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SUBSURFACE EXPLORATION IN THE LITTLE SUSITNA DISTRICT, MATANUSKA COAL FIELD, ALASKA, IN 1953 AND 1954

By

F. F. Barnes and Daniel Sokol

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This report is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature.

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ABSTRACT

Preliminary geologic mapping of the Little Susitna district in 1952 showed that an area of at least 40 square miles is underlain by coal-bearing rocks of Tertiary age, and indicated that coal beds of minable quality and thickness might be present at several localities. Detailed exploration with a bulldozer and power auger was done at these localities in 1953 and 1954, with special attention to strip-mining possibilities.

All the beds examined at the four localities tested were judged to be either too thin or too dirty to be minable under present conditions, and none of them are favorably situated for strip mining.

INTRODUCTION

The Little Susitna district of the Matanuska coal field lies on the north side of the lower Matanuska Valley, in south-central Alaska. A preliminary geologic report (Barnes, 1953) on the geology and coal deposits of the area was based on surface investigations made in 1952 and showed that the district is largely, if not entirely, underlain by coal-bearing rocks of Tertiary age. Although the bedrock is mostly covered by unconsolidated deposits of Quaternary glacial and alluvial material, sufficient indications of the presence of possibly valuable coal deposits were found to warrant a more detailed investigation using subsurface methods. The present report embodies the results of bulldozer trenching and power-auger drilling in parts of the district in 1953 and 1954 and is intended as a supplement to the preliminary report, to which the reader is referred for a general description of the geology and known coal occurrences of the district. The locality numbers used in this report are those shown on plate 1 of the preliminary report. The areas covered by subsurface exploration are shown on plate 2 of this report.

The work in 1953 and 1954 was in part experimental, to determine the applicability of a tractor-mounted power-auger to coal exploration on certain types of Alaskan terrain. Progress in 1953 was not as great as anticipated, chiefly because it was necessary to remedy mechanical defects of the auger and of its mounting on the tractor, and to develop operating techniques to meet special conditions. Nevertheless, it is believed that the equipment can prove valuable in exploring certain types of coal deposits, particularly those beds within about 30 feet of the surface, provided the overburden does not contain an excessive proportion of cobbles and boulders. Experience has shown that the auger is also stopped by relatively thin layers of coarse gravel.

This report is based on field work during the periods July 2 - August 31, 1953, and June 23 - July 27, 1954. In 1953 investigations were made at localities 5 and 6 in which the writers were assisted by W. T. Ashlock and R. E. Rowland, field assistants, and a bulldozer operator-mechanic to operate and maintain the equipment. P. D. Haire filled the operator-mechanic position until July 31, when he was injured, and was replaced by A. E. Holmberg until the end of the season. In 1954 investigations were made at localities 3 and 4, where the writers were assisted by A. E. Burford and W. S. Hopkins, geologists, and J. W. Dawson, operator-mechanic. Coal localities 3, 4, and 5 were mapped topographically and tied in with the land net by plane-table surveys. Locality 6 was tied to the land net but was not mapped topographically.

EQUIPMENT AND METHODS

The equipment used consisted of a Model B-50 Mobile Drill, manufactured by Mobile Drilling, Inc. of Indianapolis, mounted on an International TD-9 crawler tractor, which was equipped with a Bucyrus-Erie hydraulically operated bulldozer adjustable at an angle for side-hill cutting during road-building and trenching operations. A heavy sled or "go-devil", towed by the tractor, was used to transport fuel, lubricants, tools, and auger sections between drilling sites, and also to move camp. A quarter-ton Willys jeep with extension body was used for transporting supplies to the camp and drilling sites over the rough tractor trails.

The drill consists of a $4\frac{1}{2}$-inch spiral auger, equipped with a drilling head fitted with six replaceable bits. The auger is made up of 4-foot sections that are joined by special hexagonal couplings that make possible rapid addition or removal of sections and also permit reversing the rotation of the auger when necessary to free a stuck bit. The maximum depth drilled in the Little Susitna district was 55 feet; considerably greater depths probably could be reached under favorable conditions.

