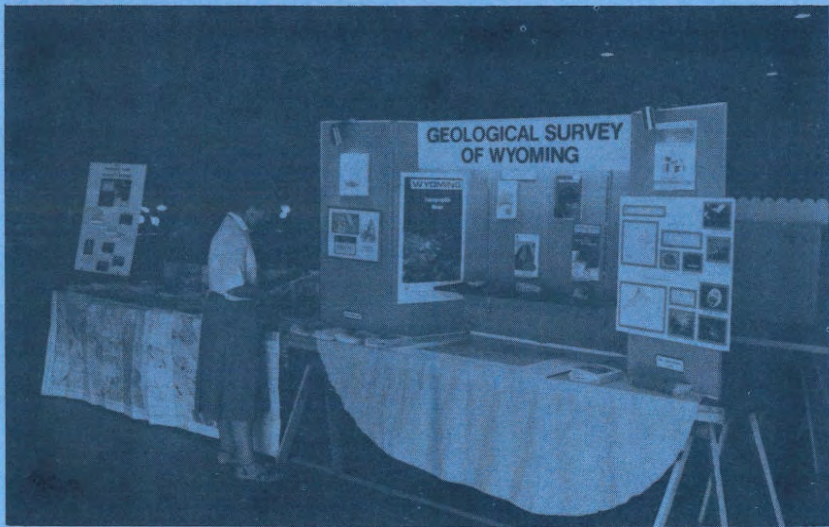


Gary B. Glass, State Geologist  
THE GEOLOGICAL SURVEY OF WYOMING

# WYOMING GEO-NOTES NO. 21



LARAMIE, WYOMING

January, 1989

THE GEOLOGICAL SURVEY OF WYOMING

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WYOMING GEO-NOTES

This quarterly digest on the State's geology and mineral resources and activities of the Geological Survey is available by subscription (four issues for \$5.00) or as single copies at \$1.50 each.

**Front cover:** The new Geological Survey display at the Casper, Wyoming, Gem, Mineral, and Hobby Show, July 30 and 31, 1988.

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The Geological Survey of Wyoming  
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- Please note -

## PHONE NUMBER CHANGE

The Geological Survey of Wyoming  
now has only one phone number:

(307) 766-2286

Several lines are accessed by this single number, so you should experience fewer busy signals. We hope this change will be more convenient for everyone.

## Minerals update

### OVERVIEW

by Gary B. Glass, State Geologist and Director, Geological Survey of Wyoming

There were some pleasant surprises in regard to minerals during the last quarter of 1988. Perhaps the most significant was a strengthening of oil prices following OPEC's agreement on new production quotas. At least at the end of December, the price had not fallen to \$10 or less a barrel as some analysts feared, and the more likely prognosis was that oil prices might show some moderate stability above \$14 a barrel for awhile. There was even some optimism for a gradual increase in prices, at least on the shorter term.

We suspect that the record coal production that we forecast in the third quarter will be exceeded. Instead of 153.3 million tons, production from Wyoming coal mines may well exceed 155 million tons in 1988. There is every reason to expect that annual coal production will remain above 150 million tons for the foreseeable future, and it could even stabilize at or above the forecast 155 million predicted for 1988.

Trona production has remained high due to increased demands related to a shortage of caustic soda.

A November announcement of significant Japanese contracts for Wyoming uranium increased optimism for the State's uranium industry. While it is still unclear how much uranium from Wyoming will really go to the announced contracts, there will certainly be some. Now at least four companies with properties in Wyoming apparently have new uranium contracts.

In the case of combustible natural gas, it still looks like California will become a significant market for some Wyoming gas production. Even one of the out-of-state competitors for this market indicated it too would use some gas from Wyoming. However, a decision on which company or companies will supply this market has still not been made.

Overall, the prognosis for the State's mineral industry improved slightly in the last quarter of 1988. Yes, Virginia, there really is a Santa Claus.

Wyoming mineral production forecast to 1992<sup>1</sup>.

Calendar Year	Oil Production <sup>2</sup>	Methane Production <sup>3</sup>	Carbon Dioxide Production <sup>3</sup>	Helium Production <sup>4</sup>	Coal Production <sup>5</sup>	Trona Production <sup>6</sup>	Mined Uranium Production <sup>6</sup>	In situ Uranium Production <sup>7</sup>	Sulfur Production <sup>8</sup>
*1981	122.1	455.4	--	--	102.8	11.8	4.6	--	0.05
*1982	118.7	465.1	--	--	107.9	10.1	2.1	--	0.07
*1983	120.9	539.7	--	--	112.2	10.5	3.0	--	0.57
*1984	127.8	600.1	--	--	130.7	11.0	1.6	--	0.63
*1985	131.0	597.9	--	--	140.4	10.8	0.6	--	0.80
*1986	122.4	563.2	23.8	0.15	136.3	13.3	0.3	--	0.66
*1987	115.9	622.7	110.5	0.84	146.5	13.6	0.2 <sup>9</sup>	0.06	1.20
1988	117.0	689.5	110.5	0.84	155.0	15.1	0.02	3.0	1.20
1989	116.0	708.4	110.5	0.84	150.0	15.3	0.02	3.0	1.20
1990	110.0	728.0	110.5	0.84	151.0	15.5	0.02	3.0	1.20
1991	103.0	748.1	110.5	0.84	152.0	15.5	0.02	3.0	1.20
1992	96.5	768.9	110.5	0.84	153.0	16.5	0.02	4.0	1.20

\*Actual values for comparison; <sup>1</sup> Geological Survey of Wyoming, January 1989; <sup>2</sup> millions of barrels; <sup>3</sup> billions of cubic feet; <sup>4</sup> billions of cubic feet, based on Exxon's estimate that the average helium content in the gas processed at Shute Creek is 0.5 percent; <sup>5</sup> millions of tons; <sup>6</sup> millions of tons of uranium ore (not yellowcake); <sup>7</sup> millions of pounds of yellowcake (U<sub>3</sub>O<sub>8</sub>), (unknown between 1981-1986 because it was reported only as taxable valuation; estimates for 1988-1992 are based on company information); <sup>8</sup> millions of tons, converted from gallons of sulfur produced at gas processing plants as reported to the Wyoming Oil and Gas Conservation Commission; <sup>9</sup> Includes previously stockpiled ore processed by the Lucky Mc mill in 1987.

## OIL AND GAS UPDATE

by Rodney H. DeBruin, Oil and Gas Division Head, Geological Survey of Wyoming

Average posted prices for Wyoming Sweet declined every month from July through November, 1988, because of increased supplies of crude oil on the world market. The average posted price in July was \$14.75 per barrel; for August it was \$14.50; for September it was \$14.00; for October it was \$13.00; and for November it dropped to \$12.75. The good news was that posted prices for Wyoming Sweet crude oil climbed to an average of \$14.50 for December because of the production agreement signed by the OPEC oil ministers at the end of November. Futures prices for 1989 delivery of West Texas Intermediate crude also climbed to between \$15.00 and \$17.00 per barrel. West Texas Intermediate generally trades for about the same price as Wyoming Sweet. The new agreement takes effect January 1, 1989, for a 6-month period and limits total OPEC production to 18.5 million barrels of crude oil per day. Prior to the agreement, oil analysts estimated total OPEC production at around 22.5 million barrels a day.

Unfortunately, the oil minister from the United Arab Emirates indicated that the output level set in the agreement was not his country's official quota. Past experience with OPEC's production agreements indicates that if one OPEC country cheats on its quotas, it isn't long until other members follow suit and the increased production from cheaters within OPEC sends prices lower. Hopefully, the production

agreement will hold and prices for Wyoming's crude oil will stabilize above \$15 a barrel.

The low prices from July through November are mirrored by the rig count for those months. The count shows a steady decline with the exception of a small increase in August (see figure on page 5). The average count for December, 1988, remained nearly level with the average count for November; however, the estimated average count of 36 for 1988 is almost the same as 1986 and slightly lower than the 1987 average count (see figure on page 5).

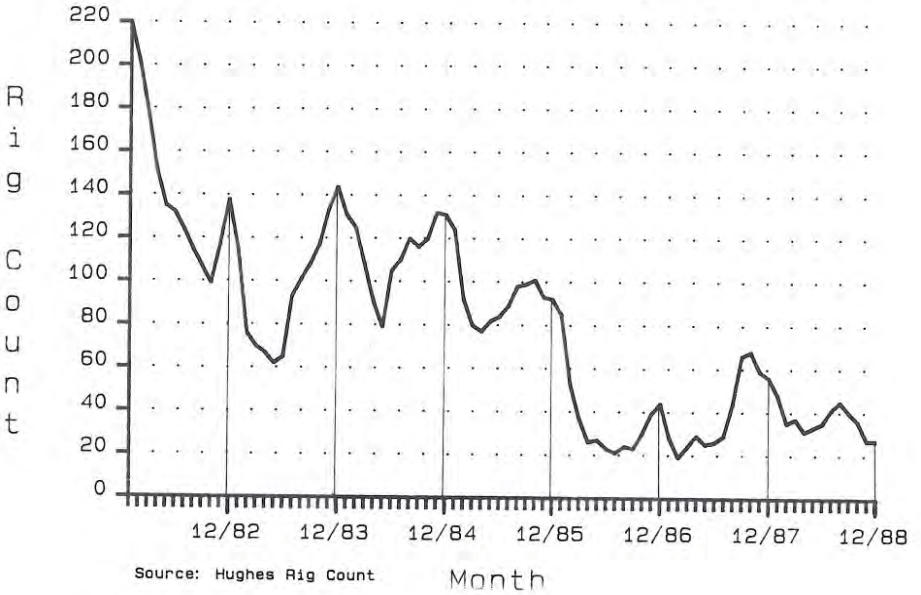
In an item related to the relatively low oil prices in 1987, figures released by the Interstate Oil Compact Commission and the National Stripper Well Association show that 18,241 stripper wells (wells that produce less than 10 barrels of oil a day) were abandoned in 1987. In the Rocky Mountain Region, Wyoming led in abandonments with 510. Colorado's 224 abandonments were a distant second. Wyoming had 3,486 stripper wells at the end of 1987. As recently as 1985, Wyoming had an estimated 5,200 stripper wells. The Wyoming Legislature's recent change in the definition of stripper production may have kept the abandonment level lower than it might have been. In 1986, for comparison, over 1,200 stripper wells were abandoned. This was before the Legislature redefined stripper production, thereby allowing operators of many marginal wells to report them as stripper wells. Stripper wells are taxed at a lower rate than other producing wells.

It was a banner year for lease sales in Wyoming. Total revenue from State and Federal sales was at a 4-year high (see tables on page 6). The U.S. Bureau of Land Management (BLM) instituted a new system of oral bids and auctioned off a very large amount of acreage. This new system helped raise total Federal revenues. On the negative side, the last two BLM and State sales realized less revenue than earlier sales in 1988. This was once again in response to low crude oil prices. The high per-acre bid at the October BLM sale was \$6,500 by General Atlantic Energy for a 160-acre lease in section 10, T.49N., R.70W. in the Powder River Basin. This lease offsets Minnelusa oil production in Winter Draw Field. This one tract accounted for a little over a quarter of the total revenue in this sale.

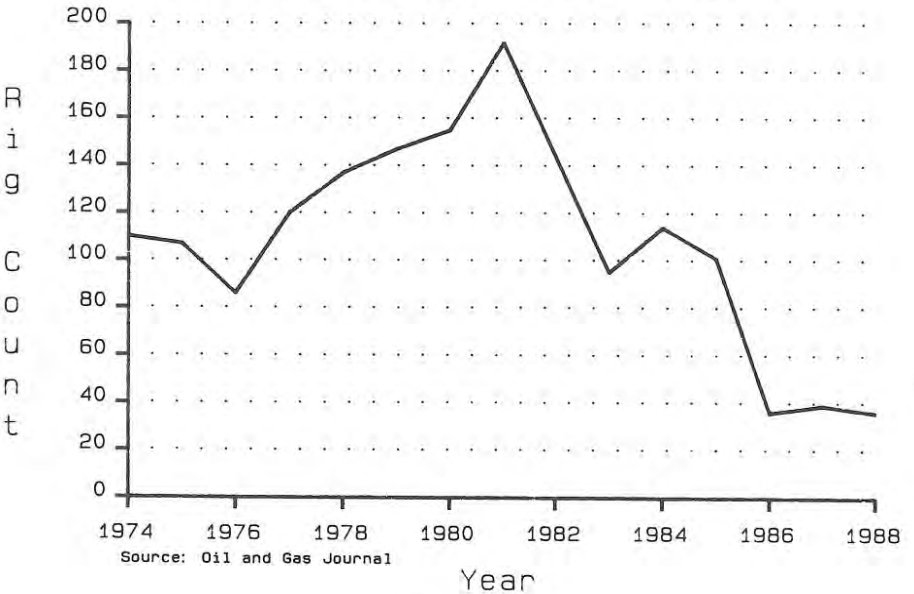
The high bid at the December BLM sale was \$330 per acre by Enron Oil and Gas for a 3.92-acre lease in the bed of the Green River in section 2, T.27N., R.112W. The lease offsets production in Bird Canyon Field. In all, 13 leases sold for \$100 or more per acre. Yates Petroleum was the most successful bidder at this sale and picked up 55 parcels.

