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# GEOLOGY AND COAL RESOURCES OF THE WESTERN PART OF THE LOWER MATANUSKA VALLEY COAL FIELD, ALASKA

by

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# INTRODUCTION

Location. The lower Matanuska Valley coal field is in southern Alaska 45 miles northeast of the city of Anchorage (fig. 1). The field is in an area bounded on the south by the Matanuska River, on the north by the foothills of the Talkeetna Mountains, and includes on the east and west, respectively, the valleys of Eska Creek and Moose Creek, which head in the Talkeetna Mountains and flow southward to the Matanuska River. The western boundary of the area described is about 8 miles north of Palmer, which is in the heart of an agricultural district.

The Eska mine and the Evan Jones mine, in the eastern part of the field, are served by a branch line of the Alaska Railroad. The Moose Creek spur of this line formerly served mines along Moose Creek but has been abandoned because of flood damage. The Buffalo mine, the only mine now operating in the Moose Creek area, is accessible by a branch auto road from the Glenn Highway and is about 12 miles from Palmer. The Eska and Evan Jones mines are not accessible by automobile.

Previous work. Detailed topographic and geologic mapping in the field was done by Ralph Tuck 1/ in 1935. Tuck mapped and described the eastern part of the field, including the area of the Eska mine, the Evan Jones mine, and the eastern part of Wishbone Hill. In 1932 a diamond-drilling project 2/, part of a government program for development of mineral resources in the Alaska Railroad belt, was carried out west of Moose Creek and about 1½ miles southwest of the Premier mine. Five holes were drilled and failed to encounter workable beds of coal. Earlier geologic work in the area of the lower Matanuska Valley coal field was done by Martin, Paige and Knopf, Martin and Katz, and Chapin.

1/ Tuck, Ralph, The Eska Creek coal deposits, Matanuska Valley, Alaska: U. S. Geol. Survey Bull. 880, pp. 185-214, 1937.

2/ Waring, G. A., Core drilling for coal in the Moose Creek area, Alaska: U. S. Geol. Survey Bull. 857, pp. 155-166, 1934.

Present investigation. This report is based on field work accomplished from June to October, 1943, and from June to October, 1944, by four geologists of the Geological Survey, including the writers and Jacob Freedman and E. Richard Larson. The work was done under the supervision of George O. Gates of the Geological Survey.

The work represents a southwestward continuation to the Premier mine of detailed mapping done by Tuck in the eastern part of the field in 1935. The western part of the valley of Moose Creek, between the Premier mine and the mouth of the creek, also was mapped and studied. In addition to topographic and geologic mapping, on the scale of 1 inch equals 400 feet, the work of the Survey field party included preparation of stratigraphic logs, on the scale of 1 inch equals 10 feet, of mine crosscuts, diamond-drill holes, outcrops, and numerous shallow trenches excavated by the Survey party.

Maps accompanying this report include only the area in which minable beds of coal are at or near the surface. Details of the geology of parts of the area are shown on three maps (figs. 3,4, and 5) on the scale of 200 feet to the inch.

The Bureau of Mines conducted a diamond-drilling and trenching program in the Moose Creek area from November 1942 to August 1943, and from June to December, 1944. G. A. Apell, engineer in charge, made available to the Geological Survey party results of his transit survey of the area between the Buffalo and Premier mines. Diamond-drill holes 1 through 5 were completed prior to the arrival of the Survey party in 1943, and the logs (fig. 7) are based in part on Mr. Apell's logs and in part on examination by the Survey party of skeletonized cores. The complete cores from holes 6 through 11 were studied and logged by the Survey party.

Mines in the Moose Creek area have been mapped by G. A. Apell, B. D. Stewart, W. G. Fenton, and J. J. Corey.

Results of the geologic investigation, as of August 1943 and October 1944, were made available to Mr. Apell by the Survey party.

## STRATIGRAPHY

Sedimentary deposits of Upper Cretaceous, Tertiary, and Quaternary ages are represented in the lower Matanuska Valley. Upper Cretaceous rocks, having an aggregate thickness of at least 4,000 feet, occupy a large part of the area between Eska Creek and Kings River, 10 miles to the east, and crop out in the banks of the Matanuska River from Moose Creek eastward to within 2½ miles of Chickaloon. The rocks consist predominently of sandstone and black shale, the lower half mostly shale and the upper half of alternating beds of sandstone and shale. They contain a marine invertebrate fauna, and coal beds are not present.

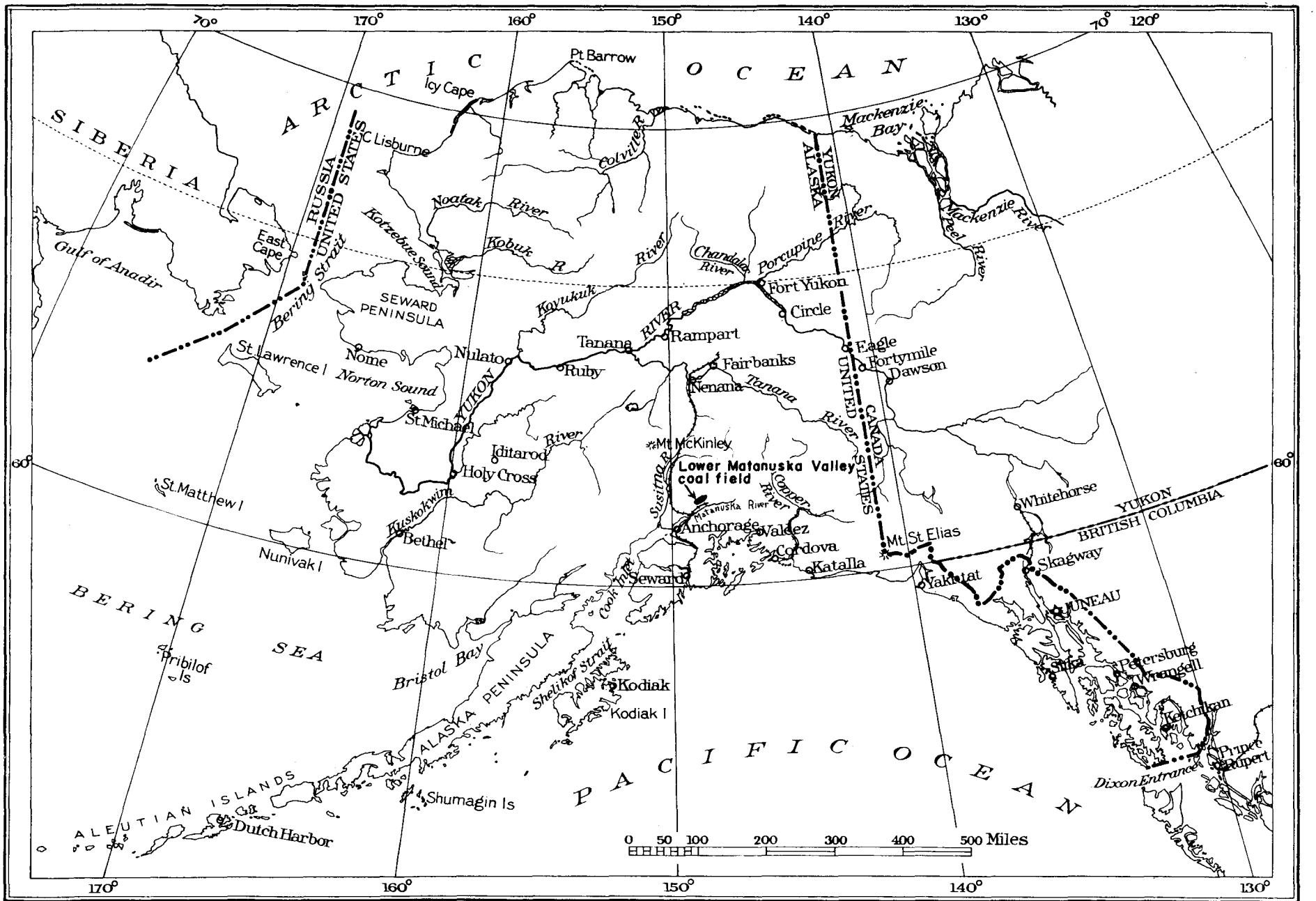


Figure 1. Index map of Alaska showing location of lower Matanuska Valley coal field

## Tertiary Rocks

As described by Martin and Katz 3/, the Tertiary rocks include three nonmarine sedimentary formations, the Chickaloon formation, the Eska conglomerate, and an unnamed formation. The Chickaloon formation is at least 3,300 feet and possibly as much as 5,000 feet thick and is divided into upper and lower parts on the basis of its coal content. The upper part (fig. 5) contains numerous workable beds of coal and is about 1,200 feet thick; it crops out in the Eska area, along the north slope of Wishbone Hill, and in the valley of Moose Creek between the Howard & Jesson and Premier mines. The lower part of the formation contains several thin beds of coal and a few dirty beds as much as 5 feet thick; it is at least 2,100 feet thick and crops out in the bluff on the north side of the Matanuska River at and below the mouth of Moose Creek, in the western part of the valley of Moose Creek between Premier and Glenn Highway, and in ravines in the area between the mines and Arkose Ridge to the north.

