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

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

INVESTIGATION OF COAL DEPOSITS FOR LOCAL USE
IN THE ARCTIC REGIONS OF ALASKA AND
PROPOSED MINE DEVELOPMENT



BY

ALBERT L. TOENGES AND THEODORE R. JOLLEY

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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 4150."

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INTRODUCTION

The construction of frame houses (fig. 1) in recent years instead of the conventional sod hut (igloo) (fig. 2) by the Eskimos in the villages along the Arctic Ocean has increased the demand for fuel in these villages. The frame houses, which are not insulated against extreme cold and are difficult to heat, are equipped with coal stoves. The well-insulated sod huts were heated comfortably with whale-oil stoves. In some years whaling is poor, consequently there is a demand for solid fuel.

The Eskimo villages usually are on the sand spits at the mouths of rivers and points of land near the best fishing and hunting grounds. These narrow necks of land usually are sand bars that are not underlain with coal, and coal must be transported to the villages. Lack of development of coal deposits in the Arctic has made it necessary to import coal from the States, generally from Washington, to supply these villages. This coal is imported by boat and is received once a year. Its cost is high, and development of coal deposits in the Arctic to supply these native villages should result in a considerable saving to the Government-operated schools and hospitals as well as to the natives.

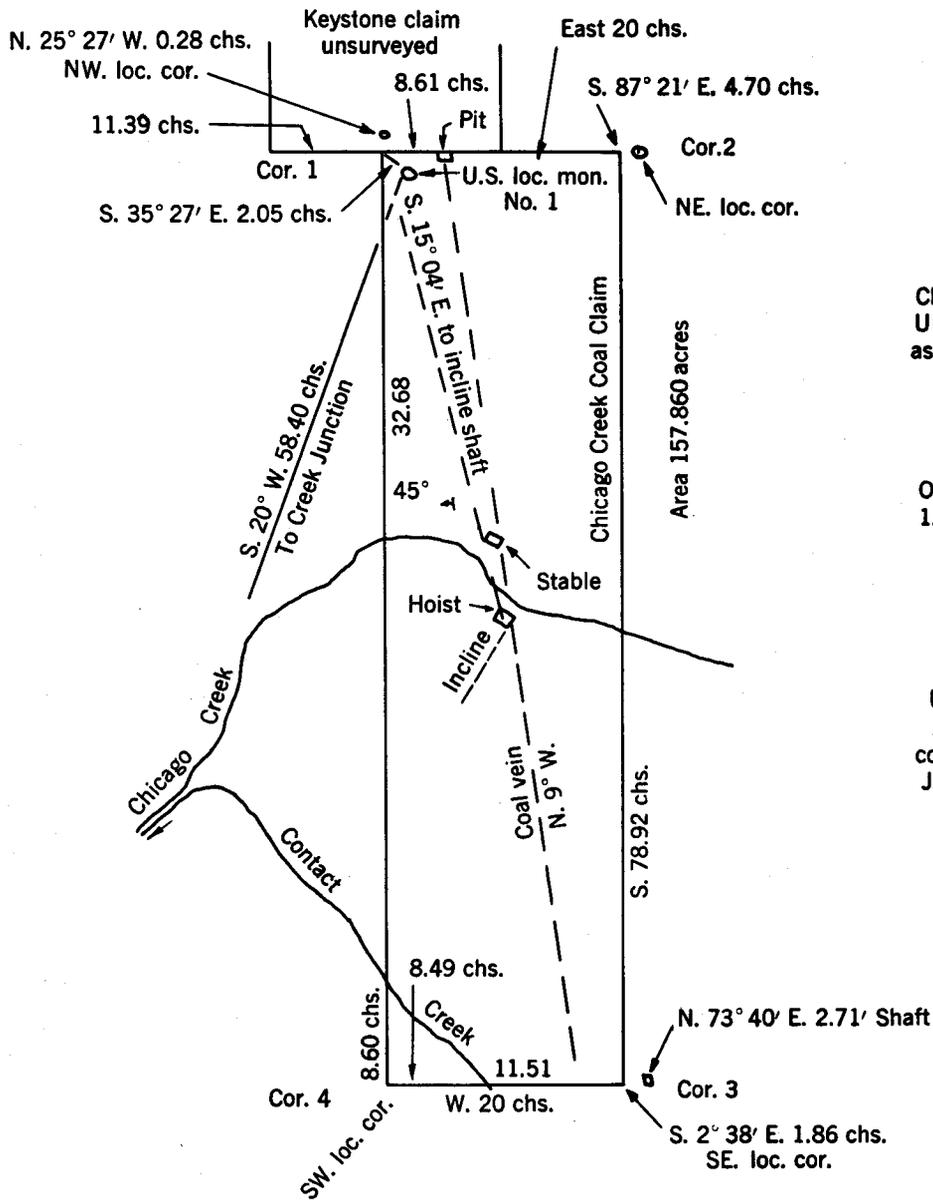
Early traders attempted to establish coaling stations in the Arctic, and the Eskimos generally know where the coal deposits are situated. A reconnaissance of a number of deposits in the Arctic was made in the summer of 1946 by engineers of the Coal Division, Fuels and Explosives Branch, Bureau of Mines, and this report describes the areas investigated and suggests plans for the development of some of these deposits.



Figure 1. - Frame houses at Deering.



Figure 2. - Eskimo sod hut (igloo).



PLAT
 of
 U. S. survey No. 194
 Chicago Creek Coal Claim
 Under act of June 6 1900
 as amended by act approved
 April 28, 1904
 of
 T.S. Solomons
 Situated
 On Chicago Creek, about
 1.25 miles eastward from
 the Kugruk River
 District of Alaska
 Variation $24^{\circ} E.$
 area 157.860 acres
 As surveyed by
 Arthur G Blake
 U.S. Deputy Surveyor
 April 16-17-18, 1907
 copied at U.S. land office
 Juneau Alaska 11-27-45
 66 feet to 1 chain

Figure 4. - Plat of U. S. Survey 194, Chicago Creek mine.

