

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

# WYOMING GEO-NOTES NO. 7



LARAMIE, WYOMING

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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

The brightest spot in Wyoming's mineral industry since the last update was the final production statistics for oil and natural gas in 1984. The Wyoming Oil and Gas Conservation Commission reported oil production was up five percent over 1983, and natural gas production increased by 11 percent. Lest one forget, however, the current production gains in petroleum and natural gas are in great part a reflection of the booming exploration of the early 1980's, particularly 1981. In other words, the discoveries of half a decade ago are now reaching fruition as the discoveries associated with that drilling approach or pass their full development.

Without accelerated activities, by 1987 the State's declining production from older oil fields will probably more than offset production from new fields, and at least oil production will start a slow decline again. Drilling activities are currently very similar to those in the late 1970's - a time when oil production was declining slowly, but steadily (see graphs on page 20).

The petroleum industry, while surviving at a reduced pace, is currently contemplating the individual and cumulative effects of new regulations under the Federal Oil and Gas Royalty Management Act (FOGRMA), the Bureau of Land Management's plans for resurveying large areas of the Powder River Basin, the proposed land interchange between the Bureau of Land Management and Forest Service, the possibility of new Federal leasing procedures, the possibility of

Table 1. Wyoming mineral production forecast to 1991<sup>1</sup>

| Calendar Year | Oil Production <sup>2</sup> | Natural Gas Production <sup>3</sup> | Coal Production <sup>4</sup> | Trona Production <sup>4,5</sup> | Uranium Production <sup>4,5</sup> |
|---------------|-----------------------------|-------------------------------------|------------------------------|---------------------------------|-----------------------------------|
| *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          | 126.0                       | 630.0                               | 134.0                        | 11.1                            | 0.9                               |
| 1986          | 125.0                       | 675.0                               | 138.0                        | 11.2                            | 0.50                              |
| 1987          | 124.0                       | 715.0                               | 141.5                        | 11.3                            | 0.20                              |
| 1988          | 123.0                       | 750.0                               | 143.3                        | 11.4                            | 0.20                              |
| 1989          | 122.0                       | 775.0                               | 144.5                        | 11.6                            | 0.15                              |
| 1990          | 120.0                       | 800.0                               | 145.5                        | 11.8                            | 0.15                              |
| 1991          | 118.0                       | 825.0                               | 147.0                        | 12.1                            | 0.20                              |

\* Actual values for comparison, <sup>1</sup> Geological Survey of Wyoming, March, 1985, <sup>2</sup> in millions of barrels, <sup>3</sup> in billions of cubic feet, <sup>4</sup> in millions of tons, <sup>5</sup> these estimates were revised in June, 1985.

a new State lease form, and a general opposition to drilling planned for remote and usually untested mountainous areas in the State (primarily National Forest Lands) even when the sites are to be built, supplied, and maintained by helicopter mobilization. All these items collectively are slowing or restraining activity at a time when demand and price are also working to slow things down. Although recent production of oil and natural gas currently does not reflect the slow down, the effects of reduced

exploration will be seen not too many years in the future if activities do not soon turn around for the better.

At least oil and gas prices have apparently stabilized for the time being. Prices for coal and uranium, however, are still falling. Although prices for most of the State's other mineral products are below their values in the early 1980's, the prices seem to have bottomed out.

The coal industry may register another good production gain in 1985 if the trend of the first quarter continues. Production for the first three months of 1985 is running about 10 percent above 1984. Unfortunately high mining costs in the Hanna Coal Field of south-central Wyoming are creating serious problems for the mines in that area. The Hanna Field will probably only have two active surface mines left before the year is out, and Wyoming's only underground coal mine could also close before the end of the year if their contract with an Indiana utility is voided, or if the utility simply pays for the coal, but refuses delivery. This modern, very efficient, long-wall mine produces 1.5 million tons per year and employs several hundred miners.

#### METALS AND PRECIOUS STONES UPDATE

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

Although the Wyoming field season arrived early this spring, only subdued exploration for metals is anticipated. The lack of interest for metals is due to the strong U.S. dollar, low gold prices, and sub-economic base metal prices.

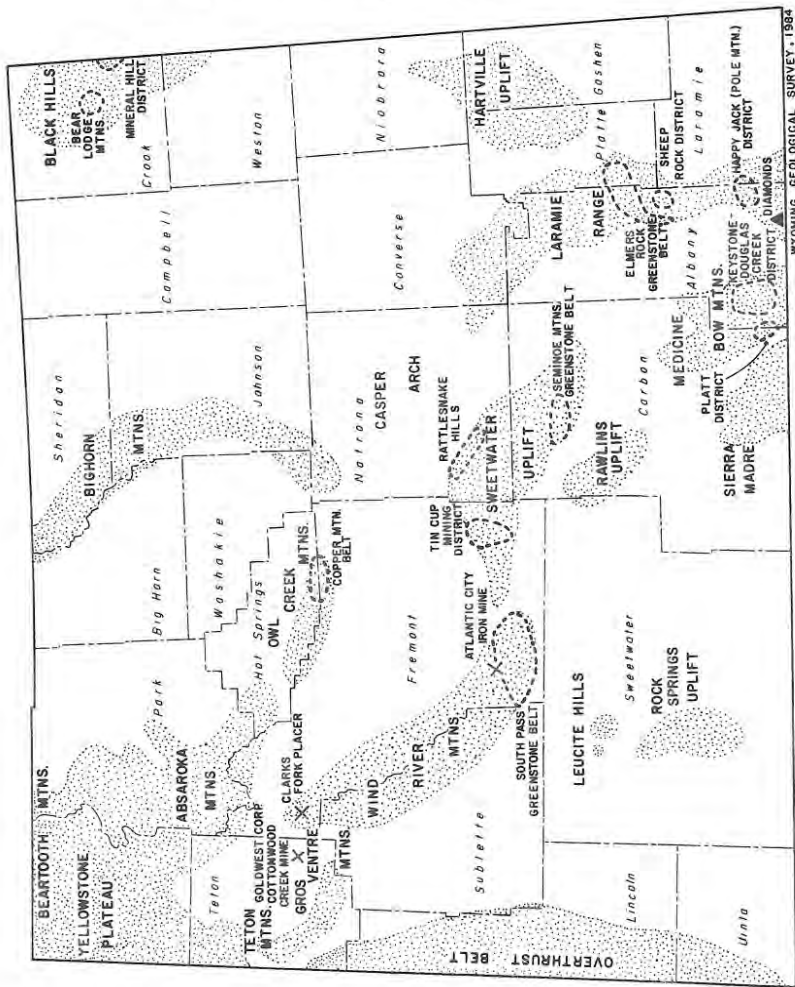
Even with the diminished activity, some areas should still receive attention - in particular, the South Pass region in the southern Wind River Mountains, and the Silver Crown District in the southern Laramie Range. In addition, one major company began grass-roots exploration for gold and zinc in Wyoming. Finally, the Metallic Minerals Section of the Geological Survey of Wyoming is conducting several investigations. One of these investigations was initiated to help avoid serious problems for future exploration activity and is related to the Department of Environmental Quality's abandoned mine reclamation program.

### South Pass

Two major gold districts occur at South Pass: the South Pass-Atlantic City and Lewiston Districts. In the South Pass-Atlantic City District, Freeport Exploration is expected to continue activities at Miners Delight, and a company based out of Salt Lake City is expected to continue underground exploration at the Carissa Mine. Freeport Exploration is also expected to continue with their project in the Lewiston District.

Last field season, Freeport sampled and trenched several zones of mineralization in both the South Pass-Atlantic City and Lewiston Districts. In the upcoming field season, they are expected to begin drilling on their Miners Delight and Lewiston properties.

The Miners Delight area includes the historic Miners Delight Mine and nearby placers. This area was the most productive in the South Pass region, with the Miners Delight Mine producing an estimated



**EXPLANATION**  
 X  
 Mines and gold placers

▲  
 Diamond localities

○  
 Mine district or supracrustal belt

●  
 Uplifted areas

WYOMING GEOLOGICAL SURVEY, 1984

REGIONS OF EXPLORATION ACTIVITY FOR STRATEGIC MINERALS



63,500 ounces of gold. Production from nearby placers that drain the Miners Delight area have accounted for an estimated 80,915 ounces of gold.

Historic records on the now inaccessible mine workings suggest that the shaft was sunk to a depth of at least 275 feet with more than 2,400 feet of drifts on a 3- to 16-foot wide shear. An unrecorded number of stopes, inclines, and crosscuts were also driven by the early miners. Gold was free-milling, and the selectively-mined ore ran from 0.35 ounce of gold per ton up to as high as 190 ounces per ton. The ore is hosted by metagreywacke intruded by meta-dacite.

The Lewiston District includes several historic gold mines - the more notable are the Burr and Hidden Hand. Historic records indicate that gold was first discovered in the district in 1879 at the site of the Burr Mine. Early newspaper articles suggest that the Burr Mine was a common household name to western miners and prospectors because of some incredibly rich gold ore produced from the property. Some mineralized zones reportedly assayed 25 to 250 ounces of gold per ton. Also at a depth of 25 feet, a zone of scheelite, assaying between 2.5 to 70 percent tungsten, was intercepted.

The Hidden Hand Mine located north of the Burr Mine, also contained some rich gold ore. Some ore from the mine contained as much as 75 ounces of gold per ton. In 1894, it was reported that one thousand tons of ore were mined that contained more than four ounces of gold per ton.

The Carissa Mine, located near South Pass City and within the South Pass-Atlantic City District, is being explored by a company out of Salt Lake City. More than a year ago a new headframe was constructed over the primary shaft, and the mine operators

recently cleared the more than 300 feet deep shaft and dewatered the upper mine levels. Presently, the company is mapping the upper workings and attempting to clear a winze to gain access to the lower level. Available maps show the mine to be 400 feet deep with four levels. More than 2,300 feet of drifts and several hundred feet of stopes were mined. The ore averaged 0.32 ounce of gold per ton and ranged from a trace to 2.64 ounces per ton. The ore is hosted by a sheared metagreywacke, and an estimated 53,680 ounces of gold were produced.

Mapping by the Geological Survey of Wyoming in the southeastern portion of South Pass has delineated a basal suite of ultramafic flows and sills. The presence of the ultramafic suite helps support the fact that South Pass is a greenstone belt and therefore should have good potential for economic gold deposits.

