38 per ton at the close of the year. By the end of March, 2004, the higher-Btu product had reached nearly $7.32 per ton compared to $6.18 per ton a year earlier (**Figure 16**).

With the price of southern Wyoming coal remaining relatively stable, the increased prices received for coal from the PRB in 2003 will cause the overall price of Wyoming coal to increase (**Table 1**). Although it is probably too early to accurately predict the price of Wyoming coal in 2004, the gains seen in spot coal prices so far, coupled with the strong prices for other fuels burned by electric utility companies, may require revising our previous estimate (**Table 1**).

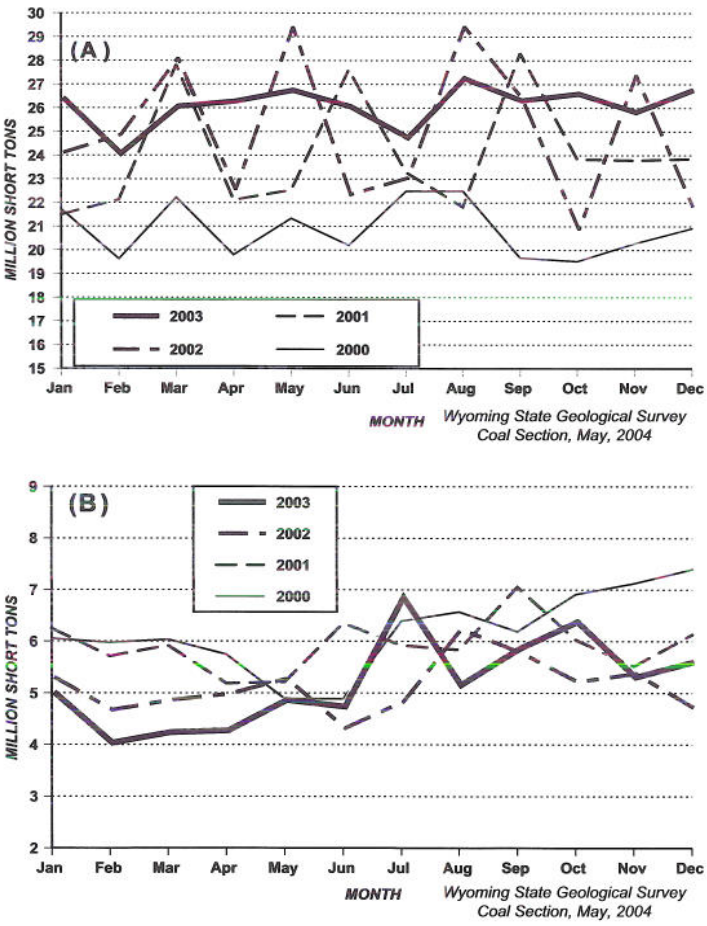


Figure 15. Monthly coal deliveries from Wyoming (January, 2000 through December, 2003). (A) Coal sold on contract and (B) coal sold on the spot market. From Form 423 of the Federal Energy Regulatory Commission (FERC) as modified by the Wyoming State Geological Survey.

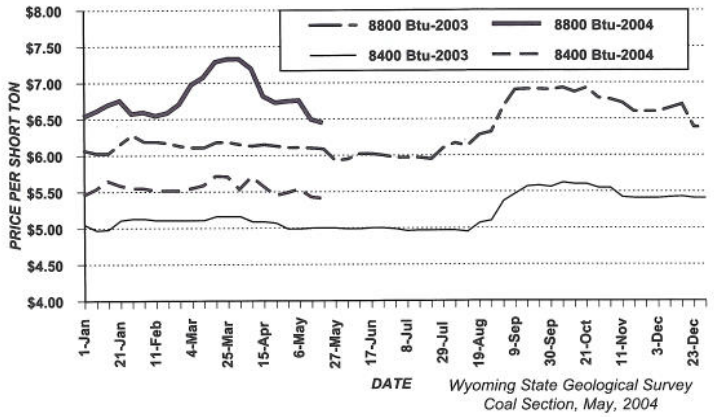


Figure 16. Wyoming Powder River Basin coal spot price watch (January 1, 2003 through May 24, 2004). Modified from Coal Daily's spot market index and U.S. Coal Review's spot market price index.

Developments in the Powder River Basin

The FTC will file a lawsuit in federal district court to block Arch Coal's proposed acquisition of Triton Coal Company. The lengthy FTC investigation started following Arch's May 29, 2003 announcement that the two coal companies had signed a definitive agreement calling for Arch to acquire all the equity of Triton for a price of $364 million.

One of the FTC's primary reasons for opposing the transaction was their concern that almost 86% of the annual Wyoming PRB coal production would then be concentrated in the hands of only three companies (Arch, Peabody, and Kennecott), significantly increasing the possibility of anti-competitive behavior. The FTC's decision to file the lawsuit was made despite the fact that on January 30, 2004, Arch entered into an agreement to sell the Buckskin mine to Kiewit Mining Acquisition for $82 million, contingent on the closing of the Triton deal (Coal Age, 5/2004).

The FTC vs. Arch lawsuit seems to fly in the face of the results of the Department of Justice investigation into possible anticompetitive practices in the coal industry which took place less than two years ago. That investigation looked primarily at coal operators in the PRB and resulted in no companies being charged. Despite the lawsuit, Arch appears ready to move ahead with their acquisition plans, and expects to have the FTC's case go to court as early as this summer (COAL Daily, 3/31/2004).

Kennecott Energy has divested its 49% share of Kfx Inc. in exchange for an additional 66% equity interest in Pegasus Technologies Inc. Formerly a Kfx subsidiary, Pegasus sells Neusight software designed to both increase boiler efficiency and better control NO_x emissions at coal-fired power plants. Kennecott and Kfx have decided to focus on different aspects of coal technology. Kennecott will focus on their long-term coal-related research efforts on projects like FutureGen that feature gasification combined with sequestration and carbon capture. For several years, Kfx and Kennecott have been pursuing joint development of a proposed 3-million-short-ton-per-year K-Fuel production facility in Campbell County (COAL Daily, 12/16/2003).

Kennecott Energy announced it would invest $32.8 million in 2004 for capital improvements at their Cordero Rojo and Antelope mines. Most of the capital will fund the purchase of a 77-cubic-yard shovel, 11 haul trucks, and associated support equipment. The shovel will be placed at Antelope, where it will be used to tackle the increasing overburden. The trucks will be used at Cordero Rojo in conjunction with a used 35-cubic-yard shovel that will be relocated from Antelope. Cordero Rojo has been troubled by highwall and spoil-stability problems since late 2002. The shovel will be used to pre-strip the uppermost overburden, which will reduce highwall heights and provide more stability in the resultant benches (COAL Daily, 1/5/2004).

The Wyoming Department of Environmental Quality gave Kennecott Energy permission to reduce its bond requirement at the Cordero Rojo mine complex. Kennecott gained a release of $1.4 million of the total $69.4 million bond for reclaimed land at the mine. The release acknowledges reclamation work completed on 932 acres. In August, the company applied for and later received a bond release on an additional 1535 acres (COAL Daily, 1/30/2004).

The German firm RAG Coal International is negotiating the sale of its RAG American Coal subsidiary to a consortium that includes First Reserve Corp., the Blackstone Group, and American Metals and Coal International. Included in the proposed sale are the Belle Ayr and Eagle Butte mines in the PRB (COAL Daily, 2/17/2004).

The U.S. Bureau of Land Management (BLM) has made available for review the South Powder River Basin Coal FEIS. Comments were to be made by January 23, 2004. It is the first time the BLM has done a single analysis on multiple coal lease tracts. The five tracts included in the FEIS are: NARO North, NARO South, Little Thunder, West Roundup, and West Antelope. In total, the five LBA tracts consist of nearly 16,000 acres of land containing just less than 1.5 billion short tons of recoverable coal.

Peabody Energy's Powder River Coal Company applied for the leases on the NARO North and NARO South tracts, which lie adjacent to their North Antelope/Rochelle mining complex. According to BLM's preferred alternative, the two tracts would consist of 5326 acres containing 577.3 million short tons of recoverable coal. Ark Land, a subsidiary of Arch Coal, applied for the Little Thunder tract, which is adjacent to their Black Thunder mine. The BLM FEIS shows that the proposed lease area encompasses 5084 acres and holds an estimated 533 million short tons of recoverable coal. Triton Coal applied for the West Roundup tract as a maintenance tract for their North Rochelle mine. The BLM is offering an area of 2653 acres underlain by an estimated 214 million short tons of recoverable coal. Kennecott Energy applied for the West Antelope lease through their Antelope Coal unit. Originally the company nominated an area of 3542 acres containing 294 million short tons of recoverable coal. However the BLM prefers to lease just 2809 acres with an estimated 170.4 million short tons of recoverable coal (U.S. Coal Review, 1/12/2004).

Developments in southern Wyoming

Bridger Coal Company, with its planned development of a longwall underground mine, has applied to BLM for 44 million short tons of additional recoverable federal coal in the Ten Mile Rift tract. The additional deep reserves would add between 10 and 15 years of fuel supply to the adjacent Jim Bridger power plant east of Rock Springs. Since the Jim Bridger surface mine first opened in 1971, about 170 million short tons of coal have been mined to fuel the power plant.

The federal coal in the Ten Mile Rift tract will be sold using BLM's competitive-bid auction procedures. A reserve block of roughly 122 million short tons in place in a logical mining unit (LMU) would be necessary to achieve a 15- to 20-year supply of coal. Ownership of these needed reserves in the LMU are distributed in a checkerboard pattern of mixed federal, state, and private ownership, making the use of federal lands a requirement to develop the new mine (COAL Daily, 2/11/2004). Although no starting date for underground operations has been announced, the new longwall should, at full production, produce nearly 5.5 million short tons annually.

Transportation developments

At the end of the first quarter of 2004, the Union Pacific Railroad (UP) will begin a major change in its western coal transportation pricing practices for coal shipped from the southern PRB area in Wyoming. The new pricing plan will allow current and prospective customers two contract options for coal movements to specific destinations, a spot-market option and a three-year commitment option. Both options will include a fuel surcharge clause. For the three-year option and its incrementally lower rates, shippers would pay $3 per ton for any shortfalls if the volume of commitment is not met over any 12-month period. UP said it would share the rate items only with customers who are eligible to ship under the program, which is detailed at http://www.uprr.com/customers/energy/coal/circulars.shtml (COAL Daily, 3/15/2004).

The UP and Burlington Northern Santa Fe (BNSF) railroads have begun construction of a 14.1-mile segment to connect two triple track sections of their joint line. The two-year, $38 million project will be completed with the laying of new track in 2005. In 2004, $10 million will be spent on grading, reconstruction of Shawnee Junction, and construction of signal bridges (Casper Star-Tribune, 4/27/2004).

Dynegy Illinois reportedly has switched its coal transportation rail service from UP to BNSF beginning in 2004. An estimated $80 to $90 million of revenue are expected to change hands between the two railroads that serve PRB coal mines. This transaction is one of the largest known rail contract changes in recent history. The news that such competitive bidding still exists should be encouraging to coal customers with access to multiple rail carriers. Captive coal shippers may be concerned that their carrier could raise rail rates to make up for profits lost to these new lower-margin contracts (COAL Daily, 10/3/2003).

The news that such competitive bidding still exists should be encouraging to coal customers with access to multiple rail carriers.

On October 2, 2003, the U.S. Court of Appeals for the 8th Circuit delayed plans for the Dakota, Minnesota & Eastern Railroad (DM&E) expansion into the PRB (**Figure 17**). The court's decision vacated the STB's January, 2002 decision to approve the project, and forces another round of regulatory review. Among the issues the STB must now readdress are the project's effects on towns impacted by the rail line and the overall impact the railroad would have on the environment. The court also said, "We believe that it would be irresponsible for the Board to approve a project of this scope without first examining the effects that may occur as a result of the reasonably foreseeable increase in coal consumption" (COAL Daily, 10/6/2004).

The above statement reflects the fear of the environmental lobby that the project would increase the country's reliance on the PRB's low-sulfur coal. It appears that some citizens would rather be held ransom by South American coal or OPEC imports for their energy needs. Officials with the DM&E have pushed back their expansion plans by several years. Upon receiving the STB's initial approval, the railroad had hoped to ramp up construction as soon as early 2004 with completion targeted by early 2007.

MEMCO Barge Lines has signed a five-year contract with American Electric Power to barge coal to Indiana-Kentucky Electric's Clifty Creek power plant beginning in early 2004. Three million short tons of the expected 4 million short tons shipped annually will originate from the PRB and will be loaded onto barges at Kinder Morgan's Cora Coal Terminal on the upper Mississippi River. The remaining coal will be sourced by Appalachian suppliers (U.S. Coal Review, 1/12/2004).

Regulatory developments

Wyoming was among five states, along with the City of Albuquerque, who submitted air quality plans to the U.S. Environmental Protection Agency (EPA) this past December designed to reduce haze over federally protected Class I areas, such as national parks and wilderness areas. The states of Arizona, New Mexico, Oregon, Utah, and Wyoming are members of the Western Regional Air Partnership (WRAP) who have taken advantage of an option in the federal rules that allows certain states to implement recommendations of the Grand Canyon Visibility Transport Commission (GCVTC) to reduce haze.