3/ Martin, G. C., and Katz, F. J., Geology and coal fields of the lower Matanuska Valley, Alaska: U. S. Geol. Survey Bull. 500, pp. 39-54, 1912.

The Eska conglomerate, at least 1,700 feet thick, overlies and appears to be gradational with the Chickaloon formation. It occurs as massive, well-cemented, ridge- and cliff-forming beds that have been eroded to form Wishbone Hill, which extends southwestward to the Buffalo mine on Moose Creek.

The Eska conglomerate crops out downstream from the Buffalo mine on the southeast side of Moose Creek, forming bluffs near the Premier mine and upstream from the Baxter mine. The lower part of the Eska formation, about 1,100 feet thick, comprises conglomerate beds consisting of rounded pebbles and cobbles, and locally a few boulders, interbedded with sandstone in layers ranging from a fraction of a foot to 40 feet or more in thickness. The coarser constituents are predominantly volcanic and metamorphic rocks, chert, vein quartz, jasper, and, to a small extent, granite. The upper part of the formation is at least 600 feet thick and consists of poorly consolidated conglomerate composed of coarse-grained granite and diorite boulders and cobbles.

The geologic map in the report by Martin and Katz (pl. 5) shows the area of Eska conglomerate as extending southwestward from the prongs of Wishbone Hill and crossing the valley of Moose Creek as a band 1½ miles wide at the canyon below the Premier mine. Relatively flat-lying beds of sandstone, conglomeratic sandstone, conglomerate, and siltstone crop out in the canyon walls and were encountered in drilling 4/ about one mile to the southwest. Information available at the present time indicates that these beds are not Eska conglomerate but are in the lower part of the Chickaloon formation. It is believed that the Eska conglomerate at the axis of the syncline at the Premier mine represents the southwesternmost extent of this formation in the area.

4/ Waring, G. A., op. cit., pl. 7.

The unnamed Tertiary formation, between 2,000 and 4,000 feet thick, consists of arkose, conglomerate, and shale and is found in a belt extending along the northern border of the Matanuska Valley from the Little Susitna to the Chickaloon River. It is only in fault contact with the other Tertiary formations and with Upper Cretaceous rocks but is believed to be equivalent to and to represent the marginal facies of part or all of the Chickaloon formation.

## Chickaloon Formation

The areal distribution of the main stratigraphic subdivisions of the Chickaloon formation, from the Premier mine to the eastern edge of the area studied, is shown in part on the maps (figs. 2,3,4, and 5.).

The upper part of the formation, about 1,200 feet thick and containing minable beds of coal (fig. 6), is here described. This 1,200-foot section, overlain by Eska conglomerate, was studied in the valley of Moose Creek upstream from the Premier mine, along the north slope of Wishbone Hill, and in the Evan Jones mine.

The Chickaloon formation is of continental origin and contains a flora, consisting of abundant remains of many species, that indicates the formation is of Eocene age. Correlation of stratigraphic sections is based on lithology and sequence of beds and on thickness of stratigraphic intervals.

With the exception of coal and associated beds, described in the section on coal deposits, the formation consists dominantly of sandstone, siltstone, silty claystone, and smooth-textured claystone. These rocks locally contain small irregular masses and lenses of coal. Fine coaly lenses are particularly abundant in claystone beds associated with coal beds. Beds of conglomerate and conglomeratic sandstone, commonly not exceeding 15 feet thick, occur locally at several horizons in the Chickaloon formation (fig. 7).

The Chickaloon beds are for the most part poorly stratified and not conspicuously jointed. Unlike fine-textured Upper Cretaceous rocks, Chickaloon beds composed of clay and silt are not shaly. The claystone beds break irregularly, generally with slick surfaces.

The sandstone beds in general are arkosic and poorly cemented. Locally, they are cemented by calcite or siderite. The conglomerate beds consist of cobbles, pebbles, granules, and sand, composed largely of vein quartz, chert, volcanic and metamorphic rocks, and fragments of locally derived clay rocks deposited during Chickaloon time by rivers. Coal beds, as well as beds composed of fine clastic sediments, contain sideritic ironstone in the form of nodular zones and as separate nodules either aligned along definite horizons or irregularly distributed within beds.

The three groups of coal beds, namely, the "Jonesville", the "Premier", and the Eska coal groups, are continuous laterally and are rather uniform throughout the area (figs. 6 and 7). Thick sections of clastic sediments, containing several widely spaced coal beds, intervene between the coal groups and are characterized by lateral intergradation, interfingering, and lensing out of conglomerate, sandstone, siltstone, and claystone. Unlike the three coal groups, the isolated coal beds in these clastic sediments are not continuous throughout the area. They either lens out or grade laterally into clastic sediments.

The transitional beds, the uppermost subdivision of the Chickaloon formation, are about 120 feet thick at the three localities at which the upper and lower contacts are exposed (fig. 7). The beds consist of cobble-pebble and pebble-granule conglomerate, sandstone, siltstone, and silty claystone. In these beds the Chickaloon formation appears to be transitional with the massive Eska conglomerate. These beds are underlain by the "Jonesville" coal group, described in the section on coal deposits. The transitional beds are exposed on the north slope of Wishbone Hill and in the valley of Moose Creek upstream from the Baxter mine and opposite the portal of the Premier mine.

The stratigraphic interval between the "Jonesville" coal group and the "Premier" coal group consists largely of sandstone and siltstone along the north slope of Wishbone Hill between the New Black Diamond mine and the eastern edge of the map (fig. 2). In gullies in the eastern part of this area the interval is about 150 feet. Beds of this interval do not crop out in the valley of Moose Creek between the New Black Diamond and Premier mines but were encountered in drill holes 3, 4, 6, and 9 (fig. 7). In hole 6 at the Premier mine the interval contains a bed of bony coal and bone. Thin beds of coal were found in a gully along the north slope (sec. N, fig. 7). Thus this dominantly clastic sequence of beds locally contains one or more coal beds or coaly zones. The sequence is undertain by the "Premier" coal group, described in the section on coal deposits.

The stratigraphic interval between the "Premier" coal group and the Eska coal group is 400 to 450 feet and is characterized by several widely spaced coal beds in a section consisting of sandstone, siltstone, silty claystone, and claystone (fig. 7). The coal beds include bed 5 at the Premier mine, bed 1 and the "Powder House" beds at the Buffalo mine, bed 2 at the Howard & Jesson mine, and other unnamed and unnumbered beds; some of these are correlative. Beds of conglomerate and conglomeratic sandstone occur locally at several horizons in this stratigraphic interval. One, a channel deposit, crops out as a large conglomeratic lens at the Wishbone Hill mine (sec. I, fig. 7). The marked lateral differences in lithology are illustrated by comparison of the upper part of the interval in the Buffalo mine area and in the New Black Diamond mine. In the drill holes and crosscut tunnel at the Buffalo mine the beds between the "Powder House" coal beds and the base of the "Premier" coal group, totaling 150 to 175 feet in thickness, consist of claystone, silty claystone, siltstone, and sandstone and include a coal bed, bed 1 of the Buffalo mine. In outcrops at the New Black Diamond mine (sec. H, fig. 7), about one mile from the Buffalo area, equivalent beds consist almost entirely of sandstone, and the coal bed is not represented. The lower part of the interval between the "Premier" and Eska coal groups, including about 150 feet of beds overlying the Eska coal group, consists of sandstone and siltstone; this laterally persistent litholigic unit locally contains beds of conglomerate.

### Quaternary Deposits

Glacial sand and gravel deposits, most of which contain large boulders, are present throughout the greater part of the area here described. Moraine deposits are found on the broad rock-defended terrace on the southeast side of Moose Creek valley between the Buffalo and New Black Diamond mines (fig. 4) and are well developed throughout the area northwest of the valley of Moose Creek. Drill hole 4, upstream from the Buffalo mine, passed through a gravel cover about 50 feet in thickness, indicating that in the higher parts of the valley bottom excavation of morainal valley fill is far from complete.

Recent alluvium is confined almost entirely to the flood plain of Moose Creek. Holes 7 and 8, drilled on the flood plain, penetrated boulder-gravel deposits 8 and 13 feet thick, respectively. Moose Creek locally is cutting in bedrock.

Slide rock, present at the base of all cliffs of Eska conglomerate, is mapped as a separate unit. It is composed of a chaotic mass of rock fragments ranging in size from loose pebbles and cobbles from the conglomerate to large slumped blocks of conglomerate 40 feet or more in diameter. Slide rock generally covers the contact between the Eska and Chickaloon formations. Exposures in gullies on the north slope of Wishbone Hill indicate that where the coal-bearing part of the Chickaloon formation is at the bedrock surface the slide rock generally is only a few feet thick, although locally it may be of considerable thickness.