ACKNOWLEDGMENTS

The cooperation of Ludlow G. Anderson, engineer-in-charge, Health and Safety Branch, Bureau of Mines, Anchorage; Commander P. W. Roberts, U.S.N., at Fairbanks; Mr. Saltzman, U.S.N., at Point Barrow; Col. N. J. Robinson, U.S.A.; Capt. Bernard Peters, U.S.A.; Capt. Byron Waldruff, U.S.A.; W. J. Stillings, U.S.A., all of Anchorage; Fred Geislin, Alaska Native Service, Juneau; George A. Parks, Office of Land Management, Juneau, and Helen Bockman, Office of Land Management, Nome; B. D. Stewart, Territorial Commissioner of Mines, Juneau; G. O. Gates, Federal Geological Survey, Fairbanks; Sig Wein, Wein Alaska Air Lines; John Cross, Northern Cross Airline; Everitt M. Calhoun, Henry Coffin, George Wallin, Pato Vestal, and Elmer Davis of Deering; Messrs. Lundberg and Robbins of Candle; Archie Ferguson of Kotzebue; Mr. and Mrs. Alexander, Point Hope; John Connery and Bob Tuckfield of Point Lay; Lester Minner, Wainwright; Ted Mathews and Ed Burnell, Point Barrow; and the Eskimos of all the villages, who greatly assisted the field party during the investigation, is acknowledged.

DESCRIPTION OF AREAS

The following areas were investigated: Chicago Creek and George Wallin mines, Deering, Fairhaven Mining District; Kukpowruk River and Tepsako River, Point Lay; and mines areas 1, 2, and 3, Kuk River, Wainwright.

The Meade River area was not studied. A description of this district is given in Report of Investigations 3934.^{4/}

Deering, Fairhaven Mining District

Two mines were examined in this area - the Chicago Creek and George Wallin mines. Their location is shown in figure 3. The George Wallin mine is situated on the north bank of the Kugruk River between Reindeer Creek and Montana Creek, approximately 20 miles S. 45° E. of Deering and approximately 12 miles west of Candle. The Chicago Creek mine is about 4 miles northwest of the George Wallin mine and is at the approximate latitude of 65° 55' north and approximate longitude of 162° 24' west. This mine is on Chicago Creek, 1-1/4 miles east of the Kugruk River and about 16 miles S. 45° E. of Deering and 14 miles west of Candle.

Chicago Creek Mine

The Chicago Creek claim was located in 1905 and surveyed for patent April 16-18, 1907, U. S. Survey No. 194, but the application for patent later was rejected. Figure 4 shows Survey 194 from U. S. Land Office Plat Book.

^{4/} Sanford, Robert S. and Pierce, Harold C., Exploration of Coal Deposit of the Point Barrow and Wainwright Areas, Northern Alaska, Bureau of Mines Report of Investigations 3934, 1946, 17 pp.

The mine opening, which is approximately 75 feet above the elevation of the Kugruk River, was caved, and no underground examination was possible. However, reference to Plat 194 (fig. 4) shows the strike of the coal bed to be N. 9° W. and that the outcrop extends approximately 5,000 feet across the claim. The dip of the bed is shown as 45° W. The portal of the mine slope is in the approximate center of the claim. The Land Office records state "that in 1907, the incline slope had been sunk to a depth of 150 feet with 700 feet of drifts and up raises at the bottom of the incline." It is reported that the mine was gassy.

A sample of weathered slack coal from the old coal pile was secured and analyzed by the chief coal sampler and analyst of the Alaska Railroad at Anchorage.^{2/} This analysis, as-received basis, follows:

	<u>Percent</u>
Moisture	33.8
Volatile matter	39.9
Fixed carbon	19.2
Ash	7.1
B.t.u.	6,825

Development and production began in 1908 and continued until 1911. Approximately 60,000 to 100,000 tons of coal are reported to have been produced. This output is said to have been distributed during the winter months from October 15 to May 15 to gold prospectors in the Fairhaven Mining District and in the vicinity of Candle by 65 to 100 teams of horses. The mine was abandoned in 1911.

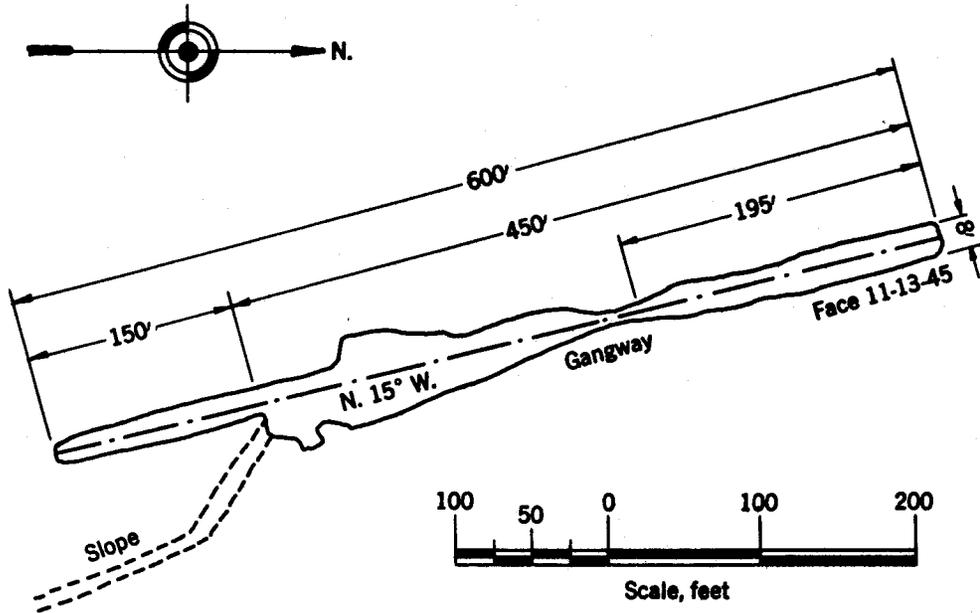
George Wallin Mine

This mine was not surveyed for patent and has operated under a free mining and prospecting permit since about 1914.

