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# A RECONNAISSANCE

OF THE

# MATANUSKA COAL FIELD, ALASKA

IN 1905

BY

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# A RECONNAISSANCE OF THE MATANUSKA COAL FIELD, ALASKA, IN 1905.

By G. C. Martin.

## INTRODUCTION.

The region described in this paper extends northeast from the upper end of Knik Arm, the northerly branch of Cook Inlet. It lies between latitudes 61° 30′ and 61° 50′ north, and longitudes 148° and 149° 30′ west. It is about 80 miles long in a northeast-southwest direction, and from 5 to 10 miles wide.

The occurrence of coal in this region was first learned from the Indians by prospectors and traders in 1894. A little exploration was done during the following year or two, but the search was chiefly for placer gold, as coal deposits in this region were then of no value because of the lack of transportation. In 1898 and 1899 the region was traversed by army exploring parties. The first of these was accompanied by W. C. Mendenhall of the United States Geological Survey, who, in his reports[a], described the region from Knik station to the headwaters of the Matanuska and northward to the Tanana. These reports outlined briefly the geology along the route traversed, and alluded to the presence of coal. The journey was, however, so hurried that Mendenhall did not see the principal coal outcrops. In 1903 the assurance of construction of the railroad from the head of Resurrection Bay to the Yukon Valley revived interest in these coal fields, and since then they have been actively prospected and steps have been taken toward securing title to coal lands. In 1904 R. W. Stone[b] compiled information in regard to this field, but made no examination of the region.

The writer, under instructions of Mr. Alfred H. Brooks, geologist in charge of the division of Alaskan mineral resources, spent about three weeks in this field in the summer of 1904; visiting the region immediately adjacent to Matanuska River from Knik Arm nearly to the mouth of Hicks Creek. The following pages contain the results[c] of this investigation, together with such other information as could be compiled.

Messrs. Frank Watson and Thomas Jeter, of Seward, George Palmer, of Knik, William Griffith, of Scranton, Pa., and many others, have extended courtesies in the field and elsewhere which have added to both the value and the pleasure of the work.

[a] Report on the region between Resurrection Bay and the Tanana River: Maps and Descriptions of Routes of Exploration in Alaska in 1898, pp. 40-50. A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 265-340.

[b] Coal resources of southeastern Alaska: Bull. U. S. Geol. Survey No. 259, 1904, pp. 153, 154, 169-171.

[c] An abstract of this report has already been published under the title Preliminary statement on the Matanuska coal field: Bull. U. S. Geol. Survey No. 284, 1906, pp. 88-100.

## GEOGRAPHY.

### TOPOGRAPHY AND DRAINAGE.

The Matanuska Valley is a depressed area from 5 to 10 miles wide and about 100 miles long, extending in a northeast-southwest direction from a point near the southwest corner of the Copper River Plateau to the head of Knik Arm (Pl. I). It is bounded on the north by the Talkeetna Mountains and on the south by a part of the Chugach Mountains. Into each of these mountain masses extend many valleys of diverse size, shape, and physiographic character, but the fronts of both ranges lie in fairly distinct lines parallel to the general course of the river. The Talkeetna Mountains seem to be made up for the most part of ridges parallel to the river,

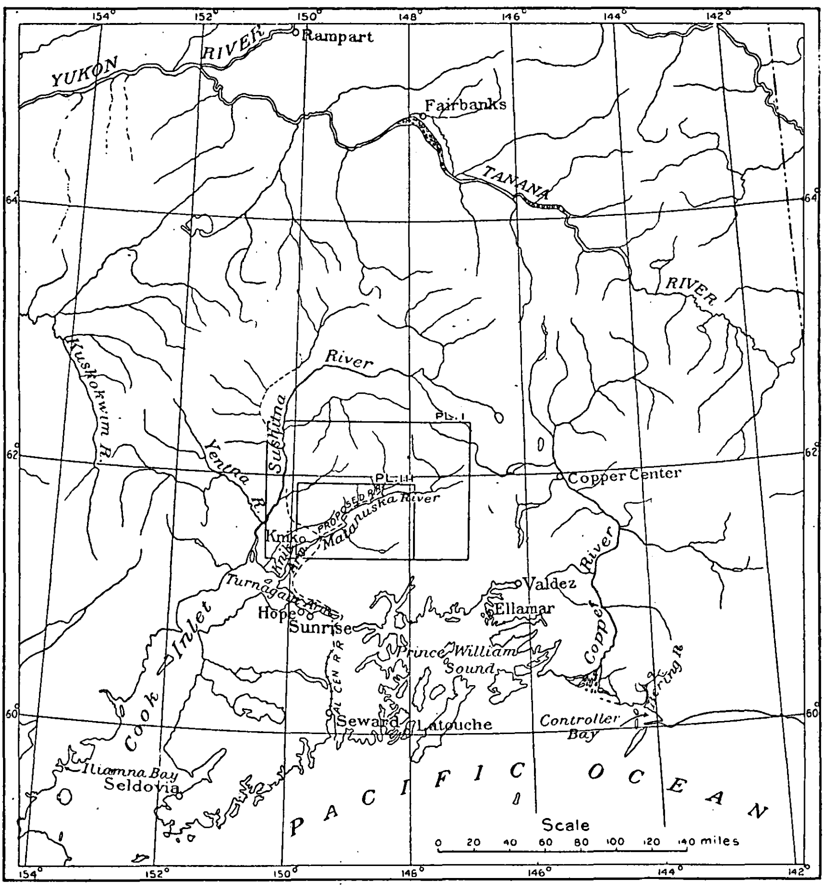
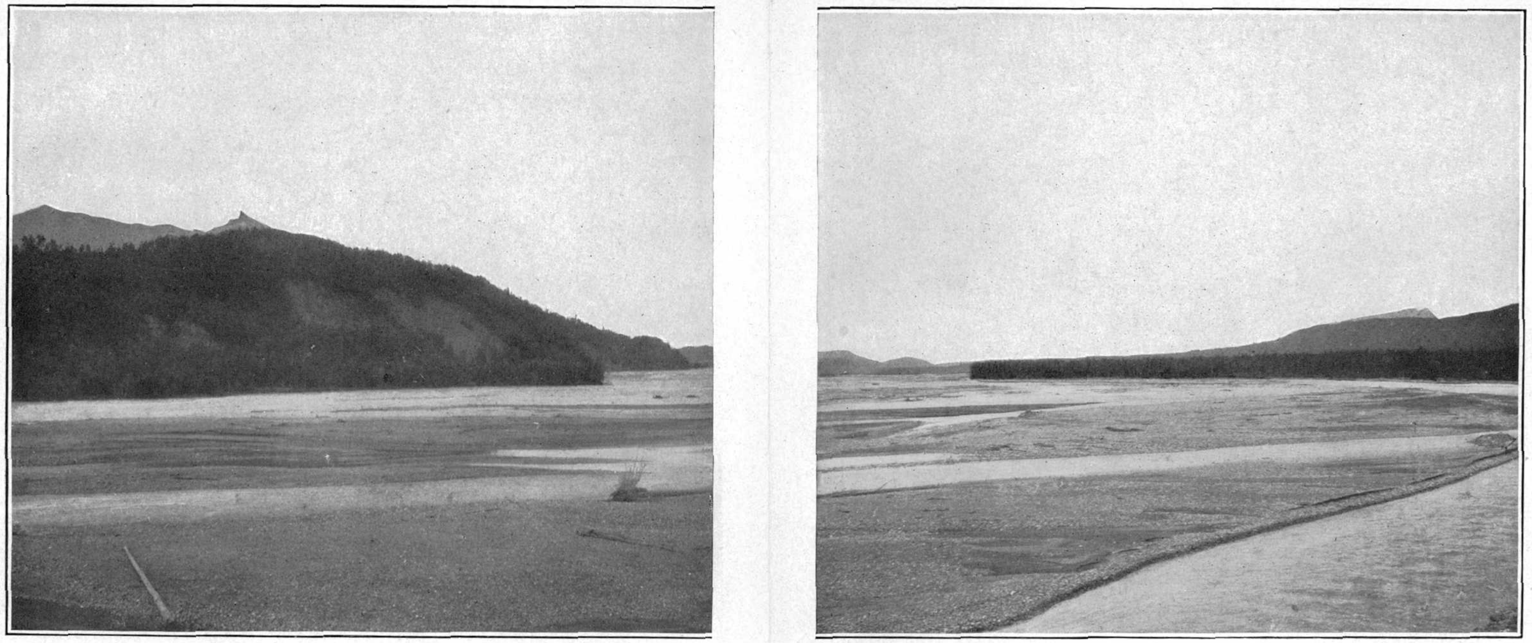



FIG. 1.—Outline map of region between Cook Inlet and Prince William Sound and the Tanana Valley, showing general location of Matanuska coal field and positions of large-scale maps.

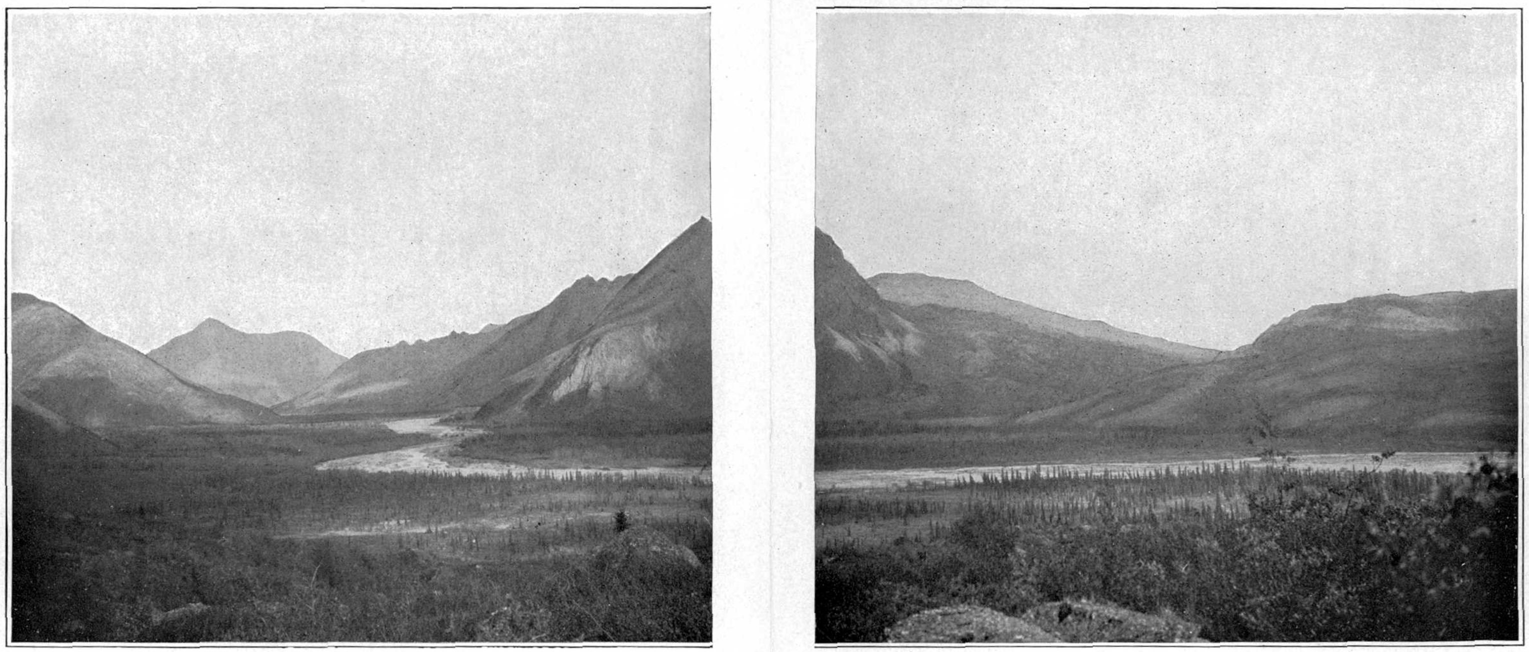
while the Chugach Mountains consist chiefly of less regular masses. The general maximum elevation of each range is roughly about 5,000 to 6,000 feet, but there is no marked regularity in the height of the summits. The hills within the valley have elevations of 1,000 to 3,000 feet and increase in height to the east.

