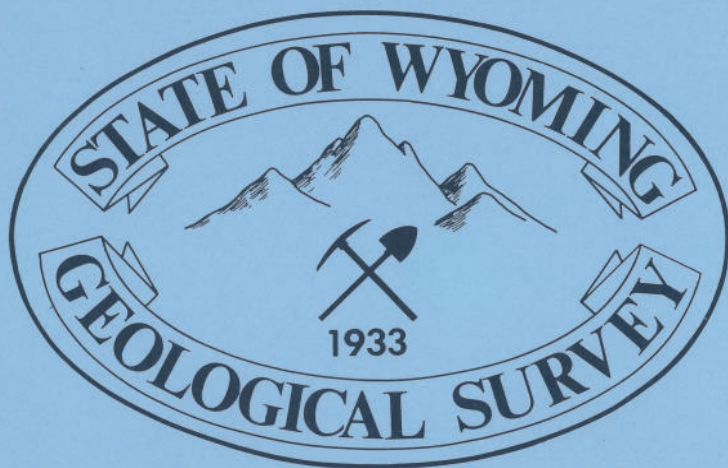


THE GEOLOGICAL SURVEY OF WYOMING

Gary B. Glass, State Geologist

WYOMING  
GEO-NOTES  
NO. 4



Laramie, Wyoming

September, 1984

## 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.

## MINERALS UPDATE

### OVERVIEW

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

Although the Nation and Wyoming's economy are showing recovery, the supply side of all the major minerals produced in the State still exceeds demand. Consequently, the prices paid for these commodities have declined two years in a row in response to lowered market demand. The decline in unit value for minerals was significant enough in 1984 that production gains in petroleum, natural gas, coal, trona, and uranium could not prevent Wyoming's total mineral valuation from declining for a second straight year. Wyoming's total mineral valuation dropped from \$5.62 billion in 1983 to \$5.58 billion in 1984 (about a 0.8 percent decline). Mineral valuations for these two years are summarized in Table 1.

Current indications are that the prices paid for Wyoming's minerals have not bottomed out yet, consequently mineral valuation still may not increase in 1985 despite forecast production increases in petroleum, natural gas, and coal. Any decline in total valuation, however, is likely to be rather small as in the past two years. There are indications that the value per unit of oil, natural gas, coal, trona, and uranium may start increasing again by calendar year 1986 or 1987.

Based on current activity and economic indicators, the Geological Survey of Wyoming prepared

Table 1. Mineral valuation<sup>1</sup>.

	<u>1983</u>	<u>1984<sup>2</sup></u>
Petroleum	\$3,182,388,462 (\$29.32) <sup>3</sup>	\$2,986,418,934 (\$27.06) <sup>4</sup>
Natural Gas	\$1,132,051,442 (\$3.22)	\$1,258,272,277 (\$3.19)
Coal	\$1,113,645,140 (\$10.71)	\$1,151,048,135 (\$10.67)
Trona	\$ 121,583,686 (\$12.07)	\$ 104,500,003 (\$9.91)
Uranium	\$ 45,555,994 (\$21.39)	\$ 50,837,054 (\$16.67)
All other Minerals	\$ 29,578,806	\$ 26,709,789
TOTAL	\$5,624,803,530	\$5,577,786,192

<sup>1</sup>Based on previous year's production.

<sup>2</sup>Preliminary statistics from Wyoming's Ad Valorem Tax Division.

<sup>3</sup>Value per unit of production shown in parentheses.

<sup>4</sup>This is a weighted average for "stripper" oil at \$29.19 a barrel and all other oil at \$26.91 a barrel.

Table 2. Wyoming Mineral Production Forecast to 1991.

Calendar Year	Oil Production (millions of barrels)	Natural Gas Production (billions of cubic feet)	Coal Production (millions of tons)	Trona Production (millions of tons)	Uranium Production (millions of tons)
* 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	124.0	580.0	120.0	10.8	1.0
1985	125.0	620.0	126.0	10.9	0.75
1986	124.0	650.0	131.0	11.0	0.50
1987	122.0	680.0	137.0	11.1	0.20
1988	120.0	700.0	139.5	11.2	0.20
1989	118.0	730.0	143.0	11.2	0.15
1990	116.0	770.0	145.5	11.5	0.15
1991	114.0	820.0	147.0	11.5	0.20

\*Actual values for comparison

revised mineral production forecasts in September (see Table 2). These forecasts indicate production of natural gas, coal, and trona will continue to increase in the next eight years. Although oil production is forecast to increase in calendar years 1984 and 1985, production will start to decline again by 1986. Uranium production is expected to decrease substantially through 1989.

#### METALS AND PRECIOUS STONES UPDATE

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

The Nation's economic recovery is out pacing the base and precious metal mining industry which is in its worst slump since the Great Depression. According to the industry, most of their problems are related to increased metal imports and the continued withdrawal of potentially mineralized and mineralized lands. There is no doubt that the present slump has affected exploration activity in Wyoming and has led to the cancellation of projects that could have led to the development of metal mines in the State.

Many of the exploration activities in Wyoming for metals and diamonds are fairly "low-key" compared to a few years ago. Several foreign mining companies are exploring for massive sulfides and Troy-type copper-silver stratiform deposits in the Sierra Madre mountains of southeastern Wyoming. Some exploration for low-grade gold deposits is also occurring in the Phosphoria Formation of western Wyoming, and some activity is continuing at Copper Mountain and at South Pass for Archean

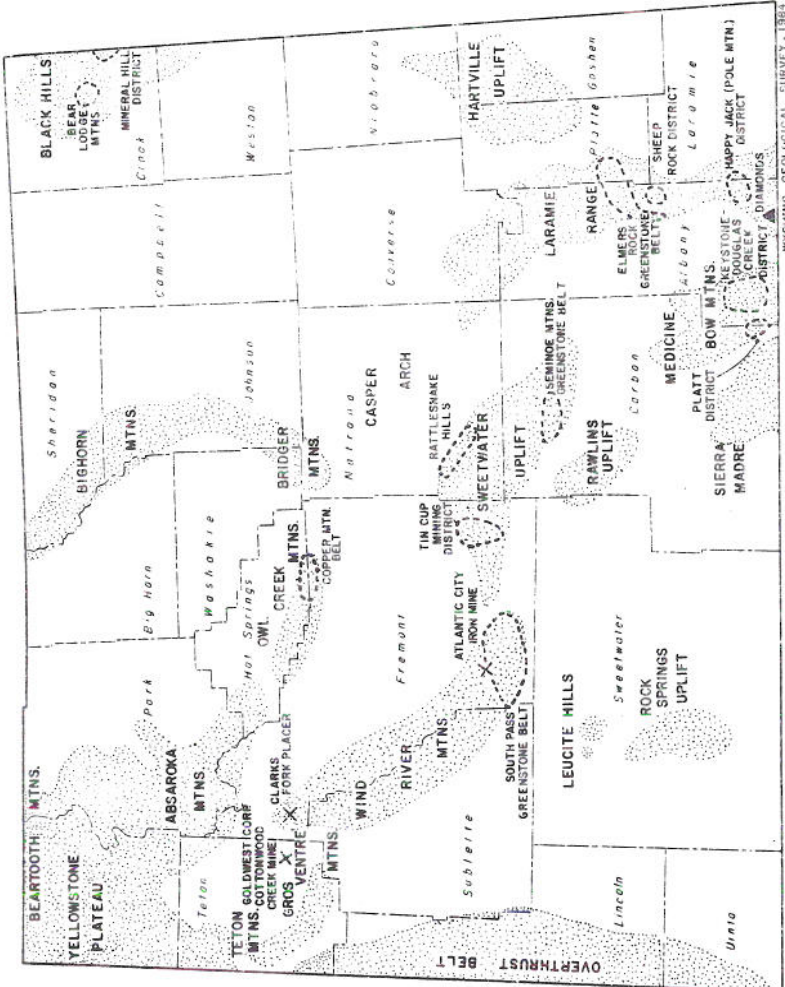
gold mineralization. Diamond exploration in southeastern Wyoming by mining companies is minimal.