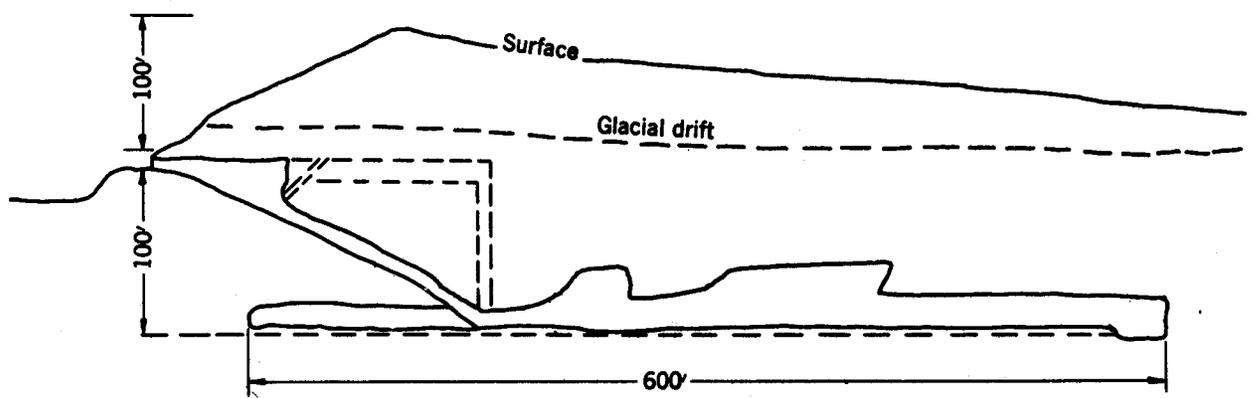
The present main opening of the mine is a drift that intersects the coal bed and a slope driven from the drift in the coal at an angle ranging from 20° to 35° across the dip of the bed. The length of this main opening is approximately 10 feet of drift and 200 feet of slope. A gangway is driven from the bottom of the slope on the strike of the bed for a distance of approximately 600 feet. No planned method of mining is followed. (See fig. 5.)

The strike of the bed is N. 15° W., and the dip ranges from 67° to 70° southwest. A measured section of the bed follows:

^{2/} John J. O'Shea, Chief.



PLAN OF MINE



SECTION OF MINE

Figure 5. - George Wallin mine, Kugruk River, Fairhaven District, Alaska.

		<u>Thickness</u>	
		<u>Feet</u>	<u>Inches</u>
	Roof, shaly claystone		
1.	COAL	4	0
	Hard, sandy clay		4 to 8
2.	COAL	6	0
	Sandy clay		4 to 6
3.	COAL	8	0
	Bottom, clay shale		

The analyses of coal benches 1, 2, and 3 on an as-received basis are reported by O'Shea^{6/} as follows:

	<u>Percent</u>		
	<u>1</u>	<u>2</u>	<u>3</u>
Moisture	32.3	32.9	34.8
Volatile matter	29.2	28.5	26.4
Fixed carbon	31.0	35.0	32.2
Ash	7.5	3.6	6.6
B.t.u.	7,575	8,035	7,555

The entire thickness of the bed is mined. The lump coal is sacked, and the slack (minus 1 inch) and partings are wasted in the mine.

At the time of the investigation the mine owner drilled and blasted the coal, and the broken coal was sold to the Eskimos and prospectors for 50 cents a sack (approximately 125 pounds) of lump coal at the fact. The purchasers sacked the coal and transported it in a mine car to the slope bottom over steel and wood track. The coal was hoisted to the surface in a sled by a hand winch. The steam hoist at the portal was not in operating condition.

Records of production are not available, but it is estimated that approximately 10,000 tons have been produced from the mine. The present annual production is about 25 to 50 tons. Past annual production is reported to have been several hundred tons. The decrease in demand for this coal is said to be due to the increased use of fuel oil and to a decrease in the population in the area.

Conclusions

The investigation indicates that there is an area of coal adjacent to the Chicago Creek mine. The extent of the outcrop, dip, and thickness of the bed should be determined by trenching or test pitting northwest of the original Chicago Creek mine.

^{6/} See footnote 5/.

This area appears more favorable than the George Wallin area because:

1. It is 4 miles nearer Deering and Nine-Mile Point than the Wallin area. Nine-Mile Point is a lightering dock for Candle.
2. The Alaska Road Commission has marked a tractor trail from Nine-Mile Point by Chicago Creek to the Kugruk River. Bridge material for two bridges across intermittent streams was available at the time of the investigation.
3. The area is above flood level. The George Wallin mine is affected by high water of the Kugruk River.
4. The dip of the coal bed is reported to be 45°, as compared with 70° at the Wallin mine.
5. A new mine can be properly planned.
6. The Chicago Creek area is unleased Government land.

The annual coal requirements for the territory adjacent to the Chicago Creek area is estimated as follows:

	<u>Tons</u>
Deering	300
Candle	500
Kotzebue	800
Other villages	400
	<hr style="width: 50%; margin-left: auto; margin-right: 0;"/> 2,000

This output could be obtained during the 6 winter months and could be freighted to Deering and Nine-Mile Point in the winter and stored for shipment by boat to Kotzebue in the summer. Other points could be served during the winter months.

The mine should be sealed during the summer months when temperatures are above freezing. Particular attention must be given in mining to obtain a maximum of lump coal, due to the slacking of the coal in storage during the summer months.

A plan of mining adaptable to the physical conditions reported at the old Chicago Creek mine is given in figure 6. This plan requires a minimum of equipment necessary to develop a coal mine that could be operated with maximum safety for approximately 2,000 tons annual production. Gas was reported in the old Chicago Creek mine, and mechanical ventilation must be provided. This coal mine should be developed by using the double-entry system.

In the Chicago Creek area, where the dip of the coal bed is indicated to be 45°, rooms can be driven up the rise of the bed, and then the coal

should flow by gravity from the face of the room to a chute in the room neck on the haulage entry. Should the dip of the bed flatten to less than 35° , a double track can be laid in the room and a sheave wheel installed at the face. In this system, a cable passes over the sheave and the loaded car pulls the empty car to the face. If steel plates are available, a lined chute can be constructed from the face to the haulage entry, and where dips range from 18 to 35° degrees, the coal should flow by gravity down the room. The coal face should be either undercut or vertically cut by hand with picks before the coal is drilled and blasted. When a room is completed, all curtains should be replaced by permanent stoppings. During sinking of the slopes that are in the coal bed, the daily requirement of coal should be obtained.