### Silver Crown District

The Silver Crown District, located in the southern Laramie Range about 25 miles west of Cheyenne, is again being explored by an undisclosed mining company. The district was mined in the late 1800's and early 1900's for copper with minor gold and silver. Presently, the primary interest in the district is for low-grade gold reserves. At the historic Copper King Mine in the southern half of the district, the following reserves have been outlined by drilling:

| <u>Tons (ore)</u> | <u>Gold (oz/ton)</u> | <u>Copper (%)</u> |
|-------------------|----------------------|-------------------|
| 2,800,000         | 0.044                | 0.36              |
| 6,000,000         | 0.038                | 0.32              |
| 13,500,000        | 0.028                | 0.26              |
| 35,000,000        | 0.022                | 0.21              |

This ore lies near the surface and extends to a depth of at least 1,024 feet. Spectrographic analyses have detected traces of lead, zinc, tungsten, and 0.5 to three percent titanium. Similar untested geophysical and geochemical anomalies occur both east and west of the Copper King.

### Abandoned Mine Reclamation

The Land Quality Division of the Wyoming Department of Environmental Quality has at least a 5-year, statewide program to reclaim abandoned coal, uranium, industrial minerals, and metals mines. Mines that are considered hazardous have high priority. The Metallic Minerals Section and other sections of the Geological Survey of Wyoming are conducting field investigations related to the program and providing recommendations on many of the mines in order to protect important historic, exploration, and scientific values. However, a number of the historic mines will be buried and reclaimed. Contracts have been issued to reclaim several mines in the Medicine Bow and Sierra Madre mountains. Contracts will be issued in the near future for mines in the Lewiston and Copper Mountain Districts.

In other activities around the State, the Geological Survey of Wyoming collected more than 500 pounds of rock from the Leucite Hills near Rock Springs to test for diamonds. The Leucite Hills consists of several scattered plugs and flows of wyomingite, orendite, and madupite that are ultrapotassic lamproites suspected to have a genetic link with kimberlite (Carmichael, 1967; Ogden, 1979). Diamonds were recently discovered in similar leucite- and olivine-lamproites in the West Kimberly Province of northwestern Australia (Atkinson and others, 1984). One of the Australian lamproites, known as

the Argyle pipe, contains more diamonds per ton than any kimberlite or any other lamproite in the world. This diamond-rich lamproite has generated considerable interest in lamproites worldwide. With this in mind, the Geological Survey of Wyoming sampled the Leucite Hills.

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- Carmichael, I.S.E., 1967, The mineralogy and petrology of the volcanic rocks from the Leucite Hills, Wyoming: Contributions to Mineralogy and Petrology, v. 15, p. 25-66.
- Ogden, P.R., Jr., 1979, The geology, major element geochemistry, and petrogenesis of the Leucite Hills volcanic rocks, Wyoming: University of Wyoming unpublished PhD thesis, 137 p.

#### URANIUM AND INDUSTRIAL MINERALS UPDATE

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

#### Uranium

On March 1st, the Petrotomics uranium mine and mill in the Shirley Basin, closed operations. Texaco closed the mine, which they had earlier acquired from

Getty Oil. This closure leaves Wyoming with three operating mines: COGEMA-Pathfinder's mines in the Gas Hills and Shirley Basin, and Bear Creek Uranium's (subsidiary of Union Pacific) mine in the Southern Powder River Basin District.

Even in Wyoming's operating mines, layoffs and cutbacks are continuing. Bear Creek laid off nine employees in the second quarter of 1985.

The prospects for a revival of the uranium mining and milling industry in Wyoming still appear slim. The current spot market price for refined uranium is \$14.25 per pound. This compares with a price of \$42.00 per pound in early 1979. The current price reflects the low demand for uranium for nuclear power plants. Although stockpiles of uranium bought by the utilities under contracts signed in the late 1970's are being depleted, the low cost of foreign uranium is reducing interest in new contracts from domestic uranium sources. However, even with the mine closings, mine production in 1984 exceeded uranium consumption by 40 percent.

Reclamation of uranium mill tailings is also in the news. Wyoming Senator Alan Simpson introduced a bill to speed up mill reclamation with costs to be shared by utilities (55 percent), mining companies (15 percent), and the Federal Government (30 percent). However, there are groups which want mining companies to bear the entire cost for cleaning up the mill tailings.

In contrast to the United States' nuclear industry, European nuclear generating facilities are being built at a rapid rate. The European Community has reduced its dependence on Middle East oil from 62 percent to 32 percent in ten years, according to an article in the American Mining Congress Journal. In

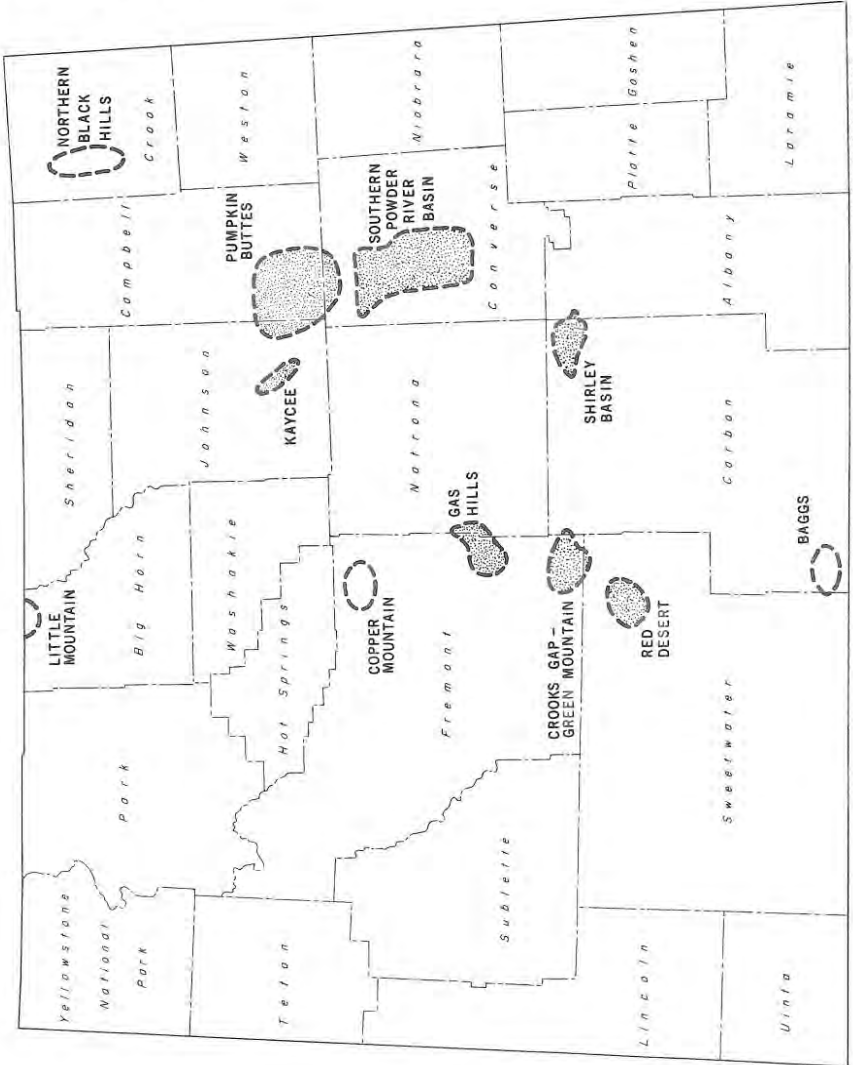
**EXPLANATION**



Uranium district with active or recent mining



Uranium district without recent mining



WYOMING GEOLOGICAL SURVEY, 1983

MAJOR ACTIVE AND INACTIVE URANIUM DISTRICTS

Europe, nuclear plant construction is economically attractive compared to other sources (Europe does not have the coal resources of the United States). As a result of the continually-increasing demand for reactor fuel, uranium prices have risen everywhere but in the United States and Japan.

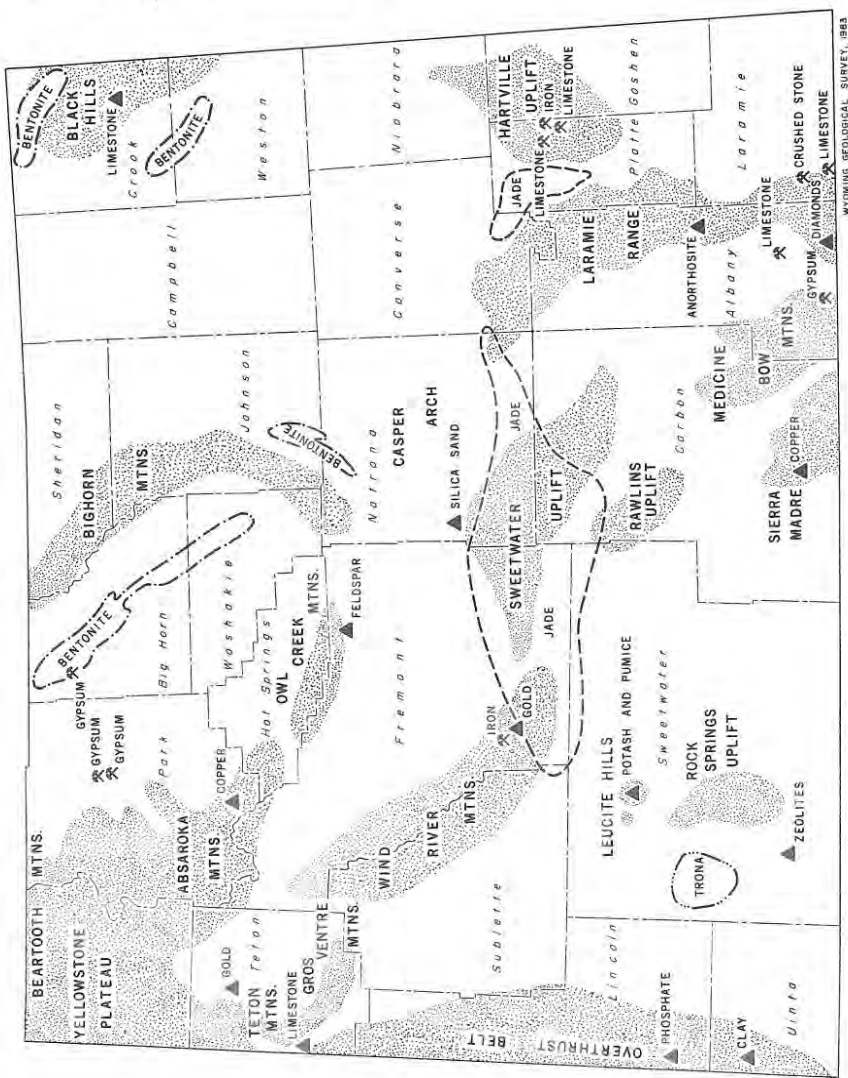
A new 1:500,000 scale map of Wyoming showing the location of uranium mines and uranium and thorium mineral occurrences is available from the Geological Survey of Wyoming in Laramie. The map also shows the apparent geologic origin of the deposits and occurrences and identifies the host rock at each location. An accompanying introduction gives a review of Wyoming's uranium industry and contains an explanation for the map.