The GCVTC's recommendations were issued in 1996 and identified strategies that were incorporated into the federal

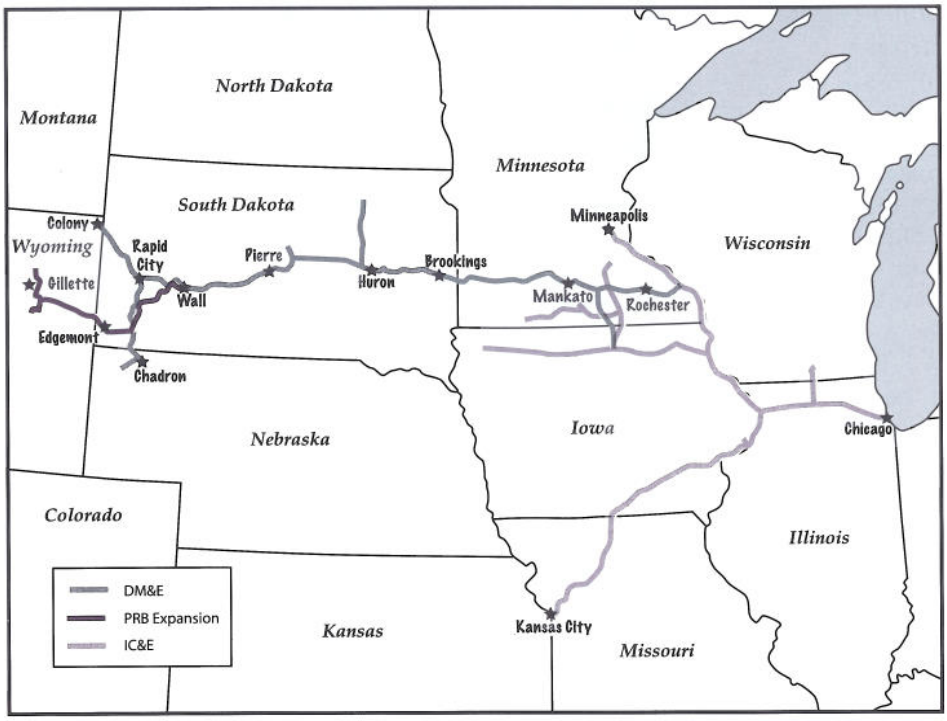


Figure 17. Index map of the Dakota, Minnesota & Eastern Railroad (DM&E) with the location of the proposed new line into the Powder River Basin, Wyoming (purple). The lighter purple line indicates the Iowa, Chicago & Eastern Railroad which was acquired by DM&E. Modified from systems map on DM&E's web site (http://www.dmerail.com).

Regional Haze Rule. To qualify for this option, western states were required to submit their plans by the end of 2003. These plans include strategies to reduce smoke from prescribed fires, increase the use of renewable energy, and increase energy efficiency. The key element of each states' plan is a strategy to reduce SO_2 emissions from major industrial sources such as coal-fired plants, smelters, and refineries. The plans institute a regional cap on SO_2 emissions in the five states by limiting the tons of SO_2 that can be emitted annually by industrial sources (U.S. Coal Review, 1/12/2004).

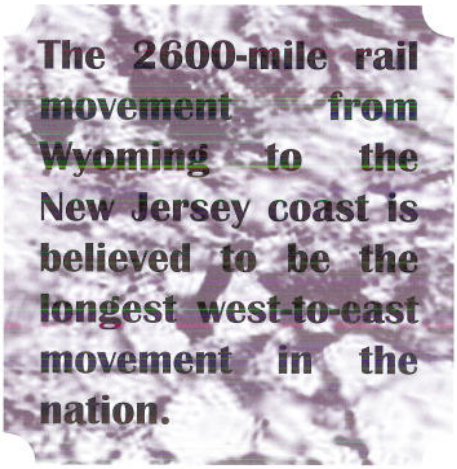
Wyoming led the nation in royalty payments from the U.S. Department of the Interior's Minerals Management Service. In 2003, the state received $503 million, nearly half of all payments made to the states under the program. In all, 36 states received a combined $1.1 billion in payments. The payments represent each state's cumulative share of revenues collected from mineral production on federal lands located within its borders and from federal offshore oil and gas tracts adjacent to the U.S. coast. Coal royalties accounted for approximately 23% of the total on-shore payments (COAL Daily, 2/18/2004).

Wyoming led the nation in royalty payments from the U.S. Department of the Interior's Minerals Management Service. In 2003, the state received $503 million...

An important part of the proposed federally funded research into clean coal technology in the coming decade will address the increased concern about carbon dioxide (CO_2) emissions and their impact on the environment (Coal Daily, 12/1/2003). Burning fossil fuels such as coal, natural gas, and petroleum-related fuels (jet fuel, gasoline, diesel) releases CO_2 as well as other by-products of combustion. CO_2 is thought to be a major contributor to the greenhouse effect known as global warming. Carbon sequestration involves the separation of CO_2 from combustion gases created by burning fossil fuels and then storing the CO_2. This concept has emerged in recent years as a popular solution to the environmental challenge of burning coal (and other fossil fuels) to generate electricity on a large scale.

One of the biggest questions posed by sequestration is what to do with the CO_2 once it has been removed. The oil industry has been using liquefied CO_2 to enhance oil production after other secondary recovery methods have been used in aging oil fields. Other options currently under study are storing CO_2 in geologic formations or injecting it into deep ocean sinks. In the former option, current researchers believe that target geological formations would need to be at least 2625 feet (800 m) beneath the surface. Some of the best targets would include depleted oil and gas reservoirs, unmineable coal beds, coal beds depleted in coalbed methane, and salt domes.

Market developments and opportunities



Coal producers in the PRB of Wyoming and Montana have made test shipments to Pacific Rim customers in Asia through Westshore Terminals at the Port of Vancouver, British Columbia, Canada. The use of Westshore to ship U.S. coal to the Pacific Rim market is a new twist on efforts to access the growing Asian demand (COAL Daily, 2/2/2004). Typical 8800-Btu coal from the PRB is priced around $30 to $32 per short ton, or about $29 per metric ton (mt), FOB Port of Westshore Terminals. With freight to Japan costing another $24.50 per mt, the delivered price is about $55 per mt. Although PRB coal delivered to many Pacific nations will be more expensive than comparable Indonesian coal, the Pacific nations are buying the cargoes as a hedge against supply disruption (COAL Daily, 3/8/2004).

Norfolk Southern announced it has partnered with UP to move PRB coal on a term basis from Wyoming to Conectiv Energy's B. L. England power plant, located at Beesley's Point near Atlantic City, New Jersey. The 2600-mile rail movement from Wyoming to the New Jersey coast is believed to be the longest west-to-east coal movement in the nation. Conectiv will be blending the PRB coal with Pittsburgh Seam coal originating on Norfolk Southern's Monongahela Railway south of Pittsburgh. This allows the power plant to reduce SO_2 emissions in an environmentally sensitive area on the east coast. The shipments will involve about 100,000 short tons of PRB coal annually (COAL Daily, 3/2/2004).

Tucson Electric Power (TEP) and Tri-State Generation and Transmission announced that they have secured financing to begin construction of a new coal-fired unit at TEP's Springerville plant in Arizona. The new 400-megawatt (MW) unit is designed to deliver 200 MW to customers in Colorado and New Mexico; Tri-State will lease the remaining 200 MW to TEP and Salt River Project. The new unit will be fueled by coal from Peabody Energy's Lee Ranch mine in New Mexico and the Antelope/Rochelle mine complex in Wyoming (COAL Daily, 10/22/2003).

Independent power producer LS Power Associates announced that they had received the necessary permits to begin construction of a new coal-fired power plant located on the Mississippi River near the town of Osceola, Arkansas. LS Power intends to break ground on their new Plum Point Energy Station in 2004 and hopes to have the 800-MW plant on line sometime in 2008. The new coal-fired plant is planning to burn low-sulfur PRB coal (COAL Daily, 10/29/2003).

Table 14 tabulates some of the contract, spot sales, test burns, and solicitations for Wyoming coal announced during the fourth quarter of 2003.

References cited

Federal Energy Regulatory Commission (FERC) Electric Form 423 (http://www.ferc.fed.us/electric/f423/form423.htm).

Stauffenberg, D.G., 2003, Annual report of the State Inspector of Mines of Wyoming for the year ending December 31, 2003: Office of the State Inspector of Mines, Rock Springs, 88 p.

Table 14. Marketing activities for Wyoming coal producers during the fourth quarter of 2003*.

Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
City of Ames, Iowa	Ames	PRB	So	290,000 t/y	For five years beginning in September, 2004
Consumers Energy	System	PRB	So	Up to 700,000 t	Delivery in second quarter of 2004
Dairyland Power	System	PRB	C	Up to 1.85 mt	Delivery in 2004
Southern Company Services	Scherer	All w/ BNSF access	So	Up to 1.5 mt	Delivery in 2004
Southern Company Services	Scherer	All w/ BNSF access	So	1.5 to 3 mt	Up to 1.5 mt in 2004; up to 3 mt in 2005-2006
Southern Company Services	Scherer	PRB	C	11 mt	Up to 1.5 mt in 2004; up to 3 mt/y in 2005-2008
Tennessee Valley Authority	System	Black Thunder/PRB	C	3 mt/y	For 10 years beginning in January, 2004
Tucson Electric Power	Springerville	North Antelope Rochelle/PRB	C	51.5 mt	Over 15 years; split with coal from Lee Ranch mine in New Mexico for first 10 years.
Westar Energy	Lawrence & Tecumseh	PRB	So	3 mt/y, option of additional 500,000 t	For 2005 through 2007 with possible extension through 2010

*Data obtained from: Coal Outlook, COAL Daily, U.S. Coal Review, FERC database, and personal contacts. Note: BNSF = Burlington Northern Santa Fe Railroad; C = contract; mt = million short tons; mt/y = million short tons per year; PRB = Powder River Basin; So = solicitation; t = short tons; t/y = short tons per year. *Wyoming State Geological Survey, Coal Section, May, 2004.*

Coalbed Methane Update

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Coalbed methane (CBM) production reported by the Wyoming Oil and Gas Conservation Commission (WOGCC) for 2003 was 348.2 billion cubic feet (BCF), with all but 2.2 BCF from the Powder River Basin (PRB) Coal Field. CBM production from the PRB has declined since reaching its peak October, 2003 and further decreases are expected in 2004. Production from mature areas of the play, especially on the east side of the PRB, is now declining faster than expected. Drilling permits from the U.S. Bureau of Land Management (BLM) are being issued at a slower than expected rate and challenges from opposition groups are slowing down the pace of development. On a more positive note, the BLM has approved a number of CBM projects in the Atlantic Rim area of southern Wyoming.

Production

The WOGCC reported 12,196 producing and 4065 shut-in CBM wells across Wyoming at the end of 2003. Production in the PRB in 2003 was 346.0 BCF, up 5.8% from production in 2002 (**Table 15**). Statewide production for 2003 averaged 29.0 BCF per month, up 6.2% from the average in 2002 (**Tables 15** and **16**). CBM accounted for 19.0% of Wyoming's total natural gas production in 2003. CBM production from the PRB is once again declining after peaking at 977 MMCF of gas per day in October, 2003; daily production in December, 2003 was only about 943 MMCF. Indications are that production rates may fall further in 2004. A more detailed discussion and analysis of this situation appears in the *Overview* article at the beginning of this issue of *Wyoming Geo-notes*.

CBM production from the PRB is once again declining after peaking at 977 MMCF of gas per day in October, 2003...

Acquisitions

Kestrel Energy will farm out 30,000 acres in the Greater Green River Basin (GGRB) to Sun Delta Inc. and Victoria Petroleum USA for exploration and development of CBM resources. The agreement calls for spending up to $3 million over the next four years to include a pilot project that will hopefully lead to the development of the Big Red coal zone in the Fort Union Formation and other coal beds located in the farmout area.

Activities

The BLM issued a finding of no significant impact (FONSI) for a shallow gas program planned by Anadarko Exploration & Production on the western flank of the Washakie Basin in Ts16 to 17N, Rs100 to 101W (**location A, Figure 12**). The Cooper Ridge project area covers about 25,000 acres, including about 11,565 acres of public land. The project area overlies Brady and Jackknife Springs fields that have been developed for oil and gas. Anadarko proposes to drill a maximum of 89 wells on 160-acre spacing that will target sandstone reservoirs and coal beds in the Almond Formation of the Mesaverde Group (Upper Cretaceous) at depths from 2000 to 4500 feet. Drilling is expected to last two to

Table 15. Monthly Powder River Basin coalbed methane production in million cubic feet (MCF) (1999 through December, 2003).