This summer did witness a small gold rush in the South Pass area when the U.S. Bureau of Land Management opened 2,000 acres of land which had been withdrawn from mineral entry since the late 1960's and early 1970's. At least six companies and numerous individuals participated in the staking rush on June 18th. Freeport Exploration Inc. added to its already substantial holdings in the area, staking 38 new lode claims.

Some areas of critical wildlife habitat, historical significance, and recreational value were still not released for staking (1,700 acres). A similar rush occurred in the Green Mountain area where 1,700 acres were opened to uranium claims (see discussion on page 10).

Geological Survey of Wyoming activities include exploration and research designed to locate undiscovered diamondiferous kimberlite intrusives. Recent successes include locating more than one dozen anomalous stream sediment samples in the Pole Mountain-Happy Jack area of the Laramie Range. Follow-up field work has identified a few pipe-like vegetation and topographic anomalies that may be kimberlite intrusives. Sampling and geophysical surveys scheduled in the near future should reveal the true nature of these anomalies.

Field work in the South Pass region along the southern tip of the Wind River Mountains is continuing. The Geological Survey of Wyoming has completed mapping of the Radium Springs 7 1/2-minute quadrangle which includes the historic gold-tungsten mineralized district of Lewiston.



WYOMING GEOLOGICAL SURVEY, 1964

**EXPLANATION**

- X Mines and gold placers
- ▲ Diamond localities
- Mine district or supercrustal belt
- Uplifted areas.

REGIONS OF EXPLORATION ACTIVITY FOR STRATEGIC MINERALS



Several abandoned and inactive gold mines in the Lewiston and Atlantic City areas have also been mapped. This project will result in the publication of a geologic map of the entire South Pass supracrustal belt, as well as mine maps, assay reports, and descriptions of wall rock alteration.

The preliminary field work has indicated several areas with a potential for gold mineralization. For example, hand specimen samples containing visible gold have been collected from mines in both the Lewiston and Atlantic City areas.

Some general information on the South Pass mineralized area was recently published in Geological Survey of Wyoming Public Information Circular No. 23 (see page 42).

The Geological Survey of Wyoming is also working with the Wyoming Department of Environmental Quality's Land Quality Division in recommending reclamation plans for abandoned or inactive metal mines across the State. Many of these mine sites provide the incentive for future exploration and serve as valuable exposures for use by exploration geologists. The Geological Survey is recommending reclamation techniques that will eliminate hazards to health and safety, yet preserve access to mines and geologic exposures with scientific as well as potential economic value. In many cases, these recommendations include the preservation of mine tailings. The tailings piles from these metal mines not only can indicate the material that was excavated in now collapsed mines, but they can also contain some of the original ore. Samples of the ore are invaluable when an investigator is trying to determine the origin of a particular mineral deposit.

The last issue of *Wyoming Geo-notes* listed some of the sites that may be reclaimed in the near future (*Wyoming Geo-notes* No. 3, p. 28-30). Geologists from the Geological Survey visited many of these sites this summer and fall and mapped and sampled some of the sites prior to any reclamation activity. These efforts will continue into next spring and summer.

#### URANIUM AND INDUSTRIAL MINERALS UPDATE

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

#### URANIUM

The uranium mining and milling industry in Wyoming continues to shrink. Although 1983 uranium production (3.0 million tons) was higher than in 1982 (2.1 million tons), some of this production was from the milling of stockpiled ore from mines closed in past years.

During the summer of 1984, seventeen more uranium workers were laid off at Western Nuclear's operations in Jeffrey City. This represents more than a third of Western Nuclear's 1984 work force at Jeffrey City. Thirty-one employees are now on the payroll, compared to 595 in 1979.

This summer also marked the closing of the Gas Hills camp. This town, 45 miles east of Riverton, once contained about 800 residents, most of whom worked in the uranium mines in the area. The camp was established in 1957. It was almost closed in the early 1960's when the Federal Government closed uranium "buying stations"; but beginning in

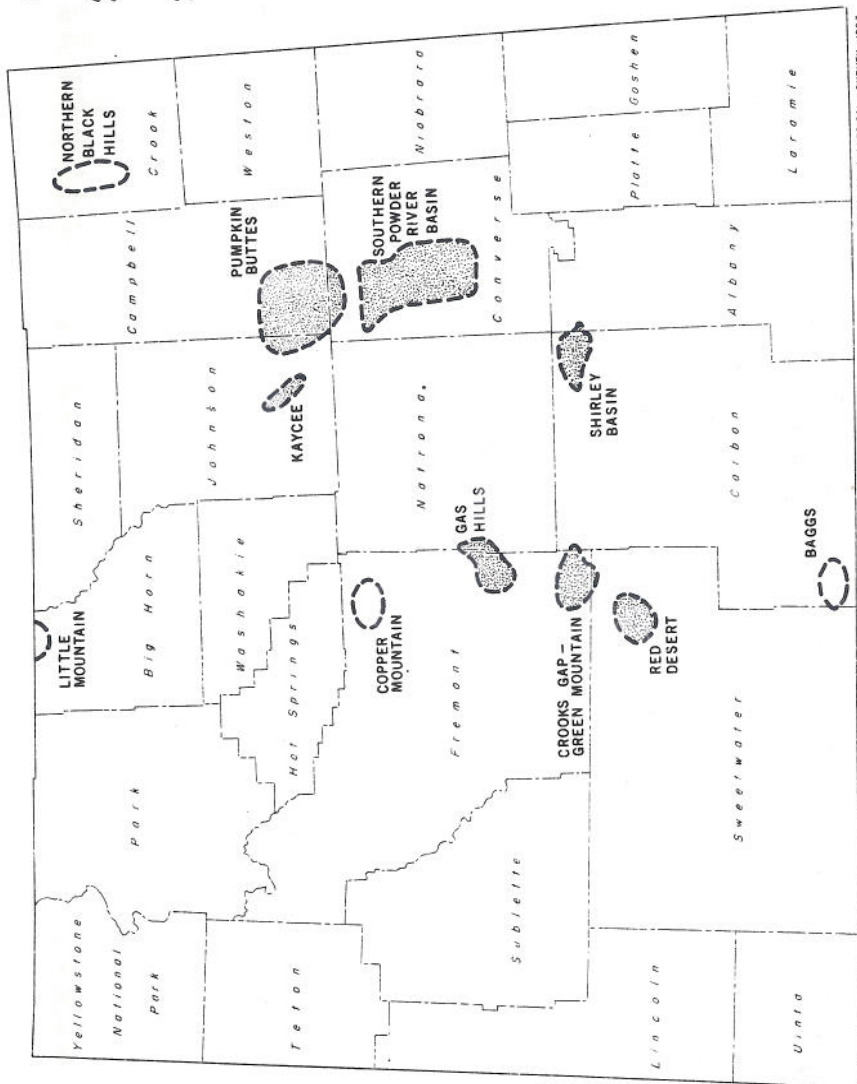
EXPLANATION



Uranium district with active or recent mining



Uranium district without recent mining



WYOMING GEOLOGICAL SURVEY, 1983

MAJOR ACTIVE AND INACTIVE URANIUM DISTRICTS

1971, it grew again as the demand for uranium for nuclear power plants increased. The closure of Gas Hills is a symptom of the condition of Wyoming's uranium industry.

