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

# WYOMING GEO-NOTES NO. 8

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WYOMING GEO-NOTES

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*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.

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# MINERALS UPDATE

## OVERVIEW

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

With nine months of the year over, the mineral picture for Wyoming has changed slightly from last quarter. The price of oil has held up better than many persons predicted and will probably be little more than $1.00 below last year's price. Oil production in 1985, however, is unlikely to match last year's production as production declines in the larger, older fields outpace production gains from new discoveries and smaller fields. The decline in State production was expected, but it had been hoped that it would not start until 1986; drilling activity is noticeably down as well.

Construction of Phase I of Exxon's huge Shute Creek gas processing plant is well underway boosting the economy of southwestern Wyoming. Phase II of the plans, though still not certain, has moved a step or two closer to fruition. In addition, the huge carbon dioxide and methane reserves of the Riley Ridge Field are now complemented by Federal approval for Exxon to market helium reserves which will be produced with the other gases (page 25). Couple this with a growing demand for sulfur derived from associated hydrogen sulfide gas in the field, and the added value of the by-products is obvious.

Marathon's North Fork well between Cody and Yellowstone National Park proved to be a dry hole. Its drilling, however, not only demonstrated the viability of helicopter mobilization in the State, but geologic data gleaned from the well will provide much needed information in this relatively unexplored portion of the State. Potentially oil-bearing rocks in the area are covered by a thick veneer of volcanic rocks.

*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 | 125.0 | 630.0 | 143.0 | 11.3 | 0.9 |
| 1986 | 124.0 | 675.0 | 148.0 | 11.4 | 0.3 |
| 1987 | 122.0 | 715.0 | 149.5 | 11.5 | 0.3 |
| 1988 | 120.0 | 800.0 | 151.5 | 11.6 | 0.3 |
| 1989 | 118.0 | 825.0 | 152.0 | 11.7 | 0.3 |
| 1990 | 116.0 | 875.0 | 152.0 | 11.8 | 0.3 |
| 1991 | 114.0 | 925.0 | 152.0 | 12.1 | 0.3 |

*Actual values for comparison, [1] Geological Survey of Wyoming, September, 1985, [2] in millions of barrels, [3] in billions of cubic feet, [4] in millions of tons.

Coal production is considerably above earlier predictions and may well reach or exceed 143 million tons - a 9.5 percent increase over the record 130.7 million tons mined in 1984 (pages 2 and 5). Coal prices are apparently still falling and are likely to be 18-20 cents below 1984 as inexpensive spot sale prices lower the average price per ton.

The Wyoming coal industry continues to look at processes to upgrade the heat value of its delivered product, which if successfully implemented, could help offset a myriad of negative factors facing its marketability in the future (page 8). At the same time, however, the largest coal mine in Sheridan County announced it may close around 1988 for lack of markets (page 13).

A new wrinkle in coal contract activity has also appeared. A utility subsidiary responsible for coal purchases is reportedly about to declare bankruptcy. Should this occur, existing coal contracts that total an estimated ten million tons, could be in jeopardy. Even more important, similar actions by other purchasing subsidiaries could affect an even greater number of contracts. Although contracts voided by such actions would likely be renegotiated with Wyoming coal producers, the contract prices could be substantially below the existing contracts, thus reducing the value as well as the taxes and royalties derived from future production.

Another uranium mine is slated to close by the end of the year, leaving only two active mines. Production forecasts for uranium production, already dismally low,, now reflect even less production in 1986.

The land exchange between the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service is undergoing many changes, but still remains a possibility. In particular, a plan to turn the Bighorn National Forest over to BLM is no longer as likely to happen.

Congress is still arguing over revisions in the Federal oil and gas leasing procedures. A wholly competitive system now seems less likely, and Governor Herschler's three-tiered procedure continues to find favor although many believe it is too complicated for BLM to manage.

In regard to coal, a new Administration plan, which seeks to make companies pay the regulatory costs of implementing the U.S. Office of Surface Mining's reclamation activities, also recently surfaced. It has met with considerable opposition from industry as well as the State.

## COAL UPDATE

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

The latest coal production forecasts for the State indicate that 1985 production will be at least 143 million tons; production by 1988 will be about 151.5 million tons (page 5). Campbell and Converse Counties will account for the major production increases. Sheridan and Carbon Counties are expected to show production decreases through the remainder of the 1980's and unless new markets develop for the mines in these counties, coal production will either decrease to less than one million tons a year or cease entirely by the mid-1990's. Sweetwater County is expected to experience a slow, steady growth into the next century while Lincoln and Hot Springs Counties will probably maintain current production levels.

Coal prices will probably remain low for the next few years because of the large amount of overcapacity at most Powder River Basin mines, and the high degree of competition that will exist for a limited number of new coal contracts. The overcapacity will be accentuated as additional coal mines in southern Campbell

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

| | 1981[1] | 1982[1] | 1983[1] | 1984[1] | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Campbell County | 71.6 | 81.2 | 88.2 | 106.8 | 118.7 | 122.9 | 124.4 | 125.9 | 127.8 | 126.6 | 127.4 |
| Converse County | 3.6 | 3.4 | 2.7 | 3.3 | 3.3 | 5.0 | 5.4 | 6.3 | 6.3 | 8.7 | 8.7 |
| Sheridan County | 2.8 | 3.0 | 2.9 | 2.5 | 2.9 | 2.0 | 2.0 | 1.5 | - | - | - |
| Carbon County | 8.5 | 5.0 | 4.8 | 5.1 | 3.2 | 2.9 | 2.4 | 2.0 | 1.6 | 1.1 | 0.3 |
| Sweetwater County | 11.2 | 11.0 | 9.5 | 8.9 | 11.0 | 10.7 | 10.5 | 10.8 | 11.2 | 10.5 | 10.5 |
| Lincoln County | 5.0 | 4.3 | 4.0 | 4.1 | 3.9 | 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 | 143.0 | 148.0 | 149.5 | 151.5 | 152.0 | 152.0 | 152.0 |
| Annual change | 9% | 5% | 4% | 16.5% | 9% | 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% | 2% | 1% | 0% | 0% | - | - | - |

[1] These are actual values for comparison. [2]M means minor tonnage (less than 0.1 million tons). Forecast by Wyoming Geological Survey, September, 1985

County and northern Converse County begin production in the next few years. Unless large new contract tonnages are added (or coal contracts are taken from neighboring states) in the next few years, Powder River Basin growth will begin to level off. By 1992, additional coal will be needed to meet new demands for coal-fired generating units and hopefully, many of these new coal supply contracts will be signed with Wyoming mines.

Estimates of the amount of future coal-fired electrical-generating capacity needed in the middle to late 1990's, as well as the annual growth rate in electric power demand, are currently being revised upward over projections made in the period 1982-1984. These earlier projections, made during times of very low or even negative growth rates in electricity demand, were influenced by several factors, including the downturn of the economy, an increase in conservation and efficiency of energy usage, an excess electrical-generating capacity, and perhaps an unrealistic view of the part that new technologies and alternative energy sources might play in solving future energy needs. During the period 1982-1984, excessive generating capacity (brought about by the start-up of power plants completed in the late 1970's and early 1980's -- which were planned during times when growth rates were three times today's rates) plagued the electric utility industry and caused the cancellation and postponement of nearly 90 (or more than half) of the new coal-fired units planned for the late 1980's and early 1990's (McGraw-Hill, 1985a).

Although excess generating capacity still exists today, this may only be a relatively short-term phenomenon. A rapid upturn in the economy in the last two years has brought about an increase in electric power demand that now exceeds three percent annually (compared to an average annual increase of nine percent for the years 1900 to 1980) (Energy Information Administration, 1985a, p. 1). Much of this new demand will be taken up by the start-up of new nuclear-powered generating plants in the next few years; coal-fired

REPORTED DELIVERED TONNAGE[1]

| | 1983 MONTHLY | 1983 CUMULATIVE | 1984 MONTHLY | 1984 CUMULATIVE | 1985 MONTHLY | 1985 CUMULATIVE |
|---|---|---|---|---|---|---|
| JANUARY | 10,313.0 | 10,313.0 | 9,540.2 | 9,540.2 | 11,601.2 | 11,601.2 |
| FEBRUARY | 8,719.7 | 19,032.7 | 9,654.6 | 19,194.8 | 10,473.9 | 22,075.1 |
| MARCH | 9,051.2 | 28,083.9 | 0,875.0 | 30,069.8 | 11,674.9 | 33,750.0 |
| APRIL | 8,195.0 | 36,278.9 | 8,721.4 | 38,791.2 | 11,632.8 | 45,382.8 |
| MAY | 8,364.6 | 44,643.5 | 9,481.5 | 48,272.7 | 11,497.9 | 56,880.7 |
| JUNE | 8,330.2 | 52,973.7 | 9,464.5 | 57,737.2 | 11,692.2 | 68,572.9 |
| JULY | 8,734.7 | 61,708.4 | 11,019.6 | 68,756.8 | | |
| AUGUST | 9,669.3 | 71,337.7 | 11,433.0 | 80,189.8 | | |
| SEPTEMBER | 9,189.7 | 80,567.4 | 10,440.0 | 90,629.8 | | |
| OCTOBER | 9,406.3 | 89,973.7 | 10,492.5 | 101,122.3 | | |
| NOVEMBER | 9,013.6 | 98,987.3 | 11,814.2 | 112,936.5 | | |
| DECEMBER | 7,680.6 | 106,667.9 | 11,486.8 | 124,423.3 | | |
| TOTAL | 106,667.9 | | 124,423.3 | | | |

TOTAL TONNAGE NOT REPORTED[2]

| | |
|---|---|
| 5,520.0 | 6,322.5 |

TOTAL TONNAGE PRODUCED[3]

| | |
|---|---|
| 112,187.9 | 130,745.8 |

1 Source: *National Marketing Reports* by Coal Marketronix, compiled from FERC Form 423 filed monthly by electric utilities.

