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

WYOMING GEO-NOTES NO. 10

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THE GEOLOGICAL SURVEY OF WYOMING

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WYOMING GEO-NOTES

This quarterly newsletter on the geology, 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.

Wyoming Geo-notes was first published in July, 1977, as a semiannual newsletter for the Geological Survey. It had a very shaky start which ended abruptly with a single issue, designated Volume 1, Number 1. The recent success of our *Quarterly Minerals Update for Wyoming*, however, has been so overwhelming that it now forms the backbone for our rejuvenated *Wyoming Geo-notes*. The newsletter is now published quarterly and has been expanded to include news about Staff and Survey activities.

***Photo front cover** - Nine Wyoming diamonds which were mined from the State Line District south of Tie Siding (centimeter scale).*

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TABLE OF CONTENTS

	Page
Minerals update	1
Overview	1
Oil and gas update	9
Uranium and industrial minerals update	18
Uranium	18
Bentonite	18
Trona	23
Limestone	27
Other industrial minerals	27
Coal update	28
Metals and precious minerals update	40
1985 Mineral exploration in Wyoming - a recap	43
Coal	43
Uranium	44
Industrial minerals	45
Metals and precious stones	47
Staff changes	49
Wyoming diamonds on exhibit	49
Recent and new publications by the Geological Survey of Wyoming	51

MINERALS UPDATE

OVERVIEW

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

About a year ago, I spoke to some professional engineers in Laramie. Then, as now I noted that forecasting mineral production for the State was relatively easy and even exciting a year or two ago. Of course, the forecasts were all optimistic at that time, and the recession had not really struck Wyoming. Many of us knew the trend could not continue forever and although State forecasts were almost always significantly below forecasts by the Federal government, it was hard to convince anyone that the mineral industry could not escape the downturn affecting the rest of our Nation.

Let us look at the bad first. Wyoming's uranium industry has weakened markedly. Annual production has fallen from 7.5 million tons in 1980 to around one million tons in 1985. In this case the demise was not just the recession. The Three Mile Island incident coupled with scaled back energy growth have had their effects and at the same time new and very competitive Canadian and Australian uranium supplies appeared on the scene.

The prognosis remains gloomy with annual production slated at less than one million tons for the rest of the decade, and the more pessimistic forecasters even see cessation of all domestic uranium mining. We suspect a total collapse is unlikely as complete cessation of domestic production is something that will likely not happen. Because Wyoming and New Mexico have the largest domestic uranium reserves and are the two largest uranium-producing states, some mines are likely to survive.

However, there is currently only one mill and one mine active in the State. Employment has dropped from over 5,000 to 1979 to less than 760 in 1985.

Wyoming mineral production forecast to 1991[1].

Calendar Year	Oil Production[2]	Natural Gas Production[3]	Coal Production[4]	Trona Production[4]	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	128.5	603.0	140.4	11.1	1.6
1986	125.0	620.0	148.0	11.3	0.3
1987	122.0	660.0	149.5	11.4	0.3
1988	120.0	700.0	151.5	11.5	0.3
1989	118.0	770.0	152.0	11.5	0.3
1990	116.0	800.0	152.0	11.7	0.3
1991	114.0	850.0	152.0	11.9	0.3

*Actual values for comparison, [1] Geological Survey of Wyoming, March, 1986, [2] in millions of barrels, [3] in billions of cubic feet, [4] in millions of tons.

We see a slim chance that production could increase very slightly by the early 1990's, but only if there is an improvement in public opinion about the safety of nuclear power. Foreign competition from Canada and Australia with their high quality ores, however, will capture an inordinately large share of any new demand. Prices have fallen over the same time period and are now hovering around $17.00 per pound, compared to $42 per pound in 1979. Prices are not likely to increase substantially.

Production history of selected other mineral commodities[1].

	1980	1981	1982	1983	1984
Ballast[2,3]	1.65	1.72	0.81	0.99	2.43
Bentonite[2]	3.58	4.81	2.35	2.18	3.08
Clay[2]	0.04	0.02	0.02	0.04	0.05
Decorative Stone[2]	0.05	0.05	0.05	0.07	0.08
Dolomite[2]	1.67	0.87	0.61	0.66	0.86
Feldspar[4]	200	25	----	----	----
Gypsum[2]	0.30	0.28	0.26	0.33	0.33
Iron Ore[2]	4.88	4.67	3.28	2.48	----
Limestone[2,5]	0.50	0.72	0.59	0.56	0.65
Sand and Gravel[2]	5.06	5.21	4.74	5.00	4.76
Scoria[2]	0.03	0.08	0.08	0.07	0.23
Shale	----	----	----	----	0.02
Sodium Sulfate[4]	----	3,201	3,174	3,194	3,250

[1]Source: Ad Valorem Tax Division. [2]Millions of short tons. [3]Includes granite, scoria and other rock. [4]Short tons. [5]Includes limestone used for cement rock, sugar beet refining and other uses. [6]Baked and fused rock, also called clinker.

Even worse than uranium, the State's iron ore industry is now defunct. In 1980, CF&I's Sunrise mine and mill near Guernsey closed. Then in 1983, U.S. Steel shut down its Atlantic City mine and mill, ending a long history of iron ore production in Wyoming. With the current demise of the Nation's steel industry, Wyoming's hopes for a revival of iron mining are dim to nonexistent in the foreseeable future.

Having discussed uranium and iron perhaps the worst is over - although some may disagree. Bentonite production, for example, declined about 41 percent between 1981 and 1983. This decline of approximately 1.2 million tons per year was coupled with the price collapsing to about one-third of what it had been. It is surprising that no bentonite operations have closed as a result of these drastic reductions in demand and price. Decreased oil and gas drilling, decreased demand for pelletized iron ore and decreased foundary demand account for the downturn. To offset price declines, companies have improved their efficiency while laying off employees.

Forecasts show gradual increases in production and price as the Nation recovers from the recession - putting bentonite production at 1.7 - 2.0 million tons per year for the remainder of the decade. The only scenario that might significantly alter this prognosis would be major increases in oil and gas drilling - something we did not anticipate happening. Wyoming, however, will remain the largest bentonite-producing state and will continue to supply 90 percent of the domestic demand.

Trona or sodium carbonate-bicarbonate production from southwestern Wyoming has hovered between 10 - 12 million tons annually for the last four years. Our forecast indicates little change is in store throughout the 1980's. The greatest hope for trona is an export market, but the trona industry has been unable to make significant progress with this potential market.

Claims that U.S. producers were trying to glut the market and eliminate their foreign synthetic soda ash competitors have prompted tough import quotas and thwarted efforts to expand markets overseas. Rail transportation costs are also a significant obstacle.

Wyoming contains the world's largest trona deposits and is the largest producer of soda ash or refined trona. The glass industry is the primary user of soda ash although there are hundreds of other uses for the product. Competition from plastic and metal containers have hurt the industry. The five large underground mines and their mills have experienced numerous layoffs over the last few years. The mills are operating at 50 - 79 percent of their capacity, averaging 70 percent. Soda ash prices have fallen from a high of $92 per ton to about $69 per ton in 1985.

Turning to oil, production has increased for the last two years and apparently increased slightly again in 1985. Current production is around 128.5 million barrels. Production will now probably resume its gradual 3 - 4 percent decline of the 1970's. Currently, we forecast annual oil production to remain above 120 million barrels through 1988.

At the same time production began increasing, the price began to fall, but the big collapse occurred in January of 1986. In 1985, the average barrel of oil in Wyoming was closer to $25 - $26 than the mid-$30's of a few years ago. Prices are now hovering around $15. There are indications that the price has not yet bottomed out. This declining price has more than offset the value of increased production.

Drilling is way below seasonal norms, and it appears lack of demand and low prices as well as industry concerns over proposed tax reforms and new regulations are causing a downturn or hesitation in activity. It is noticeable that most drilling is in the Powder River or Bighorn Basins - the State's oil-producing areas.

Production of natural gas is somewhat encouraging since it appears 1985 production exceeded that of 1984. Production in 1985, however, was disappointing although it did apparently exceed 603 billion cubic feet - but that was about 28 billion cubic feet below our forecast. Our forecast is for continued increases in production, perhaps exceeding 800 billion cubic feet by 1990. Of course these gains, as substantial as they seem, are held down by the gas bubble. There is capacity for far greater production if a market were only there.

Prices of natural gas have also fallen slightly for three years in a row. Although we anticipate further erosion of the price, which is now about $2.89 per thousand cubic feet, we expect the price to begin increasing in the last half of the decade, but no big increases are forecast.

The huge carbon dioxide (CO_2) reserves (40 trillion cubic feet) in southwestern Wyoming are another bright spot. Exxon's planned production from Riley Ridge will be substantial and the real bonus will be the oil recovered by the CO_2-enhanced recovery projects supplied by this production - that is if the weak oil prices do not lead to the abandonment of all the projects.

I saved coal for last. Although the prognosis is good, the current marketing actions are making accurate forecasts quite difficult. For example, as recently as December, 1985, we projected 1985 coal production at 145 million tons - an eleven percent increase over 1984. The actual gain turned out to be closer to seven percent and pushed production to 140.4 million tons. 1984 production was 130.7 million tons. In 1985, Wyoming did become the second largest coal-producing State in the U.S., behind only Kentucky. We had been a steady third for some years with West Virginia holding second place.

Wyoming now accounts for almost 15 percent of the Nation's coal production and about one-fourth of the Nation's production from surface mines. Contributing to the U.S. and Wyoming production increases was the six to seven percent increase in coal consumption reported by electric utilities for 1984 and probably 1985. The mines in the Powder River Basin accounted for most of the increase: the 119.8 million tons produced from this basin in 1985 was up six percent over 1984. Coal production from Campbell County alone now accounts for nearly 82 percent of Wyoming's production. The Powder River Basin now accounts for about 86 percent of the State's production.

A total of 30 coal mines reported coal production in 1985. Six of the State's coal mines produced over 10 million tons each. With 1985 production of 23.2 million tons of coal, Black Thunder remains the biggest coal mine in the Nation. Kerr-McGee's Jacobs Ranch mine (13.0 million tons) is now second in production, followed by Amax's Belle Ayr mine (12.8 million tons) and Carter Mining's Rawhide mine (12.2 million tons).

Despite the surge in coal production, employment at Wyoming coal mines only increased slightly in 1985 after declining slightly in 1984. Current employment is 5,374. This employment rate combined with the production increases means that productivity (tons per miner) remains very high and reflects a shift to the larger, less labor intensive surface mines in the Powder River Basin as well as an increase in overall mining efficiency.

Coal production increases in 1984 and 1985 were dampened by the erosion of price. Coal prices apparently fell again in 1985 and mark the third consecutive year where prices fell. Unfortunately it does not look like the price has bottomed out yet and although we forecast higher prices by the end of the decade, those prices won't be much more than making up for the recent declines - in other words, the 1990 price could be the

same as the 1981 or 1982 price of coal. The average price for a ton of Wyoming coal dropped from $10.67 in 1983 to $9.64 in 1984. Powder River Basin coal is now about $7.18 per ton compared to $22.63 from other areas of the State. Most of the additional price drop in 1985 is attributed to substantial declines in the prices paid for Powder River Basin coals on new and spot contracts - some prices are below $5.00 per ton.

Coal mine capacity is currently estimated at 243.4 million tons per year, putting production at 57 percent of capacity. Proposed new mines could add another 80.4 million tons of capacity by 1990. We estimate the State's coal mines will still be between 43 - 57 percent of capacity by 1990.

