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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

EXPLORATION OF LEASING BLOCK NO. 28 IN THE NENANA COAL FIELD, ALASKA

BY

H. MARSTRANDER, G. A. APELL, F. A. RUTLEDGE, AND J. H. HULBERT

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By H. Marstrander,[2/] G. A. Apell,[2/] F. A. Rutledge,[3/] and J. H. Hulbert[4/]

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INTRODUCTION

The inability of Alaska coal mines to supply the quantity of coal required by public and private consumers and by the armed forces in Alaska caused the Coal Procurement Section of the Alaska Department, U. S. Army, to be established. It proposed to investigate the coal deposits and to expedite production of coal. The Bureau of Mines has closely cooperated in this program and was in direct charge of exploration.

As to develop and equip an underground coal mine would have taken time and the need for coal was acute, a deposit that could be prepared for mining quickly was desirable. Several such deposits of stripping coal were known

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1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 3951."

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to occur in the Nenana field and were examined by the Bureau. One of these, the Diamond strip mine 4 miles west of Healy, was brought into production late in the fall of 1943. This mine was operated for the Army Coal Procurement Section by the C. F. Lytle Co. and the Green Construction Co.

The Roth property, or Leasing Block No. 28, in the Healy Creek Valley offered the largest available tonnage of both stripping coal and total reserves. A program of exploration by the Bureau of Mines was inaugurated in 1943 and completed in 1944. Field parties of the Federal Geological Survey mapped the area and correlated the coal beds during the 1944 and 1945 summer seasons.

ACKNOWLEDGMENTS

In its program of exploration of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each exploratory project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the actual exploratory work, and prepares the final report. The Metallurgical Branch, R. G. Knickerbocker, chief, analyzes samples and performs beneficiation tests. Both these branches are under the supervision of Dr. R. S. Dean, assistant director.

Exploration of Alaska coals by the Bureau of Mines was integrated with the program of the Coal Procurement Section of the Alaska Department, U. S. Army.

Acknowledgment is due to A. C. Fieldner and his staff for research on production of liquid fuels and lubricants. Samples for the tests on low-temperature carbonization of Alaska coals were furnished by the Alaska Division of the Mining Branch.

With respect to this report, special acknowledgment is due to R. S. Sanford, acting chief, Alaska Division, for revision of the report and supervision of the exploration program. Acknowledgment is also made to Lt. Col. C. W. Jeffers, Major D. L. Sibray, Major Chapman, and Capt. J. M. Rasch of the Alaska Department; to Maurice L. Sharp coal analyst of the Alaska Railroad, and H. M. Cooper, senior chemist, Bureau of Mines, for analyses of samples; to the Federal Geological Survey for correlation of coal beds in the Healy Creek Valley and use of their maps; to B. D. Stewart, Territorial Commissioner of Mines, and C. R. Garrett, deputy mine inspector, Territorial Department of Mines, for their assistance and cooperation, and to Col. O. F. Ohlson of the Alaska Railroad. The cooperation and assistance given by Austin Lathrop, president of Healy River Coal Corp., and by Peder Nilsen, superintendent of the Suntrana Mines, are gratefully acknowledged.