The river channel flows through many narrow gorges, but for most of its course in a valley from 1 to 2 miles wide (Pl. II, *A*), with walls rising steeply to an elevation of from 200 to 500 feet. This valley is in turn sunk within the broader one referred to above, whose width varies from 5 to 10 miles. The slope of this broader



*A.* MATANUSKA RIVER AT LOW WATER.

Looking down from near the mouth of Kings Creek; showing the general character of the lower valley.



*B.* BOULDER CREEK, WITH ANTHRACITE RIDGE IN THE MIDDLE BACKGROUND, FROM THE WEST.

Showing the flood plain of Boulder Creek above the gorge, or where it is flowing on the old upland surface.

valley descends from an elevation of about 2,800 feet at the mouth of Hicks Creek to about 2,000 near Chickaloon Creek and to about 600 feet at Tsadaka Creek.[a] From this point it descends more gradually until it is barely 100 feet above tide. The mouth of this broad valley may, in a general way, be considered to be near the mouth of Tsadaka Creek, for here it widens out into the great flats, from 1 to 20 miles in width, which extend all around the head of Cook Inlet.

Matanuska River rises in the southwest corner of the Copper River Plateau, in latitude 62° north and longitude 147° west (see fig. 1 and Pl. I). It flows in a westerly and southwesterly direction for an air-line distance of about 100 miles and empties into Knik Arm, the northernmost branch of Cook Inlet. Its volume fluctuates greatly according to the rainfall and state of melting of the snow and glaciers. The lower course of the river averages about 400 feet wide and 4 feet deep at low water, but reaches a width in some places of 2 miles, with a probable average depth of 10 feet at flood.

The tributaries, named in order from east to west, include Caribou, Hicks, Chickaloon, Kings, Granite, and Tsadaka creeks on the north side; and Matanuska Glacier, a large number of small creeks (mostly unnamed), and Knik River on the south side. Tsadaka Creek, which enters the Matanuska about 30 miles above Knik, is 12 miles long, drains an area of about 40 square miles, and is about 30 feet wide and 2 feet deep at the mouth. It can be bridged with a tree or forded almost anywhere. Granite Creek is of about the same size. Kings Creek is about 20 miles long, drains an area of 100 square miles, is 100 feet wide and 4 to 10 feet deep at the mouth, and has a velocity at many points of about 7 miles per hour. At several places on the lower course it is narrow enough to be bridged, and there are several fords. Its largest tributary is Young Creek. Chickaloon Creek (see Pl. IV) is 40 miles long and has a drainage basin of about 200 square miles. Its average width near the mouth is about 100 feet. The depth is probably 5 to 10 feet and the velocity in some places is 8 miles an hour. The largest tributary is Boulder Creek (see Pl. II, *B*), which enters it from the north and which is about as large as Tsadaka Creek. All these streams flow in part through broad, open valleys, and in part through box canyons.

The Matanuska has an elevation of about 3,000 feet at its source and falls at a gradually decreasing rate to about 850 feet at the mouth of Chickaloon Creek, to about 550 feet at the mouth of Kings Creek, to 470 feet at the mouth of Granite Creek, to 430 feet at the mouth of Eska Creek, and to about 300 feet at the mouth of Tsadaka Creek.

## CLIMATE.

The climate of the Matanuska Valley offers no hindrance to the development of its mineral resources; on the contrary, it is such as to encourage not only mining, but even agricultural interests. The nearest points at which there are meteorological records are on Cook Inlet, and it will be useful to compare this valley with that region, of which it has been said:[b]

> The Cook Inlet region, including the lower part of the Sushitna basin, though somewhat colder than that part of the seaboard which lies directly on the open ocean, has probably the most delightful climate of any portion of Alaska. While the winters are cold compared with southeastern Alaska, the upper part of the inlet being usually locked in ice from November to May, they are not so severe as those of Bering Sea. The charm of the Cook Inlet climate is its bright, clear weather in the spring and summer, when there is just enough rainfall to insure ample water for the growth of vegetation.

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[a] Commonly known as Moose Creek.

[b] Brooks, A. H., and Abbe, C., jr., General climatological features of Alaska: Prof. Paper U. S. Geol. Survey No. 45, 1906, p. 145.

The following table is taken from the report just cited:

*Temperature and precipitation on Cook Inlet.*

| | Temperature, °F. | | | | | Precipitation. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | | Minimum. | | Mean. | Days with rain exceeding 0.01 inch. | | Rainfall (including snow) inches per month. | |
| | Kenai. | Tyonok. | Kenai. | Tyonok. | Tyonok. | Kenai. | Tyonok. | Kenai. | Tyonok. |
| January | 45 | 38 | −40 | −27 | 5.41 | 5.3 | 7.7 | 0.78 | 2.15 |
| February | 45 | 49 | −32 | −17 | 15.30 | 4.4 | 5.7 | .70 | .65 |
| March | 52 | 66 | −34 | − 9 | 23.60 | 7.4 | 4.5 | .97 | .71 |
| April | 58 | 59 | 4 | 1 | 37.70 | 6.4 | 4.0 | .83 | .88 |
| May | 66 | 68 | 20 | 22 | 43.10 | 6.4 | 3.7 | 1.01 | .44 |
| June | 79 | 82 | 26 | 33 | 55.10 | 5.1 | 4.2 | .73 | .61 |
| July | 82 | 83 | 30 | 38 | 58.70 | 8.9 | 8.2 | 1.69 | 2.09 |
| August | 73 | 73 | 28 | 31 | 56.40 | 13.4 | 17.7 | 3.31 | 4.71 |
| September | 65 | 70 | 17 | 25 | 49.00 | 11.7 | 14.2 | 2.46 | 4.86 |
| October | 60 | 61 | −10 | 10 | 35.40 | 10.0 | 12.2 | 2.06 | 4.15 |
| November | 44 | 44 | −26 | 13 | 29.20 | 7.4 | 6.5 | 1.13 | .88 |
| December | 45 | 49 | −43 | −21 | 17.00 | 6.0 | 7.2 | .88 | 1.31 |
| Year | ........ | ........ | ........ | ........ | ........ | 92.4 | 95.8 | 16.55 | 23.44 |

The Matanuska Valley is somewhat colder and has less rain than Cook Inlet. The proportion of bright days in summer is probably greater at the head of Knik Arm than at any other point on the coast of Alaska. Conditions are practically the same throughout the Matanuska Valley as on Knik Arm, except as they are modified by differences in altitude.

It appears highly probable that the region bordering Knik Arm and part of the Matanuska Valley will support important agricultural industries. The district should become to a large degree not only self-supporting, but capable of supplying garden produce to such surrounding regions as are connected with it by adequate means of transportation.

## VEGETATION.

The flats at the head of Cook Inlet are densely timbered with a small but fairly uniform growth of cottonwood, spruce, quaking aspen, and birch (the latter predominating), with a sparse undergrowth of alder, willow, currant, and huckleberry bushes. Scattered throughout the forests are broad meadows of excellent grass. A similar growth of timber extends throughout the valley of the Matanuska and its tributaries (see Pl. IV, *B*) up to an elevation of 2,000 feet. From this altitude to about 2,500 feet the timber becomes thinner (see Pl. II, *B*), and at a maximum elevation of about 2,800 feet it finally disappears.

The spruce is considered of good quality, though small. Some of it will square 12 inches, considerable of it 8 inches, and most of it 6 inches. There will probably be abundant timber for mining and local building purposes, especially as the supply will not be drawn on for fuel.

Those who are interested in the development of the region should, however, bear in mind that the cost of mining will depend very largely on the timber supply, and that though there seems now to be plenty for many years to come, yet great care will have to be used in preventing and extinguishing forest fires. Owing to the dry climate fires have already done great damage to standing timber. They are certain to become more frequent and extensive as the region is settled and especially as the timber is cut, and it is entirely possible that unless due care is used mining operations may be severely crippled through the destruction of the local timber supply.

### TRANSPORTATION.

Knik, the post-office and shipping port for the entire region, is at the head of steamboat navigation on Knik Arm, and can be reached by an ocean voyage of seven to twelve days from Seattle to Seldovia and one or two days by local steamers on Cook Inlet. In 1905 steamers sailed from Seattle for Seldovia four times a month throughout the year, but navigation on Cook Inlet above Seldovia is usually closed from October 15 to April 20. The region can be reached at any time by leaving the steamer at Seward and going overland to the head of Cook Inlet. At present the railroad can be used for only the first half of the trip from Seward to Turnagain Arm, the rest being made on foot or with horses.

A good horse trail leads from Knik to the coal field. It requires a day or a day and a half to go from Knik to Tsadaka Creek, and a day from Tsadaka Creek to Chickaloon Creek. Matanuska River can be ascended under favorable conditions as far as Chickaloon Creek, or possibly farther in skillfully handled poling boats. But the best and cheapest way to move freight up the valley at present is with sleds in the winter. Summer freight can possibly be moved most cheaply with boats, but more safely with pack animals.

Supplies can be purchased at Knik, where there are two stores, and natives can usually be hired there. Horses can sometimes be hired at Knik, but it is not safe to depend on them unless they are engaged in advance.