The top bid of \$130 per acre at the Wyoming Department of Public Land's November sale was made for two Powder River Basin leases. Don Sullivan picked up an 80-acre lease in section 36, T.47N., R.71W., just south of Minnelusa production in Big Hand Field. Woods Petroleum bid successfully for an 80-acre parcel in section 36, T.48N., R.72W., just over a mile northeast of Minnelusa production in Oxbow Field. Only two other parcels received high bids of \$100 or more per acre. Very low oil prices in November and the fear that OPEC might not reach

WYOMING RIG COUNT  
 AVERAGED BY MONTH (1982 TO PRESENT)



WYOMING RIG COUNT  
 AVERAGED BY YEAR (1974 TO 1987)





# WYOMING FEDERAL AND STATE COMPETITIVE OIL AND GAS LEASE SALES

## BLM SALES

Month	Total Revenue	Number of parcels offered	Number of parcels sold	Total acres	Acres sold	Average price per acre sold	High price per acre
1986							
February	\$ 1,992,326	211	154	58,507	38,809	\$ 51.34	\$ 680.00
April	1,795,890	189	116	54,136	29,938	59.99	1,881.88
June	1,332,216	86	75	27,137	24,512	54.35	437.50
August	529,184	104	88	25,686	22,725	23.29	227.63
October	840,950	76	68	17,827	16,604	50.65	516.86
December	774,824	110	82	28,057	19,840	39.05	3,313.13
<b>TOTAL</b>	<b>\$ 7,265,390</b>	<b>776</b>	<b>583</b>	<b>211,350</b>	<b>152,428</b>	<b>\$ 47.66</b>	<b>\$ 3,313.13</b>
1987							
February	\$ 814,653	78	64	18,866	15,537	\$ 52.43	\$ 1,226.56
April	779,821	95	68	23,338	16,214	48.10	332.00
June	6,436,196	123	121	26,188	25,668	250.75	6,555.00
August	1,327,186	81	74	22,908	21,055	63.03	800.01
October	3,274,611	137	129	34,858	33,828	96.80	6,031.15
December	3,091,692	213	190	71,264	65,658	47.09	521.00
<b>TOTAL</b>	<b>\$15,724,159</b>	<b>727</b>	<b>646</b>	<b>197,422</b>	<b>177,960</b>	<b>\$ 88.36</b>	<b>\$ 6,555.00</b>
1988							
March	\$ 7,338,210	866	336	1,073,940	315,387	\$ 23.27	\$ 525.00
June	7,564,135	820	375	755,242	293,050	25.81	575.00
August	5,827,548	847	363	827,471	278,198	20.95	1,350.00
October	3,913,765	820	257	994,618	282,145	13.87	6,500.00
December	3,045,203	766	260	761,242	182,117	16.72	330.00
<b>TOTAL</b>	<b>27,688,861</b>	<b>4,119</b>	<b>1,591</b>	<b>4,412,513</b>	<b>1,350,897</b>	<b>20.50</b>	<b>6,500.00</b>

## STATE SALES

Month	Total Revenue	Number of parcels offered	Number of parcels sold	Total acres	Acres sold	Average price per acre sold	High price per acre
1986							
January	\$ 630,069	200	123	83,064	49,783	\$ 12.66	\$ 320.00
March	773,492	199	112	77,237	44,504	17.38	370.00
May	354,941	200	70	74,128	27,543	12.89	140.00
July	418,280	200	63	86,495	25,461	16.43	234.00
September	171,975	200	80	87,017	33,738	5.10	360.00
November	99,403	200	74	75,385	24,728	4.02	120.00
<b>TOTAL</b>	<b>\$ 2,448,160</b>	<b>1,199</b>	<b>522</b>	<b>483,326</b>	<b>205,757</b>	<b>\$ 11.90</b>	<b>\$ 370.00</b>
1987							
January	\$ 300,404	200	74	87,145	32,606	\$ 9.21	\$2,300.00
March	270,234	200	83	87,034	35,770	7.55	100.00
May	416,108	200	88	81,343	34,111	12.20	260.00
July	477,891	200	107	91,884	47,015	10.16	125.00
September	362,903	200	100	82,367	44,698	8.12	210.00
November	699,027	200	127	81,865	50,540	13.83	290.00
<b>TOTAL</b>	<b>\$ 2,526,567</b>	<b>1,200</b>	<b>579</b>	<b>511,638</b>	<b>244,740</b>	<b>\$ 10.32</b>	<b>\$2,300.00</b>
1988							
January	\$ 826,698	200	142	76,953	56,430	\$ 14.65	\$ 200.00
March	800,213	200	133	76,304	48,423	16.53	465.00
May	1,649,974	200	182	75,987	69,285	23.81	290.00
July	1,855,646	200	155	77,168	60,519	30.66	375.00
September	751,646	200	142	68,456	55,168	13.63	180.00
November	318,547	200	119	71,085	42,118	7.56	130.00
<b>TOTAL</b>	<b>6,202,724</b>	<b>1,200</b>	<b>873</b>	<b>445,953</b>	<b>331,943</b>	<b>18.69</b>	<b>465.00</b>

Sources: Wyoming Department of Public Lands, Petroleum Information Corporation - Rocky Mountain Region Report, and U.S. Bureau of Land Management.

a production agreement helped make this sale a poor one in terms of total revenue and average price per acre (see table on page 6).

Two environmental groups filed a protest against the BLM's December oil and gas lease auction in Wyoming on the grounds that the BLM failed to perform adequate environmental studies on the tracts. The BLM claimed that only 24 of the 766 parcels offered at this sale might be affected by the protest and the sale was held as scheduled.

U.S. Department of the Interior officials have refused to grant Exxon Corporation millions of dollars in extraordinary allowances. If these allowances had been granted, Exxon would have owed the Federal government substantially lower royalty payments. Wyoming stood to lose several million dollars since half the Federal royalties come back to the State. The Minerals Management Service, which already granted Exxon allowances for reasonable costs associated with the Shute Creek gas processing plant in southwest Wyoming, denied the company relief under the extraordinary cost allowance provision of the Interior Department's product value regulations. Exxon must now pay \$6.5 million in additional 1988 royalties, but may appeal the decision.

In a somewhat related item, Wyoming's share of royalties, bonuses, rents, and other mineral revenue from mineral production on Federal lands totaled \$151.9 million during fiscal year 1987, which was a drop of \$1 million from fiscal year 1986. Wyoming received 40.3 percent of the \$377 million distributed to 29 states. According to the U.S. Department of the Interior (Minerals Management Service, 1988), oil companies in the State produced 71.3 million barrels of oil from Federal land, and gas companies produced 267.6 billion cubic feet of gas from Federal land. Of the \$151.9 million paid to the State, nearly \$98 million was from royalties on oil and gas production.

A draft environmental impact statement just released by the BLM concludes that Amoco Production's proposed carbon dioxide oil recovery project will have very few long-term adverse effects on the environment. If the proposed project is implemented, Amoco would drill 10 wells in Raptor Field, build a gas processing plant in southwest Wyoming, lay 266 miles of trunk pipelines, and build plants to recover carbon dioxide at the fields proposed for tertiary recovery (see *Wyoming Geo-notes No. 18*, p. 29-32, for more information on this project and on carbon dioxide in the State). Carbon dioxide flooding at Elk Basin, Salt Creek, Beaver Creek, and Little Buffalo Basin Fields could recover a total of 160 million additional barrels of oil according to the draft statement. Nearly 3,000 workers would be needed on the construction phases of the various projects planned between 1990 and 1994.

Another major new project is the proposed pipeline to supply gas to cogeneration projects in California. It was announced that the Wyoming-California Pipeline Company (WyCal) won conditional Federal approval for its proposed pipeline to California. A spokesman for the company said that the approval is helping the company in its negotiations with prospective shippers. The Kern River Gas Transmission Company would also ship Wyoming natural gas and is vying with WyCal for Wyoming's proposed \$250 million gas pipeline loan. It is expected that Kern River's application will also be approved soon. Probably

only one pipeline will be built to supply southern California's market. Other pipelines, which originate outside Wyoming, are also in the competition. In fact, representatives of the Mohave Project made a presentation to Wyoming's Pipeline Authority in mid-December.

In a related matter, a conference sponsored by several State agencies and a legislative subcommittee was chaired by Governor Mike Sullivan in Casper on November 30. The purpose of the conference was to help promote the sale of Wyoming gas to California markets. Attendees included officials from Wyoming as well as representatives from the California Public Utilities Commission, the California Energy Commission, a number of southern California utilities, the Federal Energy Regulatory Commission, and WyCal and Kern River Pipeline Companies.

The Interior Department will once again sell Federal land to holders of oil shale mining claims. About 54,000 acres in Lincoln County, Wyoming, are covered by 340 oil shale claims, but as yet no patent applications have been filed on the Wyoming claims. The patenting process allows claimholders to purchase land for \$2.50 per acre if they can prove that they invested at least \$100 a year to develop the oil shale on the claim.

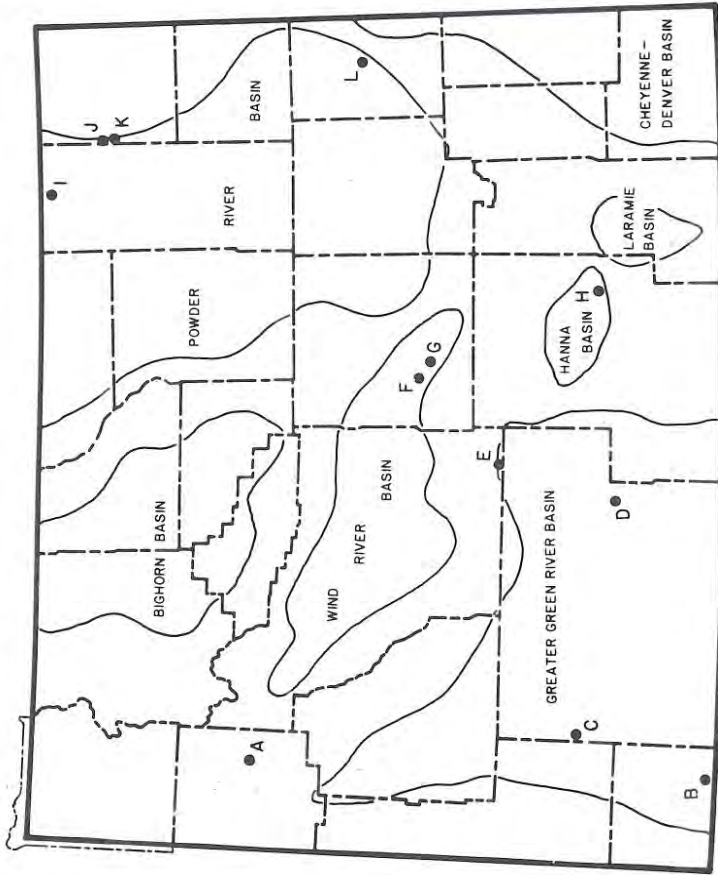
Based on company data and on information compiled and published by Petroleum Information, the following significant exploration and development events occurred in Wyoming during the fourth quarter of 1988. The letters preceding the following discussions refer to locations on the map on page 9.

A. Amoco Production Company successfully fought off several appeals that would have prevented them from drilling the 1-35 Sohare Unit well in section 35, T.43N., R.112W. in Teton County, and they will begin construction of an access road next summer. The well will be drilled next summer and is projected to 11,050 feet in the Madison Limestone.

B. Texaco, Incorporated completed an exploratory well in the Luckey Ditch area. The 2 Whiskey Springs Unit in section 6, T.12N., R.114W. was completed in the Dakota and flowed 546 barrels of oil, 1.1 million cubic feet of gas, and 20 barrels of water per day. The well is a mile west of current production from the Dakota at Luckey Ditch Field.

C. Two new producing wells were completed in the Swan/Lincoln Road/Blue Forest area. General Atlantic Energy completed their 20-23 Federal well in section 23, T.24N., R.111W. for 975,000 cubic feet of gas and 75 barrels of condensate per day from the Dakota. Thermal Exploration completed their 2-8 Raptor Unit well in section 8, T.24N., R.111W. for 1,839,000 cubic feet of gas and 120 barrels of condensate per day, also from the Dakota.

D. Amoco Production announced plans to drill an 18,900-foot test to the Morrison Formation near Wamsutter, Wyoming. The well will be drilled in section 13, T.19N., R.95W., about 3 miles northwest of Wild Rose Field, which has produced gas from the Mesaverde Group.



WYOMING GEOLOGICAL SURVEY, 1989

OIL AND GAS EXPLORATION ACTIVITY IN WYOMING

E. Production casing was set at the 1 Outlaw-Federal well, drilled by Sun Exploration and Production in section 25, T.27N., R.92W. A completion will be attempted in the Frontier Formation at 14,347 feet. The nearest Frontier production is at Lost Soldier Field, nearly 10 miles southeast of this well.

F. BHP Petroleum tested their 5-22 Sun Ranch Field development well in section 22, T.33N., R.86W. for 498 barrels of oil and 519,000 cubic feet of gas per day from the Muddy Sandstone. Effective November 23, the Wyoming Oil and Gas Conservation Commission ordered production from the Muddy Sandstone in Sun Ranch Field shut in until a pressure maintenance unit is formed. Evidence presented at the November hearing indicated that the Muddy is presently producing below the bubble point and the gas/oil ratio is increasing. Production should resume in the summer of 1989.

G. Tenneco Oil completed the 1-7 Schloegel-Federal well as a confirmation well for the Austin Creek Field discovery. The well in section 7, T.32N., R.84W. flowed 801 barrels of oil and 985,000 cubic feet of gas per day from the Muddy Sandstone between 10,723 and 10,763 feet.

H. A new Dakota pay zone was established by Marathon Oil Company in Big Medicine Bow Field. The 4-25 Big Medicine Bow Unit well in section 25, T.21N., R.79W. pumped 263 barrels of oil, 8,500 cubic feet of gas, and 13 barrels of water per day. The field presently produces from the Tensleep Sandstone and the Sundance Formation.

I. Lario Oil and Gas completed a Muddy Sandstone oil discovery in section 15, T.57N., R.72W. pumping 182 barrels of oil and 100,000 cubic feet of gas per day. The 1 Ute-Federal is a mile east of Muddy production at Ute Field.