	1999		2000		2001		2002		2003	
	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative
January	3,660,420	3,660,420	8,465,248	8,465,248	18,216,791	18,216,791	25,814,734	25,814,734	29,491,004	29,491,004
February	3,462,675	7,123,095	8,706,458	17,171,706	16,918,619	35,135,410	23,380,195	49,194,929	26,450,759	55,941,763
March	4,110,431	11,233,526	9,864,450	27,036,156	19,824,513	54,959,923	26,045,128	75,240,057	28,972,661	84,914,424
April	4,040,981	15,274,507	10,549,945	37,586,101	19,699,644	74,659,567	25,383,973	100,624,030	27,992,881	112,907,305
May	4,422,524	19,697,031	11,824,542	49,410,643	20,714,721	95,374,288	27,268,027	127,892,057	28,819,962	141,727,267
June	4,605,477	24,302,508	12,196,467	61,607,110	20,516,641	115,890,929	26,372,024	154,264,081	28,218,733	169,946,000
July	4,877,860	29,180,368	13,031,976	74,639,086	21,843,289	137,734,218	27,919,362	182,183,443	29,028,155	198,974,155
August	4,793,060	33,973,428	14,185,648	88,824,734	22,402,964	160,137,182	28,666,892	210,850,335	29,862,075	228,836,230
September	5,125,791	39,099,219	14,403,249	103,227,983	21,652,656	181,789,838	28,208,254	239,058,589	29,290,319	258,126,549
October	5,961,184	45,060,403	15,396,043	118,624,026	24,103,492	205,893,330	29,244,072	268,302,661	30,287,206	288,413,755
November	5,947,893	51,008,296	15,233,376	133,857,402	24,092,741	229,986,071	28,980,587	297,283,248	28,358,292	316,722,047
December	7,180,697	58,188,993	16,903,406	150,760,808	25,697,131	255,683,202	29,707,016	326,990,264	29,225,939	345,997,986
Total		58,188,993		150,760,808		255,683,202		326,990,264		345,997,986

Data from the Wyoming Oil and Gas Conservation Commission. MCF = thousands of cubic feet. *Wyoming State Geological Survey, May, 2004.*

Table 16. Other Wyoming coalbed methane production in million cubic feet (MCF) (2000 through December, 2003).

	2000		2001		2002		2003	
	monthly	cumulative	monthly	cumulative	monthly	cumulative	monthly	cumulative
January	31	31	1,594	1,594	21,118	21,118	123,681	123,681
February	119	150	1,982	3,576	12,069	33,187	115,247	238,928
March	167	317	2,486	6,062	6,737	39,924	162,466	401,394
April	366	683	2,738	8,800	6,713	46,637	157,434	558,828
May	637	1,320	4,255	13,055	8,640	55,277	179,883	738,711
Jun	1,494	2,814	5,149	18,204	32,691	87,968	177,829	916,540
July	992	3,806	5,453	23,657	39,716	127,684	213,937	1,130,477
August	1,417	5,223	3,329	26,986	52,391	180,075	214,106	1,344,583
September	1,459	6,682	2,993	29,979	69,082	249,157	220,629	1,565,212
October	1,165	7,847	2,667	32,646	71,672	320,829	221,578	1,786,790
November	1,335	9,182	4,434	37,080	77,640	398,469	186,793	1,973,583
December	1,317	10,499	39,232	76,312	99,629	498,098	203,161	2,176,744
Total		10,499		76,312		498,098		2,176,744

Data from the Wyoming Oil and Gas Conservation Commission. MCF = thousands of cubic feet. *Wyoming State Geological Survey, May, 2004.*

four years, with a projected producing life of 15 to 20 years.

The BLM issued a FONSI for the Red Rim exploration project proposed by Anadarko and Warren Exploration & Production. The project is located in T20N, R89W (**location B, Figure 12**) and is one of nine areas proposed for exploratory drilling to provide information that will be used in preparing the environmental impact statement (EIS) for the Atlantic Rim natural gas project. The project consists of drilling and producing eight exploratory wells, testing and operating eight existing exploratory wells, and utilizing two injection wells and a compressor station. Access roads, utilities, flow lines, and other production facilities are included in the project. Drilling targets are coal beds in the Almond Formation, Pine Ridge Sandstone, and Allen Ridge Formation, all part of the Mesaverde Group, at depths from 2880 to 5390 feet. The estimated life of the project is 10 to 20 years. In 2002, Anadarko and Warren created an area of mutual interest that covers about 211,000 acres in the Washakie Basin (southeastern part of GGRB) to jointly explore and develop CBM resources in the Atlantic Rim area.

...delays in developing overall CBM production...and higher than expected rates of decline...caused [Northern Border Partners] to reduce its long-term outlook.

The BLM also issued a FONSI for the Doty Mountain CBM project proposed by Anadarko, Warren, and Double Eagle Petroleum. The area is in T17N, R91W (**location C, Figure 12**) and is another of nine areas proposed for exploratory drilling in support of the Atlantic Rim EIS mentioned above. This project will target Mesaverde Group coal beds and includes drilling, completing, and producing 24 exploratory CBM wells, utilizing two deep water-injection wells, constructing new access roads and facilities, and developing production facilities. The life of the project is estimated at 10 to 20 years.

Kerr-McGee applied for permits to drill two Fort Union Formation wildcat wells in the Jack Morrow Hills area. One well will be drilled in NW SE section 36, T26N, R103W, to 5500 feet and the other well will be drilled in SE NW section 16, T25N, R102W, to 3900 feet (**location D, Figure 12**). Kerr-McGee drilled a stratigraphic test at the second location late in 2003 that targeted the Fort Union, with net coal thicknesses of 100 to 150 feet in the area.

The BLM State Director for Wyoming remanded an environmental assessment (EA) to the Buffalo Field Office. This action vacated the field office's decision to approve operations connected with 18 CBM wells and will result in better documentation of the analysis, according to the BLM. Pennaco Energy (Marathon Oil) applied for permits to drill 18 wells in August, 2002. After completion of the EA, the BLM approved the permits in September, 2003; the State Director reviewed and then remanded the EA in early January, 2004. The groups requesting the review included the Powder River Basin Resource Council and several of its members.

In a related item, Northern Border Partners will record non-cash charges of approximately $219 million to reflect asset and goodwill impairments for its natural gas gathering and processing business segment. The impairment analyses involve long-term forecasting of the partnership's gathering and processing business, particularly in the CBM play of the PRB. Northern Border concluded that delays in developing overall CBM production by PRB producers, and higher than expected rates of decline in the mature development area of the PRB, caused the partnership to reduce its long-term outlook. Many of the recent delays in developing CBM production in the PRB can be related to the increased amount of red tape that producers have to cut through in order to get a drilling permit from the BLM, the slow rate of approvals by the BLM for those permits despite increased staff in the Buffalo Field Office, and opposition in the form of lawsuits and other delay tactics from groups opposed to development.

Industrial Minerals and Uranium Update

Ray E. Harris, Wyoming PG-46

Senior Staff Geologist–Industrial Minerals and Uranium, Wyoming State Geological Survey

The production of the major industrial minerals in Wyoming remained mostly steady in 2003. Some commodities increased in production, and some decreased slightly. Production of trona, the most valuable commodity, increased slightly. Uranium continued to be produced at two *in situ* localities in Wyoming but the amount produced decreased from 1.4 to 1.2 million pounds of yellowcake. However, the price of yellowcake increased from $14.50 per pound at the end of 2003 to $17.75 at the end of May, 2004. The number of inquiries to the Industrial Minerals and Uranium Section at the Wyoming State Geological Survey (WSGS) regarding reopening uranium mines or locating new deposits began to increase by the end of 2003. In response to these inquires, the section is beginning a new uranium database and map in the summer, 2004.

Bentonite

Bentonite production increased from 3.6 million short tons in 2002 to 3.8 million short tons in 2003. Seven companies operate 13 plants in Wyoming (**Figure 18**). At each operation, bentonite of different properties is mined from separate pits and hauled to a mill, where it is blended into products of consistent quality.

Construction aggregate

Wyoming's construction aggregate production declined about 14% from 17.2 million short tons in 2002 to 15.1 million short tons in 2003. However, statistics for construction aggregate, along with other industrial minerals, have to be viewed in the light of intermittent production. With low-cost commodities, transportation, mining, and processing costs are more critical than the raw cost of the material in the quarry. Aggregate producers minimize their costs by quarrying a lot of material at one time, then stockpiling it for later use. For tax purposes, production is reported as the material leaves the quarry, so actual mined and stockpiled production is not reported annually, just the product used. Averaging production over a period of five years probably gives a better picture of production trends. **Figure 19** shows material quarried at Plumbago Creek in late 2003, stockpiled in a currently inactive pit. Construction aggregate production for 2004 will be about the same as the previous two years, considering stockpiling provisions.

Decorative and dimensional stone

Strid Marble and Granite of Cheyenne operates a dimensional sandstone quarry southeast of Rawlins (**Figure 18**). The stone that faces the Union Pacific Railroad Depot in Ogden, Utah; the old Wyoming State Penitentiary; some buildings on the University of Wyoming campus; some of the Wyoming State Capitol Building (**Figure 20**); and probably others, came from this quarry.

Moss rock, flagstone, and fieldstone are sold regionally to markets in the Wasatch front of Utah and the Front Range and developing ski towns of Colorado. Some stone has been sold as far away as California and Chicago. There

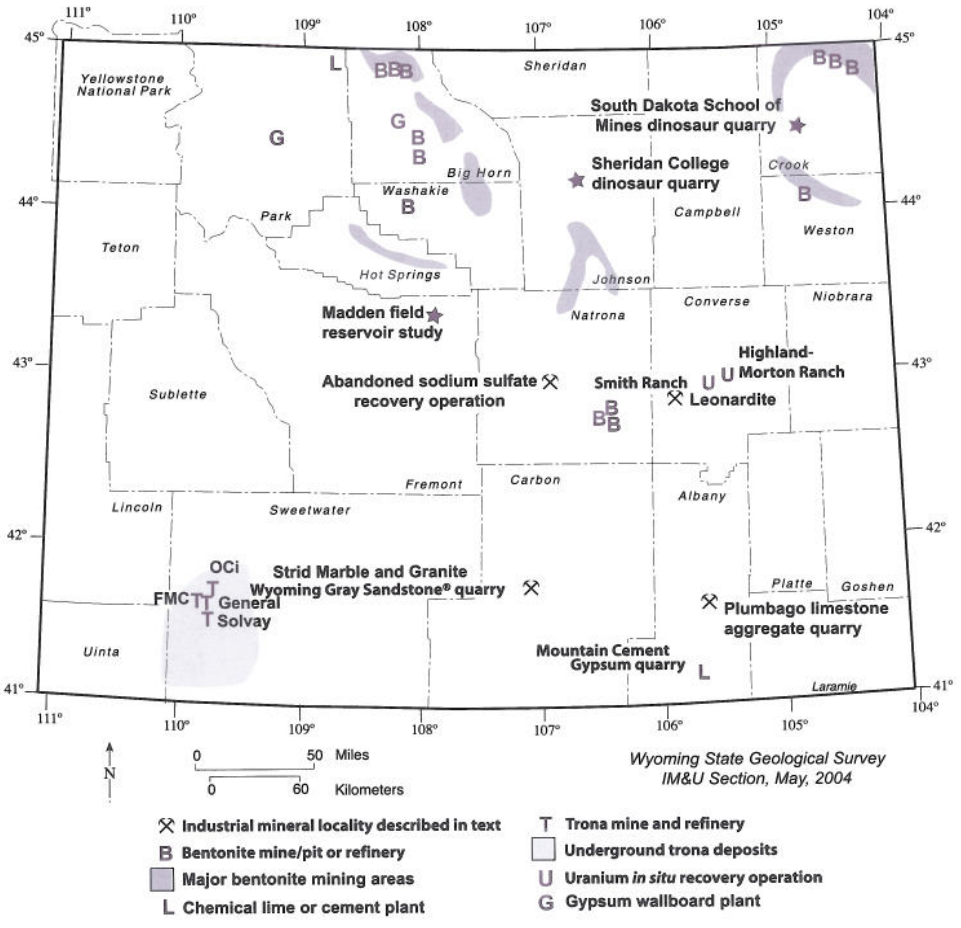

Figure 18. Index map of Wyoming showing the location of industrial mineral and uranium sites described in the text, selected mining areas, State of Wyoming permitted dinosaur quarries (purple stars), and location of a newly published study on Wyoming geology (purple star).

Figure 19. Plumbago Creek limestone aggregate quarry.

were about 12 producers of these commodities in Wyoming as of the end of 2003 and many of these were individuals or small producers.

Gypsum

Gypsum is produced at three localities in Wyoming (**Figure 18**); two are associated with wallboard manufacturing plants in the Bighorn Basin, and at the third locality, gypsum is quarried for use as a retardant in cement manufacture at Mountain Cement's plant south of Laramie. Gypsum production decreased slightly in 2003, from 0.43 million short tons in 2002 to 0.42 million short tons in 2003, because Mountain Cement reported no gypsum production.

Leonardite

Leonardite, a viscous liquid or a solid hydrocarbon residue of lignite, is used as a soil conditioner, in drilling fluids, and in wood stain, along with miscellaneous other products. North Dakota is the principal leonardite-producing state but it is produced in relatively small quantities in the southern Powder River Basin, Wyoming (**Figure 18**). Leonardite production in Wyoming increased from 30,000 short tons in 2002 to 32,000 short tons in 2003.

Limestone

Limestone is produced for two purposes, construction aggregate and as a source of lime. The lime can be used in cement manufacture as well as other industrial applications such as in scrubbers for coal-fired generating plants. Chemical grade limestone (another commodity that is quarried and stockpiled) production decreased from 0.93 million short tons in 2002 to 0.74 million short tons in 2003. All chemical grade limestone quarried in Wyoming is used at Mountain Cement's plant south of Laramie (**Figure 18**). Lime is produced by Wyoming Lime near Frannie (**Figure 18**), but the source limestone is quarried in Montana.

Sodium sulfate

Sodium sulfate used to be produced in Wyoming at Natrona, west of Casper; there is still a landmark shed along

Figure 20. The Wyoming State Capitol Building in Cheyenne is faced with dimensional sandstone quarried near the Wyoming State Prison south of Rawlins.

State Highway 20 that housed the material (**Figure 18**). No production has been reported for the last four years. Unless there is renewed production, reports for this commodity will cease.