The following general procedure was followed in drilling a given area. The initial drilling site was chosen as near as possible to a coal outcrop, where the expected depth to the coal could be readily estimated and the thickness and character of the coal bed as determined from the drill cuttings could be checked by comparison with the exposed section. Logging of the boreholes requires almost constant examination of the drill cuttings as they emerge from the top of the hole, as the auger is a continuous-sampling device. Two men were assigned to operate the drill -- an operator-mechanic to handle the controls, and a geologist to log the hole and assist in adding and removing auger sections. Drilling was continued wherever possible through the lowest known coal bed within range of the auger, but in many holes the drill was stopped either by hard masses, mainly concretions, or by sticky wet claystone that would bind the auger and prevent its rotation. At many points boulders were encountered in the overburden, but in some holes, particularly at localities 5 and 6 (pl. 2), it was possible to force the drill past by applying heavy pressure with the hydraulic feed. If a boulder proved too large to be forced aside, the drill was moved a short distance and a new hole started. The ease and speed with which this type of drill can be moved and a new hole started is one of its chief advantages. At localities 3 and 4 (pl. 2) the overburden contained such a high proportion of cobbles and boulders that it was impossible to reach bedrock at any point without first stripping away much or all of the overburden with the bulldozer.

The choice of location of boreholes was based on the position of coal beds as inferred from their attitude in nearby outcrops and modified by results of previously drilled holes. The general plan was to outline areas in which potentially minable coal lies within stripping depth, and to get as much information as possible on the thickness and quality of the coal and the depth of overburden. For detailed information on the coal it was necessary to rely on either natural or artificial exposures, and as natural exposures were scarce, the bulldozer was extremely useful in exposing coal beds at favorable localities as well as for exploration where excessive boulders in the overburden made drilling impossible.

INTERPRETATION OF DRILLING RESULTS

The purpose of drilling is to determine the geologic structure and lithology when insufficient surface information is available. The ideal drill would be one that would furnish, quickly and inexpensively, a complete and accurate record of the thickness and character of the successive types of material penetrated. Core drilling obtains relatively complete and accurate evidence of the rocks penetrated but is slow and costly. In an auger-type drill exactness in detail is sacrificed for speed and economy of operation; consequently neither the thickness nor the character of the beds can be determined with a high degree of accuracy.

Perhaps the most difficult problem in this type of drilling is the determination of the depth at which the drill head passes from one type of material to another. The difficulty arises from the fact that by the time the cuttings from a particular depth have been brought to the surface by the auger, the drill head will have advanced some distance beyond the depth at which the cuttings originated, thus introducing an error in the recorded depth to the bed represented by the cuttings. The interval which has been drilled while the cuttings are travelling to the surface, here called the lag interval, varies directly with the rate of drilling and the depth of the hole, and inversely with the rate at which the cuttings move up the auger. While the drilling rate and the hole depth can be measured, the rate of movement of the cuttings is less easily determined. In uniform material the rate of movement is fairly constant and the distance the drill advances while the cuttings are rising to the surface can be estimated with reasonable accuracy. However, uniformity rarely obtains, and variations in the character--particularly the moisture content--of the penetrated material greatly affects the rate of movement of the cuttings. Relatively dry cuttings tend to move at a fairly rapid and uniform rate, whereas moist cuttings, particularly clayey material, tend to stick to the auger and may even block it. In most holes the lag interval must be estimated by taking into account such factors as the depth of the hole and the rate and constancy of the rise of cuttings from the hole. In general, the lag interval varies from 10 to 20 percent of the depth of the drillhead, the exact value used depending on the observer's judgment of the rate at which the cuttings were moving to the surface. In some holes the depth to certain beds can be determined within narrow limits by a change in the "feel" of the auger as it reaches them. Unfortunately, few of the coal beds drilled in the Little Susitna district differed sufficiently in hardness from the enclosing rock to be detected by "feel".

A second problem involved in this type of drilling is the determination of the lithology and texture of individual beds and of the character or quality of the coal beds drilled. Because of mixing and contamination of the drill cuttings as they move up the auger, no accurate impression of the details of a bed can be obtained from examination of the cuttings. For example, it is difficult, if not impossible, to tell whether a mixture of coal and rock fragments represents a relatively clean coal bed with material from the roof and floor mixed in, or a dirty bed including numerous rock partings. For this reason it is highly desirable to supplement the drilling with trenching to expose the coal beds for detailed measurements and sampling wherever practicable.

