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Gary B. Glass, State Geologist

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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: In 1987, the Wyoming Legislature designated, *Knightia*, as the State Fossil. *Knightia*, which is a herring, is a common fossil in rocks of the 50-million-year-old Green River Formation of western Wyoming. This fossil was named after Wilbur C. Knight, pioneer Wyoming geologist and Wyoming State Geologist (1897-1902). Green River Formation rocks and fossils are featured at Fossil Butte National Monument, west of Kemmerer, Wyoming. The front cover photograph, by Lance Grande, is from Geological Survey of Wyoming Bulletin 63, *Paleontology of the Green River Formation, with a review of the fish fauna*.

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MINERALS UPDATE

OVERVIEW

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

The prognosis for the State's mineral industry is still a mixed bag. There are, for certain, some good things happening, but all is not rosy and the good things are often only in the eye of certain beholders. At least many down-trends have slowed or even turned around, but subsequent events cast a slight pallor on most everything positive that happened in the last three quarters of 1987. Overall, however, things have improved over 1986.

While increased rig counts and higher posted oil prices do bode better times for the State's petroleum industry, neither of these events will stop the overall decline in Wyoming's oil production. It took four to five times the drilling activity and more than a $10/barrel better price for the decline in oil production to stop in the early 1980s and neither of those events are likely to occur again in the near term. For the next few years, however, there is a good probability that oil prices will stabilize or even gradually increase and that these relatively higher prices will encourage modest drilling levels that may lead to enough production to reduce the current seven percent decline in oil production. The increase in production shown in 1989 (table on page 2), is reflecting resumed or new production from Buck Draw, Lost Soldier, Wertz, Luckey Ditch, Taylor Ranch, and Hickey Mountain Fields.

The petroleum industry has also availed itself of some tax incentives passed by the Wyoming Legislature during the past several years. These various tax incentive bills reduced severance taxes on an estimated 6.3 million barrels of gross oil production in 1987 (the bills reduced the six percent tax to four percent). By 1991, an estimated 18.7 million barrels of gross production could benefit by these incentive bills. Collectively, companies may save two percent on an estimated 70.6 million barrels of oil produced between 1987 an 1991. The tax incentive bills, each with slightly differing durations, included breaks for tertiary recovery operations, for new wildcat wells drilled after January 1, 1987, and for units whose average well production, under a new definition, qualify as stripper production (most notably production from the Salt Creek field is now stripper production). While helping the depressed oil industry, however, these same incentives have an inverse relationship to the State's operating revenues since the excused two percent tax previously went into the State's General Fund.

Although natural gas production continues to climb, the price has not rebounded as hoped by many. While most forecasters believe the gas glut is essentially over, Wyoming still has many natural gas wells shut-in. The Kern River pipeline project offers some hope for finding a market for up to 350 million cubic feet of gas per day. Amoco's Phase II project at Bairoil will also put more of Exxon's carbon dioxide to use. Complicating the benefits of increasing natural gas production, particularly from a revenue standpoint, are the facts that taxes on 120 billion cubic feet of carbon dioxide and 60 billion cubic feet of methane and other gases from Exxon's Shute Creek plant are not

collectible because of ongoing litigation. In both cases, Exxon is arguing that there is no value after the cost of processing the raw gas. The outcomes of these cases have some far-reaching consequences for the State and Federal governments as well as for numerous other royalty owners.

Coal production should recover from its decline of last year, but at very modest rates into the 1990s. No big jump in production is forecast although some new beneficiation projects, which increase the heat value of Wyoming coal, offer some hope for the future in attracting new markets. Tempering these bright spots was the recent announcement that the Clovis Point mine in the Powder River Basin would go on standby in 1988. This is the first major coal mine in the Powder River Basin to close.

As mentioned last quarter, *in situ* production of uranium is resuming. This is occurring at the same time that Wyoming's last surface-mining-uranium company has cautioned that new tax rates threaten its continued existence.

As a final bright spot in Wyoming's mineral industries, interest in gold is continuing though there are still no gold mines in operation. Placer mining is recovering significant gold, but on a rather small scale. With the coming winter, gold exploration will decline as snow moves into the mountains of the Cowboy State.

Wyoming mineral production forecast to 1991[1].

Calendar Year	Oil Production[2]	Natural Gas Production[3]	Carbon Dioxide Production[3]	Coal Production[4]	Trona Production[4]	Mined Uranium Production[4]
*1981	122.1	455.4	--	102.8	11.8	4.6
*1982	118.7	465.1	--	107.9	10.1	2.1
*1983	120.9	539.7	--	112.2	10.5	3.0
*1984	127.8	600.1	--	130.7	11.0	1.6
*1985	131.0	597.9	--	140.4	10.8	0.6
*1986	122.4	563.2	23.8	136.3	13.3	0.3
1987	115.6	613.0	120.0	140.0	13.4	0.3
1988	111.0	630.0	120.0	143.0	13.6	0.3
1989	117.0	665.0	120.0	146.0	13.7	0.3
1990	108.0	700.0	120.0	149.0	13.8	0.3
1991	100.4	730.0	120.0	152.0	13.9	0.3

*Actual values for comparison; [1] Geological Survey of Wyoming, September, 1987; [2] millions of barrels; [3] billions of cubic feet; [4] millions of tons.

OIL AND GAS UPDATE

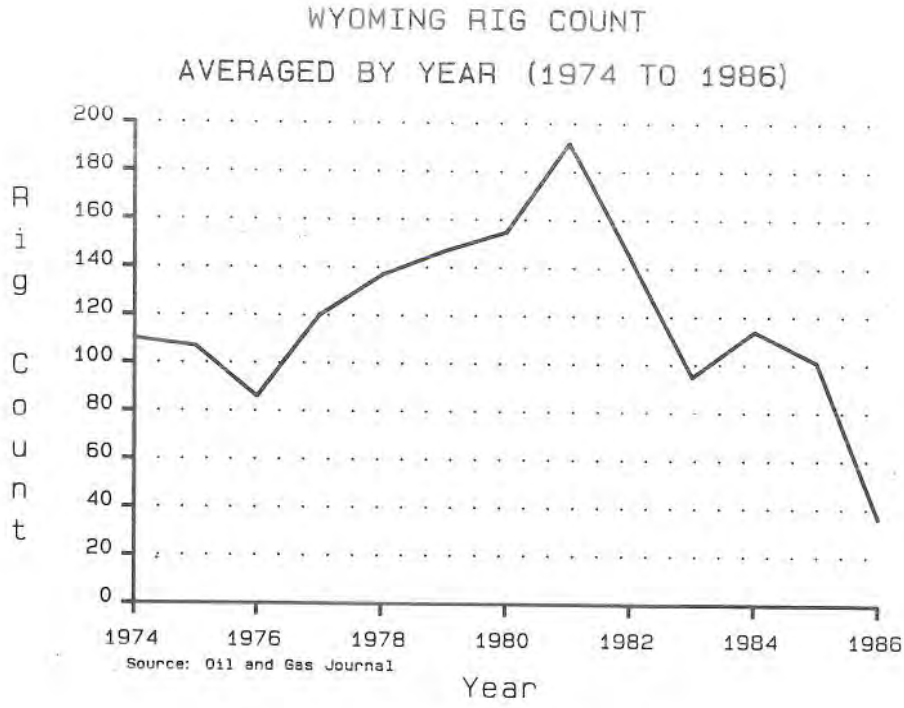
by Rodney H. De Bruin, Oil and Gas Geologist, Geological Survey of Wyoming

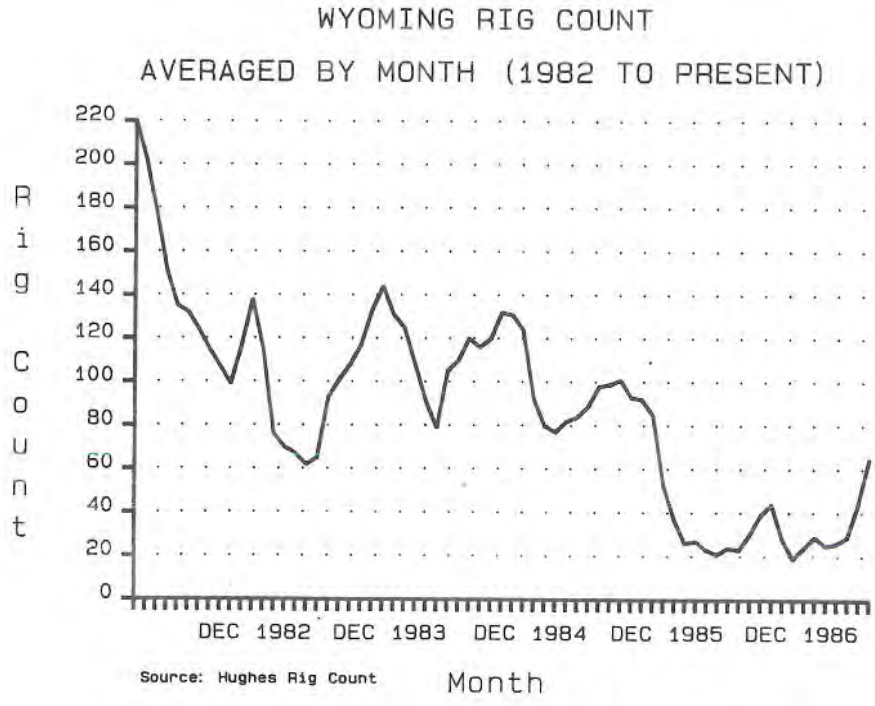
Several encouraging developments related to the Wyoming petroleum industry occurred during the third quarter of 1987. The rig count rose rapidly from a monthly average of 29 in July to a monthly average of 65 in September (see graph on page 4). There was an average weekly increase of four rigs since the second week in July when only 26 rigs were working in the State. In early October there were 68 rigs at work in Wyoming. The last time the rig count was this high was in January 1986. The increase in drilling activity over the third quarter gave a much needed boost to oil field service companies which provide oil field equipment, service, and transportation. Another bright spot is that Wyoming's rig count increased by eight while the national count decreased by 14 in the same period. With seasonal adjustments, Wyoming's rig count could approach 90 rigs by year-end (see graph on page 4).

Amoco Production Company recently announced plans to proceed with Phase II of their enhanced oil recovery project at Bairoil, Wyoming. More stable crude oil prices and currently favorable results at Wertz field (Phase I) are cited as reasons for initiating Phase II. Production at Wertz increased steadily from an average of 4,100 barrels per day in December, 1986, to an average of slightly over 10,000 barrels per day in June, 1987, the last month for which production statistics were available. Phase II was delayed by Amoco in March, 1986, because of falling crude oil prices at that time. Phase II will expand the project to Lost Soldier field where a pipeline distribution system will be built to inject carbon dioxide into the Tensleep Sandstone and Madison Limestone to recover additional hydrocarbons. The existing carbon dioxide recycling plant at nearby Wertz field will also be expanded. Construction on the $70 million project will begin next Spring with injection of carbon dioxide scheduled to begin in November, 1988, and plant expansion to be finished in April, 1989.

