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Recent Surface Mining Development In The Western States[1]

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RECENT SURFACE MINING DEVELOPMENT IN THE WESTERN STATES

ABSTRACT

Collectively, production from surface coal mines in Wyoming, Montana, North Dakota, New Mexico, and Arizona may increase 4-fold or exceed 187 million tons per year by 1980. Additionally, production from Wyoming, Montana, and North Dakota, alone, could easily exceed 263 million tons per year by 1985 and perhaps 360 million tons by the year 2000. These forecasts will satisfy announced demands for coal-fired power plants and coal gasification plants.

To accomplish this expansion, coal companies are developing strip mines that will each produce an average of 5 to 20 million tons per year. Because of the nature of western coal deposits, conventional mining equipment will play the major role in this development at least in the near term. While companies are accelerating production, they can be expected to refine systems that even now combine mining and reclamation.

Mining will also be supplemented by processing and loading facilities capable of handling materials in the quantities demanded by these large mines. Railroads will dominate transportation mediums, but they may be augmented with railroad to barge systems. Coal-slurry pipelines may also play an increasing role in the transportation of western coals if water requirements can be met.

The coal mining industry of the Rocky Mountain and Northern Great Plains provinces of the United States is emerging so rapidly from its depression era of the 1960's that no one can keep pace with it. Because production forecasts are outdated only days after they are made, it is only safe to say that western coal mining is accelerating at unprecedented rates and that surface mining is behind this acceleration. Of the nine states in these coal provinces, Wyoming, Montana, New Mexico, North Dakota, and Arizona best exemplify this activity.

Surface mining already accounts for 88-100 percent of the coal mined in each of these five states. Collectively, their annual production almost quintupled between 1969 and 1973 or from 14.8 million tons to 43.1 million tons per year. Individually, each state's production has also more than doubled. As for the more immediate future, the total annual production from these five states, alone, could easily exceed 187 million tons per year by 1980.

ANNUAL COAL PRODUCTION (1969-1972) WITH ESTIMATES FOR 1973, 1975, 1980, AND 1985

	PRODUCTION IN MILLIONS OF TONS							
	1969	1970	1971	1972	1973	1975	1980	1985
ARIZONA[1]	.0	0.1	1.1	1.1	2.9	10.0	13.0	13.0+
MONTANA[2]	1.0	3.4	7.1	8.2	9.9	19.8	41.0	74.0
NEW MEXICO[3]	4.5	7.4	8.1	8.2	9.3	17.0	27.0	27.0+
NORTH DAKOTA[2]	4.7	5.6	6.1	6.8	7.4	11.7	19.0	49.1
WYOMING[4]	4.6	7.2	8.1	10.9	13.6	22.9	87.0	140.0
TOTAL	14.8	23.7	30.5	35.2	43.1	81.4	187.0	303.0

[1]Forecast by Arizona Bureau of Mines, 1973
[2]Forecast by Northern Great Plains Resource Program (most probable), 1973
[3]Forecast by New Mexico State Bureau of Mines and Mineral Resources, 1973
[4]Forecast by Wyoming Geological Survey, March 1974

Behind this accelerated activity are not only familiar names like Peabody, Amax, North American and Consolidated but also newcomers such as Arch Mineral, Pacific Power and Light, Atlantic Richfield, Carter Oil, and Kerr-McGee to name a few. All of the active companies and many of the projected newcomers will provide low sulfur coal to electric utilities throughout the western half of the United States as well as to some east of the Mississippi River. Also beginning in the late 1970's, many of these same companies and others as well will supply coal to the impending coal conversion industry. By 1980, it is predicted that Wyoming, New Mexico, and North Dakota will each have at least one coal gasification plant on line. Forecasts of 9 to 10 more plants in the Rockies by 1985 is not unrealistic and may be quite conservative.

MAJOR COAL MINING COMPANIES AND COAL LEASEHOLDERS

	COMPANIES AND LEASEHOLDERS				
	WYOMING	*MONTANA*	*NORTH DAKOTA*	*NEW MEXICO*	*ARIZONA*
Active mining companies	*Amax* *Arch Mineral* *Kemmerer* *Pacific Power & Light* *Rosebud Coal Sales* *Big Horn* *Wyodak Resources* *Energy Development*	*Decker* *Peabody* *Western Energy* *Westmoreland Resources* *Knife River*	*Baukol Noonan* *Consolidation* *Knife River* *North American*	*Pittsburg & Midway* *Utah International*	*Peabody*
Leaseholders not yet active	*Atlantic Richfield* *Carter Oil* *Kerr-McGee* *Peabody* *Medicine Bow* *Mobil Oil* *Sun Oil* *Texaco, Inc.* *Tipperary Resources*	*United States Steel* *Gulf Mineral Resources* *Amax* *Shell Oil* *Norsworthy & Reger* *Chevron Oil* *Consolidation*	?	?	?