Production for the Powder River Basin, which was near or even above contracted production in 1985, is expected to increase by up to ten million tons in 1986; statewide production was only three percent less than contracted production in 1985 and is expected to come close to one percent in 1986 (implying less than contracted production or lost contracts in southern Wyoming). From 1986 to 1990, we expect to see the production curve flatten out, with annual rates of increase leveling off or increasing only one to three percent. Similarly, the amount of production below contract amounts will become less and less. By 1990, it is expected that both actual production and contract production will only reach 152 million tons.

The bottom line is that if bad times do not last too long nearly all the State's mineral industries are postured to rebound quickly. If demand stays down too long, some excess capacity may disappear under Chapter 11 or out of frustration and marginal profits that simply shut down exploration, wells, mines and mills.

OIL AND GAS UPDATE

by Rod De Bruin, Petroleum Geologist, Geological Survey of Wyoming

The most important development for Wyoming in the past few months is, unfortunately, the continued slide in crude oil prices. Over this period, world spot prices have fallen dramatically and are currently in the $13 to $15 a barrel range. The posted price (the price refiners pay domestic producers for crude oil) is somewhat higher. The large drop in price is attributed to the current oversupply of crude oil on the world market. There is also a good chance that the spot price of natural gas may drop further if fuel oil prices drop substantially. This erosion of oil prices, the continuing gas glut and pending Federal legislation detrimental to the petroleum industry have all contributed to a slowdown in drilling activity as the rig count dropped to an average of 55 for the first three weeks in February. Compare this to the average rig count of 93 for all of 1985 (see Tables on pages 14 and 15).

Well completion statistics are in for 1985 and are summarized and compared with figures for 1984, 1983 and 1982 in the table below:

	New field wildcats				All wells			
	Oil	Gas	Dry	Total	Oil	Gas	Dry	Total
1985	64	8	469	541	820	109	809	1,738
1984	57	9	440	506	801	142	750	1,693
1983	23	13	305	341	698	152	550	1,400
1982	68	28	404	500	1,029	272	827	2,128

From: Petroleum Information Corporation, Rocky Mountain Region Report, January 8, 1986, p. 8.

These figures illustrate the continued decreased interest in gas exploration. Although there was a

WYOMING FEDERAL AND STATE COMPETITIVE OIL AND GAS LEASE SALES

BLM SALES 1984

Month	Total Revenue	Number of parcels offered	Number of parcels sold	Total acres	Acres sold	Average price per acre sold	High price per acre
February	$ 7,262,056	21	21	2,304	2,304	$3,151.31	$21,239.34
March	615,088	28	28	4,015	4,015	153.20	500.00
April	330,798	29	29	3,977	3,977	83.17	412.51
May	1,571,896	77	75	14,565	14,470	108.63	1,300.00
August	12,465,683	162	162	30,110	30,110	414.00	13,333.33
October	2,521,434	115	115	19,852	19,852	127.01	3,852.00
December	4,761,794	123	123	29,202	29,202	163.07	5,751.50
TOTAL	$29,528,749	555	553	104,025	103,930	$ 284.12	$21,239.34
			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

STATE SALES 1983

Month	Total Revenue	Number of parcels offered	Number of parcels sold	Total acres	Acres sold	Average price per acre sold	High price per acre
August	$ 2,604,676	88	88	43,262	43,262	$ 59.21	$ 479.00
October	1,875,687	100	86	52,412	42,891	42.73	290.04
TOTAL	$ 4,480,363	188	174	95,674	86,153	$ 52.00	$ 479.00
			1984				
January	$ 2,316,714	200	165	118,285	92,785	$ 23.97	$ 502.04
March	2,173,851	200	166	85,993	66,781	31.49	524.00
May	1,527,903	200	162	87,469	67,579	32.49	390.00
July	2,028,880	200	181	86,387	73,849	26.46	2,100.00
September	1,379,138	200	141	87,095	53,066	24.99	1,020.00
November	739,766	200	135	82,363	51,640	13.33	280.00
TOTAL	$10,166,252	1,200	950	547,592	405,700	$ 25.05	$2,100.00
			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

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

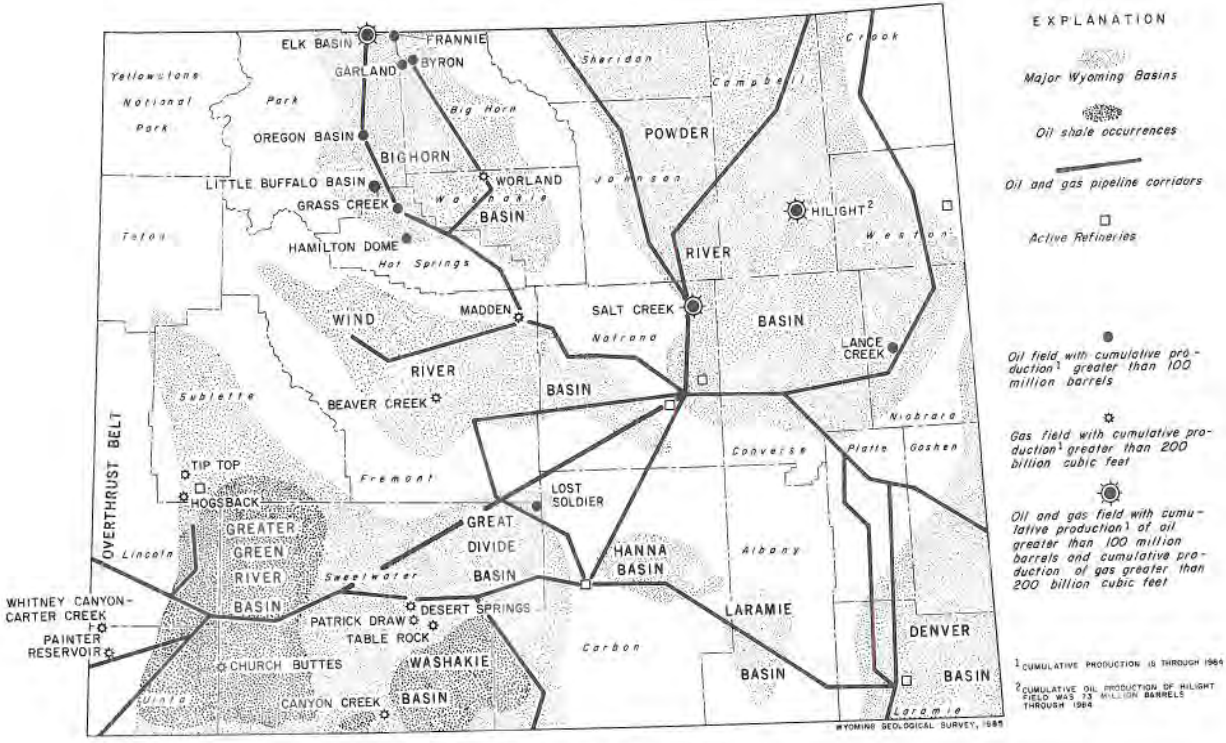
small increase in total completions from 1984 to 1985, the percentage of successful completions dropped to 53.5 percent in 1985 from 55.7 percent in 1984. During the first six weeks of 1986, the number of completed exploratory wells has decreased more than 50 percent, and there has been nearly a 40 percent decrease in all wells drilled for oil and gas, compared to the same period in 1985. This disturbing trend can be linked directly to the lingering gas surplus and to declining oil prices.

In 1985, the Powder River Basin was the most active area in terms of wildcat and development drilling. The main target in the northern part of the basin was the Minnelusa Formation while drilling in the southern part of the basin was aimed at younger Cretaceous formations.

Besides losing revenue from lower oil prices, Wyoming could also lose $8 million in fiscal year 1986 and as much as $43 million in fiscal year 1987 under the present interpretation of the budget-cutting Gramm-Rudman Act. The loss would be caused by a reduction in royalty funds paid to Wyoming for production from Federal lands in the State. This loss of revenue would make Wyoming the most impacted state in the union.

The geophysical industry is also feeling the effect of surplus oil and gas. According to the Society of Exploration Geophysicists, the number of seismic crews, working in the U.S. and its waters, declined for the sixth straight month in January. There was a drop of 16 crews from the December, 1985, figure of 326. The January, 1986, count is 129 less than January, 1985, and 167 less than the January, 1984, total.

In an item related to the recent drop in oil prices, several oil companies have announced severe budget cuts. As an example, Atlantic Richfield Company (Arco) slashed its capital spending budget by nearly one-third. The hardest hit area was in exploration and



GENERALIZED OIL AND GAS INDEX MAP OF WYOMING

production spending where cuts were made from $2.95 billion in 1985 to $1.35 billion this year.

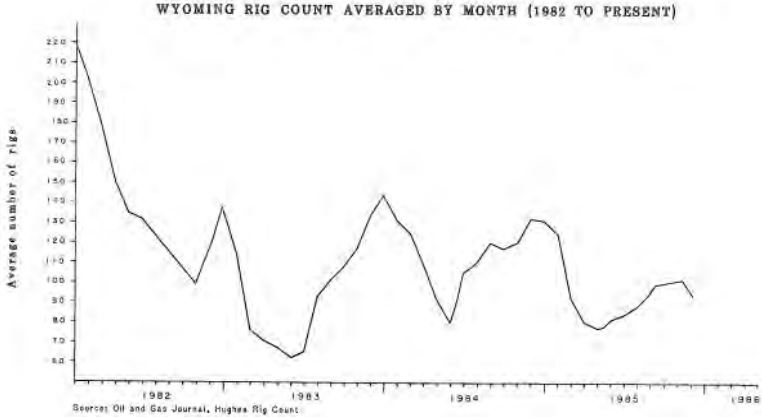
On an upbeat note, based on the most recent Wyoming Oil and Gas Conservation Commission figures, it seems likely that oil production for 1985 will be around 128.5 million barrels of oil compared to 127.8 million barrels in 1984. Gas production for 1985 should approximate 603 billion cubic feet compared to 600.1 billion cubic feet in 1984.

Since the last issue of Geo-Notes, the U.S. Bureau of Land Management has held two lease sales. The December 13th sale drew high bids totaling $1,467,265 for 46,908 acres. There were bids on 141 parcels out of the 211 parcels offered. The average bid per acre was $31.28. Exxon Corporation's high bid of $1,167.23 per acre was for an 80-acre lease in the Powder River Basin only one mile from Frontier oil production in Crawford Draw Field.

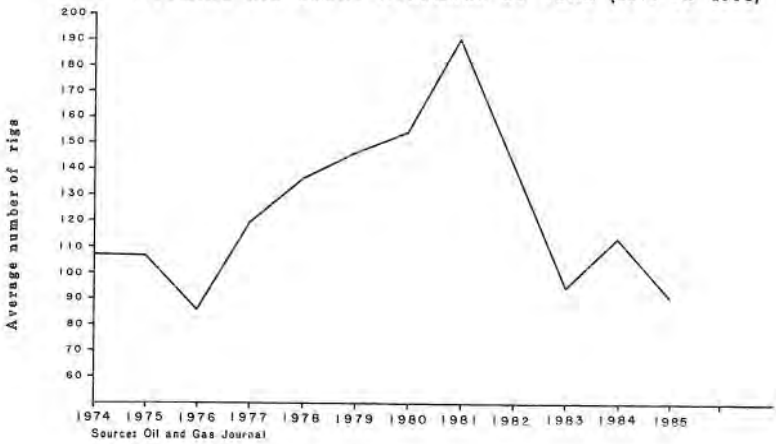
The February 5th sale drew high bids of $1,992,326 for 38,806 acres. There were bids on 154 parcels out of 208 parcels offered. Exxon Corporation made the high bid of $680 per acre for a 160.05-acre lease in Amos Draw Field. Exxon also made the sale's 2nd, 3rd and 4th highest bids for three other Amos Draw tracts. The average bid for the sale was $51.34 per acre. For a comparison with past sales, see the Table on page 10.