Wyoming sweet crude had an average posted price of about $19.50 per barrel for the first half of the third quarter, but dropped to an average of $18.25 per barrel by mid-September due to concerns that OPEC members were cheating on their production quotas. Futures prices for November delivery increased during the last week of the quarter to around $19.50 per barrel in response to OPEC's announcement that their production was much less than was reported and to increased tension in the Persian Gulf. There is a good chance that crude prices will stabilize in the $18-$20 range, at least through 1987.

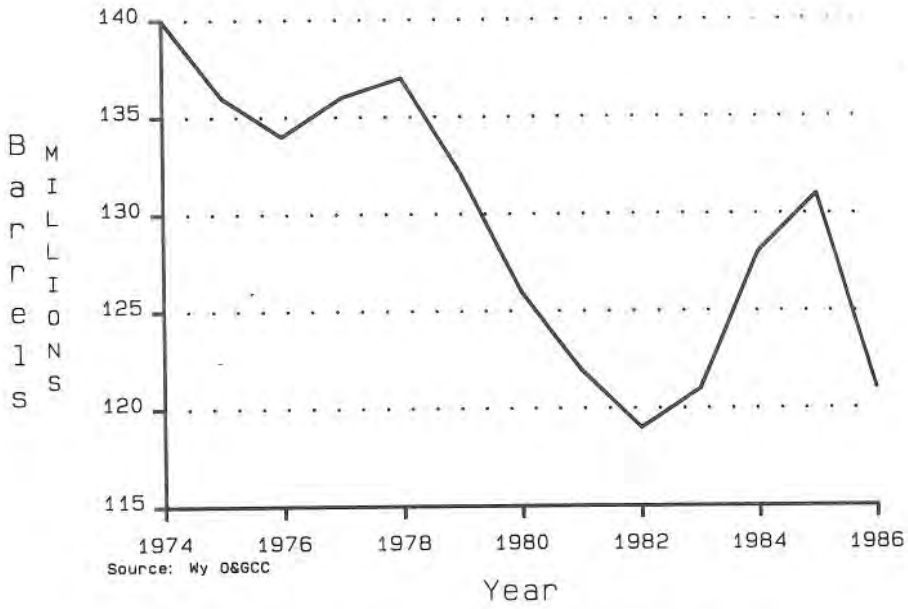
The Wyoming Board of Land Commissioners sold over half the acres offered at their July and September lease sales. This is the first time back-to-back State sales have sold over 50 percent of the total acres offered since the first two sales of 1986. The July sale had high bids of $477,891 on 47,105 acres with an average bid of $10.16 per acre. The total revenue in this sale was the highest generated since the March, 1986, sale. Richard Troost of Casper made the high


WYOMING RIG COUNT
AVERAGED BY YEAR (1974 TO 1986)
Rig Count
200
180
160
140
120
100
80
60
40
20
0
1974
1976
1978
1980
1982
1984
1986
Source: Oil and Gas Journal
Year


WYOMING RIG COUNT
AVERAGED BY MONTH (1982 TO PRESENT)
Rig Count
220
200
180
160
140
120
100
80
60
40
20
0
DEC 1982
DEC 1983
DEC 1984
DEC 1985
DEC 1986
Source: Hughes Rig Count
Month

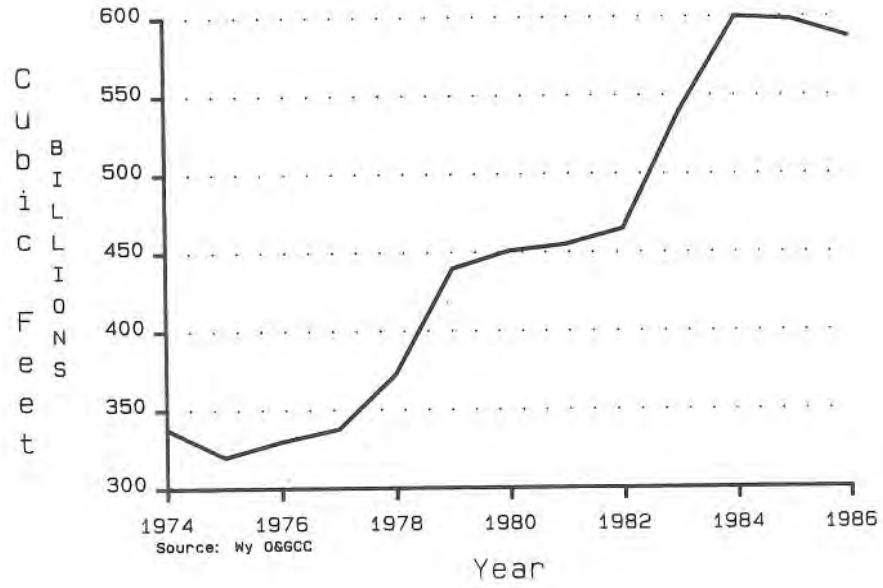
WYOMING OIL PRODUCTION

BY YEAR (1974 TO 1986)



WYOMING NATURAL GAS PRODUCTION

BY YEAR (1974 TO 1986)



bid of $125 per acre for a 553.17-acre tract in the Powder River Basin in section 36, T.56N., R.73W. The tract is just north of Collums field which has oil production from the Muddy Sandstone. Three parcels in this sale drew per-acre bids of $100 or more and 23 drew per-acre bids of $10 or more.

The September State sale received high bids totaling $362,903 on 44,698 acres for an average bid of $8.12 per acre. The top bid of $210 per acre was made by Kennedy Oil of Denver for a 76.63-acre tract in section 7, T.49N., R.67W. in the Powder River Basin. The tract is near Minnelusa oil production at Robinson Ranch South and Thorson fields. Only the high-bid parcel in this sale drew a bid of $100 or more per acre; however, 20 parcels sold for $10 or more per acre. State sale results are summarized in the table on page 9.

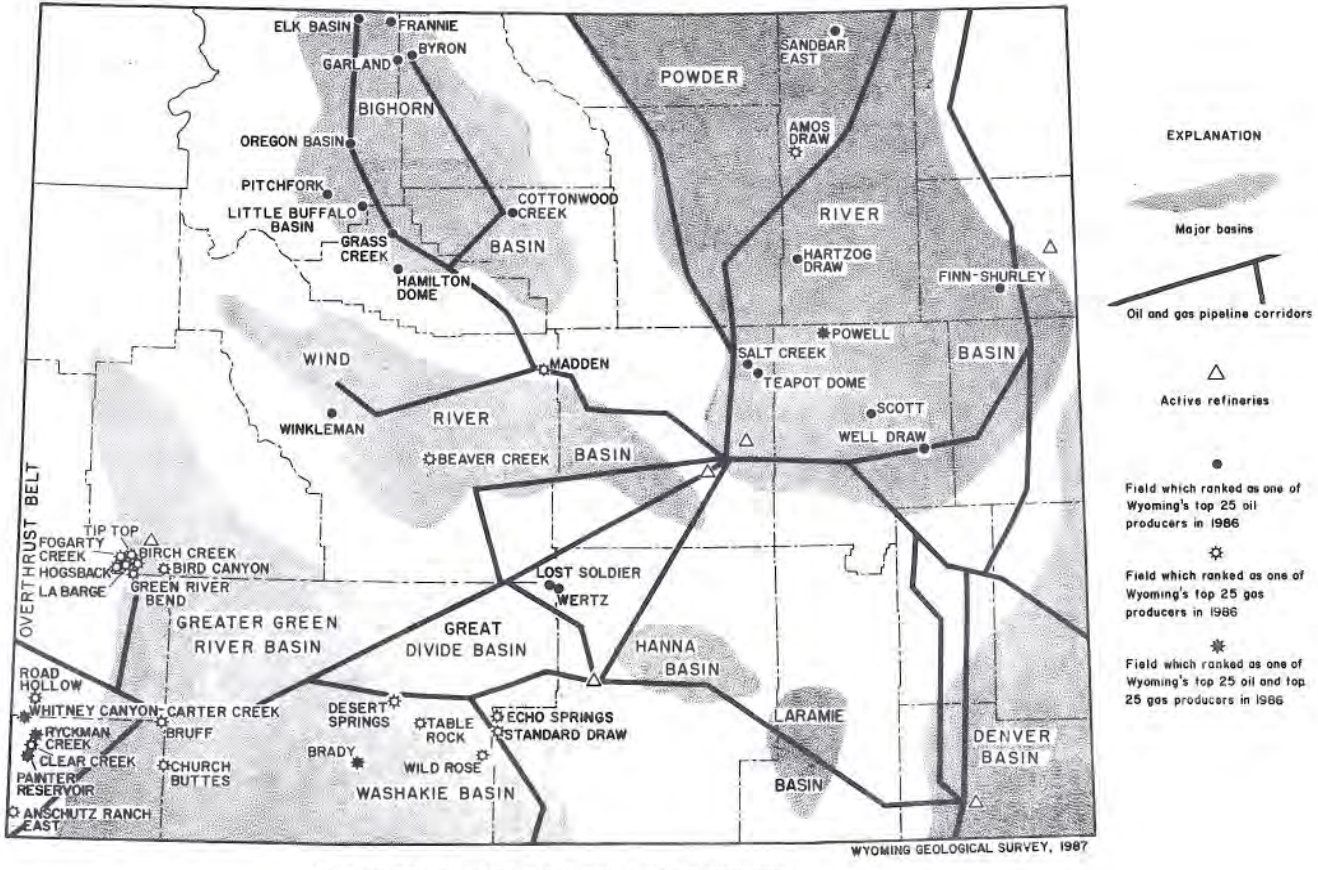
The U.S. Bureau of Land Management's (BLM's) August sale generated $1,327,186 in high bids while 16 of the tracts sold for $100 or more per acre. Half of the 16 high-bid tracts were in the Powder River Basin and the other half were in the vicinity of recent Dakota discoveries at Blue Forest and Lincoln Road fields on the Moxa Arch. A total of 21,055 acres in this sale drew bids which averaged $63.03 per acre. The high per-acre bid was submitted by Donald B. Anderson for a 31.32-acre parcel in section 2, T.55N., R.73W. in the Powder River Basin. The tract is adjacent to Muddy Sandstone oil production from Collums field. The last two BLM sales have generated more revenue than the six BLM sales in 1986. For comparison with past BLM sales, see the table on page 9.

A significant discovery by Thermal Exploration was completed in August at Red Bird field on the southeastern flank of the Powder River Basin. The well, in section 19, T.38N., R.61W., pumped 112 barrels of oil per day from the Jurassic Sundance Formation. The new discovery is approximately 25 miles northeast of the nearest Sundance production, which is at Lance Creek and Lightning Creek fields.

General Atlantic Energy and Argentia Operating pumped 520 barrels of oil per day from their new Minnelusa discovery in section 27, T.52N., R.69W. The well is about one mile east of Mac field and one mile west of Breaks field which both produce oil from the Minnelusa.

The Bighorn Basin may have a new producing oil field. CNG Producing has completed a Tensleep Sandstone discovery in section 10, T.48N., R.91W. about 2 miles southwest of Bonanza field. No details are yet available on production rates. A north offset to the discovery is now being tested and another north offset is being drilled. Three more locations have been staked in the area by CNG.

Chevron announced it will drill a Madison Limestone test in the Overthrust Belt. The well will be drilled about 30 miles southeast of Jackson in section 11, T.36N., R.115W. The Madison test is also 14 miles southwest of Chevron's noncommercial Frontier gas discovery at the Game Hill unit.



