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COAL DEPOSITS OF THE COSTELLO CREEK BASIN, ALASKA

by

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44-26

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INTRODUCTION

During the summer of 1943 the Geological Survey examined the Costello Creek coal basin, Alaska. In parts of June and July 1943, an area in the vicinity of the Dunkle coal mine was mapped on a scale of 1:2400 (1 in. to 200 ft.) by Clyde Wahrhaftig and Jacob Freedman. From the middle of August to the middle of October, geological studies were carried out in conjunction with a diamond-drilling and trenching program of the Bureau of Mines in part of the basin. The work of the Geological Survey included reconnaissance mapping, geologic advice on location of drill holes and trenches, logging of drill cores, and interpretation of drill-core data. Franklin A. Rutledge, engineer in charge of the Bureau of Mines project, surveyed the locations of drill holes and trenches.

The basin containing the coal-bearing rocks covers about 7 square miles (see fig. 2) and lies on the southern flank of the Alaska Range about 11 miles by road northwest of Colorado Station on the Alaska Railroad (see fig. 1). The coal basin is a gently rolling plateau about 3,000 feet in average altitude, containing many muskeg-covered flats, and dissected by numerous canyons 100 feet to 300 feet deep. It is bounded on the northwest by mountains as much as 5,000 feet in altitude, and on the east by low hills about 500 feet high. South of the basin the land slopes steeply into the valley of the West Fork of the Chulitna River.

Coal in the Costello Creek basin was first mined in 1912 and 1913 for blacksmithing requirements of local gold prospectors. The first coal-prospecting permit was issued to Henry Stevens in July 1929 and reissued in 1934 and 1939. In July 1941 it was transferred by Stevens to W. E. Dunkle.

Work was performed in the no. 1 entry of the Dunkle coal mine as early as 1931 by Henry Stevens. From 1939 to 1941 the coal was used at the Golden Zone mine, a gold mine approximately 8 miles by road south of the coal deposits. Late in 1941 entry no. 2 was opened, and a horizontal tipple and 50-ton bunker were constructed. Production of coal for markets along the railroad was started in December 1941. About 5,000 tons of coal were mined and shipped by September 1943. Present development work at the Dunkle coal mine includes straightening and extension of the main haulage way of entry no. 2, with the intention of mining the "Billie" beds, and installation of a conveyor system in the mine.

GENERAL GEOLOGY

The Costello Creek coal basin is one of several small isolated areas of coal-bearing rocks of Tertiary age that lie in a broad depression which includes Broad Pass and the valleys of the upper Nenana and Chulitna Rivers. The coal-bearing rocks of the Costello Creek basin are partly consolidated and in general only moderately deformed. They rest upon metamorphosed and considerably deformed sedimentary and igneous rocks. The coal is subbituminous in rank, and the coal beds range greatly in thickness within short distances.

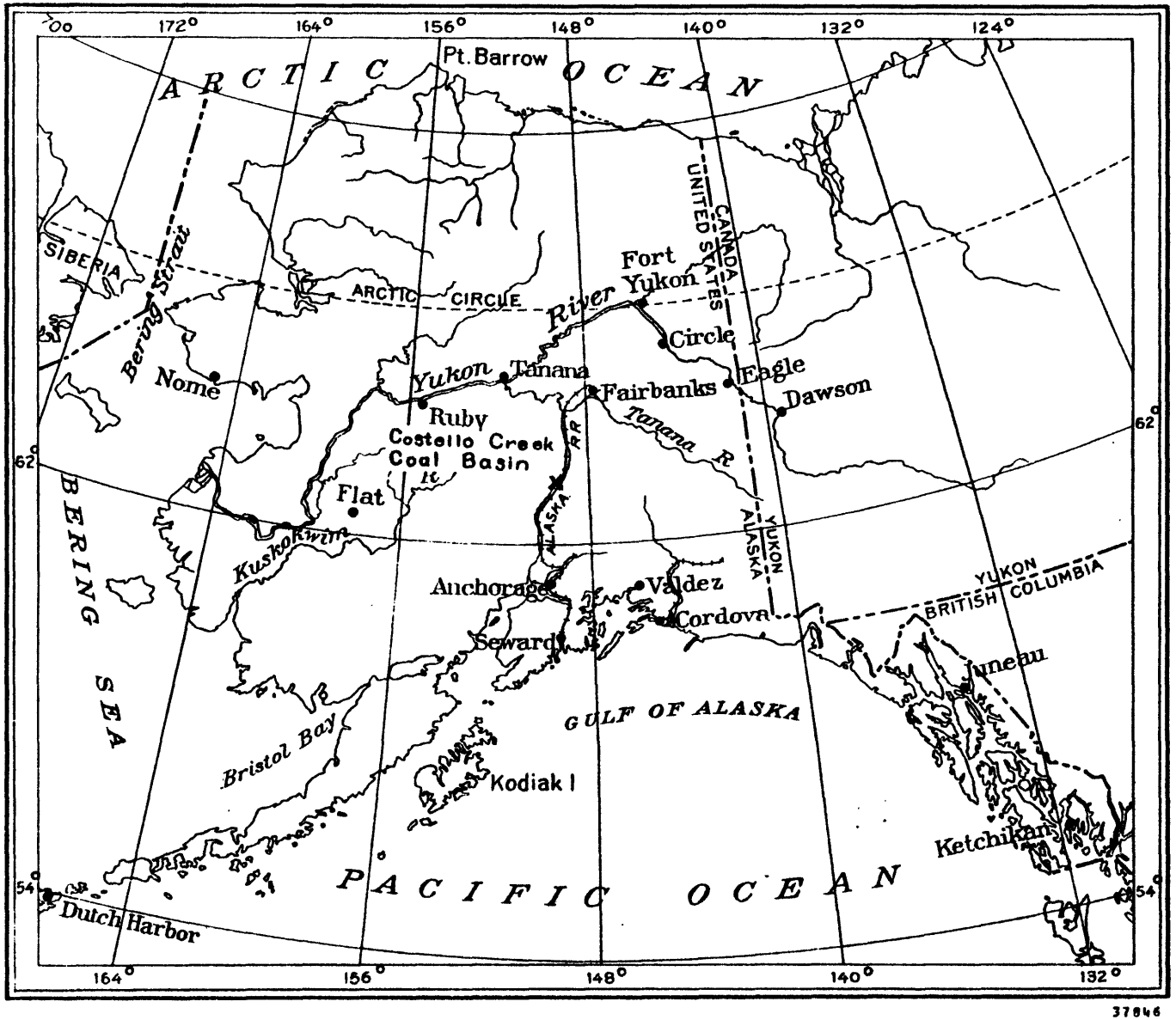

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Fig. 1. Map showing location of Costello Creek Coal Basin, Alaska

Pre-Tertiary rocks

The oldest rocks exposed in the vicinity of the Costello Creek basin are partly metamorphosed and considerably deformed volcanic and sedimentary rocks. According to Ross 1/ and Capps 2/ these rocks range in age from Permian to Jurassic. These rocks contain no coal. Small bodies of diorite and quartz diorite, also older than the Tertiary coal-bearing rocks, intrude the Paleozoic and Mesozoic rocks. The pre-Tertiary rocks were not differentiated in the mapping (see figs. 2 and 3).

