STRIPPABLE RESERVES OF BITUMINOUS COAL
AND LIGNITE IN THE UNITED STATES

By Staff, Bureau of Mines

*************** open file report

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Assistant Director--Mineral Supply, Washington, D.C.
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ABSTRACT

The economically strippable reserves of coal and lignite in the U.S. were calculated in accordance with the prevailing conditions of seam thickness and depth of overburden in each of the several coal-producing areas of the Nation. Within defined limited of seam thickness and depth of overburden, it is estimated that there is a remaining strippable resource of 119 billion tons of raw bituminous coal and lignite as of January 1, 1968. Because of topography, natural and man-made features, and other limitations, only 45 billion tons of the resource is economically recoverable. Of this, 32 billion tons is considered low-sulfur (less than 1 percent), 4 billion tons is medium-sulfur (1 to 2 percent), and 9 billion tons is high-sulfur (over 2 percent) coal.

Due to a cleaning loss to that portion of strip coal that is mechanically cleaned, the 45 billion tons or strippable reserves are reduced to 39.6 billion tons of marketable coal.

Without regard to rank, Wyoming has the largest reserve of strip-minable coal in the Nation—almost 14 billion tons, followed by: Montana, 7 billion tons; Alaska, 4 billion tons; and Illinois with
3 billion tons. According to rank, the largest reserve of economically strippable bituminous coal is in Illinois, followed by West Virginia and Missouri; the largest reserve of subbituminous coal is in Wyoming, followed by Alaska, Montana, and New Mexico. The largest reserves of economically strippable lignite are in Montana, North Dakota, and Texas.

The location of major low-sulfur reserves depends on the rank of coal. West Virginia with 1.1 billion tons has the largest available reserve of bituminous coal, followed by Kentucky, 532 million tons; Alaska, 460 million tons; and Colorado, 476 million tons. The largest reserve of subbituminous low-sulfur coal is in Wyoming with 13.4 billion tons; Alaska has 3.9 billion tons, followed by Montana with 3.2 billion tons and New Mexico with 2.5 billion tons. Large reserves of low-sulfur lignite are in Montana with 3.0 billion tons, North Dakota with 1.7 billion tons, and Texas with 625 million tons.

A brief discussion is given for each coal-producing State, summarizing past and present production, historical background, and outlook. Appendix I contains reserve data by State, county, seam, and sulfur content. Appendix II contains in tabular form, the general information and requirements necessary to comply with the current strip mining laws covering 21 States.

INTRODUCTION

During 1969, one-third of the bituminous coal and lignite produced in the United States was from strip mining operations. By 1980, the demand for coal is expected to be 53 percent greater than it was in
1967 and by the year 2000, the projected demand will be 78 percent greater—probably resulting in more and larger strip mines. Of particular significance is the increasing demand for coal of low-sulfur content to comply with present or proposed air quality standards.

This study was undertaken to establish the location and extent of coal of varying sulfur content available for strip mining. The project was a joint undertaking of several Bureau of Mines offices. In each of these offices, coal and lignite reserves were estimated in accordance with the locally prevailing criteria and mining techniques.

For each of the States except Alaska the strippable coal reserves were identified by county and by seam. Reserves have been compiled by State and coal province. Resources and reserves have been determined by rank—bituminous, subbituminous, and lignite. Additionally, the reserves were compiled by seam, by sulfur content, and the coal presently in-place within specified limits of overburden thickness.

The U.S. Geological Survey has published reports on strippable coal resources of the United States and for selected areas of Montana, North Dakota, and Pennsylvania. A joint study was made of the strippable coal in Indiana by the U.S. Geological Survey and the Indiana Geological Survey. The strippable resources of Kansas were estimated by the Kansas Geological Survey. The Illinois Survey has calculated the resources in five counties in that State.
This report differs from previous reports in that it is primarily concerned with strippable reserves, that portion of the resource which is recoverable with present prices, technology and other conditions; it is also concerned with the amount and location of coal reserves by sulfur content.

ACKNOWLEDGMENTS

The manuscript was compiled with the assistance and cooperation of many people concerned with coal resources and coal mining by stripping methods. The authors gratefully acknowledge advice and criticism on all aspects of strip mining, from representatives of the coal and utility companies. The list of agencies and individuals that contributed coal data includes many State Geological Surveys, State Mining Departments, and authors of U.S. Geological Survey and Bureau of Mines publications; to them, a special note of appreciation. Thanks are extended to those Bureau of Mines engineers whose review and criticism contributed to the accuracy of this report.