2 Includes industrial, residential/commercial, and smaller utility sales.

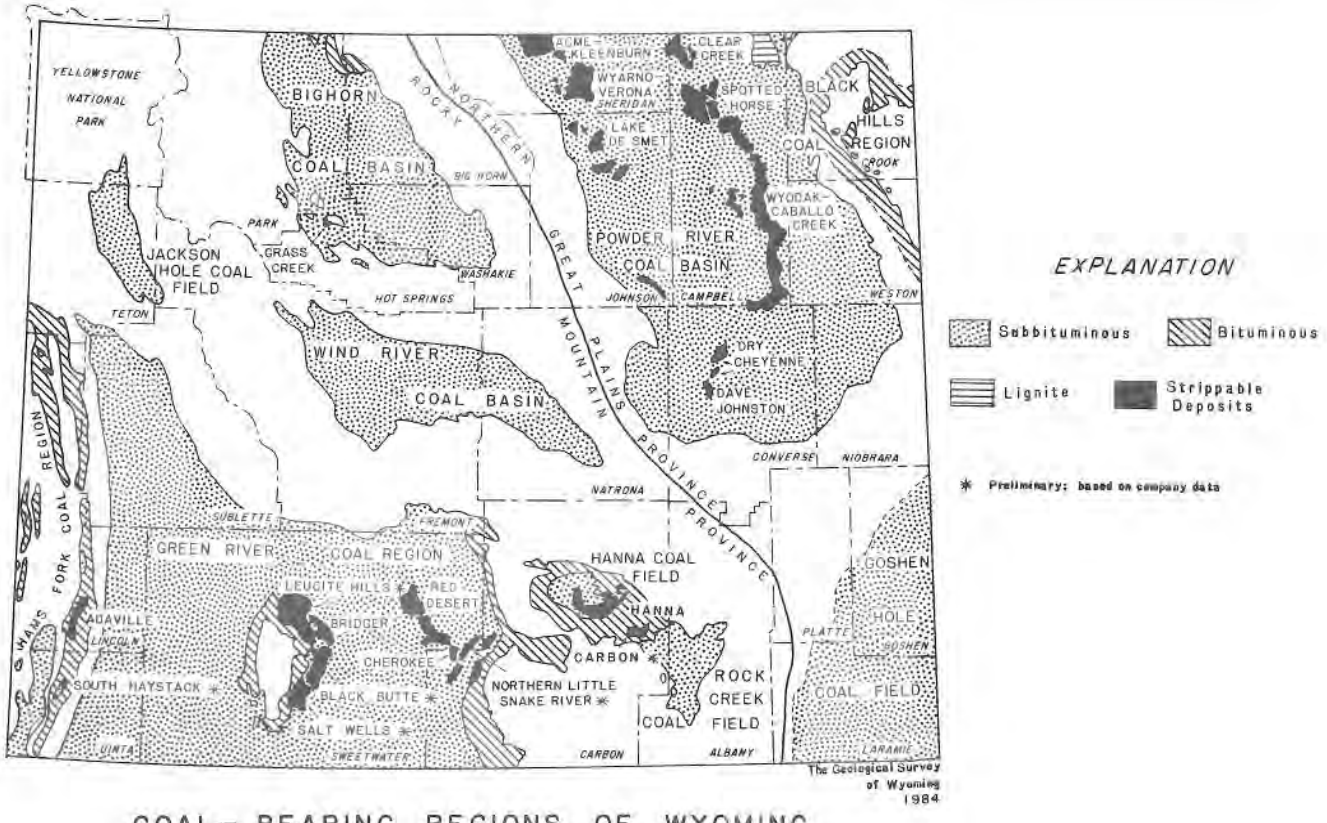
3 Source: Wyoming State Mine Inspector's Annual Report for 1983 and for 1984.

plants will take up an estimated 35 percent of this new demand (McGraw-Hill, 1985b).

Most market analysts for the coal and utility industries are now convinced that new coal-fired generating capacity will be needed to meet the demand by the mid-1990's. An estimate of future electrical demand by Data Resources Inc. (DRI) concluded that between 1988 and 2005, 34,692 megawatts of power will come from new coal-fired units, but more than three times this amount, or 115,232 megawatts, will be needed over this same period of time (McGraw-Hill, 1985b). Other analysts are also predicting that by the early and middle 1990's, electric power shortages may occur in many parts of the United States. Clearly, the planning and construction of new coal-fired power plants, which often takes from 5 to 15 years to complete, must begin now if projected power demands in the 1990's are to be met. Because almost 98 percent of Wyoming's coal is used to fuel steam-electric generating plants, the State's coal production is more likely to increase than decline after the mid-1990's.

Factors that may affect the State's coal industry in the future include foreign competition, transportation costs, changes in both State and Federal coal royalty and mineral tax structures, resumption of Federal coal leasing, Congressional action (or inaction) on coal-related regulations, State and Federal regulations on nitrogen and sulfur emissions from power plants as acid rain control measures, possible breakthroughs in coal burning and electricity generation technology that will allow greater flexibility in choice of coal types (e.g. high sulfur vs. low sulfur coal), the influence of world oil prices on the choice of fuels for electricity generation and industrial applications, and possible breakthroughs in coal beneficiation prior to shipping.

In this latter case, Powder River Basin coal companies continued to experiment with ways to upgrade their low-Btu, low-sulfur coal to make it even more

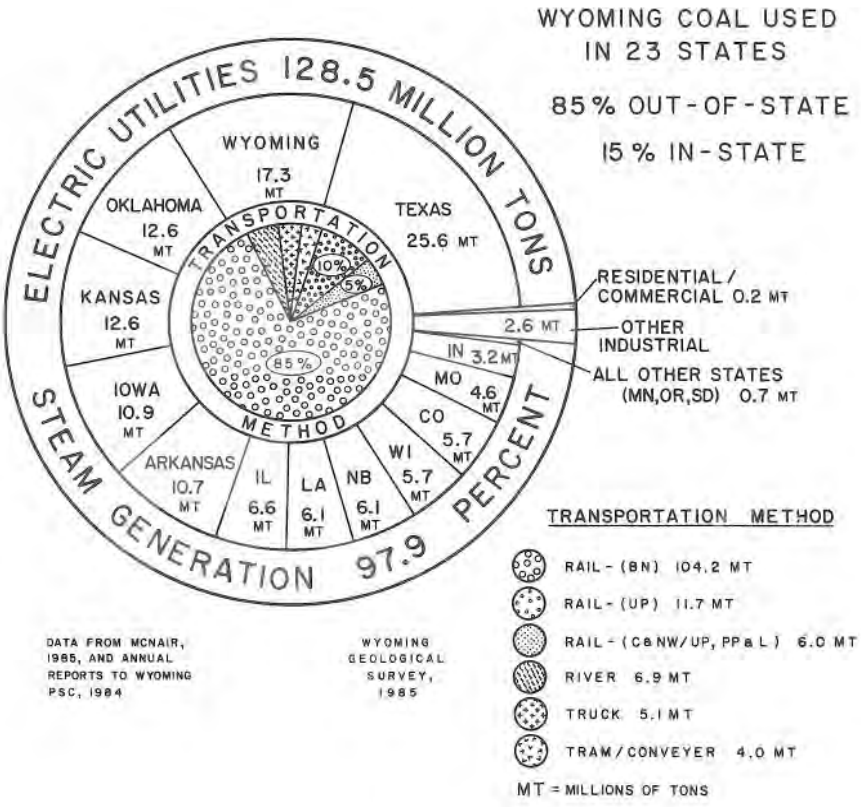



COAL- BEARING REGIONS OF WYOMING

competitive in the market place. By reducing the moisture content of the coal from about 30 percent as-mined to about ten percent as-shipped, the heat value of the coal can be upgraded from an average of 8,400 Btu/pound to about 10,500 Btu/pound. Most companies have examined processes ranging from simple solar drying to the high pressure-high temperature Koppelman process ("K-fuel"). Anaconda Minerals Company (a division of Arco) has developed a process using fluid-bed drying, fluid-bed cooling, and an unspecified proprietary treatment to reduce the dried coal's reactivity. Their process is very promising but has yet to be tested on a commercial scale or on the market place. Fort Union Coal Company, in conjunction with Energy Brothers, Inc. and SRI International, is experimenting with a small commercial-scale unit that uses the patented Koppelman process to produce a high-Btu coal fuel pellet, "K-fuel". Evidently, Wisconsin Power and Light has purchased the first two years output from this plant. Most recently, Mobil Coal Producing, in cooperation with ENI Engineering of Monroeville, Pennsylvania, completed testing a pilot coal-drying unit at the Caballo Rojo mine south of Gillette. This process reportedly produces a 10,500 Btu/pound low-sulfur coal. ENI apparently has several other coal companies interested in the project. Mobil is conducting cost and marketing studies on the process to determine the feasibility of commercial operation.