Uranium companies, however, are suggesting there is a future for Wyoming's industry by not only holding onto some properties, but also picking up some new properties. This summer, when the U.S. Bureau of Land Management opened areas on Green Mountain and Whiskey Peak, northwest of Lamont and southeast of Jeffrey City, mining companies staked 1,700 acres in a staking rush reminiscent of the early 1970's.

The spot market price of uranium oxide has remained steady this summer at \$17.50 per pound. This compares with a 1979 high of \$42.00 per pound. When adjusted for inflation, the current price is near the price which the old Atomic Energy Commission paid for uranium in the late 1950's.

The outlook for Wyoming's uranium mining and milling industry remains poor through at least the 1980's. The demand for uranium oxide for nuclear fuel continues low in the United States since utility stockpiles are large and nuclear plant completions are few. Foreign uranium consumption has risen dramatically in the past several years. This does not, however, affect Wyoming uranium since foreign uranium oxide, particularly from Canada and Australia, is less expensive than production from the United States. Consequently, foreign utilities are contracting with these foreign sources. Domestic power producers may also contract to buy foreign uranium, postponing the recovery of Wyoming's uranium industry. A slow recovery in the uranium mining industry, of

less than five percent annual growth in production, may take place in the 1990's, following continued production declines through the 1980's (see Figure 2 on page 3).

### TRONA

The amount of trona mined in Wyoming increased slightly (four percent) to 10.5 million tons in 1983. Because the primary market for soda ash (refined trona), is the glass industry, the decreasing use of glass bottles, particularly disposable bottles, has affected trona production. However, economic recovery and an increase in the use of plate glass and sodium chemicals has offset this decline somewhat.

Continued growth of Wyoming's trona mining and refining industry, however, may depend in no small measure on the export market. With the world's largest trona resource, Wyoming is in a position to increase production to meet any new foreign demand. If exports of soda ash do not increase, near stagnant production levels may characterize the trona industry into the 1990's (see Figure 2 on page 3).

### BENTONITE

Wyoming's bentonite mining and refining industry has recently gone through some very hard times and is slowly recovering. Bentonite production fell 37 percent from 1981 to 1982, and declined another one million tons, or about 35 percent, from 1982 to 1983. This was coupled with a price reduction to around one-third of the 1981 market price for all types of bentonite products. It is

remarkable that no bentonite operation in Wyoming, which supplies about 90 percent of all domestic bentonite, has closed.

Based on 1982 figures, bentonite is used primarily for drilling mud (51 percent), taconite (iron ore) pelletizing (15 percent), foundry castings (12 percent), other minor uses (9 percent), and exports (13 percent). It is apparent that the dramatic decline in oil well drilling, the oversupply of taconite for steel making, and the reduction of factory orders for foundry products combined during the 1982 recession to reduce the total bentonite market by almost 78 percent. Drilling and steel making has carried the bentonite industry for the last two years.

Since December 1983, orders for bentonite for taconite pelletizing and foundry castings have continued to increase. At the same time, the demand for oil well drilling mud has increased only slightly. Given these conditions, bentonite production, is expected to increase slowly through 1984. In the next five years, bentonite production should continue to increase though not so dramatically as it did prior to 1981. A dramatic increase in production is not expected unless oil well drilling increases substantially -- an event not presently forecast.

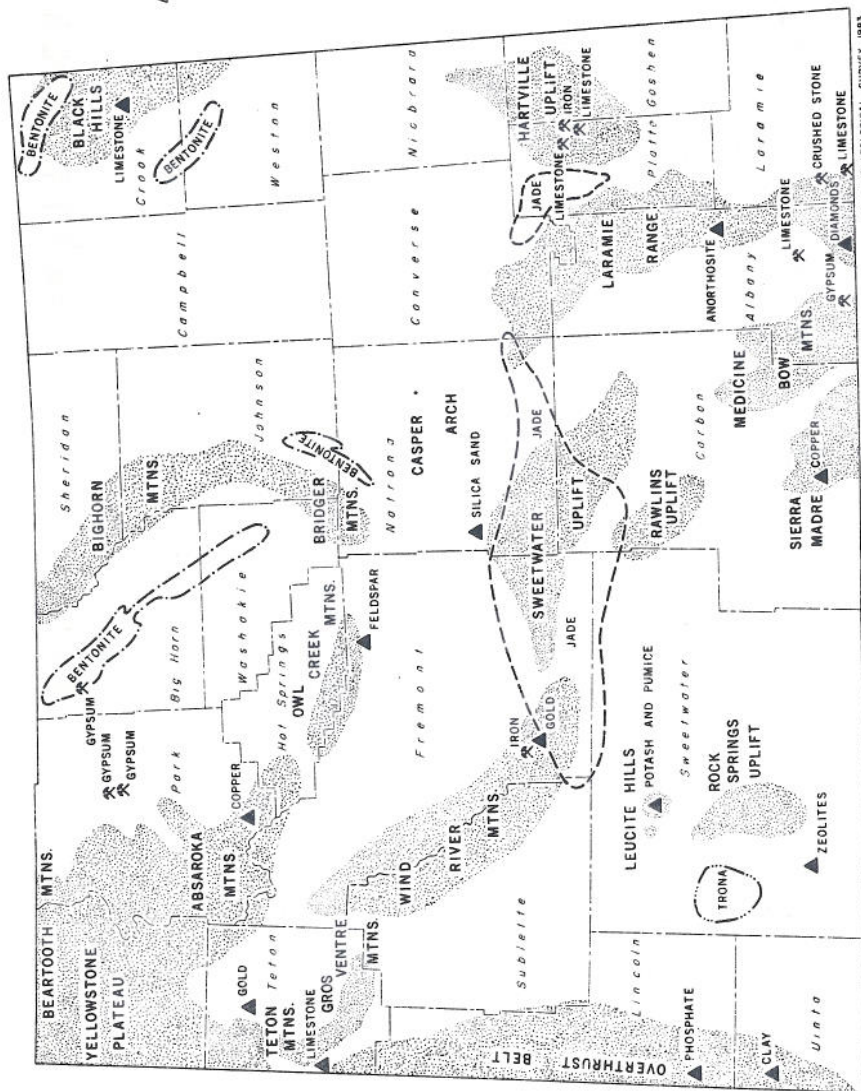
The price of bentonite reflects competition, with producers increasing their efficiency and

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<sup>1</sup>Hynes, R.E., 1984, *Wyoming bentonite in the 80's*: Colorado Mining Association 1984 Mining Yearbook, p. 87-92.

EXPLANATION

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



WYOMING GEOLOGICAL SURVEY, 1968

SELECTED MINERAL AND ROCK OCCURRENCES

laying off hourly and salaried workers to reduce costs. However, the price to the buyer also reflects transportation costs, mostly rail, which are one to three times the sale price of bentonite at the plant.<sup>2</sup> Consequently, the cost savings derived from increased efficiency and reduced labor forces have little effect on the purchase price.

Regarding future markets, because of its low permeability and ion-exchange capacities, bentonite could work both as a sealant and an adsorbant in the isolation and containment of some types of hazardous wastes. It is currently being investigated for use in the reclamation of the contaminated area near the old Union Pacific tie treatment plant in Laramie.

#### OTHER INDUSTRIAL MINERALS

Following the trend of better economic times, increased regional and local construction should boost aggregate (sand and gravel, including crushed rock) production in 1984 over the preceding two years. Similarly producers of gypsum, limestone, ballast, cement, sodium, marble, and other industrial commodities should also produce more in 1984 as the local economy improves and demand for these products increase.