HISTORICAL BACKGROUND

Strip mining is thought to have started in 1877 in the area of Pittsburg, Kansas (160). The fully revolving steam shovel made its appearance at Pittsburg in 1910; the capacity of the bucket was 1-1/2 cubic yards. The early shovels were mounted on rails and moved in the coal pits on portable track. They were used primarily to remove overburden. The uncovered coal was drilled and blasted and hand loaded into wooden mine cars.
In the Appalachian area, contour stripping on hillsides began about 1917. Because of the steep slopes, the work was difficult and progress was slow until the advent of crawler-track-mounted equipment.

During World War II when road construction was reduced, much earth-moving equipment was diverted to strip mining. Many road contractors continued to strip mine coal after the war, and never returned to highway construction. Over the ensuing years, the number of mines increased, and equipment became larger and more efficient.

During the 30 years preceding 1969, coal production in the U.S. from underground mines declined about 3 percent from 357 million tons to 347 million tons per year. Meanwhile strip mining increased 113 percent, from 38 million tons to 195 million tons. Auger mining, which was virtually unknown in 1939, produced 16 million tons of coal in 1969. During 1969, 30 percent of the coal mines were strip operations—accounting for 35 percent of total production. There were 87 strip mines with annual production of more than one-half million tons each.

**Constraints on the Industry**

The Nation is experiencing an increasing demand for energy. From the 53.8 quadrillion Btu of energy consumed in 1966, it is estimated that 159 quadrillion Btu will be required annually by the year 2000 (118). Coal in general as well as the portion of production that is strip mined, is expected to share in this increased market. The extent of expansion by strip mining will depend on various constraints; these include safety legislation, regulations on strip-mine reclamation, competition from other fuels, and pollution controls.
The Air Quality Act of 1967 enables the Federal Government to establish controls for industries that contribute to air pollution. While no such regulation has been established nationally, various local regulations have been applied which limit the sulfur content of fuel or stack gas emission of sulfur oxides. Since as yet no acceptable system has been developed to remove sulfur either from coal or stack gas, there has been a trend towards the consumption of low-sulfur fuels. In some areas this has resulted in a switch by the major consumer of coal, electric utilities, to low-sulfur residual fuel oil; it has also given some impetus to the development of nuclear power.

The first law requiring reclamation of strip-mined land was enacted in West Virginia in 1939. Since then, 20 more States have enacted similar regulations. Certain provisions are common to these laws: Need for a permit, posting of bonds, land descriptions and progress reports, restoration standards, time limits, water pollution controls, and penalties for violations. While the impact of current regulations has been considered in this report, more stringent regulations are being considered. The effect of future regulations along with recently implemented safety legislation has not been fully assessed.

In most cases, these regulations will result in additional costs to the consumer. This will affect the competitive position of strip-mined coal as well as the amount of strip coal available.

DEFINITIONS

The words "resource" and "reserve" have occasionally been used interchangeably in other publications. To eliminate possible confusion, these and other terms used in this report are defined as follows:
COAL. - When used alone, includes bituminous coal, subbituminous coal and lignite.

MINABLE COAL. - A coalbed equal to or greater than a specified minimum thickness. Grade or quality of the coal is not considered.

STRIPPABLE RESOURCE. - The quantity of coal in-place under a specified maximum depth of overburden and minable by surface methods.

REMAINING STRIPPABLE RESOURCE. - The total original coal resource reduced by depletion computed from past strip and auger mining production.

RECOVERABLE STRIP RESOURCE. - The resource that is recoverable with technology and equipment presently available or available in the foreseeable future. The remaining strippable resource multiplied by a mining recovery factor.

STRIPPABLE RESERVES. - The recoverable resource adjusted to conform to the current economic conditions, and further reduced by the amount of coal that for various other reasons cannot be mined.

RECOVERY FACTOR. - The proportion of the resource that is technically capable of being produced, usually expressed as a percent.

DEPLETION. - The tonnage mined plus the coal lost as a result of the mining operation.

STRIPING RATIO. - The ratio of overburden to coal, expressed generally in two ways:

1. As cubic yards of overburden per ton of coal either mined or marketable (cubic yards to ton).

2. As average feet of overburden thickness per foot of coalbed thickness (feet to feet).
OVERBURDEN. - Soil and rock material overlying the coalbed.