The minimum amount of equipment necessary to develop and operate a coal mine to produce 2,000 tons per year in 6 months' operation at Chicago Creek, based upon the physical conditions reported at the old mine, is as follows:

- 1 portable steam boiler, approximately 50 hp., complete with injector. This type of boiler is suggested because of its simplicity.
- 1 25-hp. steam hoist.
- 1 5-hp. steam engine for driving a 6,000 cu. ft. per min. disk fan.
- 1 disk fan - 6,000 cu. ft. per minute - minimum Bureau of Mines safety code requirements.
- 1 5-kw. steam-engine generator set, d.c., 110 volts. If electric lights are used at the faces underground, no electric cap lamps for miners will be necessary.
- 1 switchboard panel.
- Miscellaneous steam and water piping and fittings.
- 600 feet of $3/8$ -inch, steel, 7 x 9 haulage rope.
- 2 3-foot steel sheaves.
- 2,000 feet of 16-lb. mine rail with switches and turnouts.
- 600 4" x 4" x 4' mine ties.
- 12 4" x 6" x 12' mine ties.
- 4 1-ton-capacity mine cars (probably obtainable in the Matauska field).
- 2,000 feet of 2-wire, waterproof, electric cable for underground workings and surface lighting.
- 5 dozen 100-watt electric-light bulbs.
- 25 weatherproof electric-light sockets.
- 25 electric-light bulb guards.
- 4 breast coal augers in sections to make augers up to 10 feet long.
- 8 2-prong coal-auger bits.
- 12 coal shovels.
- 12 coal miners' picks with handles.
- 12 coal-pick handles (extra).
- 3,000 lb. permissible explosive (coal).
- 1,500 electric detonators.

- 1 hand electric magneto for blasting.
- 2 permissible flame safety lamps.
- 500 feet electric blasting cable.
- 6 wood tamping sticks 1-1/4" x 7'.
- 250 yd. brattice cloth 96 inches wide.
- 1 boiler, hoist, and shop building.
- 1 powder magazine.
- 1 detonator storage magazine.
- 2 Diesel tractors, one with bulldozer attachment.
- 2 house sleds (Wannagin).
- 4 freight sleds.
- 1 blacksmith forge.
- 1 set of blacksmith tools.
- 1 anvil.
- 1 hand winch.
- 1 set of mechanics tools.
- Miscellaneous electrical wiring supplies, including tape, insulators, fuses, and switches.
- 1 set of carpenter's tools.
- 1 set of block and tackle with manila rope.
- Assortment of bolts, nails, drift pins, and steel plates.
- Framed timber for slope collars.
- Lumber for storehouse and shelter.
- Extra tracks for tractor and spare parts.
- 200 barrels of Diesel fuel oil.
- 10 barrels of gasoline.
- 2 barrels of tractor lubricants.
- 1 snow-and-ice melting tank for water supply.
- 500 mine props, 8 feet long.
- 1,000 wood wedges.

Trenching and test pitting at the outcrop should determine whether conditions at the Chicago Creek mine continue to the northwest.

Point Lay Area

Kukpowruk River

The natives of Point Lay have used coal from two sources, one on the Tepsako River about 15 miles east of Point Lay and deposits on the Kukpowruk River. A deposit on this river 45 miles upstream from Point Lay is of particular interest and importance.

A reconnaissance was made in July 1946 of coal deposits on the Kukpowruk River. The party traveled up this river in a skin boat with mushers, a four-dog team, and line to draw the boat upstream. It was necessary to lift the boat off the bottom of the river at rapids and shallow water, and progress for the 45 miles was 27 hours, or about 1.7 miles per hour.

An outcrop of coal in the river bank was observed at a point about 5 miles from the mouth of the river. This bed is approximately 5 feet thick, but little of this bed was above water level, as the river bank is low at this point.



Figure 7. - Coal deposit on Kukpowruk River, approximately 45 miles upstream from Point Lay.