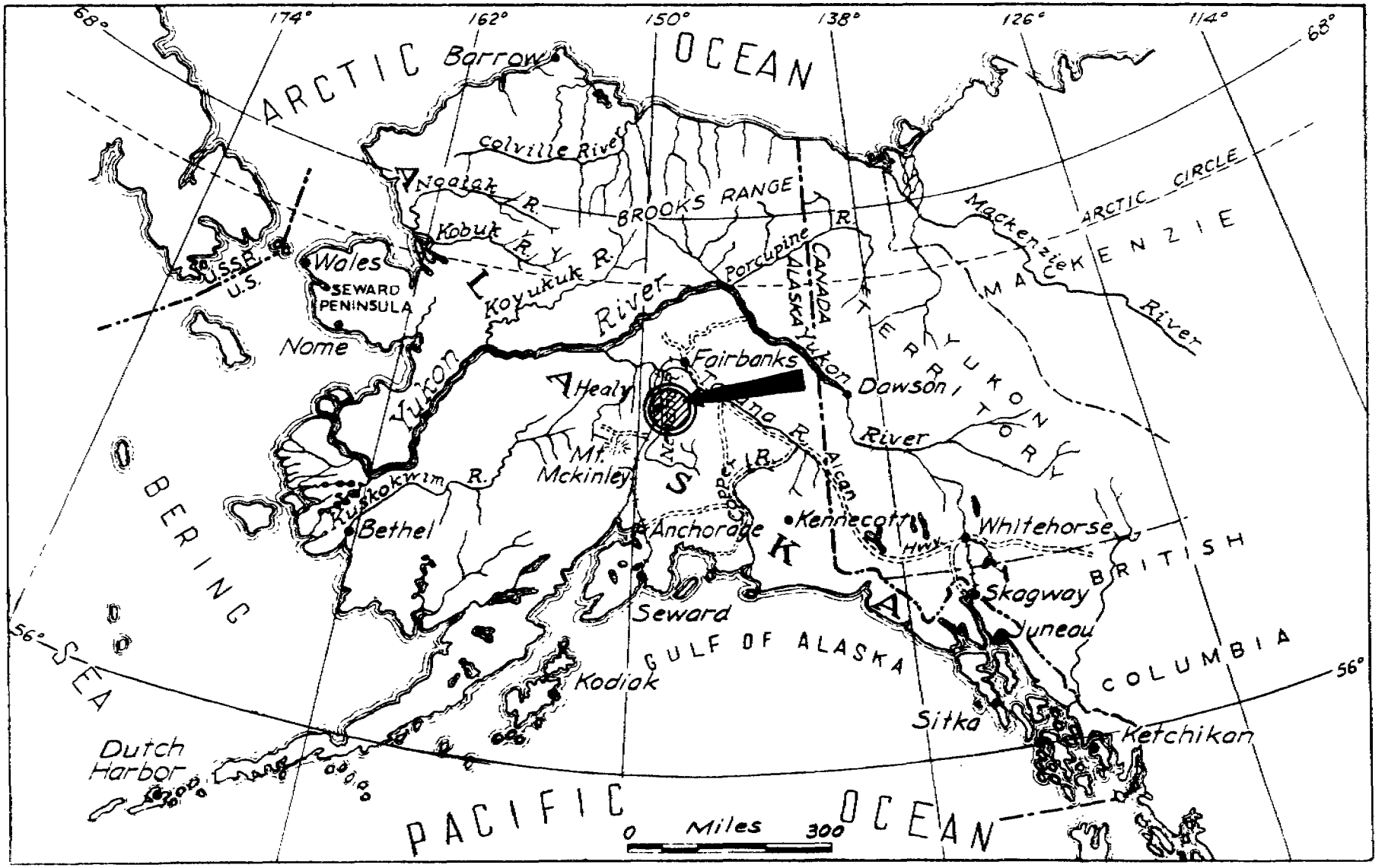


FIG. 1 INDEX MAP ~ LEASING BLOCK NO. 28

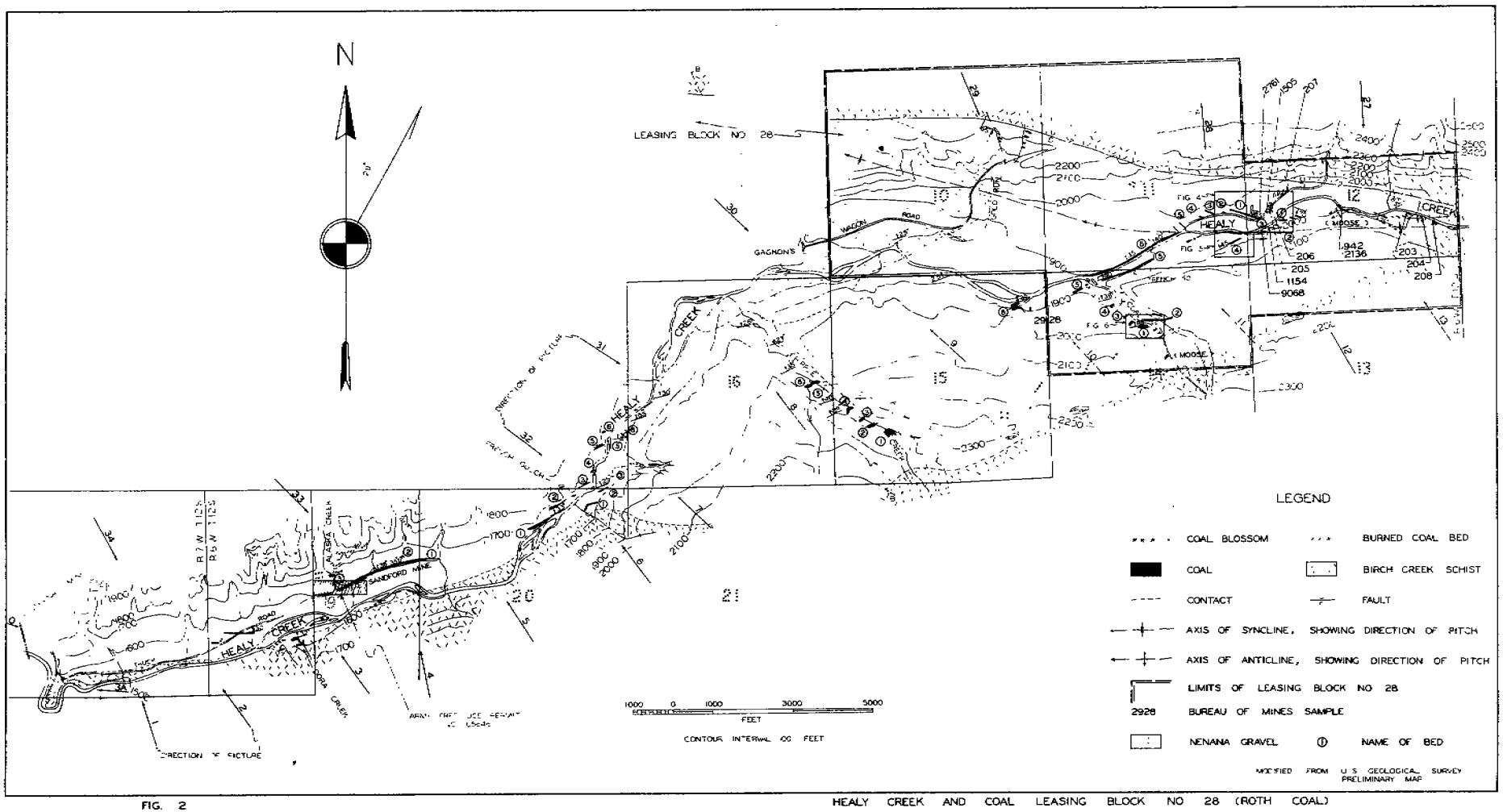


FIG. 2 HEALY CREEK AND COAL LEASING BLOCK NO 28 (ROTH COAL)

LOCATION AND ACCESSIBILITY

Coal Leasing Block No. 28, formerly known as the Roth property lies on Healy Creek at the eastern end of a synclinal structure of the coal-bearing formation. The area covers both sides of Healy Creek, and its location is shown on figures 1 and 2. Leasing Block No. 28 of the Healy River Coal Corp. and the intervening country drained by Healy Creek are part of the Nenana coal field in the northern foothills of the Alaska Range.

The Suntrana mine of the Healy River Coal Corp., at the west end of the area examined, is connected to the Alaska Railroad at Healy by 4.4 miles of standard-gage track. Healy is 244 miles from Anchorage and 112 miles from Fairbanks, Alaska. At present there is only one passenger train a week each way through Healy, going north to Fairbanks on Wednesdays and returning on Thursdays. In emergencies, passengers may obtain permission to ride on the daily freight trains. All freight, express, mail, telegraph, and telephone services are handled by the Alaska Railroad.

Charter airplane service from either Anchorage or Fairbanks is available, as Suntrana has a small landing strip serviceable for small planes.

A truck road for hauling mine timbers has been graded from the Suntrana mine up Healy Creek for about 3 miles, and crosses the creek in four places close to the Suntrana mine. Usually it can be used by trucks or tractors except during high water. After heavy rains, however, repairs are required and the road is not adequate for any large-scale operations.

To avoid the stream crossings, obtain better facilities for loading coal into railroad cars, and to avoid the immediate construction of a tunnel through the ridge above the Suntrana mine, the Bureau of Mines proposed construction of a road up the east side of the ridge. From a point at the top of the ridge the coal could be dumped into a bin, from which it could be dropped down the steep west side of the ridge through a chute to railroad cars on the spur at the bottom. This plan was adopted, and a short connection with a maximum grade of 8 percent was built between the existing road and the top of the ridge. A combined coal bin and chute also was constructed by the operators.

Present plans for developing Leasing Block No. 28 provide for construction of a permanent road to replace the timber road and trail up Healy Creek. This would be built on the terrace on the north side of the creek, where it will be 20 to more than 50 feet above flood water and safe from damage by floods. (See fig. 2.) The length of the road east of the slope on the ridge would be a little more than 7 miles.

As such a road could not be connected with the railroad at Suntrana without great expense, it is planned that the road up the ridge be improved and the present method of handling coal through a chute be continued until this field is opened for mining coal on a large scale.

In advance of a road-location survey, the problem was discussed with Ike Taylor, chief engineer of the Alaska Road Commission, who estimated that the first mile of road over the ridge east of Suntrana will cost $25,000 and the remaining distance $12,500 a mile, or a total of approximately $100,000.

There would be no great difficulty in extending the Suntrana railroad spur to Leasing Block No. 28 when production warrants such development.

PROPERTY AND OWNERSHIP

All coal lands in Alaska are owned by the United States Government and are under the jurisdiction of the Department of the Interior. Coal-prospecting permits and mining leases may be granted to individuals or groups of individuals who are citizens of the United States.

A coal-prospecting permit grants to the applicant, for 4 years, the exclusive right to prospect for coal on the described land. A royalty of 10 cents a ton is paid to the Government for all coal removed. A maximum of 2,560 acres can be held by an individual or group by permit or lease. It was further provided that an individual could not acquire or hold any interest in two or more leases the total acreage of which is over 2,560.

A mining lease on coal lands in Alaska is of indefinite duration, provided the provisions of the Coal Leasing Act of October 20, 1914 (38 Stat., 741), are fully observed by the lessee. The Government exacts a minimum royalty of 2 cents a ton for all coal removed during the first 5 years of the lease and a minimum of 5 cents a ton for the following 20 years, after which royalties are adjusted from time to time but never exceed 5 percent of the selling price of the coal.

The area discussed in this report contains 2,080 acres and has been segregated as Coal Leasing Block No. 28. The lease was relinquished by its holders, Cannel Coal Corp., in 1935.

The adjacent area to the west along Healy Creek between Leasing Block No. 28 and the area held by the Healy River Coal Corp. has been included in the summary of reserves. This area included 40 acres held by the Army under a free-use permit. Description of the area covered by Leasing Block No. 28 follows:

T. 12 S., R. 6 W.:

	Acres
Sec. 10.....	640
Sec. 11.....	640
S½, sec. 12.....	320
N½ N½, sec. 13.....	160
N½, sec. 14.....	320
	2,080

The area held by the United States Army under permit 05646 is as follows:

S½ S½ SW¼ NE¼ sec. 19, T. 12 S., R6W...40 acres.

As coal lands in Alaska are held by the Government, exploration by the Government increases the value of the deposits and is valuable in formulating a mining program. Sufficient information has been obtained by the Geological Survey and Bureau of Mines from their program to indicate large coal reserves: 143,680,000 tons in Leasing Block No. 28 and 188,700,000 tons in the area between the leasing block and the lease of the Healy River Coal Corp.

PHYSICAL FEATURES AND CLIMATE

The Nenana coal field is part of a foothill belt on the north side of the Alaska Range and lies on both sides of the railroad. This range extends in a crescent shape from Lake Clark on the west to the Nutzotin Mountains on the east. Numerous peaks reach an altitude of more than 10,000 feet; Mt. McKinley, the highest peak in North American, has an altitude of 20,300 feet. The coal field lies between the Alaska Range on the south and the broad flats of the Tanana Valley on the north. The topography of the district consists of nearly parallel ridges separated by lowlands, many of which are terraced. The streams that flow into the Tanana River from the south, such as the Nenana River, originate in the glaciers of the Alaska Range at approximately 5,000 feet. The southern half of the territory drained by the Nenana is rough and broken, whereas there is considerable level, gently rolling country in the northern half. Healy Creek, which flows across Leasing Block No. 28, and Lignite Creek (Hoseanna Creek), farther north, enter Nenana River from the east.

Near the mouth of Healy Creek the Nenana debouches from a steep canyon in the schist that forms the backbone of the foothills and flows northward in a valley eroded across the coal-bearing formation. On both sides of the valley the coal-bearing formation rises in bluffs or terraces ranging in height from 100 to 500 feet. Opposite the mouth of Healy Creek the terrace is about 100 feet in height and 600 to 1,000 feet in the width. A series of terraces follow, one above the other.