Tertiary rocks

The Tertiary sequence consists of partly consolidated sandstone, siltstone, mudstone, and conglomerate, and includes discontinuous coal beds. The sequence has been divided into a lower part, from the base up to and including the upper "Billie" bed, characterized by coal and brown siltstone, and an upper part characterized by coarse sand beds containing grains of quartz and argillite. The lower part ranges from about 16 feet to about 85 feet in thickness. This range reflects the irregularity of the surface on which the Tertiary rocks were deposited, and the differential compaction of the Tertiary beds. The lower part of the sequence has been recognized with certainty only along the banks of Camp Creek and its tributaries. The total thickness of the upper part is not known, because the top of the sequence is not exposed. However, 500 or more feet of beds are exposed in the syncline in the northeastern part of the area shown on figure 2. The greatest thickness of the upper part of the Tertiary sequence observed in the vicinity of the Dunkle coal mine is 105 feet.

The coal-bearing rocks rest on an irregular surface carved in the earlier deformed rocks. At this surface, and extending in places for 30 feet beneath it, is a zone of intensely weathered rock. The weathered rock at the contact is distinguished with difficulty from the immedately overlying sediments. Most of the surface of this unconformity is mangled by an unsorted breccia, composed of angular fragments derived from pre-Tertiary rocks, in a matrix of silt. The fragments range in diameter from a fraction of an inch to several inches and make up from 5 to 60 percent of the rock. The breccia ranges from a few feet to more than 20 feet thick. Siltstone containing as much as 10 percent of angular fragments from 0.05 inch to 0.5 inch in diameter is interbedded with coal and claystone throughout the lower part of the coal-bearing sequence.

1/ Ross, C. P., Mineral deposits near the West Fork of the Chulitna River, Alaska: U. S. Geol. Survey Bull. 849-E, pp. 294-302, 1933.

2/ Capps, S. R., The eastern portion of Mount McKinley National Park: U. S. Geol. Survey Bull. 836-D, p. 263, 1933.

The siltstone and claystone which make up most of the lower part of the Tertiary sequence contain coal laminae, in places in sufficient abundance to class the rock as bony coal. Some of the claystone beds contain gray concretions as much as 2 feet in diameter and flattened parallel to the bedding. These concretions weather bright orange and effervesce in hydrochloric acid. The beds containing them are more free of carbonaceous material than other beds.

The sandstone beds in the lower portion of the Tertiary sequence are from 6 to 24 inches thick. The sandstone is ordinarily cross-bedded and in many places occupies channels eroded in coal and claystone. The sandstone is grayish-brown and consists of grains derived from the weathered basement rocks. These grains are cemented by silt and clay.

Correlations of beds within the lower part of the Tertiary coal-bearing sequence suggested by the graphic logs (see figs. 5, 6, and 7) are open to considerable question. The most dependable horizon appears to be the top of the upper "Billie" bed, and it is marked by a pronounced change in the kind of materials making up the clastic sediments. In calculating the coal reserves, it was assumed that the 9-foot coal bed penetrated by diamond-drill hole 14 represents the "Billie" beds. It is possible, however, that this coal represents the "Dunkle" bed, and that the "Billie" beds are absent from the section in the vicinity of this hole (see fig. 7).

The upper part of the Tertiary sequence includes all beds above the upper "Billie" bed. It is characterized by thick beds of blue-gray sandstone, which contain abundant subangular to well-rounded grains of black argillite and milky quartz. The sandstone is interbedded with some blue and gray silt, in which excellently preserved leaf prints have been found. Fossil leaves collected from a locality in this part of the sequence have been determined by R. W. Brown to be of Upper Eocene or later age 3/. Only a few thin beds of coal are known in the upper part of the Tertiary sequence. No beds of minable thickness have been found. Carbonized logs and branches are common in the more sandy layers.

Quaternary deposits

In most places the Tertiary coal-bearing sequence and older rocks are overlain by glacial outwash of probable Pleistocene age. The deposits are poorly sorted and rudely stratified and contain varved clay in places. Angular boulders of granite and conglomerate, up to 10 feet on a side, are scattered over the surface of the coal basin and occur in gravel and sand beds.

3/ Ross, C. P., op. cit., p. 303.

The glacial deposits are undeformed and unconsolidated. They were laid down over an irregular surface which approximates in a general way the present configuration of the land. The outwash deposits are thought to be fluvially reworked morainal material. Till has been observed in the mountains on the north side of the basin.

STRUCTURAL GEOLOGY

The Costello Creek coal basin is a complex structural depression. Poor exposures and the irregularity of the surface beneath the coal-bearing rocks render solution of detailed structural problems difficult.

The basin appears to be bounded on the northwest by a major uplift. Where relations between the Tertiary rocks and the Mesozoic rocks to the northwest were observed, the Tertiary rocks either were faulted down against the Mesozoic rocks or were folded down with respect to the bordering areas of Mesozoic rocks. On the southeast border of the basin, from the vicinity of the Dunkle coal mine to and beyond the first large tributary of Camp Creek from the southeast above Coal Creek, locally known as Carbon Creek, the Tertiary sequence appears to be bounded by a complex series of normal(?) hinge faults. The beds throughout much of the basin appear to be nearly flat, except locally, as in the syncline in the northeast part of the basin, where the dip in places is as steep as 90 degrees.

Normal(?) hinge faults, with displacements as much as 200 feet, separate Tertiary from pre-Tertiary rocks in the northeast and southwest parts of the area in the vicinity of Dunkle coal mine (see fig. 3). The Tertiary beds in this area are gently warped and tilted. A monoclinal fold in the vicinity of diamond-drill holes 12, 14, and 15 has a small syncline at its base. The difference in altitude between portions of the same bed on either side of the monocline increases to the north. Northward the monocline may pass into the normal(?) fault in the northeast part of the area shown on figure 3. If this is the case, the structure probably passes west of diamond-drill hole 19, which goes directly from glacial material into pre-Tertiary rocks at about 65 feet below the surface.

Many reverse faults of small displacement were observed in the workings of the Dunkle coal mine. The largest displacement measured is 10 feet, vertically. These faults strike northwest and dip 20° to 60° in either direction. On one or the other, or both, sides of each of the reverse faults, the beds are warped gently in a direction opposite that of the displacement along the fault (see fig. 4). Consequently the displacement of a bed at a distance of 50 to 100 feet from a fault is much less than the vertical component of the displacement along the fault.

COAL DEPOSITS

The maximum thickness of the thickest coal bed in the Costello Creek basin is 9 feet. The coal beds near the base of the Tertiary sequence are very lenticular. For example, a 36-inch coal bed exposed in trench no. 4 thins to three 3-inch beds in a distance of 14 feet (see fig. 5). The coal beds higher in the section are more uniform in thickness and more continuous. The two upper coal beds of the lower part of the Tertiary coal-bearing sequence, the upper and the lower "Billie" beds, were originally continuous over most of the area shown on figure 3 (see figs. 5, 6, and 7). Along the east and northwest borders of the area containing minable coal (see fig. 8), glacial deposits cover the truncated edges of the coal beds.