GENERALIZED OIL AND GAS INDEX MAP OF WYOMING

TOP 25 GAS FIELDS IN WYOMING BASED ON 1986 PRODUCTION

Name	Year discovered	1986 Production (MCF)	Cumulative production through 1986 (MCF)
Whitney Canyon - Carter Creek	1978	89,144,674	391,526,850
Painter Reservoir	1977	59,678,885	284,405,821
Fogarty Creek	1976	30,508,965*	48,526,836†
Brady	1973	21,276,723	240,587,093
Ryckman Creek	1976	18,296,828	85,374,720
Table Rock	1946	16,013,252	400,273,741
Powell	1954	15,552,079	60,509,911
LaBarge	1925	15,352,069	217,681,475
Clear Creek	1979	14,519,223	72,181,467
Echo Springs	1976	14,090,874	113,622,347
Madden	1969	11,707,666	231,744,323
Standard Draw	1979	11,582,745	73,450,531
Bruff	1974	10,114,917	88,828,778
Beaver Creek	1938	9,880,068	544,602,386
Amos Draw	1982	9,656,388	26,940,696
Tip Top	1928	8,525,852	321,728,920
Anschutz Ranch East	1982	7,455,887	13,925,772
Wild Rose	1975	7,035,148	60,869,442
Green River Bend	1958	6,950,794	173,500,876
Church Buttes	1956	6,840,041	343,439,492
Hogsback	1955	6,329,294	301,323,312
Birch Creek	1957	5,590,347	159,330,629
Desert Springs	1958	5,425,460	243,638,800
Bird Canyon	1971	5,131,286	31,338,599
Road Hollow	1981	4,530,532	14,754,047
TOTAL		411,189,997*	4,544,106,864†

* Approximately 20,000,000 MCF are carbon dioxide
† Approximately 32,000,000 MCF are carbon dioxide

TOP 25 OIL FIELDS IN WYOMING BASED ON 1986 PRODUCTION

Name	Year discovered	1986 Production (Barrels)	Cumulative production through 1986 (Barrels)
Oregon Basin	1912	9,997,721	370,110,499
Hartzog Draw	1976	6,512,823	52,990,136
Painter Reservoir	1977	6,088,409	41,142,836
Salt Creek	1889	5,871,938	616,497,863
Little Buffalo Basin	1914	3,418,312	112,911,796
Brady	1973	3,219,469	50,257,368
Hamilton Dome	1918	3,147,906	224,385,244
Elk Basin	1915	2,974,391	426,137,432
Powell	1954	2,966,108	14,460,830
Lost Soldier	1916	2,756,406	205,395,877
Garland	1906	2,713,807	157,514,598
Grass Creek	1914	2,454,303	180,060,763
Wertz	1921	2,052,699	92,671,038
Frannie	1928	1,638,821	109,884,666
Whitney Canyon - Carter Creek	1978	1,633,804	5,647,985
Byron	1918	1,611,089	118,148,574
Pitchfork	1930	1,610,322	31,115,852
Ryckman Creek	1976	1,360,100	15,124,538
Winkleman	1917	1,317,792	84,213,624
Teapot Dome Naval Reserve	1922	1,170,580	18,065,223
Scott	1979	1,051,704	9,853,287
Cottonwood Creek	1953	977,280	51,207,710
Sandbar East	1968	890,126	5,653,297
Finn-Shurly	1965	762,478	6,883,574
Well Draw	1973	751,952	25,643,879
TOTAL		68,950,340	3,025,978,489

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
			1985				
February	$ 3,547,273	117	115	34,948	34,028	$ 104.24	$ 1,700.00
April	2,025,793	133	128	25,497	24,056	84.21	2,609.53
June	1,963,897	140	137	40,304	38,904	50.48	2,577.15
August	2,854,821	190	146	75,094	56,906	50.17	1,732.14
October	1,876,105	208	105	81,611	32,052	58.53	1,108.77
December	1,467,265	211	144	73,723	46,908	31.28	1,167.23
TOTAL	$13,735,154	999	772	331,177	232,854	$ 58.99	$ 2,609.53
			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
TOTAL	$ 7,265,390	776	583	211,350	152,428	$ 47.66	$ 3,313.13
			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

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
			1985				
January	$ 757,214	200	86	80,019	27,520	$ 26.51	$1,700.00
March	2,077,478	300	172	137,321	69,781	29.77	1,600.00
May	936,374	199	117	73,625	35,273	26.55	350.00
July	636,350	200	113	83,491	43,630	14.59	280.00
September	989,069	200	126	95,052	60,356	16.39	325.00
November	494,739	200	109	70,144	41,399	11.95	320.00
TOTAL	$ 5,891,224	1,299	723	539,652	277,959	$ 21.19	$1,700.00
			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
TOTAL	$ 2,448,160	1,199	522	483,326	205,757	$ 11.90	$ 370.00
			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

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

The Federal Energy Regulatory Commission should make a ruling next month on which pipeline will supply natural gas to southern California. The Wyoming Natural Gas Pipeline Authority formed by Governor Mike Sullivan will push for up to $250 million in State financing for the Kern River Pipeline if it is chosen. At least 350 million cubic feet of natural gas per day would be supplied by Wyoming producers if the Kern River Pipeline is built.

Exxon contends that the costs of transporting gas to its Shute Creek gas plant and the costs for separating and processing the gas make the gas at the wellhead worthless. Exxon is refusing to make royalty payments to many leaseholders at the present time and is not paying any severance taxes on gas production. The matter is in litigation.

Standard Oil Company of Ohio (Sohio) announced this month that they will close their Casper office by year-end. There are 14 workers in the office as well as 11 oil field workers who report to the office.

Similarly, Amoco Production Company may close its Casper, Evanston, Powell, and Riverton offices. Amoco expects the closures will come in the next one to three years.

In other bad news for the Wyoming petroleum industry, the U.S. Environmental Protection Agency released a draft report in September on the regulation of drilling fluids and produced water. Although the draft does not contain a regulatory determination, it lists costs at three levels of compliance: oil prices will increase by 72 cents to $1.69 per barrel; 0.23 percent to 36.63 percent of all producing wells will be abandoned; Federal lease bonuses and royalties will decline $85.5 million to $325.2 million by the year 2000; and states' severance taxes will fall $190 million to $989 million per year. The draft stated that an average of ten barrels of water is produced for each barrel of oil produced in the lower 48 states. States which have a higher average, such as Wyoming which produces over 13 barrels of water for each barrel of oil produced, will incur the higher compliance costs.

The U.S. House of Representative's Minerals and Mining Subcommittee passed a bill in September to reform the Federal oil and gas leasing system. Under the bill, all leases would be subject to competitive bid and any lease not sold through bidding would be offered to the first interested party for up to a year. If there are no takers, the lease would again be put up for bid. Another section of this bill would bar oil and gas leasing on Federal lands not covered by comprehensive land use plans.

COAL UPDATE

by Richard W. Jones, Coal Geologist, Geological Survey of Wyoming

It is encouraging to note that coal deliveries in the first half of 1987 increased by about two million tons from deliveries made in the first half of 1986 (see table on page 12 and the figure on page 13). Increased deliveries to Minnesota, Indiana, Iowa, and Louisiana during this period more than offset decreased deliveries to Illinois, Kansas, and Oklahoma. Mines in the eastern Powder River Basin are accounting for nearly all the increased deliveries in 1987. If deliveries in the second half of 1987 surge ahead as they did in the second half of 1986, Wyoming's 1987 coal production should exceed last year's production of 136.3 million tons.

Although production from Powder River Basin coal mines is increasing, the low coal prices and the high level of competition between producers has finally resulted in a mine closure. Kerr-McGee Coal Corporation announced in early October that their Clovis Point mine east of Gillette would close in early 1988. All the coal company's production would then be shifted to the Jacobs Ranch mine in southern Campbell County. Coal from Clovis Point is currently shipped to Public Service Company of Oklahoma's Northeastern plant at Oologah, Oklahoma. The mine began production in 1979, reached a production peak of 3.7 million tons in 1981, and produced 1.4 million tons of coal in 1986. Cumulative production through 1986 for Clovis Point is about 16.6 million tons of coal from a State of Wyoming coal lease. Fortunately, the 75 employees at the mine will not be laid off but will instead be transferred to the Jacobs Ranch mine. Because coal from Clovis Point has a delivered heating value of about 8,000 Btu/pound or less (one of the lowest in the Gillette area) and because the mine is served only by the Burlington Northern railroad, competition with other mines in the area was probably quite difficult.

Wyoming coal production figures for 1986 have been revised slightly from those presented in an earlier coal update. The table on page 14 and the figure and table on page 15 are revisions of the preliminary data that appeared in *Wyoming Geo-notes No. 14* (April, 1987, p. 14-16).

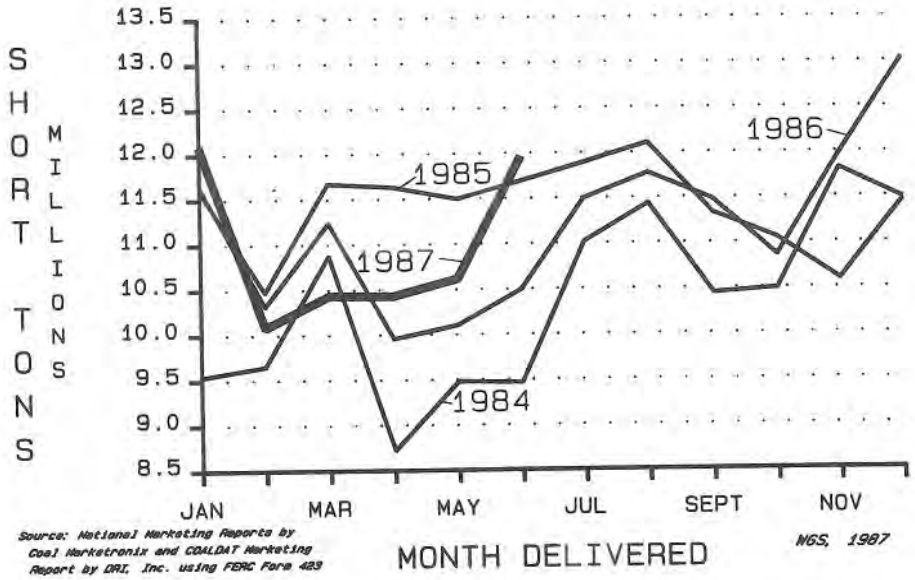
Several developments at southern Wyoming coal mines occurred in the third quarter of 1987, including the sale of an underground coal mine, a contract extension, and additional layoffs of coal miners. In early September it was announced that Cyprus Coal Company of Englewood, Colorado, had purchased Carbon County Coal Company's underground mine in the Hanna Basin. The mine, which was a joint venture of Dravo Corporation and Union Pacific Resource Company (formerly Rocky Mountain Energy Company), has been idle and on standby status since early 1986, following the loss of the mine's lone coal contract with Northern Indiana Public Service Company (NIPSCO). Cyprus Coal Company, a subsidiary of Cyprus Mineral Company (formerly Amoco Mineral Group of Standard Oil of Indiana but now an independent company), operates surface and underground coal mines in Colorado, Utah, Kentucky, Pennsylvania, and Virginia and produces about 13 million tons of coal per year from its mines. The underground mine in Carbon County would be