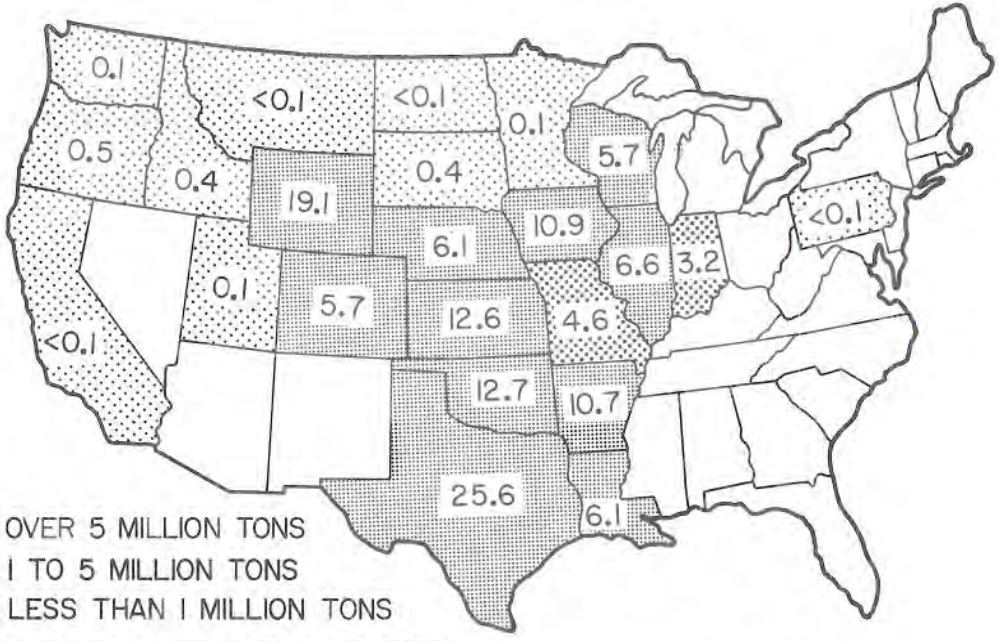
Statistics on the distribution and utilization of Wyoming's 1984 coal production (McNair, 1985) indicate that Wyoming coal was used in 23 States (page 11). As in 1983, Texas was the largest consumer of the State's coal with 25.6 million tons, followed by Wyoming with 19.1 million tons. These two States plus Oklahoma and Kansas used over half the coal produced in Wyoming; 80 percent of the State's production went to only seven different states. Nearly 98 percent of the State's total production in 1984 was used by electric utility companies for power generation and about 85 percent of the State's production was shipped out-of-state (page 11). About 1.8 million tons of the 2.8 million tons in

# UTILIZATION AND TRANSPORTATION OF WYOMING COAL, 1984




"other industrial" and "residential/commercial" categories went to Wyoming users. Most of this coal was used by the State's trona, bentonite, and cement industries. Additional coal was used by sugar beet processing plants and by FMC Corporation's formcoke plant in Lincoln County. FMC's plant converts non-coking coal to formcoke through the company's patented process. About 200,000 tons of coal consumed in

# DISTRIBUTION OF WYOMING COAL, 1984
## (IN MILLIONS OF TONS)




131.2 MILLION TONS DISTRIBUTED TO 23 STATES

0.2 MILLION TONS IMPORTED FROM 4 STATES

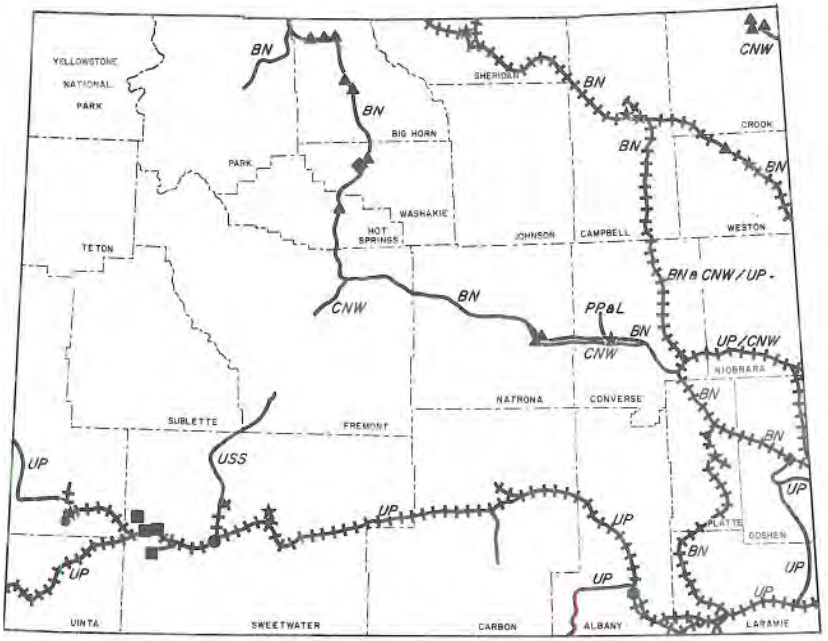
ADAPTED FROM MCNAIR, 1985
WYOMING GEOLOGICAL SURVEY, 1985

Wyoming in 1984 came from Utah, Montana, Colorado, and Pennsylvania.

Over 93 percent of the State's coal production was shipped by rail in 1984, compared to 90 percent in 1983. Burlington Northern Railroad (BN) accounted for about 85 percent of the total rail transportation, followed by Union Pacific (UP) with ten percent. The Chicago and North Western/Union Pacific (C&NW/UP) joint venture railroad, along with Pacific Power and Light Company's (PP&L's) private rail line at Glenrock, accounted for the remaining five percent of the rail tonnage.

In other news involving coal transportation, the C&NW/UP joint venture railroad recently announced the signing of three more coal haulage contracts. The first contract, announced in July, was with Kansas Power and Light for shipment of 1.0 to 1.3 million tons of coal per year from Amax Coal Company's Belle Ayr mine to power plants at Lawrence and Topeka, Kansas. Shipments are due to begin in 1987 and will originate on the C&NW/UP joint venture's new ten-mile long northern extension rail line. The second contract calls for shipment of 1.2 million tons of coal per year from a yet-unnamed Powder River Basin mine to Wisconsin Power and Light's Columbia Unit 2 power plant at Portage, Wisconsin. The third contract calls for shipment of 0.8 million tons of coal per year from Thunder Basin Coal Company's Coal Creek mine to Wisconsin Power and Light's Edgewater Power Plant at Sheboygan, Wisconsin. With the signing of these three coal transportation contracts, the joint venture railroad now has nine signed contracts for the transportation of a total of 20 million tons of coal.

Big Horn Coal Company, a subsidiary of Peter Kiewit, Sons, announced in July that their coal mine northeast of Sheridan could close in 1988 when their contract with Commonwealth Edison expires. The mine has been operating since 1943. This mine produced 2.5 million tons of coal in 1984, employed about 230




## EXPLANATION

- ★ Coal-Fired Electrical Generating Plant
- ■ Trona Plant
- ▲ Bentonite Plant
- ● Synthetic Coke Plant
- ◆ Sugar Beet Plant
- ⬢ Cement Plant

- *UP* Union Pacific R.R.
- *CNW* Chicago North Western Transportation Co.
- *BN* Burlington Northern Inc.
- *USS* United States Steel Co.
- *PPaL* Pacific Power and Light
- Unit Coal Train Route

N

# RAILROAD ROUTES AND MAJOR COAL USERS IN WYOMING

workers (with 20 employees laid off at the end of August), and provided about 46 percent of Sheridan County's assessed valuation. Although the heat value of the coal at the Big Horn mine is much better than that in the "Gillette strip" in Campbell County, the coal beds are thinner, under more overburden, and are more expensive to mine. The Big Horn mine is evidently experiencing the same situation that most of the coal mines in the Hanna Basin face: they cannot compete with the large, efficient, highly productive eastern Powder River Basin mines.