The coal is thought to represent accumulations of carbonaceous material in a marshland. Small streams entering the marshland carried in silt and clay and deposited lenticular bodies of argillaceous sand. The coal is believed to have accumulated chiefly in thos areas where plant growth was thick enough to prevent infiltration of silt and clay.

Minable coal in the Costello Creek basin is known in three beds. The lowest is the "Dunkle" bed. The other two are known collectively as the "Billie" bed. All are in the immediate vicinity of the Dunkle coal mine in the southeastern part of the basin.

Character of the coal

The coal has a dull to shiny luster, is black with a dark-brown to black streak, and has a conchoidal fracture. The coal commonly is thinly laminated, the laminae averaging about 0.1 inch thick. The coal in the present workings is well jointed.

The quality of the coal in the "Dunkle" bed can best be judged from bulk analyses of coal shipped to markets along the Alaska Railroad. The bulk analyses listed in table I, analyses 1 to 5, are on coal obtained from the no. 2 workings in the "Dunkle" bed. Proximate analyses of 3 samples taken by C. R. Garrett are listed as nos. 6 to 8 in table 1. Ultimate analyses of these 3 samples are shown in table II.

Analyses of coal from the upper and lower "Billie" beds are listed as nos. 13 to 24, table I. No. 13 was taken by C. R. Garret from the present workings; the others are from samples obtained in the diamond-drill cores. The coal has been classified as subbituminous B, non-agglomerating ash.

The analyses of coal from the diamond-drill holes show a much higher content of ash than those of coal from the workings. Impurities worked into the coal during drilling may be responsible in part for the increase in ash content.

Analyses with ash content over 15 percent were reported on coal from diamond-drill holes 11 and 15 only.

The coal is crushed along several of the small reverse faults.

TABLE II

Ultimate analyses of coal from Dunkle coal mine

Analysis no. *	Location of sample	Form of analysis	H	C	N	O	S	Ash	B. t. u.
6	Approx. 450' from portal, entry no. 2. At face in haulage way.	A	6.1	55.1	0.8	28.2	0.6	9.2	9,700
		B	5.9	58.3	0.9	24.5	0.7	9.7	10,260
		C	5.0	67.5	1.0	14.4	0.8	11.3	11,880
		D	5.7	76.0	1.1	16.4	0.8	----	13,380
	Softening temperature of ash 2530° F.								
7	140' from portal, entry no. 1. 30' to face in room no. 2 N.	A	6.3	57.1	0.9	29.0	0.5	6.2	10,040
		B	6.0	60.2	0.9	25.8	0.5	6.6	10,590
		C	5.2	70.3	1.1	15.2	0.6	7.6	12,360
		D	5.6	76.1	1.1	16.6	0.6	---	13,380
	Softening temperature of ash 2090° F.								
8	40' from portal, entry no. 2, room no. 1. 120' to face from haulage way.	A	6.2	59.7	0.9	26.7	0.5	6.0	10,600
		B	6.1	61.6	1.0	24.6	0.5	6.2	10,940
		C	5.3	71.0	1.1	14.8	0.6	7.2	12,610
		D	5.7	76.5	1.2	16.0	0.6	---	13,580
	Softening temperature of ash 2440° F.								
13	Approx. 40' from portal, entry no. 1. In raise 5' above hanging wall of "Stevens" bed (Dunkle bed).	A	6.3	56.8	0.9	27.9	0.5	7.6	9,970
		B	6.1	59.0	0.9	24.5	0.5	8.1	10,520
		C	5.3	69.4	1.1	14.3	0.6	9.3	12,200
		D	5.8	76.5	1.2	15.9	0.6	---	13,450
	Softening temperature of ash 2520° F.								

* Nos. refer to analysis nos. in table 1.

TABLE III

RESERVES OF INDICATED COAL IN MINABLE BEDS, COSTELLO CREEK BASIN

Name of bed	Area underlain by bed (see fig. 8)	Average thickness (weighted)	Tons of coal in bed
Upper Billie	810,000 sq. ft.	3.9 ft.	125,000
Lower Billie	1,253,000 sq. ft.	3.4 ft.	170,000
Dunkle (vicinity of workings)	261,000 sq. ft.	5.3 ft.	50,000
Dunkle (vicinity of D. D. H. 16)	47,000 sq. ft.	4.6 ft.	8,000
		Total	353,000

Coal reserves

The accuracy of calculations of the coal reserves, based on study of the outcrops, trenches, mine openings, and diamond-drill information, is dependent upon the accuracy of the correlations of coal beds from place to place. It has already been pointed out that these correlations are open to considerable question.

It was assumed that the minimum thickness of coal that can be mined in a given level is 30 inches. Coal with ash content as much as 23 percent was included in the reserves. This does not compare unfavorably with some coal which has been shipped from the Alaska Railroad's mine at Eska Creek 4/. The boundaries of the areas underlain by coal which has been considered minable are shown on figure 8a. Contour lines, drawn on the base of the supposed minable coal in the "Billie" bed, are also shown on this figure, as well as on figure 3. If the 9-foot coal bed penetrated by diamond-drill hole 14 is the "Dunkle"bed rather than the "Billie" beds, the structure and distribution of supposed minable coal beds are as indicated on figure 8b.

For the calculations of the volume of coal in the individual beds, it was assumed that the thickness of a bed changes uniformly from place to place. The volume of 1 ton of coal was taken to be 25 cubic feet.

The coal in the upper "Billie" bed is overlain by soft clay in diamond-drill holes 12, 15, and 16, and the coal in the lower "Billie" bed is overlain by soft clay in diamond-drill hole 13. If it is found necessary to leave coal to support the roof during mining in such places, the tonnage of coal recovered will, of course, be reduced.

4/ Tuck, Ralph, The Eska Creek coal deposits, Matanuska Valley, Alaska: U. S. Geol. Survey Bull. 880-D, p. 203, 1937.

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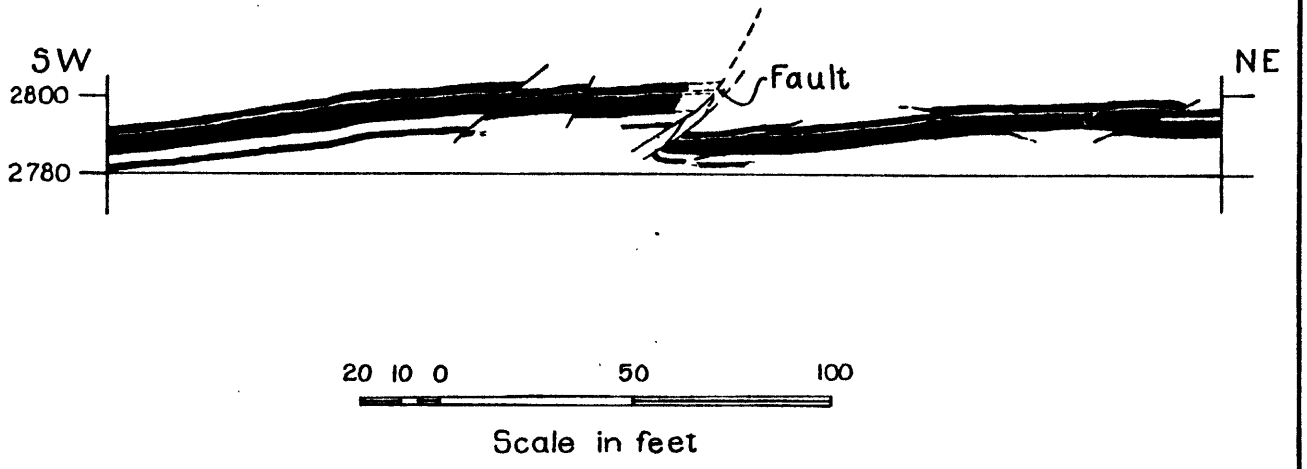