The Alaska Central Railway, now under construction from Seward, on Resurrection Bay, toward the interior of Alaska, is planned to reach the Matanuska coal fields. This railroad was begun in 1904, and is now completed for 45 miles, with about 30 miles more under way. The railroad route leads northward from Seward, which is at the head of Resurrection Bay, across the mountainous Kenai Peninsula to the head of Turnagain Arm, along the north shore of that arm, and up the east shore of Knik Arm to the mouth of Matanuska River. The head of Turnagain Arm is 60 miles from Seward, the point where the railroad route leaves Turnagain Arm is 40 miles farther, and the mouth of Matanuska River is 140 miles from Seward. It is planned to have the road fork at this point, the main line going up the Sushitna Valley to the Tanana and a branch going up the Matanuska to the coal fields. The first coal will be reached on Tsadaka Creek, at a distance of 18 miles from the mouth of Matanuska River. The Kings Creek coal is about 34 miles, the Chickaloon Creek coal 38 miles, the Coal Creek coal 38 miles, and the anthracite coal 53 miles from the mouth of the Matanuska.

## GEOLOGY.

### STRATIGRAPHY.

#### GENERAL FEATURES.

The rocks in that part of the Matanuska region which was visited by the writer consist of granites and other coarse crystalline rocks bordering the valley on either side; Jurassic rocks known only from stream bowlders; coal-bearing sediments, partly Mesozoic and partly Tertiary, two distinct horizons apparently being represented; a large number and considerable variety of dikes and volcanic flows, and extensive sheets of gravels.

The sedimentary rocks of this region (exclusive of gravels) were called the "Matanuska series" by Mendenhall, who assigned them tentatively, on paleontologic evidence, to the lower Cretaceous. Mendenhall's description of the Matanuska series is as follows:[a]

After leaving Knik Arm for the trip to the interior by way of the valley of the Matanuska River no hard rocks are found in place until the trail descends into the valley of Tsadaka Creek, 40 miles

[a] A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 307-309.

from Palmer's store. For 40 or 50 feet above the bed of this creek, and underlying the loose gravels which fill all this part of the valley of the Matanuska, is to be seen an exposure of shales and sandstones with a few thin streaks of bright, hard coal. The beds remind one strongly in lithologic characteristics of the sediments of the lower coal measures in the Appalachian region. They are completely consolidated, although here not altered in the least, and have been disturbed so as to dip now about 25° NW. Across the Matanuska similar beds make the bluffs of the stream.

Opposite the mouth of Granite Creek the same beds are exposed, showing a fault of probably slight throw, and from this time until the Copper River Plateau is reached all rock exposures are of related sediments and intrusive beds.

With the data gathered on this reconnaissance it has not been found possible to subdivide them, so that they are all treated here as the Matanuska series.

The great mass of these beds are shales, similar physically to those first seen at Tsadaka Creek and displaying many colors, red, green, buff, and black being especially abundant. Besides shales, many coarser beds occur. Much the most important of these beds is the heavy conglomerate which makes the base of Castle Mountain and gives it its pinnacled and castellated outlines, so strikingly different from any of the neighboring hills and at once suggesting its name. This bed is probably not less than 1,000 feet thick, 600 feet of it having been measured, and the estimated height of the cliff above me at the time of the measurement being 300 to 400 feet. The heavy conglomerate plates, which together make up the mountain, are separated by thin, sandy shale sheets, which constitute but an insignificant quantity of the mass. The pebbles of the conglomerate contain a great variety of rocks, among them many igneous types. They are well rounded and vary in size up to a foot in diameter. Overlying the Castle Mountain bed is a body of soft, green shales with a cap of red sandstone. To the southwest this conglomerate is cut off by a great intrusive mass of porphyry, and northeastward it is probably dropped down by a fault of slight throw.

Other conglomerates occur on Hicks Creek and the headwaters of Caribou. These, however, are wholly different in character from the Castle Mountain bed, consisting generally of small, well-rounded pebbles of white quartz with but little extraneous material. The irregular occurrence of the Caribou Creek deposits appears to be best explained by the supposition that they were laid down in local channels cut in shales rather than in sheets. On Bubb Creek, a few miles below our camp of August 7 and 8, conglomerate cliffs about 200 feet high extend for half a mile along the stream, and represent either a broad channel or a slight anticline in the strata.

Limestone nodules occur at a number of places in the shale, but only one bed of any extent appears along our route. It was first seen as a gray cliff forming a scarp around the hilltops just before Limestone Gap was reached. Dips bring it lower as the gap is approached, and the trail passed over it, but it rises again and disappears from the hills along the upper course of Bubb Creek within a few miles of its source. The thickness is about 300 feet.

* * * * * * *

A few fossils were collected at the base of the limestone bed at the head of Bubb Creek and submitted to Mr. T. W. Stanton for examination. He says:

"The fossils * * * have been examined and found to consist of numerous examples of *Aucella crassicollis* Keyserling and a few fragments of a *Belemnites* which can not be identified specifically. The species determined is sufficient to fix the age of the bed from which they came as lower Cretaceous."

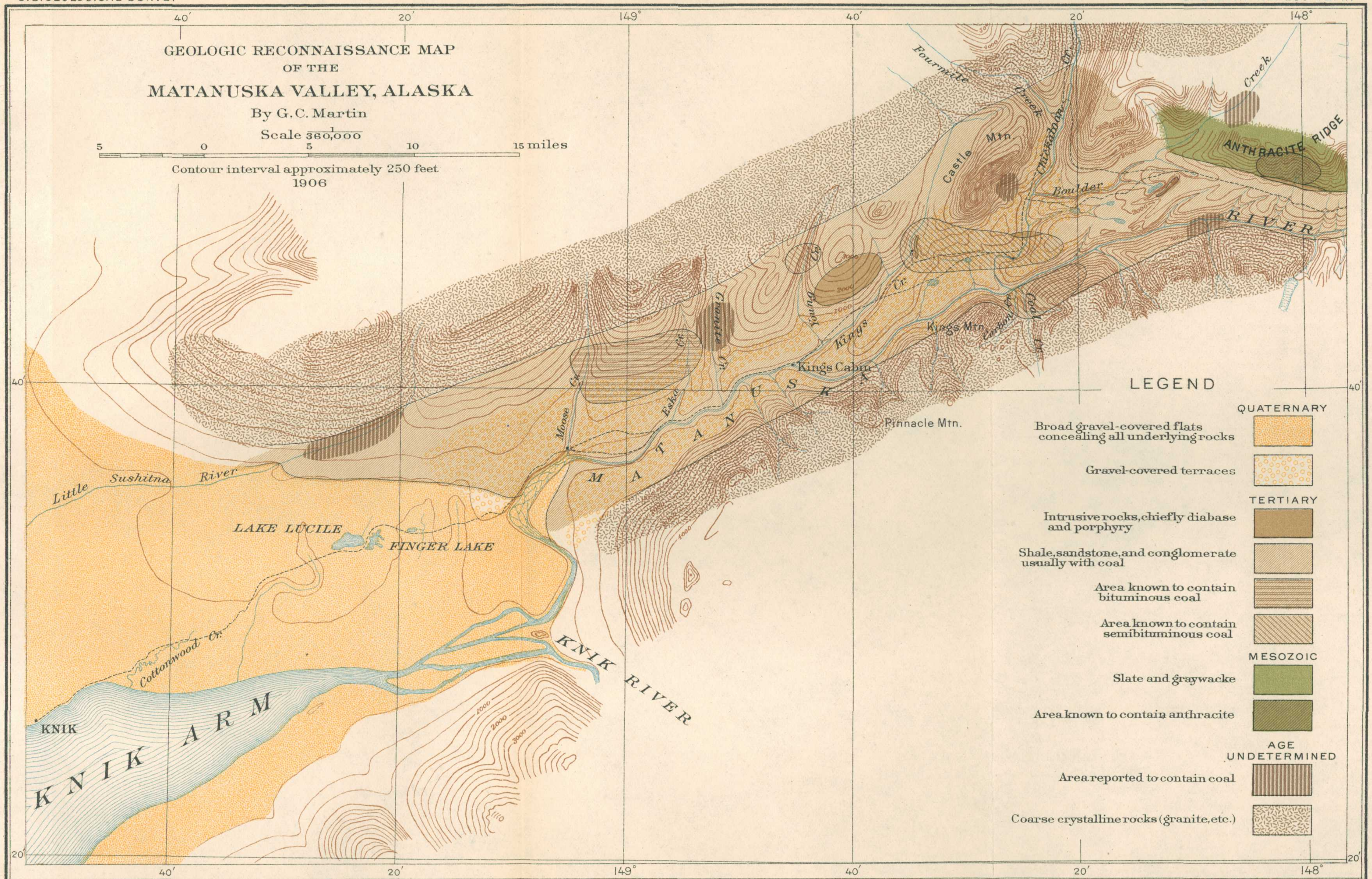
On the basis of this determination the whole series is tentatively assigned to lower Cretaceous, or an older period, since the limestone bed appears to occur near the top of the series. Fragmentary fossil leaves of well-developed exogenous types were collected at a number of places, but, being impressions on a very fragile matrix, were crushed in the attempt to transport them to the coast by pack trains.

As a result of further work, however, it appears that this "Matanuska series" contains beds of several ages, while the beds in the greater part of the Matanuska Valley, including all of those seen by the writer in the immediate vicinity of the river, are not Cretaceous. For these reasons it seems best not to employ the term in the original sense. Our present knowledge is so imperfect that it is not advisable either to restrict the term or to define new formations which can be included within it. Consequently in the following discussion the rocks will be grouped according to age and lithologic character and described without formation names.

The areal distribution of the several rock masses is shown on the geologic map (Pl. III) and the structural relations as far as are known are indicated in fig. 2.

### COARSE CRYSTALLINE ROCKS.

The crystalline rocks occur in the high mountains on either side of the Matanuska Valley. They are known to the writer only from the stream bowlders, from the reports of prospectors, and from the appearance of the mountains as seen from a dis-




A. HOEN & CO. BALTIMORE.

tance. They appear to consist chiefly of granite, though a variety of other rocks, including greenstone, is present. The position of these belts is shown approximately on the map (Pl. III). The areas thus mapped are certainly predominantly crystalline, but may possibly include some masses of sediments which are probably Mesozoic or older.

The relation of these rocks to the sedimentary rocks, described below, is not definitely known. They may be late Tertiary or post-Tertiary intrusive masses, or the contact may be one of faulting. The writer is inclined to believe, largely from analogy with other regions, that they are plutonic masses of early Mesozoic or pre-Mesozoic age against which the Tertiary rocks have been faulted. Further discussion of this problem is presented in the section on structure (p. 17).

## MESOZOIC STRATA.

The Mesozoic rocks, which may represent one or more horizons, are known only from bowlders, from outcrops seen only in the extreme east end of the region visited by the writer, and from outcrops in localities still farther east which were reported by Mendenhall.

Bowlders of dark, flinty sandstone of very different lithologic character from anything seen in place by the writer were found in the bed of Chickaloon Creek. It contains many specimens of *Aucella*, determined by T. W. Stanton to be "of the type of *Aucella pallasi* Keyserling, an upper Jurassic species." The presence of upper Jurassic rocks in the Talkeetna Mountains is thus established. The bowlders were much worn and not abundant, indicating that the outcrops of these beds are at a considerable distance from the Matanuska.