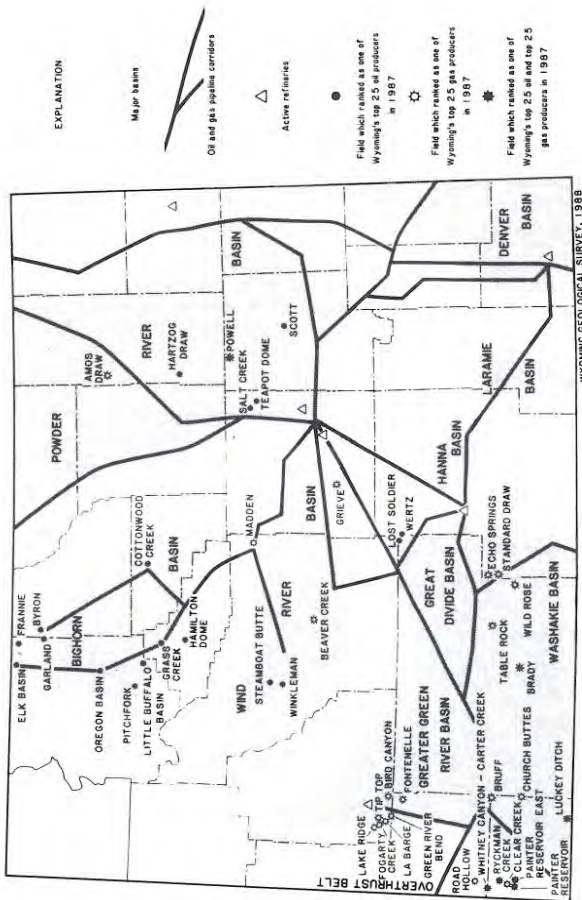
J. Wolf Draw Field has its second producing well. Decalta International completed the 34-18 Wolf Draw Federal in July, 1988. The well, in section 18, T.52N., R.68W., produced 4,785 barrels of oil through September from the Minnelusa Formation.

K. Quintana has a probable Minnelusa oil discovery in section 35, T.51N., R.68W. Five barrels of oil per hour were swabbed from the 1-35 West Prong-Federal during tests. The well is a mile west of Prong Creek Field, which also produces from the Minnelusa.

L. Powder River Petroleum has an apparent Minnelusa discovery. The 41-1 Johnson well in section 1, T.36N., R.64W. was cased after a drill-stem test recovered 310 feet of gas-cut oil and 300 feet of highly oil-cut and slightly water-cut mud.

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Minerals Management Service, 1988, Minerals revenues, the 1987 report of receipts from Federal and Indian leases: U.S. Government Printing Office, Washington, D.C., 109 p.



Top 25 oil fields in Wyoming based on 1987 production (Wyoming Oil and Gas Conservation Commission, 1988).

Name	Year discovered	1987 Production (barrels)	Cumulative production through 1987 (barrels)
Oregon Basin	1912	9,086,649	379,197,148
Hartzog Draw	1976	6,829,163	59,819,299
Salt Creek	1889	4,982,911	621,480,774
Painter Reservoir East <sup>1</sup>	1977	3,491,415	3,491,415
Wertz	1921	3,172,664	95,843,702
Hamilton Dome	1918	2,944,580	227,329,824
Elk Basin	1915	2,872,268	429,009,700
Little Buffalo Basin	1914	2,862,738	115,774,534
Brady	1973	2,725,373	32,982,741
Garland	1906	2,601,900	160,116,498
Powell	1954	2,443,335	16,904,165
Grass Creek	1914	2,426,463	182,487,226
Lost Soldier	1916	2,311,582	207,707,459
Pitchfork	1930	1,961,699	33,077,551
Painter Reservoir <sup>1</sup>	1977	1,910,939	43,053,775
Whitney Canyon - Carter Creek	1978	1,732,484	7,380,469
Frannie	1928	1,287,598	111,172,264
Luckey Ditch	1985	1,253,525	2,119,764
Byron	1918	1,243,343	119,391,917
Winkelman	1917	1,156,005	85,369,629
Teapot Dome Naval Reserve	1922	1,095,793	19,161,016
Ryckman Creek	1976	987,191	16,111,729
Scott	1979	923,473	10,776,760
Cottonwood Creek	1953	828,244	52,035,954
Steamboat Butte	1943	720,001	84,934,238
TOTAL		63,851,336	3,136,729,551

<sup>1</sup> Before 1987, production for Painter Reservoir and Painter Reservoir East Fields was combined under Painter Reservoir.

Top 25 natural gas fields in Wyoming based on 1987 production (Wyoming Oil and Gas Conservation Commission, 1988).

Name	Year discovered	1987 Production (MCF)	Cumulative production through 1987 (MCF)
Fogarty Creek <sup>1</sup>	1976	111,625,772	160,152,608
Whitney Canyon - Carter Creek	1978	99,987,425	491,514,275
Lake Ridge <sup>1</sup>	1981	53,461,941	57,266,187
Painter Reservoir <sup>2</sup>	1977	34,556,317	318,962,138
LaBarge	1925	25,648,090	243,329,565
Painter Reservoir East <sup>2</sup>	1977	24,134,974	24,134,974
Brady	1973	22,455,215	263,042,308
Madden	1969	21,448,856	253,193,179
Powell	1954	17,397,582	77,907,493
Ryckman Creek	1976	17,241,015	102,615,735
Clear Creek	1979	16,148,254	88,329,721
Echo Springs	1976	15,437,832	129,060,179
Standard Draw	1979	14,920,427	88,370,958
Table Rock	1946	14,235,648	414,509,389
Bruff	1974	9,541,900	102,273,383
Beaver Creek	1938	8,768,756	553,371,142
Wild Rose	1975	7,633,542	68,502,984
Amos Draw	1982	7,038,038	33,978,734
Green River Bend	1958	6,506,014	180,006,890
Church Buttes	1956	6,462,245	346,130,838
Tip Top	1928	5,603,179	327,332,099
Luckey Ditch	1985	5,434,437	9,871,072
Bird Canyon	1971	5,300,826	36,639,425
Fontenelle	1974	4,543,967	43,698,949
GrIewe	1954	4,186,355	93,305,742
TOTAL		559,718,607 <sup>3</sup>	4,507,499,967 <sup>4</sup>

<sup>1</sup> Approximately two-thirds of production from this field is carbon dioxide.

<sup>2</sup> Before 1987, production from Painter Reservoir and Painter Reservoir East Fields was combined under Painter Reservoir.

<sup>3</sup> Approximately 110,000,000 MCF are carbon dioxide.

<sup>4</sup> Approximately 145,000,000 MCF are carbon dioxide.

## COAL UPDATE

by Richard W. Jones, Coal Division Head, Geological Survey of Wyoming

Our previous estimate that Wyoming mines would produce 153.3 million tons of coal in 1988 may have been too low judging from the first three quarters of coal deliveries. Total coal delivered to electric utility companies from Wyoming mines through September, 1988, is over 10 million tons more than that reported for the same period a year ago (see table on page 14). The hot, dry weather over most of the United States in July and August resulted in record coal deliveries from Wyoming mines these 2 months as coal-fired electrical demand continued (see figure on page 15). Even if coal deliveries during the remainder of the year only equal coal deliveries during the last 3 months of 1987, coal production in 1988 could exceed 155 million tons. This would break the State's coal production record set last year by 8.5 million tons. Although accurate production figures are not yet available, Kentucky's coal production in 1988 is expected to be equal to or greater than the 161 million tons that they produced in 1987, and Wyoming, therefore, will remain the Nation's second largest coal-producing state.

A coal production forecast for Wyoming is presented in the table on page 16. After record production in 1988, Wyoming coal production will probably drop slightly in 1989 as coal demand stabilizes in response to more normal coal usage. Coal production should reach or exceed 150 million tons a year each of the next 4 years. Slight increases in total production are expected in 1991 and 1992 as new coal supply contracts are signed and expiring contracts are renewed.

A comparison of Federal, State, and privately-owned coal production in Wyoming (table on page 18) demonstrates the increased role of Federally owned coal in Wyoming. In 1981, only about 58 percent of the State's production was from Federal coal leases. By 1986, production from Federal coal leases (located primarily in the Powder River Basin) accounted for 82 percent of the State's total production. In contrast, coal production from State leases decreased dramatically between 1981 and 1987.

In 1987, the State of Wyoming received \$6.3 million in royalties from State coal leases, a decrease of almost 28 percent from the \$8.6 million in royalties received in 1986. Because coal production from State leases decreased only 20 percent between 1986 and 1987, part of the 28 percent decrease in collected royalties was caused by a decrease in the value of the coal. Indeed, the average royalty received from a ton of coal mined on a State lease in 1987 was 10 percent less than that received in 1986. The royalty rate on State coal ranges from 7 to 12½ percent of the value of the coal; the average royalty rate may vary from year to year depending on which State leases produce coal that year.

Federal coal produced in Wyoming in 1987 was valued at about \$1.6 billion and generated about \$60.9 million in royalties (of which the State of Wyoming received half). In 1986, Federal coal produced in Wyoming was valued at \$1.5 billion and generated about \$28.5 million



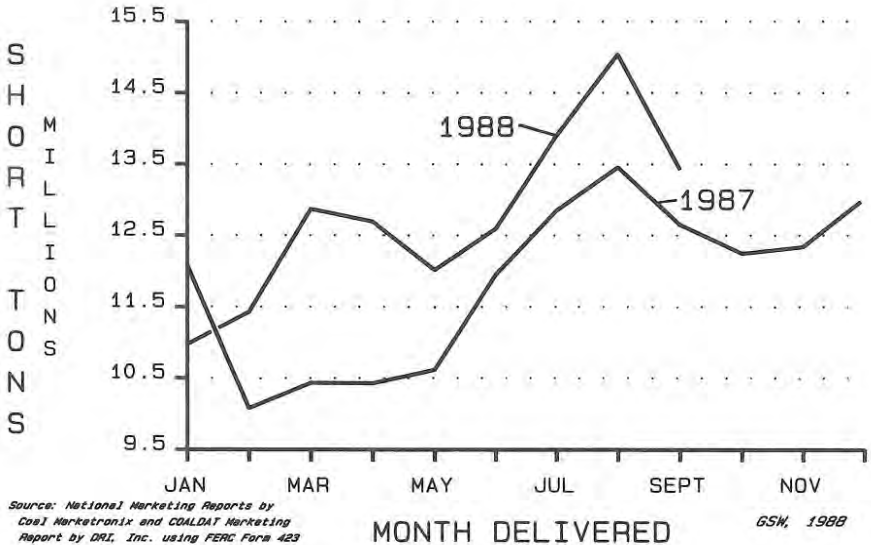
COAL DELIVERIES BY MONTH FROM WYOMING MINES<sup>1</sup>

	1984 MONTHLY	1984 CUMULATIVE	1985 MONTHLY	1985 CUMULATIVE	1986 MONTHLY	1986 CUMULATIVE	1987 MONTHLY	1987 CUMULATIVE	1988 MONTHLY	1988 CUMULATIVE
JANUARY	9,540,200	9,540,200	11,601,200	11,601,200	11,646,300	11,646,300	12,085,570	12,085,570	10,976,860	10,976,860
FEBRUARY	9,654,600	19,194,800	10,473,900	22,075,100	10,317,700	21,964,000	10,315,680	22,401,250	11,431,380	22,408,240
MARCH	10,875,000	30,069,800	11,674,900	33,750,000	11,401,720	33,365,720	10,436,610	32,837,860	12,871,090	35,279,330
APRIL	8,721,400	38,791,200	11,632,800	45,382,800	9,954,170	43,319,890	10,429,180	43,267,040	12,694,660	47,973,990
MAY	9,481,500	48,272,700	11,497,900	56,880,700	10,105,320	53,425,210	10,619,470	53,886,510	12,017,500	59,991,490
JUNE	9,464,500	57,737,200	11,692,200	68,572,900	10,499,280	63,924,490	11,953,650	65,840,160	12,595,480	72,586,970
JULY	11,019,600	68,756,800	11,893,500	80,466,400	11,497,190	75,421,680	12,850,240	78,650,400	13,905,670	86,492,640
AUGUST	11,433,000	80,189,800	12,107,100	92,573,500	11,773,510	87,195,190	13,460,470	92,150,870	15,041,090	101,533,730
SEPTEMBER	10,440,000	90,629,800	11,325,000	103,898,500	11,474,820	98,670,010	12,651,550	104,802,420	13,433,610	114,967,340
OCTOBER	10,492,500	101,122,300	11,048,500	114,947,000	10,854,670	109,524,680	12,248,080	117,050,500		
NOVEMBER	11,814,200	112,936,500	10,589,700	125,536,700	11,971,990	121,496,670	12,340,720	129,391,220		
DECEMBER	11,486,800	124,423,300	11,459,300	136,996,000	13,025,490	134,522,160	13,008,300	142,399,520		
TOTAL TONNAGE REPORTED	124,423,300		136,996,000		134,522,160		142,399,520		114,967,340	
TOTAL TONNAGE NOT REPORTED	6,322,479		3,784,154		1,782,896		4,089,128			
TOTAL TONNAGE PRODUCED <sup>2</sup>	130,745,779		140,780,154		136,305,056		146,488,648			

<sup>1</sup>Source: National Marketing Reports by Coal Marketlink, compiled from FERC Form 423 filed monthly by electric utilities.

<sup>2</sup>Source: Wyoming State Mine Inspector's Annual Reports.

# REPORTED DELIVERIES FROM WYOMING COAL MINES



in royalty revenues. Although average coal prices decreased between 1986 and 1987, many Federal coal leaseholders began paying a higher royalty rate in 1987. The royalty rate increase was mandated by the Federal Coal Leasing Amendments Act of 1976, which changed royalty rates from a cents-per-ton basis to 12.5 percent of the market value. Many of the large Federal coal leaseholders continued to pay royalties on a cents-per-ton-basis in 1986 while protesting the readjustment of their leases to the 12.5 percent rate. When the U.S. Supreme Court declined to review a lower court's ruling on a case that upheld the 12.5 percent rate, the leaseholders were forced to pay the additional (deferred) royalties. The precedent-setting court ruling involved coal mined by FMC Corporation Wyoming, operator of the Skull Point mine in Lincoln County, Wyoming. Besides the additional royalty payments, Congress passed legislation in October, 1988, that allowed interest accrued from the deferred royalty payments to be shared on a 50 percent basis with the state where the coal was produced. As an example, coal produced in Wyoming by Amax Coal Company has been assessed additional Federal royalties of \$42 million, plus \$8 million in interest.

The Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division, recently released its tabulation of taxable valuation for 1988. Coal valuation was \$1,006 billion in 1988, a decrease of \$105 million from the previous year. Taxable coal production increased from 128.1 million tons in 1986 to 132.7 million tons in 1987. In the case of minerals, assessed production is that of the previous year.

Coal production and forecast to 1992 (millions of tons).

	1981 <sup>1</sup>	1982 <sup>1</sup>	1983 <sup>1</sup>	1984 <sup>1</sup>	1985 <sup>1</sup>	1986 <sup>1</sup>	1987 <sup>1</sup>	1988	1989	1990	1991	1992
Campbell County	71.6	81.2	88.2	106.8	113.9	111.0	122.3	128.0	123.7	124.2	124.3	125.8
Converse County	3.6	3.4	2.7	3.3	3.6	4.8	5.1	5.9	6.0	6.2	6.6	7.0
Sheridan County	2.8	3.0	2.9	2.5	2.4	1.4	1.2	1.7	0.5	M	M	M
Carbon County	8.5	5.0	4.8	5.1	3.3	1.5	2.2	3.0	2.0	2.3	2.2	2.0
Sweetwater County	11.2	11.0	9.5	8.9	13.2	12.9	11.8	12.1	12.8	13.2	13.6	13.1
Lincoln County	5.0	4.3	4.0	4.1	4.3	4.0	3.8	4.3	5.0	5.1	5.3	5.1
Hot Springs County	M <sup>2</sup>	M	M	M	M	M	M	M	M	M	M	M
Total Wyoming	102.8	107.9	112.2	130.7	140.7	135.7	146.5	155.0	150.0	151.0	152.0	153.0
Annual change	9%	5%	4%	16.5%	7.7%	-3.6%	+8.0%	+5.8%	3.2%	-	+1.3%	+0.7%
Estimated contract- ed production	110.0	119.0	122.6	137.7	145.2	149.2	150.0	155.0	150.0	151.0	152.0	153.0
Below contract	7%	9%	8%	5%	3%	9%	2%	-	-	-	-	-

<sup>1</sup>These are actual values for comparison) <sup>2</sup>M Means minor tonnage (less than 0.1 million tons). Forecast by Geological Survey of Wyoming, December, 1988.

In 1988, coal accounted for 16.8 percent of the total assessed valuation of Wyoming and about 28 percent of the assessed valuation of minerals in Wyoming (see figure on page 19). It is interesting to compare 1988 assessed valuations for the State of Wyoming with valuations in 1986 (mineral valuations are based on 1985 production). The 1986 valuations were before oil and gas prices (as well as coal prices) dropped (see figure on page 19). Although non-mineral valuation remained nearly constant between 1986 and 1988, its proportionate share of the State's total valuation has increased from nearly 30 percent in 1986 to 40 percent in 1988. This difference is directly related to the decline in the value of energy minerals produced in the State.

The average assessed value per ton of Wyoming coal produced in 1987 was \$7.58, a decrease of 12.6 percent from the previous year's \$8.67 a ton. Coal from the Powder River Basin dropped in value from \$6.63 a ton to \$6.04 a ton, a decrease of 8.9 percent; coal from southern Wyoming decreased in value from \$20.74 a ton in 1986 to \$18.07 a ton in 1987, a decrease of 12.9 percent (see figure on page 20). A discussion of coal valuation projected to 1995 appears in *Wyoming Geo-notes No. 20*, November, 1988, p. 13 and 15.

This fall, the Wyoming Supreme Court ruled on a legal action brought by the Wyoming Mining Association and a group of Wyoming coal producers against the State Board of Equalization's decision to extend the 2 percent coal impact tax into 1987. This tax was due to expire on January 1 of the year after total proceeds from the tax reached \$160 million. Many coal companies prepaid some of their severance taxes for 1987 in 1986 in an attempt to push the impact tax account over the \$160 million by the end of 1986. In the judicial review of the case by the Wyoming Supreme Court, it was ruled that the coal impact tax did indeed expire in 1986 (after exceeding \$160 million in cumulative taxes) and that the State of Wyoming was able to accept advance tax payments from the coal producers.

In another legal action, this time involving a coal transportation issue, an out-of-court settlement was reached in late November between Burlington Northern, Inc. (BN) and Energy Transportation Systems, Inc. (ETSI). ETSI had brought a damage suit against several railroad companies in connection with ETSI's failed coal slurry pipeline project (see related stories in *Wyoming Geo-notes No. 17*, January 1988, p. 17; *No. 19*, July, 1988, p. 15; and *No. 20*, November, 1988, p. 16-17). The settlement calls for BN to pay ETSI \$175 million; in turn, all legal action against BN by ETSI and an intervenor in the suit, Houston Lighting and Power Company (HL&P), was terminated. In earlier settlements and court decisions, Union Pacific Railroad (UP), Kansas City Southern Railway Company (KCS), and Chicago and North Western Transportation Company (C&NW) have all paid damages to ETSI. Part of BN's settlement with ETSI/HL&P involves \$58 million in cash payments to HL&P and future rate adjustments on the remaining 12 years of a transportation contract from the Powder River Basin to HL&P power plants. Additional lawsuits against KCS and Atchison, Topeka, and Santa Fe Railway Company are still pending.

COAL PRODUCTION STATISTICS FOR WYOMING BY COAL OWNERSHIP

Year	FEDERAL <sup>1</sup>		STATE <sup>2</sup>		PRIVATE <sup>3</sup>		TOTAL <sup>4</sup>	
	Short tons	Percent of Total	Short tons	Percent of Total	Short tons	Percent of Total	Short tons	Short tons
1979	30,121,000	42%	10,805,182	15%	30,689,649	43%	71,615,831	
1980	33,434,000	35%	21,592,172	23%	39,768,435	42%	94,794,607	
1981	59,576,163	58%	26,485,275	26%	16,722,026	16%	102,783,464	
1982	63,612,335	59%	19,872,591	18%	24,469,657	23%	107,954,583	
1983	67,975,848	61%	18,189,147	16%	26,022,908	23%	112,187,903	
1984	69,610,360	53%	19,166,425	15%	42,035,878	32%	130,812,683	
1985	100,621,788	72%	16,541,094	12%	23,531,104	17%	140,693,986	
1986	111,407,678	82%	8,535,191	6%	16,362,187	12%	136,305,056	
1987	120,404,508	82%	6,850,053	5%	19,234,287	13%	146,488,648	

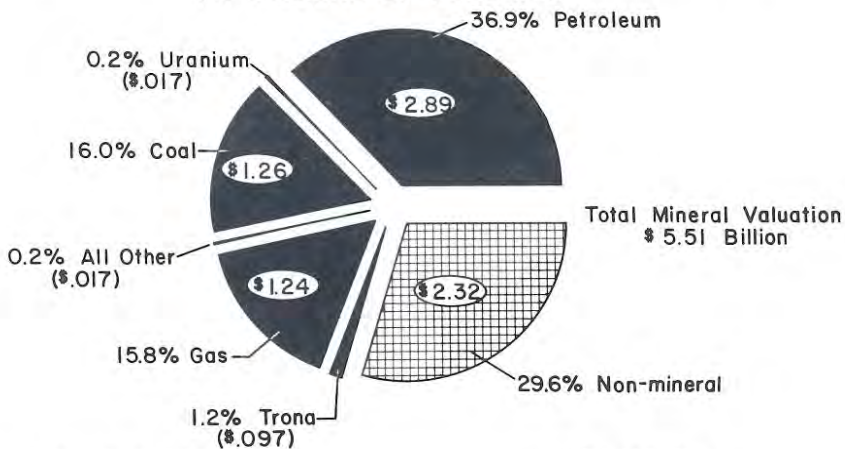
COAL PRODUCTION ON STATE LEASES, BY COUNTY<sup>2</sup>

YEAR	CAMPBELL	CARBON	CONVERSE	LINCOLN	SHERIDAN	SWEETWATER	TOTAL
1979	10,292,768	376,112		136,302			10,805,182
1980	21,417,481	160,584		14,107			21,592,172
1981	26,274,778	186,430		6,114			26,485,275
1982	19,015,683	384,578	17,953				19,872,591
1983	17,297,232	353,974	472,330				18,189,147
1984	17,968,567	121,175	537,941			186,973.0	19,166,425
1985	15,816,484	79,518	889,710			236,186.0	16,541,094
1986	8,340,540		408,906			194,651.0	8,535,191
1987	6,850,053						6,850,053

Data sources:

- <sup>1</sup> Minerals Management Service, Annual Mineral Revenue Reports, 1981-1988 and U.S. Department of Interior, Federal Coal Management Reports, FY 1980 and 1981.
- <sup>2</sup> Wyoming Department of Public Lands, Annual Reports, 1979-1988; all production in short tons.
- <sup>3</sup> Derived by subtracting State and Federal production from total production.
- <sup>4</sup> Annual Reports, Wyoming State Mine Inspector and Wyoming Ad Valorem Tax Division.

## WYOMING'S ASSESSED VALUATION-1986 (IN BILLIONS OF DOLLARS)



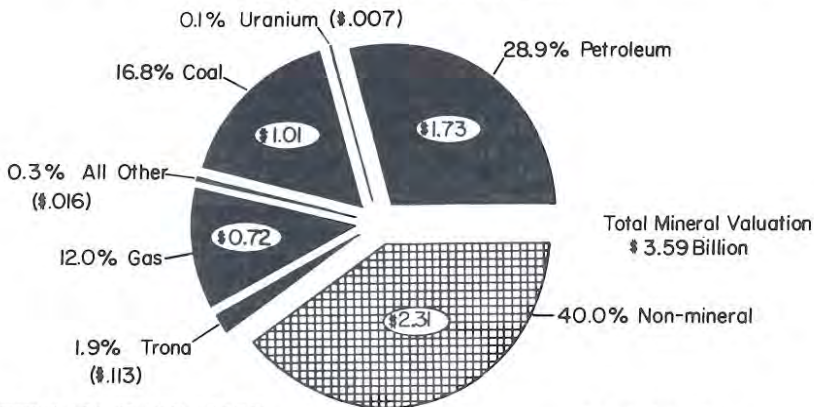
NOTE: ASSESSED VALUATION OF MINERALS IS BASED ON PREVIOUS YEAR'S PRODUCTION.

Total Valuation  
\$ 7.83 Billion

Source: Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division Annual Report for 1986.

Geological Survey of Wyoming, December, 1988

## WYOMING'S ASSESSED VALUATION-1988 (IN BILLIONS OF DOLLARS)



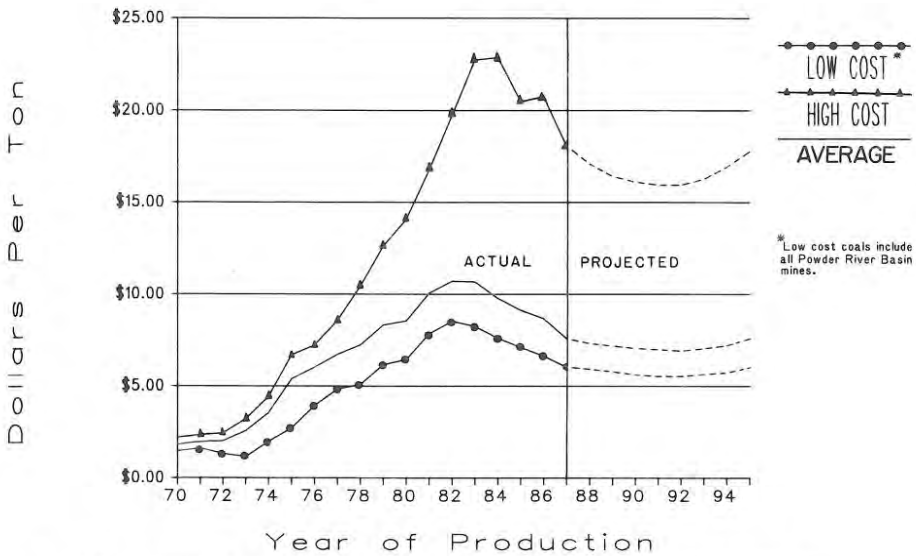
NOTE: ASSESSED VALUATION OF MINERALS IS BASED ON PREVIOUS YEAR'S PRODUCTION.

Total Valuation  
\$ 5.89 Billion

Source: Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division Annual Report for 1988.

Geological Survey of Wyoming, December, 1988

# COAL VALUATION 1970-1995



SOURCE: Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division Annual Reports.

Geological Survey of Wyoming, October, 1988

## Developments In the Hanna Basin

The most important development during the last quarter of 1988 was the mid-December announcement that Arch Mineral Corporation had purchased Union Pacific Mineral's (UPM) share of Medicine Bow Coal Company's mine west of Hanna and planned to shut down their Seminoe 2 mine. Arch of Wyoming (a wholly-owned subsidiary of Arch Mineral Corporation) and UPM had operated Medicine Bow as a joint venture; the coal company and the mine will now operate as a joint venture between Arch Mineral Corporation and Arch of Wyoming. The 74 miners at Seminoe 2 would presumably have an opportunity for employment at Medicine Bow, which currently employs only 24 miners.

The Seminoe 2 mine has been a mainstay of Hanna Basin coal production since the mine opened in 1972. A total of 31.3 million tons of coal had been mined at Seminoe 2 through 1987; Arch estimated that 1.75 million tons of coal would be produced by Seminoe 2 in 1988. The mine's peak production year was 1975, when 2.9 million tons of coal were produced. Peak employment at Seminoe 2 was 325 miners in 1979. Kansas Power and Light Company's contract for coal from this mine apparently will be met in February, 1989, after which Arch plans to begin reclamation at the mine.

The Medicine Bow coal mine has no major coal contracts at present, but in 1988 it provided test shipments of coal to five different customers. Evidently, any new contracts or coal sales from Arch's

Hanna operations will be filled by coal from Medicine Bow. Even though the heating value of coal from the Medicine Bow mine is less than that at Seminoe 2, the mining costs (including mining ratios, overburden handling, and coal haulage costs) at Medicine Bow are lower than at Seminoe 2, thereby making the coal's price more competitive.