## STRUCTURE

### "Wishbone Hill" Syncline

The dominant structural feature of the lower Matanuska Valley coal field is a broad canoe-shaped syncline that strikes northeastward and is here referred to as the "Wishbone Hill" syncline. Wishbone Hill derives its name from the topographic expression of the Eska conglomerate in the synclinal structure. The Eska mine is at the northeast end and the Premier mine at the southwest end of the canoe structure. The syncline plunges 10 to 15° SW. in the Eska and Jonesville areas; in the vicinity of the Premier, Baxter, and Buffalo mines the plunge is northeast.

Maps accompanying this report (figs. 2-5) include the southwest end and part of the northwest limb of the syncline. The strike of the Eska conglomerate in the area changes gradually from about due east on the north slope of Wishbone Hill to N. 40° E. near the Baxter mine; the average dip is about 35° SE., but locally the dip is as gentle as 20° SE. or as steep as 50° SE. The structure of the Chickaloon beds appears to conform with that of the overlying Eska conglomerate except in two areas of subsidiary folding on the northwest limb where the Chickaloon beds are tightly folded and complexly faulted.

## Transverse Faults

The "Wishbone Hill" syncline is cut by two sets of transverse faults of dominantly horizontal displacement. Faults of one set strike northwest and are best developed in the western part of the field, at the Premier mine and upstream from the Baxter mine (fig. 2). Along these faults the eastern blocks are displaced southward. Faults of the other set strike approximately N. 20° E. and are best developed in the eastern half of the syncline; they include the Eska fault zone and the Jonesville fault, which are east of the area mapped for this report, and two unnamed faults (fig. 2) that cut the north limb of the syncline on either side of the boundary between R. 2 E. and R. 3 E. The blocks west of these transverse faults are displaced southward.

The transverse fault at the Premier mine is almost vertical and strikes N. 70° W. It cuts off the "Premier" coal group at the northeastern end of the Premier mine workings. The drag of bed 3 on both limbs of the syncline at the Premier mine (fig. 3) indicates that the "Premier" coal group has been displaced horizontally to the southeast on the northeast side of the fault. The horizontal slip is at least 250 feet as indicated by a tunnel driven southeast along the fault from bed 3 that failed to intersect the "Premier" coal group on the northeast side of the fault. Other evidence suggests that the total displacement probably is about 1,500 feet. At the surface, the fault is marked by a gouge zone nine feet wide on the southeast bank of Moose Creek and by the abrupt termination to the northeast of the bluff of Eska conglomerate across Moose Creek from the portal of the Premier mine.

Displacement along the transverse fault upstream from the Baxter mine is indicated by the disparity between the position of the Eska conglomerate at the upstream end of the bluff northeast of the Baxter mine and the inferred position of the base of the Eska conglomerate in the Buffalo mine area. The northeast side of this fault likewise has moved southeast, probably about 2,000 feet.

The trace of a transverse fault, striking about N. 15° W., is indicated by the alignment of offsets of hogback ridges on the southeast limb of the "Wishbone Hill" syncline with small stream courses and saddles and with a gully on the northwest side of the valley of Moose Creek. The fault crosses Moose Creek about midway between the Buffalo and New Black Diamond mines (fig. 2). Horizontal slickensides in this fault zone were found on the southeast limb of the syncline, where offsets of hogback ridges indicate that here the west side has been displaced southward about 200 feet.

## Thrust Fault

Evidence of a thrust strike fault concealed beneath slide rock was found on the northwest limb of the "Wishbone Hill" syncline in the area between the transverse fault upstream from the Buffalo mine and the gully east of the Howard & Jesson mine designated M (fig. 2). This inferred fault, extending along the base of the cliff of Eska conglomerate, is believed to dip southeastward more gently than the beds. Displacement has cut out a section of Chickaloon and Eska beds as much as several hundred feet thick. At the "Wishbone Hill" mine (fig. 5) beds of the "Premier" coal group, normally at least 300 feet below the base of the

Eska conglomerate, crop out not more than 150 feet stratigraphically below a recognizable stratigraphic horizon at least 500 feet above the base of the Eska, indicating that at least 650 feet of Chickaloon and Eska beds are cut out at this locality.

Drill holes 10 and 11 on the bench between the New Black Diamond and Buffalo mines are in the Chickaloon formation on the footwall side of the inferred southeast-dipping thrust fault, which evidently runs along the northeast side of the hogback ridge of Eska conglomerate at this locality (fig. 4). A 600-foot thickness of beds, including the upper part of the Chickaloon and the lower part of the Eska, is cut out here. Faults encountered in hole 11, drilled S. 32° E. at a 45-degree pitch, cut out parts of the stratigraphic section and probably represent small subsidiary faults on the footwall side of the main thrust fault.

The area of known displacement along the fault coincides with an area of tight folding and complex faulting in the Chickaloon formation. This suggests that the folding and thrusting were concomitant, the weak Chickaloon beds having been tightly folded on being thrust under and against the Eska conglomerate. The displacement decreases eastward from the Howard & Jesson mine and probably dies out between the gully designated M (fig. 2) and the outcrops of the "Premier" coal group in the vicinity of the boundary between R. 2 E. and R. 3 E., T. 19 N. At the latter locality the Chickaloon beds are accordant in attitude with the Eska conglomerate, and the normal stratigraphic thicknesses of both formations appear to be represented.

### Small-Scale Faults

Faults having displacements ranging from a few inches to a hundred feet or more cut the Chickaloon formation and are numerous and closely spaced in the tightly folded areas, especially at the axes of folds. They are of three types: (1) normal faults of diverse attitudes, (2) thrust faults, both high- and low-angle types, for the most part parallel to the strike of the beds, and (3) steeply dipping horizontal-slip faults that cut obliquely across the beds.

The Eska conglomerate is cut by few small-scale faults other than the steeply dipping horizontal-slip type, probably related to the two sets of major transverse faults.

### Areas of Simple Structure and Areas of Complex Structure

The area mapped may be subdivided on a structural basis into five areas named for the purpose of discussion as follows: the Premier area, Baxter area, Buffalo area, Howard & Jesson area, and "north slope" area. In the Baxter and Howard & Jesson areas tight and locally overturned subsidiary folds in the Chickaloon formation are superimposed on the northwest limb of the "Wishbone Hill" syncline. The Premier, Buffalo, and "north slope" areas are characterized by simpler structure.

The Baxter area is separated from the Premier area by the transverse fault at the Premier mine and from the Buffalo area by the transverse fault northeast of the Baxter mine (fig. 2). The Howard & Jesson area extends southwestward from the Howard and Jesson mine at least as far as the New Black Diamond mine, and may be separated from the Buffalo area by the transverse fault midway between the Buffalo and the New Black Diamond mine. The complex structure of the Howard & Jesson area continues eastward at least as far as the gully at the center of sec. 13, T.19 N., R.2 E.(M. fig.2). The beds cropping out near the western boundary of sec. 18, T.19N., R.3 E., and in other gullies to the east along the north slope of Wishbone Hill are rather uniform in attitude. The area that includes these gullies is designated as the "north slope" area. The nature and position of the boundary between this area and the Howard & Jesson area are unknown because of lack of exposure.

Premier area. An open, asymetrical, northeast-plunging syncline is the dominant structural feature of the Premier area (fig.3). The axis of the syncline strikes N. 45°E. and pitches about 25° NE. in the mine workings; the northwest limb of the syncline dips more steeply than the southeast limb (cross section through drill hole 6, fig.3). The rocks of the syncline at Premier are cut by a number of faults, particularly in the mine workings on the steep part of the northwest limb. Near the axis of the syncline four hinge faults, which locally eliminate as much as 40 feet of section, cut the "Premier" coal group (structure contour map of the Premier mine, fig.3). In the bluff across Moose Creek from the portal of the Premier mine, a fault has displaced the base of the Eska conglomerate at least 40 feet vertically. In drill hole 6 a few hundred feet of beds, including the "Premier" coal group, have been cut out by faulting (cross section, fig.3).

Baxter area. Tight subsidiary folding and complex faulting characterize the structure of the Baxter area (fig. 3). The subsidiary folds strike S. 80° E. to N. 80° E. and plunge 30° to 40° E. At least one fold, the anticline on the southeast side of Moose Creek opposite drill hole 7, is slightly overturned toward the south. Hole 7, directed toward the northwest limb of this anticline at a 45-degree pitch, failed to intersect at depth the Eska coal group that crops out there. This probably is due to a reversal in attitude of the beds, in the form of a syncline, between the northwest limb of the anticline and the drill hole, the hole having passed beneath the coal-bearing part of the syncline (cross section, fig. 3). The fact that the lower part of the southeast-pitching hole is almost parallel to the stratification suggests that this part of the hole is on the northwest limb of a syncline. Changes in attitude of the beds on the northwest limb of the anticline, as shown on figure 3, further indicate the presence of an adjoining syncline.

Outcrops at the Baxter mine, in the vicinity of the portal and the airway, are on the north limb of an east-plunging anticline, but the main workings of the mine, on the so-called "big bed", are on the gently dipping south limb near the axis of the adjoining syncline. Northeast of the Baxter mine, differences in attitude of beds suggest the presence of other folds.