Three additional coal supply contracts have been signed with Wyoming coal mines. Carter Mining Company (Exxon Coal) was recently awarded a contract for 430,000 tons of coal from their Rawhide mine to Grand River Dam Authority's GRDA No. 1 generating plant at Chouteau, Oklahoma. Deliveries are slated from September to December, 1985. The Grand River Dam Authority also awarded Nerco a contract for 70,000 tons of coal from the newly constructed Antelope mine in Converse County. This coal could be the first production shipment from the Antelope mine. An extension of Carter Mining Company's spot contract with the Lower Colorado River Authority and the City of Austin, Texas, was recently signed. It calls for delivery of 200,000 tons of coal from the Caballo mine to the Fayette Power Project between September and December of this year.

Amax Coal Company announced in early September that eleven salaried positions at their Wyoming coal mining operations were being terminated as part of the company's plan to trim 12 percent or 1,500 people from their national workforce by the end of the year. Five people from Amax's Western Division office in Gillette, two at the Belle Ayr mine, and four at the Eagle Butte mine were terminated, reducing the number of Amax employees in Campbell County to 706. The two mines will probably not be reducing their coal production, however. Earlier this summer, Amax announced that production from their two mines had passed 200 million tons. The Belle Ayr mine has produced 140.7 million

tons since it opened in 1972, and the Eagle Butte mine has produced 59.3 million tons since it opened in 1978. In July, Thunder Basin Coal Company's Black Thunder mine also shipped its 100 millionth ton of coal after only 7.5 years of operation.

News concerning Federal coal leasing was quite varied during the last three months. The U.S. Bureau of Land Management (BLM) recently rejected an application for a Federal coal exchange with Whitney Benefits on the grounds that the coal offered in exchange had a negative coal value and could not be mined at a profit under the proposed mining plan. Whitney Benefits, a charitable organization in Sheridan, Wyoming, had leased over 200 million tons of privately-owned coal under lands along the Tongue River to Peter Kiewit, Sons for possible mine development, but the Wyoming Department of Environmental Quality determined that the coal lands were under an alluvial valley floor (AVF) and were unsuitable for mining. Under Federal regulations, this private coal was eligible for exchange with Federal coal of equal value elsewhere. Whitney Benefits has appealed the decision in court claiming that they should be given Federal coal of equal negative value.

A Federal coal lease sale for 2,973 acres of land containing about 13 million tons of recoverable coal in the Hanna Basin was held on July 8, 1985. Medicine Bow Coal Company, the sole bidder on the tract, bid $185.57/acre, or $551,706.34 for the parcel, but the BLM rejected the bid on the grounds that the bid did not meet the fair market value established by the Government for the lease. Arch Mineral Corporation, the controlling owner of Medicine Bow Coal Company, had previously filed an application for an emergency lease on these lands. The Medicine Bow mine, which is adjacent to the Federal tract, is currently idle because of the lack of coal contracts. Pursuant to a reoffering request by Medicine Bow Coal Company this same acreage will be offered in a competitive lease sale set for October 16, 1985.

Meanwhile the lawsuit filed several years ago by environmental groups to halt the controversial 1982 Powder River Basin coal lease sale continues in Billings, Montana, as the U.S. District Court hears arguments on several issues. In May of this year, the sale of Federal coal lease tracts located in the Montana portion of the Powder River Basin was declared void. Arguments now being addressed in the case may affect leases in the Wyoming portion of the basin.

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## OIL AND GAS UPDATE

by Alan J. VerPloeg, Petroleum Geologist, Geological Survey of Wyoming

Midyear completion statistics have recently been released by Petroleum Information Corporation (Rocky Mountain Region Report, 8-12-85, p. 3-4). The data for Wyoming (through June 28, 1985) are shown below:

| | New Field Wildcats | Other Exploratory Wells | All Wells Drilled |
|---|---|---|---|
| Oil | 14 | 12 | 259 |
| Gas | 2 | 3 | 22 |
| Dry | 187 | 33 | 304 |
| Total | 203 | 48 | 585 |
| Footage | 1,722,035 | 416,809 | 4,507,766 |

*(Note: Completion is deemed to have occurred when (1) total depth has been reached, (2) final status has been determined, and (3) in the case of producing wells, a gauge or initial production rate is reported).*

Total wells drilled are apparently behind the 1984 pace for the year, however, because second-half activity traditionally runs higher, the decline may not be as substantial as it now looks. Once again, oil completions are running far ahead of gas completions, reflecting the market situation.

High bids at the U.S. Bureau of Land Management's latest Wyoming lease sale (August, 1985) totaled $2,854,821 for 146 tracts, comprising 56,906 acres (page 19). The average bid was $50.17 per acre.

High bids at the Wyoming Board of Land Commissioners' latest lease sale, held in September, totaled

## WYOMING FEDERAL AND STATE COMPETITIVE OIL AND GAS LEASE SALES

### BLM SALES 1984

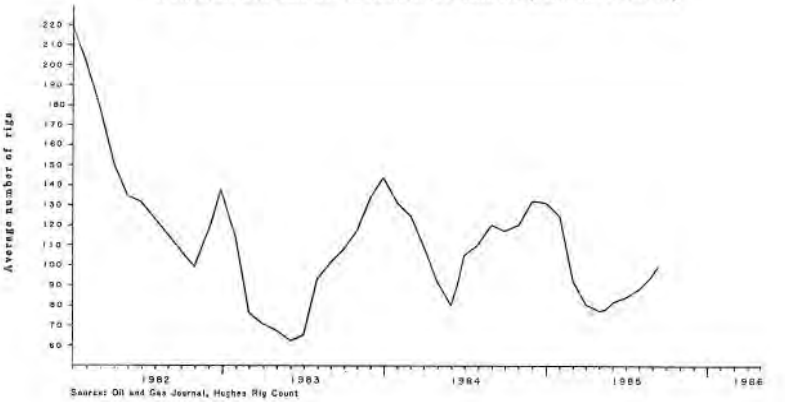
| Month | Total Revenue | Number of parcels offered | Number of parcels sold | Total acres | Acres sold | Average price per acre sold | High price per acre |
|---|---|---|---|---|---|---|---|
| February | $ 7,262,056 | 21 | 21 | 2,304 | 2,304 | $3,151.31 | $21,239.34 |
| March | 615,088 | 28 | 28 | 4,015 | 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 |

### STATE SALES 1983

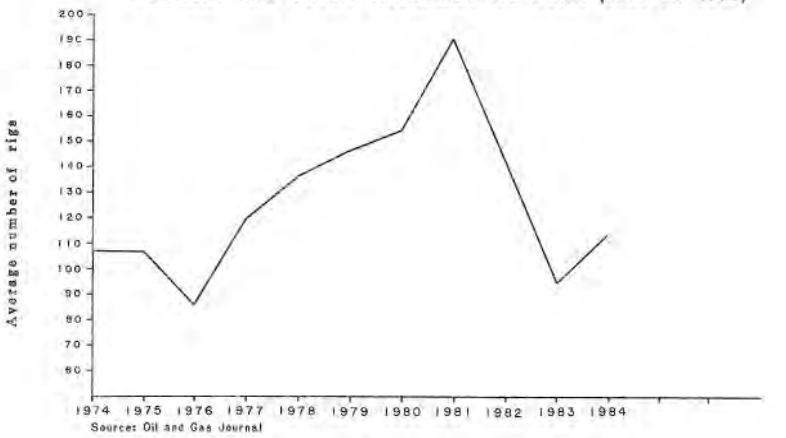
| Month | Total Revenue | Number of parcels offered | Number of parcels sold | Total acres | Acres sold | Average price per acre sold | High price per acre |
|---|---|---|---|---|---|---|---|
| August | $ 2,604,676 | 88 | 88 | 43,262 | 43,262 | $ 59.21 | $ 479.00 |
| October | 1,875,687 | 100 | 86 | 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 |

*Sources: Wyoming Department of Public Lands and Petroleum Information Corporation - Rocky Mountain Region Report*

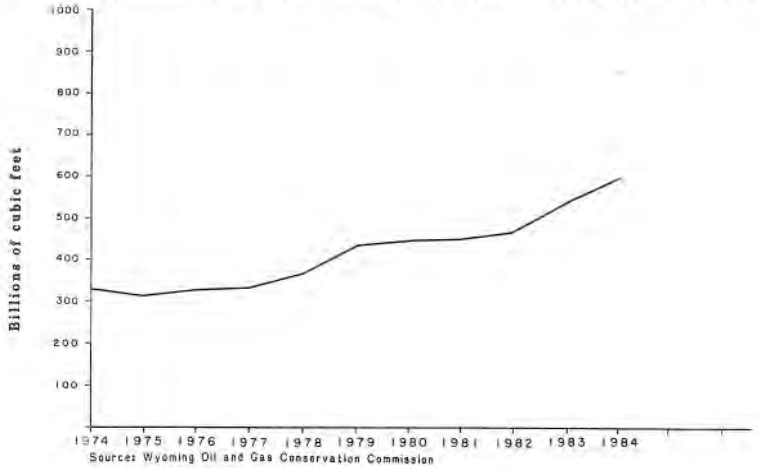
WYOMING RIG COUNT AVERAGED BY MONTH (1982 TO PRESENT)