The coal industry of the western states is gearing up to meet present and future demands by opening new, large strip mines and by expanding the capacity of existing ones. Moreover, they are doing it with essentially conventional mining equipment. At the same time, they are combining mining and reclamation into a continuous system. They are augmenting this mining with processing, loading, and transportation systems designed for the rapid bulk handling demanded by many large mines.

In 1969, there were 36 strip mines in these five states, which averaged out to less than 400,000 tons per mine. By 1972, the number of strip mines had dropped to 28, but production had increased to about one million tons per mine. It is estimated that there will be about 44 strip mines in these same states by 1980 and that annual production will then average out to approximately 4 million tons per mine.

NUMBER OF WESTERN SURFACE COAL MINES (1969-1972) WITH ESTIMATE FOR 1980

	NUMBER OF STRIP MINES				
	1969	1970	1971	1972	1980
ARIZONA	0	1	1	1	2
MONTANA	5	4	6	4	9
NEW MEXICO	3	3	2	2	6
NORTH DAKOTA	20	20	15	9	11
WYOMING	8	9	9	12	16
TOTAL	36	37	33	28	44

In regard to mine size, many western strip mines are slated to be very large -- in excess of 5 million tons per year and several as high as 20 million tons. In Wyoming, for example, Amax, Carter Oil, Kerr-McGee, Atlantic Richfield, Pacific Power and Light, Kemmerer, and Peabody each expect to have one or more strip mines producing between 5 and 20 million tons per year by 1980. For comparison, Utah International's Navajo mine in New Mexico, which is currently the largest surface coal mine in the nation, produces about 7.3 million tons per year.

Before discussing the equipment used in these large mines, several attributes of western coal deposits should be described. Firstly, overburden is relatively thin, and "relatively" is stressed. No more than 200 feet of rock and soil overlie the majority of the strippable reserves in these five states. In fact most of the current mining removes only 30 to 80 feet of overburden. Although overburden thicknesses will obviously increase as the shallower portions of each company's reserves are depleted, it should average less than 120 feet thick for a decade or two. Secondly, the thickness of the strippable coals really brings home the meaning of "relatively" thin overburden. Wyoming has one seam in excess of 220 feet thick, several others between 70 and 100 feet thick, and many between 25 and 50 feet thick. Similarly Montana has coal up to 60 feet thick. Although these states locally strip coals as thin as 4-6 feet, in no case is this even half a state's average coal thickness. The average strippable coal in these five states varies from about 70 feet thick in Wyoming to 10 feet thick in Arizona. Consequently, overburden to coal ratios frequently are less than 1:1 and seldom exceed 7:1. This means that the biggest concern for many companies is the rapid excavation of the coal itself not the overburden. In such instances, overburden removal can be relegated to secondary importance, often guided more by reclamation intentions than by the haste to expose coal. Thirdly, one generally finds these same coal deposits in areas of relatively low relief. This frees most western strip mines from the problems of casting spoil on steep slopes.

THICKNESS OF STRIPPABLE COALS CURRENTLY MINED IN THE WEST

	THICKNESS IN FEET		
	MAXIMUM	MINIMUM	AVERAGE
WYOMING	118	6	70
MONTANA	60	5	25
NORTH DAKOTA	27	5	16
NEW MEXICO	15	4	11
ARIZONA	30	4	10

Now we can briefly examine the equipment that is helping to exploit these western coals. The emphasis, of course, is selection of equipment that well keep incremental costs of all handled materials to an absolute minimum. This is particularly important in the Rockies since mining costs must be low enough to offset the high trans-

portation costs of moving western coals to distant markets. At the mine, the average selling price of Montana coal was $2.00 a ton in 1972. Coal from the Powder River Basin of Wyoming was still selling for less than $2.50 a ton for some long term contracts in 1973. Transportation costs, however, can already triple the cost of western coal by the time it reaches its destination.