COAL DELIVERIES BY MONTH FROM WYOMING MINES

	1983 MONTHLY	1983 CUMULATIVE	1984 MONTHLY	1984 CUMULATIVE	1985 MONTHLY	1985 CUMULATIVE	1986 MONTHLY	1986 CUMULATIVE	1987 MONTHLY	1987 CUMULATIVE
JANUARY	10,313,000	10,313,000	9,540,200	9,540,200	11,601,200	11,601,200	11,646,300	11,646,300	12,085,570	12,085,570
FEBRUARY	8,719,700	19,032,700	9,654,600	19,194,800	10,473,900	22,075,100	10,317,700	21,964,000	10,315,680	22,401,250
MARCH	9,051,200	28,083,900	10,875,000	30,069,800	11,674,900	33,750,000	11,401,720	33,365,720	10,436,610	32,837,860
APRIL	8,195,000	36,278,900	8,721,400	38,791,200	11,632,800	45,382,800	9,954,170	43,319,890	10,429,180	43,267,040
MAY	8,364,600	44,643,500	9,481,500	48,272,700	11,497,900	56,880,700	10,105,320	53,425,210	10,619,470	53,886,510
JUNE	8,330,200	52,973,700	9,464,500	57,737,200	11,692,200	68,572,900	10,499,280	63,924,490	11,953,650	65,840,160
JULY	8,734,700	61,708,400	11,019,600	68,756,800	11,893,500	80,466,400	11,497,190	75,421,680		
AUGUST	9,669,300	71,377,700	11,433,000	80,189,800	12,107,100	92,573,500	11,773,510	87,195,190		
SEPTEMBER	9,189,700	80,567,400	10,440,000	90,629,800	11,325,000	103,898,500	11,474,820	98,670,010		
OCTOBER	9,406,300	89,973,700	10,492,500	101,122,300	11,048,500	114,947,000	10,854,670	109,524,680		
NOVEMBER	9,013,600	98,987,300	11,814,200	112,936,500	10,589,700	125,536,700	11,971,990	121,496,670		
DECEMBER	7,680,600	106,667,900	11,486,800	124,423,300	11,459,300	136,996,000	13,025,490	134,522,160		
TOTAL TONNAGE REPORTED	106,667,900		124,423,300		136,996,000		134,522,160			
TOTAL TONNAGE NOT REPORTED	5,519,300		6,322,479		3,697,986		1,782,896			
TOTAL TONNAGE PRODUCED	112,187,200		130,745,779		140,693,986		136,305,056			

Source: National Marketing Reports by Coal Marketronix, compiled from FERC Form 423 filed monthly by electric utilites.
Annual Reports of Wyoming State Mine Inspector and Ad Valorem Tax Division.

REPORTED DELIVERIES FROM WYOMING COAL MINES



operated as Cyprus Shoshone Coal Company. Cyprus is currently seeking markets for the high quality bituminous coal and would reopen the mine if enough coal contracts could be secured. The mine currently employs 18 maintenance workers and is equipped with a longwall mining system that can produce more than 1.5 million tons of coal per year.

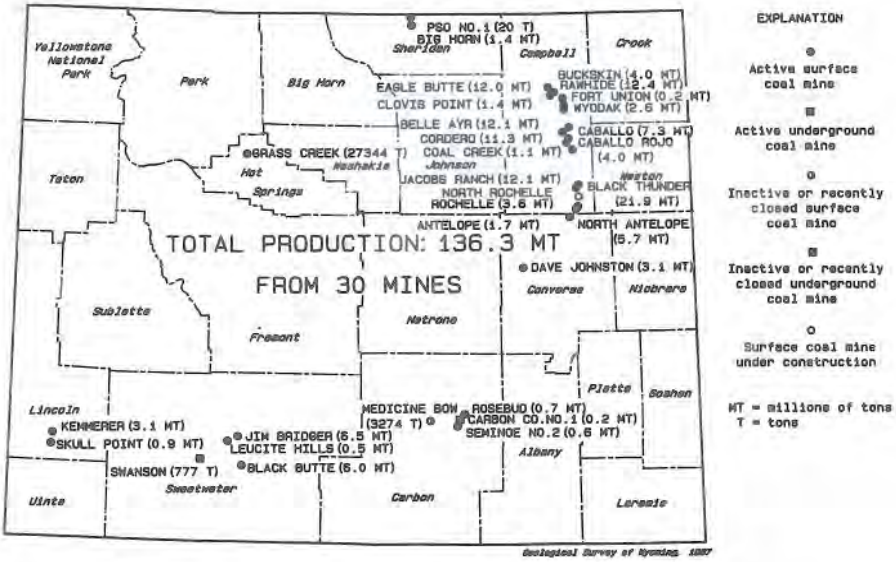
Arch Mineral Corporation, operator of the Seminoe II strip mine in Carbon County, announced in early September that they had negotiated a 15-month extension of their current contract with Kansas Power and Light Company (KPL). However, the current 3-year contract, which was due to expire on December 31st of this year, was amended to reduce the utility's take from 3 million tons to 2.6 million tons. The new contract calls for an additional 812,000 tons of coal. In addition, prices for coal delivered under the current and the extended contact were reduced from 172¢ per million Btu to 131¢ per million Btu and the Btu guarantee increased from 10,800 Btu/pound to 11,000 Btu/pound (McGraw-Hill, 1987a). The new delivered price is an average of $29.54 per ton, or 25 percent less than the current delivered price. Evidently Arch was able to accept the price concessions because of savings made earlier in the year in the form of decreased labor costs (Seminoe II workers took pay cuts) and decreased severance taxes (through a tax break given to high-cost coal producers by the Wyoming Legislature). In addition, rail rates for transportation of the coal

1985 and 1986 WYOMING COAL PRODUCTION AND EMPLOYMENT[1]

Company	Mine Name	1985 Employees	1985 Production (short tons)	1986 Employees	1986 Production (short tons)
POWDER RIVER BASIN					
Amax Coal Company	Belle Ayr (strip)	358	12,829,379	343	12,145,900
	Eagle Butte (strip)	293	11,808,014	287	12,000,280
Antelope Coal Company	Antelope (strip)	31	66,344	38	1,709,787
Ash Creek Mining Company	PSO No. 1 (strip)	1	2,589	1	20
Big Horn Coal Company	Big Horn (strip)	201	2,400,000	123	1,360,805
Carter Mining Company	Caballo (strip)	184	8,977,927	194	7,272,741
	Rawhide (strip)	186	12,236,695	181	12,403,975
Cordero Mining Company	Cordero (strip)	271	10,085,299	252	11,314,275
Fort Union Coal Company	Fort Union (strip)	36	532,716	15	219,313
Glenrock Coal Company	Dave Johnston (strip)	284	3,508,059	175	3,051,331
Kerr-McGee Coal Corporation	Clovis Point (strip)	78	1,423,649	75	1,435,045
	Jacobs Ranch (strip)	336	12,967,996	319	12,050,711
Mobil Coal Producing, Inc.	Caballo Rojo (strip)	117	4,221,574	109	3,989,622
North Antelope Coal Company	North Antelope (strip)	136	5,720,425	130	5,689,608
Rochelle Coal Company	Rochelle (strip)	14	206,565	43	3,571,177
Thunder Basin Coal Company	Black Thunder (strip)	621	23,207,616	504	21,868,336
	Coal Creek (strip)	56	2,608,592	28	1,111,305
Triton Coal Company	Buckskin (strip)	104	3,958,420	90	3,996,492
Wyodak Res. Develop. Corp.	Wyodak (strip)	68	3,163,026	65	2,600,000
TOTAL		3,375	119,924,885	2,972	117,790,723
HANNA BASIN					
Amar[2]	Seminoe No. 2	11	37,721	16	96,362
Arch Mineral Corporation	Seminoe No. 1 (strip)	15		30	
	Seminoe No. 2 (strip)	144	1,256,586	106	543,071
Carbon County Coal Company	Carbon No. 1 (deep)	278	1,060,367	21	163,700
Medicine Bow Coal Company	Medicine Bow (strip)	13	288,425	14	3,274
Rosebud Coal Sales	Rosebud (strip)	92	613,832	85	707,021
TOTAL		553	3,256,931	272	1,513,428
GREEN RIVER BASIN					
Black Butte Coal Company	Black Butte (strip)	496	5,508,428	494	5,984,526
Bridger Coal Company	Jim Bridger (strip)	422	7,224,977	419	6,480,450
Prospect Point Coal Company	Leucite Hills (strip)	62	417,075	50	474,200
Western Wyoming Fuels	Swanson (deep)	2	894	1	777
TOTAL		982	13,151,374	964	12,939,953
HAMS FORK REGION					
FMC Corporation	Skull Point (strip)	106	911,196	101	905,939
Pittsburg and Midway Coal Mining Company	Elkol and Sorenson (strip)	355	3,418,392	358	3,127,668
TOTAL		461	4,329,588	459	4,033,607
BIGHORN BASIN					
Northwestern Resource Company	Grass Creek (strip)	3	31,208	4	27,345
TOTAL		5,374	140,693,986	4,671	136,305,056

[1] Sources: Wyoming State Inspector of Mines, 1985 and 1986 Annual Reports; Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division, 1986, and 1987 Annual Reports.

[2] Auger mining operation under contract with Arch Mineral.



WYOMING COAL MINES AND PRODUCTION, 1986

1986 WYOMING COAL PRODUCTION BY COUNTY AND COAL BASIN[1]

County	Production	Percent of Total Production	Number of Producing Mines	Number of Employees
		POWDER RIVER BASIN		
Campbell	111,668,780	81.9	15	2,635
Converse	4,761,118	3.5	2	213
Sheridan	1,360,825	1.0	2	124
TOTAL	117,790,723	86.4	19	2,972
		GREEN RIVER BASIN		
Sweetwater	12,939,953	9.5	4	964
		HAMS FORK REGION		
Lincoln	4,033,607	3.0	2	459
		HANNA BASIN		
Carbon	1,513,428	1.1	4	272
		BIGHORN BASIN		
Hot Springs	27,345	<0.1	1	4
TOTAL WYOMING	136,305,056		30	4,671

[1]Source: Wyoming State Inspector of Mines, Annual Report and Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division, 1986 and 1987 Annual Reports.

to KPL's Lawrence and Tecumseh, Kansas, plants were also reduced. Arch's only other contract, with Iowa Public Service Company, is due to expire in January, 1993.

Although the sale and possible reopening of the Carbon County Coal Company mine and the extended contract from Arch Mineral Corporation are certainly positive developments in southern Wyoming, two negative developments have offset the optimism. At Black Butte Coal Company's mine east of Rock Springs, it appears that a layoff of both salaried and hourly employees may soon be inevitable. In 1986, the mine produced nearly six million tons of coal and employed almost 500 miners, but because of cutbacks in shipments to Commonwealth Edison's (CE) plants in Illinois, the mine may only produce four million tons in 1987. Nearly all Black Butte's production is contracted to Commonwealth Edison; deliveries for the first half of 1987 confirm that the mine's production is about one million tons less than it was a year ago. The decreased tonnage to CE is thought to be the result of CE's plans to start up and place on-line several new nuclear-powered generating plants, thereby displacing some of their coal-fired capacity.