Other Mesozoic beds of less definite age were seen on the summit and southern slope of Anthracite Ridge, which is a long, sharp-topped mountain (see Pl. II, *B*), about 5,500 feet high, bordering the north side of the Matanuska Valley between Boulder and Hicks creeks. This ridge is part of the southern front of the Talkeetna Mountains. It consists chiefly of graywacke, with numerous calcareous concretions and beds of sandstone, intrusive masses of diabase, and several beds of anthracite coal. A very few fragmentary fossils were obtained, partly from the summit and partly from an elevation of 3,450 feet on the southern flank of the ridge. Stanton says of them:

> The very small and fragmentary lot (No. 3318) from this locality (elevation 5,500 feet) contains a *Nucula* and fragments of the fibrous shell of an *Inoceramus*. So far as can be determined from these specimens the horizon may be as low as middle Jurassic or as high as upper Cretaceous. It is certainly not outside of these limits.
>
> This lot (No. 3319, from elevation 3,450 feet) includes a very young ammonite not generically determinable, a fragment of another ammonoid which apparently belongs to some loosely coiled form like *Hamites*, a part of the phragmacone of a *Belemnites*, several species of a small *Ostrea*, and fragments of *Inoceramus* shell. The remarks concerning the age of No. 3318 are applicable to this lot also.

Rocks of possibly the same age were seen by Mendenhall near the headwaters of Bubb and Caribou creeks, about 25 miles northeast of the last-mentioned locality. Mendenhall says:[a]

> Limestone nodules occur at a number of places in the shale, but only one bed of any extent appears along our route. It was first seen as a gray cliff forming a scarp around the hilltops just before Limestone Gap was reached. Dips bring it lower as the gap is approached and the trail passes over it, but it rises again and disappears from the hills along the upper course of Bubb Creek within a few miles of its source. The thickness is about 300 feet.

His notes are more explicit and read:

> In the head of the stream rising on the east side of Limestone Gap, at the beginning of the limestone gorge about a mile from the gap, is a curious exposure of mingled conglomerate and fossil-bearing rocks. The shells are embedded in a sand matrix and are often only casts. These beds are at the base of the limestone as exposed here. The limestone, however, seems to be high up in the sedimentary series. The limestone lies in a syncline, at the deepest point of which the fossils were gathered. East of this dips are westward and rocks mostly soft shale.

[a] Op. cit., p. 308.

The fossils were submitted to T. W. Stanton, whose report upon them has been quoted on p. 10.

### TERTIARY STRATA.

The rocks in the valley of the Matanuska from Chickaloon Creek to Tsadaka Creek consist chiefly of shale and sandstone, with many coal beds and at least one bed of massive conglomerate.

The conglomerate belongs near the top of these rocks (see Pl. IV, *B*), which altogether can not be less than 3,000 or 4,000 feet thick. Mendenhall reports the following section in Castle Mountain:

*Section of Tertiary rocks in Castle Mountain.*

| | Feet. |
|---|---|
| Red sandstone (?) | 200+ |
| Soft green rock | 200+ |
| Conglomerate | 1,000 |

The interval between the conglomerate and the beds exposed at the base of the mountain on Chickaloon and Kings creeks is not known. The following sections were measured by the writer:

*Section at bend of Chickaloon Creek, one-half mile above Watson's camp.*

| | Ft. | in. |
|---|---|---|
| 1. Gray shale with occasional concretions | 16 | |
| 2. Hard clay shale, nodular | 2 | 6 |
| 3. Fissile gray shale with iron balls | 16 | |
| 4. Dark-gray limestone | 1 | |
| 5. Dark fissile shale | 4 | 6 |
| 6. Micaceous sandstone | 2 | 6 |
| 7. Dark liver-colored fissile shale containing strata of iron concretions | 2 | |
| 8. Arkose | 1 | |
| 9. Dark fissile shale | 12 | |
| 10. Iron ore | | 3 |
| 11. Black shale | | 9 |
| 12. Carbonaceous shale and bone | | 6 |
| 13. Black shale | 3 | |
| 14. Dark fissile shale with many strata of ironstone nodules | 33 | |
| 15. Carbonaceous shale | 2 | |
| 16. Dark shale with thin strata of ironstone balls | 23 | |
| 17. Ironstone with fossil gasteropods | | 6 |
| 18. Dark shale with many streaks of iron ore | 6 | |
| 19. Soft black carbonaceous shale | 6 | |
| 20. Ironstone | | 6 |
| 21. Dark fissile shale with bands of ironstone | 35 | |
| 22. Massive sandstone[a] | 10 | |
| 23. Black shale | | 6 |
| 24. Coal, with some bone and shale | 14 | |
| 25. Shale and sandstone | 10 | |
| 26. Coal, with some bone and shale | 8 | 9 |
| 27. Dark shale | 6 | |
| 28. Dark shale with coal streaks | 2 | |
| 29. Shale with sandstone and ironstone bands | 19 | |
| 30. Sandstone with sandy shale bands | 9 | |
| 31. Shale | 1 | |
| 32. Coal, impure, much distorted and changed by heat | 5 | 6 |
| 33. Shale with iron bands | 9 | |
| 34. Sandstone (in roll) | 4 | 6 |
| 35. Shale | 7 | |
| 36. Igneous intrusion (sill) of diabase, with local occurrence of natural coke on top | 11 | |
| 37. Irregular mass of coal and carbonaceous matter much distorted by the dike | 15 | |
| | 300 | 3 |

[a] Shown in the base of the cliffs at the right in Pl. IV, *B*. All the underlying beds in this section are also shown in the photograph.

The rocks are concealed for a short distance below this section, but the stratigraphic interval is very small, surely not over 100 feet. The following section then appears:

*Section at Watson's camp, Chickaloon Creek.*

| | | Ft. | in. | Ft. | in. |
|---|---|---|---|---|---|
| 1. | Shale | | | 10 | |
| 2. | Coal | 9 | 4 | 9 | 4 |
| 3. | Shale | | | 9 | |
| 4. | Coal | 1 | | | |
| 5. | Shale | 1 | | 2 | 6 |
| 6. | Coal | | 6 | | |
| 7. | Gray concretionary shale | | | 14 | 6 |
| 8. | Massive sandstone | | | 13 | 6 |
| 9. | Sandstone and shale | | | 50 | |
| 10. | Possibly small concealed interval. | | | | |
| 11. | Shale | | | 10 | |
| 12. | Coal | 1 | 8 | | |
| 13. | Shale | | 6 | | |
| 14. | Bony coal | 1 | 8 | 10 | 10 |
| 15. | Shale | | 10 | | |
| 16. | Coal | 6 | 2 | 6 | |
| 17. | Shale | | | 28 | |
| 18. | Possibly concealed, not over | | | 10 | |
| 19. | Shale | | | 3 | |
| 20. | Coal (1 ft. 8 in. to 3 ft. 7 in.) | 2 | 8 | 2 | 8 |
| 21. | Shale | | | 8 | |
| | | | | 187 | 4 |

The following sections come closely below, not over 100 feet intervening:

*Section on west bank of Chickaloon Creek below Watson's camp.*

| | | Ft. | in. |
|---|---|---|---|
| 1. | Massive sandstone. | | |
| 2. | Shale | 2 | 6 |
| 3. | Coal | 1 | |
| 4. | Shale with coal streaks and iron ore concretions (approximation; beds contorted) | 44 | |
| 5. | Shale with coal streaks and large concretions | 22 | |
| 6. | Gray massive sandstone | 9 | 6 |
| 7. | Dark shale with nodules and coal streaks | 22 | |
| 8. | Gray sandstone with shale streaks | 5 | 7 |
| 9. | Shale with coal streaks | 12 | |
| 10. | Limestone | 1 | 6 |
| 11. | Gray shale | 5 | 10 |
| 12. | Gray sandstone with many sticks | 9 | 7 |
| 13. | Gray shale | 3 | 6 |
| 14. | Gray sandstone | 3 | 6 |
| 15. | Gray shale with coal streaks | 13 | |
| 16. | Impure limestone | 2 | 6 |
| 17. | Dark soft shale with leaves and coal streaks | 5 | |
| 18. | Coke | 1 | 6 |
| 19. | Baked shale and coke | 1 | |
| 20. | Volcanic bed (varies from 1 to 5 feet), average | 2 | 6 |
| 21. | Gray and black shale | 10 | 4 |
| 22. | Reddish sandstone | 2 | 6 |
| | | 180 | 10 |

The rocks on Kings Creek near the upper bridge appear to belong at approximately the same position as those just described on Chickaloon Creek.

*Section on east bank of Kings Creek above upper bridge.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| 1. Volcanic flow | | | 50+ | |
| 2. Shale | | | 69 | |
| 3. Sandstone with shaly bands | | | 9 | |
| 4. Coke | 1 | | | |
| 5. Shaly sandstone | | 8 | 2 | 2 |
| 6. Coal | | 6 | | |
| 7. Black shale | | | 6 | |
| 8. Shale with thin coal streaks | | | 5 | |
| 9. Sandstone | | | | 6 |
| 10. Impure coal | 3 | | 3 | |
| 11. Shale | | | 13 | |
| 12. Coal | 1 | | 1 | |
| 13. Fissile shale | | | 20 | |
| 14. Sandy shale | | | 10 | |
| 15. Fissile shale | | | 51 | |
| 16. Shale | | | 30 | |
| 17. Massive sandstone | | | 3 | |
| 18. Concealed, 30 to 60 feet | | | 45± | |
| 19. Shale | | | 12 | |
| 20. Shaly sandstone | | | 4 | |
| 21. Shale | | | 13 | |
| 22. Coal with many shale bands | 6 | | 6 | |
| 23. Sandy shale | | | 6 | |
| 24. Coal (as on p. 23) | 10 | | 10 | |
| 25. Carbonaceous shale | | | 10 | |
| 26. Massive sandstone | | | 6 | |
| 27. Shale | | | 10± | |
| 28. Sandstone. | | | | |
| | | | 394 | 8 |

Strike N. 28° W.

These beds have yielded fossils at two points on Chickaloon Creek and at one on Kings Creek. The uppermost fossiliferous bed on Chickaloon Creek is the thin ironstone (No. 17) in the section on page 12. Stanton reports on these fossils as follows:

This lot (No 3316) consists entirely of fresh-water gasteropods, of which all but one specimen belong to a single species of *Viviparus* of a type that occurs in both the upper Cretaceous and the Tertiary. The other specimen is a more slender form, too imperfect for generic determination. These fossils are apparently an undescribed species—at least they are new to Alaska—and they do not fix the horizon more closely than is above indicated.

The other fossil bed on Chickaloon Creek is the roof of the coal (No. 2) in the section on page 13. The fossils consist entirely of leaves, of which F. H. Knowlton says:

I find the following species:

Taxodium distichum miocenum (Brgt.) Heer.
Salix varians Heer.
Populus arctica Heer.
Corylus macquarrii (Forbes) Heer.
Juglans nigella Heer.