Fig 4: Section through Dunkle coal bed in No. 2 workings

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WAR MINERALS INVESTIGATION
PRELIMINARY MAP

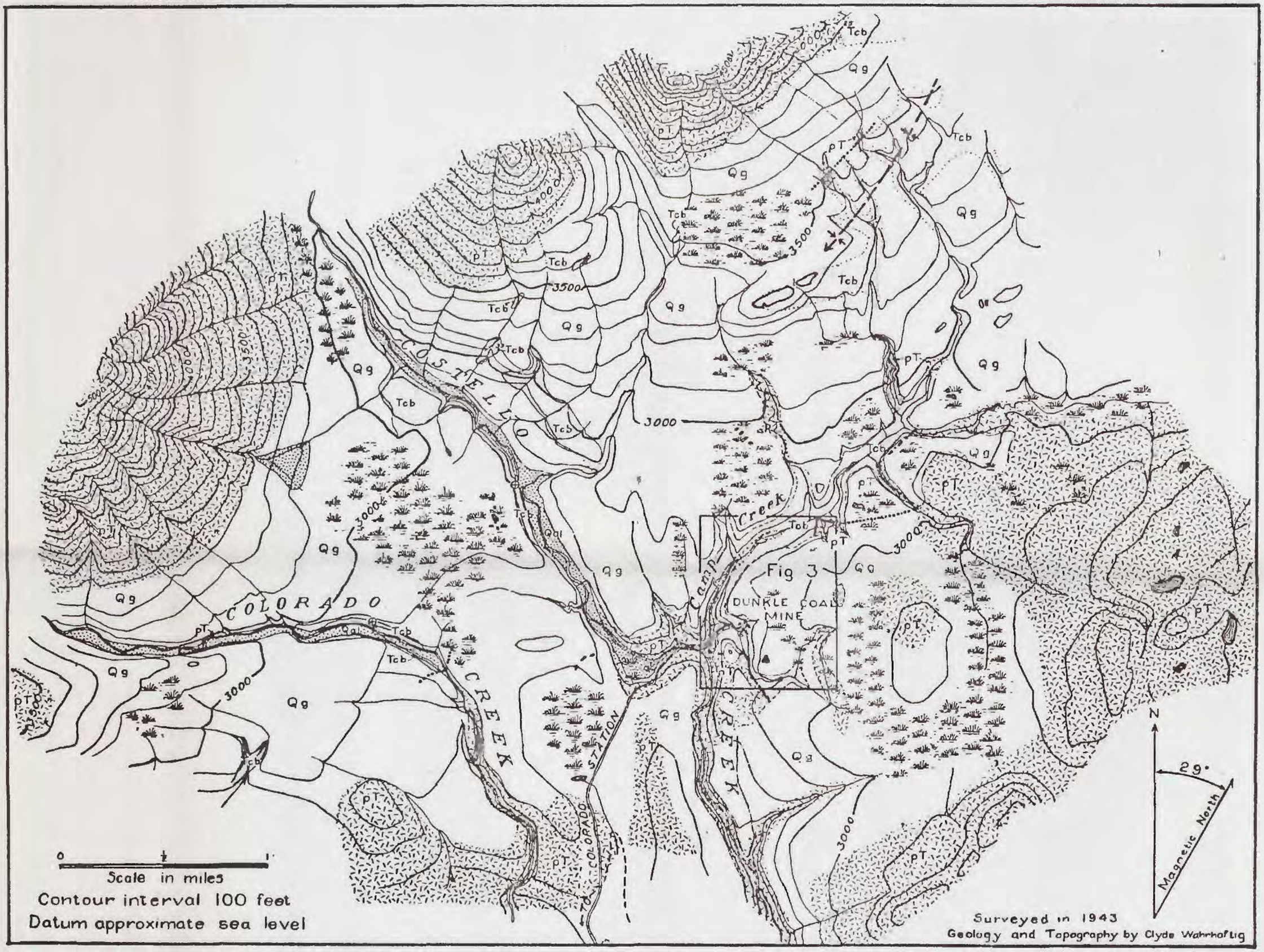

FIG. 2. GEOLOGIC AND TOPOGRAPHIC SKETCH MAP OF COSTELLO CREEK COAL BASIN, ALASKA

EXPLANATION

QUATERNARY
- Recent
  - Qal — Alluvium
  - UNCONFORMITY
- Pleistocene
  - Qg — Glacial outwash deposits and till
  - UNCONFORMITY

TERTIARY
- Tcb — Coal-bearing Sediments (partly consolidated, interbedded sandstone, conglomerate, siltstone, and claystone, containing discontinuous coal beds).
- UNCONFORMITY

PRE-TERTIARY
- pT — Undifferentiated igneous and sedimentary rocks, Permian to Cretaceous

- Fault, approximate
- Fault, covered
- Fault, inferred
- Fault, inferred and covered
- 15 — Strike and dip of sediments
- Strike of vertical sediments
- Flat-lying sediments
- Axis of syncline (showing direction of pitch)