WYOMING RIG COUNT AVERAGED BY YEAR (1974 TO 1984)

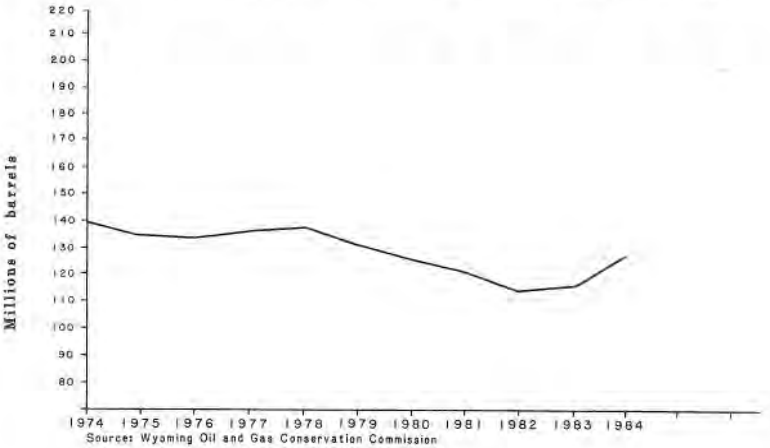


WYOMING NATURAL GAS PRODUCTION BY YEAR (1974 TO 1984)




Source: Wyoming Oil and Gas Conservation Commission

WYOMING OIL PRODUCTION BY YEAR (1974 TO 1984)




Source: Wyoming Oil and Gas Conservation Commission

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) | 0.9 billion barrels[2] |
| Indicated and inferred reserves | 2.8 billion barrels[3] |
| Total | 3.7 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) | 10.1 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, 1984, *U.S. crude oil, natural gas, and natural gas liquids reserves: 1983 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.

$989,069. Bids averaged $16.39 per acre for 126 parcels, totaling 60,356 acres (page 19).

In late July, Amoco announced that they would proceed with their proposed enhanced oil recovery project for Wertz and Lost Soldier Fields north of Rawlins. The project will utilize carbon dioxide ($CO_2$) from Exxon's new gas processing plant east of Kemmerer. The company estimates an incremental recovery of 40 million barrels of oil according to a recent Petroleum Information report (Rocky Mountain Region Report, 7-25-85, p. 1). The project will cost at least $250 million. Actual injection of carbon dioxide will begin in the Tensleep reservoir of Wertz Field in October of 1986. Three additional phases of carbon dioxide injection are expected to get underway in 1987 or later. According to Amoco, earlier water-flooding techniques have left 50-60 percent of the original oil in place in the two fields, and this $CO_2$ project could recover an additional 5-15 percent.

Nationally, seismic activity, which is often considered a leading indicator of petroleum exploration, increased over ten percent from 1983 to 1984, according to a recent report based on data from the Society of Exploration Geophysicists (Rocky Mountain Region Report, 8-2-85, p. 7-10). During the same period, the cost of acquiring seismic data dropped a bit more than five percent. Onshore work in the United States remained virtually even with 1983 levels while offshore activity increased almost 15 percent. In Wyoming, line-miles of seismic surveys totaled 12,239 in 1984, a 9.6 percent drop from 1983. An estimated $68,690,233 was spent for seismic surveys in Wyoming in 1984.

Exxon officials recently stated that hopes are fading for their planned initiation of construction on Phase II of their giant Shute Creek gas processing plant in the La Barge area. The $2.2 billion project will be the largest gas plant in the Rocky Mountain region and one of the biggest in the United States.

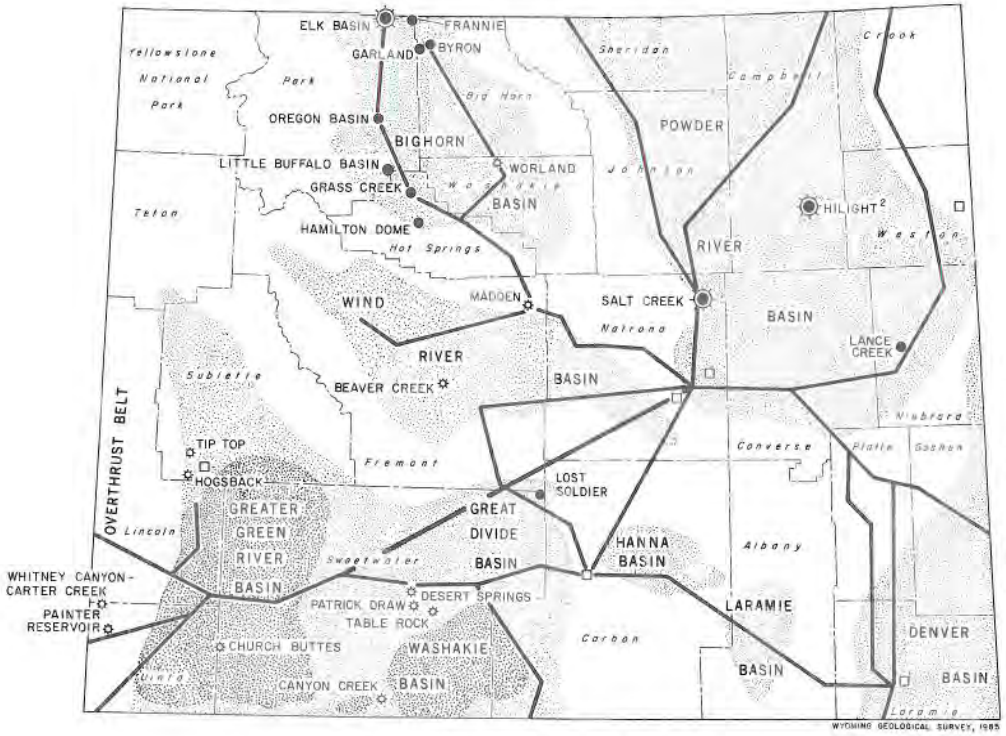
There are currently 4,000-4,300 employees working on Phase I. Another 1,000 employees would be added if Phase II gets started. Permitting delays and the need to locate markets for processed products were cited as the causes for the potential delay. In mid-September, the Wyoming Department of Environmental Quality issued an air quality permit for the second phase of Exxon's plant.

In a related item, on June 7, 1985, the U.S. Department of Interior announced it had agreed to the sale of Government-owned helium from Exxon's Riley Ridge Field in southwestern Wyoming.

Under the agreement, Exxon, will extract the helium as part of its natural gas operations in the Riley Ridge Field, due to start in mid-1986, and sell the helium to private industry, paying a royalty to the Government from the proceeds of the sale. The agreement is set to run for 20 years, producing approximately $60 million in Federal royalties.

"This agreement provides a benefit for the Government and for the private sector," said Robert C. Horton, Director of the U.S. Bureau of Mines, who signed the agreement for the Interior Department. "It allows private industry access to Riley Ridge helium at a time when private helium resources are beginning to decline. It also makes use of natural resources without a costly Government storage and conservation program."

The Riley Ridge Field, located just east of the Overthrust Belt in southwestern Wyoming, is estimated by the U.S. Bureau of Mines to hold more than 100 billion cubic feet (BCF) of helium in association with other natural gases. Some private estimates place the total helium content at more than 200 BCF. Exxon has leased tracts in the area from the Government for oil and gas development, but under provisions of the Mineral Lands Leasing Act of 1920, the helium remains Federal property. Currently, the Government has adequate




GENERALIZED OIL AND GAS INDEX MAP OF WYOMING

EXPLANATION

Major Wyoming Basins

Oil shale occurrences

Oil and gas pipeline corridors

Active Refineries

Oil field with cumulative production[1] greater than 100 million barrels

Gas field with cumulative production[1] greater than 200 billion cubic feet

Oil and gas field with cumulative production[1] of oil greater than 100 million barrels and cumulative production of gas greater than 200 billion cubic feet

[1] CUMULATIVE PRODUCTION IS THROUGH 1984

[2] CUMULATIVE OIL PRODUCTION OF HILIGHT FIELD WAS 73 MILLION BARRELS THROUGH 1984

supplies of helium, and efforts to separate and store the gas for future use would involve an expensive conservation program.

Under the terms of the new agreement, the helium in the ground remains the property of the Federal government, but Exxon assumes ownership when the gas enters the company's above-ground production facilities. The company will then sell the gas, paying the Government a royalty of one-eighth the gross proceeds from the sale of crude helium, and one-twelfth the gross proceeds from sales of refined helium, including liquid helium. Exxon expects to produce about 800 million cubic feet of helium per year. Minimum royalties of $3.00 per thousand cubic feet (MCF) for crude helium, $3.12 per MCF for gaseous refined helium, and $3.33 per MCF for liquid helium, are included in the agreement but are subject to adjustment.