The Wyoming Board of Land Commissioners' lease sale held January 21st drew $630,069 in high bids. Of the 200 tracts offered, 123 tracts covering 49,783 acres received bids. The average bid was $12.66 per acre. Duane Haley of Englewood, Colorado, made the high bid of $330 per acre for a 320-acre lease in the Powder River Basin. This tract is near Bishop Ranch, East Field which produces oil from the Minnelusa Formation. For a comparison with past sales, see the Table on page 10.

WYOMING RIG COUNT AVERAGED BY MONTH (1982 TO PRESENT)

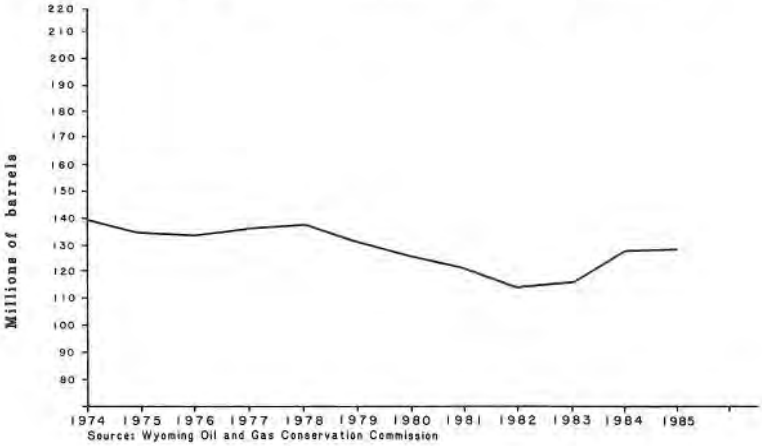


WYOMING RIG COUNT AVERAGED BY YEAR (1974 TO 1984)



WYOMING NATURAL GAS PRODUCTION BY YEAR (1974 TO 1984)

WYOMING OIL PRODUCTION BY YEAR (1974 TO 1984)



Once again Exxon's LaBarge Project is in the news. It was recently announced that the work force at the gas processing plant will probably shrink to about 2,000 workers in April as work on the first phase nears completion. Work on the second phase has been delayed due to the uncertainty over the status of enhanced oil recovery (EOR) projects using carbon dioxide. The economic feasibility of such projects is being adversely affected by lower crude oil prices. The Wyoming Industrial Siting Council has granted Exxon a rehearing on two disputed requirements in its siting permit for the second phase of its project.

Amoco Production Company has been granted a siting permit for its proposed carbon dioxide separation plant at Bairoil. Total cost of the project is now estimated at $142.5 million, down from an earlier estimate of $164.8 million. A portion of the project has already been delayed, and an Amoco spokesman has said that if oil prices drop much more the project will be stopped. If the project proceeds, construction on the plant will begin this summer, but the entire system will not be developed as soon as originally planned reportedly because of the limited availability of carbon dioxide. Amoco plans to begin injecting carbon dioxide into the Tensleep Sandstone of Wertz Field by October, 1986. The peak workforce is estimated at 647 in the third quarter of 1986 with levels to remain around 600 workers until the middle of 1987.

Amoco has also announced plans to construct a $134 million gas plant northeast of Evanston. The plant will process sour natural gas from Ryckman Creek, Painter Reservoir, East Painter Reservoir and Clear Creek Fields and will have a design capacity of 240 million cubic feet of gas daily. Other partners in the project include Chevron and Champlin Petroleum.

Gas from five Wyoming overthrust belt fields would be transported to Bakersfield, California, if the Federal Energy Regulatory Commission (FERC) approves

plans for a pipeline between Kemmerer and Bakersfield. Approximately 356 million cubic feet of gas per day with a daily value of about $1 million would be provided by the Wyoming producers. The gas would be used to produce steam heat for recovery of heavy oil in several California fields. If approved, construction of the pipeline would begin in 1987 and would be completed in 1988.

Snyder Oil Company plans to drill a 3,600-foot core hole this summer in the South Fork Valley of the Shoshone National Forest. The location is about 33 miles southwest of Cody. The test will be used for gathering geologic information and will not be completed for oil or gas production. If test results indicate potential for oil or gas production, the well will be shut-in and an environmental impact statement will be completed before production can begin. So far, Snyder has not filed an application with the U.S. Bureau of Land Management for a permit to drill.

Anschutz Corporation has applied for a permit to drill a 5,000-foot well in the Mosquito Creek drainage in the Palisades Wilderness Study Area. The well location is about six miles southwest of Wilson. The Wyoming Wilderness Act allows oil exploration in the Palisades area and full field development could be permitted if done in an environmentally acceptable manner.

Three new rules were proposed at the February hearing of the Wyoming Oil and Gas Conservation Commission: (1) Production curtailment schedules are proposed for exception wells; (2) The deletion of rectangular spacing patterns is proposed by dropping 80- and 320-acre spacings; and (3) Surveyors are being instructed to show the type and location of corners used to determine well locations. The public hearings on these proposed rules are scheduled for the April 8th Commission hearings. Written comments will be accepted at least up until the April hearings.

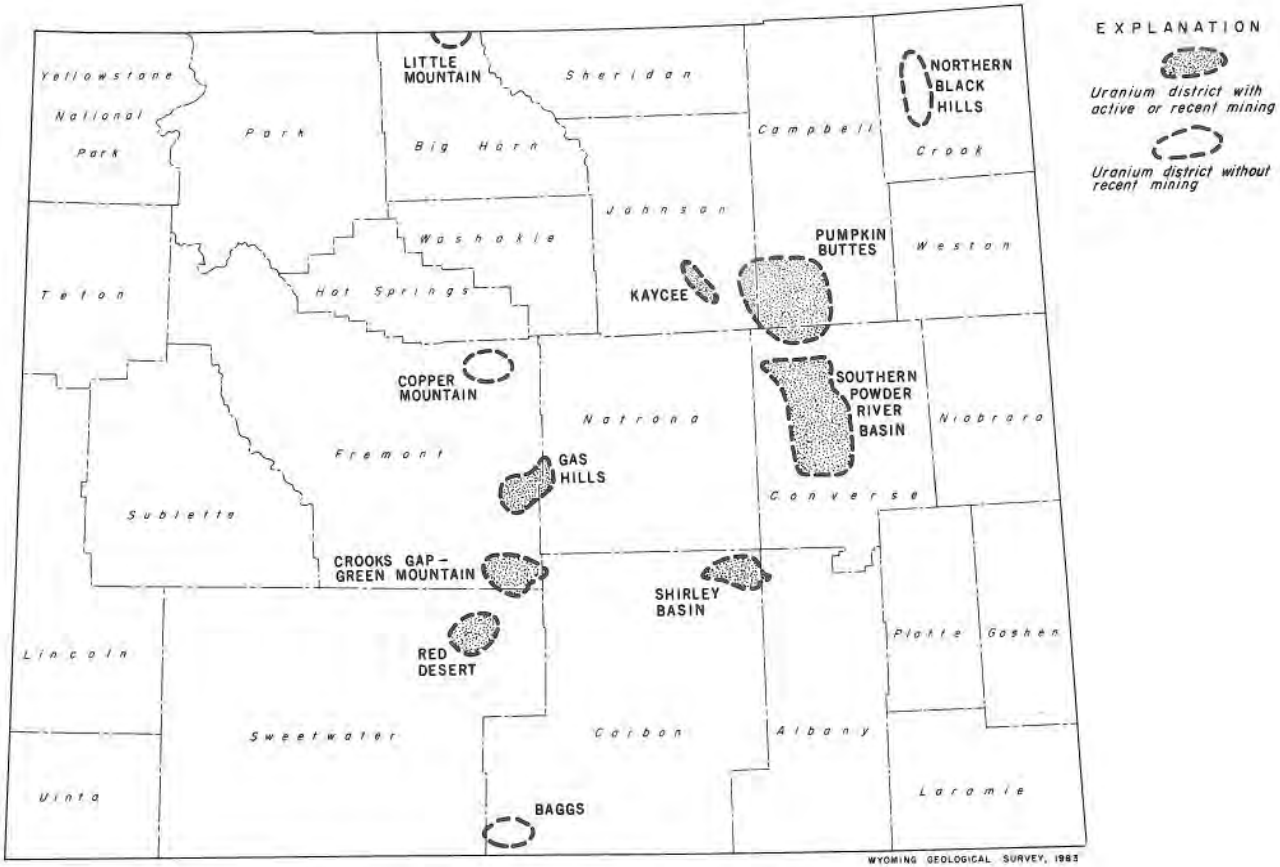
The U.S. Geological Survey held its second annual V.E. McKelvey Forum on Mineral and Energy Resources on February 5 and 6 in Denver. Several talks and poster sessions presented by U.S. Geological Survey geologists dealt with subjects related to oil and gas in Wyoming. Topics included: (1) *Three statistical methods for estimating undiscovered resources based on the Minnelusa play, Powder River Basin; (2) An integrated approach using computers in the geologic assessment of hydrocarbon resources in the Powder River Basin, Wyoming and Montana*; (3) *Sequential tectonics of the western margin of the Powder River Basin, Johnson and Sheridan Counties, Wyoming*; and (4) *Structure and petroleum potential of the Palisades Roadless Area, Idaho-Wyoming thrust belt salient near Jackson, Wyoming*. Extended abstracts of all the presentations are available in U.S. Geological Survey Circular 974. This circular is free on application to the Distribution Branch, Text Products Section, U.S. Geological Survey, 604 South Pickett Street, Alexandria, VA 22304.

URANIUM AND INDUSTRIAL MINERALS UPDATE

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

Uranium

Only one uranium mine remains active in Wyoming, the COGEMA-Pathfinder Shirley Basin mine in Carbon County. COGEMA's Gas Hills mine and mill (the Lucky Mc) remains closed for remodeling. COGEMA is negotiating for purchase of uranium properties in the Gas Hills from the Tennessee Valley Authority, in order to provide additional reserves for their expanded operation, scheduled to resume production in mid-1986. COGEMA-Pathfinder's production is exported to France to fuel nuclear power plants. Bear Creek Uranium's Bear Creek mine in the Powder River Basin closed in December.



MAJOR ACTIVE AND INACTIVE URANIUM DISTRICTS

The American nuclear power industry has reduced stockpiles of uranium oxide that it had built up under contracts signed in the late 1970's enough so that new contracts have been let. The American Electric Power Service Corporation signed a contract with Energy Resources of Australia, Ltd. for yellowcake (uranium oxide) from Australia. The Pennsylvania Power and Light Company signed a supply contract with the same Australian Company, as did a third, unnamed utility. As a result, Energy Resources of Australia Ltd. announced plans to double its output from the Ranger mine, the world's largest, located in Northern Territory, Australia. Obviously, none of the these contracts are helpful to Wyoming's uranium industry. The spot market price of uranium oxide is $17.00 per pound, up $2.00 from February, 1985.