The map and explanation are available as Open File Report 85-6 *Uranium Mines and Uranium and Thorium Occurrences in Wyoming*. The cost of Open File Report 85-6 is \$7.00.

A set of two maps that show expected background gamma radiation levels of the Torrington 1° x 2° map area is also available from the Geological Survey of Wyoming. The Torrington Map area covers the northern parts of Albany, Goshen, and Platte Counties, southern Niobrara County, and southeastern Converse County and includes the towns of Torrington, Wheatland, Lusk, Douglas, and Glenrock. The maps and accompanying explanation were compiled from 340 field measurements. Natural background gamma radiation comes from two sources: radioactive isotopes contained in all earth material (terrestrial radiation) and cosmic radiation. The two maps show values for both cosmic and terrestrial radiation.

The maps and explanation are available as Open File Report 85-9. The cost is \$6.50. These open

- EXPLANATION**
- ▲ Mines and quarries
  - (BENTONITE) Bentonite mining district
  - (TRONA) Trona mining district
  - ▲ Localities
  - (JADE) Jade collecting areas
  - ▲ Uplifted areas



WYOMING GEOLOGICAL SURVEY, 1983

SELECTED MINERAL AND ROCK OCCURRENCES



file reports may be ordered from the Geological Survey of Wyoming, Box 3008, University Station, Laramie, Wyoming 82071 or call (307) 766-2286.

### Bentonite

The outlook for bentonite production in Wyoming remains good as demand for bentonite other than for drilling mud is expected to increase. Prices remain at a low level but should rise as demand increases. Uncertainty in the petroleum industry, however, does cloud the future. New uses of bentonite for environmental containment projects may increase demand in the future.

The Wyoming Department of Environmental Quality has let contracts for the reclamation of abandoned bentonite pits in the Colony bentonite mining district in Crook County. This work will continue through the remainder of 1985.

### Trona

Wyoming's trona mining industry continues to struggle with overcapacity and a near stagnant market. Soda ash prices, however, may have reached their low in mid-1984 and may increase somewhat in 1985, reflecting a trend that began at the end of 1984.

FMC announced plans to lay off 76 workers by October, 1985. Soda ash (refined trona) is used primarily for the production of container (bottle) glass, a market that is diminishing due to the increased use of plastic bottles. Exports, which currently account for 19 percent of domestic soda ash production, offer promise as a way to increase pro-

duction. Recent negotiations with China also offer some optimism.

In a surprise move, Allied Chemical announced the closure of its synthetic soda ash plant in Syracuse, New York. Only last quarter, Allied had laid off employees because of planned production increases from the same synthetic plant. Producers of natural soda ash in southwestern Wyoming expect to pick up most of the 500,000-ton-per-year demand attributable to the closure of Allied's New York plant.

FMC is also expecting to start producing soda ash from its newly developed *in situ* field south of its Westvaco plant. Industry experts expect that *in situ* mining will be 25 percent less expensive than conventional underground mining. It is also less labor-intensive and will not increase employment proportional to increased production.

### Other Industrial Minerals

The production of construction materials (sand and gravel, gypsum, limestone mined for cement, stone, ballast, and baked and fused rock [clinker]) should increase in the remainder of 1985 as construction in Wyoming increases.

Limestone production for sugar refining has declined in Wyoming and is expected to continue declining in 1985. In fact, most of the limestone produced by Holly Sugar at their Lost Day Quarry north of Fort Laramie is shipped to the Laramie River Station Power Plant for use in emission's control.

The production of other industrial minerals depends on the economy and should increase in the

remainder of 1985. These other industrial minerals include clay and sodium sulfate.

The Geological Survey of Wyoming has released information on the occurrences of baked and fused rock (clinker) in the Powder River Basin. In this area, clinker is often the best material for construction aggregates. Three 1:250,000-scale maps covering the Gillette, Newcastle, and Sheridan 1° x 2° AMS map areas have been released as Geological Survey of Wyoming Open File Reports 85-5, 85-7, and 85-8. The maps, by John E. Meyer, are available from the Geological Survey of Wyoming at \$3.00 each.





The Geological Survey also released Open File Report 85-2, *Selected references on construction materials in Wyoming*. This report lists sources of information for construction materials, indexed by commodity. The report by Ray E. Harris and John E. Meyer is available for \$2.25.




#### OIL AND GAS UPDATE

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

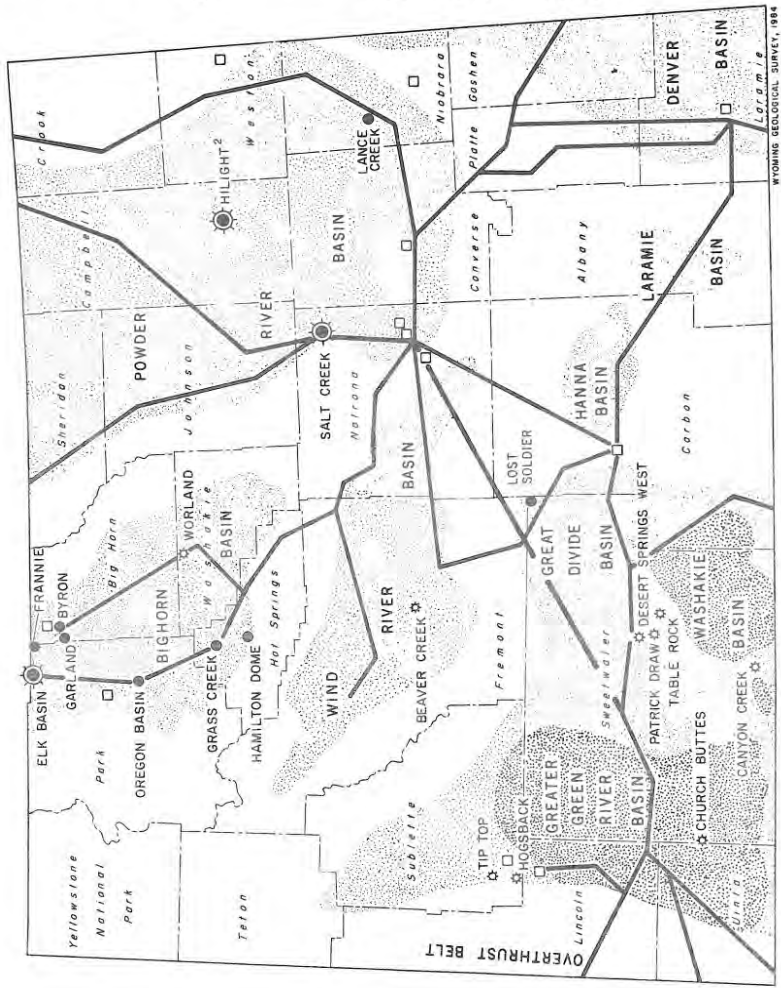
Final 1984 oil and gas production totals were recently released by the Wyoming Oil and Gas Conservation Commission. Oil production was 127,763,146 barrels, up five percent from 1983; natural gas production was 600,137,792 MFC, up 11 percent from 1983. This makes the second year in a row that oil production has shown an increase after several years of steady decline. Although gas production had been increasing fairly steadily over the last several years, the increases of the past two years have been more significant.

**EXPLANATION**

-  Major Wyoming Basins
-  Oil shale occurrences
-  Oil and gas pipeline corridors
-  Refineries

-  Oil field with cumulative production greater than 100 million barrels
-  Gas field with cumulative production greater than 200 billion cubic feet
-  Oil and gas field with cumulative production<sup>1</sup> of oil barrels and cumulative production of gas greater than 200 billion cubic feet

<sup>1</sup> CUMULATIVE PRODUCTION IS THROUGH 1981  
<sup>2</sup> CUMULATIVE OIL PRODUCTION BY HIGHLIGHT SYMBOLS DO NOT INCLUDE BENTLEY THROUGH 1981



WYOMING GEOLOGICAL SURVEY, 1984

GENERALIZED OIL AND GAS INDEX MAP OF WYOMING

In a recent report by the Potential Gas Committee, it appears that "disappointing" results in recent exploratory drilling in the Overthrust Belt area and the Wind River Basin have contributed to a drop in estimated natural gas reserves for the nation. The group revised their 1982 estimate for these two areas downward from 60 trillion cubic feet, to 31 trillion cubic feet. Results of drilling in the areas of the Overthrust Belt, exclusive of southwestern Wyoming and northeastern Utah, have been especially disappointing according to the group. Their estimate of "potential supply" for the nation i.e., what could additionally exist in known fields; what might exist in other areas with favorable geology; and what is recoverable with current technology, fell from 876 trillion cubic feet to 784 trillion.

Subsidiaries of Williams Company and Tenneco, Inc. recently announced plans to construct a 762-mile-long, 36-inch carrier pipeline from Kemmerer, Wyoming, to Bakersfield, California. Natural gas from the Overthrust Belt would be transported to fuel thermal projects in California's heavy oil and tar sand fields.

Falling gasoline prices and scheduled decreases in the amount of lead permitted in gasoline are having a devastating effect on small refineries in the Rocky Mountain area and the nation as a whole, according to the Intermountain Oil Marketer Association. Using non-lead formulations to boost octane levels in gasoline is quite expensive and small refineries, which tend to be older, require expensive remodeling to meet new standards. As a result, many have closed and more closures are anticipated. In Wyoming, eight of the smaller refineries have already closed leaving only the larger refineries in Sinclair, Casper, Cheyenne, and Gillette still operating. Of the 29 refinery closures across the

nation in 1984, 28 were smaller refineries according to the Oil and Gas Journal.

