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INVESTIGATION OF A SUBBITUMINOUS COAL DEPOSIT SUITABLE FOR OPENCUT MINING, BELUGA RIVER COALFIELD, ALASKA

By Robert S. Warfield

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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Stewart L. Udall, Secretary

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This publication has been cataloged as follows:

Warfield, Robert S

Investigation of a subbituminous coal deposit suitable for opencut mining, Beluga River coalfield, Alaska. [Washington] U.S. Dept. of the Interior, Bureau of Mines [1963]

100 p. illus., maps, tables. 27 cm. (U. S. Bureau of Mines. Report of investigations 6238)

1. Bituminous coal—Alaska. I. Title: Subbituminous coal deposit. II. Title: Opencut mining. (Series)

TN23.U7 no. 6238 622.06173

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INVESTIGATION OF A SUBBITUMINOUS COAL DEPOSIT SUITABLE FOR OPENCUT MINING, BELUGA RIVER COALFIELD, ALASKA

by

Robert S. Warfield[1]

ABSTRACT

The Bureau of Mines investigated a geologically favorable area in the Beluga River coalfield in south-central Alaska to determine if there were sufficient minable coal reserves for onsite utilization to meet the projected thermal power needs of the Anchorage area. A program of diamond core drilling and sampling delimited a shallow saucerlike structure estimated to contain indicated reserves of more than 20 million tons of subbituminous coal in a seam over 50 feet thick that could be mined by opencut methods. A large sample of fresh coal was taken across the full width of the seam for washability studies. This sample, with 4 volume-percent of clay partings eliminated, contained 24.4 percent moisture and 16.8 percent ash and had a calorific value of 7,162 Btu per pound. The studies indicated that mechanical cleaning would be of doubtful value.

INTRODUCTION

As part of its program of determining minable coal reserves, the Bureau of Mines investigated a geologically favorable area in the Beluga River coalfield in south-central Alaska, beginning in 1959 and continuing through the field seasons of 1960 and 1961. A reconnaissance of the area in August 1957[2] had indicated favorable possibilities for the occurrence of large reserves of subbituminous coal that might be utilized for the onsite production of low-cost thermoelectric power to supply the future demands of the rapidly expanding military and civilian installations in the Anchorage area.

Overburden in the area, which is about 53 miles west of Anchorage, ranges in depth from a few feet to 225 feet; it consists of glacial till and soft, poorly compacted sandy to silty claystone with an occasional relatively thin bed of fairly hard dense sandstone. Much or all of the overburden could be removed by heavy equipment without recourse to blasting, although it might be

[1] Mining engineer, Alaska Office of Mineral Resources, Division of Mineral Resources, Region I, Bureau of Mines, Juneau, Alaska.

[2] Maloney, R. P. Reconnaissance of the Beluga River Coalfield, Alaska. BuMines Rept. of Inv. 5430, 1958, 18 pp.

Work on manuscript completed May 1962.

necessary to rip the sandstone members. Hydraulic methods could be used but would be complicated by drainage problems.

ACKNOWLEDGMENTS

Special recognition is extended to Farrel F. Barnes of the Geological Survey for helpful onsite geologic appraisal and interpretation during his several visits to the Beluga River project. Employees of the Fish and Wildlife Service, Division of Aircraft, were especially helpful and cooperative during the entire project; Theron A. Smith, supervisor-pilot, flew supplies and fuel to the project, sometimes under adverse conditions, and Clara Evanson, administrative assistant, maintained radiotelephone communications with the Beluga River camp. Max R. Geer, chief, and Michael Sokaski, mining methods research engineer, of the Bureau of Mines Seattle Coal Research Laboratory cut a large channel sample of unweathered coal from near the discovery outcrop and determined the washability characteristics of this sample in the Seattle laboratory.

LOCATION, ACCESS, AND TRANSPORTATION

Beluga Lake, a large glacier-fed body of water 60 miles northwest of Anchorage, is the most prominent landmark near the project area. The Beluga River originates at the east end of the lake, flows southeast, and empties into the northern end of Cook Inlet about 35 miles west of Anchorage. The thick coal seam crops out along the cutbank of an unnamed creek about 2 miles upstream from its confluence with the Beluga River; this creek joins the Beluga River about 1 mile downstream from Beluga Lake (fig. 1). The area of investigation lies within T 15 N,R 12 W, Seward meridian; the township, range, and section landlines were originally established by protraction, but the Bureau of Land Management is presently (1961) surveying and marking the lines necessary to define the boundaries of land selected by the State of Alaska. Much of the Beluga River area has been selected.

The lower Beluga River can be navigated from tidewater by small boats equipped with outboard motors; the upstream limit for such travel depends on water level but seldom exceeds about 12 river miles from the mouth. Bureau of Mines drilling and other equipment was transported from Anchorage by tug and barge and landed about 4.5 river miles above the mouth of the Beluga River. The movement of equipment was timed to coincide with the maximum tides occurring during the latter part of June 1959, so that the landing could be made as near as possible to the upstream limit for the size of craft used.

From the barge landing site, equipment and supplies were moved overland by tractor through an unexplored and trackless region. The overland trip required 5 weeks and an estimated 40 trail miles to cover an air-line distance of approximately 20 miles. Aerial photographs were used extensively and to great advantage in choosing a route. After the route was established, a round trip to the barge landing required only 10 days.

The area between the project site and Cook Inlet is of generally low relief that would permit relatively easy (by Alaskan standards) road or railroad construction. The ease of construction would depend on the availability of suitable materials for road-base fill along a swampy or poorly drained route.

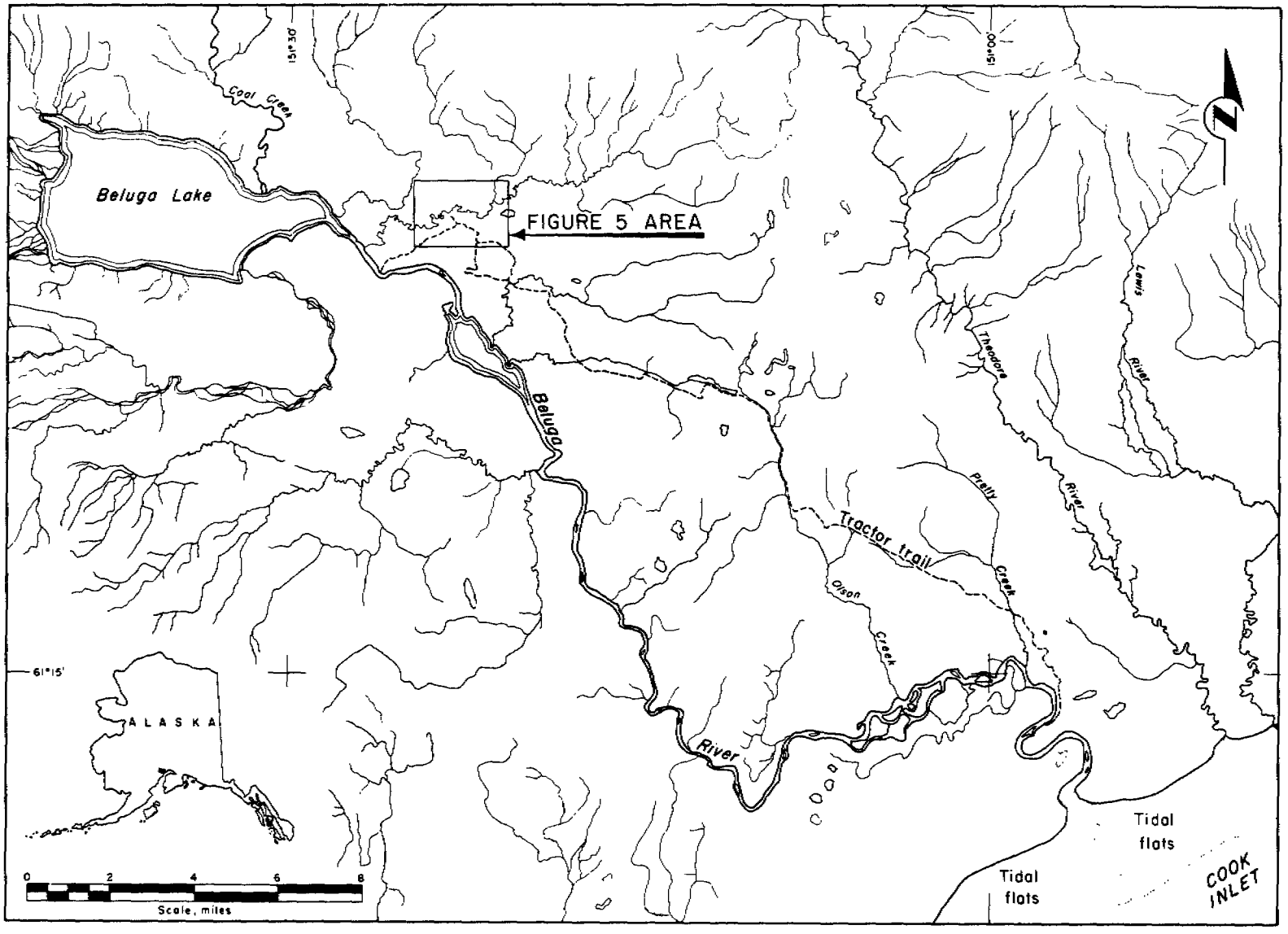

FIGURE 1. - Location Map, Beluga River Project Area.

Access to the region by air is relatively easy. Amphibious-type aircraft or pontoon-equipped light planes can operate from the silt-laden Beluga Lake or from numerous locations along the Beluga River; also, there are a few clear-water lakes large enough to accommodate waterborne aircraft. The project area, however, is several miles from the nearest of these landing sites. Therefore, a 1,500-foot landing strip was cleared and smoothed at the project site to accommodate movement of personnel, supplies, and coal samples. This strip becomes very slippery and soft during the frequent periods of wet weather; however, even under these conditions it was successfully used by light aircraft equipped with oversized tires. During dry weather, the field was used by a twin-engine aircraft to land loads weighing as much as 1 ton (fig. 2). Helicopters provide an ideal means of transportation for reconnaissance work within the region.

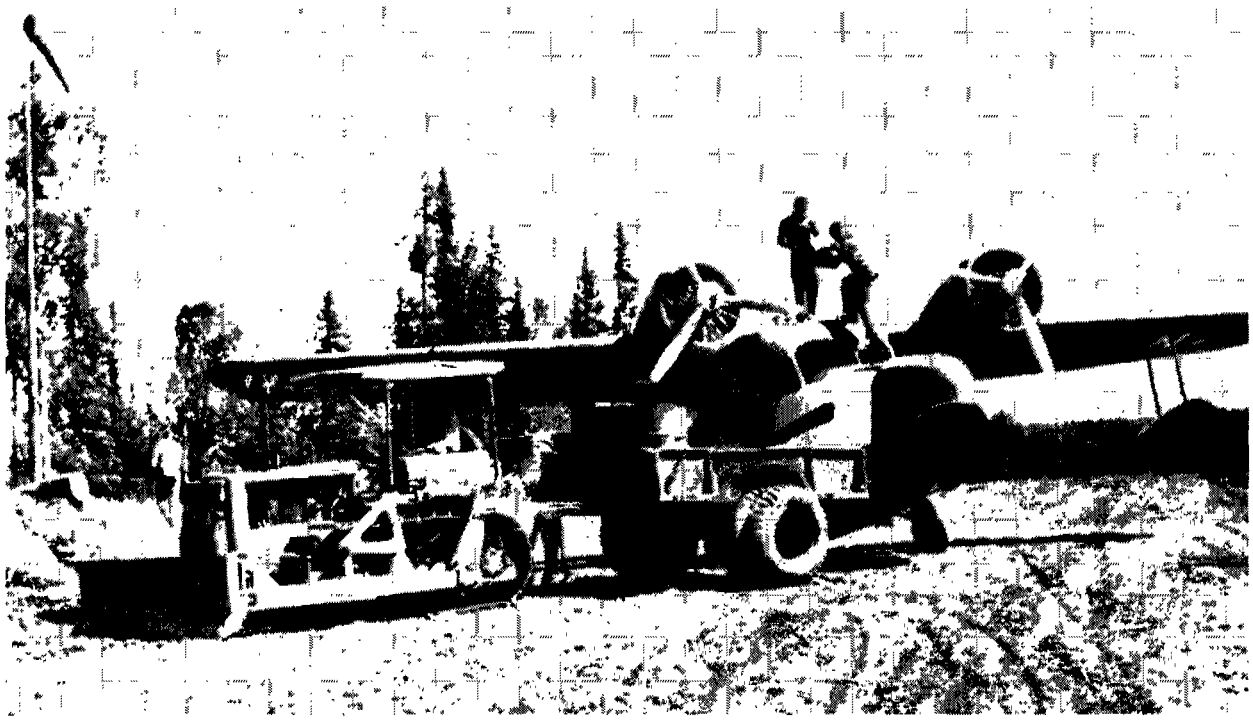

FIGURE 2. - Unloading Fuel and Supplies, Beluga Project Airstrip.

PHYSICAL FEATURES, CLIMATE, AND VEGETATION

The Beluga River coalfield is in a gently rolling piedmont plain of low to moderate relief that is dissected by the Beluga River and its tributaries. The altitude of the river at its head in Beluga Lake is only 246 feet, but at some places along its course the relief exceeds 700 feet and the stream is deeply entrenched. In these trenches, steep clifflike cutbanks expose sections of bedrock and some coal seams. Tributary streams, in general, become more deeply entrenched as they approach the Beluga River; the deeper trenches occasionally have bedrock cutbanks 40 to 50 feet high. Except along stream courses, bedrock exposures are very rare.

No weather records are available for the Beluga River area, but the climate is similar to that in other parts of the Cook Inlet region. Summers are mild with many cloudy days, and winters usually are severe with a good deal of snow. The average annual precipitation in Anchorage is about 20 inches; personal observation (no actual records kept) by the author during three summer seasons indicated that the Beluga River area may receive considerably more precipitation than Anchorage. No permafrost was encountered within the project area, and the entire district is believed to be free of permafrost.

Spruce, birch, and alder constitute the main timber stands of the area; the timber stands and muskeg areas are indiscriminately interspersed. The spruce and birch may attain diameters of as much as 2 and 1 feet, respectively. Alders occur along stream courses and as patches within spruce and birch stands; the alders sprawl along the surface to form an almost impenetrable jungle. Large cottonwoods are numerous along the Beluga River and also along some tributary streams. A thick undergrowth of brush and grass covers the ground within the stands of timber.

Muskeg areas have a meadowlike appearance owing to the various types of short grasses and low bushes that flourish in the swampy environment (fig. 3). The muskegs contain numerous ponds and a number of small lakes.

GENERAL GEOLOGY

The general geology of the Beluga River coalfield is described in previous reports by the Geological Survey[3] and the Bureau of Mines[4]; this information is summarized as follows:

The Beluga River coalfield is comprised of Tertiary sediments (probably Eocene) that consist of clay, silts, sandstone, pebbly sandstone, conglomerate, and coal. Much of the material is poorly compacted or loosely cemented. Except where exposed by stream action, the formations are concealed beneath a mantle of vegetation, glacial till, and glaciolacustrine deposits. The Tertiary coal-bearing sediments were laid down in fresh water as estuarine, river flood plain, or marsh and swamp deposits. Sedimentation probably occurred over local areas within the regional lowland rather than over the region as a whole; in other words, at any given time the adjacent highlands were supplying rock components to one locality while another locality was accumulating organic materials that later became coal.

None of the earlier investigators were able to estimate total thickness of the Tertiary sediments because nowhere did they find an exposed complete section nor were they able to correlate between exposures over any great distance. However, recent successful drilling for petroleum on the Kenai Peninsula to the southeast on the opposite side of Cook Inlet has penetrated as much as 10,000 feet of Tertiary sediments that are believed to be contemporaneous with, or part of, the same regional formation as the Beluga River

[3] Atwood, W. W. Mineral Resources of Southwestern Alaska. Geol. Survey Bull. 379-C, 1909, pp. 116-121.
Capps, Stephen R. The Southern Alaska Range. Geol. Survey Bull. 862, 1935, pp. 60-65, 70-73, 95-96.

[4] Pages 5-6 of work cited in footnote 2.

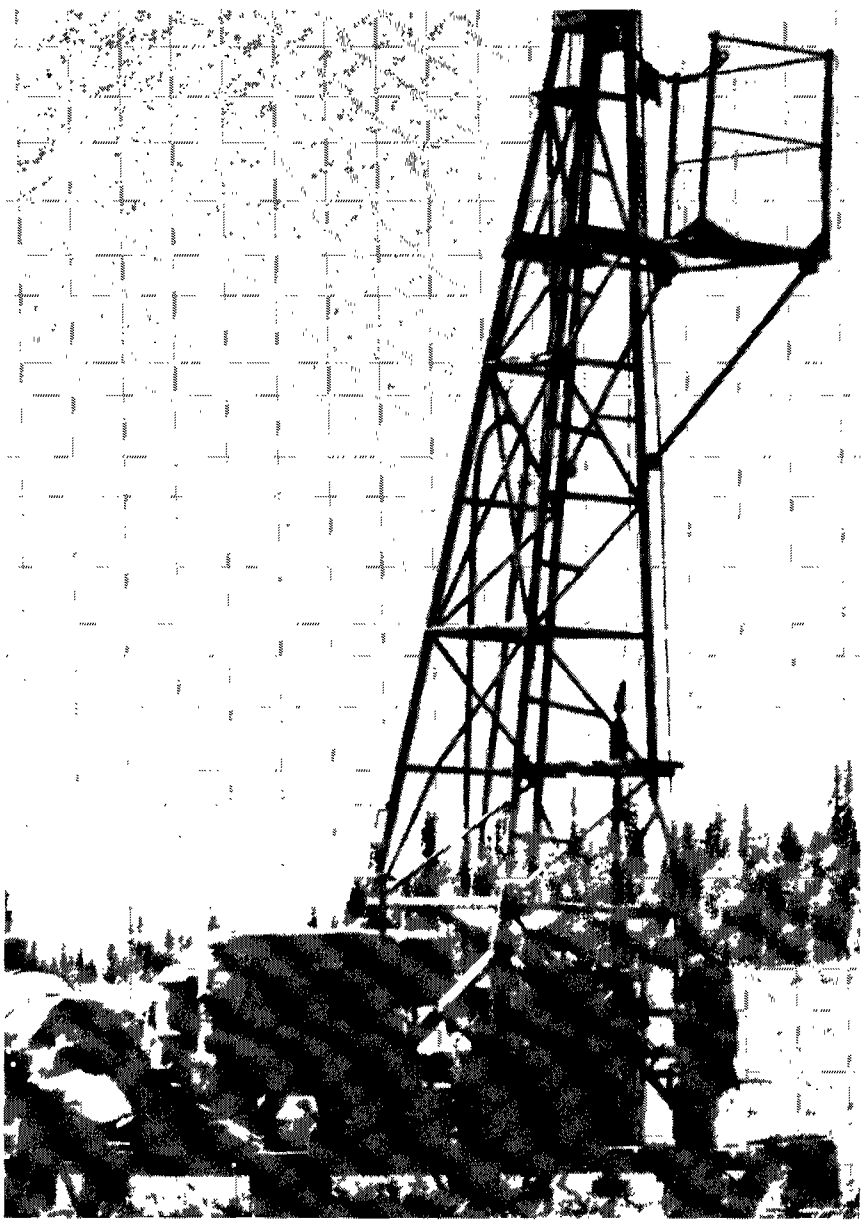

FIGURE 3. - Typical Topography and Vegetation; Core Drill Operating on Muskeg.

sediments. Granitic intrusives crop out at several localities within the Beluga River area as isolated satellites; however, these are probably of Cretaceous age and therefore have not altered or disturbed the younger coal-bearing Tertiary sediments.

In post-Eocene time the mountains surrounding the Cook Inlet lowland probably were uplifted; during this uplift the Tertiary sedimentary beds of the lowland were locally warped, folded, and faulted. Erosion by streams and glaciers then removed much material from the folded and warped beds; still later, the remaining beds were covered with a mantle of glacial drift and outwash gravel.

Figure 4 shows the general geology of the Beluga River area and the location of coal outcrops discovered prior to the Bureau's project. Subsequent geologic mapping by the Geological Survey revealed numerous coalbeds, some of considerable thickness, cropping out along the Chuit River; the approximate locations of these outcrops are also shown.

CORE-DRILL EXPLORATION

The principal purpose of the Beluga River coal investigation was to determine the quality, attitude, extent, and strip-mining characteristics of a 50- to 65-foot-thick coal seam; the discovery outcrop which is an almost vertical face, forms one bank of a large creek (figs. 5 and 6). Under the direction of

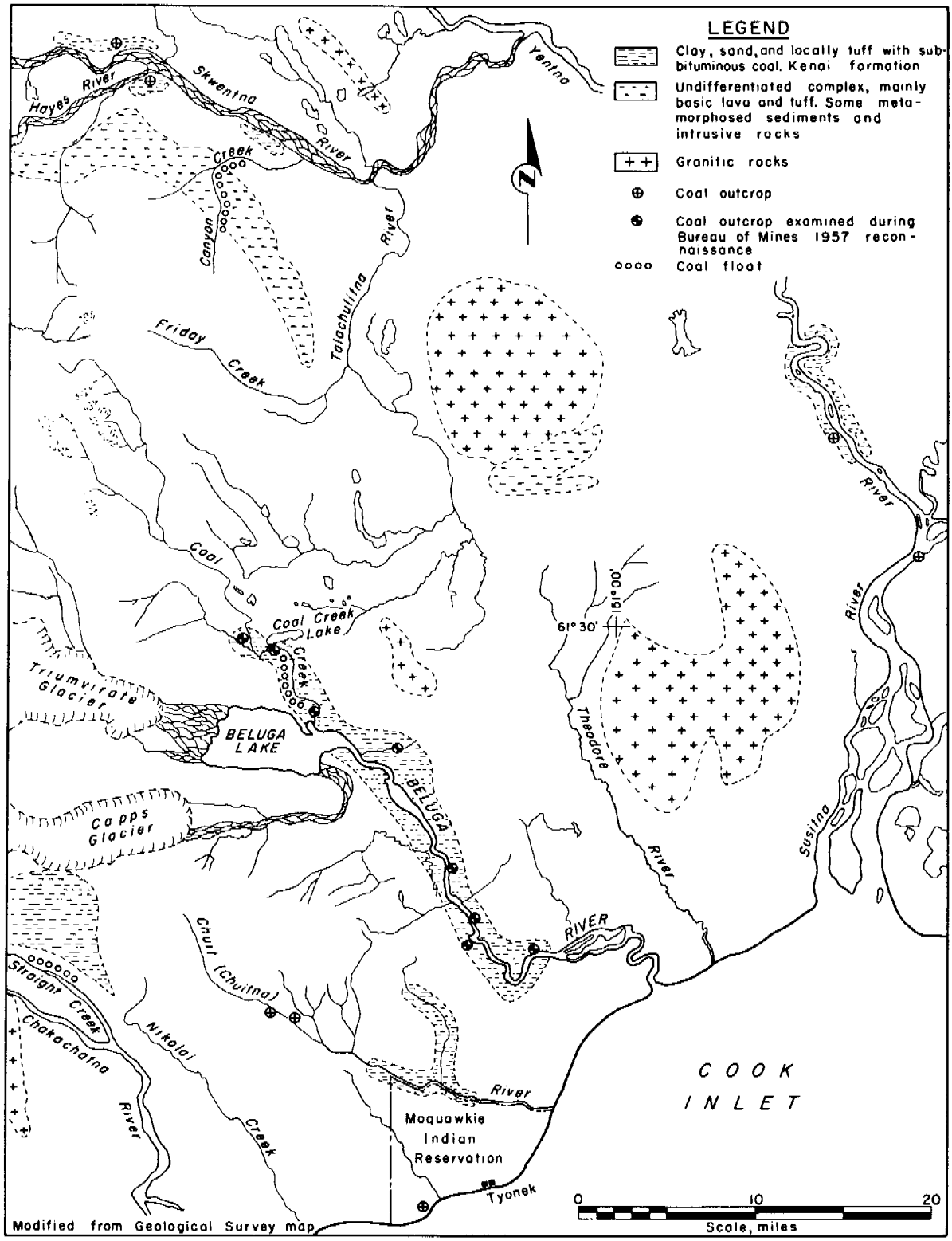

FIGURE 4. - General Geology, Beluga River Coalfield.