The age indicated is Kenai.

The other locality is not exactly known, but is at some place on Kings Creek, where a few fossil leaves were collected by Mr. W. A. Langille, of the Forest Service. Knowlton reported on them as follows:

The specimens are small and the plants fragmentary and poorly preserved. With some uncertainty I am able to recognize the following species:

Taxodium tinajorum Heer.
Sequoia langsdorfii (Brgt.) Heer.
Populus arctica Heer.
Corylus macquarrii (Forbes) Heer

If these determinations have been correctly made, and it seems probable that they have, the age should be "Arctic Miocene" or Kenai. But it should be added that more and better material will be needed before the position can be positively determined.

It may be seen from the foregoing that there is little doubt that part, at least, of these beds are approximately of the same age as the coal-bearing rocks at Homer, on Cook Inlet, which are generally considered to be middle Tertiary (Oligocene).

GRAVELS.

The valley of the Matanuska and its tributaries from the head of Cook Inlet to somewhat above Chickaloon Creek is covered with thick deposits of coarse gravels, which occur in a series of benches or terraces, often concealing all of the hard rocks. These extend from 50 to 300 feet above the river bed and have a general elevation which rises toward the east from about 100 feet on the shores of Knik Arm to about 450 feet at Tsadaka Creek and to about 1,000 feet at the mouth of Chickaloon Creek. The best exposures of these gravels are at the point where the trail crosses Tsadaka Creek and at the lower ford at Kings Creek. These gravels contain bowlders of diverse character and vary in size from fine sand to material a foot or more in diameter. It is reported that they carry very small amounts of gold, but, so far as known, not enough to be of value even where the gravels have been reworked by the streams that are cutting through them.

These gravels were probably of original glacial origin, but were laid down in their present position by water, either in a large stream at considerable distance from the glaciers or in an arm of the sea. The approximately level surfaces of the terraces and the fact that there is a more or less definite altitude, above which the gravels are not found, indicate that the distribution of the gravels was at least controlled by the position of the sea. If so it was during a period when the land stood at a lower relative level than it does now, and that period was followed not only by elevation of the land, but by tilting.[a] It is not, however, the opinion of the writer that these deposits in themselves necessarily indicate much greater extent of the glaciers than exists at present There undoubtedly has been a somewhat greater extension of the existing glaciers, but these gravels may or may not have been contemporaneous with it.

DIKE ROCKS.

There are numerous dikes throughout the greater part of the Matanuska Valley. They are more frequent and larger toward the upper end of the valley and are also more numerous wherever folding and faulting was strongest. The most important of them are shown on the map (Pl. III), from which, however, by far the larger number are omitted on account of their small size and of the incomplete character of the investigation.

*Diabase.*—Dikes and sills of diabase are very abundant in both the Mesozoic and the Tertiary rocks. The base of the front of the Talkeetna Range between Bowlder and Hicks creeks is marked by a zone of faulting and sharp folding. Large masses of basic diabase have been intruded parallel to the strike along this zone and are responsible, in part at least, for the anthracitic character of the coal. The rock is somewhat altered, containing serpentine and an altered glassy base in addition to basic plagioclase and augite. The largest of these dikes is of fairly coarse grain. A dike of similar composition but finer grain, mentioned by Mendenhall,[b] cuts across Chickaloon Creek, about 2½ miles below the ford (not at the head of Chickaloon Creek). This dike is very prominent because of the ridge which it makes, and because of the gorge produced in the creek at this point. The coal-bearing rocks for

[a] Mendenhall, W. C., A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 315-316, 328-330.
[b] Op. cit., p. 310.

a mile below this point are cut by numerous small dikes and sills of the same rock, which, wherever it comes into close proximity with the coal, alters it to a dense, hard coke. One of these sills is shown at the left in Pl. IV, *B*. Dikes of this general character are common throughout the greater part of the coal field and always have this effect on the coal.

*Porphyritic rocks.*—A large intrusive mass occupies the mountain south of Kings Creek and immediately west of the trail. (See map, Pl. III.) This has been described by Mendenhall,[a] as follows:

> The first mass detected in the summer's reconnaissance forms a part of the north wall of the valley just below Kings Creek. Although its limits are not known except on the valley side, it is presumably of considerable extent, since the mountain from which this specimen was collected appears to be homogeneous and continuous for several miles northeast and southwest from Kings Creek crossing. The rock is a light-gray, fine-grained porphyritic mass, which appears under the microscope to be a quartz-diorite porphyry carrying a light-green hornblende. Microscopically it exhibits no evidence of mechanical deformation. There was no opportunity to search for a contact, but the porphyry is considered to be later than the surrounding sediments and intrusive in them, because these latter do not exhibit either the structure or the lithologic characteristics which we would expect had the porphyry served as a base upon which the sediments were deposited.

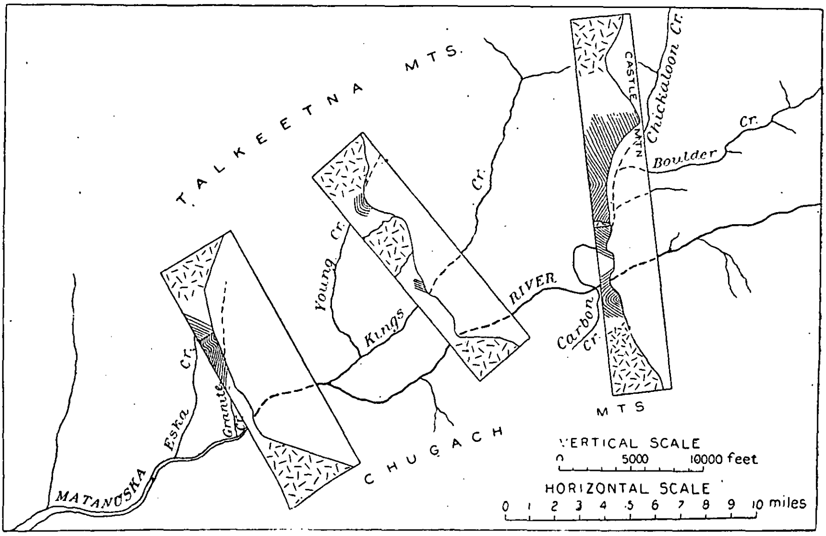



FIG. 2.—Sections showing structure of Matanuska Valley.

At the upper bridge over Kings Creek, 3 miles above the locality described by Mendenhall, is a sheet of porphyritic rock apparently interbedded in the Tertiary coal-bearing rocks. The relations are shown in the section above. This rock appears under the microscope to be made up largely of holocrystalline porphyritic feldspars—chiefly plagioclase, though orthoclase is also abundant—in a groundmass of chlorite, magnetite, quartz, and calcite. The character of the original ferromagnesian constituents could not be determined. The rock is of intermediate type, possibly being a porphyritic monzonite. It is probably either an apophysis or a flow from the porphyritic mass described by Mendenhall.

## STRUCTURE.

The Matanuska Valley follows a zone of soft Tertiary shales and sandstones, with some conglomerates and igneous rocks, the whole included within two parallel masses of plutonic rocks which are associated with Mesozoic sediments. The Tertiary belt

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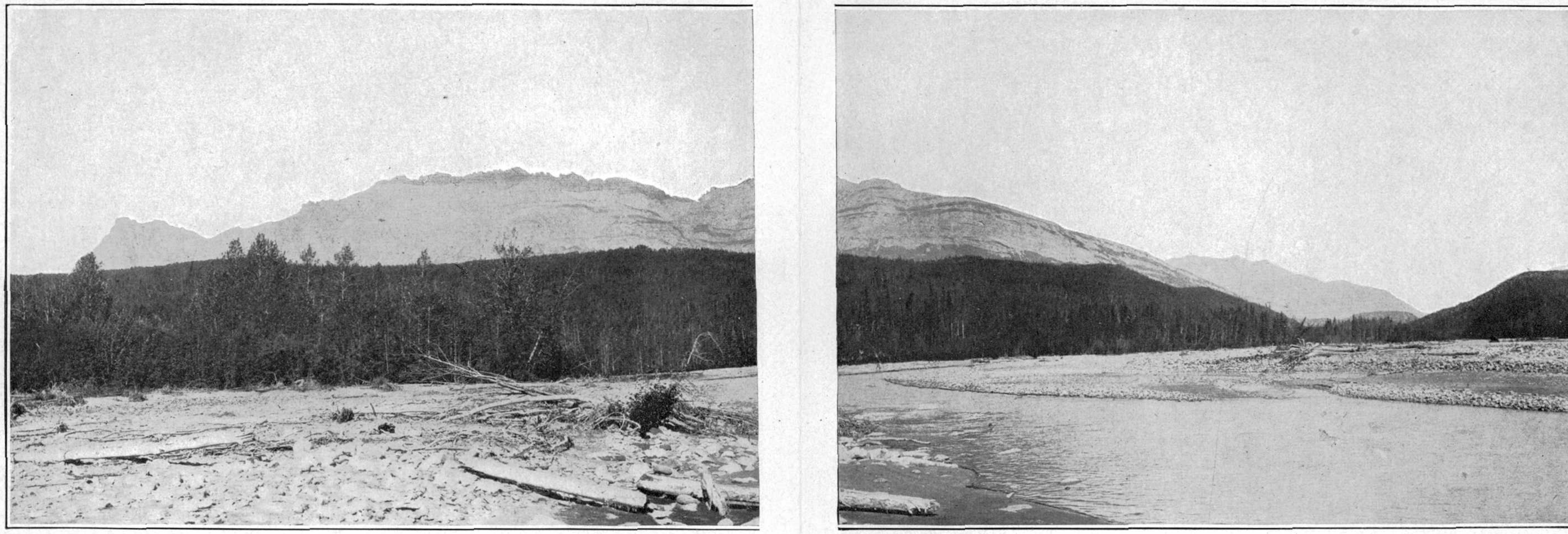
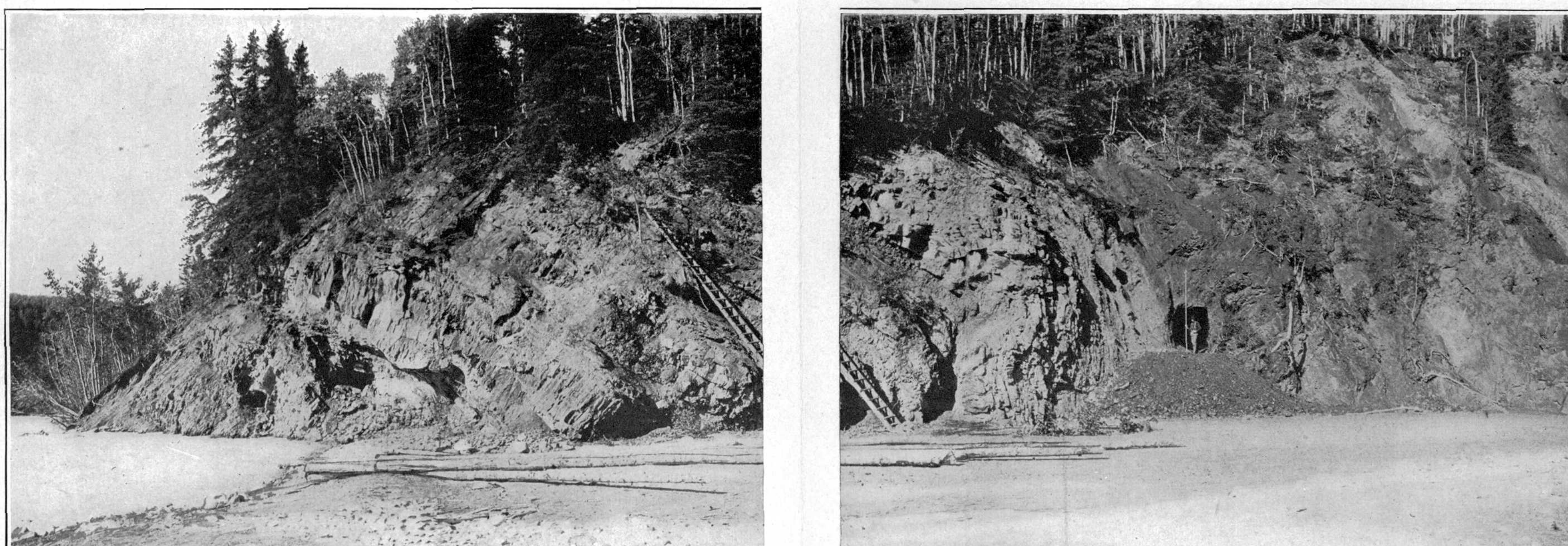
[a] Op. cit., pp. 309-310.