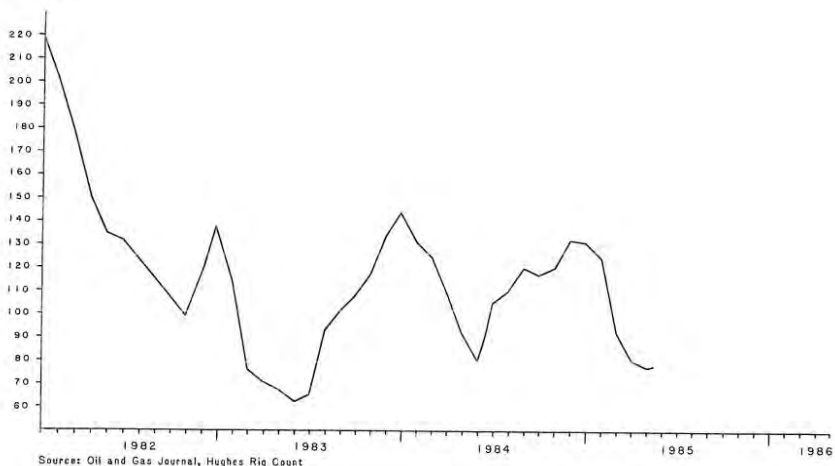
A growing list of groups and agencies are coming out in opposition to the renewal of 31 oil and gas leases in the Bridger-Teton National Forest near Grand Teton National Park. Jack Stark, superintendent of Grand Teton National Park, recently indicated his opposition to the lease renewal. He is joined by various environmental groups, the Jackson Town Council, the Teton County Commissioners, the Wyoming Wildlife Federation, and the Outfitters and Guides Association. The hydrocarbon potential of this area is relatively untested at this time.

The Bureau of Land Management (BLM) has recently announced that it will relax penalties for minor oil and gas lease violations while it reviews the controversial Federal Oil and Gas Royalty Management Act (FOGRMA) regulations adopted last October. The BLM set a one year grace period for minor violations. A task force will draft a revised set of regulations taking into account numerous public comments and industry objections. They also intend to examine the agency's inspection and enforcement strategies. Industry especially objected to rapidly escalating fines that could reach \$25,000 per day.

A June public hearing on Wyoming's proposed new oil and gas lease form indicated that there was still significant disagreement between the State and the petroleum industry. Although industry objections centered on the royalty provisions of the form, there were objections to many other portions of the proposed form as well. The State Land Board listened to a full day of testimony in opposition to provisions of the form. The record was left open so that written testimony could be sent in, and Governor Herschler, Board Chairman, asked for briefs on the

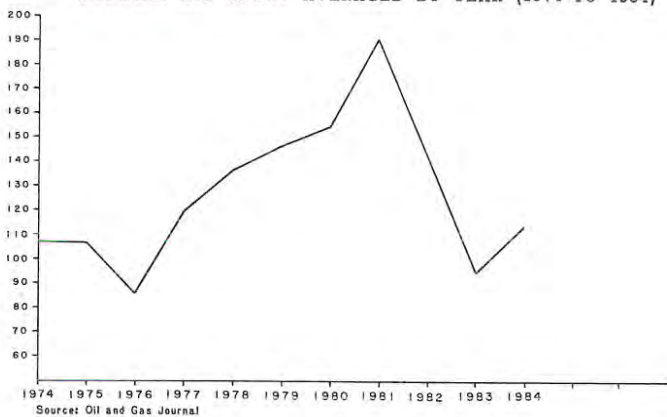
WYOMING RIG COUNT AVERAGED BY MONTH (1982 TO PRESENT)

Average number of rigs

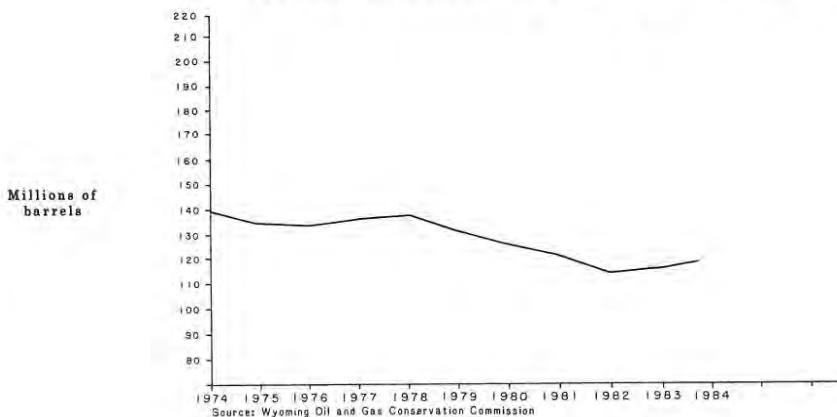


WYOMING RIG COUNT AVERAGED BY YEAR (1974 TO 1984)

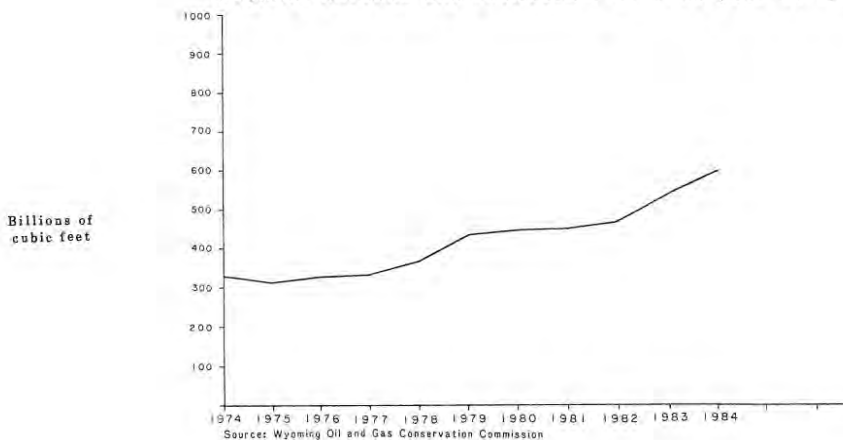
Average number of rigs



### WYOMING OIL PRODUCTION BY YEAR (1974 TO 1984)



### WYOMING NATURAL GAS PRODUCTION BY YEAR (1974 TO 1984)





legality of the "single payor" clause in the lease. Several persons testified that if the form were not materially changed, it would dampen or even eliminate interest in leasing State lands. Copies of the proposed lease form are available from the Commissioner of Public Lands, Herschler Building, 122 West 25th Street, Cheyenne, Wyoming, 82002-0600 or call (307) 777-7331.

The Bureau of Land Management (BLM) recently approved Marathon Oil Company's plans to drill a controversial oil well in the mountains west of Cody. Personnel and equipment for the 5,000-foot test will be brought in by helicopter to prevent damage to the scenic area. Even with helicopter-mobilization, the Park County Resource Council indicates it will go to court to restrain Marathon from drilling.

The BLM estimates that at least 107 townships in Campbell County need to be resurveyed because of major discrepancies between original and later surveys. The BLM discovered that royalties for several mislocated oil and gas wells may have been paid to the wrong people or government entities. A BLM report estimates that it will take 22 years to resurvey the area. There is considerable concern over the matter since the question of ownership and mineral rights could have a deleterious effect on oil and gas development in the Powder River Basin, which is the most active basin in Wyoming at this time.

Ronald Terry, co-director of the Enhanced Oil Recovery Institute at the University of Wyoming, indicated recently that approximately 1.5 billion more barrels of Wyoming oil are recoverable with available enhanced recovery techniques. About one-third of that could be recovered over the next 30 years. Terry was one of several speakers at the first Wyoming Enhanced Oil Recovery Symposium spon-

sored by the University of Wyoming and held recently in Casper.

In the May 21st oil and gas lease sale held by the State of Wyoming, the high bid was submitted by Charles Kerr at \$350 per acre for a 160-acre tract in northern Campbell County. High bids at the sale totaled \$936,373.70. The average bid per acre was \$26.55. One hundred seventeen of 199 tracts offered for lease received bids.

Exploration in the Overthrust Belt is again in the news. Unconfirmed reports indicate Mesa Petroleum has completed a discovery in Jurassic Nugget Sandstone just south of the town of Evanston. Details have not been released according to Petroleum Information Corporation. Also, Amoco Production announced the completion of a Triassic Thaynes discovery just north of Chicken Creek Field approximately seven miles southwest of Evanston. The well flowed gas at 589,000 cubic feet per day from a depth of 15,700 feet. The nearest Thaynes production is 22 miles to the north in the Whitney Canyon - Carter Creek area.

The Powder River Basin continues as the dominant site for oil exploration activity in the State. Several new discoveries have been completed, the most significant being a prolific Frontier oil discovery by Jerry Chambers Exploration 25 miles northeast of Casper in the Sand Dunes Field area. The well flowed 1,100 barrels of oil and 2.2 million cubic feet of gas from below 11,000 feet.

The importance of the Minnelusa play in the Powder River Basin is illustrated in a recent Petroleum Information article which listed 45 rigs working in the Powder River Basin as compared to 57 rigs in the Bighorn, Wind River, and Green

River Basins combined. Activity in Campbell County is especially high with 186 wildcats completed through April of this year. Of these completions, 23 opened new fields and 17 tapped the Minnelusa at depths ranging from 7,000 to 15,000 feet according to an article by Irving Garbutt in the May issue of *Western Business*.

#### COAL UPDATE

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

The assessed value of the 130.7 million tons of coal produced in Wyoming in 1984 was about \$1.23 billion, an increase over 1983's \$1.15 billion. Taxable production, which is less than actual production because Federal and State royalties (converted to tons) are not included, was 125.9 million tons, an increase of 18 million tons over 1983's 107.9 million tons. Despite coal's increased total valuation, the average value per ton has decreased for the second consecutive year. After reaching an all-time high value of \$10.71/ton in 1982, the value dropped to \$10.67/ton in 1983 and \$9.77/ton in 1984. This eight percent decrease in average value per ton reflects the increased production of lower cost coal from the Powder River Basin. Only low-Btu lignites from Texas and North Dakota are cheaper than coal from the Wyoming portion of the Powder River Basin.