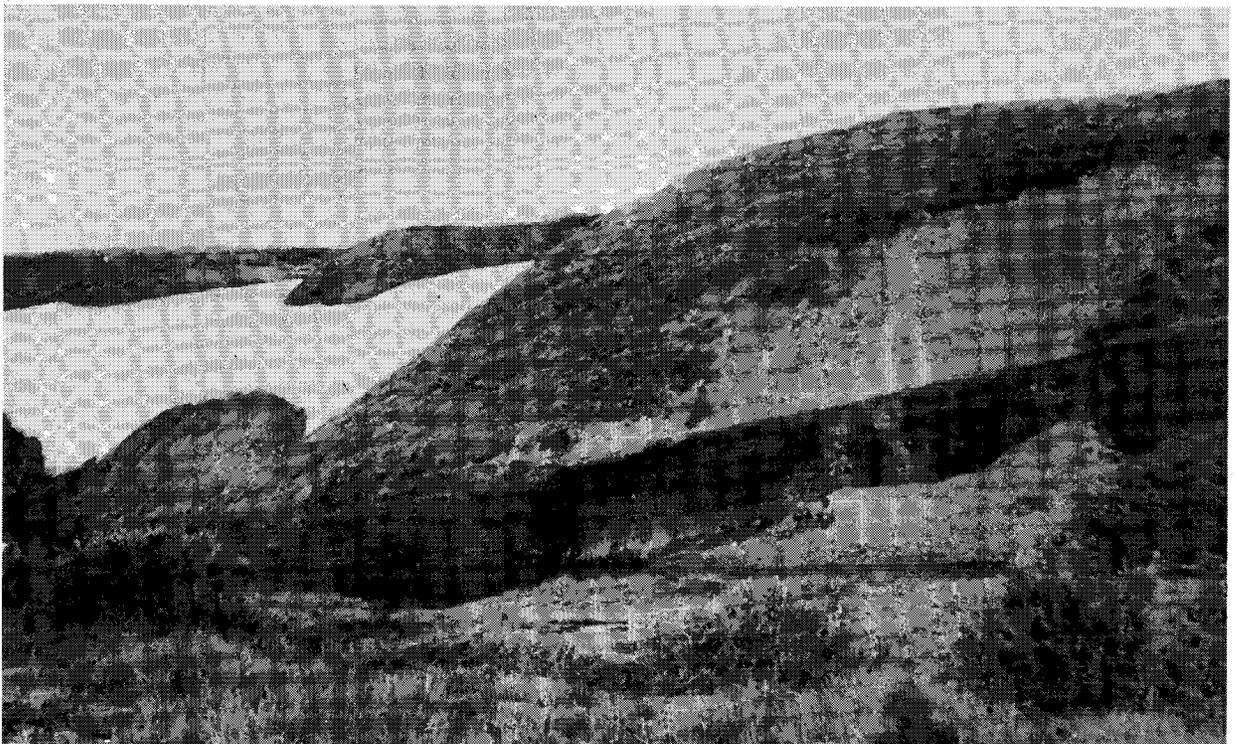


Figure 8. - Coal deposit on Kukpowruk River, approximately 45 miles upstream from Point Lay.

A thin bed from which 100 sacks of coal had been mined in the past occurs at a point about 10 miles up the river from the mouth. Mining conditions are not favorable here.

Coal outcrops were observed along the banks of the Kukpowruk River at intervals about a mile apart for a distance of about 25 miles, beginning about 20 miles from the mouth of the river. The beds were thin and dipped steeply (40° to 80°) at the outcrops first observed. At about 35 miles upstream, the dip of the beds was less, and in many places the outcrops were at water level or slightly above water level. These beds do not appear to be favorable for mining, as they are often under water or beneath overhanging snowbanks. A bed of highly weathered subbituminous coal 3 feet thick, which strikes N. 70° W. and dips 5° west, was examined. A fresh sample of the coal could not be obtained. At about 39 miles upstream, a 4-foot, 6-inch bed of coal that was weathered and showed evidence of cracking and slacking was observed. The strike of this bed is N. 50° E., dip 5° E.

During the winter, considerable coal had been dug from several outcrops for a distance of 5 miles 30 to 35 miles from the mouth of the river. The openings are near the summer water line of the river. It is assumed that the river level is lower in the fall and winter after the early summer snow run-off and that coal outcrops at or below water level in July would be accessible for mining in the late fall and winter.

A deposit of great interest is about 45 miles from the mouth of the Kukpowruk River. (See figs. 7 and 8.) This deposit is approximately 35 air miles S. 20° E. from Point Lay and approximately 15 air miles east of the Arctic Ocean coast line. The coal bed, which is exposed on the north-east bank of the river, is hard and forms a cliff in the river bank. The bed is exposed for about 500 feet along the bank. The strike of the bed, which is approximately at right angles to the river at this point, is S. 85° W., and the dip is 7° to 12° N. A section of the outcrop follows:

		Thickness		
		Feet	Inches	
Overlying glacial drift		80	0	
Roof, shaly claystone		20 [±]		
Shaly coal ^{1/}		0	4	
1.	{ COAL	2	7	} Analysis C-61130
	{ Bony coal ^{1/}	0	0-3/8	
	{ COAL	3	0-5/8	
2.	COAL	4	0	Analysis C-61131
3.	COAL	3	0	Analysis C-61132
<u>1/</u> Excluded from sample.				

Analyses of samples are given in table 1.

The total bed thickness is about 15 feet, but approximately 2 feet of the bed was under water.

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TABLE 1. - Analyses of coal from deposit on Kukpowruk River, approximately 45 miles upstream from Point Lay^{1/}

Lab. No.	Condi- tion ^{2/}	Proximate percent				Ultimate percent					Calorific value, B.t.u.	Ash fusion temp., °F. ^{3/}	Agglom- erating index
		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydro- gen	Carbon	Nitro- gen	Oxygen			
C-61130	1	8.6 ^{4/}	29.1	58.0	4.3	0.1	5.3	72.5	1.2	16.6	12,560	2,230 IDT	CP
	2	-	31.9	63.4	4.7	.1	4.7	79.3	1.3	9.9	13,740	2,330 ST	
	3	-	33.4	66.6	-	.2	4.9	83.2	1.3	10.4	14,410	2,610 FT	
C-61131	1	4.6	35.6	54.0	5.8	.2	5.2	73.7	1.2	13.9	12,820	2,470 IDT	CF
	2	-	37.3	56.6	6.1	.2	4.9	77.2	1.3	10.3	13,440	2,520 ST	
	3	-	39.7	60.3	-	.2	5.2	82.2	1.3	11.1	14,310	2,620 FT	
C-61132	1	4.6	37.0	54.8	3.6	.1	5.5	75.3	1.3	14.2	13,300	2,330 IDT	CF
	2	-	38.8	57.4	3.8	.1	5.2	79.0	1.3	10.6	13,940	2,420 ST	
	3	-	40.3	59.7	-	.1	5.4	82.1	1.4	11.0	14,480	2,780 FT	

^{1/} Analyses by Coal Analysis Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

^{2/} 1, Sample as received; 2, dried at 105° C; 3, moisture- and ash-free.

^{3/} IDT = initial deformation temperature; ST = softening temperature; FT = fluid temperature.

^{4/} Sample moist.

Natives report that this bed was observed several miles east of the outcrop, and few if any white men have seen it.

The coal is very hard, and it was necessary to use a heavy pick to obtain a channel sample. About 50 sacks of this coal (the remainder of 400 sacks that had been mined 4 years ago) were piled on the river bank. The coal in these sacks comprised lumps approximately 6 inches in size, and there had been no disintegration of the lumps due to weathering. As this coal had been subjected to the elements for 4 years and no degradation had taken place, the coal should not slack in transportation and storage.

Tepsako River

Bob Tuckfield, a native of Point Lay, reported a coal bed approximately 10 feet thick situated about 15 miles east of Point Lay on the Tepsako River. A sample of this coal was taken from 1,000 pounds of mine-run coal stored in sacks in the basement of the Point Lay school house, and the analysis of the coal is given in table 2, analysis C-61139.