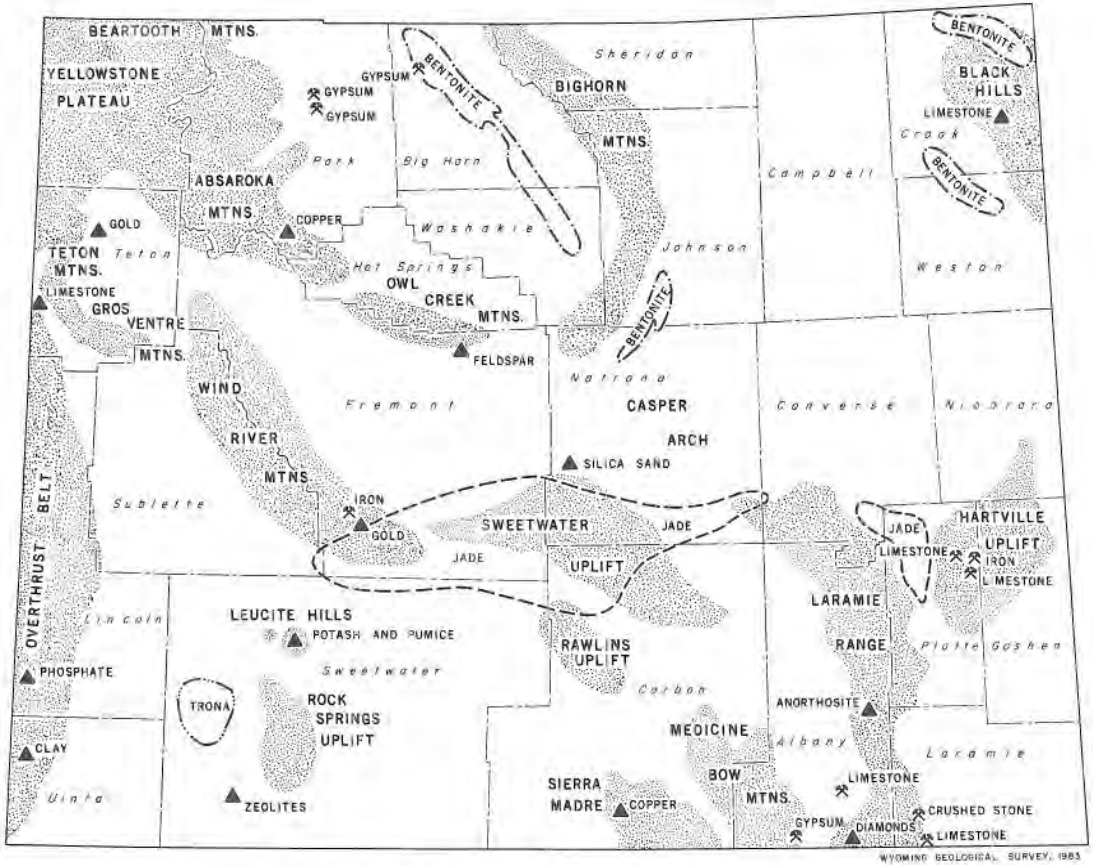
Domestic uranium producers have been calling for import restrictions on foreign uranium. The production costs for domestic uranium is about 50 percent greater than the pre-transportation production costs for Canadian and Australian uranium deposits. This is due primarily to the higher grade and the size of the foreign deposits. The average grade for U.S. deposits was about 0.1 percent, U_3O_8, compared to about 3.0 percent in Canada and Australia, with as much as 8.0 percent U_3O_8 reported from one Canadian deposit. Government subsidies of foreign producers have also been cited as a cause of lower foreign production costs. According to the February 17, 1986, issue of the Northern Miner, David Haglund of Queen's University, says that the dominance of U.S. import markets by Canada has little to do with politics or government policies but almost everything to do with geology (grade and size of the ore deposits). The U.S. Trade Representative recommended to Energy Secretary John Herrington that restricting uranium imports is not warranted and that foreign subsidies are not a significant factor determining the price advantage of foreign uranium. The Uranium Producers of America disagree with the conclusions of the U.S. Trade Representative and continue to

press for import restrictions, saying that such restrictions are required under existing Department of Energy regulations.

Foreign uranium purchasers have expressed an interest in uranium production from the United States. Taiwan Power Company (Taipower) has approved a $25 million uranium exploration contract with Rocky Mountain Energy Company to explore for uranium in four states, including Wyoming. Taipower is contributing 20 percent towards a five-year exploration effort.

Reclamation proposals as well as reclamation requirements have generated the most news regarding uranium in Wyoming in the first quarter of 1986. The Wyoming Department of Environmental Quality (DEQ) has proposed full State funding to clean up abandoned tailings now located at the Susquehanna mill tailings site near Riverton. The U.S. Department of Energy (DOE) wants to stabilize the tailings at Riverton at a cost of $15 million, while the DEQ wants to transport the tailings to abandoned mine sites in the Gas Hills, 45 miles east of Riverton, at a cost estimated to be between $18 and $35 million.

COGEMA-Pathfinder has been asking DEQ to relax mine reclamation rules, particularly as applied to reclamation of abandoned mines acquired by purchase. COGEMA is planning to purchase property from the Tennessee Valley Authority in the Gas Hills. This property contains some unreclaimed mines. Governor Herschler asked DEQ to modify its rules on reclamation of mines acquired by purchase. These rules currently require immediate reclamation unless delayed by permit revision, which is a long process requiring public notices. New rules proposed by the DEQ in February, 1986, would allow companies to delay reclamation on up to 20 percent of their land for as long as five years, subject to notifying DEQ. Pathfinder, however, has indicated it is not pleased with the new regulation, calling it "counter-productive, arbitrary and inconsistent" with State law.



EXPLANATION

Mines and quarries

BENTONITE

Bentonite mining district

TRONA

Trona mining district

Localities

JADE

Jade collecting areas

Uplifted areas

SELECTED MINERAL AND ROCK OCCURRENCES

The Leuenberger Ranch deposit in Converse County was reportedly purchased by the London Central Power Exchange, Ltd. The Leuenberger Ranch property was formerly owned by Teton Exploration, and was developed as an *in situ* mine. Although production tests were run on the ore body in 1981 the deposit never made full production before being shut down in 1982.

Trona

Trona production in Wyoming has increased about five percent over the first quarter of 1985. However, domestic consumption of soda ash (refined trona) for all of 1985 was almost identical to that of 1984. Wyoming trona production is expected to increase slightly this year due to the phase-out of the synthetic soda ash plant owned by Allied Chemical Company in Syracuse, New York.

In related trona news, FMC Corporation announced an expansion of its processing plant in Green River to produce more sodium tripolyphosphate, used in detergents. This expansion will not significantly increase total trona production, but it will expand detergent-related sales, slightly offsetting the decline in glass-related consumption of soda ash.

FMC Corporation also reported successful testing of the new trona *in situ* mining process. This method, which recovers chemically-dissolved trona through pumping wells, reportedly recovers nearly 100 percent of the trona, compared with 45 percent recovery from underground mining methods. It is also less labor-intensive. This process also costs as much as 25 percent less than conventional mining. If this method lives up to its promises, FMC would be able to produce trona at less cost than the other producers and gain an advantage over its competitors. Since demand is still much less than capacity, the development of this method

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Resources (January 1, 1985)

Discovered (Includes 10 billion barrels recoverable by enhanced recovery techniques)	13.5 billion barrels[1]
Undiscovered	7.6 billion barrels[1]
Total	21.1 billion barrels

Remaining Reserve Base (January 1, 1985)

Measured reserves (Proved reserves)	0.95 billion barrels[2]
Indicated and inferred reserves	2.8 billion barrels[3]
Total	3.75 billion barrels

NATURAL GAS

Remaining Resources (January 1, 1985)

Discovered	19.8 trillion cubic feet[1]
Undiscovered (there is another 35 trillion cubic feet of noncombustible CO_2 gas)	58.0 trillion cubic feet[1]
Total	77.8 trillion cubic feet[1]

Remaining Reserve Base (January 1, 1985)

Measured reserves (Proved reserves)	10.48 trillion cubic feet[2]

COAL

Remaining Resources (January 1, 1985)

Identified (Discovered)	136.4 billion tons[4]
Undiscovered	800.0 billion tons[5]
Total	936.4 billion tons

Remaining Reserve Base (January 1, 1985)

Demonstrated strippable (Measured and indicated reserve base)	27.5 billion tons[4]
Demonstrated underground-minable (Measured and indicated reserve base)	38.4 billion tons[4]
Total	65.9 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 (January 1, 1983)		995,000 tons[7]
Remaining Reserve Base (January 1, 1983)	ORE	U_3O_8
Ore recoverable at $30 or less/ton	29.4 million tons	39,700 tons[7]
Ore recoverable at $30.01-$50.00/ton	225.1 million tons	151,500 tons[7]
Ore recoverable at $50 or less/ton	254.5 million tons	191,200 tons

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, 1985, *U.S. crude oil, natural gas, and natural gas liquids reserves: 1984 Annual Report, October.* (1984 production has been subtracted).

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

[4] Wyoming Geological Survey, March, 1985. (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. Department of Energy, 1983, *Statistical data of the uranium industry:* Open-file Report GJO-100-(83), 77 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.

will not increase the total production of trona in Wyoming.

FMC was also in the news in the first quarter of 1986 as it became the target of hostile takeover attempts by both General Dynamics and United Technologies. Two other trona producers were taken over in recent years - Allied by the Signal Corporation, an electronics company, and Texasgulf by a French government corporation. Stauffer was acquired by Cheseborough - Ponds last year. No changes are expected in the trona region if the takeover of FMC is successful.

Limestone

During this last quarter, the Monolith Portland Cement plant in Laramie and its associated contractor, Wyoming Construction, Inc., were purchased by Centex Cement Enterprises, Inc., headquartered in Texas. Centex also announced the acquisition of additional limestone reserves in the Laramie area and plans to expand and modernize the plant. During the modernization phase, Centex will continue to supply cement to existing consumers through purchases from other producers in the region. Monolith was Wyoming's only producer of cement. The production of cement in Wyoming seems likely to resume once the plant modernization is completed.

Other Industrial Minerals

Bentonite production remained stable during the first quarter of 1986. Companies have been facing low prices for three years as demand lags. The recent decrease in oil prices will probably result in further decreases in demand and prices for bentonite as oil and gas well drilling slows.

Chevron Chemical Company continued construction of its Rock Springs fertilizer plant, scheduled to begin production this July. Chevron also announced that it was closing a liquid fertilizer plant in Salt Lake City and transferring the production of this plant to the Rock Springs facility. This will not increase the total projected output of the plant (200,000 short tons per year), but it will change the output product mix to include liquid as well as granular phosphate fertilizers. The plant will use phosphate mined north of Vernal, Utah. The phosphate will be slurried to the Rock Springs site. Sulfur for the plant will come from Chevron's natural gas desulfurization plant in Uinta County, Wyoming.

Naturally-occurring sulfur deposits near Thermopolis (see Geo-Notes No. 9, page 35) were recently acquired by Continental Sulfur Company, and proposed mining plans were announced in December. If opened, this will be Wyoming's first mineral sulfur mine since the 1920's when these Thermopolis deposits were last worked.