CUT. - Width of coal uncovered in one position of the stripping equipment.

HIGHWALL. - The final face of the overburden at the last cut.

AREA STRIPPING. - Mining of large areas of flat-lying beds under relatively shallow overburden. Overburden is removed in many successive cuts.

CONTOUR STRIPPING. - Mining of coal on hillsides in hilly or mountainous areas. Overburden is removed in one or several cuts by equipment following the coal outcrop along the natural contour of the surface of the ground.

LOW SULFUR COAL. - Coal containing less than 1 percent sulfur, by weight.

MEDIUM SULFUR COAL. - Coal containing 1 to 2 percent sulfur, by weight.

HIGH SULFUR COAL. - Coal containing over 2 percent sulfur, by weight.

MARKETABLE COAL. - Coal in a condition ready for sale to consumers; includes both raw and cleaned coal.

RAW COAL. - Coal shipped to the consumer as mined, without prior preparation other than crushing to a desired maximum size, but which causes no appreciable additional loss.

CLEANED COAL. - Coal recovered after processing by cleaning and sizing. A loss averaging more than 20 percent of the raw coal entering the preparation plant results from cleaning.
COALFIELDS OF THE UNITED STATES

The bituminous coal and lignite fields of the United States are subdivided geographically by the U.S. Geological Survey, as follows: (1) The Eastern province, (2) the Interior province, (3) the Gulf province, (4) the Northern Great Plains province, (5) the Rocky Mountain province, (6) the Pacific Coast province, and (7) Alaska (figs. 1 and 2). Within these provinces the bituminous coal and lignite deposits are further subdivided into regions, basins, and fields.

The Eastern Province

In the Eastern province, bituminous coal occurs throughout the Appalachian Region, an area of about 70,000 square miles. This region encompasses parts of Pennsylvania, Ohio, Maryland, West Virginia, Virginia, eastern Kentucky, Tennessee, Alabama, and Georgia. The coal occurs in formations of Pennsylvanian and Permian ages. There has been some structural deformation of the coal-bearing formations into broad, open folds. Attitudes of the seams vary from flat to gently dipping, with local steepening in some fields.

There are approximately 90 minable coal seams throughout the Appalachian Region. Sixty of the seams can be strip-mined to varying extents, depending on location and depth of overburden. West Virginia
The Pacific Coast Province

The Pacific Coast province covers parts of California, Oregon, and Washington; minor deposits occur in the first two. The largest strippable reserves of importance occur in Washington. All the coals of this province are in Tertiary formations. There is only one major strippable deposit. It is located in the Tono Basin, Centralia region of the State of Washington. Strippable coal occurs in two seams, the Big seam and Smith seam. The Centralia region contains many other coal seams for which no strippable reserves have been estimated. The coal seams range from 5 to 50 feet in thickness. Over 90 percent of the estimated reserve is in the Big seam. The coal is subbituminous in rank and is mined to supply an electric generating plant. Washington is the only State in the province with a sizable deposit of coking coal, none of which is considered strippable.

Alaska

Alaska has six coalfields for which strippable reserves have been estimated. Figure 2 shows the known coalfields of Alaska. The coals are of Cretaceous and Tertiary ages, and rank from lignite to anthracite. The seams vary from nearly flat to steeply dipping, and from relatively continuous to lenticular. Seam thicknesses range up to 50 feet; strippable reserves are estimated for a minimum thickness of 14 inches. The coal is low in sulfur, with generally less than 1 percent, and much of it less than one-half percent sulfur.
Nearly all the coal currently produced is consumed within 150 miles of the mine. Transportation is by rail or truck. The markets are electric utilities and space heating. However, natural gas is becoming more competitive for heating purposes.

METHODOLOGY

The procedure in ascertaining strippable coal resources was dependent upon the type, quantity, and quality of information that was available. The criteria for evaluating these resources were based on economic consideration for each area under study.