The natives report that an offensive odor is given off by the burning coal and that they do not like it for domestic use. The area was not visited. The deposit is probably in the low coastal plains, and the natives state that it is not extensive.

Conclusions

The Kukpowruk River deposit is 45 miles upstream from Point Lay.

The estimated annual demand for coal in villages not too distant from the Kukpowruk deposit is as follows:

	<u>Tons</u>
Point Hope	200
Point Lay	200
Wainwright	600
Other villages	200
	<u>1,200</u>

A mine capable of satisfying these requirements would be small. As the quality of this coal is such that there is little or no degradation, the coal could be transported greater distances to all villages from Kotzebue north. The annual demand would then be approximately 3,200 tons, exclusive of Barrow.

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TABLE 2. - Analysis of coal from deposit on Tepsako River, about 15 miles east of Point Lay^{1/}

Lab. No.	Condi- tion ^{2/}	Proximate percent				Ultimate percent					Calorific value, B.t.u.	Ash fusion temp., °F. ^{3/}	Agglom- erating index
		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydro- gen	Carbon	Nitro- gen	Oxygen			
C-61139	1	10.5	37.3	49.4	2.8	0.4	5.6	67.7	1.2	22.3	11,800	2,300 IDT	CP
	2	-	41.6	55.3	3.1	.4	5.0	75.6	1.4	14.5	13,180	2,430 ST	
	3	-	43.0	57.0	-	.4	5.1	78.1	1.4	15.0	13,610	2,470 FT	

^{1/} Analysis by Coal Analysis Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

^{2/} 1, Sample as-received; 2, dried at 105° C.; 3, moisture- and ash-free.

^{3/} IDT = initial deformation temperature; ST = softening temperature; FT = fluid temperature.

Winter transportation is facilitated by freezing, and the distances to villages are less circuitous than during summer river travel. It is doubtful if the Kukpowruk River could be navigated by barges in summer because of the many bars and rapids. Therefore, coal should be transported in winter. Dog sleds or tractors with sleds can travel over the tundra and frozen streams by direct routes in winter. Reconnaissance may show a more direct route west to the Arctic Ocean than the estimated 15 miles. Coal could be stock-piled in winter at a point on the shore and loaded into barges when the ice breaks and the passage to coast towns is open. Probably reasonable barge rates could be obtained from private owners of tugs and barges at Kotzebue or Nome. The feasibility of supplying bituminous coal to all Arctic villages from a mine on the Kukpowruk River can be determined only by a thorough study of all factors involved.

Overburden at the point where the bed was sampled is about 100 feet thick - 80 feet of glacial drift and 20 feet of shale. As the dip of the bed is 7° to 12° north, the outcrop, which may be buried under the tundra, would be to the south. The outcrop should be investigated by trenching and test pitting to determine the extent and thickness of the bed. A mine can then be opened in the bed at the outcrop. A barrier pillar of coal should be left between the area to be mined and the river. Mining should be done in winter, when the overburden is frozen. Winter operation in frozen ground has been successful in the George Wallin mine on the Kugruk River. The mine should be sealed in summer to prevent thawing of the strata overlying the coal. Thus, rock falls would be minimized.

The plan of mining, as shown in figure 6, with some slight modification, would be adaptable to conditions at the Kukpowruk deposit. As the dip of the bed is 7° to 12° , rooms should be driven across the dip, which will permit miners to push cars to the face. The slopes, entries, and rooms should be driven 7 or 8 feet high, and roof coal in rooms can then be extracted on retreat after the rooms have been driven full length. Production of the mine can be gaged by the number of working places and number of men employed. The minimum requirements of a mine plant and equipment for the mine shown in figure 6 would give an output in excess of that needed, but such supplies as explosives, detonators, and brattice cloth should be decreased or increased proportionately according to the annual demand.

Wainwright Area

Kuk River

Coal deposits on the Kuk River were reconnoitered in July 1946. Three areas were examined on the east bank of the Kuk River. Coal in these deposits has been mined by the natives from openings in the outcrop along the river bank. The beds are at water level and are accessible for mining in winter, when the Kuk River, adjacent lagoons, and tundra are frozen. These deposits are also accessible by boat in summer but are not workable at that time because of thawing of the overlying strata.

The topography is rolling to flat, and the river banks, which comprise coal, shale, sandstone, and glacial drift, are approximately 50 feet high. A description of the areas follows:

Mine area 1. - The deposit referred to by the natives of Wainwright as Mine 1 is approximately 7 air miles S. 45° E. of Wainwright on the east bank of the Kuk River. The outcrop was covered with snow, and the adit driven through the snow to the coal was filled with water, so that a section of the bed could not be measured. Coal had been mined the previous winter, and approximately 10 tons of slack coal was piled on the ground. (See Fig. 9.) The strike of the strata above the bed is S. 3° E., and the dip is 7° W. It is reported that the outcrop extends about 1,000 feet along the shore line at water level.

A sample of the slack coal from the past winter's mining was obtained, and the analysis on an as-received basis follows:^{1/}

	<u>Percent</u>
Moisture	25.9
Volatile matter	28.8
Fixed carbon	43.3
Ash	2.0
Sulfur2
B.t.u.	9,350

Mine area 2. - This area is referred to locally as Mine 2 and is approximately 12 air miles S. 20° E. of Wainwright on the east bank of the Kuk River. A measured section of the outcrop follows:

	<u>Thickness</u>		
	<u>Feet</u>	<u>Inches</u>	
Soft shale roof	1	4	
1. COAL (not mined)	2	2	Analysis C-61133
2. Rash ^{1/}	0	5	
3. COAL	3	0	Analysis C-61134 ^{2/}
4. Clay parting ^{1/}	1	4 ^{3/}	
5. COAL	5	0	Analysis C-61134 ^{2/}

The bottom of the bed is at river level.

- ^{1/} Excluded from sample.
- ^{2/} Coal samples of benches 3 and 5 were combined.
- ^{3/} Clay parting varies in thickness and extent.