Coal Leasing Block No. 28 and the immediately adjacent coal lands are at the east end of an elongated basin bordered on the north and south by converging steeply dipping ridges of schist. Healy Creek flows approximately along the major axis of the basin. Small tributaries from the north and south have cut deeply into the rims of the basin. The south side of the basin is comprised largely of terraced lands, which rise steeply into the schist hills. The north side is only slightly terraced.

Vegetation in the immediate vicinity of the coal deposit is low brush, grass, and the moss commonly found in this part of Alaska. Along the valleys, spruce and cottonwood large enough to serve as mine timbers may be obtained.

The temperatue varies widely in the area, and the precipitation, although light in comparison with that of the coastal region, is greater than at Fairbanks. According to the Weather Bureau, the total annual precipitation in the lower Tanana and middle Yukon Valleys is about 12 inches. Virtually all precipitation in December, January, and February and nearly all that in November and March is in the form of snow. Commonly, the wettest months are July and August, June and September following in that order. Over half the total annual precipitation occurs in these 4 months and consists chiefly of

violent showers. A study of the data gathered over 15 years shows that the wettest years had more than twice the precipitation of the driest years, and that the difference lay in the amount that fell in summer. Generally only 25 percent of the precipitation is in the form of snow. The average annual precipitation is 15 inches.

The Nenana coal field is in nearly the warmest portion of interior Alaska. The mean temperature for July is slightly above 60° F., and 70° F. and higher is common from June to August and occasionally in May and September. Winters are cold, with temperatures of minus 50° F. to minus 60° F. High winds are rare and seldom occur when the temperature is below minus 10° F.

Climatic conditions will permit open-cut mining during 8 or 9 months of the year and underground operations throughout the year. One effect of the severe winter cold is the small flow in Healy Creek, so that there is little trouble from ice. No serious trouble is expected from freezing and icing of the gravel road built on the flats above the creek. This opinion has been confirmed by residents of the valley for more than 20 years.

LABOR AND LIVING ACCOMMODATIONS

No mine labor is available in the Healy district. The 1940 census gave Healy a population of 41 inhabitants, and all labor at Suntrana is needed for that mine. It would be necessary to import labor for any large mining operation. In 1943, miners were brought from Pennsylvania and the west coast to work in the Alaskan coal mines. During the acute coal shortage, the Army furnished labor through furloughed soldiers.

The wage scale now (January 1946) in effect at the Evans-Jones mine, the largest coal producer in Alaska, is as follows:

Inside mine:

	Per hour
Shot firers	$1.37
Timbermen	1.37
Trackmen	1.37
Bratticemen	1.37
Brushing	1.37
Drainage	1.37
Motormen	1.37
Pipemen	1.37
Timber packer	1.37
Chute chaser	1.37
Brakeman or chute leader	1.27

Helpers in the above catagories are paid $1.27 per hour.

Outside mine:

	Per hour
Mechanic foreman.	$1.35
Washerymen.....	1.30
Mechanics.....	1.30
Lead firemen.....	1.30
Car loader.....	1.15
Picking table....	1.15
Shakermen.....	1.15
Rock hoistmen....	1.15
Yardmen.....	1.00
Laborer.....	1.00

Fireman and mechanic helpers receive $1.15 per hour. The above rates are subject to the Fair Labor Standards Act, which stipulates that time and one-half shall be paid for work in excess of 40 hours a week.

During World War II unskilled labor at some mines was paid $1.10 to $1.25 an hour. Tractor operators have been paid $1.60 to $1.75 an hour.

The only living accommodation (except at the Suntrana mine) is one privately owned, and it will be necessary to construct camps for any operation, whether it be exploration or mining.

HISTORY AND PRODUCTION

The first mention of mining coal from the Nenana field near Healy is found in the Twelfth Annual Report of the Bureau of Mines:

> Attention was attracted first to the outcrop on Lignite Creek, and during the period of construction of the northern division of the railroad lignite was mined there and supplied to towns along the line, including Fairbanks. When the railroad was built through Healy, a somewhat better grade of coal was found in the river bank and underlying the right of way. This was mined and put on the market. Prospecting was extended, with the result that there was found on Healy Creek, about 4 miles from the main line of the railway, a large deposit of subbituminous coal so situated as to permit cheap and easy mining. The beds dip into the hills at 30° to 45°.

The first production figures for the Nenana field are found in the Report of the Territorial Mine Inspector for 1920:

> In the Nenana coal field, mining was conducted by two private companies, one being the Peterson mine of the Healy River Coal Corporation, on the Government Railroad at the mouth of Healy Creek, and one on the left limit of Lignite Creek, 1½ miles from the railroad and across the Nenana River. From these two mines, approximately 21,000 tons of coal were mined during 1919 and 1920. A considerable amount of this coal was disposed of to private buyers at Nenana and Fairbanks, the remainder being used by the Alaskan Engineering Commission. The coal was delivered at Fairbanks for $9 per ton.

In the period from 1920 to 1922, the Peterson mine of the Healy River Coal Corp., on the west bank of the Nenana River, produced about 12,500 tons of coal. In 1922, the same company started work on the inclined slope of a second mine, called the New mine, about 1,000 feet from the Peterson entry. The total production from the New mine was only 1,500 tons.

Development of the Suntrana mine on Healy Creek was undertaken in November 1921. In October 1922, a railroad spur 4.4 miles long was completed from the Alaska Railroad to Suntrana. The Suntrana mine has been in almost continuous operation since that time and has been an important producer of coal. In recent years, production has been 200 to 500 tons a day.

The critical shortage of fuel during the winter of 1942 influenced the development of several open-cut mines in the Nenana field for the quick production of coal. One of these, the Diamond strip mine 4 miles west of Healy, was brought into production in the late fall of 1943. The Diamond mine was operated for the Army Coal Procurement Section by the C. F. Lytle Co. and the Green Construction Co. Production was approximately 500 tons a day.

Application was made by the Army for free use permits covering several locations in the Healy Creek field west of Leasing Block No. 28. From only one of these, Free Use Permit No. 05646, was there any production, and other areas were relinquished. This mine, known as the T. E. Sandford, was operated by Emil Usibelli and Thadeus Sandford, both of Suntrana, for the Army Coal Procurement Section, and the coal produced was contracted for by the Army. A description of the area covered by the permit follows:

Serial No. 05646.
$S\frac{1}{2}S\frac{1}{2}SW\frac{1}{4}NE\frac{1}{4}S\frac{1}{2}S\frac{1}{2}SW\frac{1}{4}NE\frac{1}{4}$ sec. 19, T. 12 S., R. 6 W., Fairbanks meridian.

The application stated that up to 25,000 tons a year was to be used for Army purposes.

The original prospecting permit for the tract now known as Coal Leasing Block No. 28 was issued on June 23, 1923, to R. F. Roth of Fairbanks, Alaska. It covered 1920 acres, was valid for 4 years, and permitted the sale of coal during prospecting. The report of the Territorial Mine Inspector of 1923 states:

> A camp has been erected, and preparations have been made to drive two prospecting tunnels on the area held by R. F. Roth of Fairbanks under a 4-year prospecting permit. This area lies adjacent to Healy Creek, 4 or 5 miles upstream from the Suntrana mine.
>
> It is planned to obtain from the two proposed tunnels sufficient coal for use in making tests to determine its commercial usefulness. It will be necessary to transport the coal to the railroad by means of sleds, which can be used only during the period that Healy River is frozen.

On October 26, 1923, this permit was amended to cover 2,080 acres. Output during the winter of 1924 was 160 tons, and in 1925 it was 590 tons.

On May 29, 1928, the Commissioner of the General Land Office recommended segregation of this property as Coal Leasing Block No. 28. Application was made by Roth, and a lease was issued to him on June 3, 1930. Soon after, the property was assigned to the Alaska Cannel Coal Corp., and official approval was granted on September 9, 1930. Only a small tonnage was produced by this company, and on September 27, 1935, the General Land Office accepted relinquishment of the lease. The property in Leasing Block No. 28 consists of sec. 10, sec. 11, S½ sec. 12, N½N½ sec. 13, and N½ sec. 14, T. 12 S., R. 6 W., Fairbanks meridian. It is in the Nenana precinct of the 4th Judicial Division.