AVERAGE PRICES PAID FOR COAL AT POINT OF SHIPMENT

	PRICE PER TON				
	1969	1970	1971	1972	1973
ARIZONA	?	?	?	?	?
MONTANA	$2.13	$1.85	$1.82	$2.00	$2.20
NEW MEXICO	3.66	2.89	3.26	3.43	3.75
NORTH DAKOTA	1.85	1.95	1.91	2.08	2.20
WYOMING	3.36	3.38	3.39	3.74	3.90
UNITED STATES	$4.99	$6.26	$7.07	$7.67	$8.12

Source: U.S. Bureau of Mines

To date, relatively conventional equipment has kept mining costs down. Shallow overburden has allowed the companies to use medium to small draglines with buckets in the 20- to 40-cubic yard range. Currently the largest draglines proposed for the region will swing 70- to perhaps 80-cubic yard buckets. The flat-lying nature of the coal seams emphasizes reach so that dragline booms are frequently 250 to 300 feet in length. Draglines are augmented with scrapers in many mines, and in some of the relatively smaller mines scrapers even replace draglines in overburden removal. Power shovels load coal and even strip off overburden. Bucket sizes for these shovels are usually between 11- and 24-cubic yards. Larger shovels are dominant since these machines often load from coal faces in excess of 20 feet high. Another obvious trend in large mines is the size of haulage vehicles. While 100- to 120-ton bottom dump haulers are prevalent, trucks with less than a 50-ton capacity are rare. Grading and backfilling are normally done with dozers, scrapers, graders, and trucks as well as draglines and are carried out concurrently with the mining.

TYPICAL CAPACITIES OF WESTERN STRIP MINING EQUIPMENT IN 1973

	EQUIPMENT TYPES		
	DRAGLINES (cubic yards)	SHOVELS (cubic yards)	HAULAGE UNITS (tons)
ARIZONA	14-36	16	120
MONTANA	30-70	16	100-120
NEW MEXICO	10-50	15-24	50-120
NORTH DAKOTA	28-32	?	40-120
WYOMING	17-62	15-24	50-120

Most western surface mines employ a continuous systems approach that combines mining and reclamation. Such an approach minimizes the acreage affected by the mining operation at any point in time and also minimizes the rehandling of spoil. Under this type of system, reclamation plays as much a part in the initial planning of a mine as it does in the mine's development since all phases of the operation are designed to complement one another.

Turning now to processing and loading systems, today's western strip mines limit processing to occasional blending and more or less routine crushing. Blending is sometimes necessary to meet specifications of power plant contracts. Selective

mining of a single seam or in a few instances of multiple seams allows blending at the truck dump areas. Crushers then reduce the coal to optimal sizes for railroad loading and transport. Because of the large mine capacities and the need to minimize transportation costs, most exporting coal companies are installing elaborate flood-loading facilities that can fill 10,000 ton unit-trains in a matter of hours. Concrete silos and covered conveyor belts are often a part of these tipple complexes.

With the exception of a few mine-mouth power plant operations, almost all of the mined coal is transported by railroad, more specifically by unit-trains or private railroads in the case of some utility companies. Additionally, new railroad lines to handle future production have been announced for both Wyoming and New Mexico. This is not to say that alternatives have been ignored. Barge-loading facilities have been proposed for St. Louis, Missouri and Superior, Wisconsin. Once railroads get western coals to those docks, inexpensive barge transportation will carry the coal even further. In Arizona, Peabody Coal Company already moves coal from its Black Mesa mine to the Mohave Power Plant in Nevada via a 273-mile long coal-slurry pipeline. Although this is the only slurry pipeline in the western coal fields, a newly proposed 1040-mile long pipeline might soon carry coal from northeastern Wyoming to Arkansas. In the west, however, the scarcity of water could be a major obstacle to the widespread use of coal-slurry pipelines. For example, annual water requirements for this Wyoming to Arkansas pipeline is estimated at 15,000 acre-feet. The future of this pipeline remains speculative, but it may mark a future trend in coal transportation.

What then is in store for the future? Accelerated growth of the western coal industry is expected to continue well into the 21st century although power plant demands will probably level off and decline slowly by the first quarter of that century. At the same time, the demands of coal conversion plants will likely increase rapidly enough to more than offset the power plant losses. To satisfy these two markets, surface mine production from the Northern Great Plains region of Wyoming, Montana, and North Dakota, alone, could easily exceed 263 million tons per year by 1985.

In conclusion, the western states, especially Wyoming, Montana, and North Dakota, have entered a new era of coal development. An era that challenges each company to protect our environment even as it strives to set annual production records dictated by our growing energy needs. Although only time will document the successes and failures, a new awareness of the importance and implications of surface mining in each of these states should help guide this development for the good of each state as well as the nation as a whole.

REFERENCES

Keystone Coal Industry Manual, 1973 edition, McGraw-Hill, Inc., New York, N. Y., 830 pp.

Minerals Yearbook, 1971 edition, U. S. Department of Interior, Bureau of Mines, pp. 325-376 (also *Mineral Industry Surveys, Preliminary Annuals*, 1972 and 1973 editions).

Strippable reserves of bituminous coal and lignite in the United States, 1971, U. S. Bureau of Mines Information Circular IC 8531, 148 pp.

Western Coal Edtion, 1973, Coal Age, Mid-April, 302 pp.