The original in-place resource was obtained mainly as follows:

a. Where outcrop maps were available, the length of each minable coalbed outcrop was measured by map meter or the area was measured by planimeter. An average coalbed thickness was determined for each seam. An average bench width from outcrop to maximum overburden thickness was estimated. From these data acres of strippable coal were calculated, and when multiplied by a tonnage factor, gave total original in-place resource. It was generally assumed that one acre-foot of coal in the ground was equivalent to 1,800 tons of bituminous coal. A lesser figure of 1,760 tons per acre-foot was used for subbituminous coal and lignite.

b. In other areas, original resource was based on latest estimates of the U.S. Geological Survey, State geological surveys, coal mining companies, and railroad companies.
In areas where coal demand was great and the supply rather limited, the minable seam thickness was generally less and the maximum overburden greater than for the country as a whole. For example, in the Appalachian area, only that coal greater than 28 inches in thickness under a 15 to 1 ratio of overburden thickness (at the final highwall) to seam thickness was considered strippable. In parts of the Rocky Mountain area, only coal in seams five feet or more in thickness are considered minable by stripping. Meanwhile, in Alaska, very large tonnages of coal, particularly on the North Slope, are considered more as a resource than a reserve because of the high cost of mining created by severe weather conditions and the lack of an export market. All coal that was considered uneconomic or unminable was excluded from the available reserve estimates. Minimum coalbed thickness, maximum overburden thickness, and economic stripping ratio used to estimate the strippable reserves in the various States are summarized in table 1.

Sulfur content was generally derived from coal analyses published by either the Bureau of Mines or State agencies. Over 11,000 analyses were recorded and used. In the absence of sufficient information on sulfur analyses of coal from strip mines, published analyses of sulfur content from underground mines was applied to the stripping portion of the same coalbed.

Procedures used to evaluate the strippable coal resources are as follow:

1. Original in-place resources were either estimated or obtained from other sources.
TABLE 2. - Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968 by rank of coal, sulfur category, and coal province

(Millions of short tons)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Strippable resources</th>
<th>Strippable reserves</th>
<th>Low sulfur</th>
<th>Medium sulfur</th>
<th>High sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>BITUMINOUS COAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Province - Appalachian Region</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Alabama</td>
<td>667</td>
<td>134</td>
<td>33</td>
<td>74</td>
<td>27</td>
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<td>Kentucky-east</td>
<td>4,609</td>
<td>781</td>
<td>532</td>
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<td>Maryland</td>
<td>150</td>
<td>21</td>
<td>0</td>
<td>8</td>
<td>13</td>
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<td>Ohio</td>
<td>5,566</td>
<td>1,033</td>
<td>0</td>
<td>126</td>
<td>907</td>
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<tr>
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<td>752</td>
<td>0</td>
<td>225</td>
<td>527</td>
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<tr>
<td>Tennessee</td>
<td>483</td>
<td>74</td>
<td>5</td>
<td>43</td>
<td>26</td>
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<tr>
<td>Virginia</td>
<td>2,741</td>
<td>258</td>
<td>154</td>
<td>99</td>
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<tr>
<td>West Virginia</td>
<td>11,230</td>
<td>2,118</td>
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<td>1,862</td>
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<tr>
<td>Arkansas</td>
<td>200</td>
<td>149</td>
<td>3</td>
<td>118</td>
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<td>Illinois</td>
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<td>3,167</td>
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<td>Indiana</td>
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<td>1,096</td>
<td>0</td>
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<td>180</td>
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<td>1,388</td>
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<td>375</td>
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<td>6</td>
<td>1</td>
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<td>0</td>
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<td>434</td>
<td>111</td>
<td>10</td>
<td>44</td>
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<td>535</td>
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<td>Rocky Mountain and Northern Great Plains Provinces 3/</td>
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<td></td>
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<td>Colorado</td>
<td>870</td>
<td>500</td>
<td>476</td>
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<tr>
<td>Utah</td>
<td>252</td>
<td>150</td>
<td>6</td>
<td>136</td>
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<tr>
<td>Subtotal</td>
<td>1,122</td>
<td>650</td>
<td>482</td>
<td>160</td>
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<td>Alaska</td>
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<tr>
<td>Alaska</td>
<td>1,201</td>
<td>480</td>
<td>1/4 480</td>
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<td>0</td>
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<tr>
<td>Total Bituminous</td>
<td>62,626</td>
<td>13,597</td>
<td>2,837</td>
<td>2,128</td>
<td>8,632</td>
</tr>
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TABLE 2. -- Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968 by rank of coal, sulfur category, and coal province—Continued