On October 6, 1943, Emil Usibelli, Suntrana, Alaska, applied for a mining lease (No. 05490) on the following property: Sec. 11, S½ sec. 12, N½N½ sec. 13, and N½ sec. 14, all in T. 12 S., R. 6 W., Fairbanks meridian. Usibelli's application covered Leasing Block No. 28, except that sec. 10 was omitted.

Government regulations require that the lessee expend $100 an acre for development during the 5-year period following granting of the lease.

On the basis of the acute need for coal by both the Army and the civilian population, the District Land Office at Fairbanks, Alaska, recommended that the lease be granted without delay. However, a leasing block can be leased only to the highest bidder, and as the Alaska Road Commission had estimated that the construction of a satisfactory road from the railroad spur at Suntrana to Leasing Block No. 28 would cost $100,000, no bid for less than this amount should be accepted.

GENERAL GEOLOGY

The geology of the coal-bearing formation along Healy Creek has been discussed by Capps[5] and more recently in a United States Geological Survey report by Wahrhaftig and Freedman.[6] The formation containing the coal in the Nenana field was deposited on an uneven erosion surface of the Birch Creek schist, and it is improbable that the lower coal beds were ever continuous. Erosion has removed portions of the deposits and left them less extensive and less continuous than they were originally. The upper portion of the schist exposed in the Healy Creek valley has been altered for several hundred feet to a light-colored material composed of quartz grains and sericite.

The Tertiary coal-bearing formation has been tentatively correlated as Miocene on the basis of a fossil fresh-water fish.[7]

5/ Capps, Stephen R., Geology of the Alaska Railroad region: Geol. Surv. Bull. 907, 1940, pp. 118-122.

6/ Wahrhaftig, Clyde, and Freedman, Jacob, Coal Deposits in the Valley of the Healy River, Alaska: U. S. Geol. Surv. Rept., 1945, 8 p.

7/ Capps, Stephen R., see p. 122 of footnote 5.

Wahraftig and Freedman divided the coal formation into three members. The lower member is composed of the coal beds, shales, sandstones, and siltstones below the base of the No. 1 coal bed. The coal beds in this member, beds A through G, inclusive, at Suntrana, and the related beds, including the Moose bed in the eastern part of the area, though locally important are not uniform in thickness nor persistent laterally throughout the area. A conglomerate consisting of rounded pebbles of chert and white quartz in a matrix of white sand and clayey material forms the base of the lower member.

The middle member, containing six major coal beds, numbered 1 to 6, inclusive, is apparently continuous throughout most of the area. Interbedded with the coal beds are sandstones, siltstones, clays, and minor coal beds. One bed, No. 6, has been traced over a strike length of 12 miles from the Nenana River nearly to the east end of the coal measures.

The upper member is composed of minor coal beds with siltstones and clay and sandstone beds. The coal is boney, and the beds are thin and discontinuous.

The coal formation is overlain in part of the area by the Nenana gravel.

The thickness of the coal formation is variable from place to place, and the maximum thickness is not known. Near the Suntrana mine the thickness is approximately 1,900 feet, whereas near the eastern limit of the Healy Creek field it is approximately 3,500 feet. The area contains a greater aggregate thickness of coal than any other in Alaska that has been examined by the Bureau.

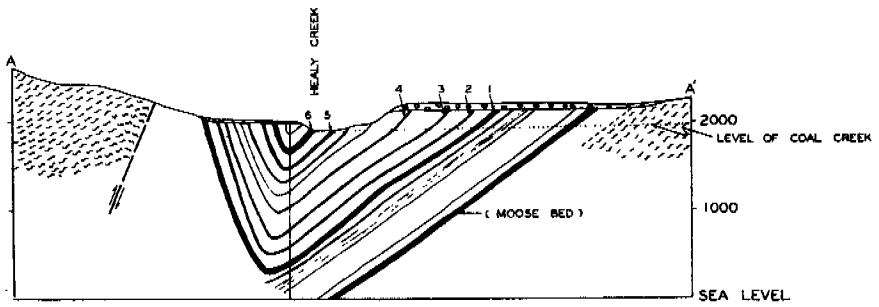
The coal basin is a syncline bounded on the north by a fault striking about N. 80° W. with an average dip 70° north. This sycline is illustrated on figures 2 and 3, plan map of Healy Creek and Coal Leasing Block No. 28 and vertical geologic sections, respectively. The beds north of the axis of the syncline strike N. 30° to 65° W. and dip 65° to 85° south. South of the axis the beds strike N. 65° E. to E. and dip 25° to 45° N.

TRENCHING AND SAMPLING BY THE BUREAU OF MINES

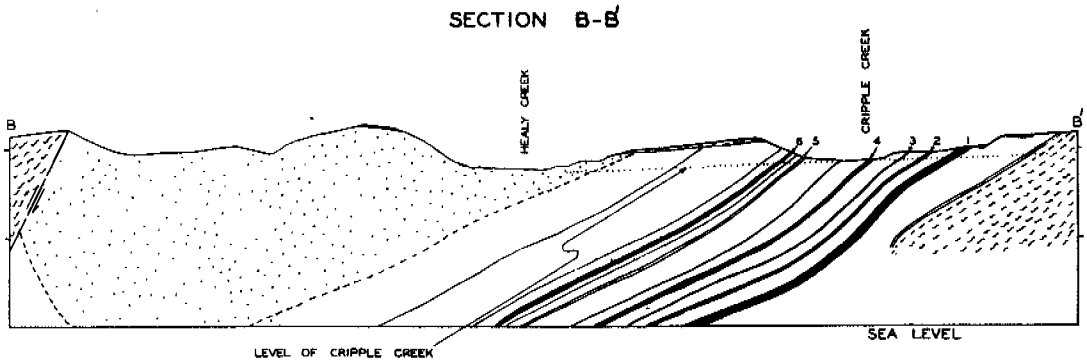
Leasing Block No. 28 was explored during two partial field seasons. In the first summer, work was under the direction of Henning Marstrander. Exploratory work consisted of surface trenching to remove overburden and sampling and measuring the beds. The total length of trenches was approximately 1,550 feet.

Trenching required about 2 weeks. Some lost time because of difficulty in moving the equipment. On the north side of the creek no difficulty was experienced from frozen ground, but on the south side of Healy Creek it was necessary to remove thawed overburden from one trench and then move to another trench, leaving the surface in the first trench exposed for further thawing. In this way, work was in progress in three trenches at a time.

SECTION A-A'



SECTION B-B'



VERTICAL SCALE EQUALS HORIZONTAL SCALE

1000 0 1000 3000 5000

FEET

LEGEND

TERRACE GRAVEL

NENANA GRAVEL

COAL FORMATION

BIRCH CREEK SCHIST

MODIFIED FROM U. S. GEOLOGICAL SURVEY

FIG. 3 VERTICAL GEOLOGIC SECTIONS

At the beginning of the work, the Army Coal Procurement Section was principally interested in exploration of the Mammoth or No. 1 bed where it is exposed on the north bank of the creek and of the parallel beds lying to the north of the No. 1 bed. No. 1 bed is exposed at this point for 900 feet. This outcrop occurs on a terrace 20 to 30 feet above the sand and gravel flats of Healy Creek. One edge of the bed is covered by sand and gravel.

At least five large beds outcrop on this terrace, all with parallel strike of approximately N. 80° W. The dip is nearly vertical.

The first trench was dug across the strike of the No. 1 bed, and 3 to 6 feet of material was removed. At this point the coal bed forms the bank of the creek, and the exact thickness could not be determined, although it is known to exceed 36 feet.

A second bed, 22 feet thick and consisting of clean coal, was uncovered 105 feet north of the No. 1 bed. At the north end of the trench, which was approximately 200 feet long, a third bed was found. To obtain better measurement of this bed, a second trench was excavated about 300 feet east of the first trench. A third trench was excavated across the Moose bed. Two beds of coal were found in this trench.

The log of a cross section of the Moose bed where it outcrops on the south banks of the creek is as follows:

	Feet	Inches
Coal	27	-
Parting		1
Coal	1	4
Parting		1
Coal	1	3
Parting		1
Coal	1	9
Parting		1
Coal	1	-
Parting		1
Coal	6	2
Dirty coal		7
Parting		4
Dirty coal	1	2
Coal	2	7
Parting		1
Coal	2	3
Parting		4
Coal	4	1
Parting		1
Coal	1	6
Bone		2
Coal	3	-

Carbonaceous shale, footwall

Thickness of bed, 55 feet
Thickness of sample, 28 ft., 1 in.

The map prepared in 1926 by Ernest N. Patty, Professor of Mining, University of Alaska, shows a barn on the north side of Healy Creek, which was directly above the Moose bed. To determine whether coal actually existed at this point, a trench was dug beside the barn, but no coal could be found.