Faults are abundant and closely spaced in the tightly folded Baxter area, especially at the axes of folds. In the tunnel that crosscuts the limbs of the anticline opposite drill hole 7, complex faulting of the beds was observed at the anticlinal axis.

Faulting in the Baxter mine is described by Chapin 6/ as follows: "... the bed is considerably broken and is cut off on both the northeast and southwest by faults, beyond which it has not been explored. The most prominent fault is exposed at the southwest end of the drift from the lower level. At this place it strikes N. 40° E. and dips 42° SE. and has faulted black slate against massive conglomerate. This is probably the overlying Eska conglomerate.."

6/ Chapin, Theodore, Mining in the Matanuska coal field, Alaska: U. S. Geol. Survey Bull. 712, p. 166, 1920.

The Eska conglomerate and the coarse-textured upper part of the transitional beds of the Chickaloon formation maintain a relatively gentle eastward dip in the Baxter area although they overlie tightly folded beds in the coal-bearing part of the Chickaloon formation. The trace of a recognizable horizon in the competent upper part of the transitional beds, indicated by the line of dots and dashes northeast of the Baxter mine (fig. 4) illustrates the relatively simple structure of these beds. The differential folding of the competent Eska and the incompetent Chickaloon beds is taken up by displacements along numerous strike and bedding-plane faults in the upper part of the Chickaloon.

Thrust faults, about parallel to the strike of the beds, were identified and mapped in this area; some eliminate and some cause repetition of beds, depending on their attitude with relation to the bedding. Both high- and low-angle types are represented.

Buffalo area. Geologic information thus far obtained from mine workings and diamond-drill holes indicate relatively simple structure in the Buffalo area (fig. 4). Outcrops are few.

Important structural features in the vicinity of the mine are: (1) progressive change to the northeast in attitude of the beds, from a strike of N. 20° E., dip 42° SE., in the lower gangway 600 feet southwest of the slope, to a strike of N. 50° E., dip 70° SE., 700 feet northeast of the slope, (2) probable reversal in dip of the beds southeast of the workings, indicated by drill hole 9, and (3) faults of small displacement in the workings and indicated by drill holes. Continued curving of the coal beds south of the present southwestern extent of the workings is suggested by the position of the "Premier" coal group indicated at hole 1 (cross section, fig. 4).

Hole 9 (fig. 4) encountered the top of the sequence of coal beds of the Buffalo mine at 350 feet rather than at about 550 feet, the expected depth based on projection of the beds down-dip from the workings. Three

possible interpretations are: (1) a small flexure lies between the workings and hole 9 such that the beds in the hole dip southeast as in the mine, (2) hole 9 and the workings are on opposite limbs of a larger synclinal flexure, and (3) a normal fault intervenes between holes 3 and 9 with the northwest side downthrown. The first two interpretations are favored by the writers, but data are inadequate to determine which is the more likely (fig. 4).

Three types of faults of small displacement have been encountered in the Buffalo mine. A normal fault, striking N.40-50° E. and dipping 42-60° NW., was traced through part of the east workings above the gangway at 750 feet altitude; the northwest side has been downthrown only a few feet. A thrust fault, about parallel to the strike of the beds and ranging in southeast dip from a few degrees to 48 degrees, cuts out the lower part of Buffalo bed 2 in part of the east gangway at 750 feet altitude and may be seen in chute 10 and in the counter between chutes 10 and 13, where the displacement is only a few feet. A horizontal slip fault, striking N.4° E. and dipping 55° NW., offsets bed 2 in the gangway at 1000 feet altitude; the west side has moved south with a strike-slip of about 30 feet.

Drill hole 3 failed to intersect bed 1 but cut a thick shattered zone at about its expected position. In the part of hole 5 below the Eska coal group, shattered zones and apparent reversals in dip of stratification in the drill core indicate the presence of numerous faults.

Little is known of the structure of the area between hole 4 and the New Black Diamond mine. Holes 10 and 11 (fig. 4) and a bulldozer trench indicate that the Chickaloon beds are about vertical and strike N.60° E. The vertical dip probably is related to the steepening in a northeast direction of beds in the Buffalo mine. The inferred position of Buffalo bed 2 northeast of hole 4 is shown in figure 4. The beds in this area are cut by a horizontal-slip fault, described in the section on transverse faults, that is believed to have a displacement possibly less than 100 feet, and not more than 200 feet, the west side having moved southward (fig. 4). The major thrust fault evidently runs along the lower part of the slope a short distance southeast of holes 10 and 11 (see section on Thrust Fault).

Howard & Jesson area. The beds of the Howard & Jesson area are folded, complexly faulted, and in places overturned (figs. 2 and 5). The major structural feature is the inferred thrust fault heretofore described. Interpretation of the structure of the area is made difficult by the fact that, except in the vicinity of the New Black Diamond and Wishbone Hill mines, exposures are limited to widely spaced gullies.

In the New Black Diamond and Wishbone Hill mines coal beds of the "Premier" coal group were worked on the limbs of a well exposed overturned anticline, the axis of which strikes approximately N.80° E. and pitches about 30° E. Several faults cut the anticline; a fault nearly parallel to the axis brings Wishbone Hill bed 1 on the north limb workings almost into contact with bed 1 on the south limb (fig. 5).

In the part of the Howard & Jesson complex area east of the Howard & Jesson mine, the beds range in strike from N. 30° E. to N. 70° E. and in dip from 40° SE. through vertical to 50° NW. The beds dipping northwest probably are overturned. Beds exposed in the mine and in outcrops in the vicinity of the mine are badly broken by faulting.

"North slope" area. Chickaloon beds exposed in the "north slope" area are rather uniform in attitude and conform in structure with the overlying Eska conglomerate. No evidence of faulting or subsidiary folding was found, but exposures are few and widely spaced.

## COAL DEPOSITS

### Character of Coal

The coal in the Eska-Moose Creek part of the Matanuska Valley is a high-volatile bituminous coal. It is black and lustrous, non-coking, and a good steam coal. It commonly has well developed cleavage or cleat, in two directions approximately at right angles, that causes friability and difficulty in obtaining a large percentage of lump.

In the graditional series from claystone through coal the following lithologic types are recognized and used in logging stratigraphic section: coaly claystone, bone, bony coal, and coal. Analyses of coal samples from the Moose Creek area indicate that in coal (non-bony type) the ash content is less than 10 percent, averaging about 6 percent; the volatile matter commonly varies only 2 or 3 percent from an average of about 41 percent, and fixed carbon varies only 3 or 4 percent from an average of about 50 percent. Bony coal has an ash content estimated as averaging 20 to 25 percent. Bony coal in which the clay is rather evenly disseminated has a dull luster and slight brownish-gray color. Another variety of bony coal consists of lustrous black coal containing carbonaceous clay laminae or dull bands of impure coaly material. The term bone denotes material in which the apparent proportion of coal to clay is roughly 50:50, generally in the form of layers of coal interlaminated with carbonaceous clay. Bone commonly is dark brownish gray in color, has a banded appearance, and is relatively heavy and tough compared with coal. Bone is intergradational with coaly claystone, which resembles bone except that it contains thicker carbonaceous clay layers, the apparent proportion of coal to clay being approximately 25:75.

Lateral change from one type to another in the gradational series from claystone through coal is common. In several places part of a bed of coal was found to grade laterally to bony coal or bone.

Impurities in coal beds that may be hand-picked or removed by washing include sideritic ironstone nodules and nodular bands, thin beds of bone and coaly claystone, and thin markers composed of carbonaceous claystone or dense, hard, siliceous claystone. They can be traced locally in mines and outcrops for some distance but, in general, do not persist from one

locality to another and are not very useful in correlation of coal beds (fig. 8). The character, thickness, number, and position of these layers of impurities in a coal bed tend to differ from place to place. Splitting and lensing-out are common. Claystone markers have been found to grade laterally to coaly claystone and bone. In places, clayey or bony layers give way laterally to ironstone modular zones.

## Coal Groups and Coal Beds

"Jonesville" coal group. The "Jonesville" coal group is named after the town of Jonesville near which it was mined in the old workings of the Evan Jones mine (beds 1-3) on the south limb of the "Wishbone Hill" syncline (fig. 6). This group, comprising the highest coal beds in the Chickaloon formation, consists of an upper and a lower part separated by 15 to 20 feet of siltstone, silty claystone, and, locally, sandstone. The total thickness of the group, including the rock section, is 50 to 60 feet.

The group is highly variable in character laterally. The upper part contains a large proportion of coal on the north slope of Wishbone Hill, but at the few localities in which it crops out along Moose Creek it contains a much smaller proportion of coal and consists of thin beds of coal interstratified with claystone. The lower part of the group, beneath the rock interval, is thin and bony on the north slope of Wishbone Hill; in drill hole 6, the only place in which it was found along Moose Creek, it is represented by coaly claystone and does not contain coal.