The other negative development in southern Wyoming was at Arch Mineral Corporation's Medicine Bow mine west of Hanna. The nine remaining miners at this mine were laid off in July, and the mine was placed on standby. Although this mine did produce a small amount of coal in 1986 and reportedly did ship some coal to Missouri for a test burn this year, the mine has not sold any significant amounts of coal since 1985. In 1978, the Medicine Bow mine produced 3.1 million tons of coal and employed 225 coal miners. With Medicine Bow now inactive, only two coal mines continued to operate in the Hanna Basin.

In coal transportation news, only one new transportation contract was announced in the third quarter of 1987. Grand River Dam Authority (GRDA), Burlington Northern (BN), and Missouri-Kansas-Texas Railroad (MKT) signed a 15-year contract for coal hauling from Carter Mining Company's coal mines near Gillette to GRDA's power plant complex at Chouteau, Oklahoma. The contract will reportedly save the utility a total of $410 million in freight rates over the length of the contract. Before the contract was signed, the utility company had planned to construct its own 30-mile-long rail spur (from BN's main line) to the power plant in order to reduce freight rates. Work on the spur line stopped when GRDA approved BN and MKT's offer. In a related matter, GRDA and Carter Mining Company are currently renegotiating a coal supply contract under a price reopener clause.

Two utility companies operating the Fayette Power Project near Austin, Texas, are also planning construction of their own rail spur in an effort to save on rail rates. The Lower Colorado River Authority (LCRA) and the City of Austin plan to construct a 20-mile-long, $34.5 million rail spur from the main line of the Southern Pacific Railroad to their generating plant. LCRA currently receives coal from Thunder Basin Coal Company's Black Thunder mine and Cordero Mining Company's Cordero mine.

In coal contract news, a short term contract and two spot sales were announced in the third quarter of 1987. Wisconsin Power and Light Company announced the purchase of 550,000 tons of coal from Mobil Coal Producing, Incorporated's Caballo Rojo mine for the last four months of 1987 and the first seven months of 1988. This coal will be transported by Chicago and North Western Transportation Company (C&NW) and the Soo Line Railroad to the utility's Columbia II generating unit at Portage, Wisconsin. Oklahoma Gas and Electric Company purchased 100,000 tons of spot coal from Thunder Basin Coal Company's Coal Creek mine. The coal reportedly sold for less than 100¢ per million Btu's (about $17.00 per ton) delivered, which is from $9.00 to $13.00 per ton cheaper than coal purchased under contract. Finally, LCRA announced a spot purchase of 1.3 million tons of coal from Cordero Mining Company's Cordero mine. The coal will be delivered via BN and MKT to LCRA's Fayette Power Project Units 1 and 2 during the months of October, 1987, through March, 1988. The winning low bid for this spot coal was $3.10 per ton F.O.B. the mine. Bids submitted from six Powder River Basin coal producers averaged $4.06 per ton with a low bid of $3.10 per ton and a high bid of $5.05 per ton F.O.B. the mine (McGraw-Hill, 1987b). As these bids demonstrate, coal prices are not improving much, if at all, and competition for coal sales continues to be intense.

Several coal-related economic development projects in Wyoming were of interest in the third quarter of 1987. In early September, the Wyoming Investment Loan Committee awarded two grants totaling $19.7 million from a $30 million fund established by the 1987 Wyoming Legislature to promote clean coal technology or coal enhancement projects. Charfuel of Wyoming, Incorporated, a subsidiary of Carbon Fuels Corporation in Colorado, was awarded $8 million for construction of a demonstration plant at Glenrock that would convert coal to a charfuel (a slurry of coal char and coal liquids) and then burn it in the boiler of a 100-megawatt generating unit (see *Wyoming Geo-notes No. 13*, January, 1987, p. 39-40). It was reported in the January, 1987, *Wyoming Geo-notes* that Charfuels had received $4 million in grants and loans for the same project from the Exxon Restitution Fund; however, these funds were not awarded by the U.S. Department of Energy after all because the State of Wyoming had not used a competitive procedure to award the funds. Charfuels did reapply for the $4 million under a competitive procedure, but no funds have been awarded yet. The Investment Loan Committee will also consider granting Charfuels an additional $10 million if enough private investors become involved in the project.

The Investment Loan Committee also awarded $11.7 million to Energy Brothers, Incorporated of Denver for construction of a prototype plant that would produce "K-fuel", a coal-based fuel pellet, from coal mined at the Fort Union mine east of Gillette. The fuel is produced by a patented process that uses both heat and pressure to convert low Btu (8,100 Btu/pound), high moisture (28-30 percent) coal to a 12,180 Btu/pound, low sulfur, low moisture fuel pellet. Evidently Wisconsin Power and Light Company has an agreement with Energy Brothers to purchase the first one million tons of fuel produced.

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Resources (January 1, 1987)

Discovered (Includes 10 billion barrels recoverable by enhanced recovery techniques).....13.3 billion barrels[1]

Undiscovered.....7.6 billion barrels[1]

Total.....20.9 billion barrels

Remaining Reserve Base (January 1, 1987)

Measured reserves (Proved reserves)..... 0.83 billion barrels[2]

Indicated and inferred reserves.....2.8 billion barrels[3]

Total..... 3.63 billion barrels

NATURAL GAS

Remaining Resources (January 1, 1987)

Discovered.....18.6 trillion cubic feet[1]

Undiscovered (there is at least another 115 trillion cubic feet of noncombustible CO_2 gas)[9].....58.0 trillion cubic feet[1]

Total.....76.6 trillion cubic feet[1]

Remaining Reserve Base (January 1, 1987)

Measured reserves (Proved reserves).....10.64 trillion cubic feet[2]

COAL

Remaining Resources (January 1, 1987)

Identified (Discovered).....136.0 billion tons[4]

Undiscovered.....800.0 billion tons[5]

Total.....936.0 billion tons

Remaining Reserve Base (January 1, 1987)

Demonstrated strippable (Measured and indicated reserve base).....27.1 billion tons[4]

Demonstrated underground-minable (Measured and indicated reserve base).....38.4 billion tons[4]

Total..... 65.6 billion tons

TRONA

Original Resources (1983 estimate)

Trona	81.7 billion tons[6]
Mixed trona and halite	52.7 billion tons[6]
Total	134.4 billion tons

URANIUM

Remaining Resource (December 31, 1985) ..... 1,990,000,000 pounds U_3O_8

Remaining Reserve Base (December 31, 1985)

	U_3O_8
Uranium oxide recoverable at $30.00 per pound	83 million pounds
Uranium oxide recoverable at $50.00 per pound	365 million pounds
Uranium oxide recoverable at $100.00 per pound	632 million pounds

OIL SHALE

Original Resources (January 1, 1983)

Identified (Discovered)	320 billion barrels of shale oil[8]

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[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, 1986, *U.S. crude oil, natural gas, and natural gas liquids reserves: 1985 Annual Report, October.* (1986 production has been subtracted).

[3] Modified from Barlow and Doelger (1983), footnote 1.

[4] Wyoming Geological Survey, July, 1987. (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.

[6] Culbertson, W.C., 1983, *Genesis and distribution of trona deposits in Wyoming* (abstract) in *Genesis and exploration of metallic and nonmetallic mineral and ore deposits of Wyoming and adjacent areas:* Geological Survey of Wyoming Public Information Circular 19, p. 34.

[7] U.S. Energy Information Agency, 1985, Uranium Industry Annual, U.S. Department of Energy Report DOE/EIA-0478(85), 142 p.

[8] Knutson, C.F., and Dana, G.F., 1982, *Developments in oil shale in 1981:* American Association of Petroleum Geologists Bulletin, Volume 66, no. 11, p. 2513.

[9] Derived from Exxon information.

Energy International, Incorporated (EI) of Pittsburgh, Pennsylvania, had also applied for $21.5 million of the $30-million clean coal/coal enhancement fund, but their request was denied. EI is attempting to secure financial backing to construct a $67 million commercial *in situ* coal gasification project west of Rawlins (see *Wyoming Geo-notes No. 12*, October, 1986, p. 28-29). The company received a 3-year, $12-million grant from the U.S. Department of Energy (DOE) in 1986 and in early October of this year signed a contract with DOE for the loan of an additional $11.8 million, subject to final approval by Congress in November. Evidently a substantial amount of private funding has also been secured for the project, which is scheduled to begin commercial production by late 1989.

In a related development, the Investment Fund Committee in July approved the loan of $750,000 to Wyoming Coalbrik, Incorporated from the State's $10-million economic development investment fund. Wyoming Coalbrik began manufacturing a "coal brick" for home heating purposes in early August after moving their factory equipment from Las Vegas, New Mexico, to Rawlins. The company had originally applied for $2 million and had planned to automate their process, but the loan committee decided to let the business operate for at least a year to show that the "coal bricks" could be marketed and that the product worked.

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McGraw-Hill, Incorporated, 1987a, Western price concessions continue; Arch cuts price to KDL 25¢, deals with rails: Coal Week, v. 13, no. 34, p. 1.

McGraw-Hill, Incorporated, 1987b, PRB spot price stays rock bottom; LCRA buys Elk River Coal at $3.10/T: Coal Week, v. 13, no. 39, p. 2.

METALS AND PRECIOUS STONES UPDATE

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

During the past quarter, Wyoming experienced a mini-boom in precious metals exploration and mining. Activity was reported at many localities in the State with the greatest interest centered at South Pass, the Medicine Bow Mountains, the Laramie Range, and in the Bear Lodge Mountains.

In the South Pass region along the southern tip of the Wind River Mountains, prospecting, exploration, and mining operations reached a near fervor by mid-summer. Placer mining and exploration occurred in several drainages within the greenstone belt including Jones Gulch, the Crows Nest, Meadow Gulch, Little Beaver Creek, Wilson Bar, and Rock Creek. Some activity was also reported in the Twin Creek Oligocene paleoplacers along the northeastern flank of the Precambrian terrain.

Several of the placer operations were centered on Rock Creek, a prominent drainage that runs through Atlantic City and cuts across a thick section of Archean metagreywacke and lesser orthoamphibolite and ultramafic schists, as well as several auriferous shears. At the Stout mine, about 2 miles southeast of Atlantic City on Rock Creek, stream gravels were averaging about 0.01 ounce per cubic yard gold with a large number of coarse, rough, nuggets.

Historically, Rock Creek has attracted many placer miners. In the 1930s, portions of the creek were dredged with favorable results. Based on available records, gold recovery on Rock Creek in the 1930s averaged 0.012 to 0.016 ounce per cubic yard with local areas that ran as high as 1.0 ounce per cubic yard (Ross and Gardner, 1935; Wilson, 1953). Production from the historical Fisher Dredge on Rock Creek totaled more than 11,500 ounces (Hausel, 1980; 1987a).

East of Rock Creek, gold recovery from a placer operation on Smith Gulch averaged 0.1 ounce per cubic yard during this past summer. The recovered gold was relatively fine with small, flattened, nuggets.

At the Mary Ellen mine near Atlantic City, the Gyorvary Mining Company began expanding its mill and hopes to begin mining in the near future. The company plans to first process the mine dumps, and then to begin mining underground on a small reserve block of 8,000 tons of 0.42 ounce per ton gold ore. The Mary Ellen is a 2400-foot inclined shaft sunk on a quartz vein hosted by Archean tonalite.