Three trenches were excavated on the south side of Healy Creek. At the point where the Moose bed outcrops, the bank rises abruptly to a height of 80 to 100 feet above the creek level, and considerable difficulty was experienced by the owner of the bulldozer in building a road to the site. The first trench was on the Moose bed, and the thickness of the bed ranges from 40 to 55 feet as measured by Charles R. Garrett, Deputy Territorial Mine Inspector, the senior author, and the greater thickness probably being accounted for by local folding. The length of exposure at this point is approximately 1,000 feet.

The trench at the eastern end of the syncline exposed the lowest coal bed, which has a thickness of 29 feet.

Some evidence of early working, apparently done 15 to 20 years ago, was found on the Moose bed on the north side of the creek. The old Anderson Tunnel No. 4 and Tunnel No. 5 were found but were caved. Abandoned and caved workings were found on the south side of the creek in the Moose and Nos. 1 and 2 beds. Tunnel No. 1 was in bed No. 2, tunnel No. 2 in bed No. 1, and tunnel No. 3 in Moose bed. It is reported that 700 tons of good coal was mined from tunnel No. 3.

There are many reports of mining cannel coal from this deposit in past years, but the engineers of the Territorial Department of Mines and the Bureau were unable to find any traces of cannel coal.

Coal beds are exposed east of the outcrop of the Moose bed on the south side of Healy Creek and at the east end of the syncline. Samples 203, 204, and 208 were taken from three of these beds. At this point, the creek bank is only 30 to 40 feet in height. The beds strike N. 30° to 65° W. and dip 75° to 85° to the southwest.

Several outcrops in the mountains near the head of Gold Run Creek and near the mouth of Coal Creek are known. Large outcrops were also reported on Cripple Creek. At the time, these beds were of no immediate interest to the Army Coal Procurement Section, and no time was available for examining them.

As exploration during the first season had been confined primarily to the coal beds exposed in the eastern part of Leasing Block No. 28, it was considered that additional trenching and sampling should be conducted in the rest of the area to complete the investigation of its resources. G. A. Apell was engineer in charge, and J. H. Hulbert was assistant engineer during the examination. The work was confined to the coal beds exposed along Healy Creek downstream from those previously examined and those outcropping along Coal Creek.