The Burlington Northern Railroad, which tested rock from the Sunrise area for ballast last November, has apparently found the material suitable, and is planning to conduct a drilling program to determine the reserves in the area. The Chicago and Northwestern Railroad continued to explore for a ballast source in Wyoming.

The production of construction aggregate in southeastern Wyoming is expected to increase as the initial construction of 50 missile silos begins this year. Material will be needed for the silos and the upgrading of access roads.

The production of gypsum and brick clay should increase in 1986 as regional construction increases. The use of crushed rock and sand and gravel for highway construction may decrease this year. Federal highway construction funds are expected to decrease, which will result in less highway construction.

COAL UPDATE

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

Year-end production figures released by the Wyoming State Mine Inspector indicate that Wyoming coal mines produced 140.4 million tons of coal in 1985 (see the Table on page 29). With Kentucky producing 161.8 million tons and West Virginia producing only 129 million tons, Wyoming was firmly in second place in U.S. coal production at the end of 1985. Although the

REPORTED COAL DELIVERIES IN TONS[1]

	1983 MONTHLY	1983 CUMULATIVE	1984 MONTHLY	1984 CUMULATIVE	1985 MONTHLY	1985 CUMULATIVE
JANUARY	10,313,000	10,313,000	9,540,200	9,540,200	11,601,200	11,601,200
FEBRUARY	8,719,700	19,032,700	9,654,600	19,194,800	10,473,900	22,075,100
MARCH	9,051,200	28,083,900	10,875,000	30,069,800	11,674,900	33,750,000
APRIL	8,195,000	36,278,900	8,721,400	38,791,200	11,632,800	45,382,800
MAY	8,364,600	44,643,500	9,481,500	48,272,700	11,497,900	56,880,700
JUNE	8,330,200	52,973,700	9,464,500	57,737,200	11,692,200	68,572,900
JULY	8,734,700	61,708,400	11,019,600	68,756,800	11,893,500	80,466,400
AUGUST	9,669,300	71,377,700	11,433,000	80,189,800	12,107,100	92,573,500
SEPTEMBER	9,189,700	80,567,400	10,440,000	90,629,800	11,325,000	103,898,500
OCTOBER	9,406,300	89,973,700	10,492,500	101,122,300	11,048,500	114,947,000
NOVEMBER	9,013,600	98,987,300	11,814,200	112,936,500	10,589,700	125,536,700
DECEMBER	7,680,600	106,667,900	11,486,800	124,423,300	11,459,300	136.996,000
TOTAL REPORTED DELIVERED TONNAGE	106,667,900		124,423,300		136,996,000	
TOTAL TONNAGE NOT REPORTED	5,519,300		6,322,479		3,428,446	
TOTAL TONNAGE PRODUCED [2]	112,187,200		130,745,779		140,424,446	

[1] Source: National Marketing Reports by Coal Marketronix, compiled from FERC Form 423 filed monthly by electric utilites.

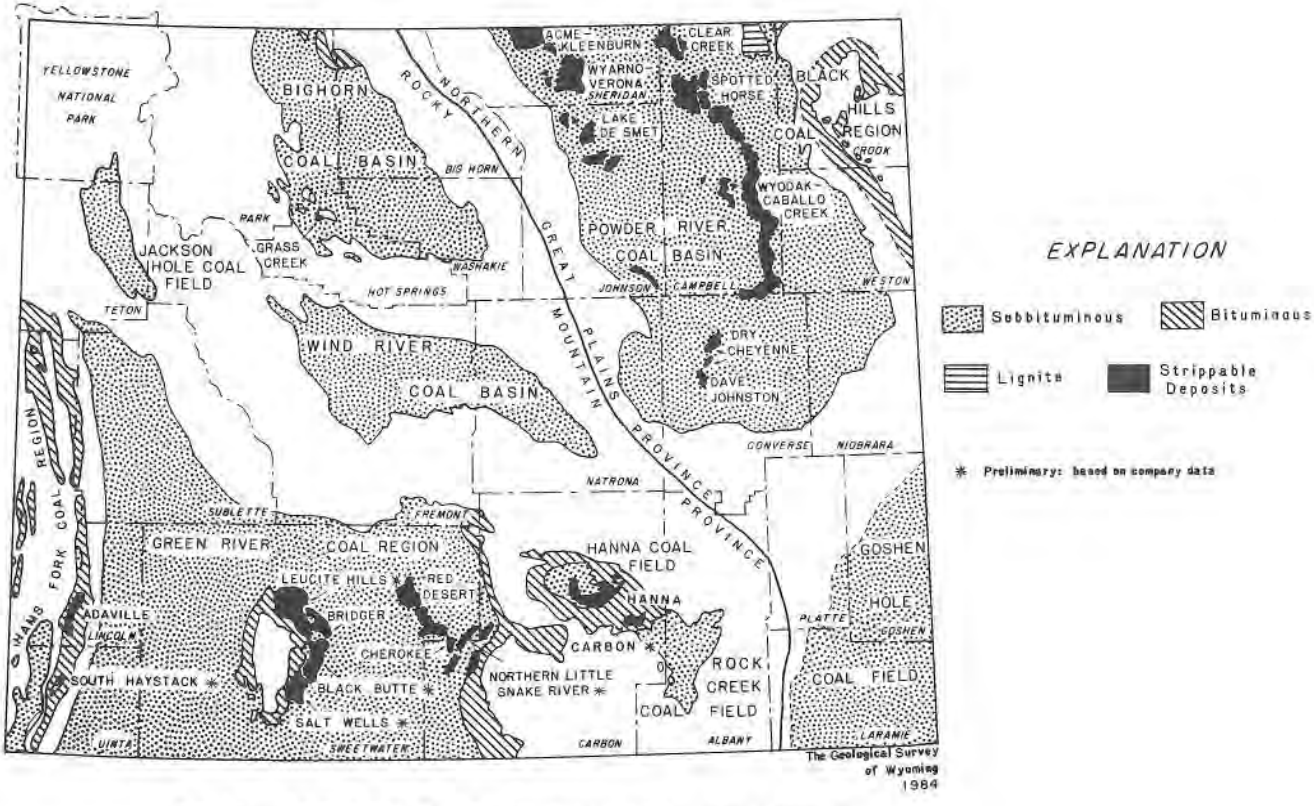
[2] Source: Wyoming State Mine Inspector's Annual Report

140.4 million tons produced last year is some five million tons less than our last prediction (Wyoming Geo-Notes No. 9, p. 24), it still represents a gain of ten million tons or a seven percent increase over last year's record 130.9 million tons. An overall decrease in unreported monthly tonnage (see the Figure on page 32) accounted for our overestimate.

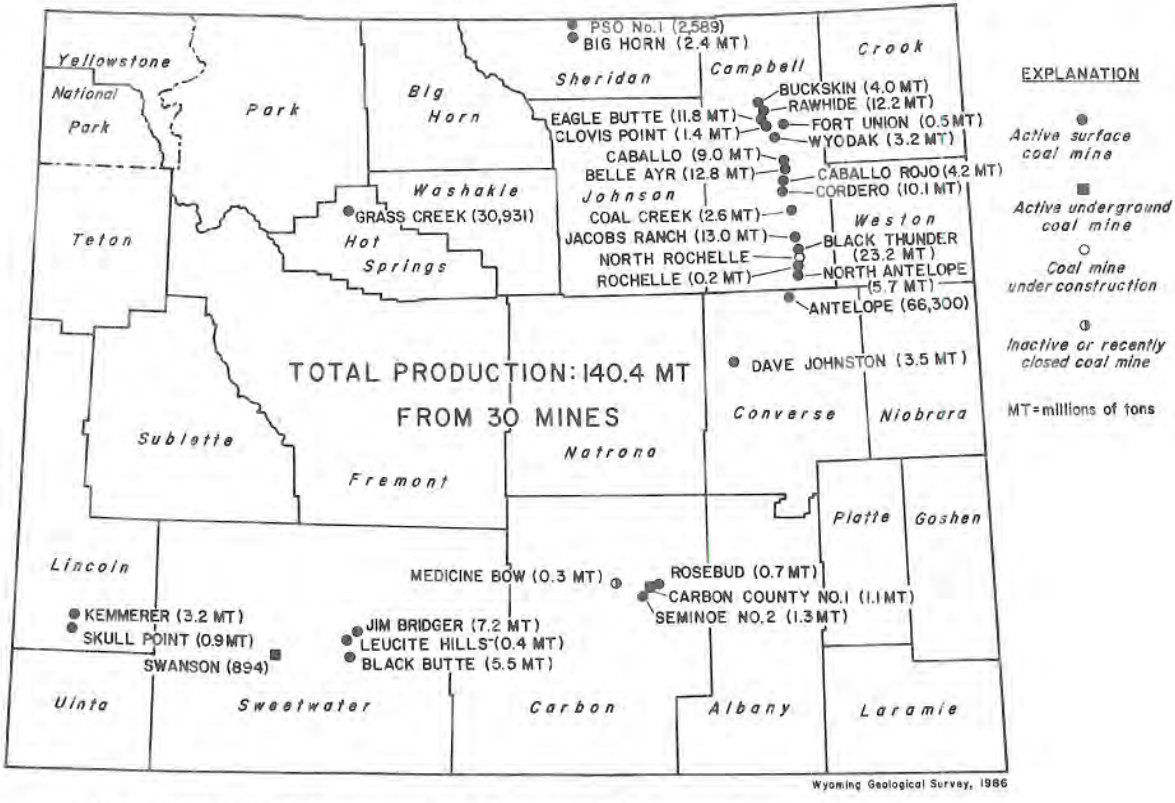
Coal production from Powder River Basin mines was up over seven million tons from 1984; nearly all this increase was in Campbell County. Oddly enough, Powder River Basin mines produced a smaller percentage of the State's coal in 1985 (85.4 percent) than in 1984 (86.2 percent). This is due to a 47 percent production increase (about 4.2 million tons) in Sweetwater County from 1984 to 1985 which resulted in Sweetwater County's increased share of the State's total production. This increase in the Green River Basin more than offset a 35 percent decrease (1.5 million tons) in Carbon County (Hanna Basin), and a slight decrease in both Lincoln County and Hot Springs County. Production from Carbon County is at its lowest level since 1971.

Thirty coal mines (see the Figure page 32) reported coal production in 1985, an increase of two mines over 1984. Campbell County gained one mine with the opening of the Rochelle mine (Peabody) in the extreme northern part of the county, and Sweetwater County gained one mine, the Swanson mine east of Rock Springs. The Swanson mine is a small underground mine that produced bituminous coal for local uses. In addition, one coal augering operation reported tonnage.

In Carbon County only four mines reported production in 1985, one less than in 1984. Arch Mineral Corporation's Seminoe No. 1 mine is no longer a producing mine and is in the final stages of reclamation. The Medicine Bow mine ended production in the Summer of 1985 and is considered inactive (except for reclamation work) at this time. Carbon County Coal Company continues to operate the State's only major underground coal mine.



COAL- BEARING REGIONS OF WYOMING



WYOMING COAL MINES AND PRODUCTION, 1985

Coal production and forecast to 1991 (millions of tons).