In general, the Mobile Drill seems best adapted primarily to outlining areas of potential stripping coal and determining the thickness of overburden, and secondarily to obtaining approximate information on the character and thickness of concealed coal beds. Although the maximum depth of drilling is reported by the manufacturers to be 100 feet or more, results obtained from beds below 50 feet appear to have relatively little value, as the lag interval becomes high and mixing of material great so that depths and thicknesses are less exact and the nature of the beds more obscure. Auger drilling is a valuable supplement to surface mapping and trenching where the auger can penetrate the overlying material, particularly in areas where the coal beds are largely concealed and lie for the most part within 30 feet of the surface.

DRILLING RESULTS AT COAL LOCALITY 6

Six auger holes, ranging in depth from 26 to 44 feet, were drilled at coal locality 6, at the east end of the Little Susitna district (pl. 2). This site was chosen for the initial tryout of the tractor-mounted power auger partly because of its reasonably easy accessibility from the Palmer-Fishhook Highway, and also to check, if possible, the extent and minability of a 3-foot coal bed exposed in the west bank of the Little Susitna River. The attitude of the exposed bed, which has a northeast strike and dips about 10° NW., suggested that it might underlie at relatively shallow depth a low terrace that extends southwestward from the outcrop (pl. 3). Graphic logs of the six boreholes appear on plate 4.

Borehole 1, which was drilled as close as possible to the outcrop, passed through $3\frac{1}{2}$ feet of coaly material at an estimated depth of 29.5 feet, or about 10 feet lower than the projected position of the coal in the outcrop. This discordance in position, together with numerous shearing planes in the coal and rock exposed in the river bluff, strongly suggests that a fault, with the west side downthrown about 10 feet, passes between the outcrop and borehole 1, as shown in section A-A' (pl. 3).

Boreholes 2 and 3 were drilled near the edge of the terrace at points about 400 and 600 feet southwest of borehole 1 but both were stopped in wet clay without reaching the 3-foot coal bed. Borehole 2 passed through about 18 inches of coal at a depth of 8.5 feet; no coal was found in borehole 3. In an attempt to check the position of the 3-foot bed, borehole 4 was drilled 60 feet southwest of borehole 1. This hole passed through two thin coal zones within 15 feet of the surface, but was continued to 36.5 feet without encountering the 3-foot bed.

The probable relations of the coal beds and boreholes are shown in section A-A', which was drawn parallel to the strike of the beds exposed in the river bluff. The 3-foot bed lies at least 40 feet below the surface of the terrace in the plane of the section, and, of course, would lie at even greater depth farther northwest, down the dip.

Boreholes 5 and 6 (pl. 3) were drilled to check the possibility that the 3-foot bed might rise to the northwest on the north limb of the synclinal structure indicated by the reversal in dip of the beds exposed in the river bank. They were drilled to depths of 38 and 36 feet, respectively, without encountering any coal.

DRILLING RESULTS AT COAL LOCALITY 5

The second area drilled with the power auger in 1953 was at coal locality 5, on a small stream known locally as Coal Creek, on land held under a prospecting permit by Emil Stadler and James Harris (pl. 5). Twenty-six boreholes, ranging in depth from 18 to 55 feet, were drilled to check the extent and stripping possibilities of coal beds exposed in scattered outcrops and opened by a few prospect pits, bulldozer trenches, and short tunnels along the lower half-mile of the creek. Locations of the boreholes are shown on plate 5, and graphic logs on plate 4.

Correlation of the borehole and surface data indicates that the Coal Creek area is underlain by at least six coal beds, probably ranging in average thickness from 2 to 4 feet and including considerable bony material. The beds in the northern part of the area have a general southerly dip ranging from 13° to 20°, the dip decreasing southward. Farther south, near the mouth of the creek, the dip as revealed by a single outcrop is 10°SW. The relation of this bed to those farther north is not known. For convenience in reference the principal coal beds have been designated beds 1 to 6, bed 1 being the lowest in the series. It was assumed that the southwest-dipping bed near the mouth of the creek overlies those to the north, and it was designated bed 6. The coal boundaries, where the coal is cut off at the bedrock surface, are shown on plate 5. On the relatively flat surfaces on either side of the creek valley the coal boundaries are concealed by 10 feet or more of surficial deposits. As the beds dip southward at a steeper angle than the land surface, the depth of overburden increases with the distance from the coal boundary (pl. 6, sec. E-E').