In November, Western Fuels Association (WFA), a fuel buyer for numerous utility companies, announced that one of their member utilities, Kansas City Board of Public Utilities (KCBPU) was conducting test burns of coals from both the Medicine Bow mine and Cyprus-Shoshone Coal Company's Shoshone No. 1 underground mine. This is the first use of Hanna Basin coal by a member of WFA (a traditional Powder River Basin coal buyer). Evidently the higher heating values of coals in the Hanna Basin are a selling point because WFA announced that they were also considering a high-Btu coal or a beneficiated (dried) coal from the Powder River Basin as a fuel source for KCBPU. This was the second indication in 1988 that coal from the Hanna Basin will probably have to compete with the dried coal product that will soon be available from Powder River Basin coal producers.

### Developments in western and southwestern Wyoming

The Federal Energy Regulatory Commission (FERC) recently gave conditional approval to the proposed merger of PacifiCorp (parent company of Pacific Power and Light Company) and Utah Power and Light Company (for additional information see *Wyoming Geo-notes No. 17*, January, 1988, p. 16). If the merger were to take place, PacifiCorp would become the Nation's 13th largest utility company, serving 1.2 million customers in a seven-state area. A condition placed on the proposed merger requires that PacifiCorp provide space on its transmission lines for use by other utilities. FERC explained that the condition placed on the merger was necessary to ensure competition and to prevent the merged company from developing a monopoly. PacifiCorp and Utah Power and Light Company have until January 25, 1989, to decide whether or not to proceed with the merger. Editors note: the companies did merge in early January, 1989.

### Developments in the Powder River Basin

Two projects involving coal in the Powder River Basin, Wyoming, were announced in the last quarter of 1988. First, Carbontec Corporation of Bismarck, North Dakota, was awarded a \$1.0 million loan from the Wyoming Investment Fund Committee for testing Wyoming coal in a coal-drying demonstration plant. The Carbontec process uses oil-based chemicals to draw moisture out of the coal. According to Carbontec, their dried product does not disintegrate or undergo spontaneous combustion like conventional, thermally dried coal products. A typical coal with 30 percent moisture and a heating value of 8,500 Btu/pound will reportedly yield a product with a heating value of 11,000 to 12,000 Btu/pound and 10 percent moisture. If the demonstration plant in North Dakota is successful, Carbontec will ask for an additional \$0.8 million to start construction of an \$8.9 million commercial plant near Gillette.

The second project is a modified coal liquefaction process developed by SGI International of La Jolla, California. The company



MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Resources (January 1, 1988)

Discovered (Includes 10 billion barrels recoverable by enhanced recovery techniques).....	13.0 billion barrels <sup>1</sup>
Undiscovered.....	<u>7.6 billion barrels<sup>1</sup></u>
Total.....	20.6 billion barrels
Remaining Reserve Base (January 1, 1988)	
Measured reserves (Proved reserves).....	0.85 billion barrels <sup>2</sup>
Indicated and inferred reserves.....	<u>2.8 billion barrels<sup>3</sup></u>
Total.....	3.65 billion barrels

COMBUSTIBLE NATURAL GAS

Remaining Resources (January 1, 1988)

Discovered.....	18.0 trillion cubic feet <sup>1</sup>
Undiscovered (there is at least another 115 trillion cubic feet of noncombustible CO <sub>2</sub> gas) <sup>9</sup> .....	<u>58.0 trillion cubic feet<sup>1</sup></u>
Total.....	76.0 trillion cubic feet <sup>1</sup>
Remaining Reserve Base (January 1, 1988)	
Measured reserves (Proved reserves).....	10.57 trillion cubic feet <sup>2</sup>

COAL

Remaining Resources (January 1, 1988)

Identified (Discovered).....	135.8 billion tons <sup>4</sup>
Undiscovered.....	<u>800.0 billion tons<sup>5</sup></u>
Total.....	935.8 billion tons
Remaining Reserve Base (January 1, 1988)	
Demonstrated strippable (Measured and indicated reserve base).....	26.9 billion tons <sup>4</sup>

Demonstrated underground-minable (Measured and indicated reserve base).....38.4 billion tons<sup>4</sup>  
 Total..... 65.3 billion tons

TRONA

Original Resources (1983 estimate)

Trona.....81.7 billion tons<sup>6</sup>  
 Mixed trona and halite.....52.7 billion tons<sup>6</sup>  
 Total.....134.4 billion tons

URANIUM

Remaining Resource (December 31, 1985)..... 1.99 billion pounds U<sub>3</sub>O<sub>8</sub>  
 Remaining Reserve Base (December 31, 1985)..... U<sub>3</sub>O<sub>8</sub>  
 Uranium oxide recoverable at \$30.00 per pound ..... 83 million pounds

OIL SHALE

Original Resources (January 1, 1983)

Identified (Discovered).....320 billion barrels of shale oil<sup>8</sup>

- 1 Modified from Barlow, J.A., Jr. and Doelger, M.J., 1983, *Wyoming mineral resources: Barlow and Haun, Inc.*, Casper, 14 p.
- 2 Energy Information Administration, 1988, *U.S. crude oil, natural gas, and natural gas liquids reserves: 1988 Annual Report*, October.
- 3 Modified from Barlow and Doelger (1983), footnote 1.
- 4 Geological Survey of Wyoming, June, 1988. (Modified from Berryhill, H.L., Jr. and others, 1950, *Coal resources of Wyoming: U.S. Geological Survey Circular 81*, 78 p.
- 5 Averitt, Paul, 1975, *Coal resources of the United States: U.S. Geological Survey Bulletin 1412*, p. 15.

announced that Shell Mining Company would be a financing partner in construction of a liquefied-from-coal (LFC) plant near Triton Coal Company's (a subsidiary of Shell Mining Company) Buckskin mine north of Gillette. If constructed, the plant would convert up to 1,000 tons per day of coal from the Buckskin mine into a solid-fuel product, plus a hydrocarbon-liquid by-product. The process is reportedly a low-temperature, atmospheric pressure, pyrolysis technique that leaves the pitch and tar in the solid product, which is a dry, clean-burning solid fuel with heating values of 11,000 to 12,500 Btu/pound. Approximately one-half to one barrel of liquid hydrocarbons is recovered from each ton of processed coal as a by-product.

Amax Coal Company appears to be very close to completion of the first commercial coal-drying facility in the Powder River Basin. A recent article in *Mining Engineering*, (vol. 40, no. 11, November, 1988, p. 1031-1032) reviewed the Amax facility and reported that the first coal-drying unit would be operational in January, 1989. Amax also announced in the last quarter of 1988 that total cumulative coal production at their Eagle Butte surface mine north of Gillette had exceeded the 100-million-ton milestone. The Eagle Butte mine began production in 1978. Three other mines in the eastern Powder River Basin preceded Eagle Butte in attaining the 100-million-ton production level: Amax's Belle Ayr mine, Thunder Basin Coal Company's Black Thunder mine, and Kerr-McGee Coal Corporation's Jacobs Ranch mine.

### Coal Contracts

In the last quarter, the announcements of new coal contracts appeared to slow down as most utility companies had secured their fuel supplies for the rest of the year and were only signing short term or spot contracts for early 1989. A summary of contract activity follows:

1) Rochelle Coal Company, a subsidiary of Peabody Holding Company, will furnish 15,000 tons of spot coal to Fremont, Nebraska Department of Utilities, from the Rochelle mine. The coal will be delivered before the end of 1986 and will be used for test burns in two generating units. The FOB mine price of the coal is reportedly \$4.60 a ton while the delivered price (via rail) is \$15.60 a ton.

2) Rochelle Coal Company will also supply 50,000 to 100,000 tons of coal to Minnesota Power Company during 1989. Delivered price of the spot coal (including final delivery by barge) is \$23.50 a ton. Minnesota Power also expects to purchase as much as 400,000 tons of additional spot coal in 1989.

3) Rochelle Coal Company will also supply Empire District Electric Company in Kansas with 200,000 tons of spot coal. This is in addition to the 300,000 tons of coal that Rochelle began supplying to Empire in July, 1988. Deliveries continue into 1989.

4) Thunder Basin Coal Company's Black Thunder mine supplied 72,000 tons of coal to Nebraska Public Power District's (NPPD) Sheldon generating plant through December, 1988. The coal was delivered through an interim agreement while NPPD negotiates a new agreement with Thunder Basin for additional coal above a contract minimum (this

relates to a current contract to NPPD's Gentleman power plant) as well as new tonnage for the Sheldon power plant. The 2-month spot sale from Black Thunder called for a delivered price of 77.3 cents per million Btu. In contrast, a previous contract to the Sheldon plant with Fort Union Coal Company carried a delivered price of 92 cents per million Btu.

5) Amax Coal Company will supply 500,000 tons of coal from their Belle Ayr and Eagle Butte mines to Omaha Public Power District's North Omaha power plant in Nebraska. The coal will be delivered via Burlington Northern Railroad (BN) between November, 1988, and April, 1989.

6) Carter Mining Company will supply 400,000 tons of coal from the Rawhide mine to Sunflower Electric Cooperative's Holcomb generating plant in Kansas via the BN and the Atchison, Topeka, and Santa Fe Railroads. The contract, which was negotiated by Western Fuels Association (WFA), calls for delivery of the coal during the first half of 1989. The FOB mine price is reportedly less than \$4.00 a ton.

7) Carter Mining Company will also supply Kansas City Board of Public Utilities' Nearman Creek generating plant in Kansas with 150,000 to 180,000 tons of coal. The coal will come from either the Rawhide or Caballo mine. Deliveries began in October, 1988, via the BN and the Union Pacific Railroads. The contract was negotiated by WFA. The FOB mine price of the coal is reportedly between \$3.80 and \$3.90 per ton.

8) During the second half of 1989, Cordero Mining Company (a subsidiary of Elk River Resources) will supply 2 million tons of spot coal from the Cordero mine to Basin Electric Power Cooperative's Laramie River generating station in Wyoming. Delivery will be by BN and the FOB mine price of the coal is reportedly less than \$4.00 a ton. The contract was negotiated by WFA for Basin Electric.

## INDUSTRIAL MINERALS UPDATE

by Ray E. Harris, Industrial Minerals and Uranium Division Head,  
Geological Survey of Wyoming

### Aggregate

Production of construction aggregate in Wyoming declines during the winter months as highway paving, building construction, and other projects that use aggregate close or slow down. Despite this seasonal downturn, there were a few aggregate-related developments in the last quarter of 1988.

Small quantities of a red granite from near Lusk were shipped to Utah for use as decorative aggregate. In addition, crushed marble from Wheatland was almost used in the Colorado Convention Center in Denver. This latter material, consisting of very finely ground marble, would have been used for smooth, white, precast concrete in facings and pillars. A contract with Georgia Marble, the company that

owns Basins, Inc. in Wheatland, was cancelled when Colorado decided it did not want to use an out-of-state product on the center. A Colorado company must now reopen an abandoned quarry in west-central Colorado to provide a similar material.

Officials in Grand Teton National Park are looking for sources of construction aggregate for park roads and structures. Although Jackson Hole and the surrounding highlands are rich in aggregate raw materials, zoning, park regulations, and other restrictions have made the development of a local aggregate pit almost impossible in that area. Therefore, aggregate for park construction will probably have to be brought in from elsewhere, possibly from out-of-state.

### Bentonite

Bentonite production remained low through 1988 due to the low demand for oil well drilling muds. No significant improvement is expected in 1989. However, Wyoming remains the Nation's leading supplier of bentonite. Specialty bentonite, which is used in soaps, cosmetics, and fillers, and bentonite for foundry castings, continue in demand. These uses formerly constituted a minor percentage of Wyoming bentonite production, but now make up a greater percentage of the total. One new (to Wyoming) company is still planning to open operations near Casper.

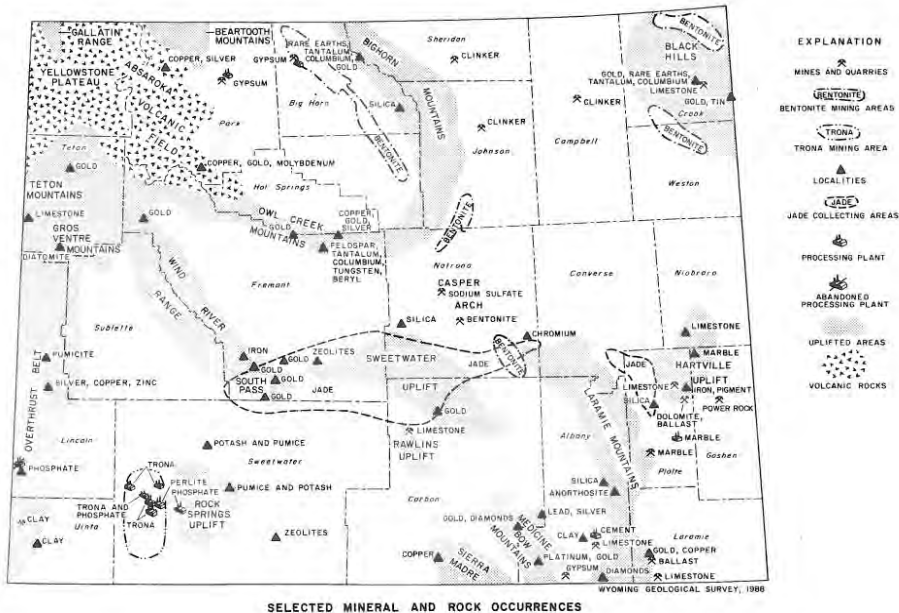
### Cement

Mountain Cement's modernized and expanded plant in Laramie was operating at near full capacity at the end of the year. Cement is produced from limestone, gypsum, and marl quarried near the plant. Mountain Cement Company is using tailings from the Iron Mountain mine, which produced magnetite ore in the 1940s, as a source of iron additives. These tailings are located about 42 miles northeast of Laramie, and about 6 miles east of the Plumbago Creek Road (Albany County Road 12).