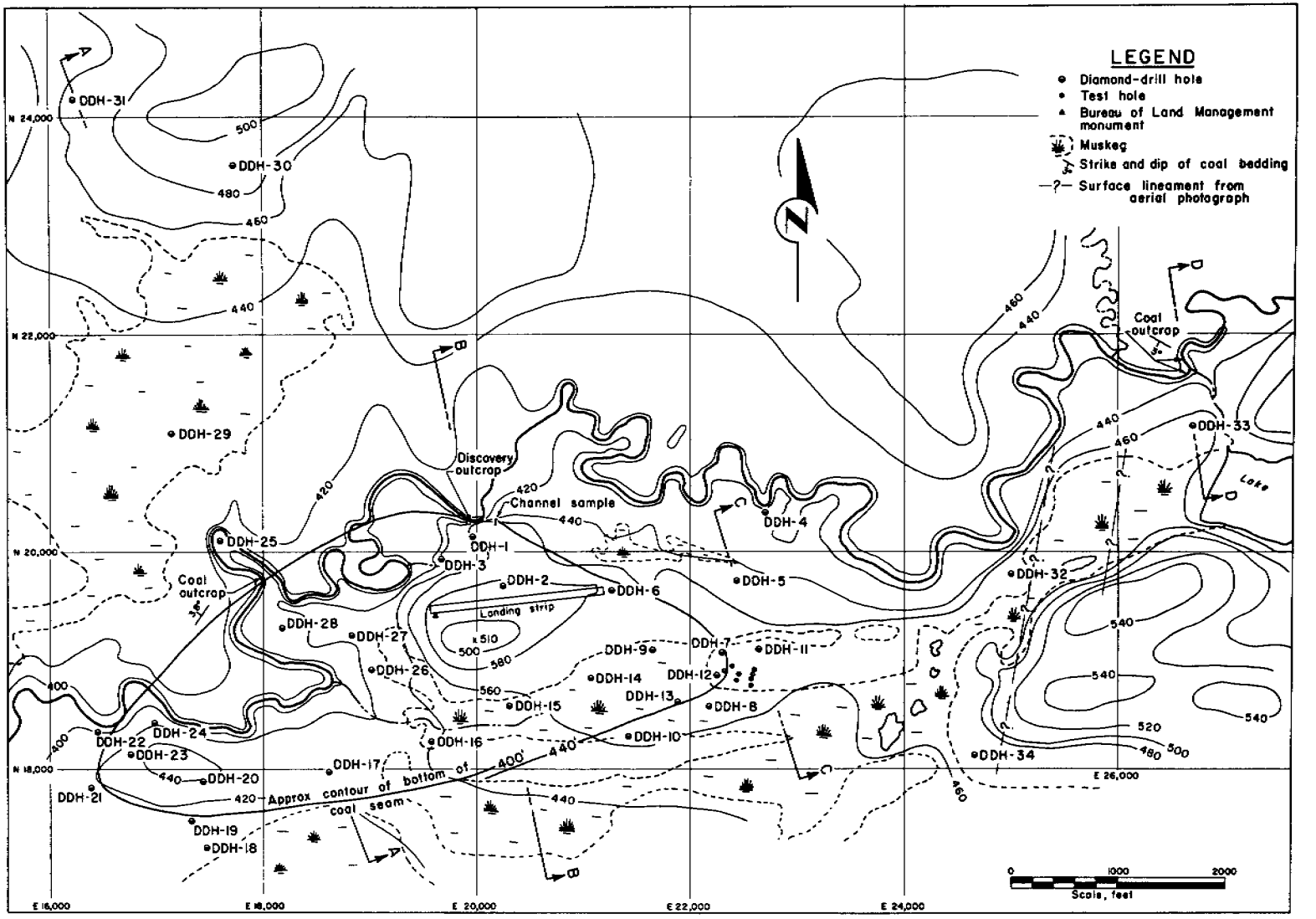

FIGURE 5. - Plan, Beluga River Project Area. (Figure 8 shows detail of sections A-A, B-B, C-C, and D-D.)

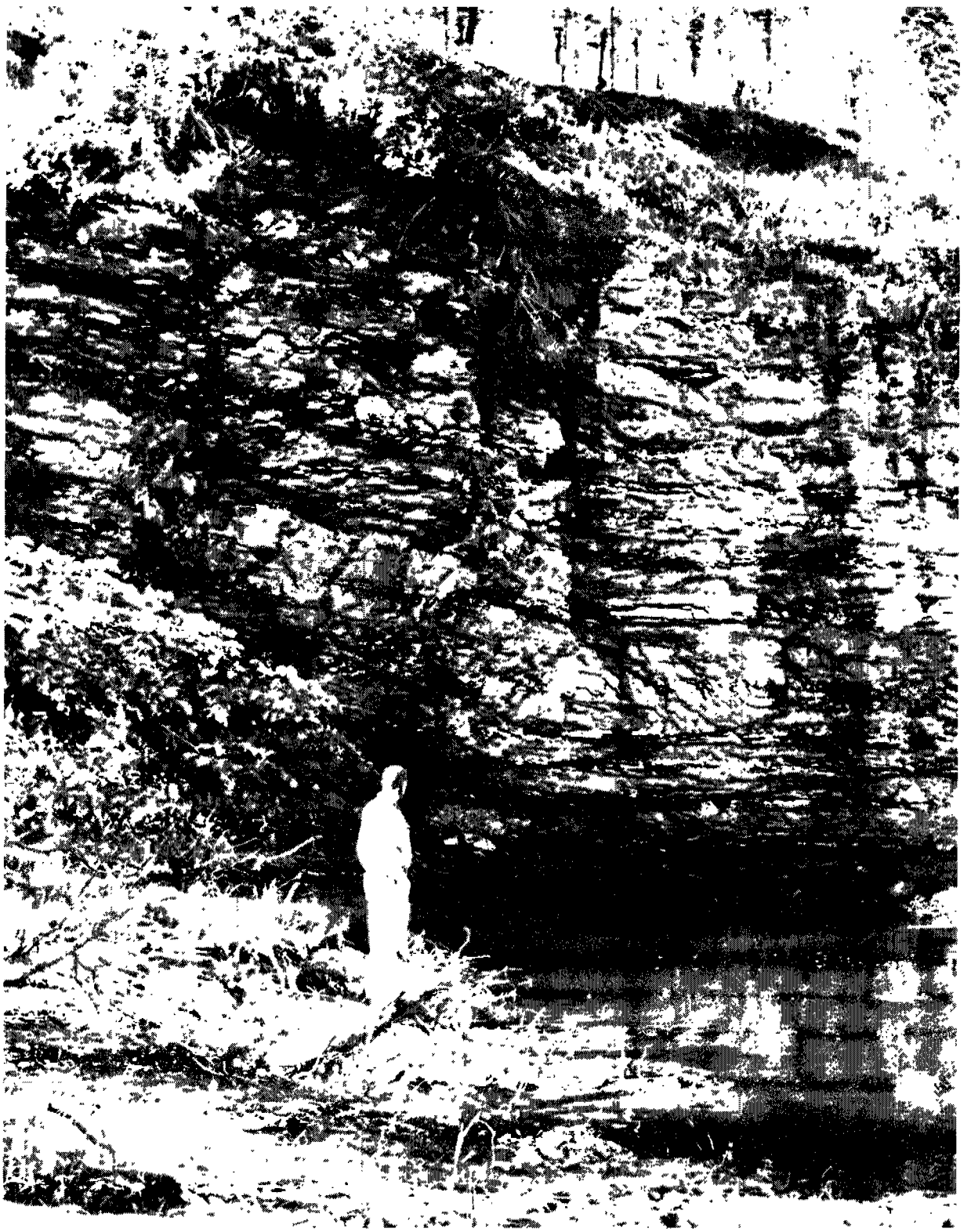

FIGURE 6. - Discovery Outcrop, Approximately 40 Feet of Coal Exposed.

the author, the deposit was explored by diamond core drilling during the field seasons of 1959, 1960, and 1961. The drill used was gasoline-engine driven and had a rated capacity of 1,000 feet of NX drill hole; it was equipped with a cathead for driving pipe through overburden. The drill and tower were mounted on a platform that had special runners designed to permit towing from either end over rough terrain (fig. 3).

The usual drilling procedure was to set 4-inch flush-coupled casing through the overburden to bedrock by a combination of driving, fishtail or drag-bit drilling, chopping, and water circulation. Large glacial boulders that stopped further advancement of the casing were broken by blasting; this was necessary in only two drill holes. NX casing equipped with a casing-shoe diamond bit to permit reaming was then installed, and NX core drilling followed. A swivel-type, high-recovery, core barrel was used for drilling all coal intersections. In holes 20, 24, and 32, where the most adverse drilling conditions were encountered, core recovery and drilling conditions were considerably improved by using bentonite mud instead of water as the circulating medium. All casing was recovered from all drill holes.

Incidental to determining the structural shape and extent of the thick discovery seam, a thinner and relatively dirty underlying seam was intersected in four rather widely separated drill holes. Delineation of the structure containing the discovery outcrop was completed about midseason 1961; thereafter, several wildcat holes were drilled in an attempt to locate a recurrence of the thick discovery seam. These wildcat holes were unsuccessful in their original purpose, but two additional intersections of the aforementioned underlying seam were made, and two holes intersected a section containing relatively thin dirty coalbeds that appear to underlie the limit of all other drilling in the area.

The 50- to 65-foot discovery seam was determined to occur in a shallow, elliptical, synclinal basin with a longitudinal axis that strikes approximately N 75° E (fig. 7). Exploration started near the discovery outcrop shown in

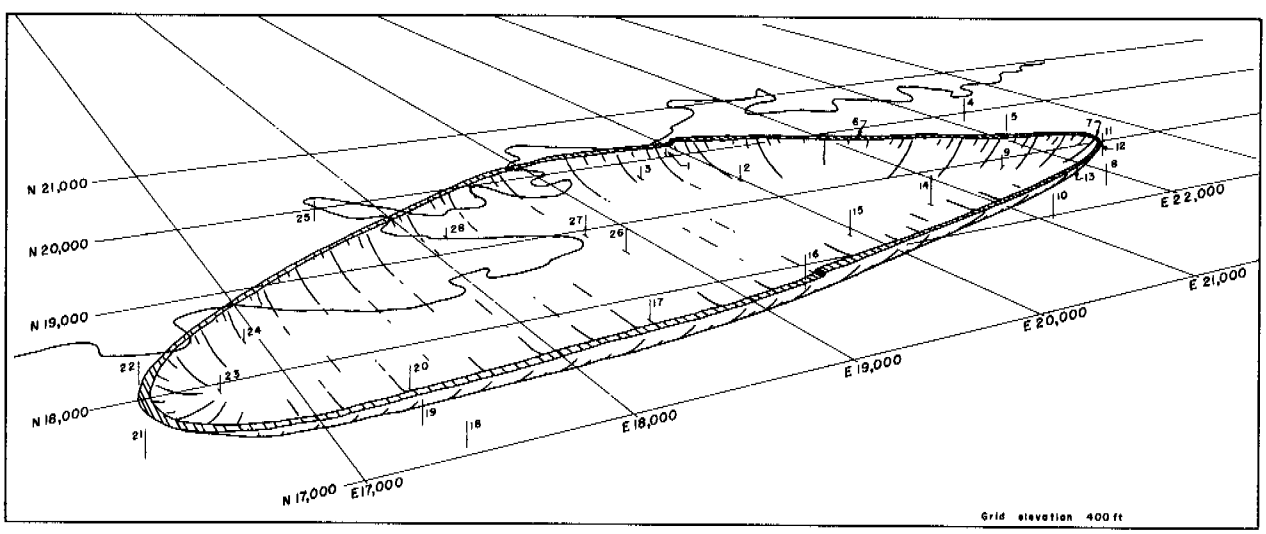

FIGURE 7. - Perspective View, Discovery Seam, Beluga River Project.

figure 6 and proceeded southeastward about 2,800 feet along the north limb of the syncline to the eastern nose and thence southwestward about 6,000 feet along the south limb to the western nose. The structure along the remainder of the north limb from the western nose to the place of starting near the discovery outcrop was explored by drill holes 25 to 28.

Holes 1 to 3 were drilled in a triangle to establish the strike and dip of the coal seam. Holes 4 and 5 were then drilled at a half-mile interval along the projected strike. Both of these holes, however, failed to intersect the thick discovery seam; hole 5 instead intersected a thinner underlying seam that previously had not been known to exist. Thereafter, the holes were spaced along the projected strike at 1,000- to 1,200-foot intervals wherever possible. Even with this relatively close spacing, much hit-and-miss probing with the drill was necessary to locate the approximate position of a buried apex that has marked changes in strike within short distances. In addition to the core drilling, eight test holes were drilled to depths of 15 to 20 feet in overburden. Observation of the relative abundance of coal particles in the drill cuttings from these holes substantially aided in defining the blunt-ended nose that forms the eastern end of the shallow syncline (figs. 5 and 7).

The trace of the coal apex and the bedding angles encountered in the various holes indicated that the structure is shaped somewhat like an oblong shallow basin with a rather broad, gently sloping base and sharply upturned sides (fig. 7 and fig. 8, section B-B).

The northwesterly dip of a poorly exposed coal outcrop occurring near water level on the creek bank about 2,000 feet southwest of the discovery outcrop (fig. 5) implied a possible repetition of the basinlike structure outlined by diamond-drill holes 1 to 24. Subsequent drilling of holes 25 to 31, however, indicated that the erratic dip was due to surface slump caused by stream erosion and that the basinlike structure continued to the northwest for a considerable distance. The outcrop marked the northwestern limit of the discovery coal seam, but the thinner underlying seam of dirty coal was encountered in holes 25, 29, and 30. An interpretation of the local structure, based on surface evidence and data from drill holes 25 to 31, is suggested in figure 8, section A-A.

The underlying seam, where intersected in six widely separated drill holes, ranges in true thickness from 17 feet (in hole 18) to 52 feet (in hole 29) and is much dirtier than the discovery seam. Because of difficult drilling conditions encountered in the very poorly cemented pebbly sandstone, no attempt was made to determine exactly the stratigraphic interval between the two seams; however, correlation of drill-hole data indicates that the interval varies and may range from 250 to 350 feet. The two seams are believed to be comformable (fig. 8, sections A-A and C-C). This wide variation in the thickness of the coal seams and interlying pebbly sandstone probably is the result of varying sedimentation rates and, possibly to a lesser degree, of compaction by later folding.

Holes 32 to 34 were drilled east of the discovery seam basin to determine the significance of an outcrop occurring in the creek bank about 7,000 feet

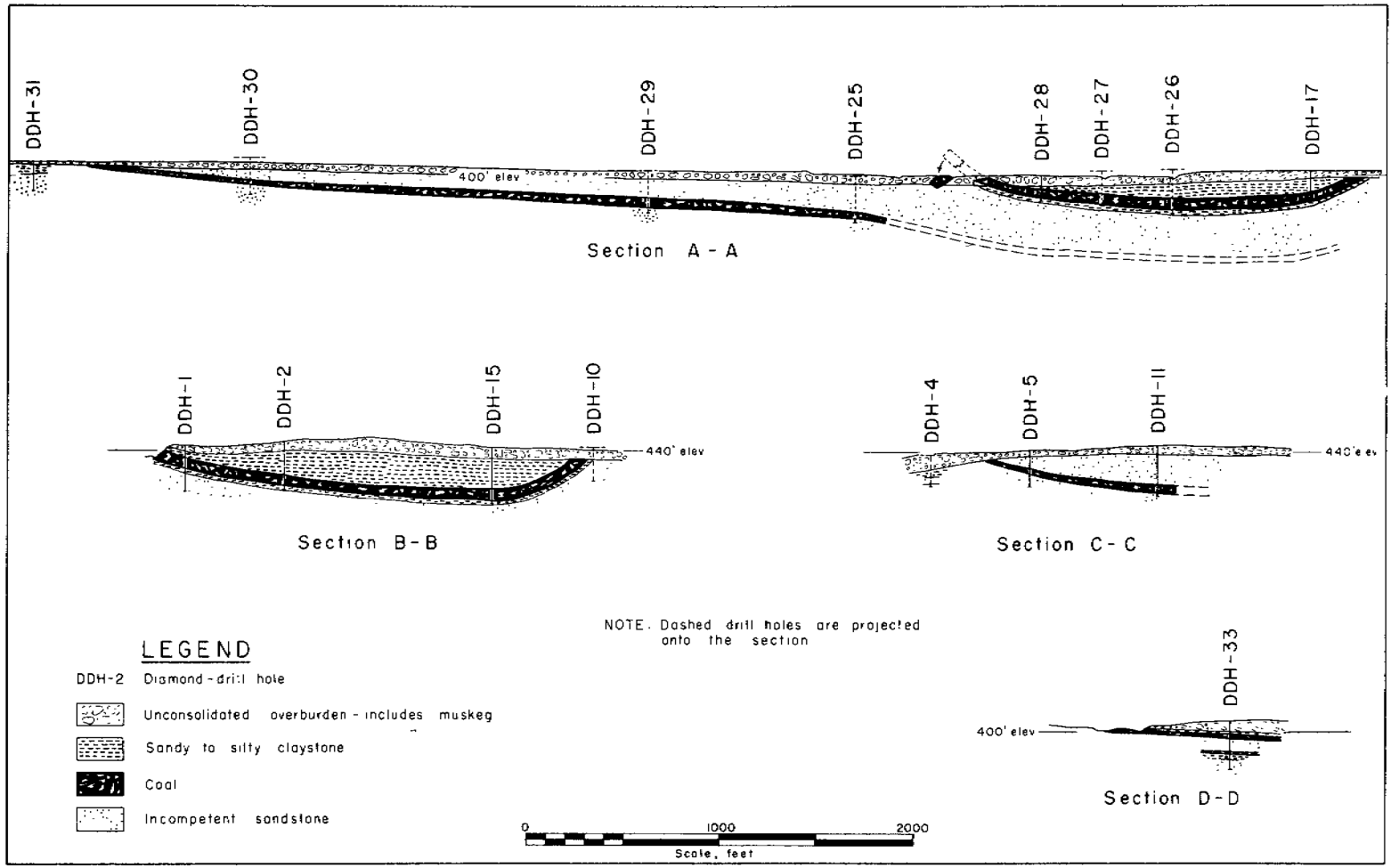

FIGURE 8. - Sections, Beluga River Project Area.

northeast of the original discovery (fig. 5). Drillhole 32 penetrated 289 feet of predominately silty claystone very similar to material found above the discovery seam, but the 19.5 feet of coal intersected below this interval was definitely not of the same quality or thickness as the discovery seam. The possibility that hole 32 may have encountered a fault is indicated by a 35° variation in bedding angles as measured in cores obtained from the interval between 302 and 319 feet.

Hole 33 intersected coal horizons 21 and 11 feet thick separated stratigraphically by 70 feet of predominately soft pebbly sandstone. The upper coal seam correlates with the outcrop on the creek bank about 500 feet north of the collar of hole 33 (fig. 5 and fig. 8, section D-D), but neither coal seam correlates with, or closely resembles, any other drilled coal seam in the area. Therefore, the stratigraphic relationship of holes 33 and 32 is not apparent, and the relation between either of these two holes and all other drilling is obscure; probably the section containing holes 32 and 33 underlies the stratigraphic limit of all other drilling in the area.

Drill hole 34 was abandoned at 113.5 feet before bedrock was reached because of exceptionally difficult drilling conditions in glacial till overburden. This hole completed the Bureau of Mines exploration of a relatively small district within the Beluga River coalfield.

Table 1 summarizes pertinent drill-hole data collected during the investigation; detailed logs are given in the appendix.

TABLE 1. - Pertinent drill-hole data

Hole	Total depth, feet	Unconsolidated overburden depth, feet	Coal section interval, feet		Coal seam	Average bedding angle
			From-	To-		
1...	236.7	21.4	66.0	118.5	Discovery seam.....	17°
2...	251.5	36.1	171.1	225.6	.....do.....	10°
3...	155.0	30.0	88.4	141.5	.....do.....	7°
4...	161.5	76.0	--	--	No coal.....	--
5...	186.5	27.0	95.0	122.8	Underlying seam.....	25°
6...	93.3	7.0	7.0	66.8	Discovery seam.....	30°
7...	82.0	17.0	17.0	33.4	Discovery seam (upper part of seam missing).....	27°
8...	196.0	30.0	--	--	No coal.....	--
9...	216.0	20.0	124.0	188.0	Discovery seam.....	15°
10...	170.0	30.0	--	--	No coal.....	--
11...	259.4	40.0	198.7	241.6	Underlying seam.....	15°
12...	79.0	12.0	12.0	53.3	Discovery seam (upper part of seam missing).....	25°
13...	55.0	18.5	18.5	34.8	.....do.....	47°

TABLE 1. - Pertinent drill-hole data (Con.)

Hole	Total depth,	Unconsolidated overburden depth, feet	Coal section interval, feet		Coal seam	Average bedding angle
			From-	To-		
14...	306.0	65.0	225.9	286.0	Discovery seam.....	3°
15...	285.0	50.0	206.2	271.3	.....do.....	10°
16...	245.8	20.0	162.6	226.7	.....do.....	27°
17...	167.0	40.0	104.4	160.8	.....do.....	27°
18...	190.0	60.0	104.5	128.5	Underlying seam.....	45°
19...	195.0	62.0	--	--	No coal.....	--
20...	225.8	100.0	141.0	206.1	Discovery seam.....	12°
21...	116.6	80.0	--	--	No coal.....	--
22...	110.0	61.0	--	--	.....do.....	--
23...	106.2	47.0	47.0	88.6	Discovery seam (upper part of seam missing).....	15°
24...	102.0	71.0	71.8	102.0	Discovery seam (hole abandoned in coal).....	27°
25...	238.2	40.0	181.2	220.2	Underlying seam.....	10°
26...	227.0	90.0	150.45	210.55	Discovery seam.....	10°
27...	191.8	118.0	118.0	174.45	.....do.....	12°
28...	131.0	58.0	60.2	112.35	.....do.....	8°
29...	207.0	65.0	131.1	183.2	Underlying seam.....	5°
30...	190.0	58.0	113.5	141.05	.....do.....	15°
31...	150.0	14.0	--	--	No coal seam.....	8°
32...	366.1	46.0	289.0	308.5	Not correlated with other drilling but probably a lower section.....	(1)
33...	252.0	68.8	76.1 167.95	97.2 179.55	.....do.....	7°
34...	113.5	113.5	--	--	No coal seam. Hole abandoned because of difficult drilling conditions.....	--

[1] 45° to 305 feet, decreases to 12° between 305 and 320 feet, 12° to bottom.

WASHABILITY STUDY

Sampling Procedure

A 1,600-pound channel sample was cut from the bed on September 12, 1960. A bulldozer was used to scrape a cut across the outcrop to expose fresh coal. This cut was inclined about 40° from the horizontal and all measurements along the cut were corrected to normal values. Table 2 shows a section of the bed at the sample location (about 150 feet north of borehole 1).

TABLE 2. - Section of bed at sample location

(Roof: Clay; floor: Clay with coal streaks)

Composition	Feet	Inches
Coal	8	5
Fusain	-	2
Coal	3	7
Clay	-	2
Coal	18	8
Coal, shale streaks	3	10
Clay	-	4
Coal	10	2
Clay	-	1
Coal, shale streaks	3	2
Clay	-	5
Coal	1	6
Thickness of bed	50	6

The sample was sealed in 55-gallon drums at the sample site and shipped to the Bureau's Seattle Coal Research Laboratory for examination. The clay was separated from the coal during the sampling process and shipped in a separate 5-gallon bucket. This was done to simplify examination in the laboratory.

The coal has the strong, tough structure typical of subbituminous coal. Table 2 shows that the bed contains about 4 volume-percent of clay at the sample location. Also, clay overlies as well as underlies the bed.

Laboratory Examination

At the laboratory, the coal was screened on a 4-inch round-hole screen, and the oversize was crushed to pass this size. The undersize was screened on 2-inch, 1-inch, 1/4-inch, and 20-mesh square-hole screens. The coal was not allowed to dry during the screening process because subbituminous coal disintegrates on drying. The specific-gravity composition of each size was determined by the float-and-sink method. Zinc chloride solutions were used for all sizes except the 20-mesh to 0 size, which was tested in organic solutions. All specific-gravity fractions were analyzed for ash content. The results of the specific-gravity analyses are given in table 3.

TABLE 3. - Specific-gravity analyses of various sizes of raw coal

Size and weight	Specific gravity	Weight, percent[1]	Ash, percent[1]	Cumulative Weight, percent[1]	Cumulative Ash, percent[1]
4 to 2 inches; weight, 35.3 percent.....	Under 1.30	8.6	4.7	8.6	4.7
	1.30 to 1.40	55.4	13.3	64.0	12.1
	1.40 to 1.50	21.8	28.3	85.8	16.2
	1.50 to 1.60	6.4	39.9	92.2	17.9
	1.60 to 1.70	2.0	49.2	94.2	18.6
	1.70 to 1.80	1.3	59.5	95.5	19.1
	Over 1.80	4.5	71.4	100.0	21.5
2 inches to 1 inch; weight, 31.5 percent...	Under 1.30	7.0	4.7	7.0	4.7
	1.30 to 1.40	54.5	13.0	61.5	12.1
	1.40 to 1.50	16.1	27.5	77.6	15.3
	1.50 to 1.60	10.0	38.3	87.6	17.9
	1.60 to 1.70	3.6	48.4	91.2	19.1
	1.70 to 1.80	2.3	56.5	93.5	20.0
	Over 1.80	6.5	67.2	100.0	23.1
1 to 1/4 inch; weight, 24.5 percent.....	Under 1.30	5.0	4.5	5.0	4.5
	1.30 to 1.40	53.1	11.3	58.1	10.7
	1.40 to 1.50	18.7	26.6	76.8	14.6
	1.50 to 1.60	6.4	37.1	83.2	16.3
	1.60 to 1.70	6.9	44.0	90.1	18.4
	1.70 to 1.80	4.9	53.2	95.0	20.2
	Over 1.80	5.0	65.3	100.0	22.5
1/4 inch to 20 mesh; weight, 7.6 percent....	Under 1.30	.2	10.1	.2	10.1
	1.30 to 1.40	30.3	7.5	30.5	7.5
	1.40 to 1.50	34.0	16.2	64.5	12.1
	1.50 to 1.60	3.8	25.3	68.3	12.8
	1.60 to 1.70	11.3	32.3	79.6	15.6
	1.70 to 1.80	8.7	40.4	88.3	18.0
	Over 1.80	11.7	54.1	100.0	22.3
20 mesh to 0; weight, 1.1 percent.....	Under 1.30	.4	9.0	.4	9.0
	1.30 to 1.40	10.3	8.0	10.7	8.0
	1.40 to 1.50	37.1	15.2	47.8	13.6
	1.50 to 1.60	18.1	25.1	65.9	16.8
	1.60 to 1.70	12.7	32.3	78.6	19.3
	1.70 to 1.80	7.7	42.1	86.3	21.3
	Over 1.80	13.7	60.7	100.0	26.7

TABLE 3. - Specific-gravity analyses of various sizes of raw coal (Con.)

Size and weight	Specific gravity	Weight, percent[1]	Ash, percent[1]	Cumulative Weight, percent[1]	Cumulative Ash, percent[1]
Composite, 4 inches to 0; weight, 100.0 percent..	Under 1.30	6.5	4.7	6.5	4.7
	1.30 to 1.40	52.2	12.4	58.7	11.5
	1.40 to 1.50	20.3	25.9	79.0	15.2
	1.50 to 1.60	7.5	37.7	86.5	17.2
	1.60 to 1.70	4.5	43.3	91.0	18.5
	1.70 to 1.80	3.1	51.9	94.1	19.6
	Over 1.80	5.9	65.8	100.0	22.3

[1] Moisture-free basis.