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WAR MINERALS INVESTIGATION
PRELIMINARY MAP

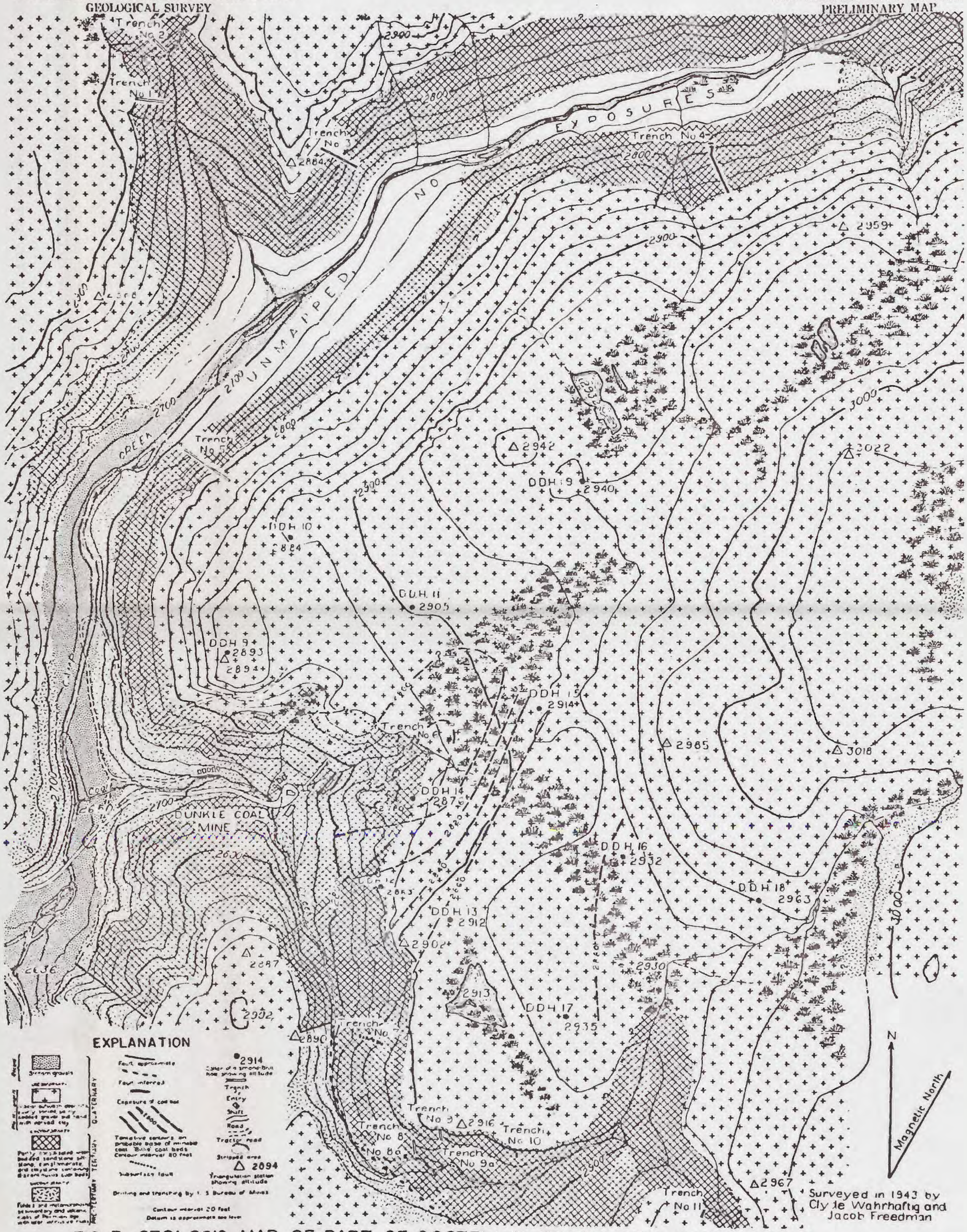

FIG. 3: GEOLOGIC MAP OF PART OF COSTELLO CREEK COAL BASIN, ALASKA

200 100 0 400 500 1000
Scale in Feet

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WAR MINERALS INVESTIGATION

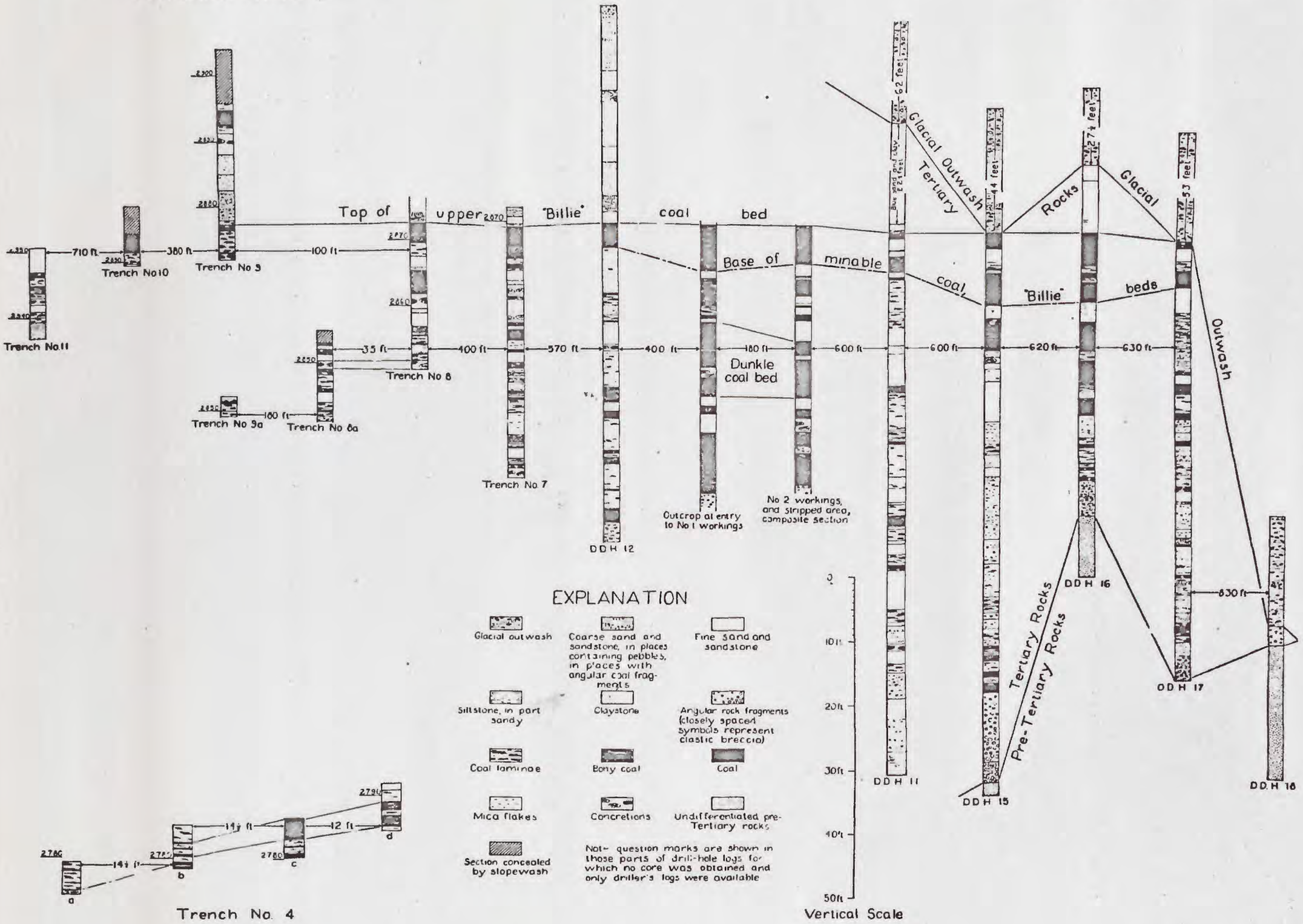

FIG 5: LOGS OF SOME OF THE TRENCHES AND DIAMOND-DRILL HOLES, COSTELLO CREEK COAL BASIN, ALASKA
(SEE ALSO FIGS. 6 AND 7)