Trona

Trona is mined in Wyoming at four underground mines and refined into soda ash and other sodium compounds at mine-mouth plants. Four companies [FMC, General Chemical Soda Ash Partners (General), OCi, and Solvay Minerals] operate the mines and refining plants (**Figure 18**). Trona production in Wyoming increased from 17.2 million short tons in 2002 to 17.5 million short tons in 2003. This production includes mined trona and trona from solution mining, but not processed soda ash. The price of mined trona decreased from $38.00 per short ton in 2002 to $37.40 per short ton in 2003.

Uranium

Uranium is produced in Wyoming at two *in situ* recovery sites, Smith Ranch and Highland/Morton Ranch by Power Resources, a subsidiary of CAMECO (**Figure 18**). CAMECO, of Saskatoon, Saskatchewan, also owns the only other current uranium production in the U.S. at Crow Butte, Nebraska. Uranium production from these two mines decreased slightly in 2003 from 1.4 to 1.2 million pounds of yellowcake.

The spot market price of yellowcake (oxidized uranium—the product of Wyoming's uranium mills) jumped during the second half of 2003 from $10.90 to $14.50 per pound, according to The Ux Consulting Company, LLC., (http://www.uxc.com/review/uxc_prices.html) and the Rocky Mountain Minerals Scout. The price increase is not due to a corresponding increase in U.S. demand, but may be a reflection of the strengthening U.S. economy.

Rock Hound's Corner: Barite

W. Dan Hausel, Wyoming PG-1025

Senior Economic Geologist–Metals and Precious Stones, Wyoming State Geological Survey

Barite, a barium sulfate ($BaSO_4$), when found in crystalline form may produce very attractive mineral specimens that will enhance most any mineral enthusiast's or rock hound's collection. This industrial mineral has a relatively low Mohs hardness (3 to 3.5) and a relatively high specific gravity (4.5). When found in large tonnages in massive form, barite may be mined and used as a drilling mud additive to aid in blowout prevention due to its high specific gravity. Its high specific gravity results in a noticeable heft to hand specimens, which aids in the identification of the mineral.

Barite crystallizes in the orthorhombic crystal system and may form aggregates or divergent groups of tabular crystals known as *barite roses* (**Figure 21**). These extraordinary crystal aggregates have a very pleasing appearance and mineral collectors often seek them. Barite has perfect basal cleavage with prismatic cleavage at right angles to the basal cleavage, and will sometimes form white masses exhibiting the distinct right angle prismatic cleavage (**Figure 22**). Tabular white, yellow, gray, blue, red, or brown, opaque, translucent, or transparent crystals have been reported.

Some of the more attractive specimens found in Wyoming are light aquamarine blue, transparent to translucent, thin tabular crystals compressed along the c-crystallographic axis. This compression produces distinctly large c[001] faces. The individual crystals of the Wyoming aquamarine blue barite occur as plates with distinct beveled edges along the a[100] axis (**Figure 23**). Perfect basal cleavage parallel to c[001] lies perpendicular to the imperfect prismatic cleavage parallel to b[010] and perfect cleavage parallel to m[110] is often evident in the crystals. Dana and Ford (1949) reported the location of this latter cleavage to be m[110] but Sinkankas (1964) reported it as m[210]. Where found in the Shirley Basin of Wyoming, the barite occurs in vugs in limestone enclosed by calcite and prismatic quartz. The best known localities to find barite in Wyoming are described below.

Bighorn Basin

Small radial clusters of white barite crystals are found in the Shoshone Canyon area (SE section 5, T52N, R102W) of Rattlesnake Mountain about 4 miles west of Cody. Some of the crystals from this area were reported to be one inch in length. This barite is associated with paleo-hot spring deposits and solution cavities in the Mississippian Madison Limestone.

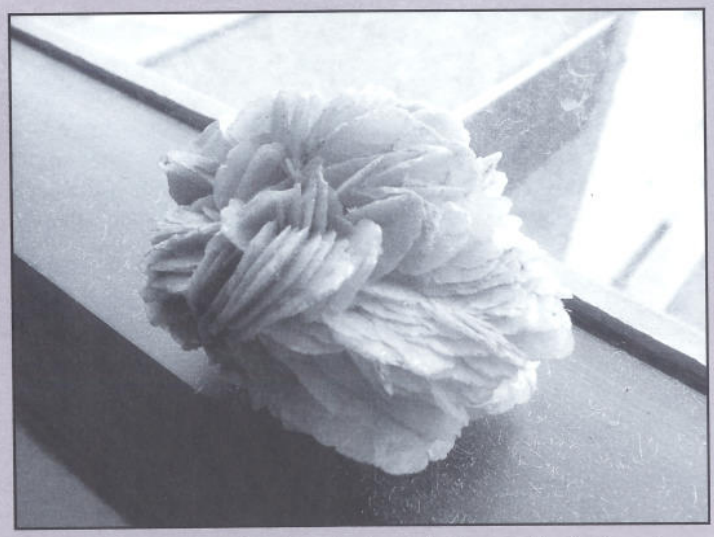

Figure 21. Barite rose showing cluster of barite crystals that produce a rose-like appearance.

Figure 22. Cleavage displayed in specimen of barite from Transylvania. Note the individual crystals in the center of the photo are flattened plates with c[001] axis perpendicular to this page. These flat surfaces also represent the basal cleavage. At right angles to the c-axis are flat edges that are nearly perpendicular to one another. These crystal faces represent prismatic cleavage at right angles to the c-axis.

Figure 23. The blue barite shows beveled edges along the edge of the a[100] axis. Note the beveled edge on the crystal in the center of the photograph.

Medicine Bow Mountains

Fine-grained to massive pyrite was reported with barite crystals at the New Rambler copper-gold-palladium-platinum mine (SW section 33, T15N, R79W) in the Medicine Bow Mountains west of Rob Roy Reservoir (Osterwald and others, 1966).

Sierra Madre

A pod-like body of barite, 40 feet wide by 300 feet long associated with opal was described by Osterwald and others (1966) in the Hog Park area (NW section 2, T12N, R85W) 15 miles southwest of Encampment. The barite was reported to occur along the northern edge of a shear zone in contact with red quartz monzonite.

Shirley Basin

White barite concretions are reported in Shirley Basin northeast of the town of Medicine Bow. These are weakly fluorescent under long-wavelength ultraviolet light.

In addition to white barite, some very attractive aquamarine blue barite crystals occur in the vicinity of Sheep Creek near Crystal Hill adjacent to the Mine Hills (section 10, T26N, R75W) along the southeastern margin of the basin (**Figure 24**) and adjacent to the western flank of the Laramie Range. The Mine Hills can be accessed from the west through Shirley Basin. The barite occurs as attractive light-blue, transparent to translucent, tabular crystals (**Figure 25**) and is found with calcite and quartz in vugs in the Casper Formation near massive psilomelane, manganite (manganese) and jasper replacements (Hausel and Sutherland, 2000).

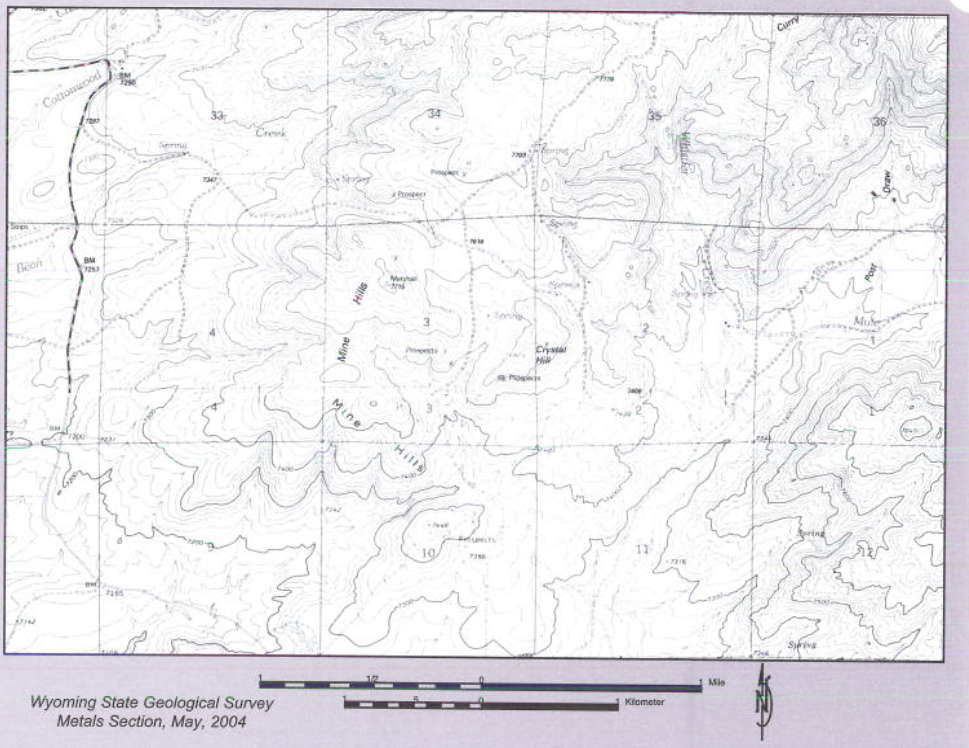

Figure 24. Location map of the Mine Hills area, southeastern Shirley Basin, where blue barite occurs in the Casper Formation. Base map from the Marshall and Rogers Creek 1:24,000-scale quadrangles.

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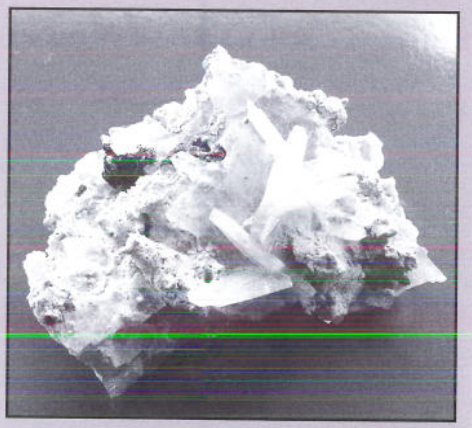

Figure 25. Blue barite crystals from the Shirley Basin, Wyoming.

Mineral Resource and Reserve Base Estimates for Wyoming

Petroleum

Remaining Technically Recoverable Resources (January 1, 2004)
- Discovered (includes oil, gas liquids, and condensate)..... 2.93 billion barrels[1]
- Undiscovered ..... 6.12 billion barrels[1]
- Total..... 9.05 billion barrels

Remaining Reserve Base (January 1, 2004)
- Measured reserves (Proved reserves) (Includes: 0.47 barrels of oil and 0.82 billion barrels of gas liquids and condensate)..... 1.29 billion barrels[2]
- Indicated and inferred reserves (Reserve growth in conventional fields)..... 2.01 billion barrels[1]
- Total..... 3.30 billion barrels

Natural Gas

Remaining Technically Recoverable Resources (January 1, 2004)
- Discovered (Includes 29.0 trillion cubic feet (TCF) of methane[1], 119.8 TCF of CO_2[3], and 30.5 TCF of coalbed methane[4]..... 179.3 trillion cubic feet
- Undiscovered (Includes 14.72 TCF of conventional methane[1]; 5.43 TCF of coalbed methane; 119.3 TCF of methane in tight gas sands in the Green River Basin; and 31.2 TCF of CO_2[3])..... 170.6 trillion cubic feet
- Total..... 349.9 trillion cubic feet

Remaining Reserve Base (January 1, 2004)
- Measured reserves (Proved reserves) (Includes 18.7 TCF of conventional methane[2], 59.5 TCF of CO_2[3], and 2.3 TCF of coalbed methane)..... 79.1 trillion cubic feet
- Indicated and inferred reserves (Reserve growth in conventional fields)..... 22.8 trillion cubic feet
- Total..... 101.9 trillion cubic feet

Coal

Remaining Resources (January 1, 2004)
- Identified and Hypothetical (Discovered)..... 1424.4 billion tons[5]
- Speculative (Undiscovered) ..... 31.5 billion tons[5]
- Total..... 1455.9 billion tons

Remaining Reserve Base (January 1, 2004)
- Demonstrated strippable (Measured and indicated reserve base)..... 22.9 billion tons[6]
- Demonstrated underground-minable (Measured and indicated reserve base)..... 42.5 billion tons[6]
- Total..... 65.4 billion tons

Trona

Original Resources
- Trona ..... 76.0 billion tons[7]
- Mixed trona and halite ..... 51.0 billion tons[7]
- Total..... 127.0 billion tons

Remaining Resources (December 31, 2003)
- Trona ..... 75.9 billion tons

Uranium

Remaining Resource (December 31, 2003)..... 1.99 billion pounds U_3O_8[8]

Remaining Reserve Base (December 31, 1989)
- Uranium oxide recoverable at $30.00 per pound ..... 66 million pounds[8]

Oil Shale

Original Resources (January 1, 1981)
- Identified (Discovered) ..... 320 billion barrels of shale oil[9]