A proximate analysis of the raw coal is given in table 4. The as-received moisture content of the coal is 24.4 percent. This is similar to the moisture content of subbituminous coal currently being mined in the Healy River field in Alaska.

TABLE 4. - Proximate analysis of raw coal

Attributes	As received	Moisture free
Moisture.....percent	24.4	-
Volatile matter.....do.....	30.1	39.8
Fixed carbon.....do.....	28.7	38.0
Ash.....do.....	16.8	22.2
Sulfur.....do.....	.2	.2
Btu per pound.....	7,160	9,470
Fusibility of ash, ° F:		
Initial deformation.....	-	2,550
Softening.....	-	2,680
Fluid.....	-	2,760

Size Composition

An examination of the amount of coal in each size fraction (table 3) shows that only 8.7 percent of the sample was smaller than one-fourth inch. This indicates that the coal would be largely represented by the coarser sizes in a surface-mining operation because of its tendency to break into large pieces ranging from blocky to slabby.

Specific-Gravity Composition

The specific-gravity compositions of individual size fractions are not significantly different from that of the 4-inch to 0 composite. This was to be expected because very little banded material of a nature that would liberate coal in the finer sizes was observed at the sample site. The bulk of the coal

is in the 1.30 to 1.50 specific-gravity range, and much smaller amounts appear in the remaining specific-gravity fractions. However, more material of greater than 1.80 specific gravity would probably be present in the coal from an actual mining operation because of contamination from both top and bottom clay.

A separation at 1.60 specific gravity would yield a clean coal of 17.2 percent ash with a theoretical yield of 86.5 percent. Separations at even considerably lower specific gravities would not result in a large ash decrease in the float product. Conversely, the ash increases further to only 22.3 percent with no cleaning.

Discussion of Results

If the primary use of this coal was for the generation of electric power, mechanical cleaning would probably not be economically feasible unless a large amount of clay contamination from roof and floor was anticipated. Clay adjacent to the top and bottom, as well as that included in the bed, would tend to soften and swell when in contact with water but should remain reasonably hard and consolidated if care was taken to prevent undue exposure to water during mining. Also, softening of the clay would not be a problem during freezing weather.

Although removing excessive amounts of soft clay can be difficult, experiments at the Seattle Coal Research Laboratory indicated that a Baum jig can remove clay from this type of coal. A log washer, however, would be much cheaper and probably would be practical for this purpose. Some fine coal would be lost in the overflow of a log washer, but the amount would be small because of the coarseness of this coal.

A comparison of the analysis of the washability sample with that of the various core samples indicates a wide variation in moisture content that probably is due to sampling procedures, which are outlined as follows:

1. The core samples were stored in core boxes for various lengths of time before the analyses and consequently lost moisture. Also, to the best degree possible, all clayey partings were rejected from the core samples that were submitted for analysis, thus eliminating some wet material.

2. The washability sample probably absorbed excessive moisture during the exceptionally wet weather that prevailed prior to cutting the sample.

For these reasons, the true bed-moisture content of the raw coal lies somewhere between the core sample analyses and the washability sample analysis.

An important factor bearing on the quality of product that might be mined without mechanical cleaning is indicated by a study of the coal-core logs. Judging by the amount of core analyzed relative to that rejected, the upper 35 to 45 feet of the seam is much cleaner than the lower part of the seam. This upper cleaner part of the seam varies in thickness with the total thickness of the seam. The economic feasibility of leaving the lower part of the seam in order to gain a cleaner run-of-mine product should be considered. Such a system would also preclude contamination from the pit floor.

CHARACTER OF OVERBURDEN AS RELATED TO MINING METHODS

Parts of the area are fairly well drained and support a dense growth of spruce, birch, and alder on a loamy soil that may be moderately thick (10 to 15 feet); other parts of the area have a poorly drained muskeg surface. The thickness, or vertical distance from surface to solid bottom, of the muskeg varies but generally does not exceed 10 feet. Igneous boulders, glacially deposited, are indiscriminately distributed on either the soil or the muskeg surface. The unconsolidated overburden beneath the soil and/or muskeg is a glacial till consisting of poorly sorted sand, silt, clay, coal, pebbles, cobbles, and boulders. Beds of poorly compacted silty material (glacial-lake-deposited), containing much clay and in places impregnated with pebbles of various origins, were also found in several drill holes and cutbanks along the creek. These beds, which probably were deposited in relatively small basins, may be both overlain and underlain by till. There are enough fines and clayey materials within the till to make it nearly impervious; this, along with low gradients of parts of the area, accounts for much of the poor drainage. Unconsolidated overburden thickness, including the soil and/or muskeg surface, ranged from 7.0 feet in drill hole 6 to 118 feet in drill hole 27.

The consolidated, or bedrock, overburden overlying the thick discovery coal seam was logged mainly as a soft, poorly compacted sandy to silty claystone. Within the soft clayey material, an occasional relatively thin bed of fairly hard dense sandstone occurs. The sandstone beds appear to be the product of gradation in particle size within a specific stratigraphic horizon. Thus, the sandstone beds are lenticular and cannot be used as correlative marker horizons over any extensive distances.

The overburden, both unconsolidated and consolidated, with the possible exception of sandstone lenses, could be cut or broken by hydraulic giant. However, the difference in elevation between the highest point within the area under investigation and the Beluga River (about 1 mile distant) is only about 265 feet. The amount of excavation necessary to cut a drain for transporting stripped materials might preclude use of hydraulic methods for overburden removal, even though a good proportion of the overburden consists of sand and fine clayey material that would remain in suspension at relatively low water velocity. In lieu of gravity disposal of materials broken by hydraulic methods, pumping the slurry to a disposal area might be economically feasible, or a suction-type dredge might be employed for both excavation and pump disposal of a slurry.

A limited amount of experience gained by the Bureau of Mines in excavating with a bulldozer indicated that all overburden, both unconsolidated and consolidated, except sandstone lenses could be stripped by heavy equipment without blasting; even the sandstone probably could be ripped. Experience also indicated, however, that the loosened excavated materials readily absorb water during wet weather. Moreover, if an appreciable amount of water is absorbed, the stripped materials become a jellylike mass that will flow. Conversely, these same materials under favorable weather and drainage conditions will become a very hard mass. Because of the frequent rainfall that generally prevails

during summer months, the working of a tracked or wheeled excavator upon a spoils pile in a continuous operation probably would be difficult, if not impossible. Therefore, any mining plan utilizing heavy equipment for mechanical stripping should include a spoils stacker that does not depend on working upon the spoils pile. In the Fairbanks, Alaska, gold-placer district, good success has been attained by stripping with a large dragline which dumps onto a shuttle conveyor that in turn discharges onto a lengthy semipermanent conveyor system for discharging onto a spoils area.

RESERVES

Coal reserves of the discovery seam were estimated for the area contained within the elliptical outline made by the bottom of coal contour lines (fig. 5). These contours, which represent the approximate apex of the coalbed, were located by interpretation of drill-hole data and the position of two outcrops. The area contains 239 acres underlain by estimated measured and indicated clean coal reserves of 20,900,000 tons. Twenty-five cubic feet of coal in place equal 1 ton. This tonnage was estimated on the basis of an average clean coal stratigraphic thickness of 47.9 feet; this average thickness is contained within a stratigraphic seam thickness that ranges from 41.3 to 54.5 feet of clean coal and from 49.2 to 64.1 feet of total stratigraphic thickness. Only those drill holes that intersected the entire thickness of the seam were used for estimating tonnage. The stripping ratio of overburden to coal ranges from near zero to no more than 5 to 1.

Because of the few widely separated hole intersections and consequent scant knowledge of the underlying coalbeds, no attempt was made to calculate reserves for these thinner seams.

APPENDIX A. - ANALYSES OF BELUGA RIVER COAL CORES

Table A-1 gives sampling data as well as the proximate analyses and calorific value of the cores; three analyses and calorific values are given for each sample, as follows: (1) As received, (2) moisture free, and (3) moisture and ash free.

TABLE A-1. - Analyses of Beluga River coal cores

Hole	Sample	Depth, feet		Interval, feet	Core, feet			Proximate, percent				Calorific value, Btu
		From-	To-		received	rejected	analyzed	Moisture	Ash	Volatile matter	Fixed carbon	
1...	1	66.0	105.2	39.2	39.2	1.65	37.55	14.4	15.2	36.2	34.2	8,620
								-	17.8	42.3	39.9	10,070
								-	-	51.5	48.5	12,250
1...	2	105.2	118.5	13.3	13.1	5.2	7.9	13.5	24.6	31.3	30.6	7,400
								-	28.5	36.2	35.3	8,560
								-	-	50.6	49.4	11,970
2...	3	171.1	213.4	42.3	41.3	1.7	39.6	14.3	15.9	35.6	34.2	8,600
								-	18.6	41.6	39.8	10,030
								-	-	51.1	48.9	12,330
2...	4	213.4	224.8	11.4	11.4	5.1	6.3	11.3	26.2	31.7	30.8	7,480
								-	29.5	35.8	34.7	8,430
								-	-	50.8	49.2	11,970
3...	5	88.4	98.4	10.0	10.0	.0	10.0	17.3	14.0	35.5	33.2	8,390
								-	16.9	42.9	40.2	10,140
								-	-	51.6	48.4	12,200
3...	6	98.4	101.9	3.5	3.5	.0	3.5	17.4	13.3	35.3	34.0	8,500
								-	16.1	42.8	41.1	10,290
								-	-	51.0	49.0	12,270
3...	7	101.9	102.3	.4	.4	.0	.4	9.4	46.5	25.7	18.4	5,080
								-	51.4	28.4	20.2	5,600
								-	-	58.4	41.6	11,530
3...	8	102.3	112.3	10.0	10.0	.5	9.5	16.6	15.3	34.5	33.6	8,310
								-	18.3	41.4	40.3	9,960
								-	-	50.7	49.3	12,190
3...	9	112.3	122.3	10.0	10.0	.4	9.6	15.6	16.2	35.6	32.6	8,430
								-	19.2	42.2	38.6	9,990
								-	-	52.2	47.8	12,360

TABLE A-1. - Analyses of Beluga River coal cores (Con.)

Hole	Sample	Depth, feet		Interval, feet	Core, feet			Proximate, percent				Calorific value, Btu
		From-	To-		received	rejected	analyzed	Moisture	Ash	Volatile matter	Fixed carbon	
3...	10	122.3	132.3	10.0	10.0	2.9	7.1	16.0	24.1	29.8	30.1	7,220
								-	28.7	35.4	35.9	8,590
								-	-	49.7	50.3	12,050
3...	11	132.3	141.5	9.2	9.2	4.8	4.4	15.6	24.2	30.8	29.4	7,200
								-	28.7	36.5	34.8	8,530
								-	-	51.2	48.8	11,960
5...	12	95.0	106.0	11.0	11.0	3.4	7.6	11.9	20.8	33.9	33.4	8,230
								-	23.6	38.5	37.9	9,340
								-	-	50.4	49.6	12,230
5...	13	106.0	122.8	16.8	16.8	10.8	6.0	13.6	23.1	30.3	33.1	7,590
								-	26.7	35.0	38.3	8,770
								-	-	47.8	52.2	11,970
6...	14	10.0	22.5	12.5	6.0	.0	6.0	13.1	14.4	37.9	34.6	8,890
								-	16.5	43.8	39.9	10,230
								-	-	52.2	47.8	12,250
6...	15	22.5	49.8	27.3	24.35	.55	23.8	13.3	15.9	36.7	34.1	8,660
								-	18.4	42.4	39.2	9,990
								-	-	51.9	48.1	12,240
6...	16	49.8	66.8	17.0	16.5	3.8	12.7	13.0	22.2	32.3	32.5	7,760
								-	25.5	37.2	37.3	8,920
								-	-	49.9	50.1	11,970
7...	17	17.0	33.4	16.4	16.4	2.5	13.9	13.4	23.8	31.7	31.1	7,540
								-	27.4	36.6	36.0	8,700
								-	-	50.4	49.6	11,990
9...	18	124.0	167.6	43.6	43.6	1.15	42.45	15.4	15.0	35.5	34.1	8,510
								-	17.7	41.9	40.4	10,050
								-	-	50.9	49.1	12,210
9...	19	167.6	188.0	20.4	20.4	7.1	13.3	13.8	25.8	30.7	29.7	7,260
								-	30.0	35.6	34.4	8,420
								-	-	50.9	49.1	12,030
11...	20	198.7	241.6	42.9	39.1	9.6	29.5	15.0	23.2	31.7	30.1	7,500
								-	27.3	37.3	35.4	8,820
								-	-	51.2	48.8	12,130

TABLE A-1. - Analyses of Beluga River coal cores (Con.)

Hole	Sample	Depth, feet From-	Depth, feet To-	Interval, feet	Core, feet received	Core, feet rejected	Core, feet analyzed	Proximate, percent Moisture	Ash	Volatile matter	Fixed carbon	Calorific value, Btu
12..	21	12.0	53.3	41.3	40.1	9.8	30.3	16.1	18.2	33.1	32.6	7,970
								-	21.7	39.4	38.9	9,490
								-	-	50.4	49.6	12,120
13..	22	18.5	34.8	16.3	16.3	6.3	10.0	16.5	19.0	31.7	32.8	7,800
								-	22.8	38.0	39.2	9,350
								-	-	49.2	50.8	12,110
14..	23	225.9	265.1	39.2	39.2	1.5	37.7	17.6	13.5	34.5	34.4	8,330
								-	16.4	41.9	41.7	10,110
								-	-	50.1	49.9	12,090
14..	24	265.1	286.0	20.9	20.9	9.8	11.1	15.9	21.9	30.5	31.7	7,460
								-	26.0	36.3	37.7	8,870
								-	-	49.1	50.9	11,990
15..	25	206.2	244.9	38.7	38.7	1.5	37.2	16.8	14.1	35.4	33.7	8,490
								-	17.0	42.5	40.5	10,210
								-	-	51.2	48.8	12,290
15..	26	244.9	271.3	26.4	22.0	10.3	11.7	16.7	20.1	30.9	32.3	7,580
								-	24.1	37.1	38.8	9,100
								-	-	48.9	51.1	11,990
16..	27	162.6	206.3	43.7	42.7	1.5	41.2	16.5	14.4	35.3	33.8	8,440
								-	17.3	42.3	40.4	10,110
								-	-	51.1	48.9	12,220
16..	28	206.3	226.7	20.4	19.6	7.1	12.5	15.3	22.7	31.2	30.8	7,420
								-	26.8	36.8	36.4	8,760
								-	-	50.3	49.7	11,960
17..	29	104.4	160.8	56.4	53.5	4.05	49.45	17.5	14.5	34.7	33.3	8,280
								-	17.5	42.1	40.4	10,040
								-	-	51.0	49.0	12,170
20..	30	141.0	192.2	51.2	48.7	2.6	46.1	17.9	16.0	34.2	31.9	8,130
								-	19.5	41.6	38.9	9,900
								-	-	51.7	48.3	12,300
20..	31	192.2	206.1	13.9	13.9	6.15	7.75	17.6	25.4	28.8	28.2	6,820
								-	30.8	35.0	34.2	8,280
								-	-	50.6	49.4	11,970

TABLE A-1. - Analyses of Beluga River coal cores (Con.)

Hole	Sample	Depth, feet From-	Depth, feet To-	Interval, feet	Core, feet received	Core, feet rejected	Core, feet analyzed	Proximate, percent Moisture	Ash	Volatile matter	Fixed carbon	Calorific value, Btu
23..	32	50.5	88.6	38.1	35.9	6.8	29.1	18.6	15.1	33.3	33.0	8,090
								-	18.5	40.9	40.6	9,940
								-	-	50.1	49.9	12,200
24..	33	71.8	102.0	30.2	13.3	.7	12.6	17.7	15.0	34.6	32.7	8,260
								-	18.2	42.1	39.7	10,030
								-	-	51.5	48.5	12,270
25..	34	181.2	220.2	39.0	39.0	17.8	21.1	15.5	28.8	28.6	27.1	6,690
								-	34.0	33.8	32.2	7,910
								-	-	51.3	48.7	12,000
26..	35	150.4	190.6	40.1	40.1	.9	39.2	16.8	16.9	34.6	31.7	8,110
								-	20.3	41.5	38.2	9,740
								-	-	52.1	47.9	12,220
26..	36	190.6	210.5	19.9	19.9	12.0	7.9	16.1	26.3	28.8	28.8	6,840
								-	31.3	34.3	34.4	8,150
								-	-	50.0	50.0	11,870
27..	37	118.0	160.8	42.8	37.6	1.3	36.3	18.3	15.5	33.9	32.3	8,100
								-	18.9	41.5	39.6	9,920
								-	-	51.2	48.8	12,240
27..	38	160.8	174.4	13.6	13.5	4.6	8.9	15.8	30.5	27.9	25.8	6,370
								-	36.2	33.2	30.6	7,560
								-	-	51.9	48.1	11,840
28..	39	60.2	94.2	34.0	34.0	1.4	32.6	19.3	17.4	32.6	30.7	7,730
								-	21.5	40.4	38.1	9,570
								-	-	51.4	48.6	12,200
28..	40	94.2	112.3	18.1	17.2	9.0	8.2	18.0	27.7	27.8	26.5	6,290
								-	33.8	34.0	32.2	7,670
								-	-	51.3	48.7	11,590
29..	41	131.1	183.2	52.1	50.6	31.5	19.1	15.4	26.8	29.5	28.3	6,980
								-	31.7	34.9	33.4	8,250
								-	-	51.0	49.0	12,070
30..	42	113.5	141.1	27.5	26.5	21.9	4.5	16.5	21.9	30.0	31.6	7,510
								-	26.2	35.9	37.9	8,990
								-	-	48.6	51.4	12,170

TABLE A-1. - Analyses of Beluga River coal cores (Con.)

Hole	Sample	Depth, feet		Interval, feet	Core, feet			Proximate, percent				Calorific value, Btu
		From-	To-		received	rejected	analyzed	Moisture	Ash	Volatile matter	Fixed carbon	
32..	43	289.0	308.5	19.5	10.6	6.8	3.8	14.9	23.9	32.5	28.7	7,770
								-	28.1	38.2	33.7	9,130
								-	-	53.1	46.9	12,690
33..	44	76.1	97.2	21.1	21.1	6.8	14.3	17.3	24.0	29.8	28.9	7,300
								-	28.9	36.0	35.1	8,820
								-	-	50.6	49.4	12,410
33..	45	167.9	179.5	11.6	11.1	7.7	3.4	17.3	23.7	30.0	29.0	7,310
								-	28.6	36.3	35.1	8,830
								-	-	50.8	49.2	12,380

APPENDIX B. - DETAILED LOGS OF DRILL HOLES

The detailed logs of drill holes are arranged in chronological order of drilling. Coal sample numbers and rejected core are designated under the column headed "Remarks." Hole location coordinates and collar elevations were determined by transit and chain surveying. The original bearing of the traverse was a compass bearing between two semipermanent hubs located near diamond-drill hole 1; the original elevation was based on interpolation from a Geological Survey map.[1] The hole drilling dates are for elapsed time from the date the hole was started to completion date including Sundays (none worked) and also maintenance work to the drill and accessory equipment that was necessary while a hole was in progress. All drill holes were completed at NX size (2-1/2-inch core diameter) except hole 29, which was reduced to BX size (1-5/8-inch core diameter) because of difficult drilling conditions.

Hole 1

Location: 20,141.5 N; 19,951.0 E.

Elevation: Collar of hole: 461.2 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 9-17, 1959.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	21.4	Unconsolidated soil and clayey overburden, occasional pebbles (mostly igneous).	21.4	0.0	
21.4	21.8	Medium-grained sandstone, hard and dense.	.4	.4	
21.8	62.0	Sandy claystone, soft, poorly compacted.	40.2	35.1	Bedding angles range from 20° to 30°.
62.0	66.0	Sandy claystone, soft, poorly compacted--numerous coal streaks, bands and inclusions.	4.0	4.0	
66.0	67.9	Top of seam. Coal dull, with occasional streaks of clay.	1.9	1.9	Sample 1.
67.9	68.0	Bony coal.	.1	.1	Rejected.
68.0	68.2	Brown clay seam, hard, bony...	.2	.2	Do.
68.2	73.8	Coal, dull, with very occasional, very thin clay seams.	5.6	5.6	Sample 1.
73.8	79.3	Coal, dull.....	5.5	5.5	Do.
79.3	79.4	Bony coal.....	.1	.1	Rejected.
79.4	79.7	Coal, dull.....	.3	.3	Sample 1.
79.7	80.0	Coaly claystone.....	.3	.3	Rejected.
80.0	80.6	Coal, dull.....	.6	.6	Sample 1.

[1] Geological Survey. Tyonek (B-4) Quadrangle, 1:63360 series (Topographic).

Hole 1 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
80.6	80.7	Bony coal.....	0.1	0.1	Rejected.
80.7	83.2	Coal, dull.....	2.5	2.5	Sample 1.
83.2	83.3	Bony coal.....	.1	.1	Rejected.
83.3	83.9	Coal, dull.....	.6	.6	Sample 1.
83.9	84.0	Bony coal.....	.1	.1	Rejected.
84.0	90.0	Coal, dull.....	6.0	6.0	Sample 1.
90.0	90.3	Bony coal, occasional minute clay seams.	.3	.3	Rejected.
90.3	95.4	Coal, dull, occasional, minute clay seams.	5.1	5.1	Sample 1.
95.4	95.6	Claystone with streaks, bands, and inclusions of coal.	.2	.2	Rejected.
95.6	103.3	Coal, dull, with occasional minute clay seams.	7.7	7.7	Sample 1.
103.3	103.35	Bony coal.....	.05	.05	Rejected.
103.35	103.7	Coal, dull.....	.35	.35	Sample 1.
103.7	103.8	Bony coal, occasional thin clay seams.	.1	.1	Rejected.
103.8	105.2	Coal, dull, occasional thin clay seams.	1.4	1.4	Sample 1.
105.2	105.3	Coaly claystone.....	.1	.1	Rejected.
105.3	108.4	Coal, dull, with thin clay seams.	3.1	3.0	Sample 2; at 107.2 feet, a 1/4-inch claystone seam--rejected.
108.4	109.8	Claystone with numerous bands, streaks, and inclusions of coal.	1.4	1.4	Rejected.
109.8	110.0	Coal, dull, with small clay seams	.2	.2	Sample 2.
110.0	111.3	Claystone with numerous bands, streaks, and inclusions of coal.	1.3	1.2	Rejected.
111.3	111.4	Claystone.....	.1	.1	Do.
111.4	112.1	Claystone with numerous streaks, bands, and inclusions of coal.	.7	.8	Do.
112.1	113.7	Coal, dull, with numerous small thin clay seams.	1.6	1.6	Sample 2.
113.7	114.1	Claystone with numerous streaks, bands, and inclusions of coal.	.4	.4	Rejected.

Hole 1 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
114.1	114.4	Coal, dull, with occasional thin clay seams.	0.3	0.3	Sample 2.
114.4	114.7	Claystone with numerous streaks, bands, and inclusions of coal.	.3	.3	Rejected.
114.7	115.5	Coal, dull, numerous clay streaks and seams.	.8	.8	Sample 2.
115.5	116.1	Claystone with numerous bands, streaks, and inclusions of coal.	.6	.6	Rejected.
116.1	116.5	Coal, dull, with numerous thin clay seams.	.4	.4	Sample 2.
116.5	116.9	Claystone with numerous bands, streaks, and inclusions of coal.	.4	.4	Rejected.
116.9	118.5	Coal, dull, with numerous thin clay seams. Bottom of seam.	1.6	1.6	Sample 2.
118.5	136.1	Claystone, numerous bands and streaks of coal.	17.6	10.7	Bedding angles range from 15° to 18°
136.1	146.1	Sandy claystone which grades to a medium- to fine-grained poorly cemented sandstone.	10.0	7.6	
146.1	156.1	Medium- to fine-grained, soft incompetent sandstone--some clayey binder.	10.0	.6	
156.1	[1]236.7	Medium- to fine-grained, soft poorly cemented sandstone containing occasional to numerous siliceous pebbles.	80.6	1.6	Core recovered consists entirely of the siliceous pebbles and cobbles.

[1] Bottom.

Hole 2

Location: 19,684.6 N; 20,246.2 E.