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WAR MINERALS INVESTIGATION

For explanation see figure 5

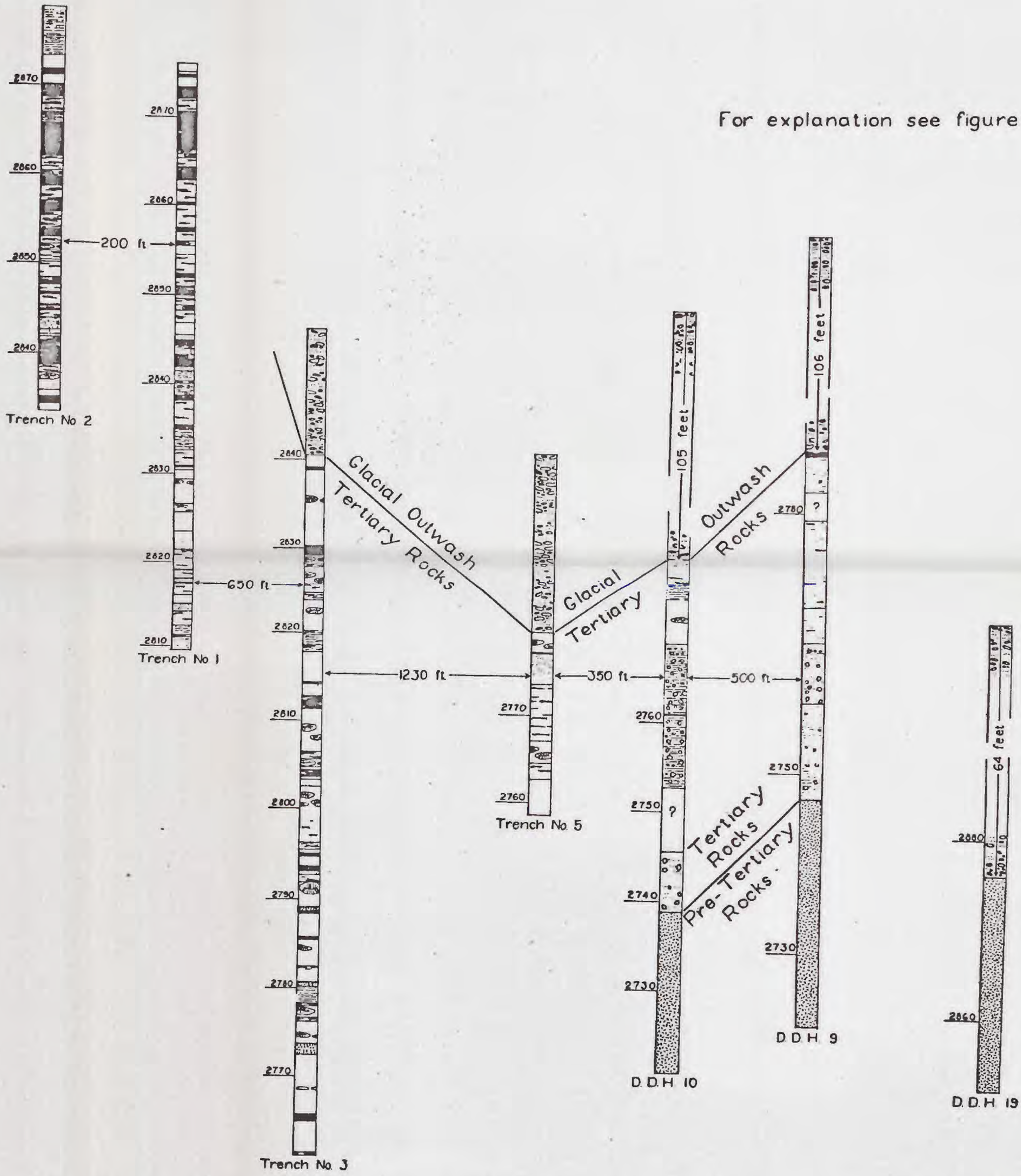

FIG. 6: LOGS OF SOME OF THE TRENCHES AND DIAMOND-DRILL HOLES
COSTELLO CREEK COAL BASIN, ALASKA
(SEE ALSO FIGS. 5 AND 7)

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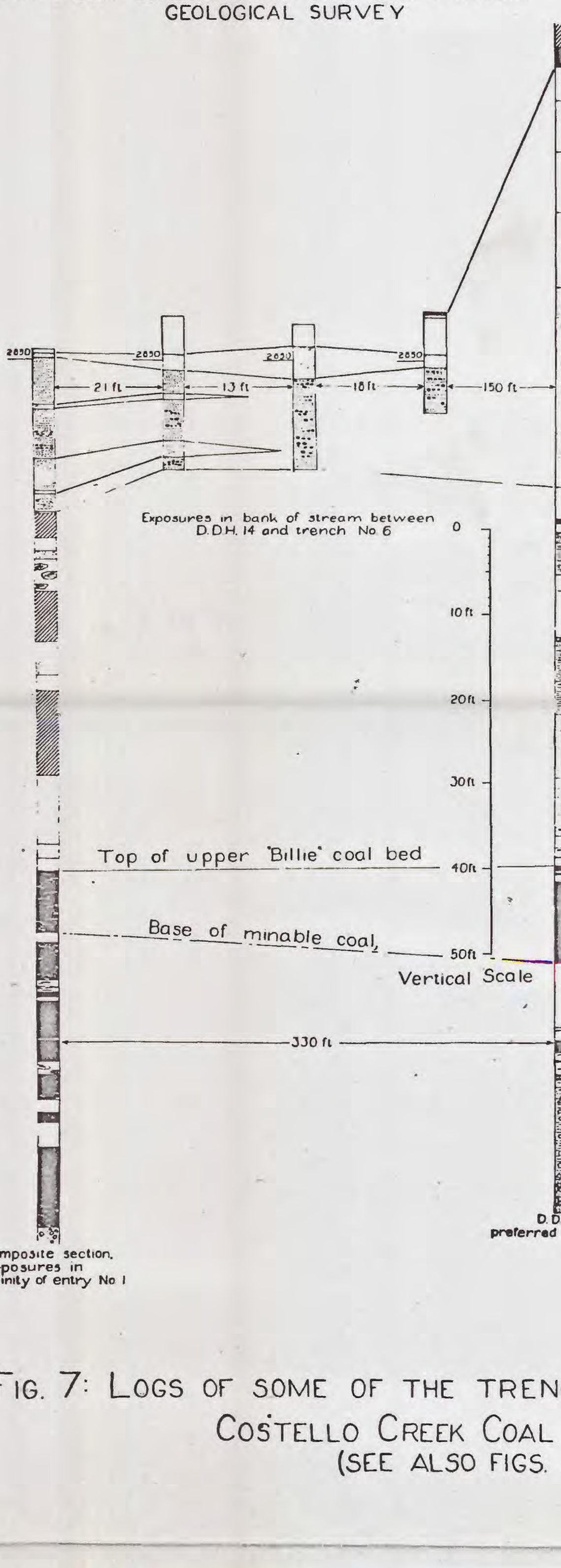
WAR MINERALS INVESTIGATION



For explanation see figure 5

FIG. 7: LOGS OF SOME OF THE TRENCHES AND DIAMOND-DRILL HOLES
COSTELLO CREEK COAL BASIN, ALASKA
(SEE ALSO FIGS. 5 AND 6)