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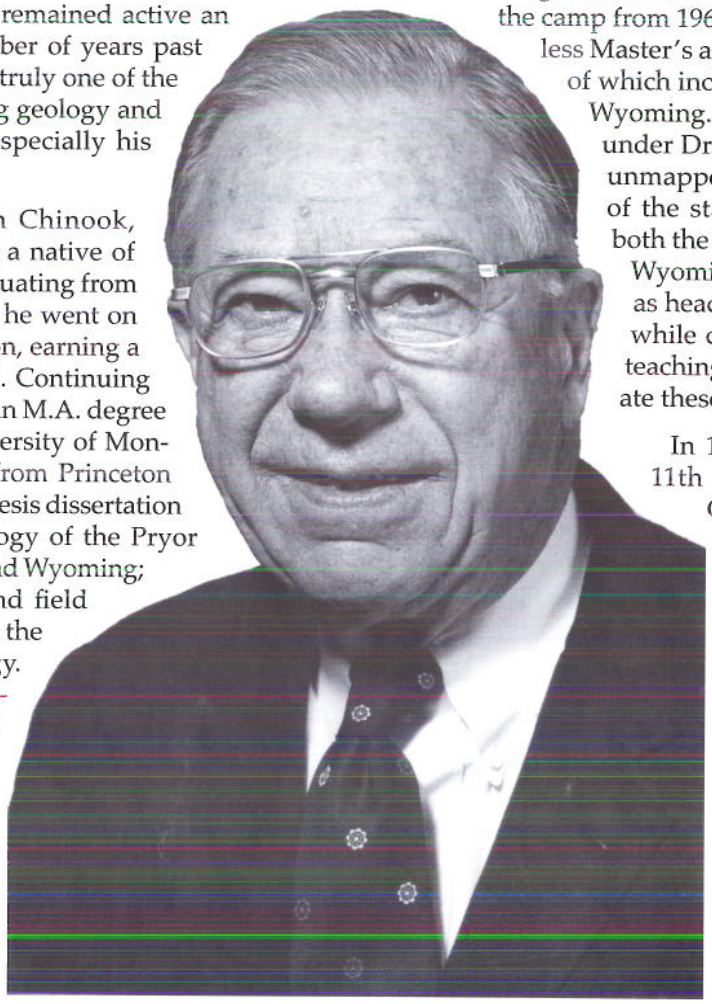
[1]Modified from U.S. Geological Survey National Oil and Gas Resource Team, 1995, 1995 National Assessment of United States oil and gas resources: U.S. Geological Survey Circular 118, 20 p. [2]Modified from Energy Information Administration, 2003, U.S. crude oil, natural gas, and natural gas liquids reserves: 2002 Annual Report: Washington, D.C., 170 p. [3]De Bruin, R.H., 2001, Carbon dioxide in Wyoming: Wyoming State Geological Survey Information Pamphlet 8, 11 p. [4]De Bruin, R.H., Lyman, R.M., Jones, R.W., and Cook, L.W., 2001; modified from Gas Research Institute (1999) and Finley and Goolsby (2000), Coalbed methane in Wyoming: Wyoming State Geological Survey Information Pamphlet 7 (revised), 19 p. [5]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. [6]Modified from Jones, R.W., and Glass, G.B., 1992, Demonstrated reserve base of coal in Wyoming as of January 1, 1991: Wyoming State Geological Survey Open File Report 92-4, 26 p. [7]Wiig, S.V., Grundy, W.D., and Dyni, J.R., 1995 Trona resources in the Green River Basin in southwest Wyoming: U.S. Geological Survey Open File Report 95-476, 88 p. [8]Energy Information Administration, 1989, Uranuim industry annual: U.S. Department of Energy Report DOE/EIA-0478(89), 121p. [9]Knutsen, 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.

MEMORIAL: DONALD L. BLACKSTONE, JR.

Richard W. Jones, Wyoming PG-2972

Editor/Senior Geologist—Publications, Wyoming State Geological Survey

Dr. Donald L. Blackstone, Jr., one of Wyoming's most respected geologists and professors for more than half a century, died on May 24, 2004. Having taught geology at the University of Wyoming (UW) since 1946, Dr. Blackstone was a cornerstone of the Department of Geology and Geophysics. He remained active an Emeritus Professor for a number of years past his official retirement. He was truly one of the grand old masters of Wyoming geology and his colleagues, friends, and especially his family will all miss him.



Born on June 16, 1909 in Chinook, Montana, he was proud to be a native of the Big Sky country. After graduating from Chinook High School in 1927, he went on to the University of Washington, earning a B.S. degree in geology in 1931. Continuing with his education, he earned an M.A. degree in geology in 1934 at the University of Montana and a Ph.D. in geology from Princeton University in 1936. His Ph.D. thesis dissertation addressed the structural geology of the Pryor Mountains uplift of Montana and Wyoming; the results of his mapping and field work were later published in the prestigious Journal of Geology. His interpretations and conclusions remain valid even today and began a career that would eventually establish him as an authority on Rocky Mountain foreland tectonics.

Dr. Blackstone worked as an exploration geologist, mostly in the Rocky Mountains, for Standard Oil of New Jersey from 1936 to 1939, after which he joined the faculty at the University of Missouri, Columbia, where he taught geology through 1941. He returned to the oil industry as a geologist with Carter Oil Company, attaining the rank of Division Geologist for the Rocky Mountain region. After World War II, he returned to his real calling, teaching, where he joined the faculty of the UW in 1946 as Associate Professor of Geology.

Dr. Blackstone was very active in his teaching and research at UW, developing outstanding undergraduate courses in structural geology, ground water geology, and field methods. He served as one of the field directors for UW's S.H. Knight Science Camp for 10 years and as Director of the camp from 1963 to 1967. He supervised countless Master's and Ph.D. graduate theses, many of which included field mapping projects in Wyoming. Most of the geologic maps done under Dr. Blackstone's direction covered unmapped or poorly understood areas of the state and contributed greatly to both the 1955 and 1985 geologic maps of Wyoming. From 1963 to 1968, he served as head of the Department of Geology while continuing a full of schedule of teaching, research, and directing graduate theses.

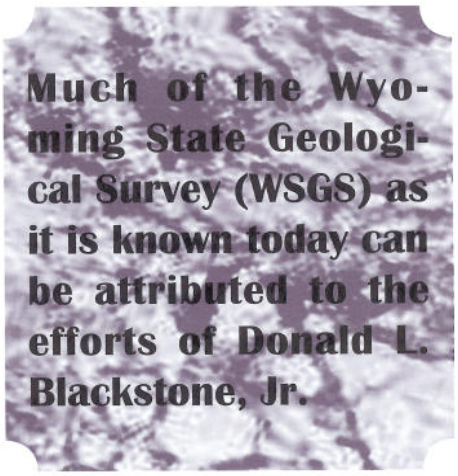
In 1967, he was appointed as the 11th Wyoming State Geologist by Governor Hathaway to serve out the unexpired term of H.D. Thomas, who died in office. As with every new opportunity or challenge, Dr. Blackstone met this phase of his career head-on; he was determined to make a difference and he did. Under his direction, the Wyoming Geological Survey published reports on two large, long-term projects (mapping the radioactive conglomerates in the Medicine Bow Mountains and mapping and evaluating the Absaroka Range). A variety of reports on other mineral resources were also published, the public service and educational activities increased, and the Survey continued its mandated roles. However, this wasn't enough for Dr. Blackstone.

Dr. Blackstone wanted to see the Survey grow and expand. He realized the limitations of having a State Geologist that

only served part-time, with little funding, and little professional or staff support (except for a part-time Assistant State Geologist). He also recognized the vast mineral resources and the huge potential for expanding Wyoming's mineral industries and thought the Survey could help move the state out of the economic doldrums of the 1960s. He began working on a plan to make "substantial changes" to the Survey.

Governor Hathaway agreed with the "substantial changes" proposed by Dr. Blackstone and in the 40th Wyoming State Legislature, the changes became law. The Geological Survey was reorganized. Much of the Wyoming State Geological Survey (WSGS) as it is known today can be attributed to the efforts of Donald L. Blackstone, Jr.

The reorganization brought about sweeping changes. The State Geologist and the WSGS were no longer part of UW or the Geology Department. The WSGS officially became a separate operating agency of Wyoming State Government; the State Geologist also became the Executive Director of the WSGS and a full-time staff member. An official advisory board for the WSGS was created as part of the Executive Branch and the biennial budget was nearly doubled. Expansion of the budget meant hiring more geologists and other personnel to accomplish the Survey's objectives. With the reorganization completed, Dr. Blackstone resigned as State Geologist and once again returned to full-time professorship at UW.



He did not completely sever his ties with the WSGS, however, as he continued to help the Survey as a member of its Advisory Board from 1969 until his final term ended in 1996. He remained a valued advisor to each successive State Geologist and was a friend and mentor to many WSGS staff geologists throughout his long association with the Survey. Dr. Blackstone went back to his research, and worked with the WSGS to publish a number of his maps and reports on Wyoming geology. The WSGS is proud to have published these reports and to make them available to the public.

He was very active in professional organizations throughout his career. As a contributing member of the Wyoming Geological Association (WGA), he served as editor for three guidebooks and was author of countless guidebook articles and presentations at the annual meetings. Dr. Blackstone received WGA's Frank A. Morgan Award for distinguished service in 1954. He became an honorary life member of WGA in 1956 and received the Distinguished Service Award in 1979. He was designated a Distinguished Geological Pioneer by the Rocky Mountain Section of the Society of Economic Paleontologists and Mineralogists in 1986. Dr. Blackstone was a Fellow of the Geological Society of America since 1945, a member of the American Geophysical Union, and a charter member of the American Institute of Professional Geologists. He was one of only a hundred Honorary Members of the American Association of Petroleum Geologists and had been an active member since 1937.

Dr. Blackstone's years of teaching, research, and service to UW was recognized in 1971 when he received the George Duke Humphrey Award. He was further recognized for his service to the state and the university in 1985 when he received an Honorary Doctor of Laws (LL.D.) degree from the University of Wyoming.

He officially retired in 1974, but "unretired" to continue part-time teaching and advising graduate students until 1984. Amazingly, he remained a productive geologist for almost another 20 years, continuing with his research, publishing, and other academic endeavors. He could almost always be found in his office on work days; his work ethics and dedication to his profession were contagious to all that worked with him.

"Don" as his friends and colleagues called him (but I think if you were one of his students, you always called him "Dr. Blackstone"), was an outdoorsman. He loved going to the field and field work, and was fascinated by nature and geology. He was an avid bird-watcher and an accomplished fly fisherman.

He married Helen Bookman in 1936 and they had four children. Helen passed away in 1980. He married Mary Frances (Ricky) in 1981 and they remained happily married thereafter. He is survived by his wife Ricky; two sons, Andy and Will; two daughters, Mary and Sarah; two stepdaughters, Ann Williams and Jean Christensen; four grandsons; three granddaughters; a great-grandson; and a great-granddaughter.

This memorial was prepared using several printed sources and the obituary that was published in the Laramie Daily Boomerang (May 26, 2004). A "Dedication to Donald L. Blackstone, Jr.," by Robert S. Houston, 1993, appeared in Wyoming State Geological Survey Memoir 5, p. vi-ix. Dr. Blackstone's role in reorganizing the WSGS is documented in "Transition and reorganization: The administration of Donald L. Blackstone, Jr.," by William Bryans, 1986, Wyoming State Geological Survey Bulletin 65, p. 85-90. The present author, however, is responsible for any errors, omissions, or inaccuracies in this article.

GEOLOGIC MAPPING AND HAZARDS UPDATE

Geologic Mapping, Paleontology, and Stratigraphy Update

Alan J. Ver Ploeg, Wyoming PG-1587

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The U.S. Geological Survey (USGS) recently notified the Wyoming State Geological Survey (WSGS) that their proposals for STATEMAP 2004 were funded in the amount of $69,952. An across-the-board cut was applied to the total funding for the 47 states applying to the program. This cut required the WSGS to modify the subproject budget and drop one subproject.

The Wyoming Geological Association (WGA) recently awarded grants to seven students planning field-mapping projects in the Rocky Mountain area. Sheridan College submitted their annual report for 2003 field activities on their State of Wyoming permitted dinosaur quarry near Buffalo. During the year, the quarry yielded some interesting dinosaur bones while serving as an outdoor classroom for Sheridan College students.

A new article relating to Wyoming geology and stratigraphy was published in the current American Association of Petroleum Geologists (AAPG) Bulletin. The article profiles a reservoir characterization study completed on the Madison Limestone producing sequence in the Madden Field of the Wind River Basin. Wells in this prolific field typically produce over 50 million cubic feet (MMCF) of gas per day from the Madison reservoir.

STATEMAP 2004 projects funded

The WSGS was notified in February that the STATEMAP review panel had awarded the Survey $69,952 for STATEMAP 2004. This brings the total STATEMAP funding awarded to the WSGS to $489,501 since participation began with STATEMAP 1994 (**Table 17**). As noted in *Wyoming Geo-notes No. 79* (March, 2004), staff members at the WSGS proposed four mapping projects for the STATEMAP 2004 Program. The four projects proposed were: 1) map and compile the Midwest 1:100,000-scale Quadrangle; 2) digitize the Casper and Saratoga 1:100,000-scale and the Keystone and Barlow Gap 1:24,000-scale bedrock geologic maps, and digitize the Rock River and Saratoga 1:100,000-scale surficial geologic maps; 3) map and compile the bedrock geology for the Rock River 1:100,000-scale Quadrangle; and 4) finish compiling and mapping the bedrock geology for the Torrington 1:100,000-scale Quadrangle. These projects were selected according to current mapping priorities established by the WSGS in cooperation with Wyoming Geologic Mapping Advisory Committee (see *Wyoming Geo-notes No. 79*, March, 2004, p. 24).

The proposal was for a total of $91,764 to complete the four subprojects listed above. Funding available for STATEMAP 2004 grants was just under $6.5 million; requests for funding from 47 states totaled nearly $8.5 million. As a result, the STATEMAP review panel decided to apply an across-the-board cut, which resulted in funding for the WSGS proposal being reduced to $69,952. In response to this reduction, the WSGS reworked the individual project budgets. Subproject 4 was rolled into subproject 2 and will be completed and digitized by the Publications Section in addition to the other maps listed above.