Nationally, production of cement in 1988 is slightly higher than in 1987 according to preliminary figures from the U.S. Bureau of Mines. This increase is an indication of a more healthy national economy reflected in increased construction. Because most of Mountain Cement's production is consumed in Colorado, Nebraska, and Wyoming, expanded production from the Laramie plant reflects economic growth in this region, particularly the Colorado Front Range area.

### Gypsum

Gypsum is quarried in Wyoming at three locations (see map on page 27). Two plants in the Bighorn Basin continue to produce wallboard, made from refined and pressed gypsum. The Laramie cement plant is using more gypsum as full production is approached (see discussion above). Overall, 1988 gypsum production in Wyoming probably increased slightly over 1987. Next year's production should also increase slightly over 1988.



## Limestone

Limestone is quarried, crushed, and screened in Wyoming for use in highway construction projects, cement, and power rock (used for burn and emissions control in coal-fired power plants). A quarry was opened about 6 miles north of Hartville this year to supply power rock to the Laramie River power plant near Wheatland. Limestone from north of Rawlins is used in power plants near Craig, Colorado.

## Phosphate and fertilizer production

Phosphate from Utah is combined with Wyoming sulfur to produce fertilizer at the Chevron Chemical Company's plant near Rock Springs (see map on this page). Production of fertilizer at this plant is up slightly over last year. The sulfur used at this plant is produced as a by-product from the refining of sour gas (natural gas containing hydrogen sulfide) from Chevron's gas fields in western Wyoming.

Nationally, phosphate production has increased over 1987 levels by about 10 percent according to the U.S. Bureau of Mines. The Bureau also estimates that western phosphate production (Idaho and Utah) has increased by about 15 percent. Chevron's Wyoming plant has apparently increased fertilizer production and phosphate production from their Utah mine by about 20 percent.

## Tripoli

Tripoli, a fine-grained silica material, has been discovered (or rediscovered) in Wyoming. A 1928 news article described an occurrence of tripoli "six miles north of Hartville". Recently, the Head of the State Survey's Industrial Minerals Division asked Hartville residents if they knew of any lightweight, white, hard material in the area. A local rancher reported that he knew of some material that his father had used to sharpen plows. When this material was located, it turned out to be amorphous, pure, fine-grained silica, or tripoli. The area is now under study by the Geological Survey of Wyoming and a request for a block grant from the Economic Development and Stabilization Board was prepared by Platte County and the Town of Guernsey. Hopefully a grant will be awarded so that there are funds to determine the quality and extent of the resource.

Tripoli is used as an abrasive and mineral filler. It is mined in Pennsylvania, Illinois, and Missouri. Scouring powders, tooth paste, and other industrial abrasives may contain tripoli.

## Trona

For the first time since the completion of the Tenneco soda ash refinery near Green River in 1982, all five soda ash (refined trona) producers are operating at or near full capacity. This year's increase in soda ash production is due almost solely to the substitution of soda ash for caustic soda in some industrial processes. Industry representatives disagree about whether this market will continue to fuel high demand for soda ash. While the major use of soda ash is in the production of glass, the glass market shrank in the 1982 recession and has never completely recovered although domestic glass production has greatly increased since then.

The export market for soda ash remains about constant at the present time. Foreign production of soda ash is primarily by a more expensive chemical process. Trade barriers continue to prevent less expensive, mined trona from the U.S. and elsewhere to be used for much of this market.

In addition to the production of soda ash, a new plant that produces finished products from soda ash opened this fall near Green River. Church and Dwight dedicated the new plant that produces washing soda, laundry detergent, and similar products. These products will be marketed under the Arm & Hammer brand. This plant will employ about 40 people.

FMC is proceeding with its plans to construct a 60-million-pound-per-year sodium cyanide plant near their soda ash plant west of Green River (see *Wyoming Geo-notes* No. 20, page 25).

## URANIUM UPDATE

by Ray E. Harris, Industrial Minerals and Uranium Division Head, Geological Survey of Wyoming

There are several encouraging signs to report this quarter relative to Wyoming's uranium mining industry. Although these indications of increased production are welcome, they are not indicative of a return to the boom years of the 1970s.

Wyoming's Congressional Delegation announced the purchase of 15.8 million pounds of U<sub>3</sub>O<sub>8</sub> uranium by five Japanese power companies over the next 10 to 12 years. About 7.5 million pounds of this uranium (U<sub>3</sub>O<sub>8</sub>) will be supplied by three companies which operate in Wyoming: Pathfinder Mines, Malapai Resources, and Everest Mines. However, the contracts announced between these producers and the Japanese were not specifically for Wyoming mines. All three producers have uranium properties elsewhere, so the total supplied from Wyoming may not be 7.5 million pounds. Another factor that may affect how much Wyoming uranium is mined is the possible availability of previously produced uranium, which might be less expensive to acquire than mining and processing new ore.

In a separate announcement, Malapai Resources, which operates an *in situ* mine near Pumpkin Buttes, reported agreements were signed with Tokyo Electric Power Company and Chubu Electric Power Company for 1 million pounds of uranium each. Initial deliveries are to begin in 1990. This announcement apparently relates to the agreements reported by Wyoming's Congressional Delegation. According to a company spokesman, this 2 million pounds may come from its Wyoming property. This represents a significant increase in production for Malapai and is a positive step towards increased uranium production in Wyoming.

Everest Minerals Corporation apparently has at least an agreement with Tokyo Electric for 1 million pounds of uranium. The agreement calls for deliveries over a 10-year span beginning in 1990.

Pathfinder Mines, on the other hand, has said that possibly none of the 3.5 million pounds it will supply to Japan will come from Wyoming. John Atkins, Pathfinder's governmental affairs representative, said the "regulatory and tax situation in Wyoming" may cause the company to develop Arizona uranium properties rather than increase production from either its active Shirley Basin or inactive Gas Hills properties. Pathfinder does plan to ask the Wyoming Legislature for a 3.5 percent reduction in uranium severance taxes (from 5.5 percent to 2 percent).

In an earlier effort to reduce their taxes, Pathfinder filed a challenge to the Wyoming State Board of Equalization's 1986 decision to base severance tax rates for uranium on the market price, rather than a rate of \$8 per pound. The \$8 per pound rate reflected a 1950s market price. This challenge was denied by the Wyoming Supreme Court in mid-December, 1988, when the court ruled that the State Board of Equalization acted properly in adjusting the rates.

Regarding the State's mineral tax structure, the Wyoming Department of Revenue has issued a new proposal on uranium valuation. The propo-









sai maintains the existing tax structure, but allows for tax deductions for some processing costs, transportation, return on investment, and royalty payments.

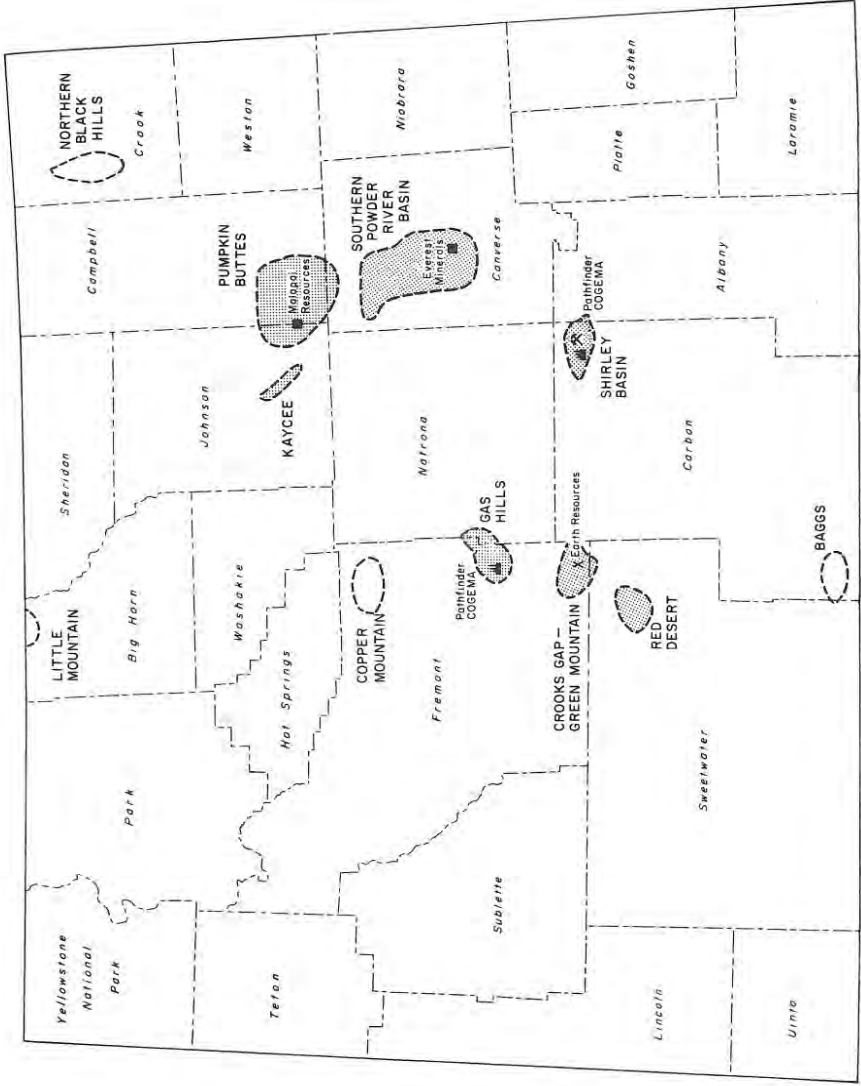
A Riverton uranium company also announced some new uranium contracts. These contracts were apparently not included in the 15.8-million-pound purchase mentioned above. USE-CC, a Joint Venture of U.S. Energy Corporation of Riverton and Crested Corporation, 44 percent of which is owned by U.S. Energy, stated that it will supply 1.8 million pounds of uranium oxide (yellowcake) to two unnamed utilities beginning in the early 1990s. This uranium may be produced from the Crooks Gap district south of Jeffrey City.

Meanwhile, Wyoming received \$4.4 million from the Federal government to reclaim an abandoned open pit uranium mine in the Gas Hills. The grant will provide funds for the reclamation including the removal of acid and radioactive waste on the 274-acre site. This unreclaimed mine operated prior to 1969.

The removal of uranium mill tailings from the abandoned Susquehanna-Western mill site south of Riverton began in 1988, but recently closed for the winter season. About 50 percent of the cleanup has been completed. So far, 1,028,000 cubic yards of material have been shipped and buried in an open pit mine site in the Gas Hills. This has involved 46,700 round trips of 110 miles each for the trucks doing the hauling. The hauling is expected to be completed next year.

**EXPLANATION**

-  Uranium district with active or recent mining
-  Uranium district without recent mining
-  Active uranium mine
-  Proposed uranium mine
-  Active in-situ production
-  Active uranium mill



WYOMING GEOLOGICAL SURVEY, 1987

**MAJOR ACTIVE AND INACTIVE URANIUM DISTRICTS**

## METALS AND PRECIOUS STONES UPDATE

by W. Dan Hausel, Deputy Director, Geological Survey of Wyoming

High gold, platinum, and palladium prices continued to stimulate exploration activity in Wyoming during 1988. In the Medicine Bow Mountains of southeastern Wyoming, four companies continued searching the Lake Owens and Mullen Creek layered complexes for all three of these metals. By mid-year, one of the four companies terminated exploration activities in the Medicine Bows because of lack of success. Later, however, another exploration group began searching for precious metals in the Lake Owens area.

The southern Sierra Madre was the site of a claim-staking rush that was initiated by rumors of the discovery of a large massive zinc, copper, and silver deposit a short distance south of Wyoming's border near Pearl, Colorado. Broken Hill and Cap Rock were reported to be drilling in Colorado. The staking in Wyoming was along the projected trend of the massive sulfide deposit.

A fair amount of activity continued in the Bear Lodge Mountains throughout 1988. At least four companies were searching for disseminated gold and rare-earth mineralization in the Tertiary alkalic complex of those mountains. The activity included both geochemical sampling and drilling.

The South Pass greenstone belt continued receiving some activity. Three Australian and one Canadian company with mineral interests in the district were financially crippled by the 1987 stock market decline, and did no known work in 1988. And the Gyorvary Mining Company completed the construction of its mill at the Mary Ellen gold mine, but was unable to satisfy all of the necessary requirements to obtain an operating permit.

On the brighter side, two drilling projects were scheduled in the district, and a third company made a discovery, which they plan to continue testing next summer. The district also received the attention of two large domestic companies. One of these two companies intersected a 30-foot-wide shear zone with ore-grade mineralization at an undisclosed location.

Throughout the 1988 summer, two placer mines operated at South Pass -- one in Rock Creek and the second at Wilson Bar. Some placer exploration was reported elsewhere in the district, and some walnut-size nuggets were discovered at an undisclosed location. Some activity was also reported on the Twin Creek paleoplacer to the northeast.

Placer mining and exploration activity continued at many locations in the State during 1988. Besides South Pass, some placer exploration and mining occurred in northwestern Wyoming south of Jackson, and along Crandall Creek near the southern margin of the Beartooth Mountains. In northeastern Wyoming, placer mining was reported in the Mineral Hill district of the Black Hills; in southeastern Wyoming, some activity occurred in the Douglas Creek district of the Medicine Bow Mountains, in the Sierra Madre, and near Baggs.

During the 1988 field season, the Metals Division of the Geological Survey of Wyoming conducted cursory examinations of several mineralized terranes in Wyoming. A brief report was presented on a few of these areas (*Wyoming Geo-notes No. 20*, p. 27-30), but most assay reports were not available at that time. Many of the samples collected during these reconnaissance surveys have now been assayed (see table on page 34).