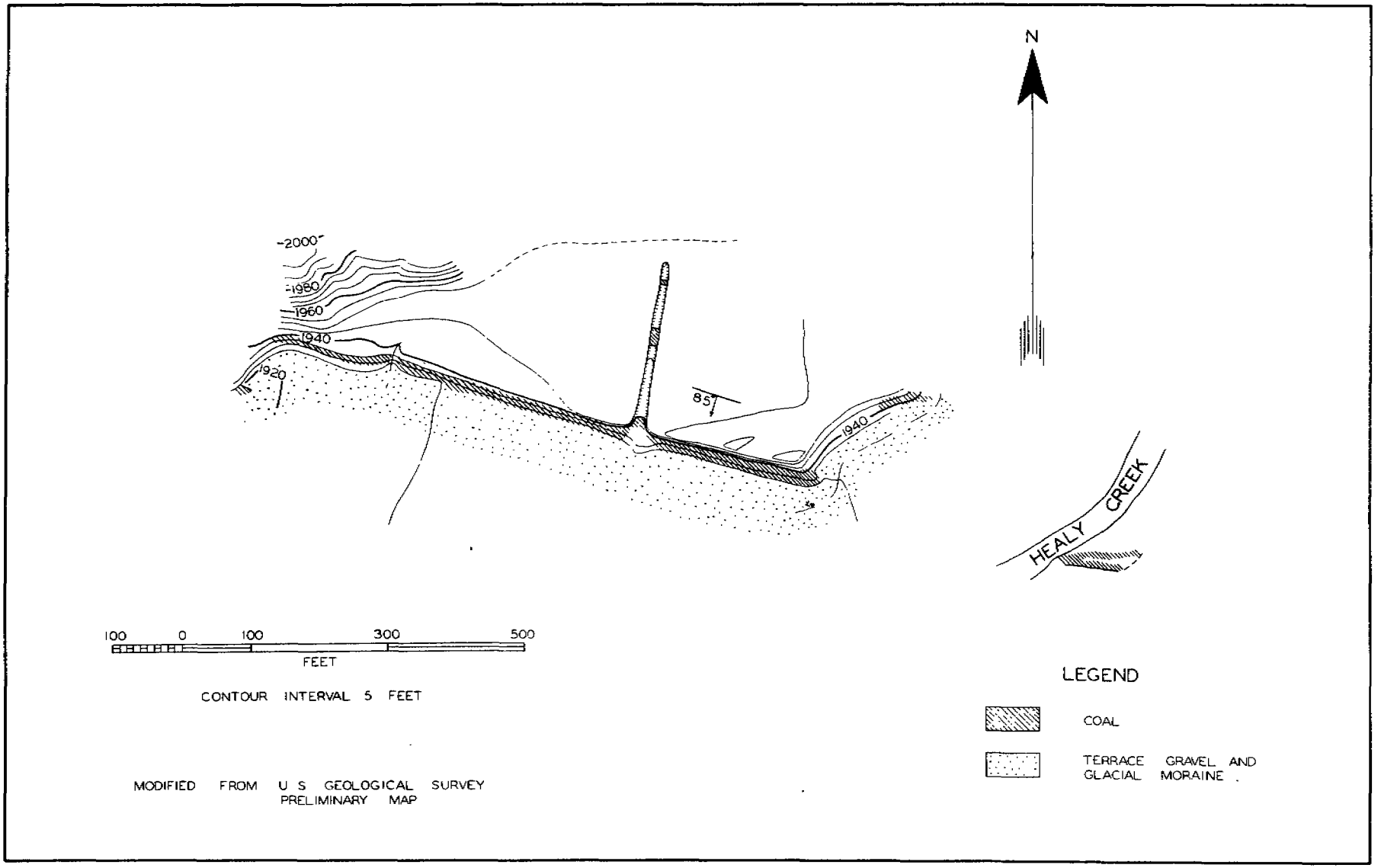


FIG. 4 STRIPPING COAL IN PART OF MAMMOTH BED

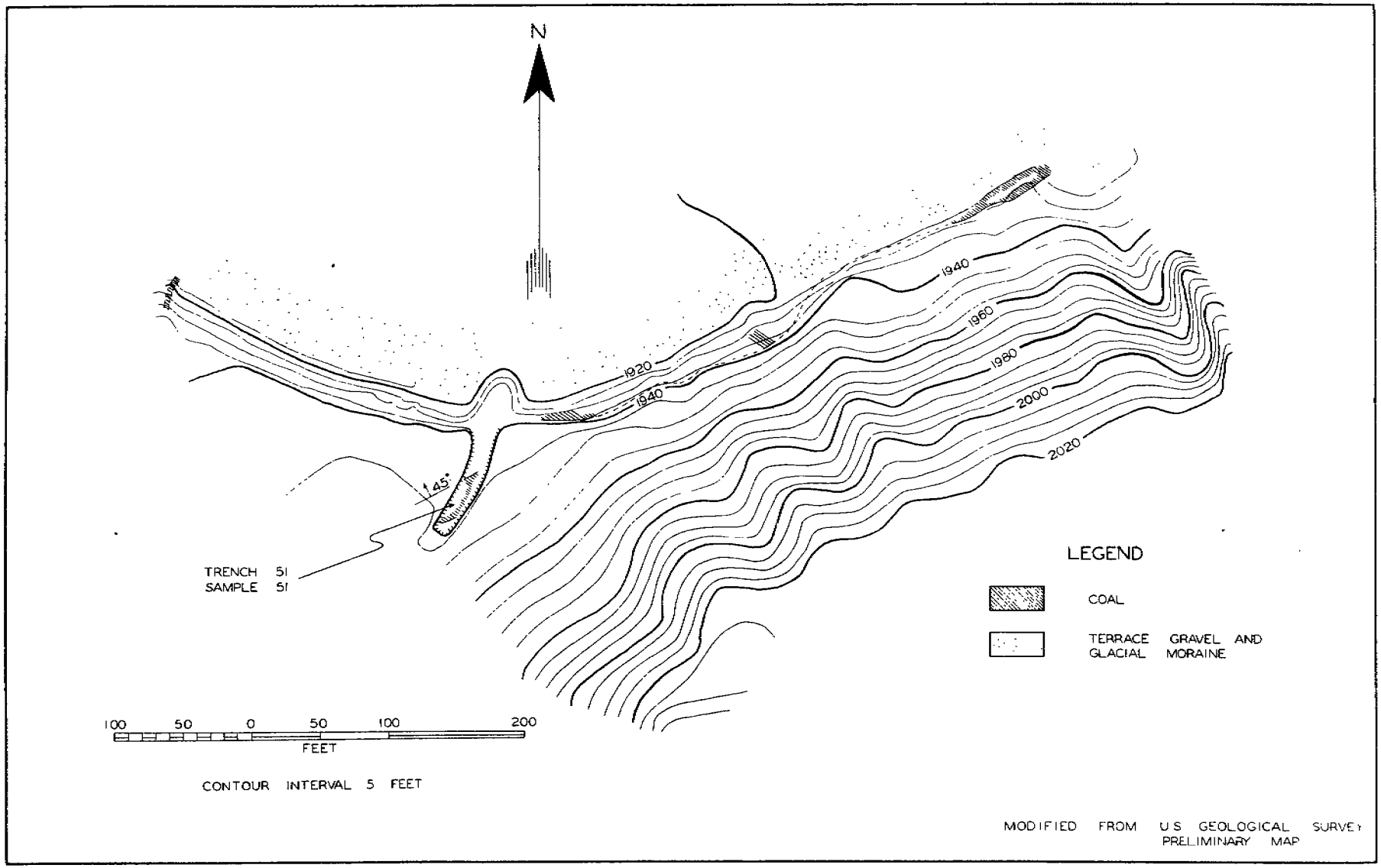


FIG. 5 STRIPPING COAL IN NUMBER FOUR (?) BED

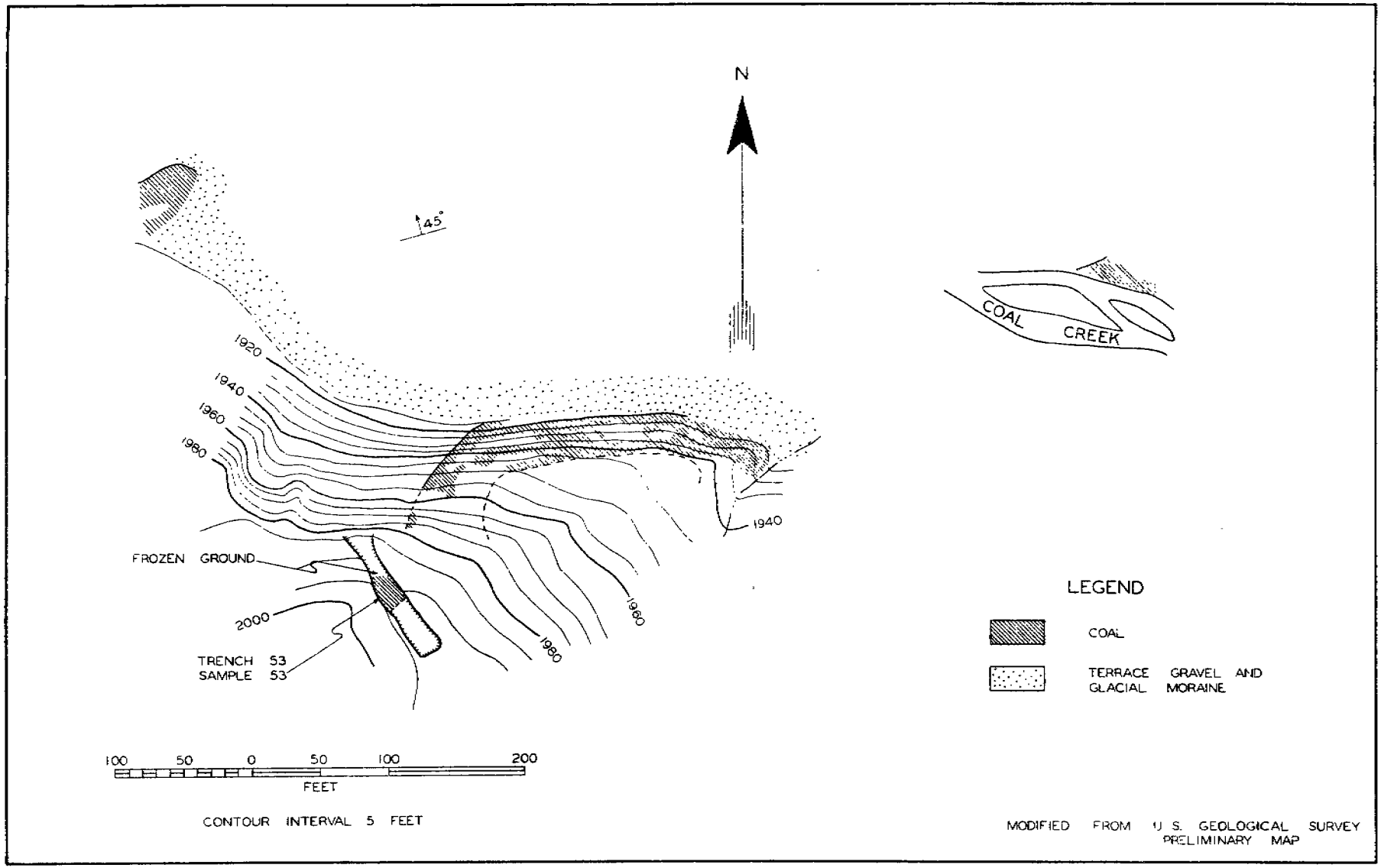


FIG. 6 STRIPPING COAL IN PART OF MAMMOTH BED

Three trenches were completed, and a fourth was started but could not be completed because the ground was frozen. A total of 570 cubic yards of overburden was removed. Three samples were taken from the coal exposed in the trenches, and two were taken from coal outcrops.

COAL RESERVES

Trenching and sampling by the Bureau of Mines and detailed mapping and correlation of beds by the Geological Survey have proved 466,600 tons of stripping coal in the Healy Creek Valley east of the Healy River Coal Corp's lease. Of this amount, 50,800 tons are classed as measured, have an estimated 16,500 cubic yards of overburden, and are within Leasing Block No. 28. In addition, the leasing block contains 356,000 tons of indicated stripping coal. The remainder of the stripping coal, 59,800 tons, is on the west bank of Cripple Creek in sections 15 and 16.

Location of areas, beds included, and calculation of stripping tonnages are given in the following tables:

TABLE 1. - Stripping coal, Leasing Block No. 28

Reserves measured and indicated by detailed mapping and trenching by Bureau of Mines and Geological Survey, 1944

Designation of bed	Figure	Coal, tons	Overburden, cu. yd.	Class reserve
No. 6	-	9,400	900	Measured
No. 5	-	9,900	5,000	Do.
No. 4	5	3,000	3,400	Do.
No. 1	4	11,100	3,000	Do.
No. 1	6	17,400	4,200	Do.
		50,800	16,500	Measured
No. 1	6	13,100	400	Indicated

TABLE 2. - Stripping coal, Leasing Block No. 28

Based on outcrops; not tested by trenching

On Middle Fork, Gold Run

Bed	Strike length, feet	Height, feet	Thickness, feet	Volume, cu. ft.	Tons
First bed east of middle fork	200	20	20	80,000	3,200
Next bed above east of middle fork	100	20	20	40,000	1,600
Next large bed above east of middle fork	200	30	30	180,000	7,200
Next bed above east of middle fork	100	30	30	90,000	3,600

TABLE 2 - Stripping coal, Leasing Block No. 28 (Cont'd)

Based on outcrops; not tested by trenching

North side Healy River - Roth

Bed	Strike length, feet	Height, feet	Thickness, feet	Volume, cu. ft.	Tons
2d bed below No. 1.....	300	14	12	50,000	2,000
South side Healy River - Roth					
No. 1.....	400	0-70	44	616,000	24,600
No. 2.....	400	0-60	30	360,000	14,400
1st bed below No. 1.....	300	0-70	20	210,000	8,400
Moose bed.....	500	80	30	1,200,000	48,000
3d bed above basal bed....	200	20	12	48,000	1,900
2d bed above basal bed....	250	20	20	100,000	4,000
Basal bed.....	250	20	40	200,000	8,000
Coal Creek, west side					
No. 1 bed west of trench..	500	50	70	1,750,000	70,000
No. 1 bed, upper terrace..	500	40	70	1,400,000	56,000
No. 2 bed.....	500	30	50	750,000	30,000
Moose bed at creek.....	500	30	50	750,000	30,000
Moose bed upper terrace...	500	30	50	750,000	30,000
Total					342,900

TABLE 3. - Stripping coal, sections 15 and 16

Based upon outcrops; - not tested by trenching

West side, Cripple Creek

Bed	Strike length, feet	Height, feet	Thickness, feet	Volume, cu. ft.	Tons
No. 1 bed.....	400	40	70	1,120,000	44,800
No. 2 bed.....	200	30	50	300,000	12,000
No. 6 bed.....	100	0-50	30	75,000	3,000
Total					59,800

TABLE 4. - Summary of stripping coal

Class	Coal, tons	Overburden, cu. yd.
Leasing Block No. 28:		
Measured.....	50,800	16,500
Indicated by trenching..	13,100	400
Indicated by outcrops...	342,900	1/
Total.....	406,800	1/
Secs. 15 and 16:		
Indicated by outcrops...	59,800	1/
Total.....	466,600	1/

1/ Not calculated.