"Premier" coal group. The largest amount of minable coal in the Moose Creek area is in the "Premier" coal group, which has been worked in the Premier, Baxter, Buffalo, New Black Diamond, Wishbone Hill, and Howard & Jesson mines. The group is 85 to 90 feet in thickness, about one-third of which is coal, and is rather uniform in character in the area studied. Available data indicate that the "Premier" coal group extends with little change in character (fig. 8) for a distance of about 5 miles from the Premier mine to the eastern edge of the area mapped.

In the Moose Creek area Buffalo bed 2, correlative with Premier bed 3, is the best bed in the "Premier" coal group, from the viewpoint of thickness, quality, and lateral persistence. It is about 8 feet thick and, in general, contains only a small proportion of bony coal and ironstone and claystone markers. Analyses of samples of this bed from the Buffalo and Premier mines are shown in table 1. Bed 1 of the Wishbone Hill mine and Bed 4 of the Howard & Jesson mine probably are correlative with this bed (fig. 7). It is believed that the bed persists eastward along the north slope of Wishbone Hill, because in section O (fig. 8) a thick coal bed occupies a corresponding position in the "Premier" coal group, which is similar in sequence of beds to the group in the Moose Creek area.

Coal beds between "Premier" and Eska coal groups. At several localities in the Moose Creek area a coal bed was found 50 to 75 feet below the base of the "Premier" coal group (fig. 7). Premier bed 5, Buffalo bed 1, and Howard & Jesson bed 2 are in this stratigraphic position and probably are correlative.

Although extensive, the bed at this horizon is not continuous throughout the Moose Creek area; it is not represented in outcrops at the New Black Diamond mine where sandstone occupies the equivalent part of the stratigraphic section. In the Premier and Buffalo areas the bed ranges in thickness from about 4½ feet to 7½ feet and contains one to four thin claystone and ironstone markers.

Outcrops, drill holes, and mine crosscuts in the Buffalo and Howard & Jesson areas indicate the presence of coal beds about midway in the rock section between the "Premier" and Eska coal groups (fig. 7). Little is known of the lateral continuity of these beds except in the Buffalo area, where the two thin beds intersected by the powder house tunnel also were found in the diamond drill holes. In drill hole 2 two thin coal beds were intersected 25 to 35 feet below the "Powder House" beds. In hole 1 these two beds were not encountered, and, inasmuch as a fault cuts the section near their expected position, it is believed that they are faulted out. In the Howard & Jesson crosscut and in section K (fig. 7) there is a thin coal bed about 15 feet beneath the beds believed to be correlative with the "Powder House" beds. The coal beds at the base of section H, at the New Black Diamond mine, may be correlative with the "Powder House" beds. According to available information, the "Powder House" beds and correlative beds and other beds in the same part of the stratigraphic section probably are not of commercially minable thickness and quality, except locally (fig. 7), under present conditions.

Eska coal group. This coal group crops out and was worked to a small extent on the southeast slope of the valley of Moose Creek opposite drill hole 7 in the Baxter area and was intersected in hole 6 in the Premier area and in holes 1, 2, and 5 in the Buffalo area. The coal bed in the Howard & Jesson crosscut beneath overburden at the portal may represent the upper part of this coal group (fig. 7).

The Eska coal group is 50 to 60 feet thick and, in the Buffalo area, contains four prominent coal beds. Reasons for believing that this group of coal beds is correlative with the Eska coal group of the Eska mine area include similarity in the total thickness and general similarity as to number, thickness and spacing of beds. Furthermore, rocks overlying and underlying the coal group in the Moose Creek area are similar to equivalent beds in the Eska mine area (see fig. 6). In both areas the coal group is overlain by a thick section of sandstone and siltstone. Underlying beds in both areas consist mainly of silty claystone, siltstone, and sandstone and contain only a few thin coal beds.

In the Baxter and Premier areas the beds of the Eska coal group are thinner and of poorer quality than in the Buffalo area. In outcrops across Moose Creek from drill hole 7 the coal group itself is 30 to 40 feet thicker than it is elsewhere, due to the presence of thin coal beds that occur above what at other localities is the top of the group. This indicates that, locally, coal deposition continued longer than at other places.

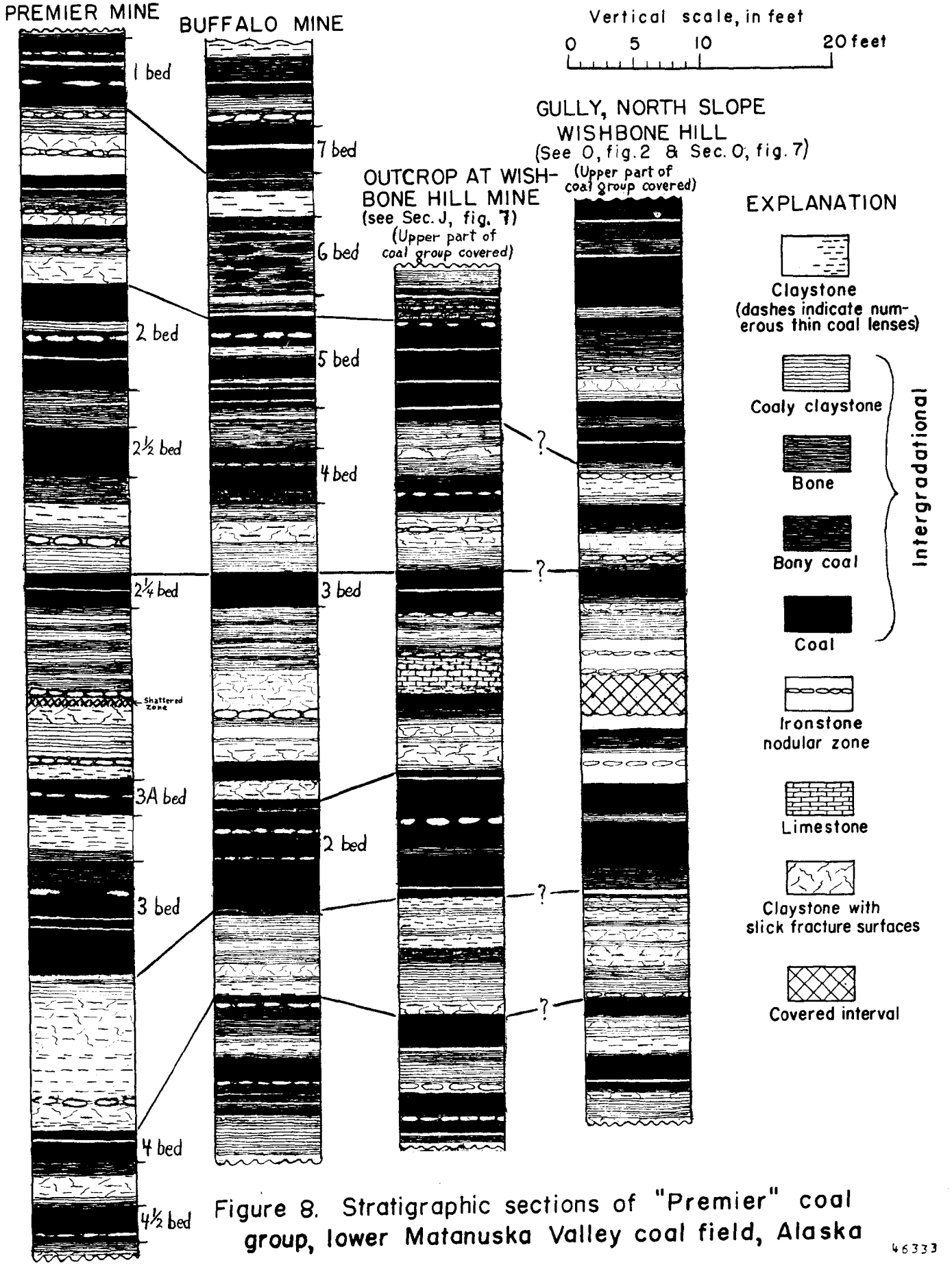


Figure 8. Stratigraphic sections of "Premier" coal group, lower Matanuska Valley coal field, Alaska

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## Premier Area

In the area of the Premier mine Chickaloon beds, from the "Premier" coal group to the base of the Eska conglomerate, come to the surface beneath the cover of Quaternary deposits and crop out locally. The beds here are in a northeast-plunging syncline, around the axis and limbs of which they curve in a U-shaped pattern terminated by a transverse fault (fig. 3) that cuts off the beds on the upstream side. The transitional beds and the "Jonesville" coal group crop out beneath the Eska conglomerate in the central part of the syncline area (secs. A-A' and B, fig. 3.). The "Jonesville" coal group was mined to a small extent in the old workings near drill hole 6; here a slope was driven on a 5-foot coal bed. The "Premier" coal group comprises beds 1 through 4½ of the Premier mine (fig. 8), the main workings being in bed 3. Premier bed 5 is separated from the coal group by a considerable thickness of rock; the bed is about 5 feet thick, contains two thin markers, and is believed to be correlative with Buffalo bed 1. Analyses of Premier beds are given in table 1.