In the Black Hills of northeastern Wyoming, samples were collected from three districts where mineralization is associated with altered Tertiary alkalic igneous intrusives. These are the Black Buttes, Mineral Hill, and Bear Lodge Mountains areas. At Black Buttes (also known as the Hurricane district), which is located 6 miles south of Sundance, several prospects lie along the contact of a Tertiary trachyte porphyry with Mississippian Pahasapa Limestone. In the NE/4 sec. 26, T.50N., R.62W., brecciated limestone is partially replaced by hemimorphite, galena, minor wulfenite, and rare fluorite (Hausel, 1988a). A group of samples collected from this and other prospects contained significant mineralization (see table on page 34). For example, one jasperoid sample (no. BB3-88) assayed 3.2 ounces per ton silver, 0.28 percent lead, and 8.3 percent zinc. A sample of mineralized limestone breccia (no. BB5-88) contained 5.8 ounces per ton silver, 0.51 percent lead, and 7.4 percent zinc.

The Mineral Hill district lies east of Black Buttes on the Wyoming-South Dakota border. Historically, Mineral Hill produced significant quantities of placer gold and tin during the late 1800s, and recently the district has been considered for possible disseminated epithermal gold deposits. However, the few samples collected in the Mineral Hill district (see table on page 34) were only weakly mineralized.

The Bear Lodge Mountains are located immediately north of Sundance, Wyoming. These mountains are formed of a Tertiary alkalic igneous complex intruded into Paleozoic sedimentary rocks. Large blocks of Precambrian granite are rafted in the Tertiary complex.

Samples collected in the Bear Lodge Mountains complex show a couple of weak gold and silver anomalies (see table on page 34). However, the most interesting samples collected were BL13-88 and BL14-88, which were trachytes partially replaced by manganese (Hausel, 1988b). These samples suggest there could be a potential for a large-tonnage, low-grade manganese resource in addition to the large-tonnage, low-grade rare earth and thorium resources reported by Staatz (1983) in the Bull Hill area. Manganese is considered a critical strategic metal (Hausel, 1987).

In the Mormon Canyon area along the northern flank of the Laramie Range south of Douglas, a fragmented Archean metasedimentary-metavolcanic terrane is intruded by granite. This region has some exposed quartz veins hosted by amphibolite.

A sample (no. MC2-88) of copper-stained milky quartz from a 30- to 40-foot-wide strike vein in sec. 14, T.32N., R.76W. was taken. This sample contained low-grade copper and traces of gold and silver (see table on page 34).

Assay results of samples collected by the Geological Survey of Wyoming at various locations in the State. ("nd"=not detected; "--"=not determined)

Sample no.	Description	Au (ppm)	Ag (ppm)	Cu (ppm)	Hn (ppm)	Pb (ppm)	Zn (ppm)*
-- BLACK BUTTES (T.50N., R.62W.) --							
BB1-88	Silicified limestone with minor fluorite (N/2 sec. 26).	nd	nd	85	245	185	115
BB2-88	Grab sample of fluorite-bearing limestone from pit in NE/4 sec. 26.	nd	nd	80	130	48	61
BB3-88	Limestone-hosted jasperoid with minor fluorite in NE/4 sec. 26.	nd	110	403	2,060	2,810	83,000
BB4-88	Jasperoid with terminated quartz in vug from pit in NE/4 sec. 26.	nd	nd	452	7,870	3,500	64,000
BB5-88	Galena-bearing limestone breccia with hemimorphite from NE/4 sec. 26.	nd	200	296	3,080	5,100	74,000
-- MINERAL HILL (T.51N., R.60W.) --							
MH1-88	Altered trachyte from Birdnest mine dump.	nd	nd	354	4,200	471	441
MH2-88	Breccia from Interocean mine dump.	0.43	2.5	1,160	8,290	88	146
MH3-88	Silicified trachyte breccia from Interocean mine dump.	nd	nd	622	1,940	--	100
-- BEAR LODGE (T.52N., R.63W.) --							
BL5-88	Iron-stained trachyte from 'Barbie Doll' adit (SW/4 sec. 27).	0.12	--	--	--	--	--
BL6-88	Precambrian granite from SW/4 sec. 20.	nd	1.1	--	1,000	--	--
BL9-88	Hematite-, manganese-stained rare earth vein (N/2 sec. 20).	nd	3.1	--	180	--	--
BL10-88	Manganese-stained rare earth vein (N/2 sec. 20).	nd	2.1	--	400	--	--
BL11-88	Feldspathic breccia (NW/4 sec. 17).	nd	nd	--	540	--	--
BL13-88	Trachyte partially replaced by manganese, south end of Bull Hill (SE/4, sec. 17).	nd	7.3	--	7.5%	--	--
BL14-88	Trachyte, partially replaced by manganese (sec. 17).	nd	2.3	--	5.1%	--	--
BL15-88	Argillized trachyte (NW/4 sec. 1).	nd	nd	--	4,400	--	--
BL17-88	Pyritized cupriferous trachyte from Copper Prince prospect (NW/4 sec. 17).	nd	7.9	2.5%	160	--	--
BL18-88	Cupriferous breccia from dump south of Copper Prince (sec. 17).	0.10	8.6	2.3%	300	--	--
-- MORMON CANYON (T.32N., R.76W.) --							
MC2-88	Copper- and limonite-stained vein (NE/4 sec. 14).	0.58	1.6	6,700	2,000	--	--
-- MINE HILLS (T.26N., R.75W.) --							
MN1-88	Massive manganese in sandstone.	nd	nd	--	29.8%	--	--
MN2-88	Massive manganese in sandstone.	nd	nd	--	26.9%	--	--
MN3-88	Massive manganese in sandstone.	nd	nd	--	21.0%	--	--
MN4-88	Manganese-stained jasper.	nd	nd	--	1.18%	--	--
-- WARBONNET DISTRICT (T.29N., R.75W.) --							
OR1-88	Chalcopyrite-bearing milky quartz.	nd	nd	1.14%	550	--	--
OR2-88	Chalcopyrite-bearing milky quartz.	nd	nd	1.18%	860	--	--
-- MCCANN PASS (T.28N., R.65W.) --							
HU9-88	Limonite-stained massive pyrrhotite.	nd	6.5	--	--	--	--

\* 1,000 ppm = 0.1%; 34.3 ppm = 1.0 ounce/ton

At Mine Hills (sec. 10, T.26N., R.75W.) in the extreme eastern part of Shirley Basin, manganese occurs as replacements and fracture fillings of Casper Formation sandstone. Mine Hills was once mined for manganese, resulting in the recovery of small tonnages of manganese ore during the early 1900s (Hausel, 1987). Four samples collected from this area showed significant manganese, ranging from 1.18 percent to 29.8 percent manganese (Hausel, 1988d).

In the Warbonnet copper district of the northern Laramie Range, a group of mines were located on cupriferous veinlets in Proterozoic mafic dikes. These dikes intrude Archean granite (Hausel, 1988e). The Oriel shaft (SE/4 sec. 10, T.29N., R.75W.) was sunk on a N40° E mafic dike. Samples from the mine dump contained chalcopyrite and minor copper carbonates. Two samples collected for assay (no. OR1-88 and no. OR2-88) yielded 1.14 percent and 1.18 percent copper with no detectable gold or silver, respectively (see table on page 34).

Finally, samples of massive pyrrhotite were collected from prospects along "gossan hill" in the McCann Pass area of the Hartville uplift (sec. 24, T.28N, R.65W.). The one sample that has been assayed to date yielded only 0.19 ounce per ton silver (see table on page 34).

Of significant interest to hard rock mining and prospecting, the U.S. Bureau of Land Management is initiating an increase in fees for paperwork related to mining claims. According to an article in the *Public Lands News* (vol. 13, no. 24, Dec. 8, 1988, p. 6) the following fee increases are anticipated:

Mining claim application	- \$ 10 (was \$5)
Annual assessment	- \$ 5 (was no charge)
Transfer of interest	- \$ 5 (was no charge)
Amendment of claim	- \$ 5 (was no charge)
Deferral of assessment	- \$ 25 (was \$10)
Patent application	- \$250 (was \$25)
Each additional patent application	- \$ 50 (was no charge)

In the upcoming year (1989), no significant increase in exploration activity for metals is anticipated in Wyoming unless a major discovery is made. This is because most mining companies are dedicating most, if not all of their available resources to Nevada. Nevada reportedly has a very favorable political and geological environment for metals mining.

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Note: The Geological Survey of Wyoming has a public file of unpublished Mineral Reports ranging from the late 1800s to the present. These are available for inspection at the State Survey Building on Campus in Laramie.

#### PROPOSED UNDERGROUND TEST SITE STUDIED

by Ray E. Harris, Industrial Minerals and Uranium Division Head, Geological Survey of Wyoming

A large, non-nuclear, underground explosive test, which is part of a U.S. Department of Defense experiment to simulate the effects of nuclear attacks on hardened underground structures, may be conducted near Guernsey, Wyoming. Two similar tests have been conducted in Nevada in different geologic environments. Currently, the Guernsey area is one of several sites under consideration.

The site has to meet rather exact geological conditions. The Defense Nuclear Agency, and the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi, have determined the criteria for the geology of the test site. One area in New Mexico and two in Texas were selected in mid-1988, and the first Texas site was drilled this fall. The rock properties at the first Texas site apparently did not meet the design criteria. Officials of Lachel, Piepenburg, and Associates, contract engineers to the Federal agencies, visited the Geological Survey of Wyoming in October, 1988, to see if there were any areas in Wyoming that might meet the geologic criteria.

Based upon geologic, topographic, and land-use criteria, three areas in Wyoming were suggested to the contract engineers. Of these three sites, the Hartville uplift north of Guernsey was considered the best site due to topography, accessibility, and the nearness of a Wyoming National Guard facility. Geologists from Lachel, Piepenburg, and Associates and others involved in the project were then given a

tour of the Hartville uplift, and rock samples were taken for testing. The rock samples met design specifications, so in early December, officials of the Defense Nuclear Agency; U.S. Army Corps of Engineers Waterways Experiment Station; and Lachel, Piepenburg, and Associates met again with the Wyoming National Guard, Platte County Commissioner Charles Frederick, Guernsey Mayor Darrell Ofte, and Ray Harris of the Geological Survey of Wyoming to discuss a project to examine the area.

Based on this meeting, a small grant was awarded the Geological Survey of Wyoming to conduct a field study of the area in January, 1989. The object of this study is to select a location for the test and locate a site for a test drill hole. Since the explosion may be strong enough to crack foundations within a half mile of the site and plaster walls up to 1 1/2 miles away, the surface location of this test must be at least 1 1/2 miles from an inhabited or maintained structure.

If a suitable site is found, a continuous core test hole will be drilled to determine rock characteristics above, at, and below the target horizon for the explosives test. If the analysis of the rocks from the core hole are suitable, and the other criteria are met, the Defense Nuclear Agency will decide what further work at the Guernsey site is needed. The test itself, including the tunnelling and support services, will cost around \$11 million, much of which will be spent in Wyoming.

Wyoming state officials, Platte County officials, and Town of Guernsey officials have expressed support for locating the facility in Wyoming. However, Wyoming will be selected only if the geological conditions are completely met.

#### MAPPING WYOMING'S GEOLOGY AND MINERAL RESOURCES

by Alan J. Ver Ploeg, Stratigraphy Division Head, Geological Survey of Wyoming

##### COGEOMAP Program

The Stratigraphy Division and the Metals and Precious Stones Division have been involved in the COGEOMAP Program since 1985. These cooperative mapping projects, funded in part by the U.S. Geological Survey, are centered around geologic mapping at the 7 1/2-minute quadrangle scale. To date, thirteen quadrangles have been completed on the two projects, and two more are nearing completion (see accompanying Index map on page 39).

The Stratigraphy Division's COGEOMAP project is located in the southern Bighorn Mountains, west of Kaycee and southeast of Tensleep. The area was chosen for mapping to provide geologic information for water-related projects in the area and to update mapping done in 1906 at 1:250,000 scale by N.H. Darton. The area mapped to date (5 quadrangles) includes rocks ranging from Precambrian through Upper Cretaceous (Cody Shale), with most of the area characterized by Paleozoic outcrops. The Big Trails fault system trends north-



northeast to south-southwest through the western part of the project area. Five open file maps have been published from the project (see index map). Field work has been completed on two more quadrangles and they will be released in early 1989. The project goal is to map 16 quadrangles (see index map for maps still in progress or planned). Upon completion of the 16 maps, a geologic report will be written detailing the stratigraphy, geologic history, and structural geology of the project area. In addition, each quadrangle map will be published in final form in the MS series as a color map at a 1:24,000 scale.

The Metals and Precious Stones Division completed eight 7 1/2-minute (1:24,000 scale) quadrangle maps as part of the COGEOMAP Program (see index map). The purpose of the project was to map the Archean geology of the South Pass greenstone belt at the southern tip of the Wind River Range. The project also resulted in the mapping of twenty-four historic gold mines on a 1:240 scale; the discovery and identification of several significant gold, silver, copper, tungsten, tin, chromium, and nickel anomalies; and the discovery of a group of possible gold placers.

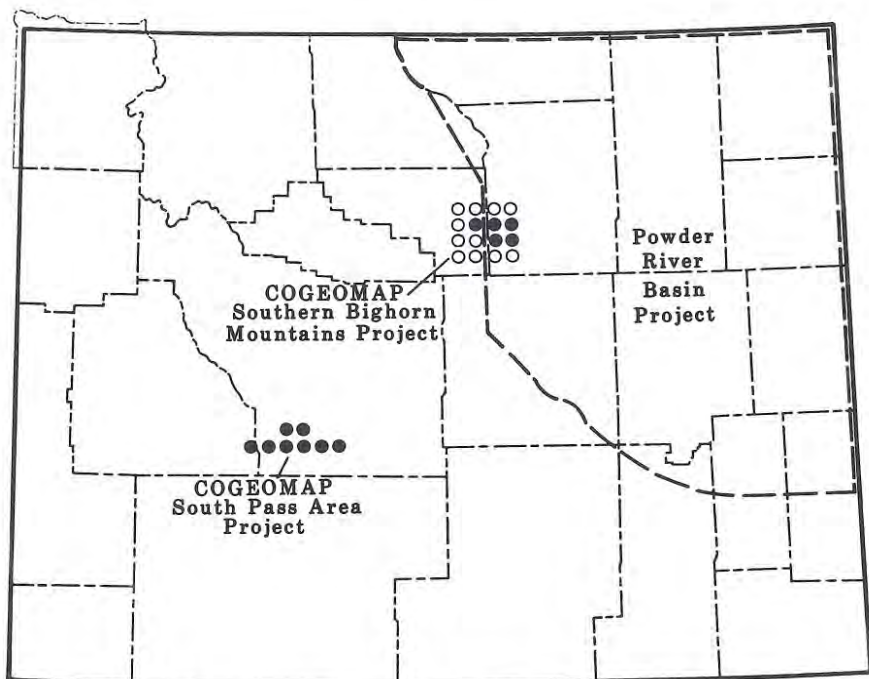
Seven of the 1:24,000-scale maps are available as open file reports and one is a completed full-color map (Radium Springs). Another color map (Atlantic City) is close to completion. The rest of the open filed maps are scheduled for printing in the color map series.