(Millions of short tons)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Remaining strippable resources</th>
<th>Strippable reserves</th>
<th>Strippable sulfur</th>
<th>Low sulfur</th>
<th>Medium sulfur</th>
<th>High sulfur</th>
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<tr>
<td>SUBBITUMINOUS COAL</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rocky Mountain and Northern Great Plains Provinces 5/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td>400</td>
<td>387</td>
<td>387</td>
<td>0</td>
<td>224</td>
<td>0</td>
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<tr>
<td>Montana</td>
<td>7,813</td>
<td>3,400</td>
<td>3,176</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>New Mexico</td>
<td>3,307</td>
<td>2,474</td>
<td>2,474</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Wyoming</td>
<td>22,028</td>
<td>13,971</td>
<td>13,377</td>
<td>65</td>
<td>529</td>
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<tr>
<td>Subtotal</td>
<td>33,548</td>
<td>20,232</td>
<td>19,414</td>
<td>289</td>
<td>529</td>
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<td>Pacific Coast Province 6/</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>California</td>
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<td>25</td>
<td>25</td>
<td>0</td>
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<tr>
<td>Washington</td>
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<td>135</td>
<td>135</td>
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<tr>
<td>Subtotal</td>
<td>600</td>
<td>160</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alaska</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Subbituminous</td>
<td>40,338</td>
<td>24,318</td>
<td>23,500</td>
<td>289</td>
<td>529</td>
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</table>

LIGNITE

Interior and Gulf Provinces 8/  

<table>
<thead>
<tr>
<th>Rank</th>
<th>Remaining strippable resources</th>
<th>Strippable reserves</th>
<th>Strippable sulfur</th>
<th>Low sulfur</th>
<th>Medium sulfur</th>
<th>High sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td>32</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Texas</td>
<td>3,272</td>
<td>1,309</td>
<td>625</td>
<td>684</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>3,304</td>
<td>1,334</td>
<td>650</td>
<td>684</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE 2. — Estimated remaining strippable resources and strippable reserves of coal and lignite in the United States, January 1, 1968 by rank of coal, sulfur category, and coal province—Continued

(Millions of short tons)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Remaining strippable resources</th>
<th>Strippable reserves</th>
<th>Strippable reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium sulfur</td>
<td>Low sulfur</td>
<td>Medium sulfur</td>
</tr>
<tr>
<td>LIGNITE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain and Northern Great Plains Provinces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Montana</td>
<td>7,058</td>
<td>3,497</td>
<td>2,957</td>
</tr>
<tr>
<td>North Dakota</td>
<td>5,239</td>
<td>2,075</td>
<td>1,678</td>
</tr>
<tr>
<td>South Dakota</td>
<td>399</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Subtotal</td>
<td>12,696</td>
<td>5,732</td>
<td>4,795</td>
</tr>
<tr>
<td>Alaska</td>
<td>8</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total Lignite</td>
<td>16,008</td>
<td>7,971</td>
<td>5,450</td>
</tr>
<tr>
<td>Grand Total</td>
<td>United States</td>
<td>119,172</td>
<td>41,986</td>
</tr>
</tbody>
</table>

1/ Bituminous coal resource and reserve not estimated for Texas and Nebraska.
2/ There may be isolated areas of some seams which might be classed in the medium-sulfur category.
3/ Bituminous coal resource and reserve not estimated for Montana, New Mexico, Idaho, and Wyoming.
4/ 478 million tons of bituminous and 3,367 million tons of subbituminous coal reserves in the Northern Alaska Fields (North Slope) are included in the estimates even though an economic export market, which is essential for exploitation, does not currently exist.
5/ Subbituminous coal resource and reserve not estimated for Colorado.
6/ Bituminous coal resource and reserve not estimated for Washington, and subbituminous coal resource and reserve not estimated for Oregon.
7/ Includes 179 million tons of undifferentiated subbituminous coal and lignite.
8/ Lignite resource and reserve not estimated for Kansas, Mississippi, Louisiana, and Alabama.
FIGURE 2. - Coalfields of Alaska.
Strip coal reserve estimates totaling 4.4 billion tons under less than 120 feet of overburden were made for six Alaskan coalfields: the Northern, Nenana, Broad Pass, Susitna, Matanuska, and Kenai fields. The Northern field, where coal is believed to underlie continuously about 30,000 square miles, contains 92 percent of Alaska's estimated total original resource of 130 billion tons. These coals are Cretaceous in geologic age, whereas coal of the other fields are Tertiary. The Nenana and Matanuska fields, located near Fairbanks and Anchorage, respectively, and served by rail, are the only fields from which sustained production has been made. Total recorded Alaskan production through 1969 is about 20.6 million tons. Production, except for a single one or two-man stripping operation, ceased during 1967 in the Matanuska field. Strip production from the Nenana field continues at the rate of about 670,000 tons per year. Analyses of Alaskan coals indicate that they nearly all fall into the low-sulfur category.