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WAR MINERALS INVESTIGATION
PRELIMINARY MAP

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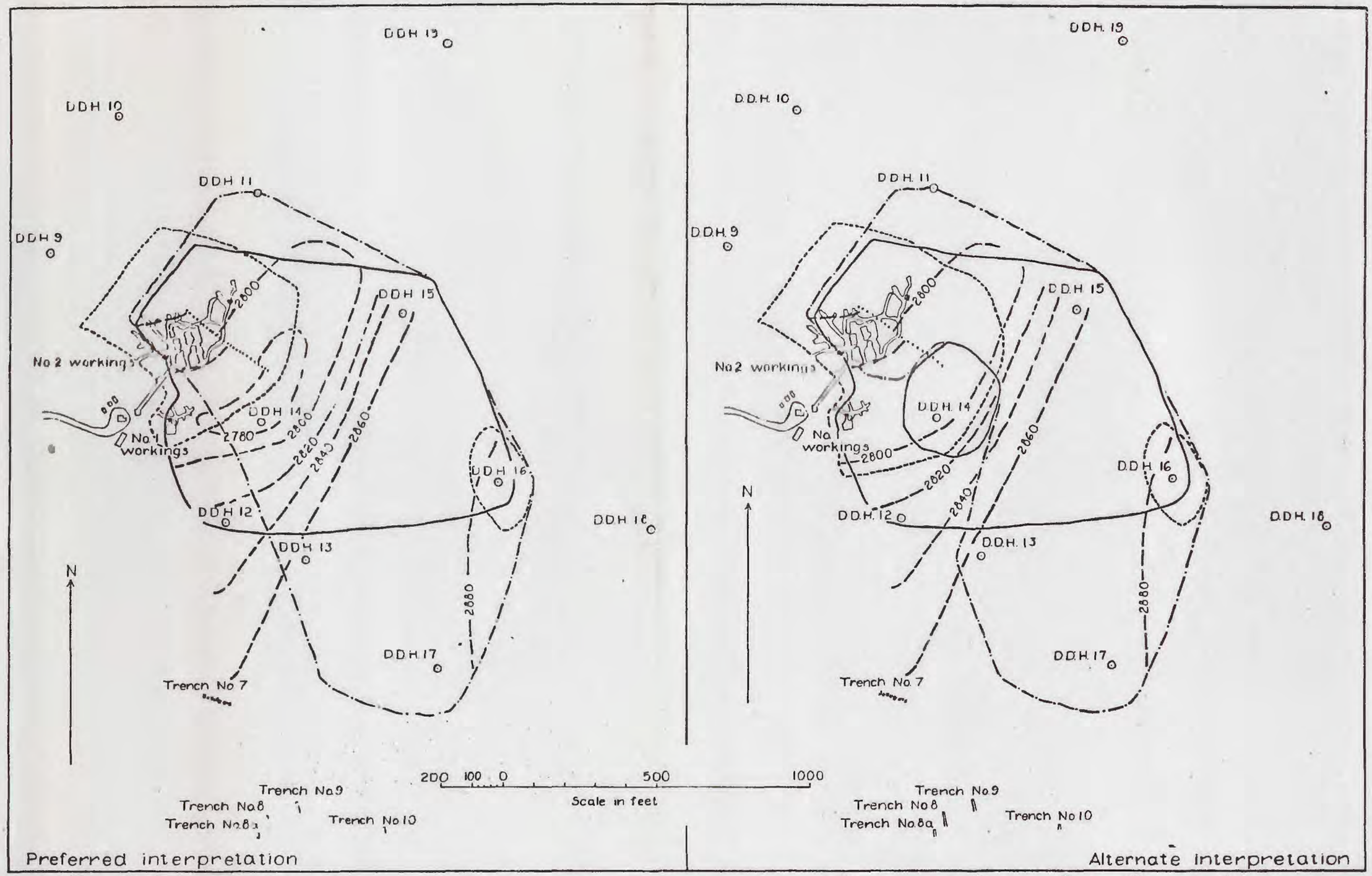

FIG. 8: MAPS SHOWING AREAS UNDERLAIN BY COAL RESERVES, COSTELLO CREEK COAL BASIN, ALASKA

EXPLANATION

Tentative contours on probable base of minable coal, "Billie" coal beds. Contour interval 20 ft