The 1:24,000-scale maps are currently being compiled into a 1:48,000-scale regional map to be included with mine maps, geochemical analyses, and whole rock analyses in a summary report on the geology, gold, iron, and other mineral resources of the greenstone belt.

### Powder River Basin Project

In another cooperative project, the U.S. Geological Survey is funding the preparation of a series of maps by the Geological Survey of Wyoming, depicting the mineral resources of the Powder River Basin (see index map on page 39). This project is a part of the U.S. Geological Survey's Evolution of Sedimentary Basins Program. Maps of coal resources, oil and gas, industrial minerals and construction materials, and metallic and radioactive minerals and semiprecious stones will be prepared.

The Coal Division is preparing a 1:500,000-scale coal resources map of the Powder River Basin. The colored map will show outcrops of coal-bearing rocks in the basin as well as outcrops of major coal beds. Overburden thickness for the Wyodak coal bed and other selected coal beds may also be mapped. The map will show the location of all active and abandoned coal mines in the basin as well as the current loadout and rail transportation systems in the basin. The map will also depict other related coal development activities in the Powder River Basin, including coal-fired power plants, transmission lines, and undeveloped projects.



**Index of ongoing and recently completed mapping projects  
of the Wyoming Geological Survey**

- recently completed quadrangle maps
- quadrangle maps in progress or planned

**Bighorn Mountains project maps available**

- OFR 87-4 Mayoworth Quadrangle
- OFR 87-5 Red Fork Powder River Quadrangle
- OFR 88-4 Fraker Mountain Quadrangle
- OFR 88-5 Barnum Quadrangle
- OFR 88-6 Tabletop Quadrangle

**South Pass area project maps available**

- OFR 86-26 Anderson Ridge Quadrangle
- OFR 87-10 Miners Delight Quadrangle
- OFR 88-2 South Pass City Quadrangle
- OFR 88-3 Lewiston Lakes Quadrangle
- OFR 88-7 Atlantic City Quadrangle
- OFR 88-8 Halls Meadow Spring Quadrangle
- OFR 88-12 Louis Lake Quadrangle
- MS 26 Radium Springs Quadrangle

The Industrial Minerals and Uranium Division and the Metals and Precious Stones Division are preparing a map of industrial minerals and construction materials and a map of metallic and radioactive minerals and semiprecious stones of the Powder River Basin. Both maps will be at a scale of 1:500,000. The industrial minerals and construction materials map will depict outcrops of bentonite, gypsum, limestone, and dolomite-bearing strata, along with granite outcrops. Bentonite pits and plants will be shown. The map will also show occurrences of various industrial commodities, dimension and decorative stone quarries, and sand and gravel pits. The map of metallic and radioactive minerals and semiprecious stones will catalog rare-earth element occurrences, gemstone and semiprecious stone occurrences, uranium mines and concentrations of high-grade uranium, and radioactive mineral occurrences.

The Oil and Gas Division is preparing an oil and gas map of the Powder River Basin at a scale of 1:316,800. The oil and gas map will depict the location of all abandoned, shut-in, or producing oil and gas fields in the basin. The boundaries of production and producing formations will also be shown. Other pertinent information related to oil and gas production, including refineries and gas plants will be included.

Completion and publication of the map of industrial minerals and construction materials and the map of metallic and radioactive minerals and semiprecious stones are planned for the first half of 1989. The oil and gas map and coal map are planned for the latter part of 1989.

### Geologic Hazards Mapping

The Geologic Hazards Division is currently completing a landslide mapping project begun in 1981. The project was initially funded through the U.S. Office of Surface Mining. Since 1982, the project has been partially funded by the U.S. Geological Survey. The mountainous portions of the western half of the State were mapped for landslides using aerial photography in conjunction with limited field investigations. Landslides in the eastern half of the State were primarily compiled from existing geologic maps, with new mapping being conducted by the Division in limited areas. Both newly mapped landslides and compiled data were plotted on 1:24,000-scale quadrangle maps. The 1:24,000-scale quadrangle maps are available for examination in the Division's files. A state-wide Index map will be prepared at a 1:500,000 scale. The map will be accompanied by a written report describing landslide types and processes in the State and outlining the landslide classification system used. Projected completion date is 1989.

The Geologic Hazards Division recently updated a map of suspected active faults that was included in Public Information Circular 25, *Earthquakes and related geologic hazards in Wyoming*, which was published in 1986. A reduced version of the updated map is presented on page 42 of this issue of *Wyoming Geo-notes*. The new map depicts faults known to have been active within the last 2 million years as well as faults known to have been recurrently active since Miocene time (last 20 million years). Data for this map were again gathered

from existing maps and reports, augmented by new data from air photo interpretation. Additional faults are to be investigated in 1989.

A statewide map of potentially seleniferous areas in Wyoming has been prepared by the Division for the Governor's Selenium Work Group. The map was released as Open File Report 88-1.

As a final note of interest, the Stratigraphy Division has completed work on a new index of geologic maps by the State Geological Survey from 1985 through 1988. The map is at a scale of 1:1,000,000 and will be available in 1989.

## ACTIVE FAULTS UPDATE FOR WYOMING

by James C. Case, Geological Hazards Division Head, Geological Survey of Wyoming

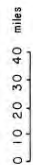
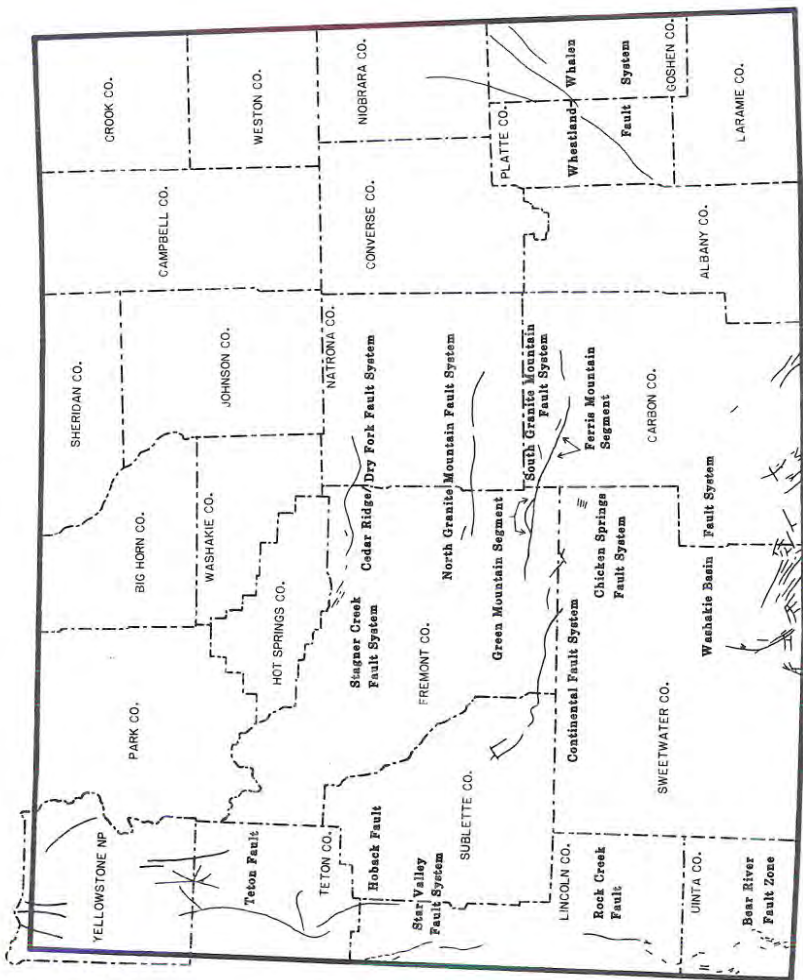
In 1987, the Geological Survey of Wyoming and the Department of Geology and Geophysics at the University of Wyoming initiated a program to map or compile information on faults with a surficial expression that have been shown to be active in the last 2 million years (Quaternary). Faults that have been active in the last 15,000 years are being flagged when possible. The U.S. Bureau of Reclamation, U.S. Geological Survey, Colorado School of Mines, University of Wyoming, and Geological Survey of Wyoming have been the most active in the fault mapping program. A summary of recent data is presented below and on the map on page 42. This map shows faults known to have been active within the last 2 million years as well as faults that have been recurrently active in the last 20 million years.

The Teton fault has been assigned a maximum credible earthquake (MCE) of magnitude 7.5, with a recurrence interval of 3,600 years and a maximum displacement of 22 feet (Gilbert, and others, 1983). The Hoback fault, located south-southeast of the Teton fault, has had a MCE of magnitude 7.5 and a recurrence interval of 71,000 years assigned to it (Gilbert, and others, 1983). For comparison purposes, the 1959 Hebgen Lake earthquake in Yellowstone demonstrated the damage that can result from a magnitude 7.5 event (maximum intensity X). Accounts of this damage are found in Witkind (1962).

The Star Valley fault system in northwestern Lincoln County in the Overthrust Belt (western Wyoming), was studied by the U.S. Bureau of Reclamation (Piety, and others, 1986). A MCE of magnitude 7.5, with a recurrence interval of approximately 5,000 years and a maximum displacement of 10 to 20 feet, has been estimated for the fault system. An active segment of the fault traverses the eastern portion of Afion, Wyoming.

The Rock Creek fault system in southwestern Lincoln County (Overthrust Belt) has been recently investigated by the Department of Geology and Geophysics at the University of Wyoming. A MCE of 7.0 has been assigned to that fault system (Chambers, 1988).

The Bear River Fault zone in Uinta County in southwestern Wyoming has been studied by Mike West of the Colorado School of Mines. A MCE



ACTIVE FAULT RESEARCH IN WYOMING

of magnitude 7.3 to 7.5, with a recurrence interval of 1,000 to 3,000 years, has been assigned to the fault system (West, 1986).

The Stagner Creek fault system located on the south flank of the Owl Creek and Bridger Mountains in central Wyoming has been active in the late Pleistocene. A MCE of magnitude 6.75, with a recurrence interval of 8,000 to 20,000 years, has been assigned to that fault system (Geomatrix, 1988a). The Cedar Ridge/Dry Fork fault system east of the Stagner Creek fault has segments that have been active in the Quaternary (Geomatrix, 1988a).

Two segments of the South Granite Mountain fault system in south-central Wyoming have been active since the late Pleistocene (Geomatrix, 1988b). A MCE of magnitude 6.75, with a recurrence interval of 5,000 to 13,000 years was assigned to the Ferris Mountain segment in northern Carbon County. A MCE of magnitude 6.75, with a recurrence interval of 2,000 to 6,000 years, was assigned to the Green Mountain segment in southeastern Fremont County (Geomatrix, 1988b). No convincing evidence for late Pleistocene fault activity has been found along the North Granite Mountain fault system (Geomatrix, 1988a, b).

The Geological Survey of Wyoming has conducted reconnaissance mapping at the Chicken Springs fault system in the Red Desert area of south-central Wyoming. Displaced soil horizons were observed.

A recent examination of the Wheatland-Whalen fault system in southeast Wyoming has not uncovered any obvious signs of Quaternary activity (Earth Technology Corporation, 1986). That fault system is of interest due to its proximity to missile silos.

Much active fault mapping and dating remains to be done in the State. Of particular interest are the suspected active faults in the south-central portion of the State (Washakie Basin). Also of interest are fault systems flanking the southern portions of the Wind River Range in west-central Wyoming (Continental fault system).

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## Recent and new publications by the Geological Survey of Wyoming

\*Geologic map of the Radium Springs Quadrangle, including the Lewiston gold district, Fremont County, Wyoming, W. Dan Hausel: Map Series 26, 1988, scale 1:24,000 (\$3.00).

\*Precambrian basement map of Wyoming: outcrop and structural configuration, D.L. Blackstone, Jr.: Map Series 27, 1989, scale 1:1,000,000 (\$3.00)

\*Index to U.S. Geological Survey topographic maps of Wyoming available from the Geological Survey of Wyoming: 1989, scale 1:1,000,000 (map scales shown include 1:24,000; 1:100,000; and 1:250,000), (first copy free, \$2.00 for each additional copy).

\*Wyoming State Geologists (postcard): 1988 (25¢ each or 5/\$1.00).

Stream-sediment sample results in search of kimberlite intrusives in southeastern Wyoming, W.D. Hausel, W.M. Sutherland, and E.B. Gregory: Open File Report 88-11, 1988, (\$12.00).

Revised geologic map of the Louls Lake Quadrangle, Fremont County, Wyoming, W.D. Hausel: Open File Report 88-12, 1988, (\$3.00).

The geology and reserves of Hawk Point Oil Field, Campbell County, Wyoming, R.H. DeBruin: Open File Report 89-1, 1989, (\$2.50).

Cassa silica rock deposit, Platte County, Wyoming, R.E. Harris: Report of Investigations 42, 1988, (\$4.00).

Geologic road log of part of the Gros Ventre River valley including the Lower Gros Ventre Slide, J.D. Love and J.M. Love: Reprint 46, 1988, (\$6.00).

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

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