Another change to the original proposal involves substituting the South Pass 1:100,000-scale Quadrangle for the Rock River 1:100,000-scale Quadrangle that was proposed in subproject 3. The Metals and Precious Stones Section made this substitution when they received information that the University of Missouri was already working on the Rock River Quadrangle in cooperation with the USGS. The South Pass Quadrangle (**Figure 26**) was chosen because the Metals and Precious Stones Section has already completed some 1:24,000-scale mapping in the South Pass area and because mineral exploration companies are showing interest in the area.

Work will begin on these STATEMAP 2004 projects in August, 2004, with the contract period running through July 31, 2005. Deliverables will be sent to the USGS and the maps will be released as open file reports by the WSGS at that time.

2004 WGA grants awarded

The WGA recently awarded grants for field expenses to seven students planning field-mapping projects in the Rocky Mountain area. The grants from the WGA's J. David Love Field Geology Fellowship support field geology projects in honor of the late J. David Love, renowned for his distinguished career as a field geologist in Wyoming with the USGS. Recipients of the grants and their research projects include:

- Dan Breecker, University of New Mexico–determining ages of tectonic burial through peak metamorphism in the northern Wind River Range of western Wyoming using monazite oxygen isotope thermochronology;
- Nathaniel Gilbertson, Colorado School of Mines–fracture analysis study of Alcova anticline in central Wyoming;

- Patrick Hughes, University of Wyoming–using high pressure granulites in the northern Teton Range, Wyoming to determine the timing and conditions of high-pressure metamorphism and to determine the tectonic context of these rocks;
- Michael Meredith, University of Wyoming–Archean crustal development in the Tin Cup Mountain area of the Granite Mountains, central Wyoming;
- Peter Schmitz, University of Wyoming–mapping and sampling the Louis Lake Batholith area at the southern end of the Wind River Range, Wyoming to determine its structural history;
- Walter Sullivan, University of Wyoming–structural significance of L tectonites in the Boy Scout Camp Granodiorite and related rocks in the Laramie Mountains, southeastern Wyoming; and
- Kate Zeigler, University of New Mexico–analysis of the lithostratigraphy, biostratigraphy, and magnetostratigraphy of the Upper Triassic Chinle Group of the Chama Basin, north-central New Mexico.

Activities on state dinosaur quarries

There are currently two dinosaur quarries holding scientific permits on State Lands in Wyoming. Mike Flynn of Sheridan College operates one quarry located southwest of Buffalo; Dr. James Martin of the South Dakota School of Mines and Technology operates the other quarry, which is in an Interstate 90 road cut west of Sundance (**Figure 18**). Both quarries, located in paleostream channels in the dinosaur-fossil-rich Jurassic Morrison Formation, are used for student instruction in paleontology; fossil removal methods; and fossil specimen collection, preparation, and research. No report of activities has been received from Dr. Martin; the quarry near Sundance was inactive during the 2003 field season.

In February, 2004, Mike Flynn submitted his annual report outlining activities during the 2003 field season. Flynn indicated that the Sheridan College quarry was used during the summer field season to instruct two sessions of a Sheridan College class on recognizing paleoenvironments, geology, and training in fossil collecting procedures. Research continued on the stratigraphy, paleobiology, paleogeography, and paleoenvironments of the Late Jurassic Morrison Formation

Table 17. Summary of the STATEMAP-funded geologic mapping program in Wyoming.

Fiscal Year	Project description and map scale	State dollars	Federal dollars	Total project dollars
1995	Geologic map of the Laramie Quadrangle, 1:24,000-scale STATEMAP94	$12,000	$12,000	$24,000
1996	Geologic map of the Howell Quadrangle, 1:24,000-scale STATEMAP95	$10,000	$10,000	$20,000
1997	Geologic map of the Guernsey Quadrangle, 1:24,000-scale STATEMAP96	$8499	$8499	$16,998
1998	1-Geologic map of the Guernsey Reservoir Quadrangle, 1:24,000-scale STATEMAP97	$14,000	$14,000	$28,000
	2-Digital geologic map of the Cheyenne Quadrangle and digital surficial geologic maps of the Casper, Cheyenne, Laramie, and Rawlins Quadrangles, 1:100,000-scale STATEMAP97	$17,000	$17,000	$34,000
	Total 1998 Funds	$31,000	$31,000	$62,000
1999	1-Geologic map of the Laramie Quadrangle, 1:100,000-scale STATEMAP98	$18,500	$18,500	$37,000
	2-Digital geologic map of the Gillette Quadrangle and surficial geologic maps of the Douglas, Powell, Rock Springs, Sheridan, and Torrington Quadrangles, 1:100,000-scale STATEMAP98	$20,000	$20,000	$40,000
	3-Geologic map of the Barlow Gap Quadrangle, 1:24,000-scale STATEMAP98	$18,650	$18,650	$37,300
	Total 1999 Funds	$57,150	$57,150	$114,300
2000	1-Geologic map of the Sheridan Quadrangle, 1:100,000-scale STATEMAP99	$19,500	$19,500	$39,000
	2-Digital geologic map of the Laramie Quadrangle and digital surficial geologic maps of the Buffalo, Cody, Newcastle, Kaycee, and Worland Quadrangles, 1:100,000-scale STATEMAP99	$20,000	$20,000	$40,000
	Total 2000 Funds	$39,500	$39,500	$79,000
2001	1-Geologic map of the Buffalo Quadrangle, 1:100,000-scale STATEMAP00	$20,500	$20,500	$41,000
	2-Digital geologic map of the Sheridan Quadrangle and digital surficial geologic maps of the Burgess Junction, Devils Tower, Lance Creek, Lusk, and Sundance Quadrangles, 1:100,000-scale STATEMAP00	$24,500	$24,500	$49,000
	Total 2001 Funds	$45,000	$45,000	$90,000
2002	1-Geologic map of the Rattlesnake Hills Quadrangle 1:100,000-scale STATEMAP01	$24,133	$24,133	$48,266
	2-Digital geologic maps of the Buffalo and Recluse Quadrangles and digital surficial geologic maps of the Midwest and Basin Quadrangles 1:100,000-scale STATEMAP01	$24,796	$24,796	$49,592
	3-Entering map data in National Geologic Map Database STATEMAP01	$6500	$6500	$13,000
	Total 2002 Funds	$55,429	$55,429	$110,858
2003	1-Geologic map of the Kaycee Quadrangle 1:100,000-scale STATEMAP02	$23,500	$23,500	$47,000
	2-Digital geologic maps of the Kaycee, Reno Junction, and Rattlesnake Hills Quadrangles 1:100,000-scale STATEMAP02	$18,437	$18,437	$36,874
	3-Geologic map of the Keystone Quadrangle 1:24,000-scale STATEMAP02	$28,976	$28,976	$57,952
	Total 2003 Funds	$70,913	$70,913	$141,826
2004	1-Geologic map of the Casper Quadrangle 1:100,000-scale STATEMAP03-in progress	$21,889	$21,889	$43,778
	2-Digital geologic maps of the Kinney Rim, Evanson, Kemmerer, and Nowater Creek quadrangles; digital surficial geologic maps of the Nowater Creek and Chugwater quadrangles 1:100,000-scale STATEMAP03-in progress	$16,745	$16,745	$33,490
	3-Geologic map of the Saratoga Quadrangle 1:100,000-scale STATEMAP03-in progress	$27,532	$27,532	$55,064
	4-Geologic map of the Torrington Quadrangle 1:100,000-scale STATEMAP03-in progress	$23,892	$23,892	$47,784
	Total 2004 Funds	$90,058	$90,058	$180,116
2005	1-Geologic map of the Midwest Quadrangle 1:100,000-scale STATEMAP04-funded	$22,803	$22,803	$45,606
	2-Digital geologic maps of the Casper and Saratoga bedrock and Saratoga and Rock River surfical Quadrangles 1:100,000-sclae; Keystone and Barlow Gap Quadrangles 1:24,000-scale STATEMAP04-funded	$19,295	$19,295	$38,590
	3-Geologic Map of the South Pass Quadrangle 1:100,000-scale STATEMAP04-funded	$27,854	$27,854	$55,708
	Total 2005 funds	$69,952	$69,952	$139,904
	TOTALS	$489,501	$489,501	$979,002

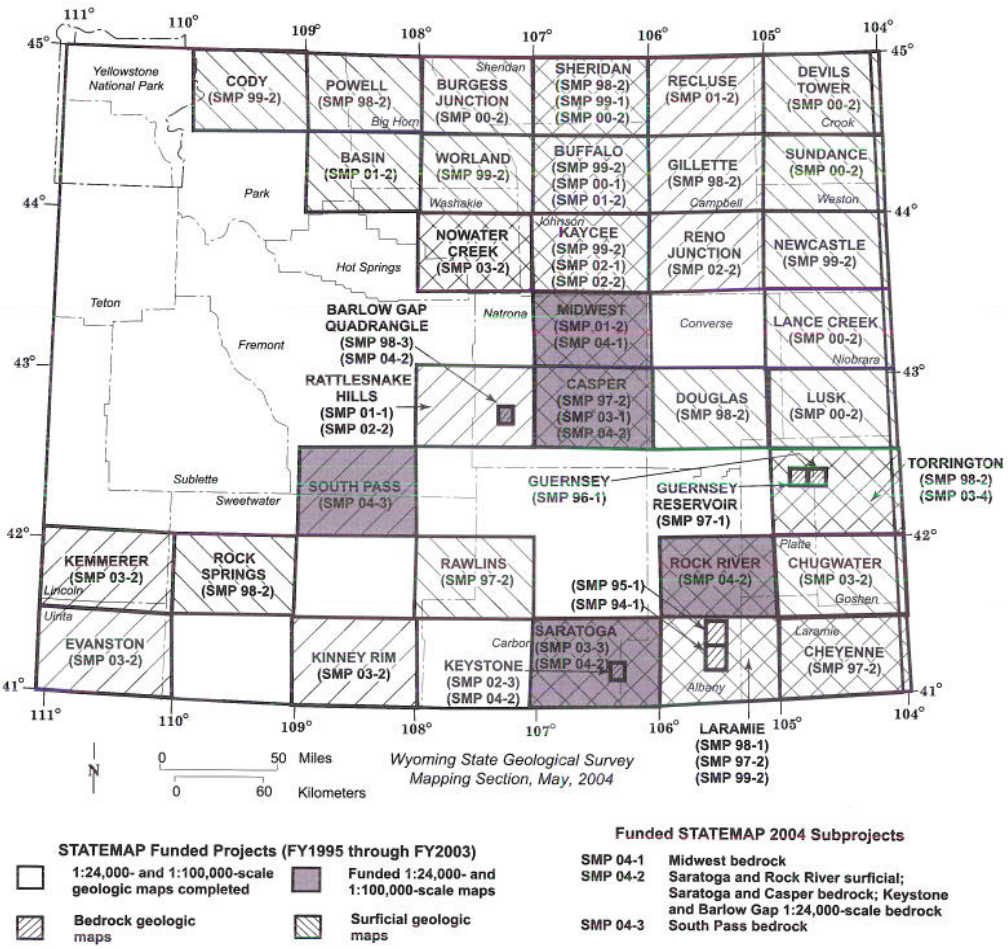

Figure 26. Index to funded, in-progress, and completed STATEMAP projects in Wyoming.

in the quarry area (**Figure 18**) and in exposures along the eastern flanks of the Bighorn Mountains. Fourteen specimens of camarasaur and sauropod bones were catalogued and removed from the quarry during the field season. These bones included cervical vertebra, metatarsal, metacarpal, and rib fragments.

Flynn implied that the quarry would continue to be excavated with accompanying fossil removal, as well as continuing to serve as a field methods classroom for three Sheridan College field geology courses in the 2004 field season. Fossil specimens located late in the 2003 field season will be documented, mapped, and removed. In a related note, the Office of State Lands and Investments recently renewed the scientific fossil removal permit held by Sheridan College for an additional five-year period.

New publication on Wyoming geology

An article by Westphal and others (2004) published in the latest AAPG Bulletin presented the results of a reservoir characterization study of the Madison Limestone in the northeastern Wind River Basin, Wyoming (**Figure 18**). This reservoir, located in the Madden Field, typically produces at rates exceeding 50 MMCF of gas per day. The authors used sedimentology, sequence stratigraphy, petrophysics, and the petrography of outcrops as well as subsurface data to identify significant heterogeneity in the petrophysical properties (including porosity and permeability) within the Madison Limestone. These variations in reservoir properties are directly influenced by original facies heterogeneity and early and later stage diagenetic overprint, most importantly dolomitization. The dolomitized portions of the Madison form the most prolific producing zones in Madden Field. Results of the study will enable expansion of the Madison reservoir within the field.

Reference cited

Westphal, H., Eberli, G.P., Smith, L.B., Grammer, G.M., and Kislak, J., 2004, Reservoir characterization of the Mississippian Madison Formation, Wind River Basin, Wyoming: American Association of Petroleum Geologists Bulletin, v. 88, no. 4, p. 405-432.

HAZUS-MH: Benefits of Census-Block-Level Analysis for Earthquakes, Teton County, Wyoming

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Hazards U.S. (HAZUS) is a nationally standardized, GIS-based, risk assessment and loss estimation computer program. Originally designed in 1997, it provides the user with an estimate of the type, extent, and cost of damages and losses that may occur during and following an earthquake. It was developed for the Federal Emergency Management Agency (FEMA) by the National Institute of Building Sciences (NIBS). There have been a number of versions of HAZUS generated by FEMA, with HAZUS–MultiHazard (HAZUS-MH) being the most recent release. HAZUS-MH incorporates a flood and wind module with the previously existing earthquake module. The Wyoming State Geological Survey (WSGS) used the 1999 version (HAZUS-99), described in *Wyoming Geo-notes No. 73* (April, 2002, p. 29-33), before upgrading to the new version.