Since the construction of hardened MX missile silos at existing Minuteman sites is in doubt, the number of people looking for construction mater-

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<sup>2</sup>Ibid



ial, particularly crushable dolomitic limestone, in southeastern Wyoming has decreased.

Rocky Mountain Energy and IMC (Industrial Mineral and Chemical Company) continued outlining reserves of zeolites in southwestern Wyoming. Zeolites are naturally occurring minerals with ion-exchange properties similar to synthetic ion-exchange substances used in water softeners. Zeolites have many potential uses in industry and agriculture. Should the production of natural zeolites become more economical than the manufacture of synthetic zeolite (a situation similar to that which occurred as Wyoming's trona reserves were outlined in the 1940's and 1950's), Wyoming may have a new industry. Important zeolite reserves are present southeast of Rock Springs and in the Beaver Rim area east of Lander and Riverton.

Rocky Mountain Energy and IMC plan to mine several thousand tons of zeolite-bearing ore and ship it to research laboratories in Illinois. The laboratories will test the material for potential uses, including water softening applications and applications related to its adsorption properties. In addition to water softeners, the product may be useful in kitty litter and feedlot deodorizers.

Construction began on Chevron Chemical Company's \$245 million ammonium phosphate fertilizer plant near Rock Springs with ground-breaking ceremonies on August 16th. This construction was originally scheduled to begin in 1982, but was postponed due to weak demand by the agriculture industry. Completion of the project is now expected in 1986. Permitted capacity of the new plant is 800,000 tons per year although the initial plant may be scaled down from that size.

The plant will use phosphate from the company's mine near Vernal, Utah, and recovered sulfur from Chevron's Carter Creek gas processing plant in Uinta County, Wyoming. The phosphate will be transported over the Uinta Mountains to Rock Springs via a proposed slurry pipeline.

Chevron's \$40 million phosphate slurry line has already been contracted to Bechtel Petroleum, Inc. with construction to begin in 1985 and completion set for 1986. The 95-mile-long line will have a diameter of 10 inches and a design capacity of 1.8 million tons of phosphate per year.

The fertilizer plant will employ about 200 people when it is operational and will further diversify the mineral industry of the Rock Springs - Green River area of Sweetwater County. Currently the area has substantial petroleum, natural gas, coal, and trona activity.

Although Wyoming does have phosphate deposits, there is no phosphate mining in the State at this time. Stauffer Chemical Company, however, operates a 750,000 tons per year beneficiating and calcining plant at Leefe, west of Kemmerer in Lincoln County. The phosphate ore, however, comes from an open pit mine in Idaho. Phosphate processed at the Leefe plant is shipped to various destinations where it is used for production of phosphatic acid or fertilizer.

Wyoming's phosphate processing industry and the State's chances for resumption of phosphate mining apparently remain dependent on the agriculture industry, particularly in the West and Midwest. For example, Chevron's new fertilizer plant is predicated on demand in that market area. Because other major domestic phosphate production is lo-

cated in Florida, North Carolina, and Tennessee, shorter rail hauls should put Wyoming's phosphate fertilizer into the Midwest and West at very competitive prices.

#### OIL AND GAS UPDATE

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

As of August 27, the rig count in Wyoming stood at 123, indicating a continued gradual increase in drilling activity for the State. The count a year ago was only 97. A recent article in World Oil Magazine predicts increased drilling in the State. World Oil forecasts wells drilled in Wyoming will total 1,650, ten percent higher than last year's 1,500. They reported that independent producers predict a 56 percent increase in their drilling in Wyoming for the second half of the year while major producers predict a five percent decrease in their second half drilling.

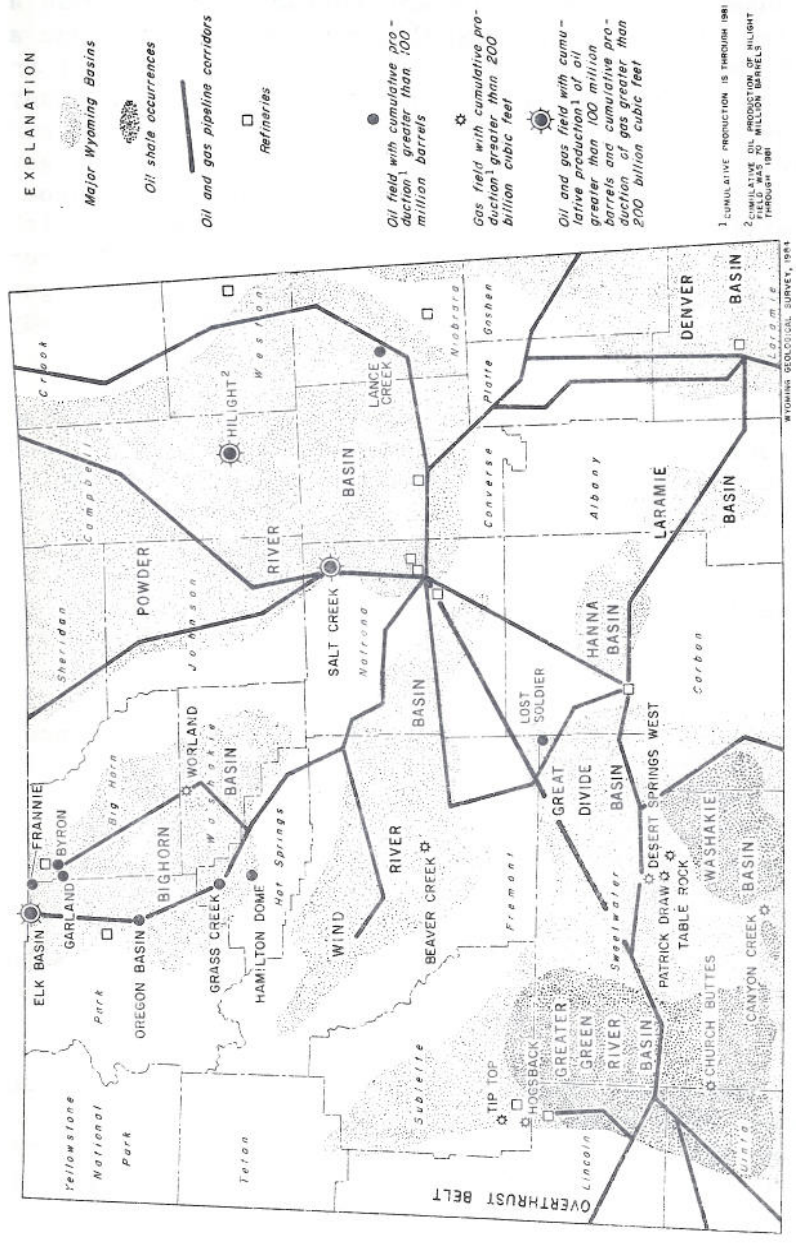
Chevron will apparently soon call for bids on its planned Painter Reservoir sour gas processing plant in southwestern Wyoming. Design capacity of the plant is 120 million cubic feet per day. The plant is expected to cost about \$78 million and should be on line in 1986. Currently, Chevron is reinjecting the gas into the Clear Creek and East Painter Reservoir oil fields both of which are retrograde condensate fields that require pressure maintenance.

Exxon recently announced plans to construct the third stage of its 600 million cubic feet per day Shute Creek gas plant in Sweetwater County, four years ahead of schedule. The schedule was acce-

lerated to take advantage of carbon dioxide (CO<sub>2</sub>) sales opportunities in Wyoming and Colorado. The plant will process natural gas with a high CO<sub>2</sub> content (70 percent) from the Riley Ridge deep gas trend on the Moxa Arch (greater than 14,000 feet). Controversy has arisen over whether Pacific Power and Light or Utah Power and Light will supply the required electricity for the new plant. A decision on this matter will be made by the Public Service Commission as both utilities want the contract.