Elevation: Collar of hole: 488.7 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 20-26, 1959.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	36.1	Unconsolidated soil and clayey overburden, occasional pebbles.	36.1	0.0	
36.1	41.5	Sandy claystone, soft, gray...	5.4	4.7	
41.5	51.5	Sandy claystone, numerous hard igneous pebbles in upper portion (possibly cave).	10.0	3.0	
51.5	71.2	Sandy claystone, soft, gray...	19.7	8.7	Average bedding angle 15°.
71.2	72.0	Fine- to medium-grained sandstone, fairly hard and dense.	.8	.8	
72.0	93.0	Sandy claystone.....	21.0	14.0	Average bedding angle 10° to 15°.
93.0	93.3	Fine- to medium-grained sandstone, light-gray to white, fairly hard and dense.	.3	.3	
93.3	101.5	Sandy claystone.....	8.2	1.4	
101.5	111.7	Sandy claystone, banded, soft.	10.2	8.7	Average bedding angle 7° to 15°.
111.7	116.7	Sandy claystone, banded, soft, some crossbedding.	5.0	5.0	Average bedding angle 5° to 10°.
116.7	117.7	Fine- to medium grained sandstone, banded, light-gray to white.	1.0	1.0	Bedding angle 10°.
117.7	147.4	Sandy claystone, banded, soft.	29.7	26.5	Average bedding angle 0° to 12°.
147.4	147.9	Medium- to fine-grained sandstone, light-gray to white.	.5	.5	
147.9	163.0	Sandy claystone, banded, soft, 1/8-inch band of coal at 161.0 feet.	15.1	12.8	Average bedding angle 5° to 13°.
163.0	167.2	Sandy claystone, banded, soft, occasional thin coal bands.	4.2	4.2	

Hole 2 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
167.2	171.1	Claystone with numerous streaks and bands of coal.	3.9	3.9	
171.1	171.15	Coal, bright band. Top of seam.	.05	.05	Sample 3.
171.15	171.4	Coal, dull, with numerous thin streaks and seams of clay.	.25	.25	Do.
171.4	183.7	Coal, dull.....	12.3	12.3	Sample 3.
183.7	184.1	Bony coal.....	.4	.4	Rejected.
184.1	198.6	Coal, dull.....	14.5	13.6	Sample 3; at 194.8 feet, a 1/4-inch stringer of bony coal--rejected; at 198.3 feet, a small resin marker (?).
198.6	198.9	Claystone with numerous streaks and bands of coal.	.3	.3	Rejected.
198.9	201.5	Coal, dull.....	2.6	2.6	Sample 3.
201.5	201.9	Claystone with bands, streaks, and inclusions of coal.	.4	.4	Rejected.
201.9	202.1	Bony coal.....	.2	.2	Do.
202.1	205.3	Coal, dull.....	3.2	3.2	Sample 3.
205.3	205.5	Bony coal.....	.2	.2	Rejected.
205.5	208.3	Coal, dull.....	2.8	2.8	Sample 3.
208.3	208.4	Bony coal.....	.1	.1	Rejected.
208.4	211.5	Coal, dull.....	3.1	3.0	Sample 3.
211.5	211.6	Bony coal.....	.1	.1	Rejected.
211.6	213.4	Coal, dull.....	1.8	1.8	Sample 3.
213.4	213.8	Bony coal with occasional thin clay seams.	.4	.4	Rejected.
213.8	214.3	Coal, dull, with occasional thin clay seams.	.5	.5	Sample 4.
214.3	214.9	Coaly claystone, occasional thin bands of bright coal.	.6	.6	Rejected.
214.9	215.2	Coal, dull, with occasional thin clay seams.	.3	.3	Sample 4.
215.2	215.3	Coaly claystone, occasional bands of bright coal and minute inclusions of dull coal.	.1	.1	Rejected.

Hole 2 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
215.3	215.5	Coal, dull, with occasional clay seams.	0.2	0.2	Sample 4.
215.5	216.8	Claystone with numerous bands, streaks, and inclusions of coal.	1.3	1.3	Rejected.
216.8	217.6	Coal, dull.....	.8	.8	Sample 4.
217.6	217.8	Claystone containing only occasional small inclusions of coal.	.2	.2	Rejected.
217.8	217.9	Bony coal.....	.1	.1	Do.
217.9	218.5	Coal, dull, occasional very thin clay seams.	.6	.6	Sample 4.
218.5	218.8	Claystone with bands, streaks, and inclusions of coal.	.3	.3	Rejected.
218.8	219.4	Coal, dull, with numerous thin clay seams.	.6	.6	Sample 4.
219.4	219.6	Claystone with streaks, bands, and inclusions of coal.	.2	.2	Rejected.
219.6	220.3	Coal with numerous small clay seams.	.7	.7	Sample 4.
220.3	220.6	Claystone with occasional small coal bands, streaks, and inclusions.	.3	.3	Rejected.
220.6	220.8	Claystone with numerous streaks, bands and inclusions of coal.	.2	.2	Do.
220.8	221.4	Coal, dull, with numerous minute clay seams.	.6	.6	Sample 4.
221.4	221.7	Claystone with numerous streaks, bands, and inclusions of coal.	.3	.3	Rejected.
221.7	223.0	Coal, dull, numerous small clay seams.	1.3	1.3	Sample 4.
223.0	224.1	Claystone with numerous bands, streaks, and inclusions of coal.	1.1	1.1	Rejected.
224.1	224.8	Coal, dull, numerous minute clay seams.	.7	.7	Sample 4.
224.8	225.0	Claystone with streaks and inclusions of coal.	.2	.2	Rejected.
225.0	225.6	Coal, dull, numerous minute clay seams. Bottom of seam.	.6	.6	Do.
225.6	232.8	Claystone, numerous streaks and bands of coal.	7.2	7.2	Average bedding angle 5° to 15°.

Hole 2 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
232.8	239.7	Sandy claystone, soft, gray, no banding.	6.9	6.9	
239.7	[1]251.5	Medium-grained sandstone, soft, incompetent, poorly cemented; some clayey binder in upper 2 feet.	11.8	3.6	Few coal streaks in small amount of core recovered between 241.0 and 251.5 feet.

[1] Bottom.

Hole 3

Location: 19,937.1 N; 19,663.9 E.

Elevation: Collar of hole: 443.8 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 27-September 2, 1959.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	30.0	Unconsolidated soil and clayey overburden, occasional pebbles.	30.0	0.0	
30.0	42.3	Sandy claystone, soft, gray, banded.	12.3	9.8	Average bedding angle 15°.
42.3	42.8	Medium- to fine-grained sandstone, fairly hard and dense, light-gray to white.	.5	.5	
42.8	56.5	Sandy claystone, soft, gray, banded.	13.7	2.8	
56.5	66.5	Sandy claystone, soft, gray...	10.0	9.8	Average bedding angle 10°.
66.5	82.3	Sandy claystone, soft, gray, banded.	15.8	15.7	Average bedding angle 0° to 10°.
82.3	84.3	Claystone, numerous streaks and bands of coal.	2.0	2.0	
84.3	84.9	Fine-grained sandstone, hard and dense, light-gray to white.	.6	.6	
84.9	88.4	Claystone, numerous bands and streaks of coal.	3.5	3.4	Average bedding angle 0° to 5°.
88.4	98.4	Coal, dull. Top of seam	10.0	10.0	Sample 5.
98.4	101.9	Coal, dull.....	3.5	3.5	Sample 6.
101.9	102.3	Bony coal.....	.4	.4	Sample 7 (ordinarily rejected).
102.3	110.6	Coal, dull.....	8.3	8.3	Sample 8.
110.6	110.8	Bony coal with thin claystone streaks.	.2	.2	Rejected.
110.8	110.9	Coal, dull.....	.1	.1	Sample 8.
110.9	111.2	Coaly claystone.....	.3	.3	Rejected.
111.2	112.3	Coal, dull.....	1.1	1.1	Sample 8.
112.3	112.6	Do.....	.3	.3	Sample 9.
112.6	112.7	Bony coal.....	.1	.1	Rejected.
112.7	115.8	Coal, dull.....	3.1	3.1	Sample 9.
115.8	116.1	Bony coal.....	.3	.3	Rejected.

Hole 3 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
116.1	122.3	Coal, dull, occasional thin clay seams.	6.2	6.2	Sample 9.
122.3	124.2	Coal, dull.....	1.9	1.9	Sample 10.
124.2	124.4	Bony coal.....	.2	.2	Rejected.
124.4	124.7	Coal, dull.....	.3	.3	Sample 10.
124.7	124.8	Bony coal.....	.1	.1	Rejected.
124.8	127.4	Coal, dull, occasional thin clay seams.	2.6	2.6	Sample 10.
127.4	127.5	Claystone with coal streaks and inclusions.	.1	.1	Rejected.
127.5	127.8	Coal, dull.....	.3	.3	Sample 10.
127.8	128.2	Banded coal and claystone.....	.4	.4	Rejected.
128.2	128.4	Coal, dull.....	.2	.2	Sample 10.
128.4	129.0	Banded coal and claystone.....	.6	.6	Rejected.
129.0	129.3	Coal, dull.....	.3	.3	Sample 10.
129.3	130.8	Claystone with bands, streaks, and inclusions of coal.	1.5	1.5	Rejected.
130.8	132.3	Coal, dull, occasional thin claystone bands.	1.5	1.5	Sample 10.
132.3	132.7	Bony coal.....	.4	.4	Rejected.
132.7	133.6	Coal, dull.....	.9	.9	Sample 11.
133.6	133.7	Claystone with coal streaks and inclusions.	.1	.1	Rejected.
133.7	133.9	Coal, dull.....	.2	.2	Sample 11.
133.9	134.4	Banded coal and claystone.....	.5	.5	Rejected.
134.4	134.7	Coal, dull.....	.3	.3	Sample 11.
134.7	136.1	Dark claystone with numerous streaks, bands, and inclusions of coal.	1.4	1.4	Rejected.
136.1	137.3	Coal, dull.....	1.2	1.2	Sample 11.
137.3	139.7	Banded coal and claystone.....	2.4	2.4	Rejected.
139.7	141.5	Coal, dull. Bottom of seam...	1.8	1.8	Sample 11.
141.5	142.4	Banded coal and claystone.....	.9	.9	
142.4	149.1	Claystone, numerous streaks and bands of coal.	6.7	6.7	Average bedding angle 0° to 5°.
149.1	[1]155.0	Claystone to sandy claystone, soft, no banding.	5.9	5.9	

[1] Bottom.

Hole 4

Location: 20,358.1 N; 22,705.2 E.

Elevation: Collar of hole: 435.7 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 10-14, 1959.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	76.0	Unconsolidated soil and clayey overburden, occasional to numerous pebbles (mostly igneous).	76.0	0.0	
76.0	91.3	Sandy claystone, numerous coal streaks and inclusions in upper 1 foot, 0.1-foot medium-grained sandstone band at 81.8 feet.	15.3	13.2	
91.3	93.5	Very fine-grained sandstone (hard and dense).	2.2	2.2	
93.5	96.0	Sandy claystone.....	2.5	0.0	
96.0	106.0	Clayey sandstone, soft, poorly compacted.	10.0	3.7	Bedding angles 20° to 26°.
106.0	107.0	Medium-grained, arkosic poorly cemented sandstone.	1.0	1.0	
107.0	108.2	Medium-grained, arkosic sandstone, hard and dense.	1.2	1.2	
108.2	116.1	Medium-grained, arkosic sandstone, soft, poorly cemented.	7.9	0.0	
116.1	131.0	Medium-grained, arkosic sandstone, contains occasional well-rounded pebbles; 3.2 feet of hard, dense, arkosic sandstone, well compacted.	14.9	3.9	
131.0	145.1	Medium-grained, arkosic sandstone.	14.1	.5	
145.1	151.5	Dark-gray sandy claystone with only occasional coal streaks.	6.4	5.6	Bedding angles 10° to 15°.
151.5	[1]161.5	Sandy claystone to claystone, occasional coal streaks.	10.0	7.7	Bedding angles 20° to 25°.

[1] Bottom.

Hole 5

Location: 19,829.5 N; 22,430.6 E.

Elevation: Collar of hole: 445.4 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 16-22, 1959.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	27.0	Unconsolidated soil and clayey overburden, occasional to numerous pebbles and cobbles; pebbles and cobbles consisted of both igneous and sedimentary rocks, including coal.	27.0	0.0	
27.0	57.0	Medium-grained sandstone, arkosic, pebbles to 1/2-inch (both coarse and rounded). Recovered sandstone is hard and dense. Unrecovered portion is soft and poorly cemented (from drilling characteristic). Clay seam noted on 1 fracture at 28.0 feet. A few highly siliceous pebbles recovered between 37 and 57 feet.	30.0	4.9	
57.0	67.0	Sandy claystone, occasional coal streaks and inclusions.	10.0	6.0	Bedding angles 20° to 25°.
67.0	76.3	Sandy claystone, numerous streaks, bands, and inclusions of coal (bands to 1/4-inch near base of run).	9.3	9.3	Bedding angles 25° to 30°.
76.3	86.5	Sandy claystone grading to dark-gray claystone, numerous streaks, bands, and inclusions of coal (bands to 1/2-inch), chert inclusion at 77.7 feet, very fine-grained, hard dense sandstone band at 79.4 feet.	10.2	10.1	Bedding angles 20° to 35°.
86.5	94.7	Claystone, numerous streaks, bands, and inclusions of coal (bands to 1/2-inch), fine-grained sandstone band at 94 feet.	8.2	8.2	

Hole 5 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
94.7	95.0	Claystone, numerous coal streaks.	0.3	0.3	
95.0	95.2	Coal, dull, with occasional thin clay seams. Top of seam.	.2	.2	Sample 12.
95.2	95.5	Claystone with numerous coal streaks and inclusions.	.3	.3	Rejected.
95.5	99.2	Coal, dull.....	3.7	3.7	Sample 12.
99.2	101.1	Bony coal.....	1.9	1.9	Rejected.
101.1	102.6	Coal, dull.....	1.5	1.5	Sample 12.
102.6	102.7	Bony coal.....	.1	.1	Rejected.
102.7	103.5	Coal, dull.....	.8	.8	Sample 12.
103.5	104.0	Claystone with bands and streaks of coal.	.5	.5	Rejected.
104.0	104.2	Bony coal.....	.2	.2	Do.
104.2	104.5	Coal, dull.....	.3	.3	Sample 12.
104.5	104.8	Bony coal.....	.3	.3	Rejected.
104.8	105.5	Coal, dull, thin bands of clay.	.7	.7	Sample 12.
105.5	105.6	Bony coal.....	.1	.1	Rejected
105.6	106.0	Coal, dull, thin bands of clay.	.4	.4	Sample 12.
106.0	106.7	Bony coal.....	.7	.7	Rejected.
106.7	107.1	Claystone with thin streaks and inclusions of coal.	.4	.4	Do.
107.1	107.7	Coal, dull, with thin clay seams.	.6	.6	Sample 13.
107.7	111.0	Claystone with thick bands, seams, and inclusions of coal, core banded in appearance.	3.3	3.3	Rejected.
111.0	111.1	Coal, dull.....	.1	.1	Sample 13.
111.1	114.2	Claystone with thick bands, seams, and inclusions of coal.	3.1	3.1	Rejected.
114.2	115.5	Coal, dull, with occasional minute clay seams.	1.3	1.3	Sample 13.
115.5	116.9	Claystone with 1/4-inch bands, seams, and inclusions of coal.	1.4	1.4	Rejected.
116.9	117.0	Coal, bright, band.....	.1	.1	Sample 13.
117.0	118.4	Claystone with numerous thick bands and inclusions of coal.	1.4	1.4	Rejected.
118.4	119.7	Coal, bright, conchoidal.....	1.3	1.3	Sample 13.

Hole 5 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
119.7	121.2	Coal, dull, occasional bands and streaks of clay.	1.5	1.5	Sample 13.
121.2	121.7	Claystone with bands and streaks of coal.	.5	.5	Rejected.
121.7	122.8	Coal, dull, with bands of clay. Bottom of seam.	1.1	1.1	Sample 13.
122.8	123.7	Claystone with numerous bands, streaks, and inclusions of coal.	.9	.9	Rejected.
123.7	128.0	Very slightly sandy claystone to claystone with numerous streaks, bands, and inclusions of coal.	4.3	4.3	Average bedding angle 25°.
128.0	130.0	Claystone with bands, streaks, and inclusions of coal.	2.0	1.2	
130.0	130.8	Sandy claystone to sandstone..	.8	.8	No banding.
130.8	131.6	Fine- to medium-grained sandstone, faint banding, hard, dense, competent.	.8	.8	
131.6	139.5	Medium- to fine-grained sandstone, incompetent and poorly cemented (locally, narrow somewhat clayey stringers); 0.3 foot of coal bands at 137.5 feet.	7.9	7.6	Faint banding; coaly stringers; bedding angles 28° to 30°.
139.5	152.0	Medium-grained, well-compacted dense sandstone grading to incompetent sandstone.	12.5	1.6	No banding.
152.0	[1]186.5	Medium- to fine-grained sandstone, soft, incompetent, with occasional coaly bands or streaks.	34.5	.0	

[1] Bottom.

Hole 6

Location: 19,639.7 N; 21,263.3 E.

Elevation: Collar of hole: 471.8 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 23-26, 1959.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	7.0	Soil and clayey overburden, occasional large cobbles.	7.0	0.0	
7.0	10.0	Drill cuttings indicate coal..	3.0	0.0	
10.0	12.0	Coal, dull, badly fractured...	2.0	1.5	
12.0	14.1	Coal, dull, 2 quartz pebbles (rejected).	2.1	1.8	Sample 14; poorly consolidated and/or coal float.
14.1	18.0	Drill cuttings indicate coal.	3.9	None	
18.0	22.5	Coal, dull, occasional bright stringers.	4.5	2.7	
22.5	23.1	Coal, dull.....	.6	.6	Sample 15.
23.1	24.6	Coal, clayey in appearance, soft; assume fractured zone.	1.5	1.3	Do.
24.6	35.1	Coal, dull, at 26.9 feet, a 1/16-inch clay seam; at 27.8 feet, a 0.1-foot high-ash seam.	10.5	10.4	Do.
35.1	35.2	Coaly claystone.....	.1	.1	Rejected.
35.2	36.9	Coal, dull.....	1.7	1.7	Sample 15.
36.9	36.95	Bony coal.....	.05	.05	Rejected.
36.95	42.1	Coal, dull.....	5.15	3.9	Sample 15; 1/4-inch bony coal at 38.7 feet--rejected.
42.1	42.5	Coaly claystone.....	.4	.4	Rejected.
42.5	49.2	Coal, dull, occasional to numerous 1/8+ inch stringers of bright coal, badly fractured.	6.7	5.3	Sample 15.
49.2	49.8	Coal, alternating dull and bright.	.6	.6	Do.
49.8	50.1	Bony coal.....	.3	.3	Rejected.
50.1	51.8	Coal, dull, badly fractured...	1.7	1.7	Sample 16.
51.8	52.3	Coal, dull, occasional thin clay seams.	.5	.5	Do.
52.3	52.8	Coal, dull.....	.5	.5	Do.
52.8	53.5	Coal, dull, occasional thin clay seams.	.7	.7	Do.

Hole 6 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
53.5	53.6	Claystone with coal streaks and inclusions.	0.1	0.1	Rejected.
53.6	56.0	Coal, dull, soft, high-ash....	2.4	2.4	Sample 16.
56.0	56.1	Claystone with coal streaks and inclusions.	.1	.1	Rejected.
56.1	56.5	Coal, dull.....	.4	.4	Sample 16.
56.5	57.6	Claystone with coal bands, streaks, and inclusions.	1.1	.9	Rejected.
57.6	58.6	Coal, dull.....	1.0	1.0	Sample 16.
58.6	59.3	Claystone with coal bands, streaks, and inclusions.	.7	.7	Rejected.
59.3	60.4	Coal, dull.....	1.1	1.1	Sample 16.
60.4	60.5	Claystone with bands and streaks of coal.	.1	.1	Rejected.
60.5	61.5	Coal, dull, at 60.9 feet, a thin 1/32-inch resin stringer.	1.0	1.0	Sample 16.
61.5	61.6	Claystone with bands and streaks of coal.	.1	.1	Rejected.
61.6	62.2	Coal, dull.....	.6	.6	Sample 16.
62.2	62.7	Claystone with bands and streaks of coal.	.5	.5	Rejected.
62.7	63.7	Coal, dull, with thin bands and streaks of clay.	1.0	1.0	Sample 16.
63.7	65.0	Claystone with bands, streaks, and inclusions of coal.	1.3	1.0	Rejected.
65.0	66.8	Coal, dull. Bottom of coal...	1.8	1.8	Sample 16.
66.8	67.0	Bony coal.....	.2	.2	Rejected.
67.0	71.3	Banded coal and claystone.....	4.3	4.3	Do.
71.3	73.3	Claystone with numerous bands and streaks of coal.	2.0	1.8	Bedding angles 28° to 32°.
73.3	79.9	Claystone to slightly sandy claystone with numerous bands, streaks, and inclusions of coal.	6.6	6.6	Coal bands to 0.2-foot thickness; bedding angles 28° to 30°.
79.9	83.3	Slightly sandy claystone to sandy claystone to clayey sandstone.	3.4	3.4	
83.3	91.9	Clayey sandstone to medium-grained, poorly cemented incompetent sandstone.	8.6	8.6	
91.9	[1]93.3	Medium-grained, poorly cemented incompetent sandstone.	1.4	.0	

[1] Bottom.

Hole 7

Location: 19,074.3 N; 22,293.8 E.

Elevation: Collar of hole: 475.9 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 3-4, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	17.0	Soil and clayey overburden, occasional hard igneous pebbles and cobbles.	17.0	0.0	
17.0	19.9	Coal, dull, occasional thin bone partings.	2.9	2.9	Sample 17; bedding angle 25° to 30°.
19.9	20.1	Bony coal.....	.2	.2	Rejected.
20.1	20.6	Coal, dull.....	.5	.5	Sample 17.
20.6	20.8	Bony coal.....	.2	.2	Rejected.
20.8	21.4	Coal, dull.....	.6	.6	Sample 17.
21.4	22.0	Banded coal and claystone.....	.6	.6	Bedding angle 25°--rejected.
22.0	23.0	Bony coal.....	1.0	1.0	Rejected.
23.0	25.6	Coal, dull, occasional very thin bony coal partings.	2.6	2.6	Sample 17.
25.6	25.7	Bony coal.....	.1	.1	Rejected.
25.7	31.5	Coal, dull, occasional thin bony coal partings.	5.8	5.8	Sample 17.
31.5	31.7	Coaly claystone.....	.2	.2	Rejected.
31.7	31.9	Coal, dull.....	.2	.2	Sample 17.
31.9	32.1	Bony coal.....	.2	.2	Rejected.
32.1	33.4	Coal, dull, occasional thin bony coal partings. Bottom of seam.	1.3	1.3	Sample 17.
33.4	38.7	Banded coal and claystone.....	5.3	5.3	Rejected.
38.7	40.9	Silty claystone, numerous streaks, bands, and inclu- of coal.	2.2	2.2	
40.9	56.8	Silty to sandy claystone.....	15.9	14.9	
56.8	66.8	Silty to sandy claystone, grades to a medium-grained incompetent sandstone near bottom.	10.0	8.9	Bedding angle 20° to 30°.
66.8	74.0	Sandstone, incompetent, medium-grained, occasional to numerous hard siliceous pebbles (largely determined from sludge); a few silty to sandy claystone pieces recovered but may be cave from above.	7.2	.3	

Hole 7 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
74.0	[1]82.0	Incompetent sandstone, medium-grained, occasional to numerous hard pebbles.	8.0	0.0	

[1] Bottom.

Hole 8

Location: 18,569.3 N; 22,166.6 E.

Elevation: Collar of hole: 461.6 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 6-9, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	30.0	Soil and clayey overburden, occasional to numerous pebbles and cobbles, collared on muskeg.	30.0	0.0	
30.0	[1]196.0	Medium-grained, soft incompetent sandstone, black and white components believed to be principally granite debris; occasional to numerous pebbles and cobbles, believed to be material underlying discovery seam.	166.0	.0	

[1] Bottom. Pan-concentrated sand cuttings.

Hole 9

Location: 19,092.7 N; 21,640.7 E.

Elevation: Collar of hole: 466.5 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 11-21, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	20.0	Soil and clayey overburden, occasional to numerous pebbles and cobbles, muskeg collar.	20.0	0.0	
20.0	40.9	Silty to sandy claystone.....	20.9	2.6	1 siliceous igneous cobble cored--possibly cave from above.
40.9	45.2	Silty to sandy claystone, occasional igneous pebbles included.	4.3	4.2	
45.2	49.0	Silty to sandy claystone.....	3.8	2.8	Bedding angle 65° to 75°.
49.0	53.4	Silty to sandy claystone, included igneous pebbles and cobbles.	4.4	.5	Only about 0.5 foot of pebbles and cobbles recovered.
53.4	55.0	..... Do.....	1.6	.9	Only about 0.9 foot of pebbles and cobbles recovered.
55.0	56.0	Sandy to silty claystone with numerous included igneous pebbles and cobbles; pebbles and cobbles apparently occur in bands.	1.0	1.0	
56.0	60.0	Silty to sandy claystone.....	4.0	1.3	
60.0	66.6	Silty to sandy claystone, occasionally included igneous pebbles.	6.6	5.6	
66.6	78.2	Silty to sandy claystone.....	11.6	10.8	Bedding angle 25° to 45°.
78.2	80.8	Fine-grained sandstone, fairly hard and dense.	2.6	2.6	Bedding angle 40°.
80.8	93.9	Silty to sandy claystone, some banded, slightly carbonaceous.	13.1	11.6	Bedding angle 30° to 35°.

Hole 9 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
93.9	114.0	Silty to sandy claystone, some banded, slightly carbonaceous.	20.1	19.1	Bedding angle 15° to 25°.
114.0	124.0	Silty claystone, occasional coal bands, streaks, and inclusions in lower 3.1 feet.	10.0	9.9	Bedding angle 15° to 20°.
124.0	138.2	Coal, dull, occasional thin bone coal partings.	14.2	14.2	Sample 18.
138.2	138.6	Bony coal, parting.....	.4	.4	Rejected.
138.6	148.5	Coal, dull, occasional thin bone coal partings.	9.9	9.9	Sample 18.
148.5	148.8	Bony coal.....	.3	.3	Rejected.
148.8	153.5	Coal, dull, occasional thin bone coal partings.	4.7	4.7	Sample 18
153.5	153.8	Bony coal.....	.3	.3	Rejected.
153.8	161.9	Coal, dull, occasional thin bone coal partings.	8.1	8.1	Sample 18.
161.9	162.05	Bony coal.....	.15	.15	Rejected.
162.05	167.6	Coal, dull, occasional thin bone coal partings.	5.55	5.55	End sample 18.
167.6	168.1	Bony coal.....	.5	.5	Rejected.
168.1	168.3	Coal, dull, occasional thin bone coal partings.	.2	.2	Sample 19.
168.3	168.6	Bony coal.....	.3	.3	Rejected.
168.6	169.3	Coal, dull, occasional thin bone coal partings.	.7	.7	Sample 19.
169.3	169.9	Banded coal and claystone.....	.6	.6	Bedding angle 15°--rejected.
169.9	172.2	Coal, dull, occasional thin bone coal partings.	2.3	2.3	Sample 19.
172.2	172.5	Bony coal.....	.3	.3	Rejected.
172.5	174.4	Coal, dull, occasional thin bone coal partings.	1.9	1.9	Sample 19.
174.4	174.7	Bony coal.....	.3	.3	Rejected.
174.7	177.7	Coal, dull, occasional thin bone coal partings.	3.0	3.0	Sample 19.
177.7	178.0	Bony coal.....	.3	.3	Rejected.
178.0	180.0	Coal, dull, occasional thin bone coal partings.	2.0	2.0	Sample 19.
180.0	180.3	Bony coal.....	.3	.3	Rejected.
180.3	180.6	Coal, dull.....	.3	.3	Sample 19.
180.6	180.9	Bony coal.....	.3	.3	Rejected.
180.9	181.1	Coal, dull.....	.2	.2	Sample 19.
181.1	181.4	Bony coal.....	.3	.3	Rejected.