At the Carissa mine near South Pass City, the Carissa Gold Mines and Consolidated McKinney Resources joint venture continued working at this once important gold mine. Last January, the joint venture drilled portions of the auriferous shear zone and began dewatering the mine workings this spring. During the summer, the company began work on the surface dwellings and on the ventilation system in the mine. The company is reportedly planning to sample the mine drifts in detail. Based on available information, the Carissa mine was one of the two most productive lode gold mines in Wyoming (Hausel, 1980).

Gold N' Oil Corporation, a Wyoming company, was actively consolidating their land position in both the South Pass-Atlantic City and Lewiston districts of the greenstone belt during the past quarter. On their Lone Pine claims in the Lewiston district, the company opened a trench and asked the Geological Survey of Wyoming to examine the exposure. The trench cut through a 17-foot-wide mineralized zone which consisted of six feet of chloritized metagreywacke and 11 feet of sheared quartz with hematitic metagreywacke. Channel samples taken across the mineralized zone by the Survey assayed 1.63 ppm gold and 2.99 ppm silver for the 11-foot-wide sheared vein, and 1.6 ppm gold with 2.9 ppm silver for the 6-foot-wide chloritized metagreywacke. A four-foot section of the 11-foot sheared vein assayed as high as 3.5 ppm gold and 4.3 ppm silver.

Sampling by the Geological Survey of Wyoming in the historic Tabor Grand mine in the South Pass-Atlantic City district proved interesting. Samples taken in the sheared orthoamphibolite on the 120-foot-level ranged from 0.05 ppm gold to 58.0 ppm gold. Furthermore, mapping in the accessible workings suggests the possibility that a second, undeveloped, parallel, mineralized shear zone may lie 20 to 30 feet south of the primary shear. Surface mapping has also shown the Tabor Grand shear continues at least for another five hundred feet east of the mine portal. At the easternmost extent of the shear, an eight-foot-wide channel sample taken across the width of the shear yielded 3.8 ppm gold and 1.7 ppm silver. Some other samples collected by the Survey in the greenstone belt during the past quarter are reported in the table on page 23.

In addition to collecting samples for trace element geochemistry, the Metals Division of the Survey has also been collecting dozens of samples for whole rock chemistry and has been mapping the surface geology of the South Pass greenstone belt at a 1:24,000 scale. A preliminary report on some of these results was recently published by the Wyoming Geological Association in their 38th annual field conference guidebook. Since this report was written (Hausel, 1987a), the Division has been revising Bayley's (1965a, b, c, d) maps in the heart of the greenstone belt by remapping some structurally complex areas and differentiating some new members of the Miners Delight Formation. In addition, a new formation (the Diamond Springs Formation) has been defined along the edge of the greenstone belt, and a gneiss complex has been identified in Bayley's border zone of the Louis Lake batholith. The new formation consists of serpentinites, talc-tremolite-chlorite schists, metadiabases, and metabasalts with chemistry similar to komatiites and high-magnesian tholeiites.

The Medicine Bow Mountains in southeastern Wyoming were also actively prospected with several family-owned placer operations searching for gold, platinum, and diamonds. Near the southern margin of the Savage Run Wilderness, the Jones Brothers continued to report interesting results on their gabbro-hosted quartz vein. The two-foot wide quartz vein carries common visible gold and often produces significant assays. For example, a selected sample from the Golden Eagle vein collected by the U.S. Geological Survey during their study of the mineral potential of the Savage Run Wilderness contained 280 ppm (8.16 oz/ton) gold! The Natures Mint vein which lies adjacent and parallel to the Golden Eagle vein produced one sample that yielded 800 ppm (23.3 oz/ton) gold (McCallum and Kluender, 1983)! The Geological Survey of Wyoming recently collected a two-foot-wide channel sample from the Golden Eagle vein that assayed 48 ppm (1.4 oz/ton) gold. One sample of gabbroic host rock collected from the property by the Jones Brothers was tested by the Geological Survey of Wyoming and yielded 6.2 ppm (0.18 oz/ton) gold.

The Douglas, Mullison, and Cortex Creek placers continued to receive some attention throughout the summer. One prospector discovered scheelite near the Keystone mine along Douglas Creek. This is the first known report of tungsten in that area.

Table 1. Selected analyses of samples from the South Pass greenstone belt.

Sample No.	Au (ppm)	Ag (ppm)	Zn (ppm)	Cu (%)	Cr (%)	Fe (%)	Sample Description
AC3-87	0.24	n.d.	--	--	--	--	Composite chip sample, 20 ft. wide vein west of Tabor Grand mine.
AC5-87	n.d.	2.9	225	--	--	--	Metalimestone (SW/4 sec. 14, T.29N., R.100W).
LUSL 19-87	0.43	0.68	--	0.01	0.23	--	Fuchsitic quartzite (sec. 9, T.29N., R .100W).
SP7-87	0.10	2.9	--	--	--	36.4	Banded iron formation (sec. 8, T.29N., R.100W).
SP13-87	0.73	27.0	--	18.1	--	--	Milky quartz vein in Exchange lode (sec. 15, T.29N., R.100W.).
SP14-87	0.13	5.3	--	--	--	--	Tertiary tuffaceous sandstone (sec. 18, T.29N., R.100W.).
DUN1-87	3.0	2.2	--	--	--	--	2 ft. channel sample western extent of Duncan mine shear.
DUN2-87	33.0	6.0	--	--	--	--	2 ft. channel sample across quartz boudin in Duncan shear.
DUN3-87	1.8	1.8	--	--	--	--	5 ft. channel sample east of quartz boudin.
DUN4-87	6.6	2.7	--	--	--	--	10 ft. channel sample adjacent to DUN3.
DUN5-87	0.71	7.4	--	--	--	--	10 ft. channel sample adjacent to DUN4.
DUN6-87	0.53	1.0	--	--	--	--	10 ft. channel sample adjacent to DUN5.
EXC1-87	2.1	1.2	--	--	--	--	2 ft. channel across Exchange shear, east of SP13.
LUSL14-87	0.16	3.2	5.1	3.23	--	--	Mineralized stockwork (sec. 33, T.30N., R.100W.).
LUSL17-87	0.05	1.0	--	--	--	--	Sheared amphibolite (sec. 3, T.29N., R.100W.).
SP2-87	0.79	n.d.	--	--	--	--	Quartz from dump near Doc Barr.
SP3-87	4.6	1.1	--	--	--	--	2 ft. channel sample from Groundhog shear.
MD15-87	0.08	n.d.	--	--	--	--	Quartz vein from dump in Cutler Gulch (sec. 2, T.29N., R.100W.).
MD16-87	0.35	n.d.	--	--	--	--	1 ft. channel sample across Rose mine vein.
MD17-87	0.61	n.d.	--	--	--	--	2 ft channel sample from sheared footwall at Rose mine.
MD18-87	0.29	1.0	--	--	--	--	Grab sample of quartz from Rose dump.
MD24-87	n.d.	1.0	--	--	--	--	2 ft. channel sample taken across Caribou shear, east of shaft.
MD25-87	2.0	1.0	--	--	--	--	6 ft. channel sample taken across shear west of Caribou shaft.
MD26-87	0.34	1.6	--	--	--	--	Carbonatized orthoamphibolite north of Caribou shaft.
MD28-87	0.14	n.d.	--	--	--	--	Sulfide-bearing milky quartz from Diamond Development mine.
MD29-87	0.06	n.d.	29.0	0.003	--	--	Milky quartz vein south of Snowbird mine.
MD32-87	0.23	3.9	--	0.10	--	--	Graphitic schist.
MD34-87	0.07	n.d.	--	--	--	--	Quartz from dump in sec. 4, T.29N., R.100W.

(n.d. = not detected; dashes mean no analysis was done)

Exploration for platinum and palladium associated with the Mullen Creek and Lake Owens layered mafic complexes continued throughout the summer by at least three major mining firms. All three companies, decided to test induced polarization (IP) and geochemical anomalies from earlier exploration activities through exploration drilling. These two large layered mafic complexes were recently examined in a report by Hausel (1987b).

The precious metal exploration activities in the Medicine Bow Mountains overflowed into the adjacent Sierra Madre where companies were searching for primary precious metal deposits and for precious metal deposits dominated by base metals. This region contains many attractive stratabound base metal occurrences (Hausel, 1986).

In the Bear Lodge Mountains of northeastern Wyoming, a major mining company continued with exploration and development drilling on a Tertiary age, low-grade, gold deposit associated with potassic fenitized alkalic igneous rock. Igneous rocks in the core of the Bear Lodge complex have yielded K-Ar ages of 38 to 55 million years old (Lisenbee, 1985). The alteration and mineralization is also believed to be Tertiary.

This region also has tremendous potential for thorium and rare earth deposits (King and Harris, 1987). The Bear Lodge complex is believed to have one of the largest resources of rare earths and thorium in the United States (Staatz, 1983). Rare earth deposits are becoming more attractive economically because of their increased use in superconductive materials (King and Harris, 1987).

It was reported by the Vancouver Stock Watch that Caledonia Resources Ltd. was drilling on the Copper King property in the Silver Crown district of the southern Laramie Range (Jim E. Bond II, personal communication, 1987). According to the report, the Copper King is considered to be a bulk mineable, disseminated, Proterozoic-age gold-copper deposit with a 600- to 700-foot strike length and a 300-foot width. Mineralization continues several hundred feet deep. The early drilling results are encouraging and have intersected mineralized zones ranging from 0.01 ounce per ton gold to 0.177 ounce per ton gold over substantial thicknesses.

Hamilton Mining Company from Sheridan, Wyoming, continued to drive an adit during the summer on a relatively wide, sulfide-bearing, quartz vein in the Bighorn Mountains south of Burgess Junction. The vein has yielded values as high as 0.3 ounce per ton gold.

Other activities related to metals in the State included a study of strategic metals. The State of Wyoming has one of the most diverse and significant assemblages of strategic mineral occurrences in the United States. Of utmost importance to our country's security are four critical strategic metals (chromium, cobalt, manganese, and platinum) which have important military and industrial uses. Nearly all of the world's production and known reserves of these metals are controlled by Eastern Block and southern African nations. Based on this recent study, the Geological Survey of Wyoming is optimistic that

significant resources may be present in Wyoming (Hausel, 1987b). In particular, the study draws attention to geological similarities of some areas of Wyoming and world-class deposits found in Russia, South Africa, and Zimbabwe.

The Geological Survey of Wyoming continued sampling in the central and north-central Laramie Range for heavy mineral indicators of diamond-bearing kimberlite. More than one dozen anomalous samples were collected in the Elmers Rock greenstone belt, and some samples taken immediately south of the greenstone belt in Sybille Canyon were extremely anomalous and contained several dozen pyrope garnets. The Metals Division is following up with detailed sampling surveys in this anomalous area in an effort to discover the source of the indicator minerals.

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INDUSTRIAL MINERALS AND URANIUM UPDATE

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

Industrial Minerals

Trona

Wyoming's trona mining industry continues to produce at record levels. The total production for 1986 (see page 27) was the highest on record, and, according to U.S. Bureau of Mines statistics, the 1987 domestic consumption of soda ash (refined trona) is about five percent above 1986 levels. This record production does not mean that the Wyoming trona mining industry is enjoying good times. Prices are low, and, since there are five trona producers in the Green River area, rather than four in 1980 when the previous high production levels were being set, the production from each plant is around 80 percent of full production capacity. Production would have to increase by about three million tons to bring the plants to nearly full production.