In the last few months, the future of coal mining operations in the Hanna Basin of south-central Wyoming dimmed further. In May, Arch Mineral Corporation announced it would shut down its dragline at Seminoe No. 1 (laying off 12 of the 39 workers presently employed at the mine) by the end of the summer. Medicine Bow Coal Company, a subsidiary of Arch and Union Pacific, also announced the end of

Table 2. Coal deliveries from Wyoming, in thousands of short tons, 1983, 1984, and 1985.

|           | REPORTED DELIVERED TONNAGE <sup>1</sup> |                    |                 |                    |                 |                    |
|-----------|---|--------------------|-----------------|--------------------|-----------------|--------------------|
|           | 1983<br>MONTHLY                         | 1983<br>CUMULATIVE | 1984<br>MONTHLY | 1984<br>CUMULATIVE | 1985<br>MONTHLY | 1985<br>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           |                 |                    |
| MAY       | 8,364.6                                 | 44,643.5           | 9,481.5         | 48,272.7           |                 |                    |
| JUNE      | 8,330.2                                 | 52,973.7           | 9,464.5         | 57,737.2           |                 |                    |
| 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 <sup>2</sup> |                    |                 |                    |                 |                    |
|           | 5,520.0                                 |                    | 6,322.5         |                    |                 |                    |
|           | TOTAL TONNAGE PRODUCED <sup>3</sup>     |                    |                 |                    |                 |                    |
|           | 112,187.9                               |                    | 130,745.8       |                    |                 |                    |

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

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

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

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 <sup>1</sup> |
| Undiscovered   | 7.6 billion barrels <sup>1</sup>  |
| Total  | 21.1 billion barrels              |
| Remaining Reserve Base (January 1, 1985)   |                                   |
| Measured reserves (Proved reserves)  | 0.9 billion barrels <sup>2</sup>  |
| Indicated and Inferred reserves  | 2.8 billion barrels <sup>3</sup>  |
| Total  | 3.7 billion barrels               |

NATURAL GAS

|  |                                       |
|--|---------------------------------------|
| Remaining Resources (January 1, 1985)  |                                       |
| Discovered   | 19.8 trillion cubic feet <sup>1</sup> |
| Undiscovered (there is another 35 trillion cubic feet of noncombustible CO <sub>2</sub> gas) | 58.0 trillion cubic feet <sup>1</sup> |
| Total  | 77.8 trillion cubic feet <sup>1</sup> |
| Remaining Reserve Base (January 1, 1985)   |                                       |
| Measured reserves (Proved reserves)  | 10.1 trillion cubic feet <sup>2</sup> |

COAL

|  |                                 |
|--|---------------------------------|
| Remaining Resources (January 1, 1985)                                  |                                 |
| Identified (Discovered)  | 136.4 billion tons <sup>4</sup> |
| Undiscovered   | 800.0 billion tons <sup>5</sup> |
| Total  | 936.4 billion tons              |
| Remaining Reserve Base (January 1, 1985)                               |                                 |
| Demonstrated strippable (Measured and indicated reserve base)          | 27.5 billion tons <sup>4</sup>  |
| Demonstrated underground-minable (Measured and indicated reserve base) | 38.4 billion tons <sup>4</sup>  |

|   |   |
|---|---|
| TOTAL.....                                  | 65.9 billion tons                                 |
| <u>TRONA</u>                                |   |
| Original Resources (1983 estimate)          |   |
| Trona.....                                  | 81.7 billion tons <sup>6</sup>                    |
| Mixed trona and halite.....                 | 52.7 billion tons <sup>6</sup>                    |
| Total.....                                  | 134.4 billion tons                                |
| <u>URANIUM</u>                              |   |
| Remaining Resource (January 1, 1983).....   | 995,000 tons <sup>7</sup>                         |
| Remaining Reserve Base (January 1, 1983)    | <u>ORE</u>  |
|   | U <sub>3</sub> O <sub>8</sub>                     |
| Ore recoverable at \$30 or less/ton.....    | 29.4 million tons..... 39,700 tons <sup>7</sup>   |
| Ore recoverable at \$30.01-\$50.00/ton..... | 225.1 million tons..... 151,500 tons <sup>7</sup> |
| 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 <sup>8</sup> |

1 Modified from Barlow, J.A., Jr. and Doelger, M.-J., 1983, Wyoming mineral resources: Barlow and Haun, Inc., Casper, 14 p.

2 Energy Information Administration, 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.

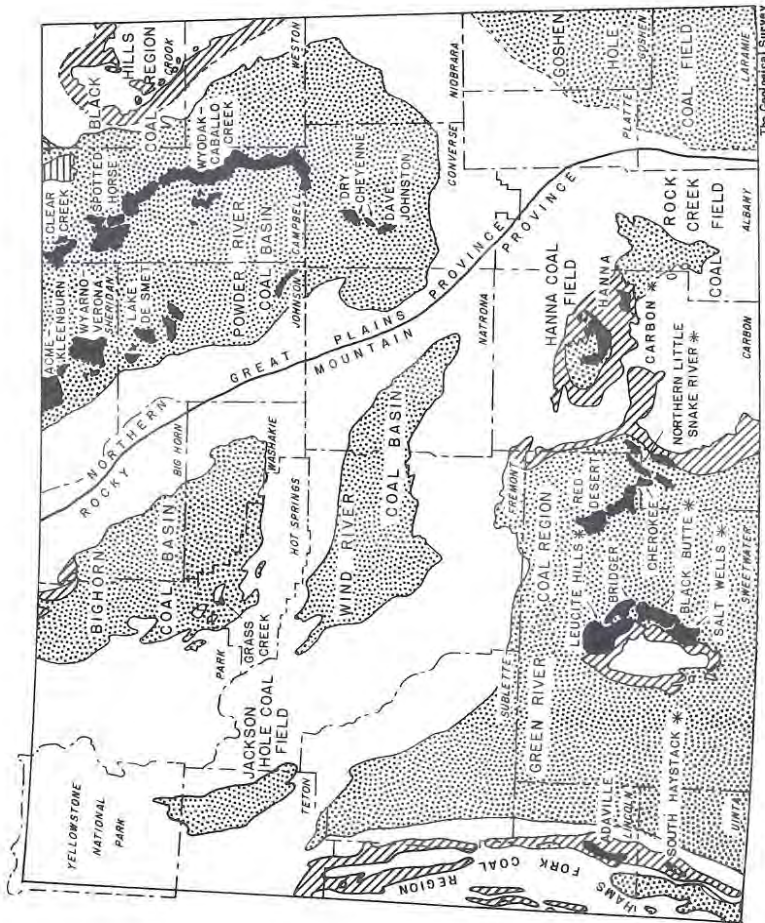
6 Culbertson, W.C., 1983, Genesis and distribution of trona deposits in Wyoming (abstract) in Genesis and exploration of metallic and nonmetallic mineral and ore deposits of Wyoming and adjacent areas: Geological Survey of Wyoming Public Information Circular 19, p. 34.

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.




coal production from its Medicine Bow Mine in July when a contract with Iowa Public Service expires. The companies have been unable to secure any new coal contracts for these two mines. This will leave Arch with only one operating mine in the basin, the Seminole No. 2 Mine; the company is still negotiating to renew a 1.5- to 2.0-million-ton-per-year contract for coal from this mine.

The future of the State's only underground coal mine, Carbon County Coal Company's Carbon County No. 1, is also very uncertain at this time. This mine, also located in the Hanna Basin, was notified by its sole customer, Northern Indiana Public Service Company (NIPSCO), that they would not take coal from the mine after May 20, 1985. Subsequently, NIPSCO filed suit in U.S. District Court in Hammond, Indiana, to break the utility's 20-year contract with the mine. NIPSCO's suit alleged that price escalations in the last seven years had boosted the price of coal at the mine from \$24.33 to \$43.44 a ton and that a two-year supply of Carbon County coal is stockpiled at the plant because it is too expensive to use in generating power at the utility's Schahfer No. 14 plant at Wheatfield, Indiana. A preliminary injunction filed by Carbon County Coal Company to temporarily continue the shipments to NIPSCO was issued shortly before the May 20th deadline; hearings continued on another preliminary injunction filed by Carbon County Coal to continue coal deliveries until the lawsuit filed by NIPSCO goes to trial later in the year. Meanwhile, negotiations attempting to settle the contract dispute continue. If NIPSCO is successful in voiding their contract with Carbon County Coal, many observers feel that the mine would be forced to close, laying off nearly 300 miners and severely impacting the town of Hanna as well as Carbon County.



The Geological Survey  
of Wyoming  
1984

### EXPLANATION

-  Subbituminous
-  Bituminous
-  Lignite
-  Strippable Deposits

\* Preliminary: based on company data

## COAL-BEARING REGIONS OF WYOMING

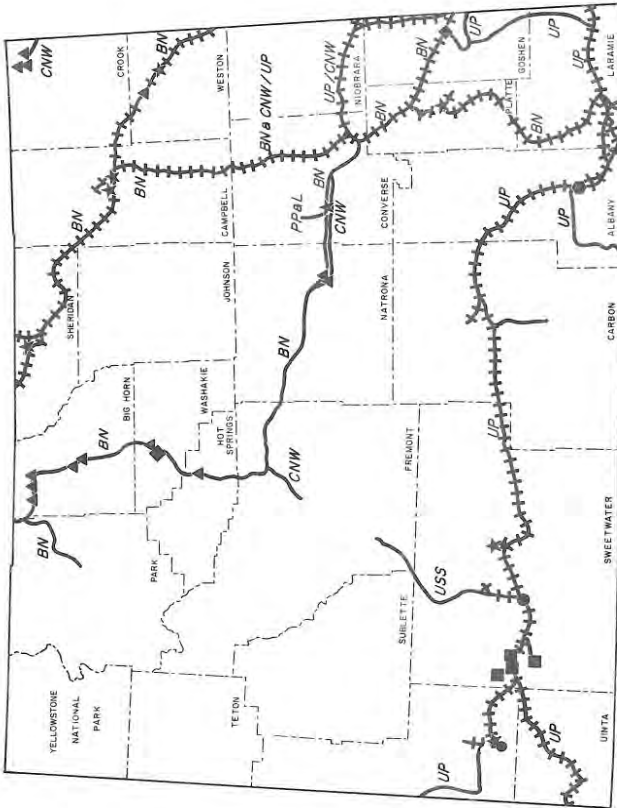


Two other Wyoming coal companies, Black Butte and Big Horn (both affiliates of Peter Kiewit Sons), recently won Federal court cases filed against them by their major contract coal customer, Commonwealth Edison. The Illinois utility had attempted to use a contract provision to decrease its coal deliveries from the Black Butte coal mine east of Rock Springs from 5.9 to 4.4 million tons per year over a ten-year period (1989-1999). Commonwealth Edison had argued that the coal from Black Butte was of poor quality and was jeopardizing their environmental operating permit. The jury found that the utility did not have good reason to reduce its contracted demand and that the utility would have to accept the 15 million tons of coal, worth about \$450 million. The jury also awarded Black Butte \$13,348 in damages because the utility did not pay full price for some of the coal delivered, but denied another damage claim to Black Butte for coal that was refused at the utility's plant because of an equipment breakdown.