*A.* CASTLE MOUNTAIN FROM CHICKALOON CREEK.



*B.* CLIFFS ON WEST BANK OF CHICKALOON CREEK.

Showing coal bed, sill, and fold. (See section on p. 12.)

is from 7 to 8 miles wide and has fairly straight and parallel boundaries which are the topographic limits of the greater valley within which the Matanuska flows. (See Pl. III.) It is suggestive of a "graben" or sunken area within parallel faults, but this appearance may be due to the more resistant character of the rocks bounding the valley. The structural relations along the lines of contact of the Tertiary with more massive and presumably older rocks are not known.

The Tertiary rocks are involved in a system of folds and faults. The folds are open and the faults often cut the axes of the folds. The general strike is parallel to the course of the Matanuska, being N. 60° E. below Chickaloon Creek and N. 75° to 90° W. above Chickaloon Creek. There seem to be several approximately parallel folds with either sinuous or offsetting axes. The character of this structure on local cross sections is shown in the sections in fig. 2. The section through Castle Mountain and Coal Creek shows the monoclinal northwestward dip of Castle Mountain, a syncline with a basaltic dike at or near its axis on Chickaloon Creek, an anticline with its axis somewhere near the mouth of Chickaloon Creek, and a syncline crossing Coal Creek about a mile above its mouth. The next section shows a syncline on the headwaters of Young Creek, the large porphyritic intrusion in the hill to the southeast, and indeterminate structure in the flats to the south. The section down

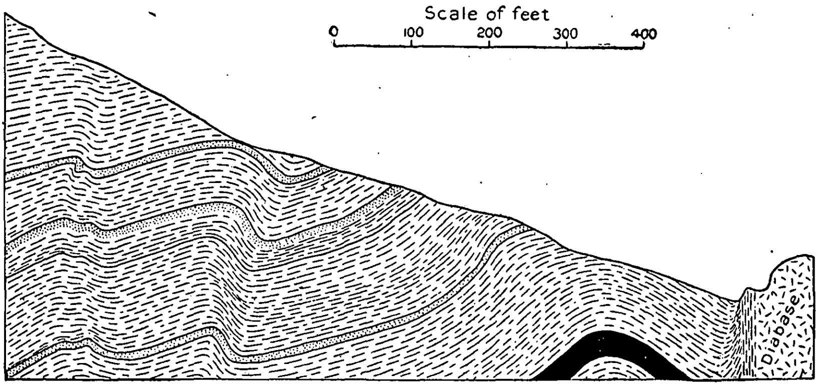



FIG. 3.—Section of part of south face of Anthracite Ridge.

Eska Creek shows several folds, the northwesternmost being a probable anticline with strongly faulted axis, followed on the southeast by a syncline, beyond which is another anticline. The observations of strike and dip on Tsadaka Creek show a general northwesterly dip, with a single outcrop showing easterly dip. It is not possible from present knowledge to connect these axes and determine whether there are a few long, sinuous folds or whether there is an offsetting of axes by complex pitch or by cross or diagonal faults.

The Mesozoic anthracite-bearing rocks east of Boulder Creek are more complexly folded, as is shown in fig. 3, than the Tertiary rocks of the center of the valley. They are separated from the latter by a fault or system of faults parallel to the axes of folding.

The igneous rocks are intruded partly parallel to the axes of folding as long and fairly persistent dikes, partly parallel to the bedding as sills (there may also be interbedded flows), and partly as large masses like the boss on the west side of Kings Creek.

## MINERAL RESOURCES

### COAL.

#### AREAL DISTRIBUTION.

Coal outcrops have been seen by the writer on Tsadaka, Eska, Kings and its tributaries, Chickaloon, and Coal creeks; on the small creeks heading in the Talkeetna Mountains between Boulder and Hicks creeks; and in the banks of Matanuska River about 3 miles above the mouth of Chickaloon Creek (see fig. 4). They have also been reported from Boulder, Hicks, and Caribou creeks, from a creek on the south side of the Matanuska 9 miles above Coal Creek, and from Little Sushitna River.

The extent of the area underlain by coal is not very definitely known. There is a coal area of at least 70 square miles in the valley of the Matanuska and its tributaries from Tsadaka Creek to Hicks Creek inclusive. This is a conservative estimate based on outcrops actually known to the writer. It is possible that there is a larger area than this, but it seems certain from present knowledge that the total area of coal-bearing rocks in the region indicated above can not in any case exceed 300 square miles except by further extensions of this field or neighboring fields outside the region visited by the writer, which might increase the area to limits which we have no means at present of knowing.

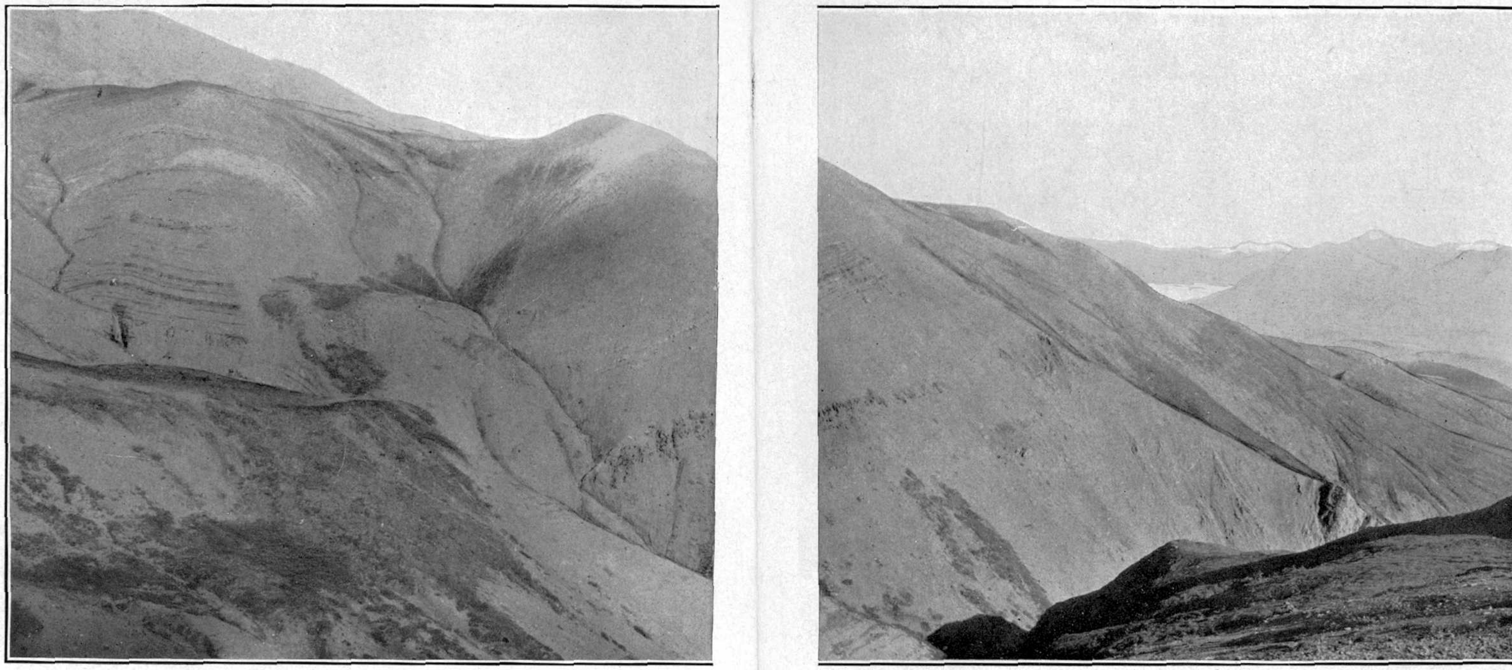
#### POSITION AND SECTIONS OF THE COAL.

There are at least two distinct kinds of coal in this region, occurring at two widely separated geologic horizons. One is the anthracite coal, which is of Mesozoic age, and the other includes various grades of bituminous coal, which are of Tertiary age.