Ground motion estimates

HAZUS was originally used to generate damage assessments and associated ground motions based largely upon analysis at the census-tract level. Census tracts average 4000 inhabitants, with the tract boundaries usually representing visible features. HAZUS-99 calculated a ground motion value for the centroid of a census tract, and applied that value to the entire tract. The calculations are based on U.S. Geological Survey (USGS) National Seismic Hazard Maps (see *Wyoming Geo-notes No. 67*, September, 2000, p. 50-55). In many of the western states, census tracts are very large and parts of the tracts may be subjected to ground motion that is considerably different than the value at the centroid.

FEMA Region VIII and their subcontractor on HAZUS, PBS&J from Atlanta, Georgia, have worked closely with the WSGS to develop a census-block-based analysis for HAZUS-MH in Wyoming. Using this level of analysis, ground motion values for Wyoming are now calculated at the centroid of census blocks. Census blocks are subdivisions of census tracts; many blocks correspond to individual city blocks bounded by streets, but blocks–especially in rural areas–may include many square miles and may have some boundaries that are not streets. In Teton County for example, three census tracts and 1062 census blocks result in a significantly larger number of ground acceleration values that will be used in all Teton County analyses. Wyoming is the national pilot project for the census-block-based analysis, which is a significant improvement over previous versions.

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HAZUS data

HAZUS is packaged with default data for infrastructure, homes, businesses, and roads from national non-proprietary data sources. The default data needs to be refined at the state and local level, which the WSGS has been doing for almost two years (*Wyoming Geo-notes No. 78*, November, 2003, p. 36-39). In addition, HAZUS can incorporate a user-defined landslide layer, a soils layer, and a liquefaction layer. The HAZUS default soils layer only has one soil type for the entire state of Wyoming. The default landslide and liquefaction layers do not show any specific hazards. The WSGS has generated statewide (county-by-county) landslide (**Figure 27**), soils (**Figure 28**), and liquefaction (**Figure 29**) layers from previous WSGS mapping. Those layers are now incorporated into HAZUS-MH, making current analyses much more defensible than those done under HAZUS-99.

Teton County scenarios

A 2500-year probabilistic earthquake scenario was run for Teton County in both HAZUS-99 and HAZUS-MH. In the HAZUS-99 scenario, the analysis used default data with ground motion values derived from the census-tract centroid. Two HAZUS-MH scenarios were generated. The first used default data with ground motion values derived from the

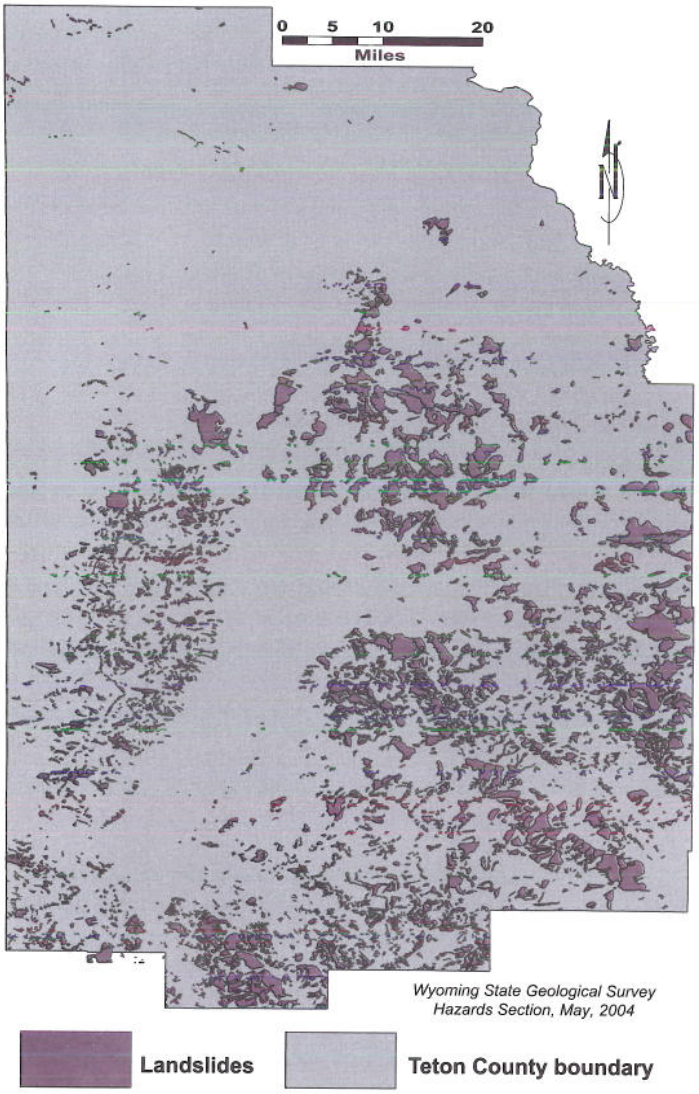

Figure 27. Landslide layers for Teton County from HAZUS-MH using data generated by the WSGS.

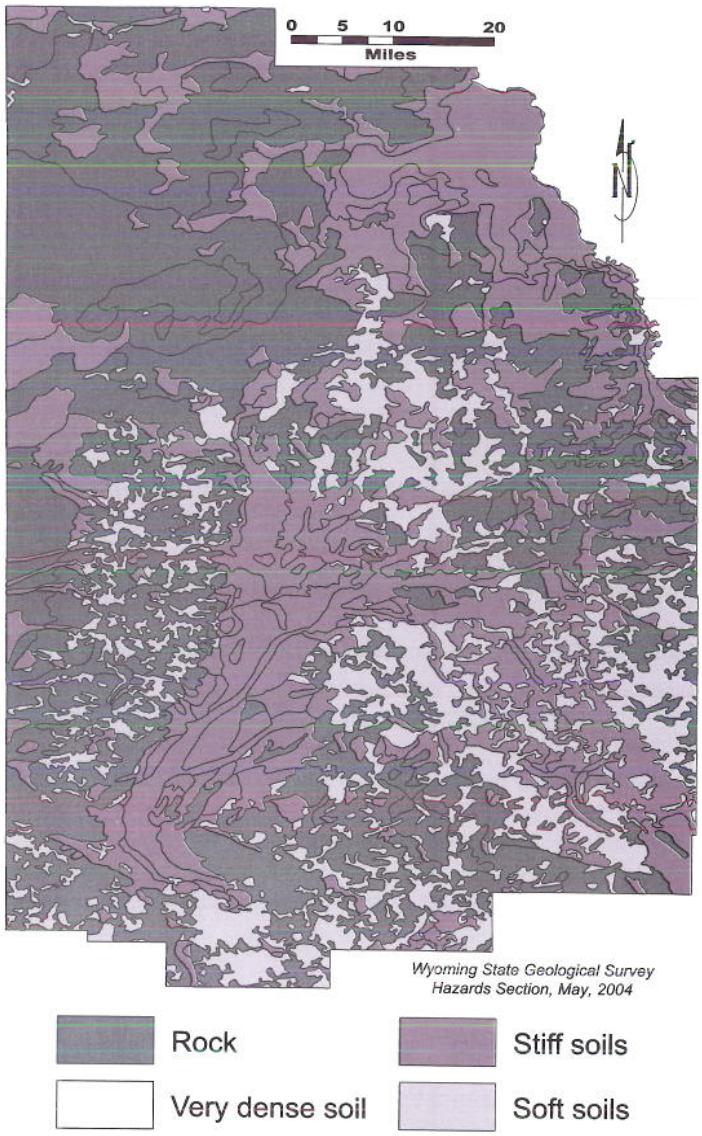

Figure 28. Soil layers for Teton County from HAZUS-MH using data generated by the WSGS.

census-block centroid. The second used refined soils, landslide, and liquefaction layers with ground motion values also derived from the census-block centroid. The HAZUS results for economic losses to buildings and for casualties are presented below but are preliminary and do not reflect all current infrastructure data. The data are to be used for comparison purposes only.

Losses for buildings

The difference in the estimated losses for buildings between HAZUS-99 census-tract-level analysis (**Table 18**) and HAZUS-MH census-block-level analysis (**Table 19**) using default data is significant—more than $241 million. There is also a significant difference ($136.85 million) between HAZUS-MH analysis using default data (**Table 19**) and HAZUS-MH analysis utilizing user-supplied soils, liquefaction, and landslide data (**Table 20**). The damage estimates for Teton County have more than doubled from HAZUS-99 to HAZUS-MH using refined data.

Table 18. Building-related economic loss estimates (millions of dollars) for Teton County, Wyoming from HAZUS-99-SR2 tract-level analysis, default data (2500-year probabilistic).

Area	Residential	Commercial	Industrial	Others	Total
Income losses					
Wage	7.5	23.3	0.6	0.4	31.8
Income	3.2	22.9	0.4	0.1	26.6
Rental	14.8	7.0	0.3	0.2	22.3
Relocation	18.9	10.0	1.4	1.6	31.9
Subtotal	44.4	63.2	2.7	2.3	112.6
Capital stock losses					
Structural	19.0	12.4	3.0	1.0	35.4
Non-Structural	84.3	35.5	7.0	2.8	129.6
Content	25.0	15.8	4.4	1.3	46.5
Inventory	N/A	0.4	1.0	0.0	1.4
Subtotal	128.3	64.1	15.4	5.1	212.9
Total	172.7	127.3	18.1	7.4	325.5

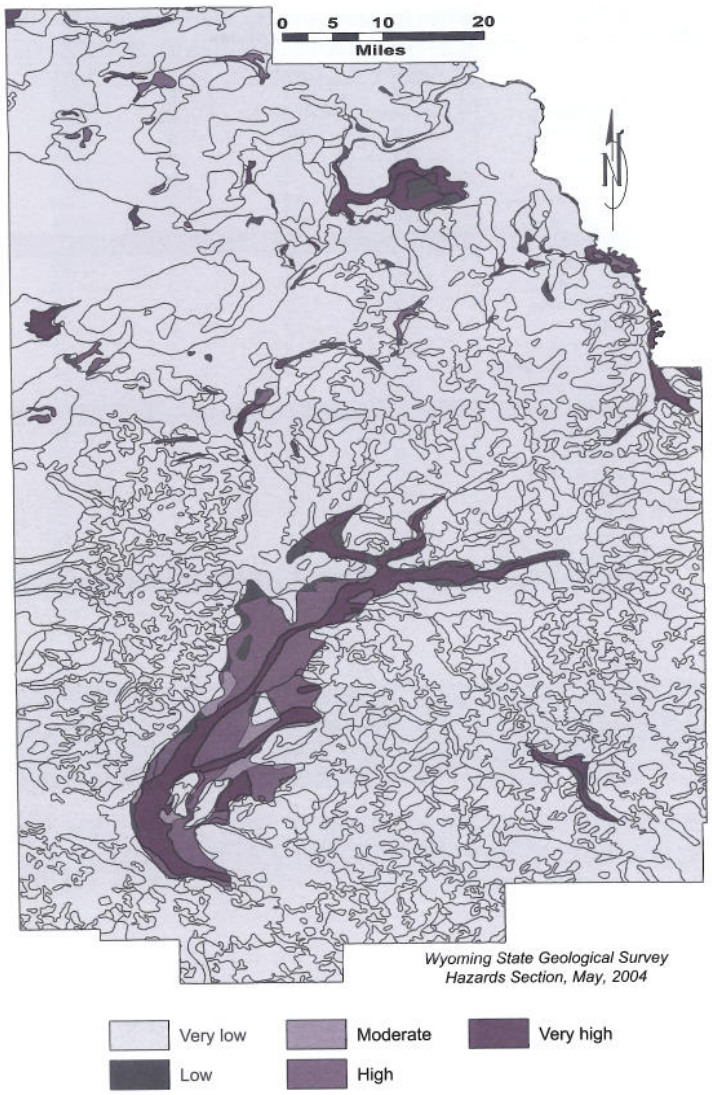

Figure 29. Liquefaction probability for Teton County from HAZUS-MH using data generated by the WSGS.

Table 19. Building-related economic loss estimates (millions of dollars) for Teton County, Wyoming from HAZUS-MH block-level analysis, default data (2500-year probabilistic).

Area	Single family	Other residential	Commercial	Industrial	Others	Total
Income losses						
Wage	0.00	7.59	31.79	0.54	0.63	40.55
Capital-related	0.00	3.24	30.91	0.30	0.12	34.57
Rental	6.81	12.37	9.21	0.06	0.28	28.73
Relocation	0.77	0.21	0.54	0.01	0.07	1.60
Subtotal	7.58	23.41	72.45	0.91	1.10	105.45
Capital stock losses						
Structural	37.73	11.29	22.18	2.66	2.40	76.26
Non-Structural	141.50	60.78	76.49	9.43	6.31	294.51
Content	34.04	12.58	34.11	5.13	2.91	88.77
Inventory	0.00	0.00	0.86	1.14	0.09	2.09
Subtotal	213.27	84.65	133.64	18.36	11.71	461.63
Total	220.85	108.06	206.09	19.27	12.81	567.08

Casualty levels

There are four levels of casualties used in HAZUS: Level 1 – minor injuries; Level 2 – X-rays or surgery required; Level 3 – life-threatening injuries; and Level 4 – mortally injured.