In the Premier crosscut tunnel bed 6 and an overlying thin unnumbered coal bed lie within a few feet of bed 5, from which they are separated by a fault. Crosscuts from bed 5 elsewhere in the mine failed to intersect bed 6, and, judging from the stratigraphic section in other parts of the Moose Creek area, the nearest coal beds probably are 80 feet or more below bed 5. It is believed, therefore, that the proximity of bed 6 to bed 5 in the main crosscut tunnel is due to faulting.

Drill hole 6 indicates that beds of the Eska coal group are thinner and of poorer quality in the Premier area than in the Buffalo area. One of the beds intersected by hole 6 is possibly of minable thickness.

## Baxter Area

In the Baxter area of tight folding the distribution of Chickaloon beds is rather complex. This area is about one mile in length and lies between the transverse fault that cuts off the beds of the Premier mine and the inferred transverse fault at the northeast corner of the map (fig. 3). Progressively younger Chickaloon beds crop out along the bluff in an upstream direction through this area.

Beds of the Eska coal group (sec. C-C', fig. 7) crop out on both limbs of a tight anticline across Moose Creek from hole 7 and were traced downstream along the slope for several hundred feet. It is believed that the part of the valley of Moose Creek between hole 7 and the transverse fault at the Premier mine is underlain by rocks older than the "Premier" coal group, that is, by the Eska coal group and thick sections of sandstone, siltstone, and claystone overlying and underlying the Eska coal group.

Along the slope between the Baxter mine and coal outcrops in the anticline opposite hole 7, beds of sandstone, siltstone, and silty claystone crop out, and coal beds not associated with coal groups were found at three

places. This area probably is underlain by the stratigraphic interval between the Eska coal group and the "Premier" coal group. The isolated coal beds probably are equivalent to bed 1 and the "Powder House" beds in the Buffalo mine area. The coal bed that crops out immediately downstream from the Baxter mine portal is believed to be correlative with Buffalo bed 1.

Part of the "Premier" coal group was worked in the Baxter mine. According to Chapin 7/, the "big bed" at the Baxter mine is 11 feet thick and

7/ Chapin, Theodore, op. cit., Bull. 712, p. 164.

contains a 2-inch marker. This bed is believed to be equivalent to both Buffalo bed 2 and the overlying thin coal bed separated from bed 2 by about 1½ feet of claystone in the Buffalo crosscut tunnel. The "big bed" and the overlying part of the "Premier" coal group are burned at the surface at the Baxter mine, the two coal beds shown on the map (fig. 3) representing only the unburned bottom beds of the coal group.

The "Jonesville" coal group crops out and was intersected in three prospect tunnels on the slope upstream from the Baxter mine (sec. E., fig. 3). The overlying transitional beds crop out along the slope beneath the bluff of Eska conglomerate northeast of the Baxter mine (fig. 3) but are covered in part by conglomerate slide rock. The line of dots and dashes on the map represents the trace of the contact of a prominent bed of sandstone with underlying siltstone in the transitional beds.

In drill hole 8 and outcrops upstream and downstream from the collar of this hole, bedrock consists of claystone, silty claystone, siltstone, sandstone, and coal that occurs as individual beds in the rock section. It is believed that these beds are part of the stratigraphic interval between the "Premier" and Eska coal groups, on the basis of their lithology and their stratigraphic distance below the "Jonesville" coal group and Eska conglomerate that crop out in the slope across Moose Creek from hole 8 (cross section through hole 8, fig. 3). If this interpretation is correct, the coal beds probably are equivalent to bed 1 and the "Powder House" beds in the Buffalo mine area. The "Premier" coal group probably underlies the creek flat about midway between the outcrop of the "Jonesville" coal beds and the drill hole.

### Buffalo Area

Because of the lack of outcrops the areal distribution of Chickaloon beds in the Buffalo mine area, except in the vicinity of the mine and diamond-drill holes, can only be inferred. The probable position of Buffalo bed 2 of the "Premier" coal group, beneath the cover of Quaternary deposits is shown on the map (fig. 4). The base of this group is believed to be at the bedrock surface a few feet east of the collars of drill holes 1 and 2. The coal group probably extends southward from hole 1 as far as the inferred transverse fault that separates the Baxter and Buffalo areas.

Drill hole 4, about 1,700 feet northeast of the haulage slope of the Buffalo mine, intersected the entire "Premier" coal group. Evidence bearing on the position of the coal beds in the area between hole 4 and the New Black Diamond mine is limited to drill holes 10 and 11 (cross section, fig. 4) and a bulldozer trench on the bench in this area. This work has indicated that the Chickaloon beds are about vertical and strike N. 60° E. The inferred position (fig. 4) of Buffalo bed 2 is based on northeast projection of the bed from the mine and hole 4, with allowance for continued northeast steepening, and on southwest projection of the strike from hole 11.

Buffalo beds 2 through 7 and two thin unnumbered beds below bed 2 are in the "Premier" coal group (fig. 8), Buffalo bed 2 being the best bed on the basis of thickness and quality. Analyses of the beds are given in table 1. In the Buffalo crosscut tunnel beds 3, 4, and 7 are each about 3 feet in thickness. Bed 5 is about 6½ feet in thickness but contains several markers. Bed 6 consists of bony coal and bone, the percentage of ash in two analyses being 34.7 and 40.3 (table 1).

Strata between the base of the "Premier" coal group and the top of the Eska coal group are exposed in the crosscut tunnel, in the powder house tunnel, and in small outcrops in the vicinity of the powder house, and were encountered in trenches and in drill holes 1, 2, and 5. Buffalo bed 1 and the "Powder House" beds are in the upper part of this 400- to 450-foot stratigraphic interval (fig. 7). The lower part of this interval consists of sandstone and siltstone. In the mine bed 1 is about 6 feet thick and contains four markers and about 1 foot of bony coal (analysis, table 1). Drill holes indicate that it is laterally continuous in the Buffalo mine area.

The Eska coal group does not crop out in the Buffalo area but was intersected in drill holes 1, 2, and 5 and probably is at the bedrock surface beneath alluvium under the present course of Moose Creek in the area between the mine buildings and hole 5. The group contains four prominent coal beds; in hole 1 they range in thickness from 3 feet 6 inches to 5 feet 6 inches (analyses, table 1).

Beds of conglomerate, sandstone, and siltstone exposed in a few small outcrops on the northwest slope of the valley of Moose Creek opposite the Buffalo mine dip to the northwest; they are believed to be in the lower part of the Chickaloon formation. The reversal in dip across the valley suggests the presence of an anticline,

### Howard & Jesson Area

The distribution of Chickaloon beds in the Howard & Jesson area (fig. 5) is complicated by folding and complex faulting. The upper beds of the Chickaloon formation, including the "Jonesville" coal group and transitional beds, are believed to have been cut out by the thrust strike fault previously described.

The "Premier" coal group is exposed along the slope at numerous localities (secs. F through M, fig. 7) and was worked in the Howard & Jesson, Wishbone Hill, and New Black Diamond mines, and to a small extent in the old workings about 500 feet downstream from the portal of the New Black Diamond mine. Wishbone Hill beds 1 and 4, correlative with Buffalo beds 2 and 5 (fig. 8), are the thickest beds worked in the Wishbone Hill mine and in the adjacent New Black Diamond mine. Bed 4 is about 7 feet thick and contains only a few thin claystone markers, whereas in the Buffalo mine, markers constitute a considerable part of equivalent bed 5. Part of the "Premier" coal group is burned at the surface above the New Black Diamond mine.

In the Howard & Jesson mine and in section K (fig. 7), measured in a gully about 1,000 feet east of the portal of the mine, the "Premier" coal group appears to contain a larger proportion of coal than elsewhere in the Moose Creek area and on the north slope of Wishbone Hill. Howard & Jesson bed 4, probably correlative with Buffalo bed 2, is 10 feet thick in the mine crosscut, according to Corey's log (fig.7), and in section K it is 9 feet thick and contains 2 thin markers. The underlying bed 3 in the mine is 11 feet 7 inches in thickness; the upper and lower parts, separated by a prominent marker, are believed to be equivalent to the two unnumbered beds at the base of the "Premier" coal group in the Buffalo mine although they are much thicker. The upper half of the coal group probably is cut out in the crosscut tunnel by faulting (fig.7); in section K a bed at least 7 feet thick occupies the same stratigraphic position as Wishbone Hill bed 4 (Buffalo bed 5). The greater proportion of coal in this area probably is the result of more sustained bog conditions, locally, during deposition of the coal group.

The thick stratigraphic section between the "Premier" coal group and the Eska coal group was penetrated in the Howard & Jesson crosscut (fig. 7). Howard & Jesson bed 2, about 60 feet below the base of the "Premier" coal group, was intersected in the crosscut, where it is more than 9 feet thick, and crops out in a gully in the vicinity (sec. K), where it is 8 feet 3 inches thick. This bed may be equivalent to Buffalo bed 1, although it is not represented in the intervening H section (fig. 7) between the Howard & Jesson and Buffalo mines.