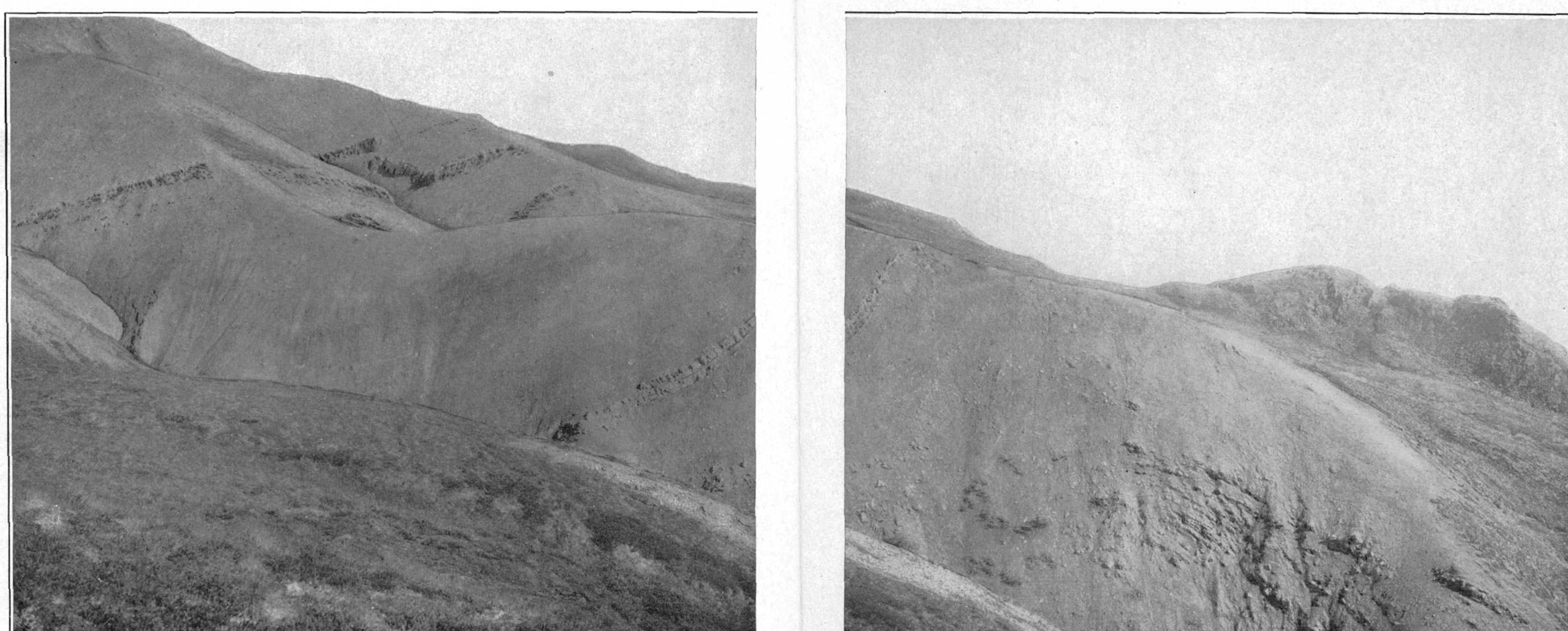
##### ANTHRACITE.

The Mesozoic coal, as stated above, is apparently all anthracite. It was seen by the writer only along the flanks of the Talkeetna Mountains, between Boulder and Hicks creeks. This coal has the ordinary physical characteristics of most good coal of this kind. It is heavy, firm, hard, and not much fractured for surface coal, and has a high luster. Pyrite was not noticed. The seams are not much broken by small partings of shale and bone.

Two sections were measured. On the south bank of Purinton Creek, at an elevation of 3,410 feet, an exposure was measured which showed 38 feet of clean, solid coal, both roof and floor being concealed (see analysis No. 1, p. 27, which represents the entire thickness as measured). At this point the strike is N. 40° E. (magnetic) and the dip is 10° NW., or into the mountain. The rocks in the vicinity are chiefly graywacke and sandstone, and show considerable variation of strike and dip (see Pl. V. and fig. 3). A short distance downstream is a good-sized mass of diabase occupying the axis of an anticline, which is in other places broken by a fault. The anthracite is probably restricted to a zone, along the face of and in the mountains, which is cut off from the valley plateau by a fault following the base of the mountains. Black streaks that are probably coal could be seen high up on the face of the mountain, and could be followed by the eye for several miles. About 1 mile northeast of the locality described above, and at an elevation of about 3,460 feet, a coal section gave the following measurements:



*A.* FOLDS AND ANTHRACITE COAL ON SOUTH SIDE OF ANTHRACITE RIDGE.



*B.* THE SAME FOLDS ABOUT ONE-HALF MILE FARTHER EAST.

*Section of coal on slope of Talkeetna Mountains.*

| | Ft. | Ft. |
|---|---|---|
| Flaggy sandstone. | | |
| Coal and shale | 3 | 10 |
| Coal | 7 | |
| Shale | | 4 |
| Coal | 1 | 1 |
| Shale | | 3 |
| Coal | 2 | 2 |
| Shale | | 2 |
| Coal | 7 | 7 |
| | | 29 |

Strike N. 60° E., dip 55° SE.

The general strike along the side of the mountain is N. 75° E. (magnetic). The area of anthracite was not estimated by the writer, and the amount available for economic mining and shipment may possibly not be sufficient to justify the necessary expenditures. On the other hand, the field may, as has been reported by some, extend far beyond the areas visited by the writer, both eastward beyond the valley of Hicks Creek and northward into the valley of Boulder Creek. Later information indicates that the eastern continuation of the coal is of lower grade, being bituminous and intermediate in character between the Chickaloon and the Tsadaka Creek coal.

BITUMINOUS.

*Eastern district.*—The coal included under this heading, probably all of Tertiary age, was seen by the writer on both sides of the Matanuska in the vicinity of Chickaloon Creek and in the valleys of Chickaloon and Kings creeks. Coal has been reported for a considerable distance along the linear extension of this belt to the east, but the amount and quality of the coal is not known.

The coal in this area all possesses about the same physical characteristics and, as will be seen by the analyses (pp. 27 and 28), the variation in chemical composition is not great, and supports this grouping. It has the ordinary properties of most bituminous coal. It is soft and fragile, but often without any well-defined planes of fracture. It burns with a short flame and a small amount of smoke, and possesses distinct caking properties. The seams generally contain a large amount of impurities, both in the form of thick partings of shale and as thin bands of shale and bone. Many of these can not be separated in mining. The coal is soft and friable, and much of it will not stand severe handling without crushing. Pyrite is present both as balls and as scales, but not abundant. The friable character of the coal is not a great detriment when it is considered that much of it will probably have to be crushed and washed (especially for coke making) and that the coal, when used for steam or heating, will cake as soon as put in the furnace, so that there will consequently be little or no loss through the grates.

The following sections were obtained on the south side of the Matanuska, near the mouth of Chickaloon Creek:

*Section of coal beds on south bank of Matanuska River 3 miles above the mouth of Chickaloon Creek.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Gray shale | | | 10 | |
| Coal | | 6 | 7 | 7 |
| Shale | | 1 | | |
| Coal[a] | 7 | | | |
| Gray shale with ironstone bands | | | 42 | |
| Coal | | 6 | 7 | |
| Shale | 1 | 6 | | |
| Coal | 5 | | | |

[a] Included in samples Nos. 7 and 8; see analyses, p. 27.

*Section of coal beds on south bank of Matanuska River 3 miles above mouth of Chickaloon Creek*—Continued.

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Gray shale | | | 7 | |
| Coal | | 6 | | 6 |
| Shale | | | 4 | 6 |
| Coal | | 8 | 6 | 5 |
| Shale | | 1 | | |
| Coal | 5 | 8 | | |
| Soft gray shale | | | 20 | |
| Concealed to river. | | | | |

Strike N. 36° E. (magnetic), dip 44° SE.

*Section on north bank of Coal Creek, elevation 1,010 feet.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Soft dark shale | | | 10 | |
| Coal [a] | 2 | 2 | 5 | |
| Parting. | | | | |
| Coal [a] | 1 | 5 | | |
| Sandstone | | 2–6 | | |
| Coal [a] | 1 | | | |
| Soft shale | | | 10+ | |

Strike N. 64° E., dip 70° SE.

*Section on north bank of Coal Creek, 500 feet upstream from section given above.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Intrusive sheet and coke | | | 12 | |
| Coke | 5 | | 5 | |
| Intrusive sheet with coke | | | 14 | |
| Shale | | | 10 | |
| Coal [b] | 6 | 3 | 8 | 7 |
| Shale | | 2 | | |
| Coal [b] | | 6 | | |
| Shale | | 11 | | |
| Coal | | 9 | | |
| Soft shale floor. | | | | |

Strike and dip as above.

A section on Coal Creek, one-half mile above the lower coal shows coal about 6 feet thick, with a strike of N. 60° E. and a dip of 55° NW.

The following sections were measured on Chickaloon Creek:

*Condensed section [c] of coal-bearing rocks on Chickaloon Creek.*

| | Ft. | in. |
|---|---|---|
| 1. Shale with many thin iron-ore bands | 180 | |
| 2. Coal with some bone and shale (as on p. 21) | 5 | 4 |
| 3. Shale | 4 | |
| 4. Coal with some shale (as on p. 21) | 4 | 10 |
| 5. Shale and sandstone (horse) | 10 | |
| 6. Coal with some shale (as on p. 21) | 8 | 9 |
| 7. Shale and sandstone | 37 | |
| 8. Coal, impure and somewhat coked | 5 | 6 |
| 9. Shale and sandstone | 20 | |
| 10. Diabase sill with local occurrence of natural coke on top | 11 | |
| 11. Coal and coke with impurities in an irregular distorted mass | 15 | |
| 12. Concealed (not over) | 100 | |
| 13. Shale | 10 | |
| 14. Coal with some shale (as on p. 22) | 9 | 4 |
| 15. Shale | 9 | |
| 16. Coal with some shale (as on p. 13) | 2 | 6 |

[a] Included in samples Nos. 9 and 10; see analyses, p. 27.
[b] Included in samples Nos. 11 and 12; see analyses, p. 27.
[c] For details see local section on pp. 12–14 and the sections of coal seams which follow.

*Condensed section of coal-bearing rocks on Chickaloon Creek*—Continued.

| | Ft. | in. |
|---|---|---|
| 17. Shale and sandstone | 88 | |
| 18. Coal with bone and shale (as on p. 22) | 10 | 10 |
| 19. Shale | 41 | |
| 20. Coal (varies from 1 ft. 8 in. to 3 ft. 7 in.) | 2 | 8 |
| 21. Shale with some sandstone, iron ore, and volcanic beds, and a few thin beds of coal and coke | 180 | |

*Section at bend of Chickaloon Creek, one-half mile above Watson's camp, showing details of beds 2 to 6 in condensed section.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Black shale | | | 1 | 6 |
| Coal | | 7 | | |
| Coal, bony | | 4 | | |
| Shale | | 5 | 5 | 4 |
| Coal | | 6 | | |
| Shale, black | 1 | 6 | | |
| Coal | 2 | | | |
| Concealed | | | 1 | |
| Shale | | | 3 | 6 |
| Coal | | 7 | | |
| Shale | | 8 | | |
| Coal | | 10 | 4 | 10 |
| Shale | | 6 | | |
| Coal | 2 | 3 | | |
| Shale and sandstone (horse) | | | 10 | |
| Coal | | 6 | | |
| Shale, with coal stringers | 1 | | | |
| Coal | | 10 | | |
| Shale | | 4 | | |
| Coal | | 2 | 8 | 9 |
| Shale | 1 | | | |
| Coal | | 6 | | |
| Shale | | 1 | | |
| Coal | 4 | 4 | | |
| Shale | | | 6 | |

The following section probably represents some of the distorted beds in the lower part of the section on page 12, or Nos. 6 to 11 in the condensed section on page 20. The dip appears to be overturned.