Big Horn Coal Company, which operates a surface mine just north of Sheridan, was awarded \$492,868 in damages from Commonwealth Edison for coal the utility did not buy because of an equipment problem at their plant in Waukegan, Illinois. Big Horn also was awarded \$237,020 in damages because the utility did not pay full price on some of the delivered coal. Commonwealth Edison is involved in five other lawsuits against Kiewit affiliates. Some observers have noted that Commonwealth's growth rate has slowed from 7.6 percent to about 1.5 percent (creating a coal oversupply that reportedly will exceed 33 million tons by 1994) and that four new nuclear reactors due to begin operation in the late 1980's, will alter the utility's fuel needs from 50 percent coal to 30 percent coal by the late 1980's.

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.
- PP&L Pacific Power and Light
- Unit Coal Train Route



RAILROAD ROUTES AND  
MAJOR COAL USERS IN WYOMING

In coal contract news, Kansas City Power and Light Company announced in late March that Rochelle Coal Company, a wholly-owned subsidiary of Peabody Holding Company, had been awarded a contract for 10.8 million tons of coal over 14 years beginning in April, 1986. The coal would come from the Rochelle Mine (located between the North Antelope and Black Thunder mines), which is currently under construction, and would be delivered to the utility's Hawthorn and Montrose generating stations in Missouri. Rochelle also has a coal supply contract with Northern States Power Company in Minnesota.

Carter Mining Company (a subsidiary of Exxon Coal USA) recently signed a six-month contract for 200,000 tons per month with the City of Austin, Texas, and the Lower Colorado River Authority. The coal from Carter's Caballo mine will be used to replace coal from a recently-cancelled contract the utilities had with the Decker Mine in Montana. The published cost of the coal is \$4.98 per ton (F.O.B. mine) with transportation charges of \$22 per ton. Wisconsin Power and Light, which began accepting coal for its new Sheboygan Plant from Thunder Basin Coal Company's Black Thunder Mine in March of this year, appears to have chosen this mine for a 1.2-million-ton-per-year contract to its plant at Columbia, Wisconsin. Although no final contract has yet been announced, the utility has accepted temporary shipments to the plant via the Chicago and North Western Transportation Company. The railroad company is also hauling the coal on a temporary basis.

Competition appears to be keen for a 2.5-million-ton-per-year coal contract and a coal transportation contract for Northern States Power Company's new 800-megawatt Sherio 3 generating plant in Minnesota. This contract is significant because three Montana coal companies (traditional

suppliers to this market area) are in competition with four Wyoming coal producers. The State of Montana recently passed legislation reducing severance taxes on coal produced under new contracts signed or extended between January 1, 1985, and June 30, 1987. If a Montana company wins this contract, it may demonstrate that a reduction in the current 30 percent severance tax rate in Montana can help that state's coal industry and would lend support to those favoring a permanent coal tax reduction in Montana.

In coal transportation news, both Chicago and North Western Transportation Company (C&NW)/Union Pacific (UP) joint venture and Burlington Northern (BN) have recently announced new coal transportation contracts for coal haulage out of Wyoming. The fifth major contract signed by the C&NW/UP venture is with the City Public Service Board of San Antonio, Texas, to haul 3.3 million tons of coal from the Cordero Mine via a new spur line (to Coal Creek Junction). Cordero hopes to complete the new line by October, 1985. The joint venture also signed a 6-month contract with the Lower Colorado River Authority to haul 0.75 million tons from the Black Thunder or Coal Creek Mines to LaGrange, Texas. Evidently, negotiations are continuing for a longer term contract.

Burlington Northern has been very active in securing several long-term transportation contracts, including a 15-year contract for 8.7 million tons per year with Utility Fuels/Houston Lighting and Power, a 28-year contract for eight million tons per year with Kansas Power and Light, and a 17-year contract with Southwestern Public Service Company of Amarillo, Texas. The railroad company also signed a three-year, three-million-ton-per-year contract with Grand River Dam Author-

ity to transport coal to Pryor, Oklahoma, and a 3-month contract with the Lower Colorado River Authority to transport coal to Fayette, Texas.

In other market news, it now appears that the Dry Fork Coal property located between the Fort Union and the Eagle Butte Mines north of Gillette is on the sales block again. Phillips Petroleum Company, which had acquired the property several years ago from Cities Service Corporation, was proceeding with a mining permit at the time the decision was reached to sell the property. The Dry Fork property reportedly contains about 350 million tons of coal reserves and is being sold along with Phillips' lignite properties in other states in an attempt to raise funds to pay off debts resulting from its successful defense against corporate takeover last year. Phillips purchased the property in late 1982 when Cities Service, in a move similar to that of Phillips, began liquidating its assets to reduce the debt that was incurred when Cities Service was absorbed by Occidental Petroleum. In 1980, Cities acquired the property, which reportedly includes 5,000 acres of coal under lease and 7,600 acres of surface rights, from Peabody Coal Company for \$77 million. The property is rumored to have cost Phillips only \$20 million.

It was also announced in March that the U.S. Synthetic Fuels Corporation had eliminated World Energy Corporation's proposed Byrne Creek *in situ* gasification project in western Wyoming from competition for Federal subsidies to aid in its development. The project was one of five projects dropped by the Synfuels Corporation, primarily because the Corporation felt that the technology for these projects was so close to commercial development that private industry could use the technology without government subsidies.

Table 3. Coal Production and forecast to 1990 (millions of tons).

|                                      | 1981           | 1982  | 1983  | 1984  | 1985  | 1986  | 1987  | 1988  | 1989  | 1990  |
|--------------------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Campbell County                      | 71.6           | 81.2  | 88.2  | 106.8 | 109.2 | 111.5 | 112.0 | 112.5 | 113.0 | 113.2 |
| Converse County                      | 3.6            | 3.4   | 2.7   | 3.3   | 5.4   | 5.0   | 6.0   | 6.3   | 6.3   | 8.6   |
| Sheridan County                      | 2.8            | 3.0   | 2.9   | 2.5   | 3.0   | 3.0   | 3.0   | 3.0   | 2.7   | 1.2   |
| Carbon County                        | 8.5            | 5.0   | 4.8   | 5.1   | 5.0   | 5.0   | 5.0   | 5.0   | 5.0   | 5.0   |
| Sweetwater County                    | 11.2           | 11.0  | 9.5   | 8.9   | 9.5   | 9.5   | 10.5  | 11.5  | 12.5  | 12.5  |
| Lincoln County                       | 5.0            | 4.3   | 4.0   | 4.1   | 4.0   | 4.0   | 5.0   | 5.0   | 5.0   | 5.0   |
| Hot Springs County                   | M <sup>2</sup> | M     | M     | M     | M     | M     | M     | M     | M     | M     |
| Total Wyoming                        | 102.8          | 107.9 | 112.2 | 130.7 | 134.0 | 138.0 | 141.5 | 143.3 | 144.5 | 145.5 |
| Increase per year                    | 9%             | 5%    | 4%    | 16.5% | 2.5%  | 3%    | 2.5%  | 1%    | 1%    | 1%    |
| Estimated contract-<br>ed production | 110.0          | 119.0 | 122.6 | 133.0 | 137.0 | 143.0 | 144.5 | 144.5 | 144.5 | 145.5 |
| Below contract                       | 7%             | 9%    | 8%    | 2%    | 2%    | 4%    | 2%    | 1%    | 0%    | 0%    |

<sup>1</sup> These are actual values for comparison. <sup>2</sup>M means minor tonnage (less than 0.1 million tons). Forecast by Wyoming Geological Survey, March, 1985

In Federal coal leasing, several developments are of interest. On April 30th a competitive emergency coal lease sale was held in Cheyenne. The lease area, known as Tract 98, encompasses 164.81 acres of coal adjacent to Pittsburg and Midway Coal Mining Company's Kemmerer mine in western Wyoming. The tract contains six minable coal beds with total inplace reserves of 3.8 million tons. Pittsburg and Midway was the apparent high bidder with a bid of \$910 per acre or a total bonus bid of \$150,150. Energy Alliance Partnership W-85 of Houston, Texas, submitted the only other bid on the tract. Also of interest, although not directly affecting Wyoming coal leasing, was the May 30th ruling by a U.S. District Judge in Billings, Montana, that voided the 1982 coal lease sale of Montana coal tracts. The Judge decided that the environmental impact statement, which was written prior to the lease sale, did not address potential social and economic effects of the lease sale on the Northern Cheyenne Indian Tribe. Western Energy Company, the winning bidder on three of the tracts, had already begun mining on two of the tracts at their Rosebud Mine near Colstrip. The effect of this decision on the Wyoming tracts leased in 1982 remains unclear.

Of interest to Wyoming, both the Powder River Basin and Green River/Hams Fork Regional Coal Teams met in June in response to coal leasing interest. No timetables for renewed leasing have been announced as a result of the meetings.

## SUMMARY OF MINERAL EXPLORATION IN WYOMING - 1984

by W.D. Hausel, Deputy Director; R.W. Jones, Coal Geologist; and R.E. Harris, Uranium and Industrial Minerals Geologist, Geological Survey of Wyoming

### Metals and Diamond - W.D. Hausel

During 1984, exploration activities related to metals in Wyoming were very limited compared to the previous three years of the current decade. There was exploration for gold in Archean (>2.5 billion years old) metasedimentary-metavolcanic supracrustal piles. Some limited grass roots activities focused on the search for gold in paleoplacers hosted by 2-billion-year-old metaconglomerates, and on gold in Tertiary and Recent placers. Some exploration was also reported for zinc-silver-copper volcanogenic massive sulfides and for silver-copper stratiform mineralization in 1.7-billion-year-old Proterozoic quartzites. Exploration for diamond deposits continued.

Exploration for gold in Wyoming's Archean supracrustal belts centered on the South Pass and Copper Mountain areas. In the South Pass granite-greenstone belt along the southern edge of the Wind River Mountains, Freeport Exploration continued to consolidate a favorable land position along the eastern edge of the greenstone belt. A few other companies conducted some very basic exploration in the region. Both auriferous shear zone deposits hosted by metagreywacke and chemical sediments occur in this region.

At the historic Carissa gold mine, several miles west of Freeport Exploration's properties, a



mining company from Salt Lake City constructed a new headframe over the primary shaft, cleared the shaft of debris, and began dewatering the workings. The Carissa Mine was one of the two largest lode gold producers in the State and averaged 0.32 ounce of gold per ton.

An association of miners and prospectors in Atlantic City in the central part of the South Pass supracrustal belt, reopened the portals of a few historic mines. These and several other mines were mapped by the Geological Survey of Wyoming during 1984. Local prospectors also recovered several ounces of gold from the Meadow Gulch placers near Miners Delight.