Hole 9 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery feet	Remarks
181.4	182.9	Coal, dull, occasional thin bone coal partings.	1.5	1.5	Sample 19.
182.9	183.6	Bony coal.....	.7	.7	Rejected.
183.6	186.7	Banded coal and claystone.....	3.1	3.1	Do.
186.7	187.0	Coal, dull.....	.3	.3	Sample 19.
187.0	187.1	Bony coal.....	.1	.1	Rejected.
187.1	188.0	Coal, dull.....	.9	.9	End sample 19.
188.0	188.6	Banded coal and claystone.....	.6	.6	Rejected.
188.6	189.1	Claystone with bands, streaks, and inclusions of coal.	.5	.5	
189.1	197.0	Silty to sandy claystone, occasional coal inclusions.	7.9	6.0	
197.0	[1]216.0	Silty to sandy claystone, some banded, slightly carbonaceous.	19.0	17.1	Bedding angle 15° to 30°.

[1] Bottom.

Hole 10

Location: 18,289.5 N; 21,424.8 E.

Elevation: Collar of hole: 463.2 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 22-27, 1960.

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery feet	Remarks
0.0	30.0	Soil and clayey overburden, occasional to numerous pebbles and cobbles.	30.0	0.0	
30.0	[1]170.0	Medium-grained, soft incompetent sandstone, black and white components believed to be principally granite debris; occasional to numerous pebbles and cobbles, believed to be material underlying discovery seam. Some clay binder but not enough to render coring possible.	140.0	.0	

[1] Bottom. Pan-concentrated sand cuttings.

Hole 11

Location: 19,106.5 N; 22,634.2 E.

Elevation: Collar of hole: 471.6 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 30-July 8, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	40.0	Soil and clayey overburden, occasional to numerous pebbles and cobbles.	40.0	0.0	
40.0	49.1	Incompetent sandstone, medium-grained, probably derived from granite, occasional to numerous hard igneous pebbles and cobbles.	9.1	0.0	
49.1	53.5	Medium-grained sandstone, occasional igneous pebble inclusions, hard and dense.	4.4	4.4	Bedding angle 25°.
53.5	189.5	Medium-grained, soft incompetent sandstone, clayey matrix, contains occasional to numerous hard igneous pebbles and cobbles.	136.0	1.6	
189.5	191.0	Silty to sandy claystone.....	1.5	.3	
191.0	196.8	Silty to sandy claystone, occasional coal bands and inclusions.	5.8	4.1	Bedding angle 15°.
196.8	197.8	Claystone, numerous streaks, bands, and inclusions of coal.	1.0	1.0	
197.8	198.2	Banded coal and claystone.....	.4	.4	Rejected.
198.2	198.7	Bony coal.....	.5	.5	Do.
198.7	199.6	Coal, dull.....	.9	.9	Sample 20.
199.6	199.8	Banded coal and claystone.....	.2	.2	Rejected.
199.8	205.5	Coal, dull, occasional thin bone partings.	5.7	5.7	Sample 20.
205.5	205.7	Bony coal.....	.2	.2	Rejected.
205.7	206.0	Coal, dull.....	.3	.3	Sample 20.
206.0	206.4	Bony coal.....	.4	.4	Rejected.
206.4	206.9	Coal, dull.....	.5	.5	Sample 20.
206.9	207.1	Bony coal.....	.2	.2	Rejected.
207.1	207.4	Coal, dull.....	.3	.3	Sample 20.
207.4	210.2	Banded coal and claystone.....	2.8	2.8	Rejected.
210.2	211.8	Coal, dull, occasional thin bone partings.	1.6	1.6	Sample 20.

Hole 11 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery feet	Remarks
211.8	212.4	Bony coal.....	0.6	0.6	Rejected.
212.4	217.4	Coal, dull, occasional thin bone partings.	5.0	5.0	Sample 20.
217.4	217.7	Banded coal and claystone.....	.3	.3	Rejected.
217.7	220.0	Coal, dull, occasional thin bone partings.	2.3	2.3	Sample 20.
220.0	220.6	Banded coal and claystone.....	.6	.6	Rejected.
220.6	220.9	Coal, dull, occasional thin bone partings.	.3	.3	Sample 20.
220.9	221.2	Bony coal.....	.3	.3	Rejected.
221.2	221.8	Coal, dull, occasional thin bone partings.	.6	.6	Sample 20.
221.8	221.9	Bony coal.....	.1	.1	Rejected.
221.9	222.0	Coal, dull, occasional thin bone partings.	.1	.1	Sample 20.
222.0	222.1	Bony coal.....	.1	.1	Rejected.
222.1	222.4	Coal, dull, occasional thin bone partings.	.3	.3	Sample 20.
222.4	222.6	Bony coal.....	.2	.2	Rejected.
222.6	223.4	Coal, dull, occasional thin bone partings.	.8	.8	Sample 20.
223.4	224.2	Bony coal.....	.8	.8	Rejected.
224.2	227.9	Coal, dull, occasional thin bone partings.	3.7	3.7	Sample 20.
227.9	228.7	Bony coal.....	.8	.8	Rejected.
228.7	231.9	Coal, dull, occasional thin bone partings.	3.2	3.2	Sample 20.
231.9	232.4	Claystone with streaks of coal on ends.	.5	.5	Rejected.
232.4	232.8	Coal, dull.....	.4	.4	Sample 20.
232.8	233.3	Claystone with streaks and bands of coal.	.5	.5	Rejected.
233.3	233.7	Bony coal.....	.4	.4	Do.
233.7	233.8	Coal, dull.....	.1	.1	Sample 20.
233.8	234.1	Bony coal.....	.3	.3	Rejected.
234.1	234.6	Coal, dull.....	.5	.5	Sample 20.
234.6	234.8	Claystone with streaks of coal.	.2	.2	Rejected.
234.8	240.5	Coal, dull, occasional thin bone partings (3.8-foot core loss--assumed to be coal).	5.7	1.9	Sample 20.
240.5	240.6	Bony coal.....	.1	.1	Rejected.
240.6	241.6	Coal, dull, occasional thin bone partings.	1.0	1.0	Sample 20.

Hole 11 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
241.6	241.9	Fine-grained sandstone with coal streaks and inclusions.	0.3	0.3	Rejected.
241.9	250.2	Silty to sandy claystone, occasional streaks, bands, and inclusions of coal.	8.3	8.3	Bedding angle 15°.
250.2	[1]259.4	Silty to sandy claystone, a few carbonaceous streaks.	9.2	8.0	Bedding angle 10° to 20°.

[1] Bottom.

Hole 12

Location: 18,859.3 N; 22,246.0 E.

Elevation: Collar of hole: 467.6 feet, mean sea level datum.

Dip of hole: Vertical.. Dates drilled: July 11-14, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	12.0	Soil and clayey overburden, coal float, occasional to numerous hard igneous pebbles and cobbles, muskeg collar.	12.0	0.0	
12.0	24.0	Coal, dull, occasional thin bone partings.	12.0	12.0	Sample 21.
24.0	24.1	Bony coal.....	.1	.1	Rejected.
24.1	29.9	Coal, dull, occasional thin bone partings.	5.8	5.8	Sample 21.
29.9	30.2	Bony coal.....	.3	.3	Rejected.
30.2	30.3	Coal, dull.....	.1	.1	Sample 21.
30.3	30.5	Bony coal.....	.2	.2	Rejected.
30.5	30.7	Coal, dull.....	.2	.2	Sample 21.
30.7	30.8	Bony coal.....	.1	.1	Rejected.
30.8	31.4	Coal, dull.....	.6	.6	Sample 21.
31.4	31.7	Bony coal.....	.3	.3	Rejected.
31.7	32.7	Coal, dull, occasional thin bone partings.	1.0	1.0	Sample 21.
32.7	34.1	Banded coal and claystone.....	1.4	1.4	Rejected.
34.1	35.6	Coal, dull.....	1.5	1.5	Sample 21.
35.6	36.5	Bony coal.....	.9	.9	Rejected.
36.5	37.5	Coal, dull, occasional thin bone partings.	1.0	1.0	Sample 21.
37.5	37.8	Coaly claystone.....	.3	.3	Rejected.
37.8	38.4	Coal, dull.....	.6	.6	Sample 21.
38.4	38.6	Bony coal.....	.2	.2	Rejected.
38.6	41.4	Coal, dull, occasional thin bone partings.	2.8	2.8	Sample 21.
41.4	42.1	Bony coal.....	.7	.7	Rejected.
42.1	44.0	Coal, dull, occasional thin bone partings.	1.9	1.9	Sample 21.
44.0	44.6	Bony coal.....	.6	.6	Rejected.
44.6	47.9	Claystone with numerous streaks and bands of coal.	3.3	3.3	Bedding angle 20°--rejected.
47.9	48.2	Coal, dull, occasional thin bone partings.	.3	.3	Sample 21.
48.2	48.3	Bone.....	.1	.1	Rejected.

Hole 12 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
48.3	48.9	Coal, dull, occasional thin bone partings.	0.6	0.6	Sample 21.
48.9	49.1	Claystone with streaks and inclusions of coal.	.2	.2	Rejected.
49.1	52.0	Coal, dull, occasional thin bone partings (1.2-foot core loss-- assumed to be coal).	2.9	1.7	Sample 21.
52.0	52.7	Bone (0.3-foot core loss).....	.7	.4	Rejected.
52.7	53.1	Claystone with bands, streaks, and inclusions of coal.	.4	.4	Do.
53.1	53.3	Coal, dull.....	.2	.2	End sample 21.
53.3	59.0	Claystone with bands, streaks, and inclusions of coal.	5.7	5.7	Rejected.
59.0	59.3	Coal, dull.....	.3	.3	Not sampled.
59.3	59.6	Claystone with bands, streaks and inclusions of coal.	.3	.3	Rejected.
59.6	59.8	Coal, dull.....	.2	.2	Not sampled.
59.8	62.8	Claystone with bands, streaks, and inclusions of coal.	3.0	3.0	Rejected.
62.8	64.0	Coal, dull, with occasional thin bone partings.	1.2	1.2	Not sampled.
64.0	64.5	Bony coal.....	.5	.5	Rejected.
64.5	64.8	Claystone with streaks and bands of coal.	.3	.3	Do.
64.8	65.9	Silty to sandy claystone with occasional streaks and inclusions of coal.	1.1	1.1	
65.9	69.5	Silty to sandy claystone with occasional small coal inclusions, light-gray.	3.6	3.6	
69.5	[1]79.0	Silty to sandy claystone, occasional small coal inclusions, one 1/4-inch coal band at 77.5 feet.	9.5	8.1	Bedding angle 25°.

[1] Bottom.

Hole 13

Location: 18,609.3 N; 21,876.9 E.

Elevation: Collar of hole: 463.3 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: July 14-15, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	18.5	Soil, clay, and muskeg overburden, occasional to numerous hard igneous pebbles and cobbles, abundant coal float.	18.5	0.0	
18.5	20.2	Coal, dull.....	1.7	1.7	Sample 22.
20.2	20.7	Claystone with streaks, bands, and inclusions of coal.	.5	.5	Rejected.
20.7	24.8	Coal, dull, with occasional thin bone partings (1.3-foot core loss--assumed to be coal).	4.1	2.8	Sample 22.
24.8	25.8	Claystone with streaks, bands, and inclusions of coal.	1.0	1.0	Rejected.
25.8	27.8	Coal, dull, with occasional thin bone partings.	2.0	2.0	Sample 22.
27.8	28.4	Claystone with bands, streaks, and inclusions of coal.	.6	.6	Rejected.
28.4	28.7	Coal, dull.....	.3	.3	Sample 22.
28.7	29.3	Bony coal.....	.6	.6	Rejected.
29.3	32.1	Claystone with streaks, bands, and inclusions of coal.	2.8	2.8	Do.
32.1	32.4	Coal, dull.....	.3	.3	Sample 22.
32.4	32.8	Bone with coal streaks and and bands.	.4	.4	Rejected.
32.8	34.0	Coal, dull, occasional thin bone partings.	1.2	1.2	Sample 22.
34.0	34.4	Coaly claystone.....	.4	.4	Rejected.
34.4	34.8	Coal, dull.....	.4	.4	Sample 22.
34.8	35.7	Claystone with streaks, bands, and inclusions of coal.	.9	.9	Rejected.
35.7	45.7	Silty to sandy claystone, 1 large coal inclusion at 39.7 feet, light-gray.	10.0	10.0	
45.7	[1]55.0	Silty to sandy claystone, 3/4-inch coal band at 48.4 feet.	9.3	9.3	Bedding angles 45° to 50°.

[1] Bottom.

Hole 14

Location: 18,842.3 N; 21,065.9 E.

Elevation: Collar of hole: 464.1 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: July 16-23, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	65.0	Muskeg collar, sand, soil, clay, occasional to numerous pebbles and cobbles.	65.0	0.0	
65.0	72.3	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing iron produce a banded appearance.	7.3	6.0	Bedding angle 5°.
72.3	82.5	Same as 65.0 to 72.3 feet, hard dense sandstone inclusion at 80 feet.	10.2	8.5	Bedding angles 5° to 15°.
82.5	82.9	Medium- to fine-grained sandstone, fairly hard and dense, white to light-gray.	.4	.4	Bedding angles 5° to 10°.
82.9	111.1	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing iron produce a banded appearance.	28.2	24.2	Do.
111.1	111.4	Medium-grained sandstone.....	.3	.3	
111.4	111.5	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing iron produce a banded appearance.	.1	.1	
111.5	112.0	Fine-grained sandstone, fairly hard and dense.	.5	.5	
112.0	138.7	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing iron produce a banded appearance.	26.7	21.9	Do.
138.7	139.0	Medium- to fine-grained sandstone, fairly hard and dense, light-gray to white.	.3	.3	

Hole 14 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
139.0	149.5	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing iron produce a banded appearance.	10.5	9.8	Bedding angles 5° to 10°.
149.5	157.9	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing hematite and/or limonite produce a banded appearance.	8.4	8.4	Do.
157.9	158.6	Fine-grained sandstone, fairly hard and dense, white to light-gray.	.7	.7	
158.6	214.5	Silty to sandy claystone, carbonaceous streaks, gray; streaks and bands containing hematite and/or limonite produce a banded appearance.	55.9	48.9	Bedding angles 0° to 10°.
214.5	219.5	Sandy to silty claystone, occasional coal streaks and inclusions.	5.0	3.9	
219.5	225.9	Sandy to silty claystone, grades to numerous coal streaks, bands, and inclusions.	6.4	6.1	
225.9	228.6	Coal, dull.....	2.7	2.7	Sample 23.
228.6	228.7	Bony coal.....	.1	.1	Rejected.
228.7	236.4	Coal, dull.....	7.7	7.7	Sample 23.
236.4	236.5	Bony coal.....	.1	.1	Rejected.
236.5	236.7	Coal, dull.....	.2	.2	Sample 23.
236.7	236.8	Bony coal.....	.1	.1	Rejected.
236.8	237.2	Coal, dull, occasional thin bone partings.	.4	.4	Sample 23.
237.2	237.3	Bony coal.....	.1	.1	Rejected.
237.3	238.2	Coal, dull, occasional thin bone partings.	.9	.9	Sample 23.
238.2	238.4	Bony coal.....	.2	.2	Rejected.
238.4	246.4	Coal, dull.....	8.0	8.0	Sample 23.
246.4	246.6	Bony coal.....	.2	.2	Rejected.
246.6	251.7	Coal, dull, occasional thin bone partings.	5.1	5.1	Sample 23.
251.7	252.0	Claystone with streaks and bands of coal.	.3	.3	Rejected.

Hole 14 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
252.0	261.8	Coal, dull, occasional thin bone partings.	9.8	9.8	Sample 23, bedding angle 0° to 5°.
261.8	262.1	Bony coal.....	.3	.3	Rejected.
262.1	264.8	Coal, dull, occasional thin bone partings.	2.7	2.7	Sample 23.
264.8	264.9	Bony coal.....	.1	.1	Rejected.
264.9	265.1	Coal, dull.....	.2	.2	End sample 23.
265.1	265.5	Bony coal.....	.4	.4	Rejected.
265.5	265.8	Coal, dull, occasional thin bone partings.	.3	.3	Sample 24.
265.8	266.2	Bony coal.....	.4	.4	Rejected.
266.2	266.9	Coal, dull, occasional thin bone partings.	.7	.7	Sample 24.
266.9	267.3	Silty claystone with streaks and bands of coal.	.4	.4	Rejected.
267.3	269.7	Coal, dull, occasional thin bone partings.	2.4	2.4	Sample 24.
269.7	270.1	Claystone with streaks and bands of coal.	.4	.4	Rejected.
270.1	271.8	Coal, dull, occasional thin bone partings.	1.7	1.7	Sample 24.
271.8	271.9	Ironstone and bony coal.....	.1	.1	Rejected.
271.9	272.4	Coal, dull.....	.5	.5	Sample 24.
272.4	272.9	Bony coal.....	.5	.5	Rejected.
272.9	273.4	Coal, dull.....	.5	.5	Sample 24.
273.4	273.6	Bony coal.....	.2	.2	Rejected.
273.6	275.1	Coal, dull.....	1.5	1.5	Sample 24.
275.1	277.0	Bony coal.....	1.9	1.9	Rejected.
277.0	278.6	Coal, dull.....	1.6	1.6	Sample 24.
278.6	278.7	Bony coal.....	.1	.1	Rejected
278.7	279.0	Coal, dull.....	.3	.3	Sample 24.
279.0	279.9	Bony coal.....	.9	.9	Rejected.
279.9	283.7	Claystone with streaks, bands, and inclusions of coal.	3.8	3.8	Do.
283.7	284.0	Coal, dull.....	.3	.3	Sample 24.
284.0	284.3	Bony coal.....	.3	.3	Rejected.
284.3	285.0	Coal, dull.....	.7	.7	Sample 24.
285.0	285.3	Bony coal.....	.3	.3	Rejected.
285.3	285.4	Coal, dull.....	.1	.1	Sample 24.
285.4	285.5	Bony coal.....	.1	.1	Rejected.
285.5	286.0	Coal, dull.....	.5	.5	Sample 24.
286.0	286.4	Claystone with streaks, bands, and inclusions of coal.	.4	.4	

Hole 14 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
286.4	287.2	Sandy to silty claystone, numerous coal streaks, bands, and inclusions.	0.8	0.8	
287.2	297.2	Clayey sandstone, numerous small coal inclusions.	10.0	9.0	
297.2	[1] 306.0	Clayey sandstone, occasional small coal inclusions, coal bands and streaks from 302.7 to 303.7 feet.	8.8	8.8	Bedding angle 5°.

[1] Bottom.

Hole 15

Location: 18,585.7 N; 20,294.5 E.

Elevation: Collar of hole: 455.9 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: July 25-August 2, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	50.0	Muskeg collar, sand, soil, clay, occasional to numerous hard, siliceous igneous pebbles and cobbles.	50.0	0.0	
50.0	60.0	Silty to sandy claystone, occasional iron-stained bands.	10.0	5.0	Bedding angle 10° to 15°.
60.0	84.0	Silty to sandy claystone, occasional iron-stained bands and carbonaceous streaks.	24.0	22.6	Bedding angle 20°.
84.0	84.4	Medium-grained sandstone, white, fairly hard and dense.	.4	.4	
84.4	110.0	Silty to sandy claystone, occasional iron-stained bands.	25.6	3.4	
110.0	150.0	Sandy to silty claystone, occasional carbonaceous streaks.	40.0	20.8	Bedding angle 10° to 20°.
150.0	165.8	Sandy to silty claystone, occasional carbonaceous streaks and iron-stained bands.	15.8	14.2	Bedding angle 20° to 25°.
165.8	176.2	Sandy to silty claystone, occasional carbonaceous streaks and iron-stained bands; fairly hard and dense medium- to fine-grained sandstone from 167.2 to 167.6 feet--white color.	10.4	9.1	Bedding angle 15° to 20°.
176.2	186.2	Sandy to silty claystone, occasional iron-stained bands and carbonaceous banding, 0.1-foot medium- to fine-grained sandstone band at 180 feet.	10.0	8.7	Bedding angle 15°.

Hole 15 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery feet	Remarks
186.2	196.2	Silty to sandy claystone, occasional iron-stained bands, 1/4-inch coal band at 190 feet, occasional carbonaceous streaks.	10.0	9.9	Bedding angle 10°.
196.2	206.2	Silty to sandy claystone, occasional iron-stained bands, grades to numerous coal streaks and bands in lower 3.0 feet.	10.0	10.0	Bedding angle 10° to 15°.
206.2	218.3	Coal, dull.....	12.1	12.1	Sample 25.
218.3	218.5	Bony coal.....	.2	.2	Rejected.
218.5	218.9	Coal, dull.....	.4	.4	Sample 25.
218.9	219.3	Bony coal.....	.4	.4	Rejected.
219.3	222.4	Coal, dull, occasional thin bony coal partings.	3.1	3.1	Sample 25.
222.4	222.6	Bony coal.....	.2	.2	Rejected.
222.6	228.1	Coal, dull, occasional thin bone partings.	5.5	5.5	Sample 25.
228.1	228.4	Bony coal.....	.3	.3	Rejected.
228.4	231.9	Coal, dull.....	3.5	3.5	Sample 25.
231.9	232.0	Bony coal.....	.1	.1	Rejected.
232.0	233.4	Coal, dull, occasional thin bony coal partings.	1.4	1.4	Sample 25.
233.4	233.5	Bony coal.....	.1	.1	Rejected.
233.5	233.6	Coal, dull.....	.1	.1	Sample 25.
233.6	233.7	Bony coal.....	.1	.1	Rejected.
233.7	244.1	Coal, dull, occasional thin bony coal partings.	10.4	10.4	Sample 25.
244.1	244.2	Bony coal.....	.1	.1	Rejected.
244.2	244.9	Coal, dull.....	.7	.7	End sample 25.
244.9	245.6	Bone and coal.....	.7	.7	Rejected.
245.6	246.0	Coal, dull.....	.4	.4	Sample 26.
246.0	246.4	Bony coal.....	.4	.4	Rejected.
246.4	247.0	Coal, dull, occasional thin bony partings.	.6	.6	Sample 26.
247.0	247.6	Bone and coal.....	.6	.6	Rejected.
247.6	248.0	Coal, dull.....	.4	.4	Sample 26.
248.0	248.3	Bony coal.....	.3	.3	Rejected.
248.3	249.9	Coal, dull, occasional thin bony coal partings (0.9-foot core loss--assumed to be coal).	1.6	.7	Sample 26.
249.9	250.3	Claystone with bands and streaks of coal.	.4	.4	Rejected.

Hole 15 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
250.3	250.7	Coal, dull.....	0.4	0.4	Sample 26.
250.7	250.8	Bony coal.....	.1	.1	Rejected.
250.8	252.4	Coal, dull, occasional thin bony partings.	1.6	1.6	Sample 26.
252.4	252.5	Bony coal.....	.1	.1	Rejected.
252.5	253.6	Coal, dull, occasional thin bony coal partings.	1.1	1.1	Sample 26.
253.6	253.8	Bony coal.....	.2	.2	Rejected.
253.8	254.1	Coal, dull.....	.3	.3	Sample 26.
254.1	254.5	Bony coal.....	.4	.4	Rejected.
254.5	254.7	Coal, dull.....	.2	.2	Sample 26.
254.7	255.3	Bony coal.....	.6	.6	Rejected.
255.3	255.6	Coal, dull.....	.3	.3	Sample 26.
255.6	255.8	Bony coal.....	.2	.2	Rejected.
255.8	259.4	Coal, dull (2.6-foot core loss--assumed to be coal).	3.6	1.0	Sample 26.
259.4	259.7	Bony coal.....	.3	.3	Rejected.
259.7	261.2	Coal, dull.....	1.5	1.5	Sample 26.
261.2	261.9	Bony coal.....	.7	.7	Rejected.
261.9	262.1	Coal, dull.....	.2	.2	Sample 26.
262.1	262.4	Bony coal.....	.3	.3	Rejected.
262.4	262.9	Coal, dull.....	.5	.5	Sample 26.
262.9	263.0	Bone and coal.....	.1	.1	Rejected.
263.0	263.3	Coal, dull.....	.3	.3	Sample 26.
263.3	263.9	Bony coal (0.4-foot core loss).	.6	.2	Rejected.
263.9	264.6	Coal, dull (0.5-foot core loss).	.7	.2	Sample 26.
264.6	268.5	Claystone with streaks, bands, and inclusions of coal.	3.9	3.9	Rejected.
268.5	269.4	Coal, dull.....	.9	.9	Sample 26.
269.4	269.8	Bony coal.....	.4	.4	Rejected.
269.8	270.4	Coal, dull.....	.6	.6	Sample 26.
270.4	270.6	Bony coal.....	.2	.2	Rejected.
270.6	270.8	Coal, dull.....	.2	.2	Sample 26.
270.8	271.0	Bony coal.....	.2	.2	Rejected.
271.0	271.3	Coal, dull.....	.3	.3	End sample 26.
271.3	272.7	Bony coal.....	1.4	1.4	Rejected.
272.7	273.3	Silty claystone with streaks and bands of coal.	.6	.6	Do.
273.3	276.6	Sandy to silty claystone, occasional small coal inclusions.	3.3	3.2	
276.6	[1]285.0	Sandy to silty claystone, occasional small coal streaks and inclusions.	8.4	8.4	Bedding angle 5° to 10°.

[1] Bottom.