The changes in casualties from HAZUS-99 to HAZUS-MH are significant. Generally, casualty estimates increase from HAZUS-99 census-tract-level analysis (**Table 21**) to HAZUS-MH census-block-level analysis (**Table 22**) using default data. The exception is for 2 pm casualties. Casualty estimates using HAZUS-MH census-block-level analyses also increase from the default data analysis (**Table 22**) to the analysis utilizing user-supplied soils, liquefaction, and landslide data (**Table 23**).

Summary

HAZUS is becoming a useful tool for estimating the effects of earthquakes. As the national pilot project state for HAZUS-MH (using census-block-level analyses), Wyoming has had the opportunity to refine earthquake damage estimates for all counties. HAZUS-MH will be further defined as default infrastructure data are replaced with data generated by the WSGS.

Table 20. Building-related economic loss estimates (millions of dollars) for Teton County, Wyoming from HAZUS-MH block-level analysis, user-supplied data (2500-year probabilistic).

Area	Single family	Other residential	Commercial	Industrial	Others	Total
Income losses						
Wage	0.00	8.58	34.73	0.58	0.70	44.59
Capital-related	0.00	3.67	34.14	0.32	0.13	38.26
Rental	9.07	14.90	9.72	0.07	0.30	34.06
Relocation	0.99	0.24	0.57	0.01	0.08	1.89
Subtotal	10.06	27.39	79.16	0.98	1.21	118.80
Capital stock losses						
Structural	52.92	14.05	24.00	2.84	2.60	96.41
Non-structural	189.33	77.74	88.55	10.81	7.26	373.69
Content	46.55	16.46	40.29	5.90	3.42	112.62
Inventory	0.00	0.00	0.98	1.33	0.10	2.41
Subtotal	288.80	108.25	153.82	20.88	13.38	585.13
Total	298.86	135.64	232.98	21.86	14.59	703.93

Table 21. Casualty estimates for Teton County, Wyoming from HAZUS-99-SR2 tract-level analysis, default data (2500-year probabilistic).

		Level 1	Level 2	Level 3	Level 4
2 AM	Residential	87	21	3	5
	Non-residential	15	4	1	1
	Commute	0	0	0	0
	Total	102	25	4	6
2 PM	Residential	22	5	1	1
	Non-residential	332	102	17	34
	Commute	0	0	0	0
	Total	354	107	18	35
5 PM	Residential	26	6	1	2
	Non-residential	148	45	8	15
	Commute	0	0	1	0
	Total	174	51	10	17

Table 22. Casualty estimates for Teton County, Wyoming from HAZUS-MH block- level analysis, default data (2500-year probabilistic).

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	3	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	25	7	1	2
	Industrial	3	1	0	0
	Other-residential	50	13	1	3
	Single family	77	18	2	4
	Total	158	40	4	9
2 PM	Commercial	201	61	10	20
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	5	1	0	0
	Industrial	26	8	1	2
	Other-residential	9	2	0	0
	Single family	14	3	0	1
	Total	256	75	12	24
5 PM	Commercial	127	39	6	13
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	7	2	0	1
	Industrial	16	5	1	1
	Other-residential	19	5	1	1
	Single family	31	7	1	2
	Total	200	58	9	18

Table 23. Casualty estimates for Teton County, Wyoming from HAZUS-MH block-level analysis, user-supplied data (2500-year probabilistic).

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	4	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	32	10	2	3
	Industrial	4	1	0	0
	Other-residential	71	19	2	4
	Single family	137	35	3	6
	Total	248	66	7	13
2 PM	Commercial	239	75	13	25
	Commuting	0	0	0	0
	Educational	2	0	0	0
	Hotels	6	2	0	1
	Industrial	27	8	1	3
	Other-residential	13	3	0	1
	Single family	26	6	1	1
	Total	313	94	15	31
5 PM	Commercial	151	47	8	16
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	10	3	0	1
	Industrial	18	5	1	2
	Other-residential	27	7	1	2
	Single family	55	14	2	2
	Total	261	76	12	23

PUBLICATIONS UPDATE

New Publications Available from the Wyoming State Geological Survey

Wyoming State Geological Survey publications

2004 Calendar, Exploring Wyoming's Geology, by the Wyoming State Geological Survey, 2004: poster, rolled - FREE.

Wyoming State Geological Survey publications catalog, August 2003: Available on CD-ROM or 40 p. printed catalog – FREE.

Fossils of Wyoming, by M.W. Hager, 1970: digital version of Bulletin 54, CD-ROM only - $5.00.

Thermal springs of Wyoming, by R.M. Breckenridge and B.S. Hinckley, 1978: digital version of Bulletin 60 (Includes Bulletin 19, The mineral hot springs of Wyoming, by A.B. Bartlett, 1926), CD-ROM only - $5.00.

A geologic tour of Wyoming from Laramie to Lander to Jackson and Rock Springs, by B Mears, Jr. and others, 1986: digital version of Public Information Circular 27, CD-ROM only - $5.00.

Coalbed methane activity in the eastern Powder River Basin, Campbell and Converse counties, Wyoming, by R.H. De Bruin, R.M. Lyman, L.L. Hallberg, and N.R. Jones, 2004: Map Series 56 (updated to March 1, 2004, replaces 2003 version), on-demand plotted color map, rolled only - $30.00.

Coalbed methane activity in the western Powder River Basin, Campbell, Converse, Johnson, Natrona, and Sheridan counties, Wyoming, by R.H. De Bruin, R.M. Lyman, L.L. Hallberg, M.M. Harrison, and N.R. Jones, 2004: Map Series 57 (updated to March 1, 2004, replaces 2003 version), on-demand plotted color map, rolled only - $30.00.

Coalbed methane activity in the Powder River Basin, Campbell, Converse, Johnson, Natrona, and Sheridan counties, Wyoming, by R.H. De Bruin, R.M. Lyman, L.L. Hallberg, M.M. Harrison, and N.R. Jones, 2004: Map Series 58 (this is a reduced and combined version of MS-56 and MS-57 at 1:250,000 scale, updated to March 1, 2004, replaces 2003 version), on-demand plotted and laminated color map, rolled only - $50.00; on-demand plotted color map, rolled only - $40.00; ESRI® ArcGIS®/ ArcReader® format on CD-ROM (including MrSid® viewable files) - $50.00.

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Wyoming multi-hazards flood map modernization state business case plan FY 2004-2008, by J.C. Case and E.A. Dobler, 2004, Open File Report 04-2, 28 pages copied - $4.20.

Staff Profile: Jesse T. Bowen

Brooke K. Culver

Publications Intern–Publications, Wyoming State Geological Survey

Jesse T. Bowen (**Figure 30**) is the Information Technology (IT) Manager for the Wyoming State Geological Survey (WSGS). Jesse is responsible for the operation and networking of all the Survey's computer hardware and software. He describes his job as "managing the day to day operations of the IT department of the Survey." His duties include performing routine maintenance, installing upgrades, and installing software for the Survey's thirty workstations. Jesse also designs and implements various software packages and databases to assist the Survey in performing its duties. He provides assistance to the Survey's staff in both IBM/PC and Macintosh computer systems and Jesse assists with spreadsheets, word processing, graphics programs, and associated hardware. Jesse maintains and updates the Survey's web site and helps the Survey's personnel use web-based applications. He creates, oversees, and implements computer databases, as well as standards and procedures for the Survey's data, maps, and records including GIS-related components.

continued on next page

Figure 30. Jesse T. Bowen is the Information Technology Section Manager at the WSGS. Photograph by Jaime R. Moulton.

*Geologic map of the Hole-in-the-Wall 1:24,000-scale Quadrangle, Johnson County, Wyoming, by A.J. Ver Ploeg, 2004: Open File Report 04-12, plotted color map, rolled only - $10.00.

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*New releases since Wyoming Geo-notes No. 79 (March, 2004).

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These components include scanning, digitizing, and plotting of maps. Jesse is responsible for maintaining a secure data infrastructure and he supervises three IT personnel.

Jesse was born in Douglas, Wyoming. He has lived all over the U.S., however, he spent most of his childhood in Douglas and in Milwaukee, Wisconsin. Growing up, Jesse was always interested in computers and started with an Apple 2C, which can be described as an eighties laptop. After graduating from Douglas High School, Jesse left Douglas to join the U.S. Navy, which provided a good education in computers. After leaving the Navy, Jesse continued his education at the University of Wyoming (UW), receiving a B.S. degree in computer science. While attending UW, Jesse had several jobs. He worked as a Computer Technician for Rocky Mountain Computers where he designed a Microsoft Access database to keep track of customers and parts inventory for the company. He worked at StarTek as a Technical Support Agent, giving technical support to America Online members. He also worked as a Cable Technician for UW Telecom where he assisted in the wiring and terminating of CAT 5 cable for UW and installing single- and multi-mode fiber-optic cable.

In July, 2001, Jesse came to the WSGS as an Information Technology Specialist, where he was responsible for assisting the IT Manager. He started working part-time and then as an intern for the IT department at the Survey. In January, 2004, Jesse officially became the new IT manager, the position he currently holds. He enjoys working for the Survey because of its flexibility, environment, and the people he works with. During his time at the Survey, Jesse has revamped the web site, basically from scratch. He is currently developing three Internet Map Service (IMS) sites, which consist of multi-layered maps of the U.S., which enable the user to zoom in and out. Jesse has completed one IMS site, along with supervising a data download project and an online stereo image library. Jesse continues to obtain more certifications since computers and related technologies are always advancing.

Jesse and his wife Antionette have two children, Brandon, 11, and Heather, 7. In his spare time Jesse enjoys playing games on the computer and lots of outdoor activities, such as hunting, fishing, camping, snowmobiling, and four-wheeling.

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USGS Bulletin 2018, Geological investigations of the Wamsutter Rim canneloid coal bed in the Eocene Niland Tongue of the Wasatch Formation, northern Washakie Basin, Wyoming, by H.W. Roehler and R.W. Stanton, 1992, 16 p., 1 pl. - $1.00.

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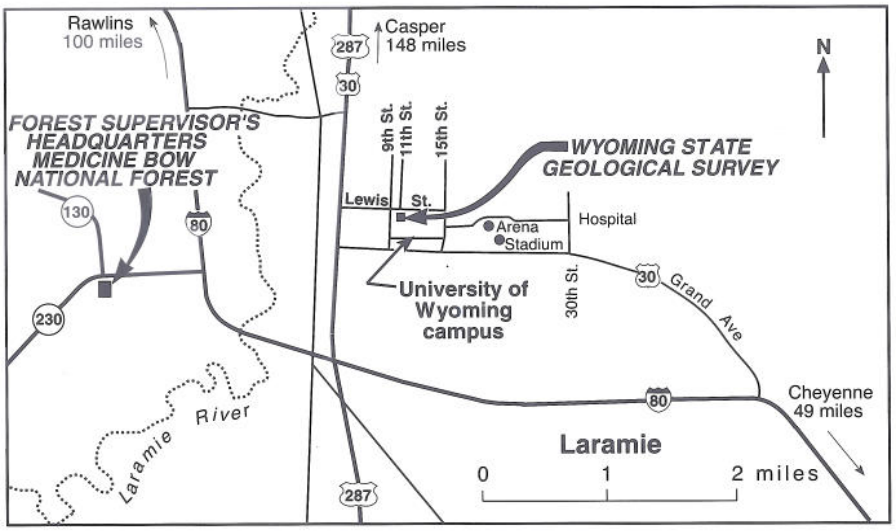

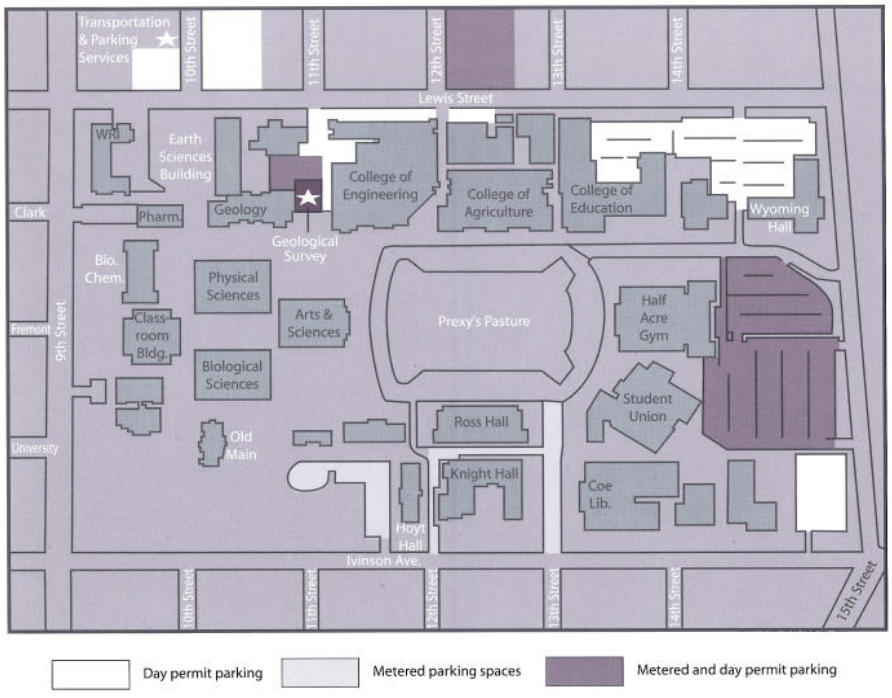

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