	1981[1]	1982[1]	1983[1]	1984[1]	1985[1]	1986	1987	1988	1989	1990	1991
Campbell County	71.6	81.2	88.2	106.8	113.9	122.9	124.4	125.9	127.8	126.6	127.4
Converse County	3.6	3.4	2.7	3.3	3.6	5.0	5.4	6.3	6.3	8.7	8.7
Sheridan County	2.8	3.0	2.9	2.5	2.4	2.0	2.0	1.5	-	-	-
Carbon County	8.5	5.0	4.8	5.1	3.3	2.9	2.4	2.0	1.6	1.1	0.3
Sweetwater County	11.2	11.0	9.5	8.9	13.1	10.7	10.5	10.8	11.2	10.5	10.5
Lincoln County	5.0	4.3	4.0	4.1	4.1	4.5	4.8	5.0	5.1	5.1	5.1
Hot Springs County	M[2]	M	M	M	M	M	M	M	M	M	M
Total Wyoming	102.8	107.9	112.2	130.7	140.4	148.0	149.5	151.5	152.0	152.0	152.0
Annual change	9%	5%	4%	16.5%	7.4%	5.4%	1%	1%	<1%	0%	0%
Estimated contracted production	110.0	119.0	122.6	137.7	145.2	149.2	149.4	151.5	148.6	150.6	151.0
Below contract	7%	9%	8%	5%	3%	1%	0%	0%	-	-	-

[1] These are actual values for comparison. [2]M means minor tonnage (less than 0.1 million tons). Forecast by Geological Survey of Wyoming, March, 1986.

In the Powder River Basin, six mines produced over ten million tons each, with Thunder Basin Coal Company's Black Thunder mine remaining the leading coal producer in the State (and in the Nation) with 23.2 million tons produced in 1985. Carter Mining Company's Rawhide mine recorded a 2.8-million-ton increase in production. Three of the basin's largest mines reported decreased production in 1985; Amax Coal Company's Belle Ayr and Eagle Butte mines were down 0.6 and 1.6 million tons, respectively, and Kerr McGee's Jacobs Ranch mine was down 1.4 million tons. Of the basins's 19 mines, only six reported decreased production in 1985.

Coal mines in Sweetwater County made significant gains in production in 1985. Bridger Coal Company's Jim Bridger mine produced 7.2 million tons of coal in 1985, an increase of nearly three million tons from 1984. Black Butte Coal Company's mine produced 5.5 million tons in 1985, an increase of 1.3 million tons and Prospect Point Coal Company's Leucite Hills mine registered an increase of 0.1 million tons. Coal mines in Lincoln County (eastern Wyoming) and Hot Springs County (Bighorn Basin) reported about the same production in 1985 as in 1984.

1985 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	113,885,439	81.1	15	2,858
Converse	3,574,359	2.5	2	315
Sheridan	2,402,589	1.7	2	202
TOTAL	119,862,387	85.3	19	3,375
		GREEN RIVER BASIN		
Sweetwater	13,124,401	9.3	4	982
		HAMS FORK REGION		
Lincoln	4,063,628	2.9	2	461
		HANNA BASIN		
Carbon	3,343,099	2.4	4	553
		BIGHORN BASIN		
Hot Springs	30,931	<0.1	1	3
TOTAL WYOMING	140,424,446		30	5,374

[1]Source: Wyoming State Inspector of Mines, preliminary data for 1985.

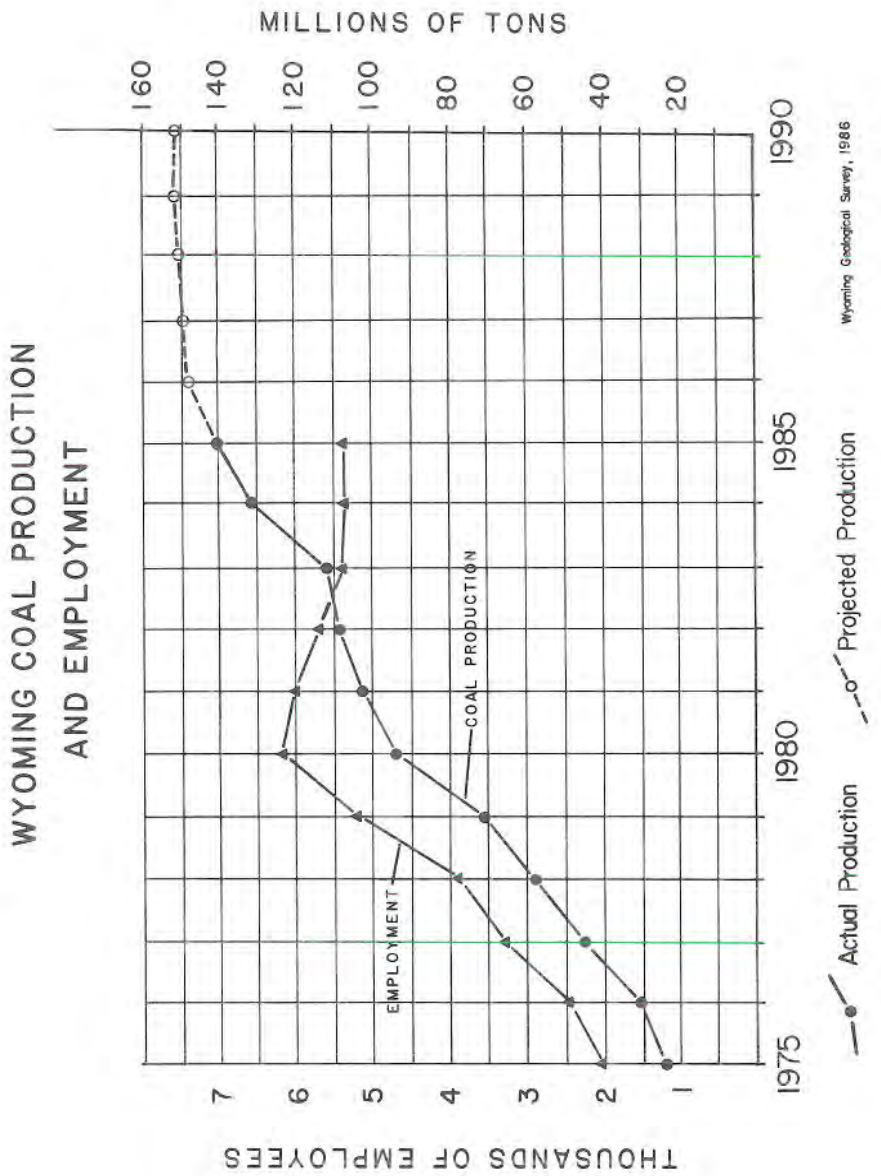
There were 38 more employees working in Wyoming coal mines at the end of 1985 than at the same time in 1984. This is the first year since 1980 that employment in Wyoming coal mines has not decreased (see the Table on page 34). In the Powder River Basin, Campbell County, mines reported 85 more employees, Converse County mines reported 51 more employees and Sheridan County mines reported 19 fewer employees. Overall, the Powder River Basin had 117 more employees in 1985 than in 1984 (see the Table on page 34). Mines in Sweetwater County reported 29 additional employees in 1985; mines in Lincoln County reported only two less employees in 1985; the Hot Springs County mine reported one less employee;

and Carbon County mines reported 105 fewer employees. In 1980, there were almost 1,000 more employees at Carbon County mines than in 1985.

Employment at Wyoming coal mines in 1986, however, may be less than in 1985. Three coal companies announced layoffs in late 1985 and early 1986. Arch Mineral Corporation layed off 23 employees at their Seminoe No. 2 mine in Carbon County on December 1 and furloughed an additional 62 employees on December 18, 1985. In mid-March, however they recalled 14 layed-off miners at the Seminoe No. 2 mine. Big Horn Coal Company announced the layoff of 18 miners in January at their Sheridan County mine. In a related announcement, Decker Coal Company, operator of two Montana mines just north of the Wyoming line near Sheridan, announced that 50 miners would be layed off in May, 1986. Most of the employees at the Decker mines reside in the Sheridan, Wyoming, area. Decker cited "curtailment of coal sales" as the primary reason for their layoffs; Big Horn's layoffs were needed to make their operations "more efficient".

In January, Thunder Basin Coal Company layed off 150 employees at the Black Thunder and Coal Creek coal mines in Campbell County. Thunder Basin Coal Company, owned by Anaconda Minerals Company, a subsidiary of Atlantic Richfield Company, cited a substantial decrease in the amount of overburden to be moved at the Black Thunder mine and the failure to secure additional coal contracts at Coal Creek as reasons for the layoffs. Although these are the largest layoffs to occur in the Powder River Basin, Thunder Basin Coal Company layed off 45 workers (both salaried and hourly) in a reorganization of management in October, 1983. In January, 1986, layoffs reduced Thunder Basin's workforce of about 670 at the two mines by about 22 percent.

Although there have been other layoffs in the Powder River Basin mines in the last few years, the Thunder


WYOMING COAL PRODUCTION
AND EMPLOYMENT
MILLIONS OF TONS
160
140
120
100
80
60
40
20
1975
1980
1985
1990
COAL PRODUCTION
EMPLOYMENT
THOUSANDS OF EMPLOYEES
1
2
3
4
5
6
7
Actual Production
Projected Production
Wyoming Geological Survey, 1986

Basin layoffs were on a much larger scale than previous layoffs and came very suddenly. The layoffs at Black Thunder and other mines has increased mine productivity. Since 1980, with each year's coal production increasing, employment has either declined or only increased slightly (see Table on page 36). For example, in 1980, each employee in a Wyoming coal mine accounted for the production of about 15,000 tons of coal. In 1985, each employee accounted for about 26,000 tons of coal. Although part of this change is explained by the shift in production from southern Wyoming to the Powder River Basin, the demands of current coal markets have forced mines to become more efficient.

In coal contract news, Northern Public Service Company (NIPSCO) purchased 100,000 tons of coal from Carbon County Coal Company (CCCC) in January on the spot market and an additional 100,000 tons of coal in February, also on the spot market. These purchases follow the settlement reached between NIPSCO and CCCC in late 1985 that resulted in cancellation of a long-term contract and an award to CCCC of $181 million in damages. These spot sales are $10 to $15 per ton (delivered) less than the coal prices paid under the rescinded contract. The first shipments to NIPSCO were taken from CCCC's coal stockpile left when mining operations were suspended in October. The additional 100,000-ton spot sale required the underground mine to return to production. Although mining was suspended for a time, none of CCCC's 280 employees were layed off. Work on roof support, maintenance and reclamation continued in the mine during the suspension. NIPSCO and CCCC are continuing negotiations for another long-term contract to replace the rescinded one.

Rochelle Coal Company (a subsidiary of Peabody Holding opened Campbell County's 15th coal mine (Rochelle mine) in the fall of 1985 when it began shipments to Northern States Power Company's generating plants in Minnesota. Rochelle's contract is the first Wyoming coal sold to utilities in Minnesota. The

Rochelle mine also expects to supply Kansas City Power and Light's Hawthorn and Montrose generating plants in Missouri under a 10-year, 11-million-ton contract that was signed in 1985. When these two plants complete the conversions necessary to burn low-sulfur, subbituminous coal, deliveries from Rochelle could start this spring and next winter. The utility hopes to save their customers $45 million in the next two years by using Wyoming coal as well as save another $300 million by eliminating the need for scrubbers on the two plants.