The first coal mine in Alaska was opened in 1855 by the Russians at Port Graham, but the mine was abandoned after only about 10 years of operation. Sustained coal production did not come about until completion of the Alaska Railroad to the Matanuska coalfield in 1916 and to the Nenana field in 1918.
All Alaskan coal production is by strip mining. The Nenana field coals are all subbituminous in rank. The greater proportion of Nenana field coal is burned for power generation in and near Fairbanks, but a considerable amount is still used directly for space heating and for space heat steam raising in central plants.

The small amount of coal still being produced from the Matanuska field is truck-hauled to market and is consumed in entirety for space heating purposes. Electric utilities in the Anchorage area which formerly burned Matanuska field coal have been converted to natural gas use.

An export market for metallurgical quality coking coals, and possibly some steam coal, exists in Japan and possibly elsewhere, but no such exports have taken place. The various reasons for nonexport can be summed into the apparent inability to make Alaskan coals economically competitive f.o.b. an Alaskan all-weather port. A factor which may enhance export possibilities is the apparent low-sulfur content of all Alaskan coals.

Some of the bituminous coking coals of Arctic Northwestern Alaska (North Slope), where exposed, exhibit simple geologic structure that they should be amenable to modern large-scale mechanized mining, either surface or underground, and perhaps their permanently frozen condition can be used advantageously in the mining system. The greatest problem of exploitation is transport of the coal to an ice-free harbor for export. The Arctic Ocean near the coal deposits has about 90 ice-free days per year.
All Alaskan coals that are or have been mined in quantity are Tertiary in geologic age. The Tertiary coals range in rank from lignite to anthracite; the Cretaceous coals from subbituminous to bituminous. Strip mining usually, but with the possible exception of some lignite beds and some Northern field subbituminous beds, is confronted with dipping beds and some faulting.

The Tertiary coalfields are much less in areal extent than the Northern Cretaceous field, and individual Tertiary beds are characteristically lenticular. Coalbeds of the Northern field are believed less lenticular, but this premise is based on the observable persistence of more resistant beds rather than actual knowledge of coalbed continuity.

Coalbed thicknesses vary from a few inches to 50 feet. Nenana field subbituminous beds currently being strip mined are 25 feet and 50 feet thick and dip about 55°. A group of eight formerly-mined Matanuska field bituminous beds vary in individual thickness from 3 feet to 16 feet, comprising a total coal thickness of about 50 feet within a total strata thickness of about 200 feet dipping approximately 40°. Coal burning ceased during the 1960's when Barrow was granted permission by Congress to use natural gas from a field just outside Barrow in Naval Petroleum Reserve No. 4.

Alaska has not enacted strip mining laws. Probably, when large-scale strip mining becomes imminent, regulations will be issued to control surface damage and to enforce reasonable reclamation practices.
There are no privately owned coal lands in Alaska; they all are either Federal Government or State held lands to which the leasing laws apply. A brief summary of the Federal leasing laws follow:

Coal Prospecting Permits are granted by the Department of the Interior for a 2-year period to qualified applicants to prospect unclaimed, undeveloped lands where prospecting or exploratory work is necessary to determine the existence or workability of coal deposits. An application for a permit must be filed, in duplicate, in the appropriate land office. Each application must be accompanied by a filing fee of $10 which is not returnable, and by full payment of the first year's rental at the rate of 25 cents per acre. In addition, the applicant must furnish a corporate surety bond or a personal bond conditional upon compliance with all the terms of the prospecting permit.

Each permit covers a maximum of 2,560 acres, and no permit holder may have more than four permits (16 square miles). The recipients of a permit may remove only as much coal as is necessary to determine the commercial value of the deposit. If coal is mined commercially, a Coal Lease must be obtained. Leases are subject to the 25 cents per acre rental fee and to a royalty payment on a minimum annual production, the payments beginning with the sixth year of the lease.

A summary of the strippable coal resources and reserves are shown in tables 4 and 5, appendix I.

State leasing laws are similar to the Federal laws.
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