Blossoming CO<sub>2</sub> markets include a 900 billion cubic feet contract with Chevron for an enhanced oil recovery project in the Rangely Field of northwestern Colorado. Amoco has also contracted for 181 billion cubic feet if it elects to proceed with CO<sub>2</sub> injection in its Lost Soldier and Wertz oil fields in southcentral Wyoming. Other CO<sub>2</sub> enhanced oil recovery projects are possible in the Powder River Basin and others basins of the State as Exxon brings the gas plant on line. Another potential market in the late 1980's or beyond is for use in carbon dioxide/coal slurry pipelines. Western Resource Transport, a subsidiary of Aquatrain, Inc., has already proposed a 1,180-mile-long, 26-inch slurry line from Gillette to Long Beach, California. Shell, which has also proposed a coal slurry line to California, has not ruled out carbon dioxide as a transporting medium for its line (see discussion on pages 25 and 27).

Last fall's moratorium on noncompetitive Federal oil and gas leasing is apparently over. A list of 555 parcels covering 900,000 acres in Wyoming and 20,000 acres in Nebraska was published recently and will be available for the September drawing. The U.S. Bureau of Land Management (BLM) changed its rules in an effort to prevent alleged



1. CUMULATIVE PRODUCTION IS THROUGH 1981  
 2. CUMULATIVE OIL PRODUCTION OF INLIGHT THROUGH 1981

WYOMING GEOLOGICAL SURVEY, 1984

**EXPLANATION**

- Major Wyoming Basins
- Oil shale occurrences
- Oil and gas pipeline corridors
- Refineries
- Oil field with cumulative production<sup>1</sup> greater than 100 million barrels
- Gas field with cumulative production<sup>1</sup> greater than 200 billion cubic feet
- Oil and gas field with cumulative production<sup>1</sup> greater than 100 million barrels and cumulative production of gas greater than 200 billion cubic feet

GENERALIZED OIL AND GAS INDEX MAP OF WYOMING

abuses that led to the moratorium. Rather than a flat \$75 filing fee, applicants must now include a \$1 per acre advance rental fee with each application. The BLM also increased its staff to study the petroleum potential of Federal properties and help ensure that lands with known oil and gas reserves are not inadvertently included in noncompetitive leases. They are also contracting with an independent consulting firm to review BLM procedures for determining what are known oil and gas reserves and to review the known areas already delineated by the Bureau.

The Federal noncompetitive oil and gas leasing program, however, is still under investigation, and there is some sentiment for eventually doing away with the simultaneous drawings altogether. If this were to happen, all Federal oil and gas leasing would be by competitive bids. There is an equally strong sentiment against cancellation of noncompetitive leasing; therefore, the eventual outcome is in doubt at this time.

Amoco Production Company recently announced plans to construct a gas processing plant in Bairoil, Wyoming. The plant would be used in a planned CO<sub>2</sub> injection project for Lost Soldier and Wertz Fields. Early cost projections are between \$140 million and \$160 million. Construction of the plant will provide 700 to 1,000 jobs in the area. Amoco has apparently signed a contract with Exxon for carbon dioxide gas from the La Barge area (see discussion page 18).

Davis Oil Company recently indicated that the Amos Draw Field in Campbell County may not have the oil reserves first thought. Industry experts had projected last summer that over 100 million barrels of oil equivalent were present. However,

it now appears that the reservoir is mostly gas. The companies involved, along with Davis, are currently examining methods to best produce the field. They may re-inject the produced gas to enhance oil recovery and put off gas production for several years until demand and prices improve.

Davis Oil Company also recently announced a new Powder River Basin oil discovery capable of producing 1,135 barrels of oil per day (BOPD) from the Minnelusa Formation. The well is in Campbell County near Kuehne Ranch Field.

Another prolific oil producer for the Powder River Basin has been completed by Hrubetz Oil Company in Thorson Field. The well tested at 1,460 BOPD from the Minnelusa Formation. Thorson Field is located south of Moorcroft in Crook County. Another offset in the field was completed recently for 1,009 BOPD from the Minnelusa Formation.

An offset well drilled by W.A. Moncrief in Teepee Flats Field flowed gas at 6,000,000 cubic feet per day from the Frontier Formation. This well expands this important sub-thrust field. In related news, Amoco completed an offset to their sub-thrust oil discovery, Boulder Dome Field in southeastern Fremont County. The well was completed as an oil well (44 BOPD) in sub-granite Phosphoria Formation. Three more tests have been staked in the field. These two recent completions will continue to fuel interest in sub-thrust drilling.

Golden Buckeye Petroleum of Denver has completed an oil discovery in Laramie County, 1 1/2 miles southeast of Silo Field. The well is flowing 170 BOPD from highly fractured Niobrara Forma-

tion. This discovery continues to enhance interest in the Niobrara play in this portion of the Denver-Julesburg Basin.

Deep drilling in the Bighorn Basin received encouragement by a recent announcement that North American Resource found gas and condensate in the Muddy and Frontier Formations below 14,000 feet. This well is located on the basin axis, 12 miles northwest of Cody.

Wexpro Company tested an apparent prolific gas producer in Church Buttes Field on the southern end of the Moxa Arch, 45 miles southwest of Rock Springs. The well flowed at rates from 7.5 million cubic feet to 13.4 million cubic feet per day from the Madison Formation below 18,400 feet. The gas contained approximately 87 percent CO<sub>2</sub>. The Pennsylvanian Morgan Formation was also tested and flowed 11.8 million cubic feet per day of sour (high H<sub>2</sub>S) gas from below 18,000 feet.

The Overthrust Belt remains in the news with Samuel Gary Jr. and Associates announcing recovery of oil from the Frontier Formation at about 6,800 feet in a wildcat three miles northwest of Kemmerer. If successful, this well would continue the Overthrust Belt production trend to the north, along with Horse Trap Field which is northeast of Kemmerer.

Updating earlier editions of *Wyoming Geo-notes*, the 1984 Wyoming Legislature funded an Enhanced Oil Recovery Research (EOR) Center at the University of Wyoming. The EOR Center is housed at the University's Petroleum Engineering Department. As earlier stated, Wyoming has an estimated 10 billion barrels of oil recoverable by enhanced reco-



very techniques.<sup>3</sup> Also in a recent memorandum, Donald B. Basko, the State Oil and Gas Supervisor, reminded oil and gas producers that initiating qualified secondary or tertiary recovery projects in Wyoming not only increases production, but also reduces Windfall Profits Tax for an operator. He noted that if recovery from the State's known producing reservoirs was only increased by five percent, it would double Wyoming's recoverable oil reserves.

Although the Wyoming Oil and Gas Conservation Commission only recently adopted new seismic rules for drilled holes, new rules are again before the Commission. The rules are directed at surface blasting techniques. After a preliminary hearing, the Commission asked industry and other interested parties to suggest rules to safeguard property and alleviate complaints of excessive noise and annoyance. The new rules will address safe distances from shots and possibly limitations on the size of explosives. The next hearing date will probably be November 13, 1984 at the Commission's Hearing Room in Casper. Persons interested in making written or oral comments should contact Donald B. Basko, State Oil and Gas Supervisor, Wyoming Oil and Gas Conservation Commission, Box 2640, Casper, Wyoming 82602 (phone 307/234-7147).

#### COAL UPDATE

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

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<sup>3</sup>Barlow, J.A., Jr., and Doelger, M.J., 1983, *Wyoming mineral resources*: Barlow and Haun, Inc., Casper, 14 p.