Several other short-term coal contracts have recently been signed with Wyoming producers. Wisconsin Power and Light will purchase one million tons of coal in 1986 from the Black Thunder mine for the Columbia Unit 2 plant at Portage, Wisconsin. Chicago and North Western Transportation Company (C&NW) will haul the coal under a five-year transportation contract with the utility. The Platte River Power Authority (PRPA) is currently negotiating a spot coal contract with Nerco Coal's Antelope mine for 35,000 tons of coal per month during 1986 for the utility's Rawhide plant near Fort Collins, Colorado. This will supplement an existing contract the utility already has with Nerco. Burlington Northern and PRPA have also renegotiated a new seven-year contract for transportation of the coal. Finally, the Lower Colorado River Authority and the City of Austin, Texas, have awarded spot contracts to Carter Mining Company and Thunder Basin Coal Company for the first half of 1986. Carter's Caballo mine will probably furnish 135,000 tons per month while 70,000 tons per month will be furnished by Thunder Basin.

On December 10, 1985, the Interstate Commerce Commission approved C&NW's request to extend their rail line ten miles farther north into the Powder River Basin. In January, Burlington Northern Railroad Company (BN) appealed the decision. If the appeal is denied, construction will begin this spring, and shipments over the new line could start by late 1986. The extension will provide three more Powder River Basin

mines (Caballo Rojo, Belle Ayr and Caballo) with a choice of using either BN or C&NW for coal transportation.

In other coal transportation news, two new contracts for hauling Powder River Basin coal were recently signed. In January, C&NW and Wisconsin Electric Power Company signed a seven-year contract for hauling 1.5 million tons of coal per year from the Powder River Basin to the utility's Pleasant Prairie generating plant in Wisconsin. Although no specific coal mines were mentioned as coal suppliers, it did not include coal supplied from Carter Mining Company's Rawhide mine, which is shipped by BN. The utility currently buys additional spot coal from several other Powder River Basin mines. The Omaha Public Power District recently signed a new 13-year coal transportation contract with BN after intense bidding competition with the rival C&NW/Union Pacific joint venture railroad. The contract calls for transportation of up to two million tons of coal per year from an unnamed Powder River Basin mine (or mines) to the utility's North Omaha and Nebraska City generating plants. The utility has been purchasing coal from Carter Mining Company's Rawhide and Caballo mines on long term contracts and spot coal from Triton Coal Company's Buckskin mine.

In Federal coal leasing developments, it now appears that the moratorium and suspension of the Federal coal leasing program may have ended. The moratorium, which Congress imposed in 1983, followed allegations of mismanagement and improprieties in the program. The program was investigated by a Congressional Commission and the Office of Technology Assessment and, following recommendations of the Commission, modifications in the program were made by the Department of the Interior. Because new environmental assessments will be required, the program will probably not resume until late 1987.

The new coal leasing program is expected to emphasize: Leasing in response to **demand** for coal, as opposed

to leasing in response to "expressions of interest"; accurate appraisal of the Federal coal's value; new procedures at lease sales to encourage competition, to ensure adequate bids and to obtain a fair market value for the coal; more public participation in the entire leasing process; and continuation of the "regional coal team" concept for determining the location of potential lease tracts, the regional coal supply and demand, amounts of coal to be leased and timetables for lease sales.

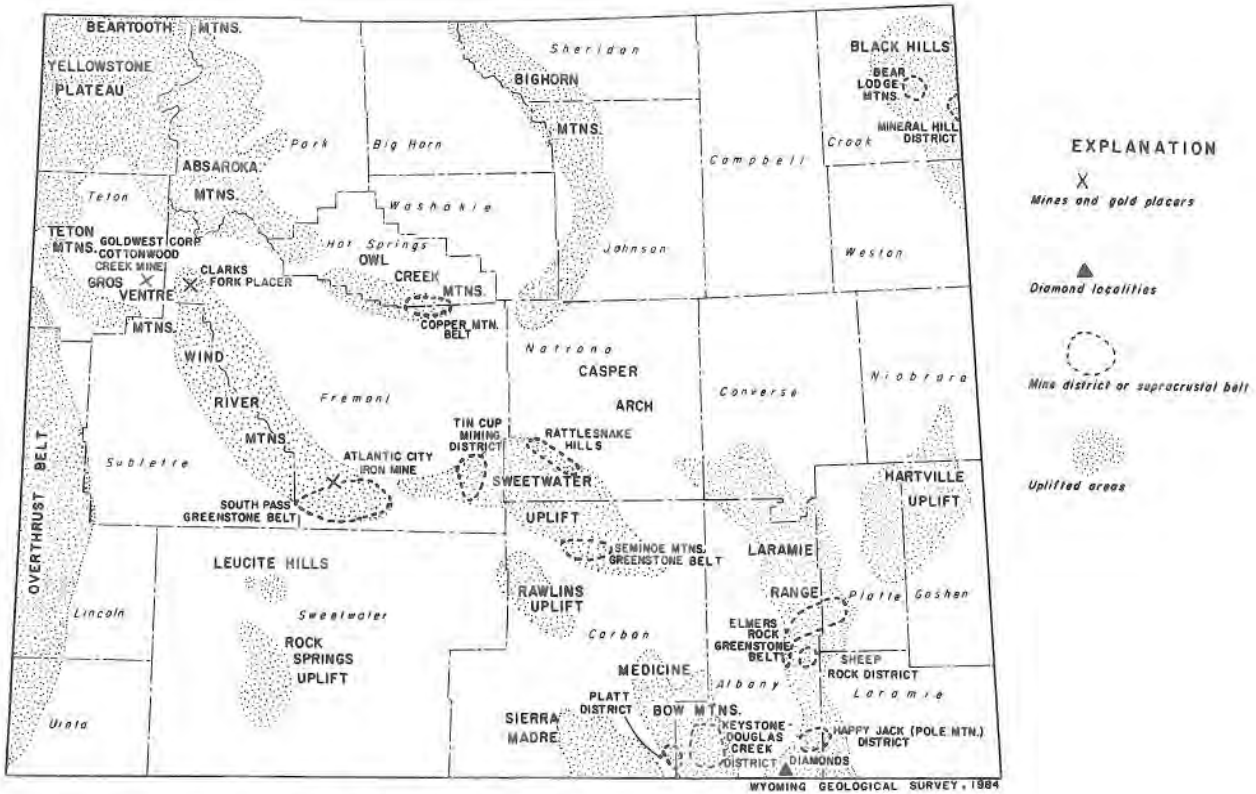
METALS AND PRECIOUS MINERALS UPDATE

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

During the 1985 field season, The Geological Survey of Wyoming mapped several mines in the South Pass region along the southern tip of the Wind River Mountains. Some samples collected for assay from these properties are presented in the Table on page 42.

The great majority of the mines listed in the Table were developed in shear zones in metagreywacke. The Tornado mine is hosted by metabasalts and greenstones, and the Snowbird is a sulfide deposit hosted by amphibolite and meta-andesite. One sample collected from the Snowbird mine by the U.S. Geological Survey in 1974 assayed 0.13 ounce of gold per ton. The mineralized zone in the Snowbird is as much as 50 feet wide, contains abundant carbonate and quartz, and massive pyrite with minor chalcopyrite.

Mines from the Lewiston district commonly produce anomalous gold assays. For example, a grab sample of quartz from the Good Hope mine dump assayed 1.18 ounces of gold per ton. Specimens containing visible gold were also recovered from this property. Of additional interest are banded iron formation samples collected



REGIONS OF EXPLORATION ACTIVITY FOR STRATEGIC MINERALS

from the northeastern edge of the district that contained detectable gold.

The Lewiston district may be Wyoming's least known gold district. Historic records on the district are few. The principal gold deposit at Lewiston occurs in silicified shear zones hosted by Archean metagreywacke of the Miners Delight Formation. Mineralized shears are conformable to regional foliation, whereas crosscutting shears are unmineralized.

In addition to the samples reported in the Table on page 42, channel samples taken in the Diana mine of the South Pass-Atlantic City district showed the Diana vein to average 0.13 ounce of gold per ton.

Selected assays from the South Pass greenstone belt.

Mine	District	Gold (oz/ton)	Gold (ppm)	Silver (oz/ton)	Silver (ppm)	Copper (%)
Gold Leaf	Lewiston	1.29	--	<0.01	--	--
Iron Duke	Lewiston	0.21	--	<0.01	--	--
Hidden Hand	Lewiston	0.05	--	<0.01	--	--
Good Hope	Lewiston	1.18	--	<0.01	--	--
Wolf	Lewiston	0.68	--	0.01	--	--
Lewiston iron-formation	Lewiston	<0.01-0.04	--	<0.01-0.1	--	--
Franklin	SP-AC*	0.50	--	--	--	--
Caribou	SP-AC	0.33	--	--	--	--
B&H	SP-AC	<0.01	--	0.16	--	--
S 1/2, Sec. 2, T.29N., R.100W.	SP-AC	0.45	--	<0.01	--	--
Rose	SP-AC	0.01	--	0.02	--	--
Sec. 32, T.29N., R.100W.	SP-AC	0.09	--	0.01	--	--
Dexter	SP-AC	0.01	--	0.02	--	--
Monarch	SP-AC	--	8.8	--	0.2	--
Smith Gulch	SP-AC	--	2.3	6.31	--	--
Outpost	SP-AC	--	1.3	--	0.2	--
Outpost	SP-AC	--	0.9	--	8.2	--
Snowbird	SP-AC	--	0.32	--	0.8	--
Tornado	SP-AC	0.45	--	--	10.0	1.68
Midas	SP-AC	--	0.405	--	--	--
Anderson Ridge Fault	Anderson Ridge	--	2.3	--	<0.2	1.86
Burnt Meadow	Anderson Ridge	--	4.0	3.03	--	2.75
Sec. 32, T.29N., R.101W.	Anderson Ridge	--	3.4	--	4.4	1.54

**SP-AC is the South Pass-Atlantic City district.*

Recently, Cominco American, Incorporated donated to the State of Wyoming approximately two-thirds of the diamonds that they recovered from Wyoming State lands during their exploration project in 1980 and 1981. At least 126 diamonds totaling 15.38 carats were recovered from State land. Diamonds were also recovered from adjoining Union Pacific lands, but no production records are available. Of the diamonds recovered from State property, forty-seven percent are gem quality. Weight of the recovered diamonds range from less than 0.1 carat to 0.86 carat.

1985 MINERAL EXPLORATION IN WYOMING - A RECAP

by Richard W. Jones, Ray E. Harris, and W. Dan Hausel

COAL

Wyoming coal exploration continued but at an even lower level than that experienced in 1984. Although the 140.4 million tons of coal produced in the State in 1985 represents an increase of seven percent over 1984's production and ranks the State second in the U.S. in coal production, the growth is not contributing to increased exploration. Low coal prices, a soft coal market and a large productive overcapacity, coupled with large amounts of known (explored) but uncommitted reserves, have all decreased the incentives and the need for exploration.

Exploration of Federally-owned coal was quite limited; no new exploration licenses (for exploration of unleased Federal coal) were issued; only two exploration licenses, covering 873 acres, were active during the year; and five licenses, covering 21,410 acres expired. Of the two active licenses, exploration on only one was completed: Black Butte Coal Company con-

ducted a drilling project on 640 acres in Sweetwater County. The other active license in 1985 was held by Texas Energy Services, Inc. in Campbell County.

The U.S. Bureau of Land Management, operating a drill rig out of Casper, drilled 44 coal exploration holes on Federal coal for a total of 20,072 feet in 1985. In the Casper District (Powder River Basin), 16 holes were drilled for a total of 7,272 feet. In the Rawlins District, 28 coal exploration holes totaling 12,800 feet were drilled. Of these totals, 544 feet of core from 12 core holes were recovered. Most of the recovered cores were coal and were used for chemical analysis.