Subsurface fault

Boundary of area underlain by indicated minable coal, upper "Billie" coal bed

Boundary of area underlain by indicated minable coal, lower "Billie" coal bed

Boundary of area underlain by indicated minable coal, Dunkle coal bed

Underground workings

Raise

Trench

Collar of diamond-drill hole

Diamond-drilling and trenching by U. S. Bureau of Mines

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TABLE 1

Analyses of coal from Costello Creek Basin

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Analysis No.	Location of sample	Laboratory No.	Air dry loss, percent	Form of analysis*	Moisture, percent	Volatile matter, percent	Fixed carbon, percent	Ash, percent	Sulfur, percent	Heating value, B.t.u.	Thickness of coal sampled	Remarks
1	Car shipment. Composite analysis of coal shipped to Ft. Richardson during Jan. 1942	ARR-8658	12.4	A	17.3	37.4	39.3	6.0	0.5	10,125		Anal. by M. L. Sharp
				B	5.6	42.7	44.8	6.9	0.6	11,560		
				C	—	45.2	47.5	7.3	0.6	12,245		
				D	—	48.8	51.2	—	0.7	13,205		
2	Composite analysis of coal shipped to Ft. Richardson during Feb. 1942	ARR-8763	8.5	A	17.1	40.0	35.8	7.1	0.5	10,020		Anal. by M. L. Sharp
				B	9.4	43.7	39.1	7.8	0.5	10,950		
				C	—	48.2	43.2	8.6	0.6	12,080		
				D	—	52.8	47.2	—	0.7	13,210		
3	Composite analysis of coal shipped to Ft. Richardson during March 1942	ARR-8842	6.1	A	16.1	36.8	40.0	6.1	0.5	10,005		Anal. by M. L. Sharp
				B	10.7	39.2	43.6	6.5	0.5	10,635		
				C	—	45.0	47.7	7.3	0.5	11,925		
				D	—	48.6	51.4	—	0.6	12,855		
4	Composite analysis of coal shipped to Ft. Richardson during Apr. 1942	ARR-8921	7.1	A	14.3	41.6	37.0	7.1	0.5	10,210		Anal. by M. L. Sharp
				B	7.7	44.9	39.8	7.6	0.5	10,990		
				C	—	48.5	43.2	8.3	0.6	11,915		
				D	—	52.9	47.1	—	0.6	12,985		
5	Composite analysis of coal shipped to Ft. Richardson during Jan. 1943	AER-9531	9.5	A	16.6	35.9	38.6	8.9	0.5	9,955		Anal. by M. L. Sharp
				B	8.1	39.5	42.6	9.8	0.5	10,965		
				C	—	43.0	46.3	10.7	0.6	11,935		
				D	—	48.2	51.8	—	0.7	13,360		
6	Approx. 450 feet from portal, entry no. 2, at face in haulage way, Dunkle Bed	USBM-C-1804	5.5	A	18.4	32.0	40.4	9.2	0.6	9,700		Anal. by H. M. Cooper, coll. by C. R. Garrett
				B	13.6	33.9	42.8	9.7	0.7	10,260		
				C	—	39.2	49.5	11.3	0.8	11,880		
				D	—	44.2	55.8	—	0.8	13,380	5' 5"	
7	140 ft. from portal, entry no. 1, 30 ft. to face in room no. 2 N.	USBM-C-1805	5.2	A	18.8	33.6	41.4	6.2	0.5	10,040		Anal. by H. M. Cooper, coll. by C.R. Garrett
				B	14.3	35.5	43.6	6.6	0.5	10,590		
				C	—	41.4	51.0	7.6	0.6	12,360	6' 2"	
				D	—	44.8	55.2	—	0.6	13,380		
8	40 ft. from portal, entry no. 2, room no. 1, 120' to face from haulage way	USBM-C-1806	3.1	A	15.9	35.9	42.2	6.0	0.5	10,600		Anal. by H. M. Cooper, coll. by C. R. Garrett
				B	13.2	37.1	43.5	6.2	0.5	10,940	7' 4"	
				C	—	42.7	50.1	7.2	0.6	12,610		
				D	—	46.9	54.0	—	0.6	13,580		
9	DDH 16 51' 6" to 56' 0"	ARR-10175	-	A	11.2	42.5	35.6	10.7	0.5	10,185		Anal. by M. L. Sharp, coll. by F. A. Rutledge
				C	—	47.9	40.1	12.0	0.6	11,470	4' 6"	
				D	—	54.4	45.6	—	0.6	13,035		
10	DDH 16 57' 6" to 60' 6"	ARR-10176	-	A	11.7	40.9	37.0	10.4	0.5	10,200		Anal. by M. L. Sharp, coll. by F. A. Rutledge
				C	—	46.2	42.0	11.8	0.6	11,565	3' 0"	
				D	—	52.5	47.5	—	0.6	13,095		
11	DDH 16 63' 6" to 65' 10"	ARR-10177	-	A	11.0	37.1	38.1	13.8	0.5	9,670		Anal. by M. L. Sharp, coll. by F.A. Rutledge
				C	—	41.7	42.8	15.5	0.6	10,870	2' 4"	
				D	—	49.3	50.7	—	0.7	12,860		
12	DDH 15 58' 0" to 62' 0"	ARR-10155	-	A	6.3	27.2	19.0	47.5	—	—	4' 0"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				C	—	29.0	20.3	50.7	—	—		
				D	—	58.5	41.1	—	—	—		
13	Approx. 40' from portal, entry no. 1. In raise 5' above hanging wall of "Stevens" bed (Dunkle bed)	USBM-C-1807	4.9	A	18.2	34.3	38.9	7.6	0.5	9,970	4' 10"	Anal. by H. M. Cooper, coll. by C. R. Garrett
				B	13.8	36.1	42.0	8.1	0.5	10,520		
				C	—	41.9	48.8	9.3	0.6	12,200		
				D	—	46.2	53.8	—	0.6	13,450		
14	Trench No. 2 Alt., 2862.0' to 2865.6'	ARR-10089	4.2	A	12.2	36.6	31.4	19.8	0.4	8,655	3' 7"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				B	8.3	38.2	32.8	20.7	0.4	9,035		
				C	—	41.6	35.8	22.6	0.5	9,860		
				D	—	53.8	46.2	—	0.7	12,730		
15	Trench No. 1, Alt., 2866.6' to 2870.0'	ARR-10090	5.4	A	15.1	43.4	23.2	18.3	0.4	7,985	3' 5"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				B	10.3	45.9	24.5	19.3	0.4	8,440		
				C	—	51.1	27.3	21.6	0.5	9,405		
				D	—	65.2	34.8	—	0.8	11,995		
16	DDH 11 89' 5" to 9' 11"	ARR-10091	6.4	A	12.8	33.1	33.1	21.0	0.5	8,510	2' 6"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				B	6.8	35.4	35.4	22.4	0.5	9,090		
				C	—	38.0	38.0	24.0	0.6	9,760		
				D	—	50.0	50.0	—	0.8	12,860		
17	DDH 12 33' 3" to 36' 11"	ARR-10092	5.1	A	10.4	37.1	40.1	12.4	0.6	10,050	3' 8"	Anal. by M. L. Sharp, coll. by F.A. Rutledge
				B	5.6	39.1	42.2	13.1	0.6	10,590		
				C	—	41.4	44.8	13.8	0.7	11,215		
				D	—	48.1	51.9	—	0.8	13,015		
18	DDH 13 40' 6" to 45' 0"	ARR-10113	2.8	A	8.7	37.7	41.4	12.2	0.5	10,115	4' 6"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				B	6.1	38.8	42.5	12.6	0.5	10,405		
				C	—	41.3	45.3	13.4	0.5	11,075		
				D	—	47.7	52.3	—	0.6	12,785		
19	DDH 14 107' 10" to 117' 2"	ARR-10114	2.5	A	8.9	38.9	38.2	14.0	0.4	9,940	9' 4"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				B	6.6	39.9	39.2	14.3	0.4	10,195		
				C	—	42.7	41.9	15.4	0.4	10,315		
				D	—	50.5	49.5	—	0.5	12,890		
20	DDH 15 44' 0" to 46' 6"	ARR-10153	-	A	10.8	36.4	35.8	17.0	0.3	9,240	2' 6"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				C	—	40.8	40.1	19.1	0.3	10,360		
				D	—	50.4	49.6	—	0.4	12,795		
21	DDH 15 50' 2" to 55' 0"	ARR-10154	-	A	10.1	35.5	33.2	21.2	0.4	8,875	4' 10"	Anal. by M. L. Sharp, coll. by F.A. Rutledge
				C	—	39.5	36.9	23.6	0.4	9,870		
				D	—	52.4	47.6	—	0.6	12,735		
22	DDH 16 38' 0" to 43' 0"	ARR-10173	-	A	13.0	36.6	37.2	13.2	0.4	9,635	5' 0"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				C	—	42.1	42.7	15.2	0.6	11,070		
				D	—	49.4	50.6	—	0.8	13,000		
23	DDH 16 45' 6" to 48' 6"	ARR-10174	-	A	11.0	38.6	37.1	13.3	0.4	9,820	3' 0"	Anal. by M. L. Sharp, coll. by F.A. Rutledge
				C	—	43.4	41.7	14.9	0.5	11,035		
				D	—	51.0	49.0	—	0.5	12,970		
24	DDH 17 57' 6" to 60' 0"	ARR-10178	-	A	11.7	38.7	37.6	12.0	0.5	9,920	2' 6"	Anal. by M. L. Sharp, coll. by F. A. Rutledge
				C	—	43.8	42.6	13.6	0.6	11,240		
				D	—	50.7	49.3	—	0.7	13,005		

* A, as received; B, air dried; C, moisture free; D, moisture and ash free.

Analyses 1 through 12, of coal from Dunkle bed; analyses 13 through 24, of coal from "Billie" beds.