The cleavage of the bed is both horizontal and vertical. The bed strikes S. 28° W. and dips 5° E. away from the river. The analyses of the coal are given in table 3.

^{1/} Analysis by Coal Analysis Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

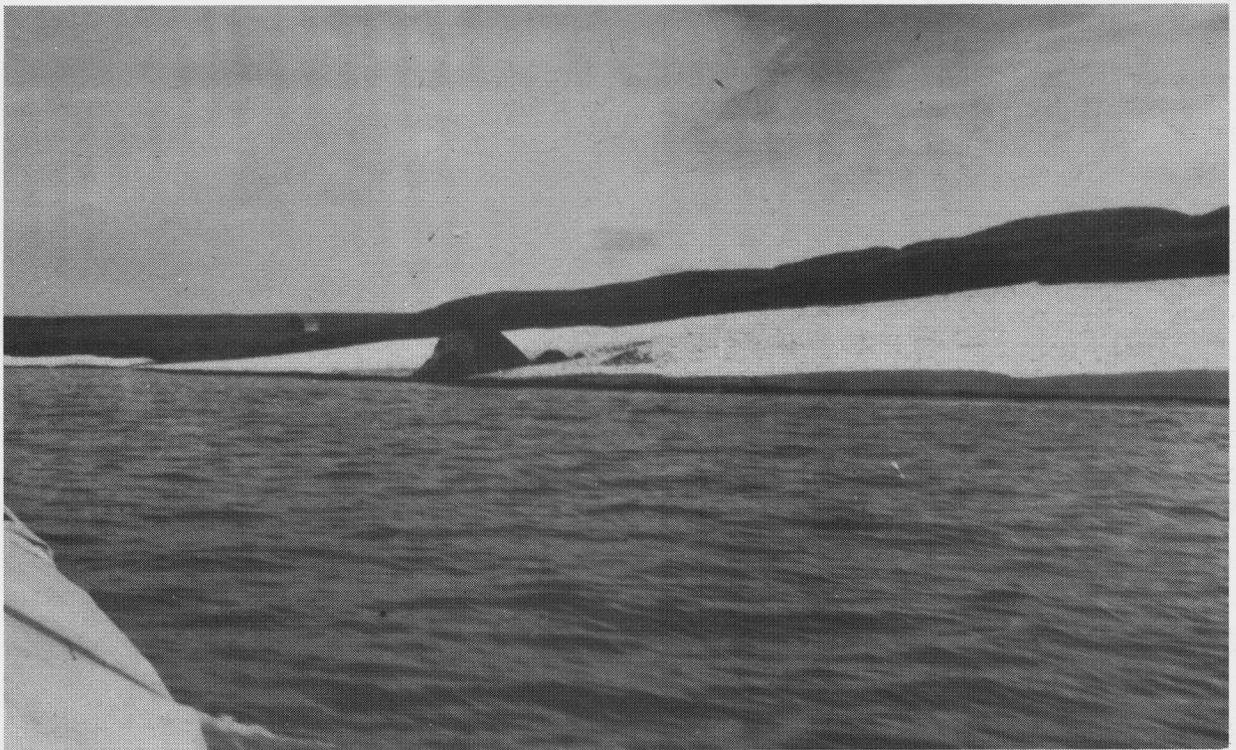


Figure 9. - Coal storage pile, mine 1, Kuk River, Wainwright area.



Figure 10. - Section of coal outcrop, mine 3, Kuk River, Wainwright area.

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TABLE 3. - Analyses of coal from deposit on Kuk River, near Wainwright, mine area No. 2^{1/}

Lab. No.	Condi- tion ^{2/}	Proximate percent				Ultimate percent					Calorific value, B.t.u.	Ash fusion temp., °F. ^{3/}	Agglom- erating index	
		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydro- gen	Carbon	Nitro- gen	Oxygen				
C-61133 ...	1	25.7	30.0	42.3	2.0	0.3	6.6	54.6	1.1	35.4	9,470	2,320	IDT	NAB
	2	-	40.4	57.0	2.6	.4	5.0	73.5	1.5	17.0	12,750	2,420	ST	
	3	-	41.5	58.5	-	.4	5.1	75.5	1.5	17.5	13,100	2,810	FT	
C-61134 ...	1	24.3	30.8	42.5	2.4	.2	6.5	55.1	1.2	34.6	9,510	2,570	IDT	NAB
	2	-	40.6	56.3	3.1	.3	5.0	72.9	1.6	17.1	12,560	2,710	ST	
	3	-	41.9	58.1	-	.3	5.2	75.2	1.6	17.7	12,970	2,750	FT	

^{1/} Analyses by Coal Analysis Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

^{2/} 1, Sample as-received; 2, dried at 105° C.; 3, moisture- and ash-free.

^{3/} IDT = initial deformation temperature; ST = softening temperature; FT = fluid temperature.

Mine area 3. - This deposit is about 16 air miles S. 5° E. of Wainwright on the east bank of the Kuk River, and is referred to by the natives as Mine 3. The outcrop extends for approximately a mile along the river. The strike of the bed is S. 40° E. and the dip is 5° W., which is toward the river. A section of the bed, shown in figure 10, is as follows:

	<u>Thickness</u>		
	<u>Feet</u>	<u>Inches</u>	
Shale roof	0	8	
Rash ¹ /	0	3	
COAL	5	2	} C-61135
Shale and bone ¹ /	0	6	
COAL	3	9	
<u>Bottom of bed at river level.</u>			
¹ / Excluded from sample.			

The analysis of the coal is given in table 4.

Conclusions

The outcrops of coal at the three deposits investigated show minable coal beds in these areas. These beds are under comparatively shallow cover, about 50 feet, and measured dips range from 5° to 7°. Except at Mine 2, the dip is toward the river, and if the dips to the west continue, the extent of the area of coal to the east, inland, may be very limited. However, at Mine 2 the dip is to the east, or inland, and if the bed continues on this dip the area of coal at this deposit may be large.