The amount of coal exploration drilling by private industry is not presently available. Although the State of Wyoming's Department of Environmental Quality receives this exploration data, the drill hole completion report (upon which this data is based) can be submitted within a year after drilling is completed. Consequently, accurate data for 1985 will not be available until late 1986. Data from previous years are available and indicate that exploration drilling (which excludes development drilling in advance of mining) decreased from 1,094 drill holes totaling 203,869 feet in 1983 to 576 drill holes totaling 131,776 feet in 1984. It is expected that the amount of exploration drilling in 1985 was about the same as that in 1984.

URANIUM

There was little exploration for uranium in Wyoming in 1985. There was no exploration drilling during the year, other than for assessment purposes. One company reportedly conducted surface studies of Oligocene and Miocene units in east-central and southeastern Wyoming.

The Geological Survey of Wyoming continued its study of nonconformities in Wyoming as hosts for nonconform-

ity-related deposits similar to those in the Athabasca region of Canada and the Pine Creek geosyncline of Australia. Uranium gamma radiation anomalies have been located in several areas of Wyoming associated with nonconformities in which the overlying unit is permeable sandstone. The preliminary report on this project is in press as an article in Geological Survey of Wyoming Public Information Circular 25, pages 66-83.

The Geological Survey of Wyoming also published two aids to uranium exploration geologists in 1985. An open file map at a scale of 1:500,000 (No. 85-6) locates uranium mines and uranium and thorium occurrences in the State. The background gamma radiation (from surface information) of the Torrington 1° x 2° Quadrangle was published as Open File Report 85-9, and includes locations of anomalous readings detected during the study.

At year's end, a letter of intent to fund a five-year $25 million uranium exploration program was signed by Taipower (Taiwan) and Rocky Mountain Energy Company. Presumably some exploration under this venture will be conducted in Wyoming in coming years.

INDUSTRIAL MINERALS

There was exploration activity in Wyoming for certain industrial minerals. However, producers of trona and bentonite, the major industrial minerals mined in Wyoming, are coping with reductions in demand, and conducted little exploration for new deposits.

There was much activity in Wyoming in exploration for natural sulfur deposits in 1985. Several companies conducted surface studies and appraisals of natural sulfur deposits in the Thermopolis, Cody and Auburn areas in western Wyoming. Property was acquired and proposed mining plans were announced by the Continental Sulphur Company for the Cedar Ridge sulfur deposits

west of Thermopolis.

Clay was needed in the Laramie area to construct an impermeable structure to divert the Laramie River around a toxic waste site. Following exploration of several sites, a pit was opened to provide the necessary clay.

The Burlington Northern and Chicago and North Western railroads conducted exploration and testing programs for railroad ballast in Wyoming in 1985. Both lines are looking for a local source of durable rock to replace rock imported into the region from eastern South Dakota, Minnesota and Oklahoma. Both railroads concentrated their search in the Hartville uplift area of east-central Wyoming, near the new rail lines into the Powder River Basin coal fields.

Limestone continued to be a major target of exploration in Wyoming in 1985. Most of the search was directed toward highway construction aggregate uses. The Monolith Portland Cement Plant at Laramie was acquired by Centex, Inc., which conducted an exploration drilling program in 1985. Centex announced additional reserves as a result of this exploration program early in 1986.

The search for durable construction aggregate supplies in the Powder River Basin area increased in 1985. Clinker (baked and fused rock) sources were explored and developed and plans were made to transport limestone aggregate into the area from the basin margin. The Geological Survey of Wyoming published three 1:125,000 scale maps of clinker in the Powder River Basin; Gillette (Open File Report 85-5), Sheridan (Open File Report 85-7) and Newcastle (Open File Report 85-8).

METALS AND PRECIOUS STONES

Gold exploration focused on the South Pass granite-greenstone terrain along the southern tip of the Wind River Mountains of western Wyoming. South Pass is a fragmented Archean supracrustal belt and has been Wyoming's most important source for gold and iron ore.

At least three major exploration firms had projects in South Pass during 1985, but sampling and drilling activities by Freeport Exploration were the most visible. The Geological Survey of Wyoming continued mapping the terrain and all accessible underground mines in an effort to produce a regional map of the greenstone belt, and to categorize the gold deposits. Nearly every sample collected by the State Survey in the greenstone belt showed anomalous gold.

The Garrett gold deposit in the central Laramie Range of southeastern Wyoming was put up for sale by Anaconda Minerals during 1985. The deposit is untested, but occurs as a stratiform deposit localized along the contact between micaceous quartzite and amphibolite. One select sample of arsenopyrite-berthierite-bearing quartz collected by the Geological Survey of Wyoming assayed 0.25 ounce of gold per ton.

Some gold exploration was also reported in the Hartville uplift and Black Hills of eastern Wyoming, and in the northern Medicine Bow Mountains of southeastern Wyoming. Gold exploration in the Medicine Bow Mountains was designed to test for Witwatersrand-type paleoplacer gold. At the old Copper King property in the southern Laramie Range of southeastern Wyoming some interest was shown for a shallow low grade, large tonnage gold deposit.

Exploration for diamond mineralization continued in the Colorado-Wyoming State Line district of southeastern Wyoming and northern Colorado. In addition the Geological Survey of Wyoming located dozens of anoma-

lous stream sediment samples and one diatreme-like structure in the Pole Mountain-Happy Jack area of the southern Laramie Range.

In the Green River Basin of southwestern Wyoming, the Survey is sampling ultrapotassic lamproite plugs in the Leucite Hills for diamond. South of the Leucite Hills, the source of scattered detrital mantle minerals (pyrope garnet and chrome diopside) found in ant hills is being looked for by the Survey.

At the end of 1985, AMAX announced plans to sell their Kirwin porphyry deposit in the Absaroka Mountains of northwestern Wyoming. The Kirwin deposit has proven reserves of 75 million tons of ore averaging 0.75 percent copper and 0.015 percent molybdenum with minor lead, zinc, gold and silver.

Papers on metallic minerals or precious stones published or submitted for publication by the Geological Survey of Wyoming in 1985 included:

Harris, R.E., Hausel, W.D., and Meyer, J.E., 1985, Metallic and industrial minerals map of Wyoming: Geological Survey of Wyoming Map Series MS-14.

Hausel, W.D., 1986, Preliminary report on the geology and gold mineralization of the South Pass granite-greenstone terrain, Wind River Mountains, western Wyoming (USA) *in* Workshop on the tectonic evolution of greenstone belts: Lunar and Planetary Institute, Houston, in press.

Hausel, W.D., 1986, Preliminary report on the geology and gold mineralization of the South Pass greenstone belt, Wind River Mountains, Wyoming: Society of Mining Engineers of AIME Preprint 86-15, 10 p.

Hausel, W.D., Graff, P.J., and Albert, K.G., 1985, Economic geology of the Copper Mountain supracrustal belt, Owl Creek Mountains, Fremont County, Wyoming:

Geological Survey of Wyoming Report of Investigations 28, 33 p.

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

STAFF CHANGES

In late January, two staff geologists of the Geological Survey of Wyoming switched responsibilities. Alan J. VerPloeg, formerly the Staff Oil and Gas Geologist, took over the Survey's Stratigraphy Section. Mr. VerPloeg will continue the current field mapping project in the southern Bighorn Mountains started last year by the Stratigraphy Section. He is also assembling a summary of ongoing geologic studies in Wyoming which were acquired through a questionnaire sent out late last year.

Rodney H. DeBruin, formerly the Survey's Stratigrapher, has taken over the Oil and Gas Section of the Survey. Mr. DeBruin has begun computerization of data on oil and gas production and reserves. This information will complement existing data used to make forecasts by expediting the manipulation of the data.

WYOMING DIAMONDS ON EXHIBIT

In 1975, some dust-size microscopic diamond particles were accidentally discovered in rocks that came from an area 20 miles south of Laramie, near Tie Siding. At the time, the discovery was thought to be only a scientific curiosity and of no economic interest. Later, research and exploration by the Geological Survey of Wyoming, Colorado State University and the University of Wyoming uncovered many new kimberlite

diatremes - the host rock of the diamonds. Today, about 100 of these kimberlite diatremes, or "diamond pipes", have been discovered in Colorado and Wyoming, and at least 16 contain diamonds.

Intrigued by the possibility of commercial diamond deposits, one mining company started a small mining operation in Wyoming, and in 1980 and 1981, identified low-grade diamond resources. A short time later, similar activity began south of the Wyoming State Line, in Colorado.

Through 1982, Cominco American Incorporated processed nearly 9,000 tons of kimberlite in Wyoming, and recovered as much as 0.01 carat per ton (average commercial diamond deposits contain about 0.25 carat per ton). In Colorado, Superior Minerals Company recovered nearly 0.2 carat per ton.

At least 126 diamonds totaling 14.38 carats were recovered from Wyoming State lands. Forty seven percent were gem quality and an unusually high proportion had good colors. Weight of the recovered diamonds ranged from less than 0.1 carat to 1.0 carat.

Approximately two-thirds of the diamonds recovered from State land were recently given to the State of Wyoming. Thirty-two of these diamonds, samples of kimberlite, and other rare kimberlite minerals will be displayed at the **BASKO BUILDING** (Oil and Gas Conservation Commission offices at 777 West First Street, Casper) to commemorate the historic discovery of diamonds in our State.

The display will be in the **BASKO BUILDING** from 12 noon to 5 p.m. on April 7th and 8 a.m. to 1.30 p.m. on April 8th. Interested persons are invited to attend.

For more information call W. Dan Hausel at 766-2286, 742-2054, or 721-3920.

RECENT AND NEW PUBLICATIONS BY THE GEOLOGICAL SURVEY OF WYOMING

Geologic map showing the present configuration of the Heart Mountain fault and related features, Wyoming and Montana, by W.G. Pierce, Map Series MS-15, 1:125,000 scale, color, 1985 ($4.00).

Oil and gas potential of the Washakie (South Absaroka) Wilderness and adjacent roadless areas, Wyoming, by J.D. Love, Report of Investigation 33, 1985, ($3.00).

Preliminary report and map on potentially seleniferous areas in Wyoming, by J.C. Case and C.S. Boyd, 1985 ($3.50).

**Geologic map of Devils Kitchen Quadrangle, Wyoming*, by C.C. Reppe, Map Series MS-18, 1:24,000 scale, color, 1986, ($3.00).

**Geologic map of Greybull North Quadrangle, Wyoming*, by L.M. Kozimko, Map Series MS-19, 1:24,000 scale, color, 1986, ($3.00).

**Geologic map of Sheep Canyon Quadrangle, Wyoming*, by R.E. Ladd, Map Series MS-19, 1:24,000 scale, color, 1986, ($3.00).

**Bibliography and index of graduate theses and dissertations of the Department of Geology and Geophysics, University of Wyoming*, compiled by J. Battisti, J. French, and R.H. DeBruin, 1986, (free).

**Metallic and nonmetallic deposits of Wyoming and adjacent areas, 1983 Conference Proceedings*, edited by Sheila Roberts, Public Information Circular 25, 1986, ($8.00).

* New releases since the last issue of *Wyoming Geonotes*.

Order these and other publications from: Geological Survey of Wyoming, Box 3008, University Station, Laramie, Wyoming 82071. Phone: (307) 766-2286.

Add $1.00 for each $5.00 of purchase price if mailed First Class ($1.00 minimum). Add an additional $1.50 for maps mailed rolled.

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