Coal activities in the third quarter of 1984 were highlighted by developments in coal transportation. On August 1, Energy Transportation Systems, Inc. (ETSI) terminated their \$3.6 billion coal slurry pipeline project, and on August 16, Chicago and North Western (C&NW) and Union Pacific (UP) railroad companies completed construction of their new joint venture railroad line out of the Powder River Basin.

Cancellation of the controversial ETSI project, which began in the middle 1970's and had persisted despite a variety of problems that plagued the project since its inception, was no real surprise to many observers. The various problems encountered by the project included: difficulties in acquisition of water, the inability to secure right-of-way (and the failure of Federal eminent domain legislation for slurry pipelines), and the lack of firm contract commitments with utility companies for coal transportation. In the final analysis, however, the project's size and cost coupled with current economic uncertainties also contributed to the project's demise.

The ETSI project is only one of several large coal slurry pipeline projects that have been canceled in the last year. The Powder River Pipeline from the Powder River Basin to Minnesota and Wisconsin and the Pacific Bulk project from Utah to west coast export terminals were also canceled. Other slurry projects that have been proposed in the United States, including the Aquatrain (Western Resource Transport) project that would move Wyoming coal to California via liquid carbon dioxide, are proceeding slowly in that they face problems similar to those encountered by ETSI. At present the 273-mile-long Black Mesa Pipeline in Arizona is the only operating major coal slurry pipeline in the United States.

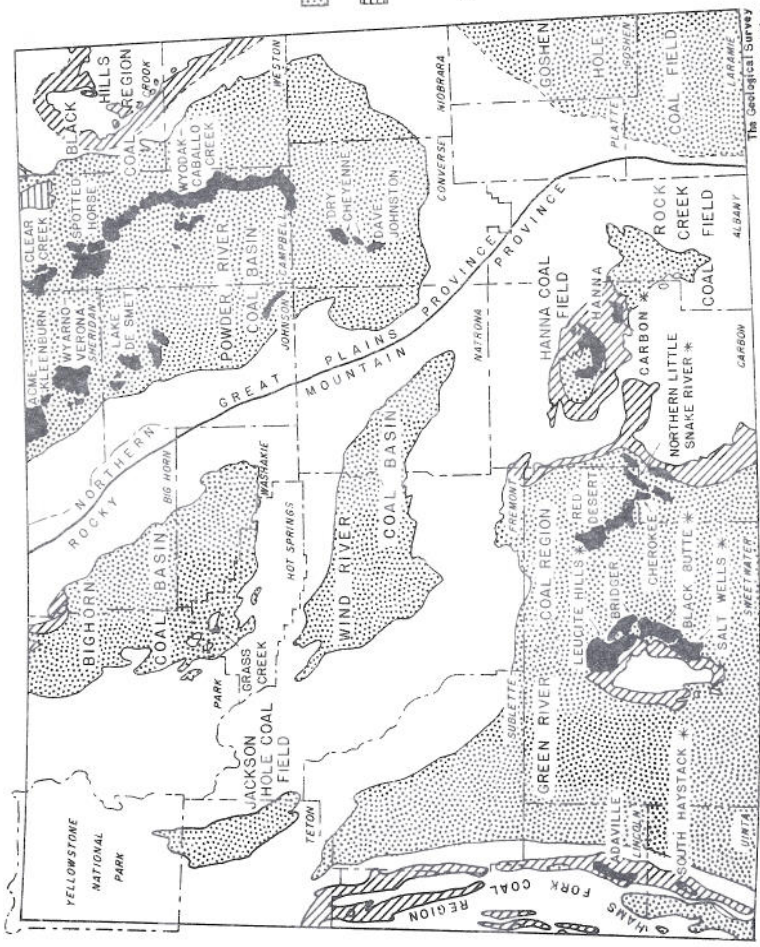
Western Resource Transport's carbon dioxide/coal slurry project is currently seeking financial support. The \$1.6 billion venture includes a 377-mile-long, 16-inch pipeline from the La Barge area of southwestern Wyoming to carry carbon dioxide to Gillette. Western estimates that it will initially need 156 million cubic feet of CO<sub>2</sub> per day to transport up to 10 million tons of coal per year. If the line is built by 1989 as planned, CO<sub>2</sub> needs could increase to 233 million cubic feet per day by 1995 when the line may be expanded to transport 15 million tons per year. The vast CO<sub>2</sub> reserves of the Riley Ridge area of Wyoming are more than capable of handling these carbon dioxide demands (see discussion on page 18).

The 1,180-mile-long, 26-inch slurry pipeline would cross Wyoming, Utah, Arizona, Nevada, and California. Western is looking for Pacific Rim markets for the coal which they hope to put on the West Coast at a transportation cost of \$19 per ton.

Another coal slurry pipeline made the news shortly before ETSI's cancellation. Shell Oil Company announced it was trying to arrange a joint venture with various Asian countries for a pipeline to the West Coast. The negotiations are being handled by a Shell Oil subsidiary, Pecten Coal International, and are in their early stages. Pecten has broached representatives from Japanese, South Korean, and Taiwanese utility companies about a pipeline from Shell's properties in the Powder River Basin. A Shell spokesman noted that no tonnage from their Buckskin Mine in Wyoming was slated for the pipeline. However, Shell has large uncommitted reserves on other Federal coal leases in Wyoming as well as reserves on the Crow Indian Reservation in Montana.

If Shell can arrange a joint venture project with end users, they might offset some financing problems since the market for the coal would be established from the onset. Shell also noted that the slurry medium was not fixed yet, and that they were considering all options to include a carbon dioxide and coal mixture. The Asian market for Wyoming coal, however, has remained elusive, and stiff competition for this market is expected from other countries as well as some Alaskan deposits much closer to the coast. Also, this market has not grown as fast as some forecasters predicted and may not be a significant market for a decade or more.

In other transportation news, the new C&NW/UP rail line is now in direct competition with Burlington Northern (BN) for coal transportation contracts in parts of the Powder River Basin. The new rail line was completed about three months ahead of schedule for about \$370 million, 20 percent less than the estimated \$460 million. The construction costs were reduced by contract bidding at a favorable time. At present, the new line is moving coal from the Jacobs Ranch Mine and the recently opened North Antelope Mine to Arkansas Power and Light Company's Independence and White Bluff power plants. Deliveries to Wisconsin Public Service Corporation's Weston plant in Rothschild, Wisconsin, will begin this fall. This coal will come from the Coal Creek and Black Thunder Mines. C&NW/UP signed an additional coal transportation contract with Northern States Power one week before the rail line was completed. This latest contract calls for transportation of about one million tons of coal per year from the Rochelle Mine (currently under construction) to the utility's power plants in the Minneapolis-St. Paul, Minnesota area. By next year, the new line



**EXPLANATION**

-  Subbituminous
-  Bituminous
-  Lignite
-  Strippable Deposits

\* Preliminary: based on company data

**COAL-BEARING REGIONS OF WYOMING**

The Geological Survey  
of Wyoming  
1984

should be hauling 12 million tons of coal per year, or about three unit trains per day. Despite this new competition for transportation contracts, a recent economic study by a University of Wyoming Professor, Scott Atkinson, concluded that rail rates would remain excessively high and would limit the production of Wyoming coal mines by more than ten million tons per year.