The Native Service advises that the ex-servicemen at Wainwright are interested in opening a coal mine in the vicinity of Wainwright. The extent of the coal bed should be determined before a mine site is selected. The Native Service owns a small churn drill. Although churn drilling is not recommended for determining the thickness and physical characteristics of coal beds, the expense of transporting a diamond drill and equipment into the area and the cost of this type of drilling is not warranted because of the limited annual demand for coal in this area. It is reported that the depth to which this churn drill can drill is limited to 40 feet. No doubt, by increasing the length of cable this depth can be increased materially. Churn-drill holes will determine the lateral extent of the bed and the approximate thickness but will not show the thickness or characteristics of the partings. The physical characteristics may not differ much from those observed at the outcrop.

If drilling proves the existence of an area of coal, the deposit can be opened either by two shafts or two slopes driven through the overburden. Drilling may determine the location of the outcrop on the shore side, and then the slopes can be driven in coal. A barrier pillar of coal at least 100 feet thick should be left between the river and the limit of the area toward the river in which mining is planned. A plan of mining similar to figure 6 can be used with some modifications.

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TABLE 4. - Analysis of coal from deposit on Kuk River, near Wainwright, mine area No. 3^{1/}

Lab. No.	Condi- tion ^{2/}	Proximate percent				Ultimate percent					Calorific value, B.t.u.	Ash fusion temp. of. ^{3/}	Agglom- erating index
		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydro- gen	Carbon	Nitro- gen	Oxygen			
C-61135 ...	1	26.7	29.1	41.9	2.3	0.2	6.6	53.4	0.9	36.6	9,230	2,080 IDT	NAb
	2	-	39.7	57.2	3.1	.3	4.9	72.8	1.3	17.6	12,590	2,200 ST	
	3	-	41.0	59.0	-	.3	5.1	75.1	1.3	18.2	13,000	2,650 FT	

^{1/} Analysis by Coal Analysis Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

^{2/} 1, Sample as-received; 2, dried at 105° C.; 3, moisture- and ash-free.

^{3/} IDT = initial deformation temperature; ST = softening temperature; FT = fluid temperature.

As the dip of the bed ranges from 5° to 7° , rooms should be driven across the dip, which will permit miners to push cars to the face. The thickness of the bed averages about 8 feet, and the full thickness of the bed can be mined on the advance.

Mining operations should be conducted in winter, as advantage can be taken of frozen ground. The mine openings should be sealed in summer to prevent circulation of warm air, which might cause thawing of the frozen roof and coal with resultant falls of roof. The mine plant and equipment listed for a mine similar to that shown in figure 6 is the minimum necessary to open a mine to supply Wainwright with coal. Mining supplies such as explosives and detonators should be decreased proportionately, unless it is planned to ship the coal to other villages.

Transportation of the coal to Wainwright in winter would be by dog sled or tractor sleds. If degradation of the coal is of little importance, the coal can be stock-piled at the mine in winter and transported to Wainwright in summer by barges.

GENERAL CONCLUSIONS

Plans for mining coal in the Arctic Regions of Alaska for native villages should be based upon natural conditions of the coal beds, climatic conditions (that is, freezing and thawing), short winter hauls by land, long summer hauls by water, reduction of present cost of coal, native ability, native economy, shortage of timber, and proper supervision. Two plans can be followed. Plan one is the development of local sources of coal at points nearest each village or group of villages. Plan two is the development of one source of coal, the transportation of coal to a stock pile on the Arctic coast, and transportation of this coal by barge to the various villages when the Arctic Ocean is free of ice along the shore.

Plan one (local sources of coal) requires the development of a mine at each local source of supply. This plan would necessitate the purchase of mine plant, equipment, and supplies for each small local mine. This would be a village participation and require a greater cost for development and equipment. Supervision would be increased, but transportation cost would be decreased.

Plan two (one source of fuel) would require only one mine, equipment and supplies, but more transportation equipment, including tugs and barges. The quality of the coal at this source must be such that there is little or no degradation in transportation and storage.

Both plans are workable and are based upon underground mining in frozen ground in winter and sealing of the mine openings in summer to prevent circulation of warm air in the mine. This warm air may cause the roof to thaw and fall. A barrier pillar should be left between mine workings and nearby rivers or streams. One disadvantage of depending on one source of coal for all villages is the possibility that shore passages in the Arctic Ocean

might be blocked with ice during some summers. In this event, shipment of coal by barges to the villages would not be possible.

The Native Service owns a small churn drill. Although churn drilling is not recommended for determining the thickness and physical characteristics of coal beds, the expense of transporting a diamond drill and equipment into an area in the Arctic and the cost of this type of drilling are not warranted because of the small annual demand for coal. If the length of the cable on the churn drill is increased, this drill should be satisfactory for determining the lateral extent of the coal beds and the approximate thickness. However, little information regarding partings in the bed can be obtained.

The extent of the outcrop, dip, and thickness of the coal bed in the Deering, Fairhaven District can be determined by trenching or test pitting along the outcrop northwest of the original Chicago Creek mine.

Bituminous coal in a deposit on the Kukpowruk River approximately 45 miles upstream from Point Lay (about 35 air miles S. 20° E.) does not show degradation after long exposure to the weather. This coal could be transported long distances with little or no degradation. This area can be considered under plan 2. The outcrop and the lateral extent of the bed can be determined by churn drilling, trenching, or test pitting.

Three areas of coal near Wainwright were investigated. Two of the areas, which are approximately 12 and 15 miles, respectively, south of Wainwright, appear favorable for development. The lateral extent and the approximate thickness of the bed can be determined by churn drilling.

There is always the danger of gas ignitions in coal mines; therefore, all coal mines must be adequately ventilated. All slopes, drifts, and entries should be driven in pairs so that one opening is always the intake and the other the exhaust in the ventilating system. At mines opened by shafts, there should be both a hoisting shaft and an air shaft. Where the mine openings are in coal, as in a slope mine, the development of the slopes produces coal and this coal will partially pay for the development.

Any coal-mining operations undertaken should be supervised by an experienced coal-mining engineer, preferably one familiar with coal mining in the States. The mining plan suggested is simple, and when the Eskimos are properly supervised by a mining engineer with coal-mining experience they should become proficient in mining coal. The mine plant, equipment, and supplies are estimated to be the minimum necessary to develop a mine in the Arctic.