The reserves of stripping coal are readily accessible for open-cut operations. However, the overburden of the coal to be mined during a current season must be removed during the previous summer, as much of the ground is permanently frozen.

The total coal reserves for Leasing Block No. 28 and the remainder of the coal-bearing area in the Healy Creek Valley between Leasing Block No. 28 and the lease belonging to the Healy River Coal Corp. (Alaska Creek) have been calculated separately. These reserves, including stripping coal, were computed assuming a 1,000-foot vertical range for the coal beds. Both the average dip of the coal beds and the angle at which the syncline plunges to the west were considered. The syncline plunges approximately 20° to the west. The following formula was used:

$$V = xt\,(h-2{,}700) + \frac{2{,}700x}{2}\,t$$

where

$$x = \frac{d}{\sin a}$$

a = angle of dip
x = slope distance along coal bed
d = vertical distance, feet
t = thickness coal, feet
h = strike length of coal, feet

The volume of coal in place was taken as 25 cubic feet.

TABLE 5. - Thickness of coal beds

Bed	Thickness, feet					
	Cripple Creek	Coal Creek	Healy Creek French Gulch	Roth, southside	Roth, northside	Gold Run
6A.....	6	5	-	-	-	-
6.....	18	20	18	-	18	-
5A.....	5	5	-	-	-	10
5.....	11	7	11	9	16	15
4A.....	-	10	5	7	6	20
4.....	12	10	13	14	11	15
3.....	15	12	16	12	5	-
2A.....	-	-	-	-	9	-
2.....	27	30	30	35	10	-
1.....	55	55	50	47	44	-
		15		20	30	
		4		15	15	
		11		6	-	
		5		7	6	
		10		9	10	
		10			5	
					13	

TABLE 5 (Cont'd)

Bed	Thickness, feet					
	Cripple Creek	Coal Creek	Healy Creek French Gulch	Roth, southside	Roth, northside	Gold Run
Moose..	15	30	-	30	13	-
..	10			12		
				12		
				7		
				14		
				20		
				15		
				15		

The coal included in the beds of the middle member of the formation, 1 through 6, inclusive, and that in the bed first below No. 1 and also the Moose bed has been classed as indicated reserves. This classification was on the basis of trenching, outcrops, and information obtained from the workings of the Suntrana mine at the western end of the area. The coal beds below the Moose have been classed as inferred reserves. Thicknesses of coal beds and calculation of reserves are given in the following tables. (Beds without name or number have been referred to by position in relation to numbered beds.)

TABLE 6. - Coal reserves, Leasing Block No. 28, south of axis of syncline

Bed	Strike length, feet 1/	Thickness, feet	Vertical depth, feet	Volume, cubic feet	Short tons	Class
6.....	3,500	18	1,000	54.7×10^6	2,188,000	Ind.
5a.....	3,800	6	1,000	20.8×10^6	832,000	Ind.
5.....	4,400	9	1,000	38.8×10^6	1,552,000	Ind.
4.....	5,500	14	1,000	82.2×10^6	3,288,000	Ind.
3.....	6,400	12	1,000	85.7×10^6	3,428,000	Ind.
2.....	6,700	35	1,000	264.8×10^6	10,592,000	Ind.
1.....	7,500	47	1,000	408.7×10^6	16,348,000	Ind.
1st below...	8,000	20	1,000	188.1×10^6	7,524,000	Ind.
Moose.....	9,500	30	1,000	345.7×10^6	13,828,000	Ind.
To base.....	10,500	95	1,000	1229.1×10^6	49,164,000	Inf.

1/ Average dip 45°, V = 1414t (h-1350)

TABLE 7. - Coal reserves, Leasing Block No. 28, north of axis of syncline

Bed	Strike length, feet[1/]	Thickness, feet	Vertical depth, feet	Volume, cubic feet	Short tons	Class
6	7,200	18	1,000	109.0×10^6	4,360,000	Ind.
5a	6,200	10	1,000	50.2×10^6	2,008,000	Ind.
5	6,500	15	1,000	80.0×10^6	3,200,000	Ind.
4a	6,500	10	1,000	53.3×10^6	2,132,000	Ind.
4	6,500	13	1,000	69.3×10^6	2,772,000	Ind.
3	6,000	12	1,000	57.8×10^6	2,312,000	Ind.
2	5,000	10	1,000	37.8×10^6	1,512,000	Ind.
1	5,000	44	1,000	166.2×10^6	6,648,000	Ind.
1st below	5,000	25	1,000	94.4×10^6	3,776,000	Ind.
Moose	4,500	13	1,000	42.4×10^6	1,696,000	Ind.
To base	2,500	95	1,000	113.1×10^6	4,524,000	Inf.

1/ Average dip 75°, V = 1035t (h-1350)

TABLE 8. - Coal reserves between leasing block and Alaska Creek

Bed	Strike length, feet[1/]	Thickness, feet	Vertical depth, feet	Volume, cubic feet	Short tons	Class
6	19,500	18	1,000	611.8×10^6	24,472,000	Ind.
5a	7,000	5	1,000	61.0×10^6	2,440,000	Ind.
5	19,500	11	1,000	373.9×10^6	14,956,000	Ind.
4	19,500	12	1,000	407.9×10^6	16,316,000	Ind.
3	19,500	15	1,000	509.8×10^6	20,392,000	Ind.
2	19,500	28	1,000	951.7×10^6	38,068,000	Ind.
1	19,500	53	1,000	1801.4×10^6	72,056,000	Ind.
				Total	188,700,000	Ind.

1/ Average dip 35°, V = 1743ht.

TABLE 9. - Summary of coal reserves, short tons

Area	Indicated	Inferred	Total
Leasing Block No. 28	89,996,000	53,688,000	143,684,000
Between Alaska Creek and Leasing Block No. 28	188,700,000	-	188,700,000
Total	278,696,000	53,688,000	332,384,000

The coal reserves in the Healy Creek Valley east of Healy River Coal Corp.'s lease total 332,384,000 tons, assuming a vertical range of 1,000 feet. Leasing Block No. 28 contains 143,684,000 tons of this amount in 17 coal beds classified as follows: Indicated, 89,996,000 tons; inferred, 53,688,000 tons. The remainder, 188,700,000 tons, is in the area between Alaska Creek and Coal Leasing Block No. 28 (fig. 2).

TABLE 10. - Analysis of coal from Healy Creek, Alaska

By Maurice Sharp, coal analyst, Alaska Railroad

Bed	Location of sample	Sample: No.	Sample: Form of analysis[1]	Proximate, percent: Moisture	Volatile matter	Fixed carbon	Ash	Ultimate, percent: Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Air-dry loss, percent	Calorific value B.t.u.
6 ...	Healy Creek, west of Coal Creek	2928	A	23.8	39.5	31.3	5.4	0.2					16.5	8410
			B	-	51.1	41.1	7.1	.3						11035
			C	-	55.8	44.2	-	.3						11875
3A ..	South side Healy Creek at Roth	9068	A	24.2	37.9	33.4	4.5	.2					16.5	8385
			B	-	50.0	44.1	5.9	.3						11060
			C	-	53.1	46.9	-	.3						11765
3 ...	do.	1154	A	21.6	39.8	31.5	7.1	.2					15.0	8865
			B	-	50.8	40.2	9.0	.3						11310
			C	-	55.8	44.2	-	.3						12435
Moose	do.	2136	A	19.0	42.4	35.3	3.3	.2					13.0	10260
			B	-	52.3	43.6	4.1	.2						12670
			C	-	54.6	45.4	-	.3						13205
Moose	do.	942	A	19.8	42.1	34.5	3.6	.2					13.5	9965
			B	-	52.5	43.0	4.5	.2						12425
			C	-	55.0	45.0	-	.3						13005
2d above Basal	do.	203	A	13.4	39.2	36.5	11.9	.3					8.2	9770
			B	-	45.3	41.0	13.7	.3						11285
			C	-	51.1	48.9	-	.4						13080
1st above Basal	do.	204	A	14.9	38.3	36.3	10.5	.3					9.6	9755
			B	-	45.0	42.7	12.3	.4						11460
			C	-	51.4	48.6	-	.4						13070
Basal	do.	208	A	11.7	41.8	36.6	9.9	.3					7.3	10385
			B	-	47.3	41.5	11.2	.3						11765
			C	-	53.3	46.7	-	.4						13246

TABLE 10. - Analysis of coal from Healy Creek, Alaska (Cont'd.)