Other notable coal developments in the State this summer centered on increased activity in the southern Powder River Basin (southern Campbell County and northern Converse County): 1) Thunder Basin Coal Company recently hired 40 additional workers for their Coal Creek and Black Thunder Mines. This hiring almost offsets the 50 employees that were laid off eight months ago. 2) North Antelope Coal Company recently hired 50 new people at the State's newest coal mine, North Antelope. The mine now has 130 employees and by the end of the year, should have the capability of producing 5.5 million tons per year. 3) Construction has resumed on NERCO's Antelope Mine in Converse County, with a construction work force of 180 expected next summer. NERCO also announced that Jacobs Engineering Group, Inc. of Pasadena, California had been awarded an engineering services contract for the mine's coal handling and loadout facility. 4) Rochelle Coal Company, a subsidiary of Peabody Holding Company, recently filed an application for a coal mine construction permit with the State of Wyoming's Industrial Siting Administration. Construction of the 11 million ton per year mine is planned for the spring of 1985.

In coal market news, Portland General Electric recently announced that they would reactivate the Carty No. 1 plant at Boardman, Oregon. This coal-

fired power plant had been on standby for the last year. Portland General's decision is in response to sharp decreases in available hydroelectric power generation in the Columbia River Basin and to a doubling in the price of hydroelectric power. Before the plant went on standby, Amax Coal Company supplied coal to the Carty No. 1 plant from their Wyoming coal mines. It is not known if Amax will continue to supply this plant, but it appears that the hydroelectric power surplus that has existed in the Pacific Northwest for the last two years may be ending. This fact, combined with the cancellation of several nuclear power plant projects in this region, may provide future markets for Wyoming coal.

Mobil Coal Producing, Inc. was recently awarded a one year contract to supply one million tons of Powder River Basin coal to Oklahoma Gas and Electric's Muskogee No. 6 power plant in 1985. Mobil's Caballo Rojo Mine is supplying approximately 0.4 million tons to the same plant in 1984. Oklahoma Gas and Electric used this short term contract to capitalize on favorable spot market prices. Other utilities are using the same strategy or at least contemplating it.

About mid-year, the Rochelle Mine, which is presently under construction, landed two more contracts with Northern States Power Company. Although details are lacking, it appears the five-year contract totals slightly more than 1.4 million tons with approximately 0.28 million tons per year going to the High Bridge power plant in St. Paul, Minnesota and another 3,000 tons per year going to the Red Wing plant at Winona, Minnesota. The contracts start with completion of the mine in 1986.

The remaining market news is not as good. Rosebud Coal Sales, which is located in the Hanna Basin of southcentral Wyoming, apparently lost its 15,000-ton per year contract with the Warren Air Force Base in Cheyenne after this year. A Colorado supplier quoted a delivered price of \$26.26 per ton. Rosebud's delivered price was \$43.82 in 1983.

Both Thunder Basin Coal Company and Triton Coal Company are suing utility companies for breach of contracts. In the first case, Thunder Basin claims Oklahoma Gas and Electric Company shorted their contract by 3.1 million tons between 1978 and 1983. The coal was contracted to the Muskogee No. 4 plant and was to be supplied by the Black Thunder Mine. Triton, a subsidiary of Shell Oil Company, is suing Western Farmers Electric Cooperative. Western Farmers has apparently canceled a 16-year contract, which called for up to 1.15 million tons per year from the Buckskin Mine. Although the contract was not to expire until 1996, Western Farmers is apparently stopping shipments to their Hugo plant in 1984.

After reviewing existing, new, and lost coal contracts the Geological Survey revised its earlier coal production forecast of March, 1984 (see page 41, *Wyoming Geo-notes* No. 3). An abbreviated version of the new forecast is included on page 3 of this edition of *Wyoming Geo-notes*. The estimate on page 32, however, gives more details than that version.

In essence, the new 1984 and 1985 production estimates are slightly higher than the March estimates. The forecasts after 1985, however, are all below the earlier estimates and show only small increases in production after 1987. Most of the



declines in the late 1980's are attributable to postponed or canceled power plants.

On a slightly different note, there are some indications that utility coal purchasers are starting to place as much emphasis on coal quality and coal performance characteristics as on coal price. This seems especially applicable to older coal-fired power plants that are unable to make expensive equipment changes (retrofitting) just to handle less expensive coals with different physical and chemical characteristics. When these older plants are required to optimize power plant performance, utility companies become very selective in choosing the correct coal to suit their needs and to match their power plants requirements. In other words, the best coal may no longer equate to the cheapest coal as coal contracts will put more emphasis on the exact coal characteristics desired, including the coal's slagging and fouling characteristics and ash fusion temperatures, its grindability and handling performance, its blending potential, and its major, minor and trace element composition.

From Wyoming's standpoint, this means the coal contracts supplying power plants built to burn lower rank Wyoming coal are fairly secure over the life of the plant. On the other hand, contracts where Wyoming coal is being substituted for higher ranked local coals or where Wyoming coal is blended with local coals may be far less secure if this trend continues. While a current surplus in generating capacity is buffering the effect on Wyoming producers, this could change in the future. There are already indications that companies plan to extend the life of many of their older plants in lieu of building new plants. When demand catches up with supply, the buffering effect of

COAL PRODUCTION AND FORECAST TO 1990 (MILLIONS OF TONS)

	1981 <sup>1</sup>	1982 <sup>1</sup>	1983 <sup>1</sup>	1984	1985	1986	1987	1988	1989	1990
Campbell County	71.6	81.2	88.2	95.2	101.2	106.2	110.2	111.7	116.0	118.5
Converse County	3.6	3.4	2.7	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Sheridan County	2.8	3.0	2.9	3.0	3.0	3.0	3.0	3.0	1.2	1.2
Carbon County	8.5	5.0	4.8	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Sweetwater County	11.2	11.0	9.5	9.5	9.5	9.5	10.5	11.5	12.5	12.5
Lincoln County	5.0	4.3	4.0	4.0	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	120.0	126.0	131.0	137.0	139.5	143.0	145.5
Increase per year	9%	5%	4%	7%	5%	4%	4%	2%	2.5%	1%
Estimated contract- 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%	10%	8%	8%	5%	3%	1%	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, August, 1984.

lower prices could be lost.

The good news is the that only 14 percent or 16 million tons of Wyoming's annual coal production falls into these latter categories. The bad news is that more than 10 million tons of that 16 million tons, or 63 percent, comes from mines in the southern part of the State (Hanna and Rock Springs areas). This is not to say that this entire 16 million tons of coal contracts will be lost, but that some portion is in more jeopardy than in the past. Further complicating the matter are the relatively high mining costs of southern Wyoming mines. Higher prices charged for these coals have already hurt marketing in that area of the State.

As a closing note, Federal coal leasing remains on hold with no resumption anticipated before July, 1985 at the earliest. The Department of the Interior has decided to conduct more environmental studies on the effects of its revised leasing program. A draft of the new Environmental Impact Statement is slated for January 1985. In the meantime, the Interior Department will only process applications for emergency leases and preference right leases.