Hole 16

Location: 18,253.1 N; 19,562.6 E.

Elevation: Collar of hole: 439.3 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 3-9, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	20.0	Muskeg collar, sand, soil, clay, occasional to numerous hard, siliceous igneous pebbles and cobbles--overburden.	20.0	0.0	
20.0	39.8	Sandy to silty claystone, pebble and cobble inclusions.	19.8	2.5	
39.8	41.0	Fine-grained sandstone, fairly hard and dense.	1.2	1.2	
41.0	44.0	Fine-grained sandstone banded almost parallel to core axis with sandy to silty claystone.	3.0	3.0	
44.0	62.5	Sandy to silty claystone.....	18.5	14.4	Bedding angle 45° to 50°.
62.5	112.5	Sandy to silty claystone, occasional carbonaceous streaks and banding.	50.0	41.3	Bedding angle 35° to 60°.
112.5	151.0	Sandy to silty claystone, occasional carbonaceous streaks and iron-stained banding.	38.5	34.8	Bedding angle 35° to 50°.
151.0	160.5	Sandy to silty claystone, occasional iron-stained banding, grading to numerous coal streaks and bands in lower 1.5 feet.	9.5	9.5	Bedding angle 25° to 30°.
160.5	162.3	Sandy to silty claystone, numerous coal streaks, bands, and inclusions.	1.8	1.8	Bedding angle 30° to 40°.
162.3	162.6	Silty claystone with streaks and bands of coal.	.3	.3	Rejected.
162.6	164.8	Coal, dull (1.0-foot core loss--assumed to be coal).	2.2	1.2	Sample 27.
164.8	164.9	Bone.....	.1	.1	Rejected.
164.9	176.7	Coal, dull, occasional thin bony partings.	11.8	11.8	Sample 27; bedding angle 25° to 30°.

Hole 16 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
176.7	176.9	Bony coal.....	0.2	0.2	Rejected
176.9	177.1	Coal, dull.....	.2	.2	Sample 27.
177.1	177.2	Bony coal.....	.1	.1	Rejected.
177.2	187.8	Coal, dull, occasional thin bony partings (1.0-foot core loss--assumed to be coal).	10.6	9.6	Sample 27; bedding angle 25° to 30°.
187.8	188.0	Bony coal.....	.2	.2	Rejected.
188.0	188.2	Coal, dull.....	.2	.2	Sample 27.
188.2	188.6	Bony coal.....	.4	.4	Rejected.
188.6	189.2	Coal, dull.....	.6	.6	Sample 27.
189.2	189.3	Bony coal.....	.1	.1	Rejected.
189.3	194.0	Coal, dull.....	4.7	4.7	Sample 27.
194.0	194.1	Bony coal.....	.1	.1	Rejected.
194.1	201.5	Coal, dull, occasional thin bony partings.	7.4	7.4	Sample 27.
201.5	201.7	Claystone and bony coal.....	.2	.2	Rejected.
201.7	202.9	Coal, dull.....	1.2	1.2	Sample 27.
202.9	203.0	Claystone with bands and streaks of coal.	.1	.1	Rejected.
203.0	206.3	Coal, dull, occasional thin bony partings.	3.3	3.3	End sample 27.
206.3	206.5	Claystone with streaks of coal.	.2	.2	Rejected.
206.5	206.6	Coal, dull, occasional thin bony partings.	.1	.1	Sample 28.
206.6	207.1	Bony coal.....	.5	.5	Rejected.
207.1	208.5	Coal, dull, occasional thin bony partings.	1.4	1.4	Sample 28.
208.5	209.0	Claystone with streaks and bands of coal.	.5	.5	Rejected.
209.0	209.2	Coal, dull.....	.2	.2	Sample 28.
209.2	210.4	Bone and coal.....	1.2	1.2	Rejected.
210.4	212.0	Coal, dull, occasional thin bony partings (0.8-foot core loss--assumed to be coal).	1.6	.8	Sample 28.
212.0	212.1	Clay.....	.1	.1	Rejected.
212.1	212.5	Coal, dull.....	.4	.4	Sample 28.
212.5	212.8	Bony coal.....	.3	.3	Rejected.
212.8	213.4	Coal, dull, occasional thin bony partings.	.6	.6	Sample 28.
213.4	213.7	Bone and coal.....	.3	.3	Rejected.
213.7	214.3	Coal, dull.....	.6	.6	Sample 28.
214.3	214.5	Bone and coal.....	.2	.2	Rejected.
214.5	214.65	Coal, dull.....	.15	.15	Sample 28.
214.65	214.95	Bony coal.....	.3	.3	Rejected.

Hole 16 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
214.95	217.7	Coal, dull, some fairly bony.	2.75	2.75	Sample 28.
217.7	217.8	Clay.....	.1	.1	Rejected.
217.8	218.1	Coal, dull.....	.3	.3	Sample 28.
218.1	218.6	Bony coal.....	.5	.5	Rejected.
218.6	219.3	Claystone with streaks and bands of coal.	.7	.7	Do.
219.3	219.8	Coal, dull.....	.5	.5	Sample 28.
219.8	220.0	Claystone with streaks of coal.	.2	.2	Rejected.
220.0	222.2	Coal, dull.....	2.2	2.2	Sample 28.
222.2	222.8	Claystone with streaks, bands, and inclusions of coal.	.6	.6	Rejected.
222.8	222.9	Coal, dull.....	.1	.1	Sample 28.
222.9	223.3	Bony coal.....	.4	.4	Rejected.
223.3	225.3	Coal, dull.....	2.0	2.0	Sample 28.
225.3	225.7	Bony coal.....	.4	.4	Rejected.
225.7	225.8	Coal, dull.....	.1	.1	Sample 28.
225.8	226.0	Silty claystone.....	.2	.2	Rejected.
226.0	226.2	Coal, dull.....	.2	.2	Sample 28.
226.2	226.6	Bony coal.....	.4	.4	Rejected.
226.6	226.7	Coal, dull.....	.1	.1	End sample 28.
226.7	228.3	Claystone with streaks, bands, and inclusions of coal.	1.6	1.6	Rejected.
228.3	228.8	Fine-grained sandstone.....	.5	.5	Do.
228.8	229.3	Coal, dull, with large inclusion of fine-grained sandstone.	.5	.5	Not sampled.
229.3	231.6	Silty claystone with streaks, inclusions, and bands (up to 0.1 foot thick) of coal.	2.3	2.3	Rejected.
231.6	238.0	Sandy to silty claystone, numerous coal streaks, bands, and inclusions in upper 1.5 feet.	6.4	5.7	Bedding angle of coal bands 20° to 25°.
238.0	[1]245.8	Sandy to silty claystone, occasional small coal inclusions.	7.8	7.4	

[1] Bottom.

Hole 17

Location: 17,970.3 N; 18,602.1 E.

Elevation: Collar of hole: 430.1 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 10-17, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	40.0	Immediate overburden, muskeg sand, soil, clay, occasional to numerous pebbles and cobbles.	40.0	0.0	
40.0	51.0	Sandy to silty claystone.....	11.0	5.2	
51.0	61.0	Sandy to silty claystone, occasional carbonaceous streaks.	10.0	8.4	Bedding angle 65°.
61.0	71.0	.....Do.....	10.0	8.6	Bedding angle 40°.
71.0	81.0	Sandy to silty claystone, occasional carbonaceous streaks; hard dense medium-grained 0.2-foot sandstone lens at 77.7 feet--granitic appearance.	10.0	8.0	Bedding angle 25° to 35°.
81.0	91.0	Sandy to silty claystone, occasional carbonaceous streaks.	10.0	5.7	
91.0	100.5	Sandy to silty claystone, occasional carbonaceous streaks; grades to numerous coal streaks, bands, and inclusions in lower 1 foot.	9.5	9.5	Bedding angle 25° to 30°.
100.5	104.1	Sandy to silty claystone, numerous coal streaks, bands, and inclusions.	3.6	3.6	Do.
104.1	104.4	Silty claystone with streaks and bands of coal.	.3	.3	Rejected.
104.4	119.2	Coal, dull, occasional thin bony partings.	14.8	14.8	Sample 29.
119.2	119.7	Bony coal.....	.5	.5	Rejected.
119.7	123.7	Coal, dull, occasional thin bony partings.	4.0	4.0	Sample 29.
123.7	123.8	Bony coal.....	.1	.1	Rejected.
123.8	124.1	Coal, dull.....	.3	.3	Sample 29.
124.1	124.25	Bony coal.....	.15	.15	Rejected.
124.25	130.5	Coal, dull.....	6.25	6.25	Sample 29.
130.5	130.6	Bone and coal.....	.1	.1	Rejected.

Hole 17 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
130.6	131.2	Coal, dull.....	0.6	0.6	Sample 29.
131.2	131.3	Claystone with streaks and inclusions of coal.	.1	.1	Rejected.
131.3	131.6	Coal, dull.....	.3	.3	Sample 29.
131.6	132.05	Claystone with streaks and bands of coal.	.45	.45	Bedding angle 25° to 30°--rejected.
132.05	136.9	Coal, dull, occasional thin bony partings.	4.85	4.85	Sample 29.
136.9	138.0	Soft muddy clay with streaks and bands of coal.	1.1	1.1	Rejected.
138.0	141.1	Coal, dull.....	3.1	3.1	Sample 29.
141.1	141.25	Claystone with streaks of coal.	.15	.15	Rejected.
141.25	149.7	Coal, dull, occasional thin bony partings.	8.45	8.45	Sample 29.
149.7	149.8	Bone with streaks and bands of coal.	.1	.1	Rejected.
149.8	153.8	Coal, dull, occasional thin bony partings (0.6-foot core loss--assumed to be coal).	4.0	3.4	Sample 29.
153.8	154.8	Coal, dull, (0.6-foot core loss--assumed to be coal).	1.0	.4	Do.
154.8	157.0	Coal, dull, (0.8-foot core loss--assumed to be coal).	2.2	1.4	Do.
157.0	157.6	Coal, dull.....	.6	.6	Do.
157.6	157.8	Claystone with streaks and bands of coal.	.2	.2	Rejected.
157.8	158.0	Coal, dull.....	.2	.2	Sample 29.
158.0	158.6	Bone and coal.....	.6	.6	Rejected.
158.6	159.0	Coal, dull.....	.4	.4	Sample 29.
159.0	159.5	Bone and coal.....	.5	.5	Rejected.
159.5	160.8	Coal, dull (0.9-foot core loss--assumed to be coal).	1.3	.4	Sample 29.
160.8	165.2	Claystone with streaks and bands of coal (1.6-foot core loss).	4.4	2.8	Rejected.
165.2	166.0	Core recovered consists of a loose fine-grained mixture of clay and coal (may or may not be representative of interval).	.8	.8	Do.
166.0	[1]167.0	Silty claystone with streaks and bands of coal.	1.0	1.0	Do.

[1] Bottom; hole terminated at or near bottom of coal seam because of difficult drilling conditions.

Hole 18

Location: 17,269.9 N, 17,446.3 E.

Elevation: Collar of hole: 417.2 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 19-23, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	60.0	Overburden, soil, clay, sand, coal, occasional to numerous highly siliceous pebbles and cobbles.	60.0	0.0	
60.0	100.0	Clayey sandstone, soft, incompetent (may be overburden).	40.0	.0	
100.0	104.5	Clayey coal and coal (believed to be lower seam but evidently badly broken and recovery poor).	4.5	1.3	
104.5	105.1	Silty claystone with streaks and bands of coal.	.6	.6	
105.1	107.4	Coal, dull (1.4-foot core loss).	2.3	.9	No sample taken.
107.4	111.5	Coal, dull (3.2-foot core loss).	4.1	.9	Do.
111.5	112.2	Silty claystone with streaks and bands of coal.	.7	.7	
112.2	114.8	Coal, dull (2.4-foot core loss).	2.6	.2	Do.
114.8	116.8	Silty claystone with streaks and bands of coal.	2.0	2.0	
116.8	118.3	Coal, dull (0.8-foot core loss).	1.5	.7	Do.
118.3	123.6	Silty claystone with streaks and bands of coal (1.6-foot core loss).	5.3	3.7	
123.6	127.7	Dirty coal with bands of silty claystone.	4.1	4.1	Bedding angle 45°.
127.7	128.5	Coal, dull.....	.8	.8	No sample taken.
128.5	135.3	Silty to sandy claystone, occasional inclusions of coal.	6.8	2.9	
135.3	144.3	Silty to sandy claystone, lens of medium- to fine-grained fairly hard and dense sandstone from 141.3 to 141.9 feet.	9.0	8.7	

Hole 18 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
144.3	146.5	Silty to sandy claystone, 0.3 foot at top of run of fine-ground coal (not ground in drilling).	2.2	2.1	
146.5	150.5	Silty to sandy claystone.....	4.0	4.0	Bedding angle 45°.
150.5	156.0	Medium-grained, soft incompetent sandstone, grades to more incompetency, carbonaceous streaks.	5.5	2.7	
156.0	181.0	Medium-grained, soft incompetent sandstone, salt and pepper appearance in cuttings, occasional hard igneous pebbles.	25.0	.0	
181.0	[1]190.0	Same as 156.0 to 181.0 feet except 0.2 foot of medium-grained hard, dense granitic sandstone recovered; 0.3 foot of incompetent sandstone and few igneous pebbles also recovered.	9.0	.5	

[1] Bottom.

Hole 19

Location: 17,516.5 N; 17,299.6 E.

Elevation: Collar of hole: 416.8 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 25-29, 1960.

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
0.0	62.0	Soil, sand, clay, coal, occasional to numerous pebbles and cobbles--overburden.	62.0	0.0	
62.0	[1]195.0	Incompetent, soft medium-grained sandstone, occasional to numerous hard, highly siliceous pebbles and cobbles--believed to be material underlying discovery seam.	133.0	.0	

[1] Bottom.

Hole 20

Location: 17,882.6 N; 17,412.5 E.

Elevation: Collar of hole: 438.7 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 31-September 13, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	100.0	Soil, clay, sand, coal, occasional to numerous hard, highly siliceous pebbles, cobbles, and boulders--overburden.	100.0	0.0	
100.0	122.6	Sandy to silty claystone, occasional carbonaceous streaks.	22.6	16.8	Bedding angle 25° to 45°.
122.6	136.9	Do.	14.3	13.4	Bedding angle 20°.
136.9	140.8	Silty claystone with numerous streaks, bands and inclusions of coal.	3.9	3.6	Bedding angle 0° to 20°.
140.8	141.0	Claystone with streaks and bands of coal.	.2	.2	Rejected.
141.0	144.2	Coal, dull.....	3.2	3.2	Sample 30.
144.2	144.3	Bony coal.....	.1	.1	Rejected.
144.3	147.1	Coal, dull.....	2.8	2.8	Sample 30.
147.1	147.2	Bony coal.....	.1	.1	Rejected.
147.2	153.5	Coal, dull.....	6.3	6.3	Sample 30.
153.5	153.6	Bony coal.....	.1	.1	Rejected.
153.6	157.0	Coal, dull, occasional thin bony partings.	3.4	3.4	Sample 30.
157.0	157.15	Bony coal.....	.15	.15	Rejected.
157.15	157.9	Coal, dull.....	.75	.75	Sample 30.
157.9	158.0	Bony coal.....	.1	.1	Rejected.
158.0	163.2	Coal, dull.....	5.2	5.2	Sample 30.
163.2	163.6	Claystone with bands and streaks of coal.	.4	.4	Rejected.
163.6	163.8	Coal, dull.....	.2	.2	Sample 30.
163.8	164.0	Claystone with bands and streaks of coal.	.2	.2	Rejected.
164.0	165.3	Coal, dull (1.1-foot core loss--assumed to be coal).	1.3	.2	Sample 30.
165.3	165.9	Coal, dull.....	.6	.6	Do.
165.9	166.05	Bony coal.....	.15	.15	Rejected.
166.05	170.2	Coal, dull, occasional thin bony partings (0.7-foot core loss--assumed to be coal).	4.15	3.45	Sample 30.

Hole 20 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
170.2	174.8	Coal, dull (0.7-foot core loss--assumed to be coal).	4.6	3.9	Sample 30.
174.8	174.9	Bony coal.....	.1	.1	Rejected.
174.9	176.15	Coal, dull, occasional thin bony partings.	1.25	1.25	Sample 30.
176.15	176.8	Bone and coal.....	.65	.65	Rejected.
176.8	181.4	Coal, dull.....	4.6	4.6	Sample 30.
181.4	181.7	Bony coal.....	.3	.3	Rejected.
181.7	186.9	Coal, dull, occasional thin clay and/or bony partings.	5.2	5.2	Sample 30.
186.9	187.15	Bone with streaks and bands of coal.	.25	.25	
187.15	192.2	Coal, dull, occasional thin bony partings.	5.05	5.05	End sample 30.
192.2	192.6	Bony coal.....	.4	.4	Rejected.
192.6	193.0	Coal, dull, occasional thin bony partings.	.4	.4	Sample 31.
193.0	193.1	Bony coal.....	.1	.1	Rejected.
193.1	193.5	Coal, dull, occasional thin bony partings.	.4	.4	Sample 31.
193.5	194.0	Bone and coal.....	.5	.5	Rejected.
194.0	194.2	Coal, dull.....	.2	.2	Sample 31.
194.2	194.6	Bony coal.....	.4	.4	Rejected.
194.6	195.9	Claystone with streaks and bands of coal.	1.3	1.3	Do.
195.9	198.0	Coal, dull.....	2.1	2.1	Sample 31.
198.0	198.8	Bone and coal.....	.8	.8	Rejected.
198.8	199.0	Coal, dull.....	.2	.2	Sample 31.
199.0	199.15	Bone and coal.....	.15	.15	Rejected.
199.15	199.75	Coal, dull, quite a few bony partings.	.6	.6	Sample 31.
199.75	200.15	Bone and coal.....	.4	.4	Rejected.
200.15	200.45	Coal, dull. quite a few bony partings.	.3	.3	Sample 31.
200.45	200.75	Bone and coal.....	.3	.3	Rejected.
200.75	201.0	Coal, dull.....	.25	.25	Sample 31.
201.0	201.1	Silty claystone.....	.1	.1	Rejected.
201.1	201.6	Bony coal.....	.5	.5	Do.
201.6	203.5	Coal, dull, quite a few bony partings.	1.9	1.9	Sample 31.
203.5	204.5	Bony coal.....	1.0	1.0	Rejected.
204.5	204.9	Coal, dull.....	.4	.4	Sample 31.
204.9	205.0	Bone with streaks and bands of coal.	.1	.1	Rejected.

Hole 20 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
205.0	205.7	Coal, dull, occasional bony partings.	0.7	0.7	Sample 31.
205.7	205.8	Silty claystone with streaks and bands of coal.	.1	.1	Rejected.
205.8	206.1	Coal, dull.....	.3	.3	Sample 31.
206.1	206.8	Bone and coal.....	.7	.7	Rejected.
206.8	210.3	Silty claystone with streaks and bands of coal.	3.5	3.5	Do.
210.3	215.8	Banded coal and claystone....	5.5	5.5	Bedding angle 10° to 15°.
215.8	[1]225.8	Silty to sandy claystone.....	10.0	10.0	

[1] Bottom.

Hole 21

Location: 17,823.0 N; 16,360.0 E.

Elevation: Collar of hole: 418.3 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 15-17, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	80.0	Overburden, soil, sand, clay, coal, occasional to numerous highly siliceous pebbles and cobbles. May have intersected very lowest part of discovery seam in lower 3 or 4 feet.	80.0	0.0	
80.0	96.6	Sandy to silty claystone.....	16.6	8.2	
96.6	106.6	.....Do.....	10.0	6.9	Bedding angle 10° to 15°.
106.6	[1]116.6	Soft, incompetent medium-grained sandstone with occasional to numerous pebbles and cobbles. Cuttings have salt and pepper appearance--granite origin. One 0.4-foot silty claystone lens and handful of pebbles recovered.	10.0	.6	

[1] Bottom.

Hole 22

Location: 18,340.7 N; 16,433.4 E.

Elevation: Collar of hole: 400.0 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 19-21, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	25.0	Overburden, soil, sand, coal, clay, occasional highly siliceous pebbles and cobbles.	25.0	0.0	
25.0	53.0	Sandy to silty blue clay--very soft and incompetent, probably overburden.	28.0	.0	
53.0	61.0	Overburden, sand, siliceous pebbles and cobbles, coal.	8.0	.0	
61.0	70.7	Sandy to silty claystone (fishtailed).	9.7	.0	Believed just below discovery seam.
70.7	81.5	Sandy to silty claystone, occasional carbonaceous streaks.	10.8	1.5	Bedding angle 5° to 10° (did not recover a good specimen for bedding angle measurement).
81.5	[1]110.0	Soft, incompetent fine-grained sandstone. Observation of cuttings indicates a clay binder but will not core. Occasional siliceous pebbles. Sand has salt and pepper appearance.	28.5	.0	

[1] Bottom.

Hole 23

Location: 18,134.1 N; 16,738.4 E.

Elevation: Collar of hole: 438.1 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 22-26, 1960.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	47.0	Overburden, soil, sand, clay, coal, occasional to numerous siliceous pebbles and cobbles.	47.0	0.0	
47.0	50.5	Coal, discovery seam.....	3.5	.0	Fishtailed and chopped.
50.5	53.3	Coal, dull.....	2.8	2.8	Sample 32.
53.3	53.8	Clay with streaks, bands, and inclusions of coal.	.5	.5	Rejected.
53.8	54.05	Bony coal.....	.25	.25	Do.
54.05	58.7	Coal, dull, occasional thin bony partings (0.9-foot core loss--assumed to be coal).	4.65	3.75	Sample 32.
58.7	62.7	Coal, dull, occasional thin bony partings.	4.0	4.0	Do.
62.7	62.8	Bony coal.....	.1	.1	Rejected.
62.8	63.3	Coal, dull, occasional thin bony partings.	.5	.5	Sample 32.
63.3	63.55	Clay and bony coal.....	.25	.25	Rejected.
63.55	67.9	Coal, dull, some quite bony..	4.35	4.35	Sample 32.
67.9	68.2	Clay with numerous inclusions of coal.	.3	.3	Rejected.
68.2	72.4	Coal, dull (0.6-foot core loss--assumed to be coal).	4.2	3.6	Sample 32.
72.4	73.0	Coal, dull.....	.6	.6	Do.
73.0	73.2	Bony coal.....	.2	.2	Rejected.
73.2	76.2	Coal, dull, occasional thin bony partings.	3.0	3.0	Sample 32.
76.2	76.4	Bony coal.....	.2	.2	Rejected.
76.4	80.6	Coal, dull, occasional thin bony partings.	4.2	4.2	Sample 32.
80.6	81.2	Clay and coal (core badly broken).	.6	.6	Rejected.
81.2	82.5	Bone banded with coal (band up to 1/2-inch wide).	1.3	1.3	Do.
82.5	83.0	Coal, dull, occasional thin bony partings.	.5	.5	Sample 32.
83.0	84.3	Claystone with streaks and bands of coal.	1.3	1.3	Rejected.

Hole 23 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
84.3	86.1	Coal, dull, occasional thin bony partings (0.7-foot core loss--assumed to be coal).	1.8	1.1	Sample 32.
86.1	87.6	Clay and bony coal.....	1.5	1.5	Rejected.
87.6	87.9	Coal, dull.....	.3	.3	Sample 32.
87.9	88.2	Bony coal.....	.3	.3	Rejected.
88.2	88.6	Coal, dull.....	.4	.4	End sample 32.
88.6	89.4	Fine-grained sandstone grading to silty claystone in lower 0.3 foot with streaks, bands, and inclusions of coal.	.8	.8	Rejected.
89.4	90.1	Coal, dull (0.5-foot core loss loss--assumed to be coal).	.7	.2	No sample taken.
90.1	90.7	Bony coal.....	.6	.6	Rejected.
90.7	92.3	Coal, dull (core badly broken). (1.0-foot core loss--assumed to be coal).	1.6	.6	No sample taken.
92.3	92.5	Bony coal.....	.2	.2	Rejected.
92.5	93.5	Claystone banded with coal (core badly broken).	1.0	1.0	Do.
93.5	95.3	Coal, dull (core badly broken). (1.1-foot core loss--assumed to be coal).	1.8	.7	No sample taken.
95.3	95.5	Bony coal (core badly broken).	.2	.2	Rejected.
95.5	96.1	Coaly clay (core mangled).....	.6	.6	Do.
96.1	98.8	Bony coal and coaly claystone (core mangled). (1.6-foot core loss)	2.7	1.1	Do.
98.8	102.2	Bony coal and coaly claystone (core badly broken). (1.0-foot core loss).	3.4	2.4	Do.
102.2	103.0	Claystone with streaks and bands of coal (core badly broken).	.8	.8	Do.
103.0	104.4	Coal, dull, occasional thin bony partings.	1.4	1.4	No sample taken.
104.4	105.0	Silty claystone with streaks and bands of coal.	.6	.6	
105.0	[1]106.2	Claystone with numerous streaks, bands, and inclusions of coal.	1.2	1.2	Bedding angle 10° to 20°.

[1] Bottom.

Hole 24

Location: 18,429.8 N; 16,959.3 E.

Elevation: Collar of hole: 416.0 feet mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 2-9, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	71.0	Overburden, soil, sand, clay, occasional small pebbles and cobbles, abundant coal float from 47 to 71 feet.	71.0	0.0	
71.0	71.8	Claystone with streaks, bands, and inclusions of coal.	.8	.8	Rejected.
71.8	72.5	Coal, some slightly bony.....	.7	.5	Sample 33.
72.5	72.9	Claystone with streaks, bands, and inclusions of coal.	.4	.35	Rejected.
72.9	79.4	Coal, some slightly bony.....	6.5	2.9	Bedding angle 25° to 30°.
79.4	79.5	Claystone with inclusions of coal.	.1	.05	Rejected.
79.5	82.2	Coal, some slightly bony.....	2.7	2.2	Sample 33.
82.2	82.35	Bony coal.....	.15	.15	Rejected.
82.35	82.85	Coal.....	.5	.4	Sample 33.
82.85	83.05	Claystone with bands and inclusions of coal.	.2	.2	Rejected.
83.05	[1]102.0	Coal, some slightly bony. Core badly broken, some recovered had crushed appearance.	18.95	6.6	Sample 33; bedding angle 25° to 30°.