The coal in the Howard & Jesson crosscut beneath overburden near the portal (bed 1) may represent the top part of the Eska coal group (fig. 7) which, on the basis of known stratigraphic intervals, would be expected to underlie the lower part of the slope eastward from the Howard & Jesson mine portal. The coal beds encountered in the crosscut between beds 1 and 2 and cropping out in the gully (sec. K) may be equivalent to the "Powder House" beds at the Buffalo mine.

### "North Slope" Area

Uniformity in attitude of Chickaloon beds on the north slope of Wishbone Hill (fig. 2) indicates that their areal distribution is relatively simple. This applies to the eastern part of section 13 (T. 19 N., R. 2 E.) and eastward through sections 18 and 17 (T. 19 N., R. 3 E.) to the Evan Jones mine.

Table 2.

Composite analyses of samples of coal shipments (unwashed) from mines on Moose Creek, lower Matanuska Valley coal field, Alaska.
(Analyses by M. L.Sharp, Chief Coal Sampler and Analyst, Alaska Railroad, Anchorage, Alaska)

| Mine | Explanation of samples | Air-drying loss, percent | Form of analysis [1] | Proximate, percent: Moisture | Volatile matter | Fixed carbon | Ash | Sulphur | Calorific value, B. t. u. | Laboratory number |
|---|---|---|---|---|---|---|---|---|---|---|
| Premier Mine | Composite of analyses of samples from 6 cars, sampled 8-5-25 | 2.6 | A | 5.15 | 40.43 | 43.54 | 10.88 | 0.21 | 11,765 | 1782 |
| | | | B | 2.40 | 41.60 | 44.80 | 11.20 | 0.22 | 12,105 | |
| | | | C | ---- | 42.63 | 45.90 | 11.47 | 0.22 | 12,400 | |
| | | | D | ---- | 48.15 | 51.85 | ---- | 0.26 | 14,005 | |
| Baxter & Bedell mine | Composite of 59 analyses of samples from 188 cars, sampled from 1-1-23 to 6-30-23 | 2.75 | A | 4.72 | 36.42 | 42.11 | 16.75 | 0.31 | 11,020 | (Yearly report, 1923) |
| | | | B | 2.03 | 37.45 | 43.30 | 17.22 | 0.32 | 11,330 | |
| | | | C | ---- | 38.32 | 44.20 | 17.58 | 0.33 | 11,565 | |
| | | | D | ---- | 46.38 | 53.62 | ---- | 0.39 | 14,035 | |
| New Black Diamond mine | Monthly composite of analyses of samples taken from cars in July, 1935 | 1.4 | A | 4.1 | 39.6 | 41.1 | 15.2 | 0.2 | 11,940 | 5692 |
| | | | B | 2.7 | 40.2 | 41.7 | 15.4 | 0.2 | 12,110 | |
| | | | C | ---- | 41.3 | 42.8 | 15.9 | 0.2 | 12,455 | |
| | | | D | ---- | 49.0 | 51.0 | ---- | 0.3 | 14,975 | |
| Wishbone Hill mine | Yearly composite of analyses of samples taken from cars in 1932 | 3.4 | A | 5.6 | 37.5 | 43.8 | 13.1 | 0.3 | 11,505 | 5222 |
| | | | B | 2.3 | 38.8 | 45.3 | 13.6 | 0.3 | 11,910 | |
| | | | C | ---- | 39.7 | 46.5 | 13.8 | 0.3 | 12,185 | |
| | | | D | ---- | 45.1 | 54.9 | ---- | 0.4 | 14,150 | |

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

Because of the sparsity of outcrops, details of the surface distribution of beds could be determined only in parts of the area. The "Jonesville" coal group is believed to be continuous along the upper part of the slope, the "Premier" coal group along the middle part, and the Eska coal group along the lower part of the slope throughout this area.

The "Premier" and "Jonesville" coal groups were logged in three gullies at the eastern edge of the map (secs. N, O, and P). In 1931 the Evan Jones Coal Co. prospected, by means of several trenches and two short tunnels, the two gullies shown at the eastern edge of the map (secs. O and P); these are the same as the westernmost two gullies mapped by Tuck on the north slope of Wishbone Hill. The report on results of the prospecting includes two 750-foot, "plan-view" sections of the sequence of beds encountered, beginning just below the base of the bluff of Eska conglomerate and extending down to the swamp at the base of the slope. These sections show coal beds near the top of the slope, in the middle part of the slope, and near the base of the slope. A prospect tunnel was driven in each gully on the beds near the top, the ones here designated as the "Jonesville" coal group (secs. O and P, fig. 7). Those in the middle part of the slope include the "Premier" coal group (fig. 8) and beds in the rock section below this group. That the beds near the base of the slope represent the Eska coal group is indicated by their stratigraphic position and by the overlying thick section of sandstone, probably equivalent to the sandstone and siltstone above the Eska coal group in the Buffalo area.

On the north slope of Wishbone Hill the "Jonesville" coal group appears to be better, as to quality and thickness of beds, than in either the Moose Creek area or in the old workings near Jonesville. The upper part of the group is about 25 feet thick, the upper 14 feet of which probably is minable (secs. N and O, fig. 7). In section N, where it is best exposed, this minable bed aggregates about 8 feet of coal, 4 feet of bony coal, and 2 feet of ironstone and claystone markers that could be eliminated by washing.

### Relationships of Beds in Moose Creek and Eska Creek Areas

Beds O and OO in the south-limb workings of the Evan Jones mine are part of a coal-bearing section, about 25 feet thick, terminated at the base in the crosscut tunnel by a fault with a thick gouge zone. It is believed that this section represents the upper part of the "Premier" coal group, the lower part of the group having been cut out in the crosscut by faulting (fig. 6).

Workings on Evan Jones bed 8 on the north limb of the "Wishbone Hill" syncline extend westward to the boundary between sections 17 and 18, T. 19 N., R. 3 E. In three gullies a quarter of a mile to a little more than half a mile farther west, the "Jonesville" and "Premier" coal groups crop out and were uncovered by trenching (secs. N, O, and P, fig. 6). The "Jonesville" coal group has not been intersected in the north-limb workings of the Evan Jones mine. Inasmuch as it probably contains large reserves of minable coal in this area, testing should be done. Evan Jones bed 5 is equivalent to

part of the "Premier" coal group, which evidently changes markedly in character a short distance east of the gully designated P (figs. 2 and 6).

Bed 10 and associated beds intersected in the Evan Jones crosscut on the north limb of the "Wishbone Hill" syncline are correlative with beds of the Eska coal group in the Moose Creek area and in the Eska mine area (fig. 6).

## Origin of Deposits

The Chickaloon formation was laid down on an extensive aggrading plain occupied by shifting river channels, flood plains, lakes, and bogs. The groups of closely spaced coal beds (fig. 7) were formed during times when long-sustained bog conditions obtained in the region. Coal beds that occur individually in the rock section (figs. 6 and 7), associated with sandstone, siltstone, and claystone, were deposited in flood-plain bogs during times when river sedimentation held sway; they are not uniform laterally and, locally, wedge out into deposits of sandstone or siltstone.

Beds of conglomerate and coarse sandstone, generally cross-bedded, represent channel deposits or near-channel flood-plain deposits; the beds of fine sandstone, siltstone, and silty claystone probably were laid down during flood subsidence on broad flood plains; and the smooth, homogeneous claystone beds were deposited in stagnant ponds and lakes. These clastic deposits abound in fossilized leaves, twigs, branches, and trunks of plants and trees that lived on and between the flood plains, including oak, walnut, cottonwood, willow, sequoia, and species of many other well known tree families. In contrast, the coal beds commonly show no megascopic woody structure or identifiable plant remains, probably because of biochemical decomposition in the bogs, and consequently, there is little record of the identity of the coal-forming plants.

Clay beds associated with coal represent temporary cessation of bog conditions, probably because of rise in water level, and deposition of clay in stagnant water bodies. Lateral variation in the proportion of coal to clay beds in the coal groups suggests that the degree of dominance of bog conditions during deposition varied considerably from place to place.

## PRODUCTION AND DEVELOPMENT

In 1915 the coal lands of the Matanuska Valley were opened for leasing and subdivided into leasing units. Coal was first produced commercially on Moose Creek in 1916 at the Doherty mine, later known as the Pioneer mine, after the Matanuska Branch of the Alaska Railroad had been completed to the mouth of Moose Creek. The coal from mines farther up Moose Creek was sledded to the railroad on the frozen creek in the wintertime until a spur was built from the Matanuska Branch to the Baxter mine in 1923 and extended to the Howard & Jesson mine in 1925. The Moose Creek spur has been abandoned since 1942 when the tracks were washed out at numerous places. Present production is carried by truck to loading bunkers at the junction of the Moose Creek spur and the Matanuska Branch of the railroad.

A summary of the history and production in the Moose Creek area is given in table 3.