At the completion of the 20-year agreement, the Government will reevaluate its need for helium and the relative merits of sales or conservation.

Marathon Oil Company recently finished the drilling phase of their controversial North Fork well in the scenic valley between Cody and Yellowstone Park. Equipment for drilling the well was brought in by helicopter to minimize environmental damage. Nevertheless, the well was opposed by several local groups. The results of the test were negative, and the well was completed as a dry hole. The objective of the 5,262-feet-deep well was the Madison Limestone.

The most significant recent discovery was completed by Monsanto Oil in the Madden Deep Unit of central Wyoming. The 1-5 Bighorn well (SW, NW, Section 5, T.38N., R.90W.) flowed 5,322,000 cubic feet of gas per day from the Mississippian Madison Limestone at a depth of 23,902-23,958 feet, according to a report by Petroleum Information Corporation (Rocky Mountain Region Report, 8-23-85, p. 1). The Monsanto well is located

on the large Madden structure, which covers more than three townships, implying a potentially huge reserve of gas. Many of the other Cretaceous and Tertiary producing traps along the Wind River Basin axis may now become targets for deep exploration.

In addition, Monsanto's well reached a total depth of 24,877 feet, not only making this the second deepest well in the Rocky Mountain region, but also giving it the distinction of being the deepest production well in the Rockies. Previously, a Colorado Interstate Gas well in the Bull Frog Unit to the east held that distinction. That well produced from Cretaceous/Jurassic rocks between 19,830 and 20,150 feet.

The Wyoming Department of Revenue and Taxation has proposed rules defining what tertiary oil production will qualify for a two percent severance tax exemption under a law passed in the last Legislative Session [W.S.§39-6-302 (j)]. Copies of the proposed rules were circulated in June, but public hearings were postponed until September or early October.

After technical presentations at a hearing in August, the Wyoming Oil and Gas Conservation Commission took the matter of pursuing enhanced oil recovery operations in the Dakota reservoir at Buck Draw Field in Campbell County under advisement until the Commission's staff could review and evaluate all the technical reports and studies that have been done on the field. Oil companies in the field significantly disagree about whether a successful enhanced oil recovery project is possible in the field. Because of the voluminous evidence provided by the different companies, the Commission's decision in this matter has been postponed until October or possibly November. In the meantime, previous production restrictions remain in force.

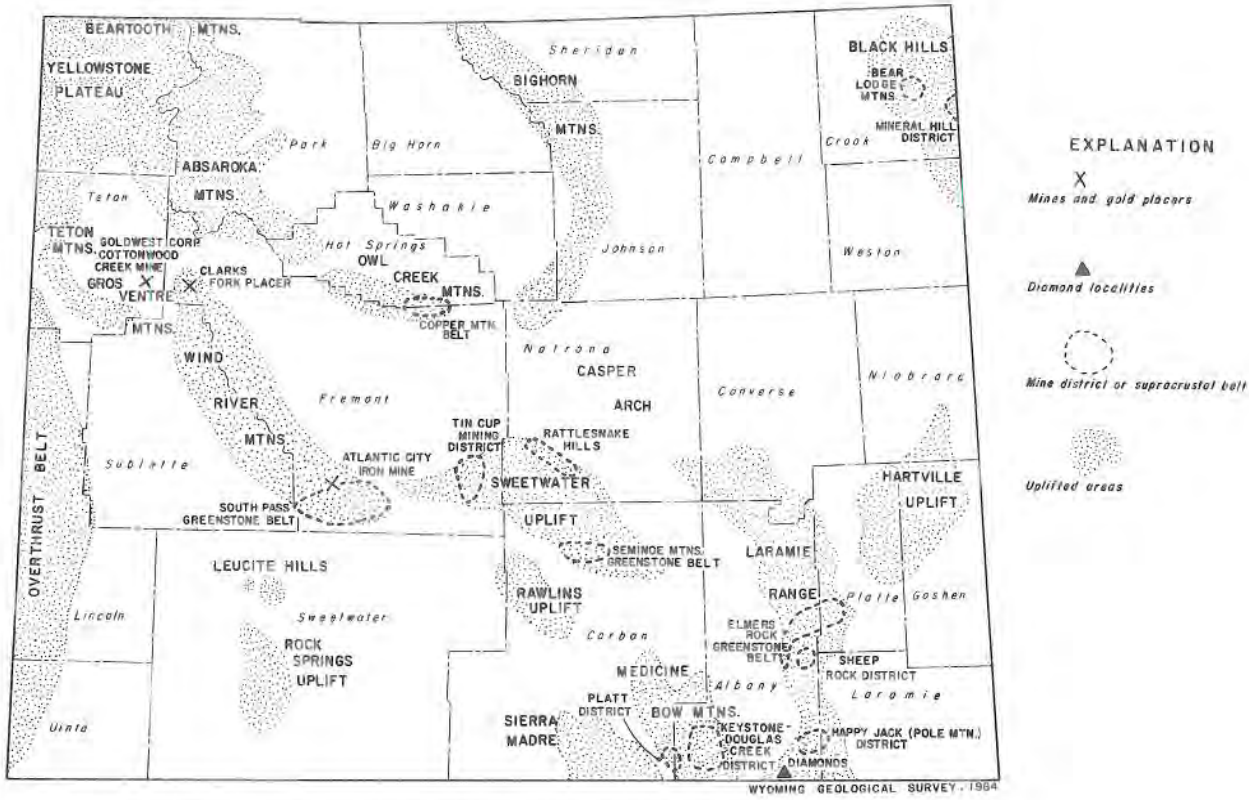
## METALS AND PRECIOUS STONES UPDATE

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

During the past quarter, there was exploration for auriferous (gold-bearing) iron-formation in the Bradley Peak area of the Seminoe Mountains District; exploration drilling for exhalative gold in the Hartville uplift; and exploration activities, including drilling, for shear zone and exhalative gold mineralization in the South Pass-Atlantic City and Lewiston mining districts. These areas are shown on a new map by Harris, and others (1985). In addition, Anaconda Minerals Company announced that their Garrett stratiform gold deposit in the Garrett supracrustal complex of the north-central Laramie Range was for sale. The Garrett property contains low-grade gold mineralization associated with arsenopyrite and berthierite ($FeSb_2S_4$); (*Wyoming Geo-notes no.* 7, p. 39).

A recent paper published in the *Engineering and Mining Journal* stimulated some interest for gold hosted by Permian through Tertiary paleoplacers in northwestern Wyoming. Phillips (1985) pointed out similarities in gold particle size, depositional environments, and the gross quantity of gold in the Wyoming deposits with the Witwatersrand deposits of South Africa. He estimated that the Wyoming paleoplacers might contain 3.55 billion ounces of gold. Some exploration groups announced that they will conduct some preliminary investigations in that region.

The Geological Survey of Wyoming continued stream sediment sampling to search for kimberlite in the Laramie Range. At the beginning of July, the Survey began sampling north of Sybille Canyon along the southern edge of the Elmers Rock greenstone belt. An overview of the kimberlite exploration project has been published (Hausel and others, 1985).




REGIONS OF EXPLORATION ACTIVITY FOR STRATEGIC MINERALS

According to an August press release, the U.S. Bureau of Land Management's (BLM) Denver Service Center began mailing to all mining claimants of record, the Mining Claim Annual Assessment Reminder, (Bureau Form 3830-2). The form will enable BLM to use an automated system to speed up the processing of "affidavits of assessment work" and "notices of intent to hold" for mining claims,, mill sites, and tunnel sites.

Anyone having a mining claim on Federal lands in Wyoming must file annual documents to maintain those claims. Holders of the mining claims are required to provide either evidence of annual assessment work performed during the preceding year or a notice of intention to hold the mining claim. BLM uses the notices to determine which claims have been abandoned and which are still active.

For each claim located before September 1, 1984, an "affidavit of annual assessment" must be filed showing that at least $100 worth of work was completed on the claim during the 12-month period ending at 12 p.m. on September 1, 1985. For claims located between September 1 and December 31, 1984, a "notice of intent to hold" a claim or an "affidavit of annual assessment" must be filed. Persons who located claims during 1985 do not have to file assessment notices until next year. The filing requirements apply to unpatented claims on all Federally-administered lands, including land administered by the U.S. Forest Service.

The use of the form is optional; however, by using it, mining claim records will be updated quickly in the BLM's computer system. The form enables BLM to provide each claimant with a listing of their mining claims and sites.

If the form is being used to file an "intent to hold," or an "assessment done," the claimant must also enclose a notice of "intent to hold" and(or) an "affidavit of assessment work". If the form is being used

to notify BLM of an "abandonment", a signed statement must be enclosed stating that the claimant is abandoning the mining claim(s) and(or) site(s). If "affidavits of assessment work" or "notices of intent to hold" are not enclosed, the BLM cannot process the form or use it to update records in the computer.