Workers at General Chemical signed a new contract with the company in July, without a strike threat. Workers, concerned about job security, settled for minimal salary changes. Fifty-one percent of General Chemical is owned by a subsidiary of Allied-Signal (a holding company) and 49 percent is owned by ACI International, an Australian glass producer.

Wyoming Trona Production

Year	FMC	General Chemical[1]	Stauffer Chemical	Tg Inc[2]	Tenneco	Total
1980	4,418,258	3,109,019	2,658,377	1,973,587	-0-	12,159,241
1981	4,684,744	2,909,953	2,645,599	1,547,435	-0-	11,787,731
1982	3,575,678	2,499,689	2,180,962	1,171,071	646,290	10,073,690
1983	3,102,074	2,818,826	2,570,190	807,475	943,852	10,242,417
1984	3,400,458	2,600,611	2,333,364	1,386,933	1,249,843	10,971,209
1985	3,164,611	2,466,095	2,191,952	1,603,339	1,350,307	10,776,304
1986	4,046,958[3]	3,061,054	2,607,878	2,043,819	1,505,038	13,264,747

[1] Formerly Allied Chemical.

[2] Formerly Texasgulf.

[3] Includes 293,718 tons produced by *in situ* recovery methods.

Another purchase of a Wyoming trona plant was made by a French firm. Rhone-Poulenc, S.A., bought a part of Stauffer Chemical Company, including the Big Island trona mine and soda ash refining plant, from the British firm, Imperial Chemical Industries. The Tg plant is also owned by a French Company, Elf Aquitaine. These sales to foreign firms are not expected to affect soda ash production, exports, or domestic sales. Only the Tenneco and FMC mines and plants are now solely owned by a domestic firm.

Cement

Mountain Cement Company announced a joint venture with Lone Star Industries. Mountain Cement purchased the Laramie cement plant from the Monolith Portland Cement Company in December, 1985, and has been modernizing the Laramie plant since then. The venture with Lone Star Industries will provide more capital to the operation and will probably be used to expand the market area for cement produced in Laramie. The plant is scheduled to begin production in 1988.

Domestic cement production is up about five percent over 1986 according to the U.S. Bureau of Mines. This reflects an increase in construction as the economy improves is some areas of the United States.

Gypsum

Regional gypsum production is down about two percent from the relatively high production of 1986. This figure reflects the continued economic stagnation of the energy-producing states. Wyoming's two active gypsum producers, Celotex in Cody and Georgia-Pacific, north of Greybull, produce wallboard for regional consumption. U.S.G. Corporation closed its Heath, Montana, gypsum mine and wall board plant. This closure may improve the market for the two Wyoming plants, so that Wyoming's gypsum production may increase in 1987 and 1988.

Bentonite

Bentonite production in Wyoming may increase in 1987. Bentonite production has declined drastically since 1982 due to the decline in drilling in the domestic oil industry. The primary use of bentonite is for oil well drilling fluid. Exploration and development drilling in the petroleum industry is increasing, and this is bringing about an increased demand for bentonite. This increase is not expected to solve the problems of the depressed bentonite industry. A significant, sustained increase in domestic oil well drilling is needed to cause a recovery in the bentonite mining industry. Wyoming, however, still is the Nation's leading bentonite-producing state.

Phosphate

Operations have stopped at the Leefe, Wyoming, phosphate plant, which is owned by Imperial Chemical Industries (ICI), a British firm. It is unclear whether this plant was involved in the Rhone-Poulenc purchase (see trona) of certain parts of ICI's holdings. Phosphate production continues in Wyoming at Chevron Chemical's Rock Springs plant which uses phosphate mined in Utah and sulfur from Chevron's sour gas refining plant in Wyoming. Nationally, the production of phosphate fertilizer is about the same as 1986, according to U.S. Bureau of Mines statistics.

Sulfur

The production of sulfur from both Frasch processes and that recovered from sour gas is up about six percent from 1986, according to U.S. Bureau of Mines figures. Wyoming's sulfur production is recovered entirely from sour gas.

Price increases have not materialized, however, as worldwide sulfur consumption is down. Long-range prospects for sulfur are good, however, because Canadian sulfur stockpiles are expected to be depleted in a few years.

Pigment

Several tons of iron ore have been shipped from the Sunrise mine near Hartville for use in pigment. This material was reportedly sent to South America for boxcar paint. This was a test shipment. The owners of the Sunrise property are looking for markets for raw iron ore, fines, and nut-sized material stockpiled on the property. Other potential uses include cement processing and heavy aggregate.

Other Industrial Minerals

In addition to the industrial minerals discussed above, sodium sulfate, construction aggregate (including railroad ballast), limestone used for burn control in coal-fired power plants, and marble are produced in Wyoming. Production of most of these commodities is the same to slightly improved over 1986. Most of these commodities are dependent on local construction and power generation schedules.

Uranium

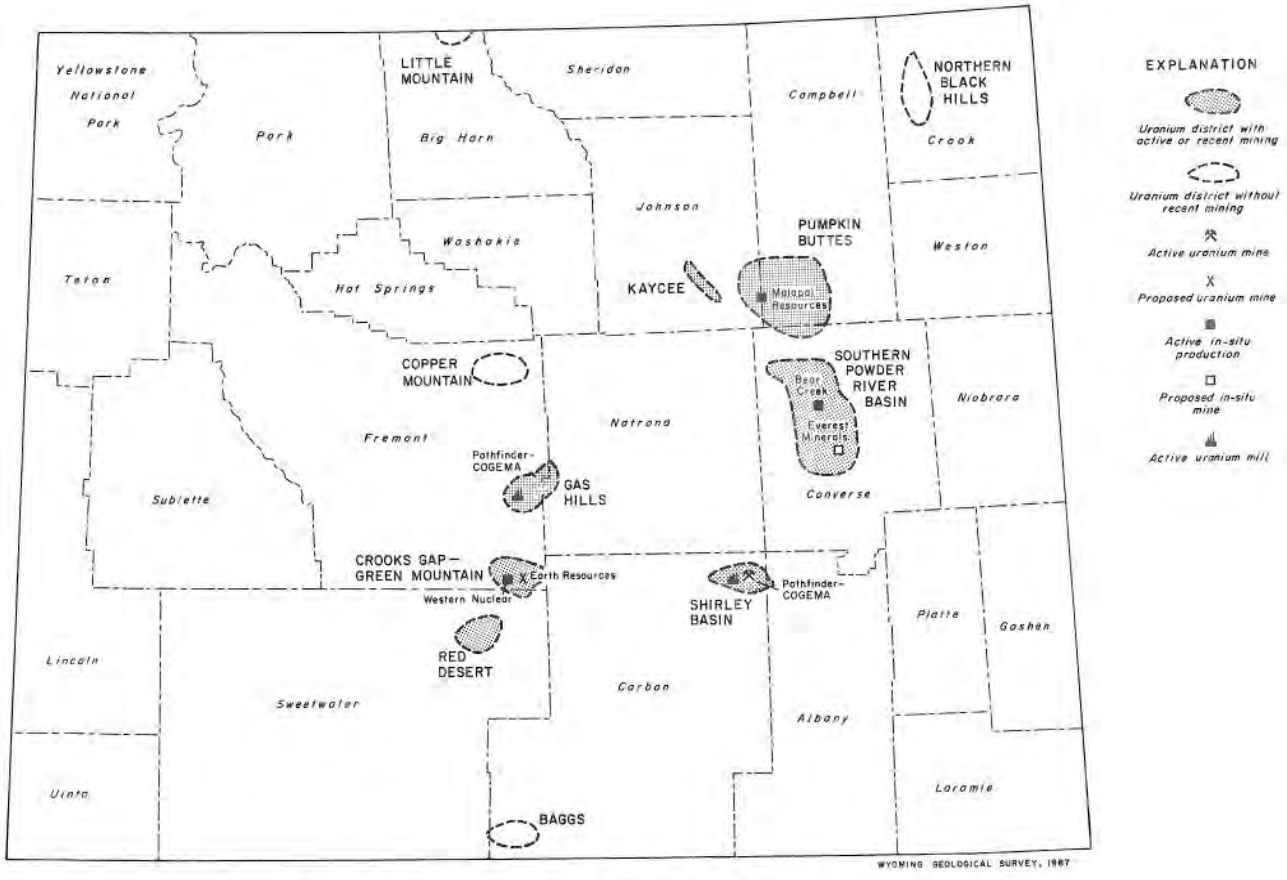
Mining and milling

In situ uranium production resumed at the Irigary Ranch property in the Pumpkin Buttes area in early August. This property, developed by Wyoming Minerals Company in the late 1970s, was sold to Malapai Resources Company by Westinghouse Electric Company, the parent company of Wyoming Minerals, in June. Malapai is a wholly-owned subsidiary of Arizona Power. Malapai is developing both the Irigary property and the adjacent Christiansen Ranch property for *in situ* production. Full production is scheduled for 1988. Malapai has announced contracts for uranium oxide deliveries beginning in 1987. Employment in the uranium industry has increased due to the opening of this deposit and the reopening of the Lucky Mc Mill (see below).

Everest Minerals plans to produce contracted uranium oxide from its Highland mine *in situ* property. Full production from this mine is also scheduled for 1988.

Pathfinder Mines, owned by the French Company COGEMA, continued to mine and mill uranium at Shirley Basin, Wyoming. This mine is Wyoming's only currently-producing mine. Pathfinder-COGEMA has resumed the milling of small amounts of stockpiled ore at the recently renovated Lucky Mc mill in the Gas Hills district. The Lucky Mc mine and all others in the Gas Hills district remain shut down. Pathfinder-Cogema also has been conducting ore grade and mining cost studies at Western Nuclear's Sheep Mountain #1 mine in the Crooks Gap district.

Surface mining of uranium in Wyoming has apparently been dealt a blow by an increase in taxes levied on mined uranium by the Wyoming Department of Revenue. According to Lee Nugent of Pathfinder-COGEMA, the uranium mining operation at Shirley Basin and their plans to resume production at Lucky Mc are threatened by the increased taxes.



MAJOR ACTIVE AND INACTIVE URANIUM DISTRICTS

Both operations may be forced to close. Nugent believes a study of the new tax rate is needed. The study should assess the effects of the tax rate on the industry's ability to survive.

Cleveland Cliffs, Incorporated has sold its uranium properties in the Pumpkin Buttes district to Uranez, U.S.A., a German-owned uranium-producing company. Getty Mining Company and Edison Development Company are minor participants in the new ownership. No plans have been announced by the new owners to resume development of these properties.

A ruling by the 10th Circuit Court of Appeals has declared that the U.S. Department of Energy must help the domestic uranium industry by processing only U.S. produced uranium in its enrichment facilities. Uranium producers in the U.S. said that this ruling, if not subsequently overturned, could lead to increased domestic uranium production. Currently, U.S. nuclear power plants use 35 to 40 million pounds of uranium oxide per year, only 10 million pounds of which is produced in the U.S. As of the end of September, no U.S. producer has announced plans to reopen a mine or a mill in response to this ruling.