[1] Bottom. Hole abandoned while still drilling in coal because of difficult drilling conditions. Drilling with bentonite mud did not solve drilling problem. Hole probably located along area of considerable folding flexure near outcrop. Coal badly broken, and core recovery poor.

Hole 25

Location: 20,106.6 N; 17,578.7 E.

Elevation: Collar of hole: 395.7 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 10-17, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	6.0	Soil, sand, clay--overburden	6.0	0.0	
6.0	40.0	Silty to sandy claystone, soft, incompetent (fish-tailed).	34.0	.0	Probably glacial.
40.0	127.0	Soft incompetent sandstone (salt and pepper appearance), occasional pebbles and cobbles (fishtailed).	87.0	.0	
127.0	131.3	Silty to sandy claystone, occasional carbonaceous banding.	4.3	3.3	Bedding angle 5° to 10°.
131.3	150.0	Silty to sandy claystone, occasional carbonaceous banding (fishtailed).	18.7	.0	
150.0	160.0	Fine- to medium-grained sandstone, occasional light carbonaceous banding, soft, incompetent.	10.0	8.7	Do.
160.0	170.0	Fine-grained sandstone, soft, incompetent; core recovery included numerous hard, highly siliceous pebbles (probably inclusions in the sandstone).	10.0	1.9	
170.0	175.8	Interbedded siltstone and fine-grained sandstone, occasional coal streaks, soft, incompetent, light-gray, occasional coal bands.	5.8	3.5	
175.8	176.5	.....Do.....	.7	.7	
176.5	179.5	Silty claystone, numerous streaks, bands, and inclusions of coal.	3.0	3.0	Bedding angle 10° to 15°.
179.5	181.2	Silty claystone with bands and streaks of coal.	1.7	1.7	Rejected.
181.2	181.5	Coal, slightly bony.....	.3	.3	Sample 34.
181.5	181.55	Bony coal.....	.05	.05	Rejected.
181.55	181.95	Coal, slightly bony.....	.40	.40	Sample 34.

Hole 25 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
181.95	183.30	Bony coal.....	1.35	1.35	Rejected.
183.30	183.6	Silty claystone with streaks and bands of coal.	.3	.3	Do.
183.6	185.5	Coal, slightly bony.....	1.9	1.9	Sample 34.
185.5	185.9	Bony coal.....	.4	.4	Rejected.
185.9	186.1	Coal.....	.2	.2	Sample 34.
186.1	186.3	Siltstone with streaks and bands of coal.	.2	.4	Rejected.
186.3	188.3	Coal, slightly bony.....	2.0	2.0	Sample 34.
188.3	188.7	Siltstone with streaks and bands of coal.	.4	.4	Rejected.
188.7	188.8	Coal.....	.1	.1	Sample 34.
188.8	189.3	Siltstone with streaks and bands of coal.	.5	.5	Rejected.
189.3	190.55	Silty claystone with streaks, bands, and small inclusions of coal.	1.25	1.25	Rejected; bedding angle 15°.
190.55	191.7	Coal, slightly bony.....	1.15	1.15	Sample 34.
191.7	192.35	Claystone with streaks and bands of coal.	.65	.65	Rejected; bedding angle 7°.
192.35	197.2	Coal, slightly bony.....	4.85	4.85	Sample 34.
197.2	198.25	Bony coal.....	1.05	1.05	Rejected.
198.25	198.8	Coal, slightly bony.....	.55	.55	Sample 34.
198.8	199.0	Silty claystone, almost white....	.2	.2	Rejected.
199.0	199.7	Bony coal.....	.7	.7	Do.
199.7	202.5	Coal, slightly bony.....	2.8	2.8	Sample 34.
202.5	203.05	Bony coal.....	.55	.55	Rejected.
203.05	205.05	Coal, slightly bony.....	2.0	2.0	Sample 34.
205.05	205.3	Siltstone with streaks of coal.	.25	.25	Rejected.
205.3	205.65	Coal, slightly bony.....	.35	.35	Sample 34.
205.65	205.75	Bony coal.....	.1	.1	Rejected.
205.75	205.90	Coal, slightly bony.....	.15	.15	Sample 34.
205.90	206.60	Bony coal.....	.7	.7	Rejected.
206.60	207.25	Coal, slightly bony.....	.65	.65	Sample 34.
207.25	209.4	Bony coal.....	2.15	2.15	Rejected.
209.4	211.2	Coal, slightly bony.....	1.8	1.8	Sample 34.
211.2	212.1	Silty claystone with streaks of coal.	.9	.9	Rejected.
212.1	213.3	Bony coal.....	1.2	1.2	Do.
213.3	213.6	Coal, slightly bony.....	.3	.3	Sample 34.
213.6	214.0	Bony coal.....	.4	.4	Rejected.
214.0	215.6	Coal, slightly bony.....	1.6	1.6	Sample 34.

Hole 25 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
215.6	215.8	Bony coal.....	0.2	0.2	Rejected.
215.8	219.95	Claystone with numerous streaks and bands of coal (bands to 3/4 inch).	4.15	4.15	Do.
219.95	220.20	Coal, slightly bony.....	.25	.25	End sample 34.
220.20	221.5	Bony coal.....	1.30	.60	Rejected.
221.5	232.0	Silty claystone with occasional streaks and bands of coal.	10.5	1.0	Core lost from barrel and unable to recover. From observation of drill cuttings, probably about 3.0 feet of coal from 225.5 to 228.5 feet.
232.0	[1]238.2	Interbedded siltstone and fine-grained sandstone, occasional carbonaceous streaks and banding, soft, incompetent.	6.2	5.9	Bedding angle 5° to 10°.

[1] Bottom. Hole artesian.

Hole 26

Location: 18,914.1 N; 19,012.3 E.

Elevation: Collar of hole: 431.2 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 19-26, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	6.0	Clayey soil overburden (fishtailed).	6.0	0.0	
6.0	60.0	Overburden, soft, loose fine sand (drove pipe and washed).	54.0	.0	
60.0	90.0	Soft, incompetent silty claystone (fishtailed).	30.0	.0	Might be glacial age.
90.0	92.3	Silty claystone, 0.5-foot lens of fine-grained sandstone--fairly hard and dense.	2.3	.7	
92.3	101.3	Silty claystone, soft, incompetent, one 0.3-foot lens of hard, dense fine-grained sandstone, one 0.1-foot lens of very fine-grained sandstone.	9.0	.4	
101.3	112.0	Silty claystone, soft, incompetent.	10.7	.0	
112.0	113.4	Fine- to very fine-grained sandstone, fairly hard and dense.	1.4	1.4	
113.4	142.0	Silty claystone, carbonaceous banding.	28.6	20.8	Bedding angle 10° to 20°.
142.0	150.0	Silty claystone grading to soft light-gray claystone, streaks, bands, and inclusions of coal in lower 1.8 feet.	8.0	8.0	Bedding angle 0° to 5°.
150.0	150.3	Claystone with streaks and small blebs of coal.	.3	.3	Rejected.
150.3	150.45	Bony coal.....	.15	.15	Do.
150.45	157.75	Coal, some slightly bony....	7.3	7.3	Sample 35; bedding angle 10° to 15°.
157.75	157.95	Bony coal.....	.2	.2	Rejected.
157.95	164.6	Coal, some slightly bony....	6.65	6.65	Sample 35.
164.6	164.7	Bony coal.....	.1	.1	Rejected.

Hole 26 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
164.7	173.8	Coal, some slightly bony, occasional resin flecks, occasional very thin clay seam.	9.1	9.1	Sample 35.
173.8	174.05	Coaly claystone and bony coal.	.25	.25	Rejected.
174.05	178.4	Coal, some slightly bony....	4.35	4.35	Sample 35.
178.4	178.65	Bony coal.....	.25	.25	Rejected.
178.65	185.9	Coal, some slightly bony....	7.25	7.25	Sample 35.
185.9	186.0	Bony coal.....	.1	.1	Rejected.
186.0	190.6	Coal, some slightly bony....	4.6	4.6	End sample 35.
190.6	190.7	Claystone with streaks of coal.	.1	.1	Rejected.
190.7	190.9	Coal, slightly bony.....	.2	.2	Sample 36.
190.9	191.3	Claystone with streaks and bands (to 1/2 inch) of coal.	.4	.4	Rejected.
191.3	191.65	Coal, slightly bony.....	.35	.35	Sample 36.
191.65	191.80	Coaly claystone.....	.15	.15	Rejected.
191.80	191.95	Coal, slightly bony.....	.15	.15	Sample 36.
191.95	193.5	Coaly claystone with streaks and bands of coal (bands to 1/2 inch).	1.55	1.55	Rejected.
193.5	194.0	Coal.....	.5	.5	Sample 36.
194.0	195.65	Bone and bony coal.....	1.65	1.65	Rejected.
195.65	197.1	Coal, some slightly bony....	1.45	1.45	Sample 36.
197.1	197.2	Bony coal.....	.1	.1	Rejected.
197.2	197.4	Claystone, slightly carbonaceous.	.2	.2	Do.
197.4	199.35	Coal, slightly bony.....	1.95	1.95	Sample 36. bedding angle 7° to 10°.
199.35	199.4	Claystone with coal streaks.	.05	.05	Rejected.
199.4	199.65	Fine-grained sandstone with streaks of coal.	.25	.25	Do.
199.65	200.0	Claystone with streaks and bands of coal, one 1-inch band of coal.	.35	.35	Do.
200.0	200.5	Bony coal.....	.5	.5	Do.
200.5	202.0	Coal, some slightly bony....	1.5	1.5	Sample 36.
202.0	203.0	Bony coal.....	1.0	1.0	Rejected.
203.0	203.15	Coal, slightly bony.....	.15	.15	Sample 36.
203.15	203.50	Bony coal.....	.35	.35	Rejected.
203.50	204.15	Coal, slightly bony.....	.65	.65	Sample 36.

Hole 26 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
204.15	204.40	Bony coal.....	0.25	0.25	Rejected
204.40	204.7	Coal, slightly bony.....	.3	.3	Sample 36.
204.7	204.8	Bony coal.....	.1	.1	Rejected.
204.8	205.1	Claystone with occasional streaks of coal.	.3	.3	Do.
205.1	205.2	Coal.....	.1	.1	Sample 36.
205.2	209.25	Claystone with streaks, bands, and inclusions of coal.	4.05	4.05	Rejected.
209.25	209.35	Coal.....	.1	.1	Sample 36.
209.35	209.7	Claystone, occasional streaks and blebs of coal.	.35	.35	Rejected.
209.7	210.1	Coal, some slightly bony....	.4	.4	Sample 36.
210.1	210.4	Bony coal.....	.3	.3	Rejected.
210.4	210.55	Coal, slightly bony.....	.15	.15	End sample 36.
210.55	210.65	Bony coal.....	.1	.1	Rejected.
210.65	212.6	Claystone with numerous streaks, bands, and inclusions of coal.	1.95	1.95	Rejected; bedding angle 7°.
212.6	212.9	Fine-grained sandstone.....	.3	.3	
212.9	217.2	Silty to sandy claystone, contains numerous small flakes of muscovite.	4.3	2.7	
217.2	[1]227.0	Silty to sandy claystone containing numerous small flakes of mica grading to soft, incompetent medium-grained sandstone.	9.8	4.8	Bedding angle 0° to 5°.

[1] Bottom.

Hole 27

Location: 19,233.4 N; 18,821.9 E.

Elevation: Collar of hole: 431.5 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: June 29-July 5, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	3.0	Clayey soil overburden.....	3.0	0.0	
3.0	118.0	Fine sand overburden, some with salt and pepper appearance (granitic debris), occasional pebbles and cobbles from 73.0 feet; thin layer of gravel material immediately on top of coal--pebbles washed out were hard and highly siliceous (quartz, chert).	115.0	.0	
118.0	121.1	Coal, fishtailed.....	3.1	.0	
121.1	129.3	Coal, some slightly bony....	8.2	8.2	Sample 37.
129.3	129.4	Coaly claystone.....	.1	.1	Rejected.
129.4	129.6	Coal, slightly bony.....	.2	.2	Sample 37.
129.6	129.8	Coaly claystone.....	.2	.2	Rejected.
129.8	139.1	Coal, some slightly bony....	9.3	9.3	Sample 37; bedding angle 10°.
139.1	139.4	Coaly claystone and bony coal.	.3	.3	Rejected.
139.4	141.3	Coal, some slightly bony....	1.9	1.9	Sample 37.
141.3	141.4	Bony coal.....	.1	.1	Rejected.
141.4	144.3	Coal,some slightly bony.....	2.9	2.9	Sample 37.
144.3	144.6	Bony coal and claystone.....	.3	.3	Rejected.
144.6	152.2	Coal, some slightly bony, occasional flecks of resin noted.	7.6	6.8	Sample 37.
152.2	152.5	Claystone with streaks and bands of coal.	.3	.3	Rejected.
152.5	160.8	Coal, some slightly bony....	8.3	7.0	End sample 37. Core loss--assumed to be coal.
160.8	161.2	Bony coal.....	.4	.4	Rejected.
161.2	161.45	Claystone with streaks and bands of coal.	.25	.25	Do.
161.45	161.7	Coal, slightly bony.....	.25	.25	Sample 38.

Hole 27 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
161.7	162.0	Bony coal.....	0.3	0.3	Rejected.
162.0	162.1	Coal, slightly bony.....	.1	.1	Sample 38.
162.1	162.45	Bony coal.....	.35	.35	Rejected.
162.45	162.75	Coal, slightly bony.....	.3	.3	Sample 38.
162.75	162.85	Bony coal.....	.1	.1	Rejected.
162.85	162.95	Coal.....	.1	.1	Sample 38.
162.95	163.60	Claystone with streaks and bands of coal.	.65	.65	Rejected.
163.60	163.7	Coal.....	.1	.1	Sample 38.
163.7	164.25	Claystone with streaks and bands of coal.	.55	.55	Rejected; bedding angle 15°.
164.25	165.65	Coal.....	1.4	1.4	Sample 38.
165.65	165.95	Claystone, soft.....	.3	.3	Rejected.
165.95	168.15	Coal, slightly bony.....	2.2	2.20	Sample 38.
168.15	168.60	Bony coal.....	.45	.45	Rejected.
168.60	171.0	Coal, slightly bony.....	2.4	2.4	Sample 38.
171.0	171.8	Bony coal.....	.8	.8	Rejected.
171.8	171.9	Coal, slightly bony.....	.1	.1	Sample 38.
171.9	172.0	Bony coal.....	.1	.1	Rejected.
172.0	172.9	Coal, slightly bony.....	.9	.8	Sample 38.
172.9	173.2	Bony coal.....	.3	.3	Rejected.
173.2	174.15	Coal, slightly bony.....	.95	.95	Sample 38.
174.15	174.25	Bony coal.....	.10	.1	Rejected.
174.25	174.45	Coal, slightly bony.....	.2	.2	End sample 38.
174.45	175.5	Claystone with streaks, bands, and inclusions of coal.	1.05	1.05	Rejected.
175.5	181.8	Claystone with numerous bands and streaks of coal.	6.3	6.3	Bedding angle 0° to 10°.
181.8	[1]191.8	Silty claystone containing numerous small flakes of muscovite, grades to siltstone.	10.0	9.2	Progressively grades to larger grain size, probably would grade into typical incompetent pebbly sandstone within next few feet.

[1] Bottom.

Hole 28

Location: 19,298.8 N; 18,164.9 E.

Elevation: Collar of hole: 403.9 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: July 7-11, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	5.0	Clayey soil overburden.....	5.0	0.0	
5.0	58.0	Sand and gravel overburden, numerous hard, highly siliceous pebble and cobble layers.	53.0	.0	
58.0	60.0	Claystone streaks and bands of coal (fishtailed).	2.0	.0	
60.0	60.2	Claystone with bands, streaks, and inclusions of coal.	.2	.2	
60.2	74.8	Coal, some slightly bony.....	14.6	14.6	Sample 39.
74.8	75.1	Claystone with streaks and bands of coal, parting.	.3	.3	Rejected.
75.1	79.95	Coal, some slightly bony.....	4.85	4.85	Sample 39; bedding angle 10°.
79.95	80.05	Coaly claystone.....	.1	.1	Rejected.
80.05	87.2	Coal, some slightly bony.....	7.15	7.15	Sample 39.
87.2	87.4	Bony coal.....	.2	.2	Rejected.
87.4	92.1	Coal, some slightly bony.....	4.7	4.7	Sample 39.
92.1	92.2	Bony coal.....	.1	.1	Rejected.
92.2	92.8	Coal, some slightly bony.....	.6	.6	Sample 39.
92.8	93.1	Coal and bone.....	.3	.3	Rejected.
93.1	93.3	Coal.....	.2	.2	Sample 39.
93.3	93.7	Bony coal.....	.4	.4	Rejected.
93.7	94.2	Coal, some slightly bony.....	.5	.5	End sample 39.
94.2	95.2	Claystone with streaks and bands of coal.	1.0	1.0	Rejected.
95.2	96.2	Coal, some slightly bony.....	1.0	1.0	Sample 40.
96.2	96.4	Claystone with bands and streaks of coal.	.2	.2	Rejected.
96.4	96.6	Coal.....	.2	.2	Sample 40.
96.6	97.3	Claystone with bands and streaks of coal and bony coal.	.7	.7	
97.3	97.45	Coal, slightly bony.....	.15	.15	Do.
97.45	97.65	Coaly claystone, soft, mudlike.	.2	.2	Rejected.
97.65	98.4	Coal, slightly bony.....	.75	.75	Sample 40.

Hole 28 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
98.4	98.5	Bony coal.....	0.1	0.1	Rejected.
98.5	99.05	Coal, slightly bony.....	.55	.55	Sample 40.
99.05	99.55	Bony coal.....	.5	.5	Rejected.
99.55	99.9	Coal, slightly bony.....	.35	.35	Sample 40.
99.9	100.4	Bony coal.....	.5	.5	Rejected.
100.4	102.6	Coal, slightly bony.....	2.2	2.2	Sample 40.
102.6	103.8	Bony coal.....	1.2	1.2	Rejected.
103.8	104.0	Coal, slightly bony.....	.2	.2	Sample 40.
104.0	104.2	Bony coal.....	.2	.2	Rejected.
104.2	105.7	Coal, slightly bony.....	1.5	1.5	Sample 40.
105.7	106.7	Bony coal and bone.....	1.0	1.0	Rejected.
106.7	108.7	Claystone with streaks and bands of coal.	2.0	2.0	Do.
108.7	109.9	Coal, slightly bony (0.9-foot core loss--assumed to be coal).	1.2	.3	Sample 40.
109.9	111.0	Claystone with streaks, bands, and inclusions of coal.	1.1	1.1	Rejected.
111.0	111.1	Coal.....	.1	.1	Sample 40.
111.1	111.45	Silty claystone.....	.35	.35	Rejected.
111.45	112.35	Coal, slightly bony.....	.9	.9	End sample 40.
112.35	113.0	Claystone with streaks and bands of coal.	.65	.65	Rejected.
113.0	121.0	Claystone that grades to siltstone, numerous bands and streaks of coal from 113 to 114.7 feet.	8.0	8.0	Bedding angle 5° to 10°.
121.0	[1]131.0	Silty to sandy claystone that grades to typical soft, incompetent pebbly sandstone.	10.0	4.0	

[1] Bottom.

Hole 29

Location: 21,087.3 N; 17,126.8 E.

Elevation: Collar of hole: 432.6 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: July 12-19, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	5.0	Muskeg overburden.....	5.0	0.0	
5.0	10.0	Sand and gravel overburden..	5.0	.0	
10.0	25.0	Silty clay, soft, incompetent, probably glacial age.	15.0	.0	
25.0	45.0	Fine sand, numerous pebbles, clayey matrix, but soft, loose running.	20.0	.0	
45.0	65.0	Fine, sandy, silty material containing coal float, loose, incompetent (overburden).	20.0	.0	
65.0	95.0	Incompetent sandstone, occasional pebbles and cobbles, salt and pepper appearance (probably almost pure quartzitic grains and pebbles), small amount of clayey binder, some layers of pea-size gravel.	30.0	.0	Probably Tertiary bedrock.
95.0	102.5	Clayey, silty material.....	7.5	.0	
102.5	109.0	Sandy to silty claystone, soft, carbonaceous streaks and bands.	6.5	6.5	Bedding angle 0° to 5°.
109.0	109.3	Fine-grained sandstone, hard and dense.	.3	.3	
109.3	110.1	Sandy to silty claystone, soft.	.8	.8	
110.1	111.5	Fine-grained sandstone, hard and dense.	1.4	1.4	
111.5	119.0	Medium-grained, soft incompetent pebbly sandstone, pebbles highly siliceous.	7.5	.0	
119.0	119.1	Highly siliceous pebbles....	.1	.1	May be cave from above.
119.1	119.4	Very fine-grained sandstone, hard and dense, limonite-stained.			

Hole 29 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
119.4	128.0	Silty claystone, occasional iron stain, occasional coal streaks and inclusions becoming numerous in lower 1 foot.	8.6	7.4	Bedding angle 0° to 5°.
128.0	129.0	Silty claystone, occasional streaks, inclusions, and thin bands of coal.	1.0	.9	Rejected.
129.0	129.4	Bony coal.....	.4	.4	Do.
129.4	131.1	Silty claystone with numerous streaks and thin bands of coal.	1.7	.9	Do.
131.1	131.65	Coal, slightly bony.....	.55	.55	Sample 41.
131.65	133.2	Claystone with streaks and thin bands of coal.	1.55	1.55	Rejected.
133.2	135.1	Coal, slightly bony.....	1.9	1.8	Sample 41.
135.1	135.4	Silty claystone with streaks and thin bands of coal.	.3	.3	Rejected.
135.4	135.5	Coal.....	.1	.1	Sample 41
135.5	135.7	Silty claystone with streaks, thin bands, and inclusions of coal.	.2	.2	Rejected.
135.7	135.8	Coal.....	.1	.1	Sample 41.
135.8	136.1	Silty claystone with occasional streaks and inclusions of coal.	.3	.3	Rejected.
136.1	138.05	Coal, slightly bony.....	1.95	1.95	Sample 41.
138.05	138.55	Silty claystone with numerous streaks and thin bands of coal.	.5	.5	Rejected.
138.55	138.65	Coal, slightly bony.....	.1	.1	Sample 41.
138.65	140.9	Silty claystone with occasional streaks, inclusions, and thin bands of coal.	2.25	2.25	Rejected.
140.9	141.35	Coal, slightly bony.....	.45	.45	Sample 41.
141.35	141.6	Silty claystone with streaks and inclusions of coal.	.25	.25	Rejected.
141.6	142.05	Coal, slightly bony.....	.45	.45	Sample 41.
142.05	144.1	Silty claystone with streaks, inclusions, and bands (to 1/2 inch) of coal.	2.05	2.05	Rejected; bedding angle 5° to 10°.
144.1	145.15	Coal, slightly bony.....	1.05	1.05	Sample 41.

Hole 29 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
145.15	145.85	Silty claystone with numer-numerous streaks and thin bands of coal.	0.7	0.7	Rejected.
145.85	145.95	Coal, slightly bony.....	.1	.1	Sample 41.
145.95	146.45	Silty claystone with numerous streaks and thin bands of coal.	.50	.5	Rejected.
146.45	146.85	Coal, slightly bony.....	.4	.4	Sample 41.
146.85	147.55	Silty claystone with occasional streaks, inclusions, and thin bands of coal.	.7	.7	Rejected.
147.55	147.85	Coal, slightly bony.....	.3	.3	Sample 41.
147.85	148.0	Silty claystone with numerous streaks of coal.	.15	.15	Rejected.
148.0	148.4	Coal, quite bony.....	.4	.4	Sample 41.
148.4	148.7	Silty claystone with numerous streaks of coal.	.3	.3	Rejected.
148.7	149.1	Coal, slightly bony.....	.4	.4	Sample 41.
149.1	149.2	Silty claystone, very occasional streaks and inclusions of coal.	.1	.1	Rejected.
149.2	149.35	Coal.....	.15	.15	Sample 41.
149.35	149.65	Silty claystone with numerous streaks and thin bands of coal.	.3	.3	Rejected.
149.65	151.35	Coal, quite bony.....	1.7	1.7	Sample 41.
151.35	151.9	Bony coal.....	.55	.55	Rejected.
151.9	152.85	Coal, some quite bony.....	.95	.95	Sample 41.
152.85	153.35	Bony coal.....	.5	.5	Rejected.
153.35	153.65	Coal, slightly bony.....	.3	.3	Sample 41.
153.65	153.9	Bony coal.....	.25	.25	Rejected.
153.9	154.1	Coal, slightly bony.....	.2	.2	Sample 41.
154.1	154.35	Bony coal.....	.25	.25	Rejected.
154.35	154.55	Coal, slightly bony.....	.2	.2	Sample 41.
154.55	154.75	Silty claystone, numerous streaks and thin bands of coal.	.2	.2	Rejected.
154.75	154.9	Coal, slightly bony.....	.15	.15	Sample 41.
154.9	155.05	Silty claystone with numerous streaks of coal.	.15	.15	Rejected.
155.05	155.7	Coal, some quite bony.....	.65	.65	Sample 41.
155.7	155.95	Silty claystone with occasional streaks and thin bands of coal.	.25	.25	Rejected.
155.95	156.3	Coal, slightly bony.....	.35	.35	Sample 41.