If the form is mailed, it must be postmarked by December 30, 1985, and received by the BLM on or before January 21, 1986. It is recommended that claimants use certified mail, return receipt requested, to insure that the BLM receives it. If the form is hand-carried, BLM must receive it no later than December 30, 1985.

The BLM's Wyoming State Office is located at 2515 Warren Avenue, (P.O. Box 1828), Cheyenne, Wyoming 82003. For further information contact Donna Kailey at the U.S. Bureau of Land Management in Cheyenne [(307) 772-2290].

## References Cited

Harris, R.E., Hausel, W.D., and Meyer, J.E., 1985, Metallic and industrial minerals map of Wyoming: Geological Survey of Wyoming Map Series 14, scale 1:500,000.

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.

Phillips, C.H., 1985, Intermountain gold anomaly - significance and potential: Engineering and Mining Journal, v. 186, no. 5, p. 34-38.

## URANIUM AND INDUSTRIAL MINERALS UPDATE

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

### Uranium

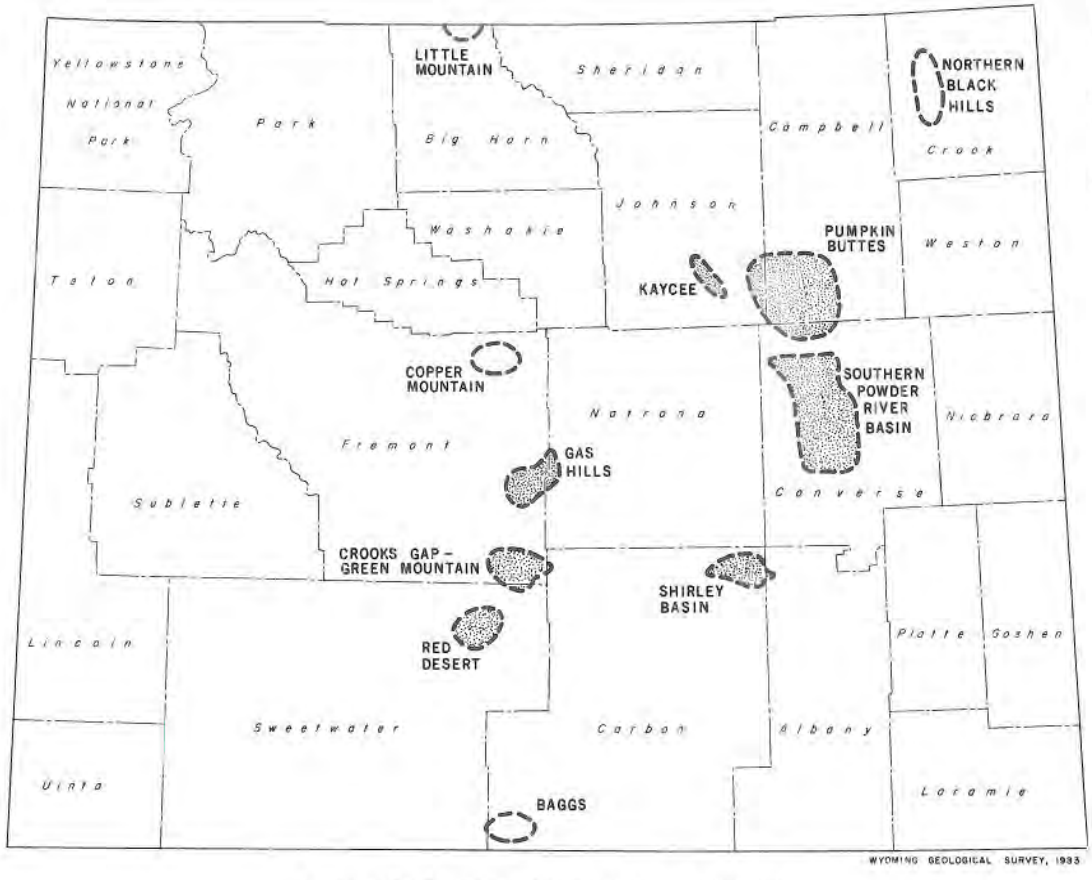
Wyoming's uranium industry continues to contract. Bear Creek Uranium, a joint venture of Rocky Mountain Energy and Mono Power Company, announced the pending closure of its uranium mine in the Powder River Basin. This action followed the early buy-out of its contract to supply fuel to Southern California Edison. The closure is to take place December 31, 1985. Only one uranium company, Pathfinder Mines, will remain in Wyoming. Pathfinder, whose parent company is COGEMA, a French consortium, operates two mines and mills in Wyoming, one in the Gas Hills and one in the Shirley Basin. In 1979, there were 17 uranium mining operations in Wyoming.

As a result of the announced mine closing, production estimates for uranium for the next five years have been revised (page 2). Production estimates reflect COGEMA's expected capacity.

During 1985, the spot market price of uranium has risen more than a dollar per pound of $U_3O_8$ (yellowcake) from $14.25 to $15.75. The price is still too low to support a mining operation and reflects sales of $U_3O_8$ from utility and other stockpiles.

### Bentonite

The outlook for bentonite is one of stable production rates and relatively low prices. In contrast to the uranium industry, bentonite mining companies have not closed down operations despite the downturn in prices and production. Over the past year, some Wyoming




MAJOR ACTIVE AND INACTIVE URANIUM DISTRICTS

bentonite has been sold as a soap filler and additive, replacing bentonite formerly imported from the eastern Mediterranean area.

## Trona

The trona industry is moving to attract foreign consumers and expand its export market. The industry sponsored a tour, including a train trip from San Francisco to the trona mines at Green River, Wyoming. The members of the tour were mostly foreign soda ash (refined trona) consumers. They were encouraged to purchase mined trona from Wyoming.

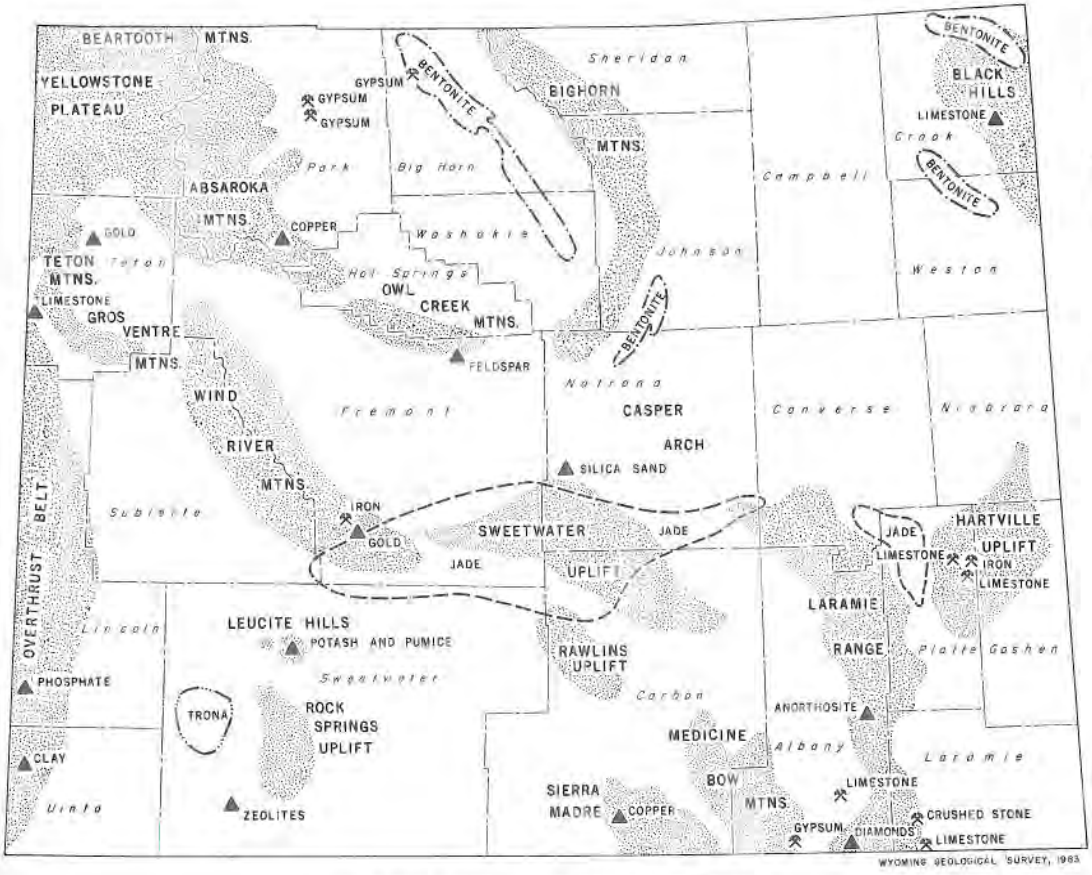
Otherwise, the trona market appears stable at slightly-below-peak production levels and low prices. Industry competition remains high as plants continue to operate below capacity.