Reclamation

Bear Creek Uranium, a subsidiary of Union Pacific Mineral Resources, completed reclamation of the Bear Creek mine in the Southern Powder Basin uranium district in Converse County. The mine closed in 1985 and reclamation began at that time. Since the reclamation work has ended, 81 workers were laid off, with only 37 employees remaining at the site to do upkeep, maintenance, and monitoring work.

The project to move abandoned uranium mill tailings from a site near Riverton to an abandoned mine in the Gas Hills is still on hold. A dispute about the awarding of the contract to Umetco Minerals Company, owned by Union Carbide, is still unresolved. Until this dispute is resolved, the tailings moving project will not proceed. However, the involved contractors anticipate a startup in October of this year if the contract dispute can be resolved.

STRATIGRAPHY UPDATE

by Alan J. Ver Ploeg, Stratigrapher, Geological Survey of Wyoming

Additional field mapping on the Barnum and Fraker Mountain Quadrangles in the southern Bighorn Mountains has been completed, and the Stratigraphy Division will release these geologic maps as open file maps by the end of the year. Work was also completed on the Tabletop Quadrangle, immediately to the west of the Fraker Mountain Quadrangle. It proved to be an interesting quadrangle, both structurally and stratigraphically.

The Big Trails Fault System cuts the northwest corner of the Tabletop Quadrangle and is represented by a highly faulted zone, at least one-half mile wide. Another major fault runs northeast to southwest through the northeast corner of the quadrangle, placing Cambrian Gallatin Limestone against Mississippian Madison Limestone, an offset of nearly 400 feet. A reverse fault trending southeast to northwest places Cambrian Flathead Sandstone against Cambrian Gallatin Limestone and Gros Ventre Formation on the east side of the quadrangle. This fault dies out into a fold to the northwest.

Numerous other faults with relatively minor offset (usually less than 100 feet) were noted, especially on the west side of the quadrangle. Some of these smaller faults, however, could be traced across the entire quadrangle. They are usually restricted to the Cambrian Flathead Sandstone and die out upward into the less competent Cambrian Gros Ventre Formation and Gallatin Limestone. These faults appear to originate in the Precambrian, as evidence indicates on the westernmost boundary of the quadrangle, where Precambrian faults occur which trend into the overlying Cambrian rocks.

The Ordovician Bighorn Dolomite thins significantly from north to south on the quadrangle. The upper dolomite sequence thins from nearly 150 feet on the north end to 10 feet or less on the southern end. The underlying Ordovician sandstone, however, appears to retain the normal thickness of 20-30 feet, although it is hard to find good exposures to verify this. The Cambrian Gros Ventre Formation and Gallatin Limestone were lumped for mapping purposes, since they are almost always poorly exposed and quite frequently involved in slope movements, such as landslides. The preliminary geologic map of Tabletop Quadrangle should be finished by the end of the year and available as an open file map by early 1988.

A new open file report has been released by the U.S. Geological Survey which will be of interest to many *Geo-notes* readers. The report is titled *Catalog of Wyoming cores housed at the U.S. Geological Survey Core Repository, Denver, Colorado* by Thomas C. Michalski and Diana L. Richards and is designated Open File Report 87-355. The core repository includes 4,700 cores and 6,000 thin section slides. The catalog lists the location, formation, name, depth, type of sample, footage represented, and operator. A computer search can be made by catalog parameters singly or in combination. For further information, contact the U.S. Geological Survey at the following address or phone number:

U.S. Geological Survey
Core Library
Box 25046 Mail Stop 975
Denver Federal Center
Denver, CO 80225
(303) 236-1930

As mentioned in the last issue of *Geo-notes*, the new proposed nomenclature chart has been released and copies were distributed to attendees at the Wyoming Geological Association annual meeting in Jackson in September. We are soliciting comments on this proposed chart and will accept comments through the end of 1987. Please notify us in writing of any suggested changes you may have along with your rationale for these changes. Send your comments or request for copies of the chart ($1.50 per copy) to the address below:

Geological Survey of Wyoming
P.O. Box 3008, University Station
Laramie, WY 82071
Attention: Alan J. Ver Ploeg

RAWHIDE VILLAGE METHANE PROBLEM

by Gary B. Glass, State Geologist

In July, the Geological Survey of Wyoming assisted the Wyoming Department of Environmental Quality in assessing the newest geological hazard identified in the State, namely the surface venting of methane and hydrogen sulfide (H_2S) gases in the Rawhide Village subdivision north of Gillette in Campbell County. While natural, surface venting of coal bed methane undoubtedly occurs in other areas of the State, this occurrence is the first scientifically documented occurrence, and it unfortunately occurs within a subdivision.

A 15-hole drilling project, confirmed that the entire subdivision is underlain by near-surface methane, frequently associated with detectable H_2S odors. The concentrations of methane within five feet or less of the surface were sufficient to allow for the potential ignition or explosion of that gas. While three surface plumes of gas were confirmed at the site by an independent soil gas sampling program conducted by Exploration Technologies, Incorporated of Casper, the remainder of the subdivision did not show similar surface plumes of gas in July.

Although many other areas of Wyoming lie close enough to coal outcrops and have similar shallow coal (less than 150 feet of cover over most of the subdivision) beneath them for this hazard to occur, the geology beneath the Rawhide Village subdivision provided some additional explanations for methane problems to occur at this site rather than at all sites that appear similar at first glance. One of the surface plumes lies above an area where the coal is exceptionally thick (130 feet). This plume also occurs above a structurally high feature which provides a good site for gas accumulation. The other two plumes are intimately associated with the northern and southern margins of a paleochannel (an ancient stream channel which cut out the uppermost part of the underlying coal). Possible fractures associated with differential compaction along the channel edges could account for gas escape to the surface in the areas of these plumes although this has not been substantiated other than by inference.

The origin of the associated hydrogen sulfide gas was not explained by the drilling project, but its occurrence beneath most, if not all, the subdivision was confirmed. Identification of a third gas, hydrogen selenide, which was at first believed confirmed in the subdivision, is now in doubt. An analysis of the one sample of gas taken to identify this other poisonous gas proved inconclusive. Until other samples of gas are taken, the presence or absence of hydrogen selenide remains unknown.

BICENTENNIAL STONE

The United States is celebrating the bicentennial of the U.S. Constitution. To commemorate the bicentennial, We the People 200, a committee formed to coordinate the commemoration of the 200th anniversary of the United States Constitution is constructing a monument to the Constitution in Philadelphia, Pennsylvania. This monument is to consist of a curved wall upon which metal reproductions of the pages of the Constitution will be mounted. The monument will be made of fifty 4 ft. x 2 ft. x 2 ft. blocks, one from each State. Five rows of 10 blocks each will make up the wall. On the reverse side of the monument each stone will have the State of origin and the date of that State's ratification of the Constitution carved into it. The stones will be laid in order, with the first States to ratify the Constitution on the lower row, the last ones on top. Wyoming's stone will be on the top row, as we were the 44th State to ratify the Constitution.

Because Wyoming has no dimension stone production or means to produce a cut block, the U.S. Bicentennial Commission offered to cut a stone to the proper dimensions. In late August, the Geological Survey of Wyoming was asked by the Wyoming Bicentennial Commission to locate a suitable stone for this monument. The Wyoming Army National Guard offered to transport the stone and the Wyoming Air National Guard offered to fly the Wyoming stone and the Colorado stone (which was cut to proper size by a dimension stone producer in that state) to Philadelphia. Later, a group from California, called "Rock Across America" announced that it was hiring truck transportation and that a team from the Public Broadcasting System (PBS) would accompany the group to film a documentary of the acquisition and transport of rocks from California, Utah, Montana, Wyoming, and South Dakota, to Philadelphia. Each State planned appropriate ceremonies to dedicate its particular rock.

Due to the proximity of the Wyoming Army National Guard facility, the stone selected by Ray Harris of the Geological Survey was a Pennsylvanian age quartzite with a distinctive tan color and red and black markings from north of Guernsey, Wyoming (see picture below). The rock was a 12,000-pound boulder from the site of the mining camp of Toadville, near the Good Fortune iron mine. The National Guard moved the rock to Guernsey, where a ceremony was organized by Darrell Offe, Mayor of Guernsey, to dedicate the stone. Several Wyoming State Legislators and County and local officials were present at the ceremony, which was made a part of Guernsey's and Hartville's Annual Labor Day celebration. Wyoming Governor Mike Sullivan presented the dedication speech. The ceremony was filmed by PBS for the documentary to be made for the Bicentennial Monument. Wyoming's rock was then loaded onto the truck for transport to Philadelphia, where it will become a part of the National Monument to the Constitution.

NEW PROCEDURES ON BAD CHECKS AND DELINQUENT ACCOUNTS

The incidences of bad checks and delinquent accounts are increasing for all merchants, and unfortunately the Geological Survey is no exception. As a State agency, State Statutes require us to take appropriate steps to ensure collection on checks returned for insufficient funds and on accounts that remain open for inordinately long periods of time. To comply with Statutes, we are contracting with CrediCheck and the Albany County Credit and Collection Bureau to assist us in these endeavors.

We are calling this to the attention of our patrons to help everyone avoid a $15.00 collection charge on bad checks and to avoid potential damage to a personal or company credit rating. We hope that we will not have to use this service in the future, but for now there is little option.

To all of you who have faithfully paid your bills, we apologize for having to introduce this procedure. We also realize this action should have no effect on you, but there is always a very small percentage that impact the majority. We do appreciate the vast majority of you who pay promptly and faithfully.

RECENT AND NEW PUBLICATIONS BY THE GEOLOGICAL SURVEY OF WYOMING

Tectonic map of the Overthrust Belt, western Wyoming, northwestern Utah, and southeastern Idaho, showing oil and gas fields and exploratory wells in the Overthrust Belt and adjacent Green River Basin, D.L. Blackstone, Jr. and R.H. DeBruin, Map Series 23, 1987, ($5.00).

Late Pleistocene periglacial wedge sites in Wyoming: an illustrated compendium, Brainerd Mears, Jr., Memoir 3, 1987, ($8.00).

*The geology and occurrence of critical strategic metals (chromium, cobalt, manganese, and platinum) in Wyoming, W.D. Hausel, Open File Report 87-7, ($5.50).

*Rare earth elements and yttrium in Wyoming, J.K. King and R.E. Harris, Open File Report 87-8, ($6.50).

*Preliminary map of wind blown sand areas in Wyoming, J.C. Case and Cynthia Boyd, Open File Report 87-9, ($3.00).

Geothermal resources of the Wind River Basin, Wyoming, B.S. Hinckley and H.P. Heasler, Report of Investigations 38, 1987, ($7.00).

The Wyoming State Fossil, *Knightia*, Postcard, 1987, (20¢ each or 6 for $1.00).

First draft of proposed stratigraphic nomenclature chart for the State of Wyoming, J.D. Love, A.C. Christiansen, and A.J. VerPloeg, 1987, ($1.50).

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

Order these and other publications from: Geological Survey of Wyoming, Box 3008, University Station, Laramie, Wyoming 82071. Phone: (307) 766-2286. Many of these publications are also available over-the-counter at the Wyoming Oil and Gas Conservation Commission (Basko Building) in Casper, Wyoming.

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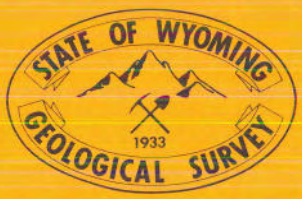
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