#### URANIUM DATA TRANSFERRED

Information collected under the National Uranium Resource Evaluation (NURE) Program (1975-1983) has been transferred from the U.S. Department of Energy to the U.S. Geological Survey. This information consists of thousands of stream sediment samples and analyses thousands of groundwater (well and spring) and surface water (stream and lake) samples and analyses, core samples, maps and

MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Resources (January 1, 1984)

Discovered (Includes 10 billion barrels recoverable  
by enhanced recovery techniques).....13.6 billion barrels<sup>1</sup>  
Undiscovered..... 7.6 billion barrels<sup>1</sup>  
Total.....21.2 billion barrels

Remaining Reserve Base (January 1, 1984)

Measured reserves (Proved reserves)..... 0.8 billion barrels<sup>2</sup>  
Indicated and inferred reserves..... 2.8 billion barrels<sup>3</sup>  
Total..... 3.6 billion barrels

NATURAL GAS

Remaining Resources (January 1, 1984)

Discovered.....20.4 trillion cubic feet  
Undiscovered (there is another 35 trillion cubic

feet of noncombustible CO<sub>2</sub> gas).....58.0 trillion cubic feet  
Total.....78.4 trillion cubic feet

Remaining Reserve Base (January 1, 1984)

Measured reserves (Proved reserves)..... 9.6 trillion cubic feet

COAL

Remaining Resources (January 1, 1984)

Identified (Discovered).....136.5 billion tons<sup>4</sup>  
Undiscovered.....800.0 billion tons<sup>5</sup>  
Total.....936.5 billion tons

Remaining Reserve Base (January 1, 1984)

Demonstrated strippable (Measured and indicated  
reserve base)..... 27.6 billion tons<sup>4</sup>  
Demonstrated underground-minable (Measured and  
indicated reserve base)..... 38.4 billion tons<sup>4</sup>  
Total..... 66.0 billion tons

(table continued on next page)

TRONA

Original Resources

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

URANIUM

U308

Remaining Resource (January 1, 1983).....	995,000 tons <sup>7</sup>
---	---------------------------

Remaining Reserve Base (January 1, 1983)

ORE

U308

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.....	<u>225.1 million tons.....</u>	<u>151,500 tons<sup>7</sup></u>
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 American Petroleum Institute, 1983, *Basic petroleum data book*: Volume III, no. 2, May.
- 3 Modified from Barlow and Doelger (1983), footnote 1.
- 4 Wyoming Geological Survey, June, 1984. (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.

reports, airborne radiometric and magnetic data, and library materials. Some of these data are also available on magnetic tapes.

This information, formerly stored in the Department of Energy facility in Grand Junction, Colorado, and other locations, is now stored by the U.S. Geological Survey. The physical materials (samples, cores, reports, and library materials) are at several locations in the Denver Federal Center in Colorado. The magnetic tapes are kept at the Earth Resource Observation Satellite Center in Sioux Falls, South Dakota.

Persons interested in obtaining NURE information on Wyoming or other areas should contact the following U.S. Geological Survey personnel:

1. Stream sediment reconnaissance samples:

Byron R. Berger  
Denver Federal Center, MS 973  
Denver, Colorado 80225  
(303) 236-1800

2. Core samples:

Thomas C. Michalski  
Denver Federal Center, MS 975  
Denver, Colorado 80225  
(303) 236-5105

3. Reports and maps (microfiche and some hard copy):

Dwight F. Canfield  
Denver Federal Center, MS 306  
Denver, Colorado 80225  
(303) 236-3832

4. NURE publications and other library materials:

Robert A. Bier, Jr.  
Denver Federal Center, MS 914



Denver, Colorado 80225  
(303) 236-1004

5. Magnetic data tapes:

Bruce F. Molina  
EROS Data Center  
Sioux Falls, South Dakota 57198  
(605) 594-6511, ext. 142

The NURE information has many potential uses beyond the original goals of the program. The trace element analyses as well as the airborne radiometric and magnetic data can be used in exploration for commodities other than uranium. Similarly these data and other NURE data can be of value for basic geology, environmental studies, land management, and other uses.

The Geological Survey of Wyoming also has hard copy records of flight lines and data for most National Uranium Resource Evaluation studies related to Wyoming. These are available for inspection at the Geological Survey offices on the University of Wyoming campus in Laramie. However, data from Wyoming that was never included in formal reports must be obtained from the U.S. Geological Survey at the locations above.

Persons interested in this information are encouraged to contact the U.S. Geological Survey or stop by the Geological Survey of Wyoming offices to inspect the reports.

#### COAL CONTRACT INFORMATION UPDATED

The Geological Survey of Wyoming now has an updated version of coal contract information for Wyoming mines. Similar data was last published in

1980 as Public Information Circular No. 12, *Wyoming coal production and summary of coal contracts*. The new version is available in a xerox format, which will be updated at least quarterly. Tabulated data summarizes contracts by utility company, by power plant, and by mine. In addition, there is a listing and description of 65 proposed mines and undeveloped properties in the State. These tabulated listings account for 3.6 billion tons of contracted tonnage from active mines. There is also information on mine capacities and original reserves for each mine or mining property. Table 3 summarizes these data.

The report is titled, *Summary of coal contracts with Wyoming mines* and was last updated in September, 1984. Data was compiled by Gary B. Glass. The price is \$15.00 per copy with ordering information given on page 43.

Table 3. Summary statistics for active and proposed coal operations in Wyoming.

PROPERTY CATEGORY (Number tallied for statistics)	ESTIMATED ORIGINAL RESERVES MT	ESTIMATED CONTRACTED TONNAGE MT	PERCENTAGE OF RESERVES COMMITTED TO CONTRACTS	ANNUAL MINE CAPACITY IN 1984	CONTRACTED ANNUAL TONNAGE IN 1984	1984		ANNUAL MINE CAPACITY BY 1990	CONTRACTED ANNUAL TONNAGE BY 1990
						PERCENTAGE OF CAPACITY UNDER CON- TRACT IN	ESTIMATED 1984 COAL PRODUCTION		
ACTIVE MINES (29)	7,967.70 MT	3,611.26 MT	45.3%	243.5 MT	133.05 MT	54.6%	122.0 MT	254.8 MT	145.5 MT
PROPOSED MINES AND AND UNDEVELOPED PROPERTIES (65)1	11,838.45	--	--	--	--	--	--	80.4 MT <sup>3</sup>	--
TOTAL	19,806.15 MT	3,611.26 MT	17.5%	--	--	--	--	335.2 MT	--

MT = millions of short tons

<sup>1</sup>Reserve estimates were available for 42 of these properties.

<sup>2</sup>Includes 3,200 MT defined as an *in situ* reserve.

<sup>3</sup>Based on all announced plans; 8.0 MT is a more likely estimate of additional capacity by 1990.

## RECENT AND NEW PUBLICATIONS

*Bibliography of Wyoming geology, 1960-1969*, by Charlotte Tancin, Bulletin 64, 1984 (\$8.00).

\**Index to selected U.S. Geological Survey Bulletins that contain geologic maps for Wyoming*, compiled by Rodney H. DeBruin, Map Series 9G, 1984 (\$2.50).

\**Index to selected U.S. Geological Survey Professional Papers that contain geologic maps for Wyoming*, compiled by Rodney H. DeBruin, Map Series 9H, 1984 (\$2.50).

*Self-guided tour of the geology of a portion of southeastern Wyoming*, by W. Dan Hausel and Richard W. Jones, Public Information Circular No. 21, 1984 (\$6.00).

\**Tour guide to the geology and mining history of the South Pass gold district, Fremont County, Wyoming*, by W. Dan. Hausel, Public Information Circular No. 23, 1984, (\$4.50).

*Alteration and mineralization associated with sandstone uranium occurrences, Morton Ranch area, Wyoming*, by Ray E. Harris, Report of Investigations No. 25, 1984 (\$7.00).

\**Geothermal resources of the Laramie, Hanna, and Shirley Basins, Wyoming*, by Bern S. Hinckley and Henry P. Heasler, Report of Investigations No. 26, 1984 (\$7.00).

\**Analyses and measured sections of 25 coal samples from the Hanna Coal Field of southcentral Wyoming*, by Gary B. Glass and Jay T. Roberts, Report of Investigations No. 27, 1984 (\$8.00).

*\*Summary of coal contracts with Wyoming mines*, compiled by Gary B. Glass, available in xerox format only, 1984 (\$15.00).

*\*Coal mining in Wyoming*, compiled by the Wyoming Highway Department, 30-page map atlas with short text, 1984 (\$10.00).

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