Bed 1 is exposed in the creek channel and in a short prospect tunnel about half a mile above the mouth of Coal Creek, where it strikes due east and dips 18° S. To check the extent and depth of this bed below the flat uplands bordering the creek valley, 12 boreholes were drilled west of the creek and 6 were drilled on the east side (pl. 5). In this way bed 1 was traced along a strike length of 1,300 feet, at depths ranging from 10 to 46 feet. The bed was represented in the boreholes by coaly zones ranging from 1½ to 9 feet in total thickness (pl. 4), and as exposed in the tunnel it includes 3.8 feet of relatively clean coal in three benches separated by rock partings. A section parallel to the general strike of bed 1 is shown in plate 6 (sec. B-B').

Bed 2, estimated to lie about 60 feet above bed 1, had been opened in a short tunnel and several test pits along the south side of the creek valley and was encountered at a depth of 8 feet in borehole 8. The following section was measured in the largest test pit:

	Feet
Silty claystone (roof)	
Silty claystone with numerous coal lenses	4.4
Coal, bony, numerous claystone lenses	1.8
Coal, dull platy, locally bony	2.5
Coal, bright friable	.6
Siltstone, sandy at top (floor)	

Strike, E.; dip, 20° S.

The log of borehole 8 shows a total thickness of about 10 feet of coaly material ranging from coaly claystone at the top to clean coal at the base, thus indicating that, at least at shallow depths, the auger gives a fairly accurate picture of the character and thickness of coal beds penetrated. A strike section on bed 2 is shown in plate 6 (sec. C-C').

Bed 3, estimated to lie between 100 and 150 feet above bed 2, is partly exposed in one outcrop in the creek bed, in prospect pits on both sides of the creek valley, and in borehole 17. The bed includes at least 2 feet of clean coal in the outcrop and is represented by a 5-foot coaly zone in the borehole, so it is probably between 3 and 5 feet thick.

Bed 4, which is about 25 feet above bed 3 in borehole 17, had been partly exposed in a deep bulldozer trench by the permittees. Borehole 7, which was drilled in the bottom of the trench, penetrated about 5 feet of coaly material, of which the upper 3.3 feet was judged to be coal and the remainder, bone. Coaly zones in boreholes 15 and 17, 3.5 and 4.5 feet thick, respectively, were correlated with bed 4.

Bed 5 was found only in borehole 17, where it lies about 20 feet above bed 4 and appeared from the drill cuttings to contain about 2 feet of relatively clean coal. A cross section along the strike of the beds through borehole 17 is shown in plate 6 (sec. D-D').

Bed 6 is exposed in an outcrop and short tunnel near the mouth of Coal Creek, and its eroded lower part was penetrated beneath surficial deposits in borehole 30. To get a more complete section the bed was opened in a sidehill cut with the bulldozer and the following section was measured:

	Feet
Coaly wash (roof eroded)	
Clay, brown-weathered	0.1
Coal, weathered	.2
Claystone, coaly, coal lenses	.5
Coal, friable	.8
Siltstone, sandy	.3
Coal, friable, few claystone lenses	1.1
Claystone, coaly, coal and ironstone lenses	1.7
Coal, bright brittle	.4
Claystone, silty	1.2
Coal, bony	1.0
Siltstone, coaly	.3
Coal, bony	.5
Claystone, silty gray (floor)	

Strike, N. 40° W.; dip, 10° SW.

The stratigraphic interval between beds 5 and 6 could not be determined accurately because of lack of outcrops in the intervening area, but it is believed to be at least 100 feet.

DRILLING AND TRENCHING RESULTS AT LOCALITY 4

Operations at locality 4 were based on a coal bed exposed along 100 feet of the west bank of a tributary of the Little Susitna River (pl. 7). This bed, at least 9 feet in total thickness including several thin partings, and with a gentle southerly dip (Barnes, 1953, p. 10) was considered potentially valuable for stripping coal; therefore drilling and trenching were started on the west side of the valley, up the dip from the outcrop, to determine the extent of the bed and to further investigate the quality of the coal. A cut was bulldozed down the west bluff of the creek about 300 feet north of the outcrop in the hope of intersecting the coal bed near the surface of the upland west of the creek. However, gravel was found to extend well below the projected position of the coal bed, indicating that the coal was absent at this point. A second cut was made about 150 feet north of the outcrop, and borehole 33 was drilled to a depth of 25 feet from the lowest point in the cut without reaching bedrock. The cut and borehole together penetrated about 15 feet of gravel and sand underlain by 18 feet of clay. As the bottom of the borehole was more than 50 feet below the top of the bluff it was concluded that no coal is present within stripping depth on the west side of the creek at locality 4.