## Phosphate

Construction progresses on Chevron Chemical Company's phosphate processing plant at Rock Springs, and the slurry pipeline from the phosphate mine north of Vernal, Utah. A controversy over fluoride emissions from the plant appears to have been settled as Chevron and the Wyoming Department of Environmental Quality agreed to new emissions standards. Because phosphate is produced from minerals that contain the element fluorine, fluorides are found in both phosphate products and plant waste.

## Other industrial minerals

The consumption of construction aggregate reached high levels during the third quarter as construction and resurfacing of highways reached their seasonal peaks. Crushed limestone, granite, dolomite, and




EXPLANATION

- Mines and quarries
- BENTONITE — Bentonite mining district
- TRONA — Trona mining district
- Localities
- JADE — Jade collecting areas
- Uplifted areas

SELECTED MINERAL AND ROCK OCCURRENCES

clinker (baked and fused rock) were used in many areas. Sorted natural gravel deposits were used where available.

The production of limestone for sugar rock continued to decline as Holly Sugar Company's Lost Day quarry near Fort Laramie was operated only intermittently.

Gypsum production is expected to increase slightly in 1985 and 1986 as the demand for wallboard increases. Two gypsum plants in the Bighorn Basin produced wallboard and other gypsum products. Gypsum mined near Laramie is used in cement.

Small-scale production of clay near Evanston and sodium sulfate near Natrona continued. Marble was quarried west of Wheatland by Basins Incorporated, and south of Lusk in the Rawhide Buttes area, by the Pacer Corporation of Rapid City, South Dakota.

Both the Burlington Northern and Chicago and North Western Railroads (C&NW) have been searching for ballast sources in Wyoming. Quartzite and granite in the Hartville uplift and Laramie Range areas have been tested. Granite from south of Lusk was used by C&NW. The Burlington Northern, however, imports its ballast from Wisconsin and Oklahoma, except for some bought from the Guernsey Stone Company (Peter Kiewit, Sons) at Guernsey.

LATITUDINAL AND LONGITUDINAL CORRECTIONS ARE MADE

You probably did not notice the shift, but the entire State has been moved slightly as a result of the National Geodetic Survey's (NGS's) North American Vertical Datum (NAVD) Readjustment Project, which is now nearly complete in Wyoming. New surveying techniques have allowed the NGS to readjust the position of latitude and longitude lines in North America. The old lines were based on much less sophisticated surveys than are now possible. The net result is that most of Wyoming has been shifted westward up to about 165 feet and slightly southward.

Before you personally start worrying about the shift, the legal boundaries of your properties are not tied to latitude and longitude. The net effect is only that the latitude and longitude coordinates of your property have changed. The readjustment, however, does have ramifications for map makers since the latitude and longitude lines on published maps are no longer correctly positioned. Similarly, data bases with points recorded by coordinates based on latitude and longitude, the Wyoming Grid System, or the UTM Grid System also now need correction.

The NGS already has a computer program which will convert outdated coordinates to new coordinates. For information on conversion procedures and the NAVD Readjustment Project in general, contact:

National Geodetic Information Center
National Geodetic Survey
Rockville, MD 20852
(301) 443-8631

One major problem still seems to exist. It will be years before the new latitude and longitude lines appear on maps, therefore, it is unclear when one should start using new coordinates -- now, or after

maps reflect the changes. The answer is not an easy one since the U.S. Geological Survey's 7½-minute quadrangle maps do not reflect the new survey, and the shift on these maps is well within plotting capabilities. No matter what is decided, there will be a need to advise map users and data users which survey a map or data are based on -- the new or the old.

## REVIEW OF ABANDONED MINE RECLAMATION

The two Minerals Sections and the Coal Section of the Geological Survey of Wyoming continue to review reclamation plans for abandoned mines for the Land Quality Division of the Wyoming Department of Environmental Quality (DEQ). To date, approximately 300 mine sites from 12 Abandoned Mined Land (AML) Reclamation Projects have been reviewed. Comments and(or) recommendations were made on at least 100 mines. In some cases, the mines have been visited, and a few have been mapped to provide DEQ with geologic information.

## SOUTH PASS PROJECT

Dan Hausel, Deputy Director and Metallic Minerals Geologist, notes that his geologic mapping project in the South Pass greenstone belt of the Wind River Mountains is continuing on schedule. This project is one of two projects (see also Bighorn Mountains Project, *Wyoming Geo-notes no.* 7, p. 52) being conducted in cooperation with the U.S. Geological Survey under their COGEOMAP Program.

The goals of the project are to map two 7½-minute quadrangles (Radium Springs and Lewiston Lakes) on the eastern edge of the supracrustal belt; two 7½-minute quadrangles (Anderson Ridge and NE Parting of the Ways) on the western edge of the belt; revise previous geologic maps of three 7½-minute quadrangles (Atlantic City, Miners Delight, and South Pass City) in the center of the belt; and to compile these quadrangles into a regional geologic map on a scale of about 1:48,000. The mineral resources are also being documented.

To date, preliminary geologic maps of the Radium Springs and Lewiston Lake Quadrangles are essentially complete. Anderson Ridge Quadrangle is about two-thirds complete, and 18 preliminary mine maps of historic gold mines have been prepared.

It appears from preliminary work that at least four different types of gold deposits are present at South Pass: the principal gold occurrences are shear zone deposits hosted by metagreywacke. Less commonly, there are vein deposits with well-defined quartz veins, and stratabound deposits where gold is localized in distinct stratigraphic units such as graphitic schist, banded iron-formation, or metavolcanics. The fourth type of deposit is Recent placers. These placers are common throughout the greenstone belt.

## RECENT AND NEW PUBLICATIONS BY THE GEOLOGICAL SURVEY OF WYOMING

* *Bibliography of graduate theses and dissertations on the geology of Wyoming, 1899 through early 1984 (exclusive of the University of Wyoming)* compiled by G.B. Glass, Public Information Circular PIC-24, 1985 ($5.00).

*Economic geology of the Copper Mountain supracrustal belt, Owl Creek Mountains, Fremont County, Wyoming*, by W.D. Hausel, P.J. Graff, and K.G. Albert, Report of Investigations 28, 1985 ($8.00).

*Geothermal resources of the Bighorn Basin, Wyoming*, by H.P. Heasler and B.S. Hinckley, Report of Investigations 29, 1985 ($7.00).

* *Trapper Canyon tar sand deposit, Big Horn County, Wyoming; an exhumed stratigraphic oil trap*, by A.J. VerPloeg and R.H. DeBruin, Report of Investigations 30, 1985 ($7.00).

*The geology, diamond testing procedures, and economic potential of the Colorado-Wyoming kimberlite province - a review*, by W.D. Hausel, M.E. McCallum, and J.T. Roberts, Report of Investigations 31, 1985 ($4.00).

* *Petrology of Hanna and Ferris Formation coals from the Hanna Coal Field, Wyoming*, by S.C. Teerman, J.C. Crelling, and G.B. Glass, Report of Investigations 32, 1985 ($6.00).

* *Index to U.S. Geological Survey Oil and Gas Investigations Maps (OM) for Wyoming*, compiled by R.H. DeBruin, Map Series MS-9I, 1985 ($2.50).

* *Index to U.S. Geological Survey Open-file Reports that contain geologic maps for Wyoming*, compiled by R.H. DeBruin, Map Series MS-9J, 1985 ($2.50).

* *Index to U.S. Geological Survey Circulars, Folios, and Annual Reports that contain geologic maps for Wyoming*, compiled by R.H. DeBruin, Map Series MS-9K, 1985 ($2.50).

* *Index to Geological Survey of Wyoming publications that contain geologic maps, excluding Open File Reports*, compiled by R.H. DeBruin, Map Series MS-9L, 1985 ($2.50).

* *Index to Geological Survey of Wyoming Open File Reports that contain geologic maps*, compiled by R.H. DeBruin, Map Series MS-9M, 1985 ($2.50).

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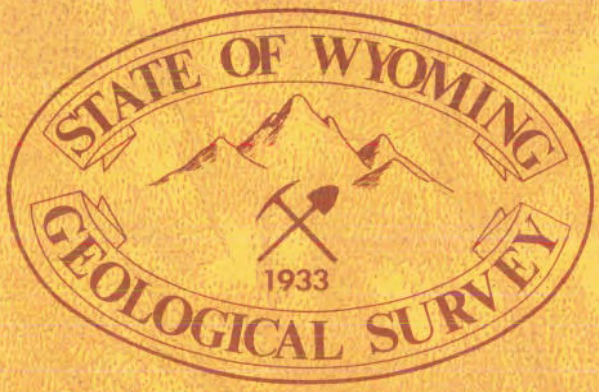
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