## COAL RESERVES

The estimates of coal reserves shown in table 4 include only the coal contained in the "Premier" coal group and the underlying Buffalo bed 1 or its equivalent. The "Jonesville" coal group contains a bed of coal 8 to 14 feet thick in the gullies on the north slope of Wishbone Hill in which sections N, O, and P were measured (figs. 2 and 7), and locally contains a 5- to 6-foot bed in the Premier and Baxter areas. The Eska coal group probably contains one to three beds of minable thickness throughout most of the area mapped. The reserves contained in the "Jonesville" and Eska coal groups were not calculated, however, because of insufficient data.

Because of the complex structure and inadequate data, estimates of reserves were not made for the Baxter area and for the part of the Howard & Jesson area west of the Howard & Jesson mine.

In calculating the reserves, the volume of one ton of coal was assumed to be 25 cubic feet in place. Coal beds less than 3 feet thick are not included in the estimates of reserves.

Locally, thick beds or beds low in ash, such as Buffalo bed 2, underlie and are separated by only a few feet of rock from thinner beds or beds higher in ash that would require washing. In these places, if the lower bed is mined first, caving may prevent mining the overlying beds, in which case the reserves would be much smaller than as indicated in table 4.

## CONCLUSIONS

The most favorable areas for further testing of coal reserves are those in which the structure is relatively simple, namely, the Buffalo area, the Premier area, and the north slope of Wishbone Hill.

Information thus far obtained in the Buffalo area is insufficient for determination of the structure and position of coal beds in the area between the Buffalo mine and outcrops of Eska conglomerate along the northeast-facing slope about 2,000 feet southeast of the mine. It is important to know whether (1) the coal beds continue down-dip from the mine to the axis of the "Wishbone Hill" syncline, or (2) there are subsidiary folds in the Chickaloon formation in this area. The latter possibility is suggested by the flexure in the coal beds indicated by drill hole 9 (cross section, fig. 4).

At the Premier mine the structure of a large part of the coal on the limbs of the syncline below 500 feet altitude possibly is as simple as the structure above the gangway at 500 feet altitude. Information adequate for determining the structure below 500 feet altitude might be obtained by drilling on the limbs.

Available evidence indicates simple structure and large coal reserves on the north slope of Wishbone Hill, including the eastern part of Section 13 (T.19 N., R. 2 E.) and the area extending eastward from the boundary between R. 2 E. and R. 3 E. (T. 19 N.) to the Evan Jones mine. Extensive trenching is needed to determine more accurately the thickness, character and continuity of the coal beds and the structure in this area. Trenching should be directed to expose the "Jonesville", "Premier", and Eska coal groups.

Drilling to determine the reserves of coal and the attitude of coal beds on the north slope of Wishbone Hill would meet with numerous difficulties. Vertical drill holes located at the base of the Eska conglomerate on north slope would intersect the "Jonesville" coal group at very shallow depth and the "Premier" coal group at a depth of 400 to 500 feet and at only a small distance down the dip from the surface. At many places, a considerable thickness of conglomerate slide rock would have to be penetrated. A hole located anywhere south of the cliff in the conglomerate area of Wishbone Hill would have to be drilled 1,500 to 2,000 feet, the greater part through Eska conglomerate, to intersect the coal-bearing part of the Chickaloon formation.

TABLE 4

COAL RESERVES OF PARTS OF THE MOOSE CREEK AREA AND THE WESTERN PART OF THE NORTH SLOPE OF WISHBONE HILL, LOWER MATANUSKA VALLEY COAL FIELD, ALASKA.

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| Area | Location | Beds | Approximate average thickness in feet. | Indicated reserves in tons 1/ | Inferred reserves in tons 1/ | Remarks |
|---|---|---|---|---|---|---|
| Premier area | Above gangway on 3 bed at 500 feet altitude | Premier 4, 4½, and 5 beds | 8.5 | 270,000 | | 1, 2, 2½ beds not included because caving and flooding of underlying 3 bed probably hase rendered them unminable. |
| | In trough of syncline underlying the area enclosed by gangway on No. 3 bed at 500 feet altitude and transverse fault at northeast end of workings. | Premier 1 through 5 beds | 23.9 | 1,150,000 | | A part of this tonnage may be badly faulted. In some places beds may dip too gently to be mined by methods thus far employed in the field. Workings on 3 bed would have to be pumped out before syncline could be mined below the gangway at 500 feet altitude. |
| Buffalo area | From D.D.H. 1 to D.D.H. 4 (2,750 feet) | Buffalo 1 bed | 5.4 | 240,000 | | These reserves include coal above a depth of 400 feet down the dip, the present depth of the Buffalo slope on the 2 bed. |
| | | Buffalo 2 bed | 6.5 | 285,000 | | |
| | | Buffalo 3 through 7 beds | 16.8 | 746,000 | | |
| | From transverse fault midway between Buffalo mine and New Black Diamond mine to transverse fault northeast of Baxter mine (5,600 feet) | Buffalo 1 through 7 beds. | 28.7 | | 3,230,000 (does not include indicated reserves shown above) | These beds may be continuous down dip to axis of syncline. Because operators of Buffalo mine plan to extend slope on 2 bed to 700 feet below the collar, a depth of 700 feet was chosen arbitrarily for use in calculating inferred reserves. |
| North slope of Wishbone Hill. | From gully in which section K was measured to gully in which section P was measured (7,000 feet) | "Premier" coal group and a bed probably correlative with the Buffalo 1 bed | 26.0 | | 5,100,000 | These beds probably are continuous down the dip to the axis of the "Wishbone Hill" syncline. A distance of 700 feet down the dip was chosen arbitrarily for use in calculating inferred reserves on north slope of Wishbone Hill. Structure in western part of area may be somewhat complex. |

1/ Reserve estimates are for coal beds 3 feet or more in thickness.

TABLE 3

PRODUCTION AND DEVELOPMENT OF COAL MINES IN MOOSE CREEK AREA, LOWER MATANUSKA VALLEY COAL FIELD, ALASKA.

46353

| Mine | Production[1] in tons | Developmental history |
|---|---|---|
| Pioneer mine | 4,190 | Mined, by means of a slope, one thin, dirty bed striking Nø. 75° E. and dipping 48° SE. 1928-29 production was cleaned in a washery. |
| Premier mine | 192,724 | Mined "Jonesville" and "Premier" coal groups (see fig. 7) on limbs of an open syncline. "Jonesville" coal group developed in 1922 by means of a tunnel, slope, and shaft on southeast side of Moose Creek. Production in 1922 came from one 5-foot bed cut off by fault near foot of slope.<br>In 1923, presence of "Premier" coal group on northwest side of creek was discovered. Almost entire 1923-1933 production came from 3 bed of this coal group which was developed by a 36° slope on the 2 bed and gangways at 500 feet altitude on the 3 bed. In 1933 mine was flooded after 3 bed had been mined out above this level. Most of production from 1941-43 came from 2, 2½, 4, 4½ and 5 beds above gangways at 700 feet altitude on northwest limb of syncline. |
| Baxter mine | 21,683 | Mined 3 beds (the "big bed" and two smaller beds) in the "Premier" coal group (see fig. 7, sec. D). Main workings were located in complexly faulted rocks near the axis of a syncline. "Big bed" cut off at northeast and southwest ends of gangway. Five other tunnels prospected "Jonesville" and Eska coal groups but did not mine them extensively. Prior to completion of narrow gauge in 1923, mining was carried on only during the winter months and the coal sledded down Moose Creek. |
| Buffalo mine | 6,924 | Intersected "Premier" coal group and the underlying 1 bed in crosscut. Most of production prior to 1944 came from 2 bed, which has been developed by means of a 1100-foot gangway at 1000 feet altitude and a slope driven 420 feet down the dip. Operators propose to drive gangways northeast and southwest from present foot of slope and eventually to extend slope 300 feet farther down dip. |
| New Black Diamond mine | 14,772 | Mined, by means of drifts and crosscuts, at least two beds (Nos. 3 and 7) of the "Premier" coal group, on south limb of a tight, complexly faulted anticline. Drifts from another tunnel 570 feet southwest of main entry were also driven on "Premier" (?) coal group, but beds are reported cut off by fault at northeast end of drift. Prior to 1925, when narrow gauge reached the New Black Diamond mine, coal was carried down Moose Creek on sleds during winter.<br>~~Coal produced by this mine had high ash content.~~ |
| Wishbone Hill mine | 4,417 | Mined "Premier" coal group on north and south limbs of same tightly folded, complexly faulted anticline on which workings of New Black Diamond mine were driven. Most of development done on two of five coal beds (Nos. 1 and 4). |
| Howard & Jesson mine | 15,777 | Originally known as "Leroy Prospect".<br>Crosscut tunnel intersected five thick beds (see fig. 7); the 1 bed, possibly equivalent to the top of the Eska coal group; the 2 bed, equivalent to the Buffalo 1 bed; and the 3, 4, and 5 beds, part of the "Premier" coal group. Almost entire production came from 3 and 4 beds, having a total thickness of 21 feet. These beds are faulted out in the east gangway.<br>Considerable surface prospecting done in the leasing unit in gullies east of the main entry. |
| Total | 260,487 | |

1/as of December 1943.