Operations were then shifted to the east side of the creek, where coaly wash had been found in a shallow test pit in the bluff opposite the coal outcrop in the creek bank. A bulldozer cut at this point exposed a thin coaly zone, and borehole 34 (pls. 4 and 7), drilled in the floor of the cut, penetrated an 11-foot bed of coal and bone that is believed to be the same as the bed exposed west of the creek. Trenching on the projected trace of the bed at points 100 and 200 feet north of borehole 34 exposed 15 to 20 feet of gravel without reaching bedrock. The cut at borehole 34 was then deepened, and revealed that the coal was not only extremely dirty and bony but was cut off a few feet north of the borehole at a steeply dipping contact with bouldery glacial clay, as shown in section H-H' (pl. 7). From this and the findings on the west side of the creek it was concluded that the coal at locality 4 has been eroded away north of a line passing just north of borehole 34 and the outcrop, and that south of the line it is probably too deep and poor in quality to be economically strip-mined.

DRILLING AND TRENCHING RESULTS AT LOCALITY 3

During investigations in 1952 a 10-foot coaly zone was uncovered along the east bank of the creek at locality 3 (Barnes, 1953, p. 9). The beds strike N. 70° E. and dip 32° SE. The character of the bed and its surface relations indicated a possibility that some of it might be minable by stripping. In order to determine if stripping were feasible, bulldozing and drilling were started on the slope above the coal exposure. The results are shown on the map and cross sections on plate 8.

The first cut, about 100 feet up the projected trace of the coal bed from the outcrop, exposed sandstone and claystone with vertical dips and slickensided faces at its lower or western end. Borehole 35 was drilled in more gently dipping beds at the eastern end of this cut and passed through 13.2 feet of sandstone and fine sandy siltstone without encountering coal. A trench to the east of the first cut exposed above 5 feet of glacial till but did not reach bedrock. Sidehill cuts above the trench revealed coaly pockets in the lower part of the till, immediately above the claystone of Tertiary age, but no coal was found in place.

The vertical dips, slickensides, and absence of coal in borehole 35 all indicate that the coal has been displaced by faulting. The relation between dips measured at the outcrop and in the cuts indicates that the southern block was downthrown, and that north of the fault the coal has been removed by erosion.

The 35° dip at the outcrop, which is unusually steep for beds in the area, is apparently due to fault drag. Cross sections J-J' and K-K', (pl. 8) through the outcrop and borehole 35, respectively, show the most probable relationship between the coal and the fault.

On the west side of the creek valley, surface prospecting for the western extension of the coal bed revealed abundant coaly wash over the bedrock, so a sidehill cut was made along the base of the slope to expose the coal bed and obtain further information on the structure. Instead of coal in place, the cut revealed a highly faulted zone marked by gouge and brecciated bedrock, including an abundance of coaly material. On the north, the zone has a sharp contact with claystone of the coal-bearing formation; to the south it grades into undisturbed bedrock in a series of small slips. This zone is believed to be a continuation of the one exposed on the east side of the creek. The probable structure and position of the coal west of the creek are shown in section I-I' (pl. 8). According to this interpretation the coal has been removed by erosion north of the fault and lies too far below the surface south of the fault to be strip-mined.

CONCLUSIONS

The purpose of the exploratory work in the Little Susitna district in 1953 and 1954 was to determine, first, whether coal beds of minable thickness and quality were present, and second, whether any such beds contained sufficient coal within stripping depth to make the opening of a strip mine feasible. The results of the investigation indicate that the coal in the areas examined is not only thin and of poor quality, but for the most part is unfavorably situated for strip mining. Consequently, no estimates were made of minable coal reserves.

REFERENCE CITED

Barnes, F. F., 1953, Preliminary report on the Little Susitna district, Matanuska coal field, Alaska: U. S. Geol. Survey open-file report.