With joint funding from the U.S. Geological Survey, the Geological Survey of Wyoming plans to accelerate its project to map the South Pass granite-greenstone belt. The belt contains two mining districts separated by several square miles of relatively unexplored metamorphics. The South Pass-Atlantic City District was last mapped during the late 1960's, and the Lewiston District was previously unmapped. During the 1984 field season, a preliminary geologic map of the Lewiston District was completed and several samples were collected from the major mines in the district for assay and studies of wall-rock alteration. Assays of the mine samples showed a trace to 1.3 ounces of gold per ton. A few hand specimens containing native gold were also collected. Assays of samples from an oxide facies iron formation located along the northeastern edge of the district ran 0.01 to 0.04 ounce of gold per ton and no detectable silver to 0.10 ounce of silver per ton. The Survey will continue its mapping in both the Lewiston District and the South Pass-Atlantic City District.

Also in the South Pass region, U.S. Steel Corporation sold its Atlantic City iron mine to Universal Equipment Company of Fremont, Ohio. More than 90 million tons of iron ore were mined from 1962 to 1983 before U.S. Steel ceased operations. Universal reportedly has a contract to supply the State Highway Department with road aggregate and will auction all mobile equipment from the property. No other plans have been announced even though the mine reportedly contains more than 10 years of iron ore reserves.

The Copper Mountain District of the Owl Creek Mountains received some exploration for stratiform gold and tungsten. At the end of the year, the Geological Survey of Wyoming published a report on the economic potential of the district (Hausel and others, 1985).

In other supracrustal belts in the State, the Garrett region along the western flank of the Laramie Range in eastern Wyoming was also explored for stratiform gold by a major mining company. The Geological Survey of Wyoming briefly examined this region and identified a potential target at the contact of a micaceous quartzite and amphibolite. The mineralized zone can be traced for approximately one mile, and at one locality, samples containing arsenopyrite and berthierite assayed 0.25 ounce of gold per ton.

Some activity was reported at Bradley Peak in the Seminoe Mountains greenstone belt. This area attracted international interest in 1981 after the Geological Survey of Wyoming discovered auriferous quartz veins and iron formation, which assayed greater than one ounce per ton. Both Kerr-McGee and Timberline Minerals have land positions in the area.

At least one company conducted exploration for Witwatersrand-type gold deposits in southeastern Wyoming. Proterozoic metaconglomerates in miogeoclinal basins in the Medicine Bow and Sierra Madre mountains have many similarities to the gold-rich South African paleoplacers. The uranium and thorium contents of the metaconglomerates were initially examined in the late 1970's by the University of Wyoming's Department of Geology and Geophysics. One sample collected by the University contained 10 ppm gold.

Gold was also sought by several local prospectors. In the Big Creek District along the west flank of the Medicine Bow Mountains, two prospectors found a rich quartz vein. A channel sample, which the Geological Survey of Wyoming took across the vein, assayed 1.4 ounces of gold per ton. The vein and claim were later bisected by the boundary of the Savage Run Wilderness, and the U.S. Forest Service denied surface access to a large portion of the vein. In the Douglas Creek District on the eastern flank of the Medicine Bow Mountains, some placer gold and platinum were recovered by prospectors.

In other placers around the State, some interest was expressed in the Dickie Springs-Oregon Gulch dry placer located in boulder conglomerates of the Wasatch Formation (Tertiary). This deposit lies 6 to 8 miles south of the South Pass greenstone belt. The U.S. Geological Survey estimates that the deposit may contain more than 28.5 million ounces of gold.

The Goshen Hole and Wind River placers received a cursory examination by consultants. The Goshen Hole placers lie near the Wyoming-Nebraska state line along Horse Creek. Early reports indicate

that noseum (invisible) gold was discovered in three to twelve feet thick gravel deposits. Average samples assayed 0.014 ounce of gold per cubic yard. The highest reported assay was 0.047 ounce of gold per cubic yard.

The Wind River placers occur in the Wind River Basin and extend outward from the Wind River for several miles, where they occur in terrace deposits. The gold is very fine grained. According to the U.S. Bureau of Mines, the richest placers were reportedly near Riverton, Wyoming, where the gravels averaged 0.014 ounce of gold per cubic yard and ran as high as 0.04 ounce per cubic yard.

Some activity for base metals and silver was reported in the southern Sierra Madre mountains. Timberline Minerals over-staked the now defunct Conoco Minerals' zinc-silver-copper volcanogenic massive sulfides; a West German-owned company conducted limited exploration in the same region. Some activity was reported north of the massive sulfide deposits in the vicinity of the Ferris-Haggarty Mine. At the turn of the century, the Ferris-Haggarty was considered a world class copper mine. The mine is located in a thick quartzite and contains stratiform and remobilized mineralization. Assays of dump material collected by the Geological Survey of Wyoming in 1983 assayed 3.23 percent copper and 0.61 ounce of silver per ton. Another sample of cupriferous quartzite produced a gold bead that assayed 0.06 ounce per ton of combined gold and silver. The Ferris-Haggarty is thought to be a Troy-type deposit although it has been affected by greater deformation and metamorphism than has the Troy Mine in Montana.

Exploration for diamond-bearing kimberlite was conducted by Cominco American Incorporated, the

Geological Survey of Wyoming in cooperation with the University of Wyoming, and by Superior Minerals. The Geological Survey of Wyoming and the University of Wyoming carried out research efforts to locate kimberlite by remote sensing methods. The State Survey also discovered a new kimberlite district in the Pole Mountain region of the Laramie Range.

Testing by Cominco American and Superior Minerals in the Colorado-Wyoming State Line District produced estimated grades of 0.01 and 0.2 carat per ton on their respective properties. Diamonds up to one carat weight were recovered with gem quality to industrial quality ratios equal to many South African diamond mines.

During 1984, the following papers were published, or completed for publication by the Geological Survey of Wyoming's "hard rock" Minerals Section.

Hausel, W.D., 1984, Preliminary geologic map of the Lewiston gold district, South Pass, Wyoming: Geological Survey of Wyoming unpublished mineral report MR 84-7, scale 1:24,000.

Hausel, W.D., 1984, Tour guide to the geology and mining history of the South Pass gold mining district, Fremont County, Wyoming: Geological Survey of Wyoming Public Information Circular 23, one sheet, colored.

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., and Jones, R.W., 1984, Self-guided tour to the geology of a portion of southeastern Wyoming: Geological Survey of Wyoming Public Information Circular 21, 44 p.
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- Harris, R.E., and Hausel, W.D., 1984, Mineral resources of Permian and Pennsylvanian rocks in Wyoming: Wyoming Geological Association 35th Annual Field Conference Guidebook, p. 369-381.
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#### Coal - R.W. Jones

In 1984, coal exploration activity in Wyoming was at its lowest level in many years. Although the State's 1984 coal production of 130.7 million short tons represented a surprising 16.5 percent increase over 1983 production, coal prices continued to fall in response to a soft coal market and a large productive overcapacity. With falling prices, the industry was forced to improve the efficiency of their operations, resulting in tightened or limited budgets, decreased employment (but higher productivity), and more emphasis placed on production and development than on

exploration. The current coal mine overcapacity, large uncommitted reserves, and soft market have decreased incentives to explore or develop new or additional properties, at least on the shorter term.

During the year, coal exploration by the Federal Government was up slightly over 1983, but still lower than previous years. As was the case in 1983, most Federal drilling in 1984 was done to evaluate specific tracts in anticipation of future leasing. For the second year in a row, no Federal coal exploration was done under contract in Wyoming. A Federal agency, traditionally involved in coal exploration, the Geologic Division of the U.S. Geological Survey, was conspicuously absent in Wyoming in 1984. This agency, which normally drills a number of holes for coal research and coal bed correlations, was plagued by severe restrictions on manpower and budget in 1984.

The U.S. Bureau of Land Management (BLM), operating a drill rig out of the Casper District, drilled 76 coal exploration holes for a total of 27,381 feet in 1984. In the Casper District (Powder River Basin), 26 coal exploration holes were drilled. Eleven holes were drilled in the Worland District (Bighorn Basin), and 39 holes were drilled in the Rawlins District (Hanna Basin and Carbon County). Of these totals, 12 core holes were drilled and about 232 feet of core were recovered. Most of the recovered cores were coal and were used for chemical analysis. An additional 98 holes were drilled in Sheridan County on unleased Federal coal via a cooperative project between BLM and private industry.

Coal exploration by private industry under Federal coal exploration licenses (on unleased

Federal coal) resulted in the drilling of 145 holes for a total of 28,099 feet. This total is significantly lower than the 506 holes drilled in 1983. Drilling was done on only three exploration licenses, with two projects in Sweetwater County and one project in Carbon County. Exploration by private industry under Federal coal exploration permits (on leased Federal coal) or within areas permitted by the State of Wyoming (including both State and privately-owned coal) resulted in the drilling of another 930 holes, totaling about 253,470 feet. These statistics may include some development drilling, but do not include drilling of water observation wells, soil test borings, or drilling for the delineation of burned-out coal areas (clinker areas).

At the end of 1984, only five Federal exploration licenses, held by four companies, were in effect. These companies were Nerco Mining, Ark Land, Anaconda Minerals, and Northwestern Resources; their licenses encompassed a total area of about 21,430 acres. Only one application for a Federal exploration license was filed in 1984. This application was filed by Texas Energy Services, Inc. for exploration of 232.5 acres in Campbell County. During the year, eight exploration licenses, held by seven companies and covering a total of 62,870 acres, expired. No Federal coal exploration licenses were issued in 1984.

It appears that the decreased exploration activity in Wyoming may also be related to uncertainties about the future of the Federal coal leasing program. Many companies involved in coal exploration are adopting a "wait and see" attitude on Federal leasing before committing funds to exploration. A draft environmental impact state-



ment on the Federal leasing program is currently circulating and will form the basis for the decisions on how Federal coal leasing will proceed. In the meantime, the Department of the Interior is processing applications for emergency lease sales and preference right leases and has scheduled a sale of two special lease tracts in Colorado and Wyoming for May, 1985.

### Uranium - R.E. Harris

Wyoming uranium production decreased in 1984 after a slight increase in 1983 that was caused by the milling of uranium ore that had been mined in previous years and stockpiled in the mine. No uranium mines or mills closed in 1984. In 1984, there were five uranium mines and four mills operated by three producers in Wyoming. COGEMA, a French conglomerate, owns Pathfinder Mines and remained Wyoming's largest producer, operating three mines and two mills. Bear Creek Uranium, a subsidiary of Union Pacific Corporation, continued to mine under a utility contract in the Southern Powder River Basin Uranium District. Getty Oil also produced uranium in 1984, but was purchased by Texaco at the end of 1984.