Hole 29 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
156.3	157.05	Silty claystone with numerous streaks and thin bands of coal.	0.75	0.75	Rejected.
157.05	157.2	Coal.....	.15	.15	Sample 41.
157.2	157.35	Silty claystone with numerous streaks and thin bands of coal.	.15	.15	Rejected.
157.35	157.8	Coal, slightly bony.....	.45	.45	Sample 41.
157.8	158.8	Bony coal.....	1.0	1.0	Rejected.
158.8	159.25	Silty claystone with occasional streaks of coal.	.45	.45	Do.
159.25	159.85	Coal, slightly bony.....	.6	.6	Sample 41.
159.85	160.25	Bony coal.....	.4	.4	Rejected.
160.25	161.35	Coal, slightly bony.....	1.1	1.1	Sample 41.
161.35	162.05	Bony coal.....	.7	.7	Rejected.
162.05	162.8	Silty claystone with occasional streaks and small inclusions of coal.	.75	.75	Do.
162.8	163.45	Bony coal.....	.65	.65	Do.
163.45	163.95	Coal, some quite bony.....	.5	.5	Sample 41.
163.95	165.0	Bony coal.....	1.05	1.0	Rejected.
165.0	166.1	Coal, slightly bony.....	1.1	1.1	Sample 41.
166.1	166.3	Bony coal.....	.2	.2	Rejected.
166.3	166.4	Coal, slightly bony.....	.1	.1	Sample 41.
166.4	166.5	Bony coal.....	.1	.1	Rejected.
166.5	168.0	Silty claystone, occasional streaks and small inclusions of coal.	1.5	1.5	Do.
168.0	168.2	Coal.....	.2	.2	Sample 41.
168.2	169.3	Silty claystone with occasional to numerous streaks and thin bands of coal.	1.1	1.1	Rejected.
169.3	169.4	Coal, slightly bony.....	.1	.1	Sample 41.
169.4	171.65	Silty claystone with occasional streaks, thin bands, and small inclusions of coal.	2.25	2.05	
171.65	171.95	Coal, quite bony.....	.3	.3	Do.
171.95	172.3	Bony coal.....	.35	.35	Rejected.
172.3	176.8	Silty claystone with occasional streaks, thin bands, and small inclusions of coal.	4.5	4.2	Do.
176.8	180.3	Silty claystone with numerous streaks and thin bands of coal.	3.5	2.7	Rejected; bedding angle 5°.

Hole 29 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
180.3	180.7	Bony coal.....	0.4	0.4	Rejected.
180.7	181.0	Coal, slightly bony.....	.3	.3	Sample 41.
181.0	181.75	Bony coal.....	.75	.75	Rejected.
181.75	183.2	Coal, some quite bony.....	1.45	1.45	Sample 41.
183.2	183.5	Claystone, coal streaks. End of coal section.	.3	.3	Bedding angle 0° to 5°.
183.5	184.5	Silty claystone.....	1.0	1.0	
184.5	185.3	Fine-grained sandstone, hard and dense.	.8	.8	
185.3	193.4	Silty to sandy claystone....	8.1	4.9	Do.
193.4	[1]207.0	Interlayered silty claystone, siltstone, and fine- to medium-grained sandstone, all soft and incompetent.	13.6	4.8	Grades to more incompetency. Bedding angle 0° to 5°.

[1] Bottom.

Hole 30

Location: 23,551.9 N; 17,715.1 E.

Elevation: Collar of hole: 494.5 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: July 20-August 1, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	58.0	Yellow clayey soil, pebbles, cobbles, and boulders, grades to sand matrix at 7 to 10 feet, some coal float (apparently some of large size), considered typical glacial overburden (difficult to penetrate).	58.0	0.0	
58.0	90.0	Incompetent sandstone, medium- to coarse-grained, occasional pebbles, salt and pepper appearance, sand and pebbles highly siliceous (fishtailed).	32.0	.0	
90.0	92.0	Silty claystone (fishtailed).	2.0	.0	
92.0	95.8	Silty claystone, carbonaceous streaks, bands of fine-grained sandstone from 92.8 to 92.9 feet.	3.8	2.3	Bedding angle 20°.
95.8	106.0	Silty claystone, carbonaceous streaks and bands, hard, dense fine-grained sandstone lens from 101.3 to 101.7 feet.	10.2	5.9	Bedding angle 10° to 15°.
106.0	112.8	Silty claystone, streaks, bands, and inclusions of coal.	6.8	6.8	Bedding angle 5° to 15°.
112.8	113.5	Silty claystone, occasional streaks and thin bands of coal.	.7	.7	Rejected.
113.5	114.35	Coal, some quite bony.....	.85	.85	Sample 42.
114.35	114.85	Bony coal.....	.5	.5	Rejected.
114.85	115.75	Coal, slightly bony.....	.9	.9	Sample 42.
115.75	116.15	Bony coal.....	.4	.4	Rejected.
116.15	117.3	Silty claystone with occasional streaks, small inclusions, and thin bands of coal.	1.15	1.15	Do.

Hole 30 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
117.3	117.9	Silty claystone with numerous streaks and thin bands of coal.	0.6	0.6	Rejected.
117.9	118.0	Coal, quite bony.....	.1	.1	Sample 42.
118.0	118.2	Silty claystone with streaks and thin bands of coal.	.2	.2	Rejected.
118.2	118.4	Coal, slightly bony.....	.2	.2	Sample 42.
118.4	118.8	Silty claystone with numerous streaks and thin bands of coal.	.4	.35	Rejected.
118.8	119.5	Coal.....	.7	.7	Sample 42.
119.5	119.7	Bony coal.....	.2	.2	Rejected.
119.7	119.8	Coal, core badly broken.....	.1	.1	Sample 42.
119.8	121.6	Silty claystone with numerous streaks and thin bands of coal.	1.8	.9	Rejected.
121.6	121.8	Coal.....	.2	.2	Sample 42.
121.8	122.05	Silty claystone, occasional streaks and small inclusions of coal.	.25	.25	Rejected.
122.05	122.2	Coal, slightly bony.....	.15	.15	Sample 42.
122.2	122.75	Bony coal.....	.55	.55	Rejected.
122.75	122.85	Coal.....	.1	.1	Sample 42.
122.85	122.95	Bony coal.....	.1	.1	Rejected.
122.95	123.05	Coal, quite bony.....	.1	.1	Sample 42.
123.05	123.2	Bony coal.....	.15	.15	Rejected.
123.2	123.7	Silty claystone with occasional streaks, small inclusions, and thin bands of coal.	.5	.4	Do.
123.7	123.9	Coal, quite bony.....	.2	.2	Sample 42.
123.9	125.95	Silty claystone with numerous streaks, inclusions, and bands (to 1/2 inch) of coal.	2.05	2.05	Rejected.
125.95	126.2	Coal, quite bony.....	.25	.25	Sample 42.
126.2	126.4	Bony coal.....	.2	.2	Rejected.
126.4	126.7	Silty claystone with occasional streaks and small inclusions of coal.	.3	.3	Do.
126.7	129.05	Banded coal and silty claystone, bands of coal to 0.1 foot, some cross-bedding apparent.	2.35	2.35	Rejected; bedding angle 20° to 25°.
129.05	129.35	Coal, slightly bony.....	.3	.3	Sample 42.

Hole 30 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
129.35	129.6	Bony coal.....	0.25	0.25	Rejected.
129.6	130.8	Claystone with numerous streaks and thin bands of coal.	1.2	1.2	Do.
130.8	135.2	Silty claystone with occasional streaks and thin bands of coal.	4.4	4.4	Do.
135.2	135.5	Bony coal.....	.3	.3	Do.
135.5	137.4	Silty claystone with numerous streaks and thin bands of coal.	1.9	1.9	Do.
137.4	137.55	Coal, slightly bony.....	.15	.15	Sample 42.
137.55	138.4	Silty claystone with occasional streaks and thin bands of coal.	.85	.85	Rejected.
138.4	140.8	Claystone with numerous streaks and thin bands of coal.	2.4	2.4	Do.
140.8	141.05	Coal, some quite bony.....	.25	.25	End sample 42.
141.05	141.4	Bony coal.....	.35	.35	Rejected.
141.4	151.4	Silty to fine sandy claystone, occasional coal streaks, bands, and inclusions, fine-grained sandstone lens from 145.5 to 146.9 feet (dense, moderately hard), grades to more sandy, less competent phase.	10.0	7.1	Bedding angle 5° to 10°.
151.4	[1]190.0	Incompetent medium-grained sandstone, occasional pebbles, constituents highly siliceous but very little or no cementing, occasional coaly inclusions (fishtailed).	38.6	.0	

[1] Bottom.

Hole 31

Location: 24,154.6 N; 16,222.1 E.

Elevation: Collar of hole: 468.1 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 2-5, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	2.5	Soil overburden.....	2.5	0.0	
2.5	14.0	Glacial sand and gravel overburden.	11.5	.0	
14.0	15.0	Silty claystone with occasional streaks and bands of coal (fishtailed).	1.0	.0	
15.0	20.0	Silty claystone.....	5.0	.2	Core recovered consisted of highly siliceous pebbles and cobbles (probably cave from above).
20.0	28.4	Silty claystone with occasional coal streaks, bands, and inclusions, contains numerous minute particles of muscovite.	8.4	7.6	
28.4	34.4	Silty claystone containing numerous minute specks of muscovite.	6.0	5.6	Bedding angle 5°.
34.4	36.8	Silty claystone.....	2.4	2.4	Bedding angle 10° to 12°.
36.8	37.6	Very fine-grained sandstone with some intermingled and crossbedded medium- to fine-grained sandstone hard and dense.	.8	.8	
37.6	42.0	Silty claystone.....	4.4	2.7	
42.0	48.0	Silty claystone, very soft and incompetent (fishtailed).	6.0	.0	
48.0	48.7	Medium-grained sandstone, granitic appearance, hard and dense.	.7	.7	
48.7	50.3	Coaly claystone with streaks and narrow bands of coal.	1.6	1.6	

Hole 31 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
50.3	54.8	Silty claystone with occasional streaks and bands of coal.	4.5	4.5	Bedding angle 5° to 7°.
54.8	55.1	Fine-grained sandstone, hard and dense.	.3	.3	
55.1	61.4	Silty claystone, very soft and incompetent.	6.3	.6	
61.4	62.2	Silty claystone.....	.8	.8	Do.
62.2	62.4	Very fine-grained sandstone, cherty appearance.	.2	.2	
62.4	72.0	Soft, incompetent fine-grained sandstone grading to medium-grained, soft incompetent pebbly sandstone.	9.6	.2	
72.0	[1]150.0	Medium-grained, soft incompetent pebbly sandstone (fishtailed).	78.0	.0	

[1] Bottom. Drill hole probably just missed underlying seam. Hole slightly artesian.

Hole 32

Location: 19,800.8 N; 24,994.6 E.

Elevation: Collar of hole: 465.2 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 8-24, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	3.0	Muskeg.....	3.0	0.0	
3.0	3.5	Yellow clayey material.....	.5	.0	
3.5	7.0	Muskeg.....	3.5	.0	
7.0	20.0	Glacial overburden, sand, pebbles, and cobbles.	13.0	.0	
20.0	24.5	Silty clay material with numerous highly siliceous pebbles and cobbles plus numerous coal pebbles, considered part of unconsolidated overburden.	4.5	3.4	Probably glacial lake deposited.
24.5	46.0	Glacial overburden, sand, pebbles, and cobbles.	21.5	.0	
46.0	46.8	Fine-grained sandstone, fairly hard and dense.	.8	.8	
46.8	64.5	Silty to sandy claystone....	17.7	12.5	
64.5	67.4	Fine-grained sandstone, hard and dense.	2.9	2.9	Contact angle at 64.5 feet = 25°.
67.4	140.4	Silty to sandy claystone, occasional limonite staining, occasional bands of almost identical appearing very fine-grained sandstone, occasional coaly streaks in lower 5 feet.	73.0	57.3	Bedding angle 60°.
140.4	143.1	Fine-grained sandstone, hard and dense, one 0.2-foot coal inclusion.	2.7	2.7	
143.1	146.4	Interbedded silty and sandy claystone.	3.3	1.0	Bedding angle 45°.
146.4	146.5	Very fine-grained sandstone, hard and dense.	.1	.1	
146.5	186.2	Interbedded silty and sandy claystone, occasional coaly streaks and inclusions, occasional limonite staining.	39.7	36.0	Bedding angle 45° to 50°.

Hole 32 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
186.2	188.0	Silty claystone with numerous thin bands and streaks of coal.	1.8	1.8	Bedding angle 60°.
188.0	188.1	Fine-grained sandstone.....	.1	.1	
188.1	191.4	Silty claystone with numerthin bands and streaks of coal.	3.3	3.3	Bedding angle 45°.
191.4	197.2	Interbedded silty and sandy claystone, occasional coaly streaks.	5.8	5.7	
197.2	198.6	Very fine-grained sandstone, hard and dense, occasional thin coaly inclusions and streaks.	1.4	1.4	
198.6	210.2	Silty claystone, occasional to numerous thin coal bands and streaks.	11.6	12.4	Bedding angle 50°.
210.2	241.7	Silty claystone, occasional limonite staining, carbonaceous streaks, and fine-grained sandstone inclusions.	31.5	29.6	Bedding angle 50° to 55°.
241.7	244.1	Silty claystone, numerous thin coal bands and streaks.	2.4	2.4	
244.1	244.5	Fine-grained sandstone, fairly hard and dense.	.4	.4	
244.5	265.6	Silty claystone, occasional carbonaceous streaks and bands, limonite staining, small limonite-stained fine-grained sandstone inclusions, and small coal inclusions.	21.1	17.9	Bedding angle 45°.
265.6	265.8	Fine-grained sandstone, fairly hard and dense.	.2	.2	
265.8	288.6	Silty claystone, occasional limonite-stained banding, inclusions of limonite-stained fine-grained sandstone, coal streaks, and thin bands.	22.8	16.4	Bedding angle 35°.
288.6	288.8	Silty claystone, occasional streaks and small inclusions of coal.	.2	.15	Rejected.

Hole 32 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
288.8	289.0	Bony coal.....	0.2	0.2	Rejected.
289.0	289.1	Coal, quite bony.....	.1	.1	Sample 43.
289.1	289.3	Bony coal.....	.2	.2	Rejected.
289.3	290.5	Coal, slightly bony.....	1.2	1.2	Sample 43; bedding angle 30°.
290.5	290.6	Bony coal.....	.1	.1	Rejected.
290.6	291.2	Coal, some quite bony.....	.6	.5	Sample 43.
291.2	294.3	Claystone, coaly hue, occasional streaks, thin bands, and small inclusions of coal.	3.1	1.8	Rejected.
294.3	298.4	Coal, some quite bony. (Core loss assumed to be coal).	4.1	1.0	Sample 43; bedding angle 45°.
298.4	298.5	Bony coal.....	.1	.1	Rejected.
298.5	301.6	Siltstone, occasional streaks, and thin bands of coal.	3.1	1.6	Do.
301.6	302.1	Bony coal.....	.5	.5	Do.
302.1	304.5	Silty claystone with streaks and bands of coal (1 band 1/2 inch thick).	2.4	2.0	Rejected; bedding angle 47°.
304.5	306.0	Coal, some quite bony, some with crushed appearance. (Core loss assumed to be coal).	1.5	.3	Sample 43.
306.0	307.4	Silty claystone with numerous streaks and thin bands of coal.	1.4	.2	Rejected.
307.4	308.5	Coal, slightly bony.....	1.1	1.0	End sample 43.
308.5	318.6	Silty claystone, occasional streaks, bands, and inclusions of coal.	10.1	10.0	
318.6	318.8	Coaly claystone.....	.2	.2	
318.8	318.9	Coal.....	.1	.1	No sample taken.
318.9	319.4	Coaly claystone.....	.5	.5	
319.4	319.55	Coal.....	.15	.15	Bedding angle 10° to 15°. No sample taken.
319.55	320.5	Coaly claystone.....	.95	.95	
320.5	320.8	Coal, slightly bony.....	.3	.3	No sample taken.
320.8	321.6	Claystone, carbonaceous.....	.8	.8	
321.6	322.1	Banded coal and claystone....	.5	.5	
322.1	328.0	Silty claystone, occasional streaks, bands, and inclusions of coal.	5.9	5.9	

Hole 32 (Con.)

Depth, feet From-	Depth, feet To-	Material	Thickness, feet	Core recovery, feet	Remarks
328.0	331.1	Carbonaceous claystone with bands of coal (to 0.3 foot).	3.1	3.1	
331.1	332.1	Silty claystone, streaks, and inclusions of coal.	1.0	1.0	
332.1	334.5	Banded coal and claystone (coal bands to 0.25 foot).	2.4	2.0	Bedding angle 10° to 15°.
334.5	335.1	Carbonaceous claystone with streaks and inclusions of coal.	.6	.6	
335.1	335.8	Silty claystone with streaks and inclusions of coal.	.7	.7	
335.8	336.8	Coal, slightly bony.....	1.0	1.0	No sample taken.
336.8	341.6	Silty claystone, occasional streaks and inclusions of coal.	4.8	4.8	
341.6	344.5	Banded coal and claystone, coal bands to 0.25 foot.	2.9	2.9	Bedding angle 10° to 15°.
344.5	345.8	Carbonaceous claystone and silty claystone, occasional streaks, bands, and inclusions of coal.	1.3	1.3	
345.8	347.3	Silty claystone grading to fine-grained, soft incompetent sandstone.	1.5	1.5	
347.3	361.0	Fine- to medium-grained, soft incompetent sandstone, occasional carbonaceous banding in lower 8 feet.	13.7	12.6	Do.
361.0	[1]366.1	Conglomerate, poorly cemented.	5.1	.0	Probably true conglomerate as compared with numerous other intersections of pebbly sandstone.

[1] Bottom.

Hole 33

Location: 21,164.4 N; 26,686.1 E.

Elevation: Collar of hole: 466.3 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: August 28-Sept. 2, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	5.0	Yellow clayey soil.....	5.0	0.0	
5.0	10.0	Glacial sand and gravel.....	5.0	.0	
10.0	12.0	Green glacial clay, soft....	2.0	.0	
12.0	30.0	Blue-gray, clayey glacial sandstone.	18.0	.0	
30.0	68.8	Gray, sandy glacial claystone.	38.8	.0	
68.8	69.05	Medium-grained sandstone, hard and dense.	.25	.25	Tertiary bedrock.
69.05	69.7	Silty claystone, soft.....	.65	.1	
69.7	69.8	Medium-grained sandstone, hard and dense.	.1	.05	
69.8	76.1	Silty claystone, coal streaks and bands in lower 0.1 foot.	6.3	6.3	Bedding angle 0° to 5°.
76.1	78.4	Coal, some slightly bony....	2.3	2.3	Sample 44.
78.4	78.55	Bony coal.....	.15	.15	Rejected.
78.55	78.85	Coal, slightly bony.....	.3	.3	Sample 44.
78.85	79.05	Bony coal.....	.2	.2	Rejected.
79.05	79.7	Coal, some slightly bony....	.65	.65	Sample 44.
79.7	79.8	Bony coal.....	.1	.1	Rejected.
79.8	80.8	Coal, some slightly bony....	1.0	1.0	Sample 44.
80.8	81.05	Bony coal.....	.25	.25	Rejected.
81.05	82.45	Coal, some slightly bony....	1.4	1.4	Sample 44.
82.45	82.55	Fine-grained sandstone, coaly hue.	.1	.1	Rejected.
82.55	83.4	Coal, some slightly bony....	.85	.85	Sample 44.
83.4	83.5	Fine-grained sandstone, streaks of coal.	.1	.1	Rejected.
83.5	84.1	Coal, some slightly bony....	.6	.6	Sample 44.
84.1	84.25	Bony coal.....	.15	.15	Rejected.
84.25	84.45	Coal, slightly bony.....	.2	.2	Sample 44.
84.45	85.2	Silty claystone with numerous streaks and thin bands of coal.	.75	.75	Rejected; bedding angle 0° to 5°.
85.2	85.6	Coal, slightly bony.....	.4	.4	Sample 44.
85.6	85.7	Bony coal.....	.1	.1	Rejected.
85.7	86.0	Coal, slightly bony.....	.3	.3	Sample 44.

Hole 33 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
86.0	86.3	Silty claystone, occasional streaks of coal.	0.3	0.3	Rejected.
86.3	86.55	Coal, slightly bony.....	.25	.25	Sample 44.
86.55	87.05	Silty claystone, numerous bands (to 1/2 inch) and streaks of coal.	.5	.5	Rejected.
87.05	87.35	Fine-grained sandstone, occasional streaks and thin bands of coal.	.3	.3	Do.
87.35	88.9	Coal, slightly bony.....	1.55	1.55	Sample 44.
88.9	89.1	Bony coal.....	.2	.2	Rejected.
89.1	89.55	Silty claystone, occasional streaks and thin bands of coal.	.45	.45	Do.
89.55	89.7	Coal, slightly bony.....	.15	.15	Sample 44.
89.7	89.8	Silty claystone, streaks and bands of coal.	.1	.1	Rejected.
89.8	90.5	Bony coal.....	.7	.7	Do.
90.5	90.8	Coal, quite bony.....	.3	.3	Sample 44.
90.8	91.3	Silty claystone, numerous streaks and bands of coal.	.5	.5	Rejected.
91.3	93.4	Coal, some quite bony.....	2.1	2.1	Sample 44.
93.4	93.55	Bony coal.....	.15	.15	Rejected.
93.55	93.7	Coal, slightly bony.....	.15	.15	Sample 44.
93.7	93.8	Bony coal.....	.1	.1	Rejected.
93.8	94.7	Coal, slightly bony.....	.9	.9	Sample 44.
94.7	95.0	Bony coal.....	.3	.3	Rejected.
95.0	95.1	Coal, slightly bony.....	.1	.1	Sample 44.
95.1	95.3	Bony coal.....	.2	.2	Rejected.
95.3	95.5	Silty claystone, coaly hue..	.2	.2	Do.
95.5	95.7	Bony coal.....	.2	.2	Do.
95.7	95.9	Coal, quite bony.....	.2	.2	Sample 44.
95.9	96.05	Bony coal.....	.15	.15	Rejected.
96.05	96.15	Coal, slightly bony.....	.1	.1	Sample 44.
96.15	96.7	Bony coal.....	.55	.55	Rejected.
96.7	97.2	Coal, some quite bony.....	.5	.5	End sample 44.
97.2	99.8	Silty claystone, occasional streaks and small inclusions of coal.	2.6	2.2	Rejected.
99.8	109.8	Interbedded silty claystone and soft medium-grained sandstone, occasional thin coaly bands and streaks.	10.0	9.8	
109.8	114.0	Medium-grained sandstone, soft, occasional coaly streaks.	4.2	4.2	

Hole 33 (Con.)

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
114.0	114.6	Medium-grained sandstone, fairly hard and dense.	0.6	0.6	
114.6	167.0	Soft, incompetent medium-grained pebbly sandstone.	52.4	.0	
167.0	167.3	Claystone, coaly hue.....	.3	.3	Rejected.
167.3	167.8	Very fine-grained sandstone, occasional small inclusions and 1 thin band of coal.	.5	.5	Do.
167.8	167.95	Claystone, coaly hue.....	.15	.15	
167.95	168.15	Coal, slightly bony.....	.2	.2	Sample 45.
168.15	169.4	Silty claystone, occasional streaks and small inclusions of coal.	1.25	1.25	Rejected.
169.4	169.8	Coal, slightly bony.....	.4	.4	Sample 45.
169.8	170.2	Bony coal.....	.4	.4	Rejected.
170.2	170.35	Coal, quite bony.....	.15	.15	Sample 45.
170.35	171.4	Bony coal.....	1.05	1.05	Rejected.
171.4	171.55	Coal, slightly bony.....	.15	.15	Sample 45.
171.55	171.8	Siltstone, occasional small inclusions and thin bands of coal.	.25	.25	Rejected.
171.8	172.0	Coal, slightly bony.....	.2	.2	Sample 45.
172.0	172.4	Coaly claystone.....	.4	.4	Rejected.
172.4	172.9	Coal, some quite bony.....	.5	.5	Sample 45.
172.9	173.1	Coaly claystone.....	.2	.2	Rejected.
173.1	177.65	Claystone, occasional small inclusions and thin bands of coal (one 1/2-inch band).	4.55	4.1	Do.
177.65	178.05	Coal, slightly bony.....	.4	.4	Sample 45.
178.05	178.15	Bony coal.....	.1	.1	Rejected.
178.15	179.55	Coal, some quite bony.....	1.4	1.4	End sample 45.
179.55	181.6	Coaly claystone.....	2.05	2.0	Rejected.
181.6	182.8	Silty claystone, occasional small inclusions of coal.	1.2	1.2	Do.
182.8	190.5	Claystone, occasional thin coal bands and streaks.	7.7	6.8	Bedding angle 0° to 5°.
190.5	221.0	Silty claystone, occasional carbonaceous streaks and banding.	30.5	28.1	Bedding angle 0° to 10°.
221.0	227.7	Incompetent, soft medium-grained pebbly sandstone.	6.7	.0	
227.7	248.0	Interbedded silty claystone and very fine-grained sandstone, occasional carbonaceous streaks.	20.3	6.8	Bedding angle 0° to 5°.
248.0	[1]252.0	Soft, incompetent medium-grained sandstone.	4.0	1.5	

[1] Bottom.

Hole 34

Location: 18,129.0 N; 24,661.7 E.

Elevation: Collar of hole: 472.8 feet, mean sea level datum.

Dip of hole: Vertical. Dates drilled: September 5-12, 1961.

Depth, feet		Material	Thickness, feet	Core recovery, feet	Remarks
From-	To-				
0.0	3.0	Soil.....	3.0	0.0	
3.0	62.0	Glacial overburden, pebbles, cobbles, boulders, and fine loose runny sand (sand was of a consistency or created a hole condition such that the sand would not wash from the drill hole).	59.0	.0	
62.0	92.0	Medium-grained, pebbly incompetent sandstone, little or no cementing, small amount of clayey binder.	30.0	.0	Probably a gradation phase of glacial till.
92.0	108.0	Silty claystone material impregnated with numerous pebbles and cobbles, some coal pebbles. Silty claystone has a coaly hue.	16.0	2.0	Probably glacial lake deposited.
108.0	[1]113.5	Pebbles, cobbles, and medium-grained loose runny sand.	5.5	.0	Probably glacial till.

[1] Bottom. Hole abandoned because of very difficult drilling conditions.

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