Bed	Location of sample	Sample: No.	Sample: Form of analysis 1/	Proximate, percent: Moisture	Volatile matter	Fixed carbon	Ash	Ultimate, percent: Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Air-dry loss, percent	Calorific value B.t.u.
1 ...	North side of	2761	A	22.0	39.6	29.0	9.4	0.2					15.0	8665
	Healy Creek		B	-	50.7	37.2	12.1	.3						11110
	at Roth		C	-	57.7	42.3	-	.3						12635
1st	do.	1505	A	24.3	38.5	33.2	4.0	.2					16.0	8745
below			B	-	50.8	43.9	5.3	.3						11550
1			C	-	53.7	46.3	-	.3						12200
2d.	do.	205	A	21.4	37.0	35.6	6.0	.3					13.0	8615
below			B	-	47.1	45.3	7.6	.4						10960
1			C	-	51.0	49.0	-	.4						11860
3d	do.	206	A	17.6	40.7	35.9	5.8	.2					10.4	9870
below			B	-	49.4	43.6	7.0	.2						11980
1			C	-	53.1	45.9	-	.3						12880
Moose	do.	207	A	21.7	37.4	29.8	11.1	.3					14.0	8290
(?)			B	-	47.8	38.0	14.2	.4						10685
			C	-	55.7	44.3	-	.4						12335
	By H. M. Cooper, Bureau of Mines, Pittsburgh, Pa.													
5 ...	South side of	52	A	22.5	38.8	34.3	4.4	0.2	6.4	51.1	0.7	37.2	13.9	8790
	Healy Creek,		B	-	50.0	44.4	5.6	.3	5.1	66.0	.9	22.1		11340
	East of Coal		C	-	53.0	47.0	-	.3	5.4	69.9	.9	23.5		12020
	Creek													
4 ...	South side of	51	A	25.8	35.4	34.2	4.6	.1	6.5	48.8	.7	39.3	17.3	8320
	Healy Creek		B	-	47.7	46.1	6.2	.2	4.8	65.8	.9	22.1		11220
	at Roth		C	-	50.9	49.1	-	.2	5.1	70.1	1.0	23.6		11970
1 ...	West side of	53	A	29.3	35.8	27.8	7.1	.1	6.6	43.3	0.5	42.4	21.3	7290
	Coal Creek		B	-	50.6	39.3	10.1	.2	4.7	61.2	.7	23.1		10300
			C	-	56.3	43.7	-	.2	5.2	68.1	.8	25.7		11460

1/ A, as received; B, moisture-free; C, moisture, and ash-free.

CHARACTER OF THE COAL

The larger proportion of the Healy Creek coal is classified as subbituminous C, having a noncoherent residue (NAa).[8] On a moisture- and ash-free basis, its calorific value ranges from 11,500 to 13,000 B.t.u. The coal is black, dull in luster, and has a dark-brown streak. Table 10 is a compilation of analyses of the samples taken by the Bureau of Mines.

LOW-TEMPERATURE CARBONIZATION OF COAL FROM THE HEALY CREEK FIELD

The increasing consumption of petroleum products in Alaska, especially by the armed forces during the war, caused anxiety concerning the supply both for fuel and lubricants. Though oil occurs in Alaska, none has been produced since 1934, and previous production was small. All required petroleum products are imported at present. Consumption during 1940, the last year for which figures are available, amounted to over 65.5 million gallons.[9]

Production of liquid fuels and lubricants from other sources than petroleum to supplement that imported was investigated by the Bureau. The investigation was a part of the Bureau's long-range program for the production of liquid fuels from coal to augment, when necessary, the supply from petroleum. Four methods have been utilized to produce liquid fuels from coals - high and low carbonization, hydrocarbon synthesis from carbon monoxide and hydrogen, and high-pressure hydrogenation of coal or coal tar.

In the low-carbonization process the products are carbonized residue or char, tar, light oil, water, ammonia, and gas. Production of liquid fuels can be increased by using the char in the gas-synthesis process and hydrogenation or cracking and distilling of the tar and oil products.[10]

The samples used for the low-temperature carbonization tests were taken from the underground workings of the Suntrana mine.

The following results were obtained by Selvig and Ode.[11] The carbonized residue produced was a char having nearly the same appearance as uncarbonized coal. The yield of char in percent by weight of coal sample varied from 47.8 to 54.3 percent. From 17.5 to 37.3 gallons of tar and light oil were produced per ton of coal. Because of their high moisture and oxygen content, the subbituminous coals yielded a large quantity of water in the carbonization test

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8/ Gilmore, R. E., and Connel, G. P., and Nicolls, J. H. H., Agglomerating and Agglutinating Tests for Classifying Weakly Caking Coals: Trans., Am. Inst. Min. and Met. Eng., Coal Division, vol. 108, 1934, pp. 255-265.

9/ Smith, P. S., Mineral Industry of Alaska in 1940. In Mineral Resources of Alaska, Report on Progress of Investigations in 1940: Geol. Surv. Bull. 933 (a), 1942, p. 85.

10/ Selvig, W. A., Ode, W. H., and Davis, Joseph D., Low-temperature carbonization of Alaskan Coals: Bureau of Mines Tech. Paper 668, 1944, 16pp.

11/ See pp. 6-9, footnote reference 10.

(25.9 to 33.3 percent). The volumes of gas for the coals tested range from 2,160 to 3,010 cubic feet per ton of coal. The heating value of the gas was 365 to 548 B.t.u. per cubic foot. In some instances, 50 percent by volume of the gas was carbon dioxide, which caused the calorific value to be low.

BRIQUETING

The subbituminous and lignite coals from the Healy Creek Valley slack on exposure and are also susceptible to spontaneous combustion. They are therefore undesirable for stock-piling. The acute shortage of fuel in Alaska during the war and especially of that rank of coal having the desired features both to stock-pile and to trans-ship to the Aleutian bases influenced the Coal Procurement Section of the Alaska Department to investigate briqueting.

A study of two commercial briqueting processes indicates that either process is mechanically feasible. The Komerak process and operating machinery have a long record of successful operation in many installations. It is estimated that 90 percent of the coal briquets produced today are made with this process. The Blaw-Knox Co., a large maker of industrial machinery, has just taken over the patents and rights to the process they now present. There are several small plants operating successfully on this or very similar processes. Improved presses of larger unit capacity are now being designed by this company. The improved design will increase operating efficiency.

Good, compact briquets that would stand much handling are easily formed by either process. Combustion characteristics are satisfactory. The bituminous coals used from the Matanuska district are coking in quality. Other Alaska coals from the Healy River district or Dunkle mine do not coke and must be mixed with coking coals to produce satisfactorily burning briquets. Tests were run at the plant of Komerak-Greaves Co., Chicago, on various mixtures of the Alaska coals, and while a 33-1/3 percent coking coal content was acceptable, a 50 percent coking coal content was considered more satisfactory.12/

CONCLUSIONS

The Healy Valley contains the largest known reserves of subbituminous coal accessible to the Alaska Railroad. Exploration by the Federal Bureau of Mines and Geological Survey has indicated 143,680,000 tons of coal in Leasing Block No. 28 and 188,700,000 tons in the area west of this block.

Low-temperature carbonization of the coal produces the following products: 47.8 to 54.3 percent char, 17.5 to 37.3 gallons of tar and light oil, and 2,160 to 3,010 cubic feet of gas per ton of coal.

Tests on briqueting indicated that although satisfactory briquets could not be made from this coal alone, an acceptable product could be obtained by adding 33-1/3 percent coking coal from the Matanuska district.

12/ Office of the Quartermaster General, U. S. Army, Preliminary Investigation of Briqueting Plant for and the Briquetability of Alaska Coals: Solid Fuels Branch, Fuels & Lubricants Division, February 20, 1944, p. 3.