In 1984, exploration for uranium in Wyoming was almost nonexistent outside of the major uranium districts where a few companies continued to conduct limited exploration and assessment drilling to hold property. COGEMA, Getty Oil, Rocky Mountain Energy, Sequoyah Minerals, Teton UNC Exploration, Union Carbide, Uranium Resources, and Western Nuclear were among those still maintaining uranium property. Teton UNC, however, closed their drilling operations and sold their equipment, citing a lack of need for uranium drilling.

There was some interest in easily-leachable uranium occurrences in the Ogallala Formation (Miocene) in eastern Wyoming. These are similar to a discovery in nearby western Nebraska. A few companies conducted surface and well-log studies in that area. No drilling or property acquisition was reported, however.

One exception to the exploration doldrums of 1984 occurred in June, when the U.S. Bureau of Land Management opened 1,700 acres of previously withdrawn land on Green Mountain southeast of Jeffrey City in the Green Mountain-Crooks Gap Uranium District. A staking rush began at 10 AM on June 18th, when Western Nuclear, U.S. Energy, and COGEMA began setting discovery posts on the mountain. For a day, the scene was a nostalgic reminder of the uranium industry as it was in the late 1960's.

The Geological Survey of Wyoming continued its efforts in assessing the potential for nonconformity-type uranium deposits in Wyoming. The Survey conducted field evaluations of several horizons where reductant-bearing igneous or metamorphic rocks are nonconformably overlain by oxidized permeable or formerly permeable sandstones. Considering the extremely large reserves of this type of uranium occurrence in both Canada and Australia, nonconformity-type uranium occurrences appear to offer the greatest exploration potential.

Other uranium-related activities by the Geological Survey of Wyoming include the compilation and classification of uranium occurrences in Wyoming, and a study of the natural surficial

background gamma radiation across the State.<sup>1</sup>

### Trona (Soda Ash) - R.E. Harris

Trona production in Wyoming, from which 90 percent of the Nation's soda ash (refined trona) is produced, decreased slightly in 1984 as the disposable glass market and exports decreased, offsetting an increase in all the other uses for soda ash. Trona remained Wyoming's number one non-hydrocarbon mineral resource in terms of dollar value of production despite an 18 percent decrease in price.

Competition was fierce between the five trona mining and refining operations in the Green River Basin in southwestern Wyoming as each strove for its share of the market. The industry as a whole operated at only 70 percent of announced plant capacity in 1984.

In 1984, FMC Corporation conducted tests on the *in situ* extraction of trona from a trona deposit, delimited by recent exploration drilling. This *in situ* mine was permitted in 1984 after it was contested by other trona producers on environmental grounds. After extraction, the pregnant (trona-bearing) solution will be piped to processing facilities near FMC's underground mine.

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<sup>1</sup>See new publications listed at the back of this issue of Wyoming Geo-notes.

## Industrial Minerals - R.E. Harris

Exploration and development work continued in 1984 for industrial minerals produced in Wyoming and for some commodities not currently produced. Bentonite, construction aggregates, gypsum, limestone and dolomite, sodium sulfate, and sugar rock producers continued to develop their reserves. Although production of all of these commodities except sugar rock increased in 1984, declines in price kept the dollar value of production and the producers' revenues equal to or lower than that of 1983.

Companies continued to express interest in developing a silica sand resource in southern Wyoming near the soda ash producers. Short transportation distances would make a glass plant attractive in this area.

The anorthosite body in southeastern Wyoming's Laramie Mountains has been considered a possible source of silica and alumina for such an industry. Alcoa maintained its property position in the anorthosite body. Anorthosite and the associated black syenite rock body are also being considered as a source for monument stone.

Phosphate is produced in Wyoming from ore mined in Utah and Idaho. Chevron's new phosphate plant south of Rock Springs is under construction as is the 95-mile-long slurry pipeline from north of Vernal, Utah, to the Rock Springs plant. Phosphate leases in western Wyoming were renewed by existing operators.

There was some interest in 1984 for limestone and dolomitic limestone for crushed rock aggregate in southeastern Wyoming. Several construction

companies were developing an information base for this resource in anticipation of construction requirements for the MX missile system. No leases were taken, however, as the future and (or) size of this project remains uncertain.

Several companies maintained an interest in zeolite properties in the Washakie Basin and Beaver Rim areas of Wyoming. One company shipped several tons of zeolite ore for research and amenability testing. Zeolites are natural ion-exchange compounds with possible uses in industrial refining, water treatment, deodorizing compounds, and pollution control.

The Geological Survey of Wyoming is conducting research into zeolites by identifying areas of occurrence and determining mineralogical differences. The Survey is also investigating the variability in the rheologic, chemical, and mineralogical properties of different bentonite beds as well as the geographic variability of these parameters within a particular bentonite bed.

Industrial mineral production in Wyoming should show a small increase in 1985. Exploration for industrial minerals is mainly dictated by the economies of minability and quality control since the supply of Wyoming's industrial minerals is much greater than current demand.

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*NOTE: This summary was prepared for and first published in Mining Engineering Magazine (volume 37, no. 5, May, 1985).*

## EARTHQUAKES DISCUSSED IN ROCK SPRINGS

In June, Jim Case, Staff Environmental Geologist, presented an *Overview of Historical Earthquakes and Geological Hazards in Wyoming* to the Governor's Workshop on Earthquake Hazards in Wyoming. The workshop, which was held in Rock Springs, Wyoming, brought participants from across the State as well as from neighboring states.

The first portion of the overview reviewed historical earthquake records in Wyoming. Newspapers and other sources dating back to the 1880's were searched for their accounts of earthquakes. This information proved very useful in refining epicenter locations and earthquake intensities. An updated statewide map of earthquake locations, dates, magnitudes, and intensities was presented, as were more detailed discussions and maps of epicenters for seven areas of the State. It was obvious from these data that the earthquakes of 1984 were not solitary or totally unique occurrences.

Five geological hazards directly or indirectly associated with earthquakes were also discussed. The hazards were active faults, landslides, mine subsidence, liquefaction, and shrinking-swelling clays. Examples of specific earthquake-related occurrences were presented for all these hazards except shrinking-swelling clays.

Two geologic hazards not related to earthquakes were also discussed. They were windblown sand deposits and geologic formations that contain enough selenium to support various types and concentrations of selenium-concentrating plants. There have been many accounts of livestock in

Wyoming either killed or deformed by ingesting selenium-concentrating plants.

Maps of all the hazards were presented. The Geological Survey of Wyoming plans to publish the maps as Open File Reports in the near future.

Also, Rod DeBruin, Staff Stratigrapher, presented An *overview of Wyoming's geology*. The geology of western Wyoming was emphasized, and its relationship to earthquakes was highlighted.

#### BIGHORN MOUNTAINS PROJECT

Rod DeBruin, Staff Stratigrapher, notes that work is progressing on his mapping project on the southeastern flank of the Bighorn Mountains. This project is being conducted in cooperation with the U.S. Geological Survey under the COGEOMAP Program. During this first year, at least two 7 $\frac{1}{2}$ -minute quadrangles are scheduled for mapping. If the program is extended to subsequent years, a total of twenty quadrangles will be mapped at a scale of 1:24,000. In conjunction with the U.S. Geological Survey, preparation and compilation of the first maps will be used to demonstrate the applicability of digital techniques to geologic mapping and map production.

## NEW GEOLOGIC MAP OF WYOMING

The U.S. Geological Survey has completed the new 1:500,000 scale, colored, *GEOLOGIC MAP OF WYOMING*. Compiled by U.S. Geological Survey geologists J.D. Love, Laramie, Wyoming, and Ann Coe Christiansen, Golden, Colorado, the map depicts the distribution of 215 rock units shown in 128 colors and patterns. Each map comes in three sheets: the geologic map, the map explanation, and a list of references used in compiling the map.

Prepared in cooperation with the Geological Survey of Wyoming, the map reflects the extensive geologic mapping that has been done in the State since the last version was released in 1955.

Copies may be purchased at the Geological Survey of Wyoming, Box 3008, University Station, Laramie, Wyoming 82071 for \$7.30 over-the-counter and \$10.50 mailed. All mailed maps will be sent First Class in a map tube. Phone (307) 766-2286. Over-the-counter copies only are also available at the Wyoming Oil and Gas Conservation Commission, 777 West 1st Street, Box 2640, Casper, Wyoming 82604.

The map is also available from the Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, Colorado, 80225.



## RECENT AND NEW PUBLICATIONS

- \* *Baked and fused rock (clinker) within the Gillette 1° x 2° topographic map area*, by J.E. Meyer, Open File Report 85-5, 1:250,000 scale, 1985 (\$3.00).
  - \* *Uranium mines and uranium and thorium occurrences in Wyoming*, by R.E. Harris, Open File Report 85-6, map, 1:500,000 scale, 1985 (\$7.00).
  - \* *Baked and fused rock (clinker) within the Sheridan 1° x 2° topographic map area*, by J.E. Meyer, Open File Report 85-7, 1:250,000 scale, 1985 (\$3.00).
  - \* *Baked and fused rock (clinker) within the Newcastle 1° x 2° topographic map area*, by J.E. Meyer, Open File Report 85-8, 1:250,000 scale, 1985 (\$3.00).
  - \* *Background gamma radiation of the Torrington 1° x 2° Quadrangle, Wyoming and Nebraska*, by R.E. Harris, Open File Report 85-9, 1:250,000 scale, 1985 (\$6.50).
  - \* *Bibliography and index to the geology of the Wind River Basin and adjacent uplifts in the vicinity of Fremont County, Wyoming*, by Philip Stoffer, Open File Report 85-10, 1985 (\$5.75).
- Economic geology of the Copper Mountain supra-crustal belt, Owl Creek Mountains, Fremont County, Wyoming*, by W. Dan Hausel, Paul J. Graff, and Karl G. Albert, Report of Investigations 28, 1985 (\$8.00).

- \* *Geothermal resources of the Bighorn Basin, Wyoming*, by Henry P. Heasler and Bern S. Hinckley, Report of Investigations 29, 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).
- \* *Tectonic map of the Black Hills uplift, Montana, Wyoming, and South Dakota*, compiled by A.L. Lisenbee, Map Series MS-13, 1:250,000 scale, color, 1985 (\$5.00).

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

Order these and other publications from:

Geological Survey of Wyoming  
Box 3008, University Station  
Laramie, Wyoming 82071  
Phone: (307) 766-2286

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.