*Section in tunnel No. 2, Chickaloon Creek.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Shale (at mouth of tunnel) | | | 20 | |
| Coal | 6 | | 6 | |
| Hard shale | | | 17 | 6 |
| Bone [a] | | 10 | | |
| Coal [a] [b] | | 2 | 5 | 3 |
| Coal, with some bone [a] | 2 | 5 | | |
| Coal [a] [b] | 1 | 10 | | |
| Shale and bone | | | 2 | 8 |
| Bony coal [a] | | 6 | | |
| Coal [a] [b] | | 11 | | |
| Bone [a] | 1 | 11 | | |
| Coal [a] [b] | 2 | 4 | 7 | 2 |
| Bone [a] | | 5 | | |
| Coal [a] [b] | | 8 | | |
| Bone | | 5 | | |
| Hard shale. | | | | |

Dip almost vertical toward mouth of tunnel.

[a] Included in sample No. 2; see analysis, p. 27.
[b] Included in sample No. 3; see analysis, p. 27.

The following sections give the details of Nos. 14 and 18 of the condensed section:

*Section in opening No. 3 near Watson's camp, Chickaloon Creek (No. 14 of condensed section).*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Shale | | | 10 | |
| Coal | 1 | 4 | 9 | 4 |
| Shale | | 6 | | |
| Bone | | 6 | | |
| Coal[a] | 7 | | | |
| Shale with coal streaks | | | 4 | 6 |

Strike N. 72°., dip 72°, 75°, 83° NW.

*Section in tunnel No. 5, Chickaloon Creek (No. 18 of condensed section).*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Shale | | | 10 | |
| Coal[b] | 1 | 8 | 1 | 8 |
| Shale | | | | 6 |
| Bony coal | | | 1 | 8 |
| Shale | | | | 10 |
| Coal[b] | 6 | 2 | 6 | 2 |
| Shale | | | 28 | |

Strike N. 62° E., dip 51° NE.

The coal seams exposed or opened on Kings Creek gave the following sections:

*Section in tunnel on east bank of Kings Creek, 100 yards above upper bridge.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Dense impure coke | 5 | | 5 | |
| Bony shale | | | 1 | |
| Coal | 1 | | 6 | 3 |
| Shale | | 1 | | |
| Coal | | 8 | | |
| Bone | | 1 | | |
| Coal | 1 | 2 | | |
| Bony coal | | 9 | | |
| Coal | 2 | 6 | | |
| Hard shale. | | | | |

This section probably represents the 6 feet of impure coal of No. 22 in the section on page 14, and is the same seam as the following:

*Section in open cut, 10 feet south of last opening.*

| | Ft. | in. |
|---|---|---|
| Coal (no cover) | 3 | |
| Shale | | 2 |
| Coal | 1 | 2 |
| Soft impure coal | | 2 |
| Coal | 1 | 8 |
| Shale | | 3 |
| Coal | | 3 |
| Shale and coal | | 7 |
| Coal | 2 | 8 |
| Hard shale floor. | | |
| | 9 | 11 |

[a] Included in sample No. 5; see analysis, p. 27.
[b] Included in sample No. 6; see analysis, p. 27.

The following section gives the details of No. 24 in the section on page 14:

*Section in opening on west bank of Kings Creek at upper bridge.*

| | Ft. | in. |
|---|---|---|
| Coal[a] | 2 | 5 |
| Sandstone | | 2 |
| Coal[a] | 1 | 4 |
| Shale | | 1 |
| Coal | 1 | 5 |
| Sandstone | | 1 |
| Bony coal[a] | 1 | |
| Sandstone | | 1 |
| Coal[a] | 3 | 4 |
| | 9 | 11 |

Strike N. 42° W. (magnetic), dip 42° NE.

The coal on Young Creek is of intermediate character between that on Kings and Chickaloon creeks and south of the Matanuska and that in the west end of the field on Eska and Tsadaka creeks. It is reported that one or more seams of workable thickness have been found, but the following is all that was seen by the writer:

*Section on west bank of Young Creek, at elevation of 1,585 feet.*

| | Ft. in. | Ft. in. |
|---|---|---|
| Shale | | 10 |
| Sandstone | | 2 |
| Shale | | 4 |
| Sandstone | | 1 |
| Shale | | 4 |
| Coal[b] | 1 | 1 |
| Shale | | 15 |
| Coal | 6 | 6 |
| Shale with sandstone bands | | 15 |
| Sandstone | | 1 |
| Shale | | 10 |

Strike N. 15° E. (magnetic), dip 20° NW.

*Western district.*—The coal in the west end of the bituminous belt, as seen on Eska and Tsadaka creeks, has been considered locally as lignite. The analyses, however, indicate that it is in all probability a low-grade bituminous coal, and this conclusion is supported by the fact that the coal does not differ greatly in physical properties from some of that on Chickaloon and Kings creeks. The seams have about the same characteristics as those to the east. Much of the coal is bright and hard, but there are frequently dull bands with a shaly fracture which resembles a very coaly bone. The appearance of these may be due in part to impurities, but is possibly also caused in part by less complete carbonization. There is little doubt that the coal is of Tertiary age, and the beds are presumably the stratigraphic equivalents of some of those to the east.

*Section on west bank of Eska Creek, elevation 875 feet.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Shale and sandstone | | | 10 | |
| Coal[c] | 1 | 3 | 7 | 8½ |
| Shale | | 1 | | |
| Coal[c] | 1 | 4 | | |
| Shale | | 1 | | |
| Coal, bony | 1 | 3 | | |
| Shale | | ½ | | |
| Coal, bony | 1 | 1 | | |
| Shale | | 1 | | |
| Coal with some shale and bone | 2 | 6 | | |
| Shale | | | | 6 |
| Coaly shale | | | 2 | |

Strike N. 30° E. (magnetic), dip 44° NW.

[a] Included in samples Nos. 13 and 14; see analyses, p. 27.
[b] Included in sample No. 17; see analysis, p. 28.
[c] Included in sample No. 18; see analysis, p. 28.

*Section on west bank of Eska Creek, about 300 feet farther up.*

| | Ft. | in. |
|---|---|---|
| Shale roof. | | |
| Coal [a] | 3 | 3 |
| Shale | | 3 |
| Coal | | 11 |
| Shale | | 5 |
| Coal | | 6 |
| Shale | | 6 |
| Coal | | 4 |
| Shale | | 1 |
| Coal | | 9 |
| Soft black shale. | | |
| | 7 | 0 |

Dip NW.

*Section on Eska Creek, about 600 feet above lower section.*

| | Ft. | in. |
|---|---|---|
| Shale and sandstone. | | |
| Coal | 2 | 6 |
| Dirty coal | 1+ | |

Dip 32° SE.

*Section in bluff on west bank of Eska Creek, elevation 1,030 feet.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Sandstone | | | 15 | |
| Coal | 2 | | 2 | |
| Shale | | | 15 | |
| Coal | 3 | | 3 | |
| Shale | | | 3 | |
| Coal | 3 | | 3 | |
| Concretionary shale | | | 6 | |
| Black shale | | | 5 | |
| Coaly shale | | | 1 | |
| Coal, shaly | | 6 | | |
| Coal | | 9 | | |
| Shale with some coal | | 8 | | |
| Coal | 2 | 1 | | |
| Shale | 1 | | | |
| Coal | 1 | 4 | 11 | 4 |
| Shale | I | | | |
| Coal | 1 | | | |
| Shale | 2 | | | |
| Coal | 1 | | | |
| Shale | | | 12 | |
| Coal | 1 | | | |
| Shale | 2 | | 4 | |
| Coal | 1 | | | |
| Shale | | | 10 | |

Strike N. 40° W. (magnetic), dip 40° SW.

A fault cuts this bluff and the section was measured above it. Below it the strike is northeast and the dip southeast.

---

[a] Included in sample No. 19; see analysis, p. 28.

The following measurements were made on Tsadaka Creek:

*Section of coal near upper end of Tsadaka Creek gorge, elevation 700 feet.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Fissile black shale | | | 1 | |
| Carbonaceous shale | | | | 6 |
| Sandstone | | | | 2 |
| Coal | | 2 | | |
| Sandstone | | 1 | | |
| Bright coal [a] | 2 | 4 | | |
| Shale | | 6 | 8 | 1 |
| Bright coal [a] | 2 | | | |
| Dull coal [a] | 1 | 2 | | |
| Shale | | 4 | | |
| Dull coal | 1 | 6 | | |
| Shale | | | 1 | |
| Massive sandstone | | | 6 | |

Strike N. 20° W., dip 24° NE.

*Section on east bank of Tsadaka Creek, about 100 yards below upper cabin, elevation 780 feet.*

| | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Coal with hard ferruginous inclusions | 3 | | 3 | |
| Shale | | | 2 | |
| Coal (bright) [b] | 4 | 6 | | |
| Shale | | 2 | | |
| Coal (bright and hard) [b] | 7 | | 12 | 8 |
| Soft shaly coal | 1 | | | |
| Soft shale with abundant iron-ore concretions | | | 80± | |
| Massive sandstone | | | 10± | |

Strike N. 50° E., dip 43° NW.

A westward extension of the coal is reported on Little Sushitna River, but that region was not visited by the writer. The coal is said to occur in thin beds and to be lignite, but it is not known whether it is a true lignite or a low-grade bituminous coal like that on Eska and Tsadaka creeks.

## ADJACENT COAL FIELDS.

Coal is reported from numerous localities in the region surrounding that described in this report. The information regarding many of these is meager, but it nevertheless seems best to bring it together here.

There is an area of lignite at or near Point Campbell, at the juncture of Knik and Turnagain arms, which has been used to a limited extent as local domestic fuel. The coal seen by the writer had been picked up at the outcrop and was a lignite of rather poor quality. It may be that the coal from this bed would be better where not so badly weathered, or that there are more valuable seams in the vicinity.

Mendenhall states[c] that "along the upper course of Bubb Creek * * * thin coals may occasionally be seen interbedded with the shales and sandstones forming the stream bluffs." No further information in regard to them is given.

Coal in thin beds is reported from Hicks Creek, about 3 miles above its mouth, and as "float" near the headwaters of the Tazlina.[d]

An outcrop of coal on Chickaloon Creek, about 26 miles above the mouth of Boulder Creek, was reported by Sergeant Mathys, of Captain Glenn's expedition. It is described[e] as "a vein of coal running across the ridge, which was 4 feet in width and

[a] Included in sample No. 20; see analysis, p. 28.
[b] Included in sample No. 21; see analysis, p. 28.
[c] Op. cit., p. 324.
[d] Glenn, Capt. E. F., Reports of Explorations in the Territory of Alaska, War Dept., Adjutant-General's Office, No. 25, 1899, p. 112.
[e] Mathys, Sergt. Frederick, Reports of Explorations in the Territory of Alaska, War Dept., Adjutant-General's Office, No. 25, 1899, p. 274.

apparently a very good quality of soft coal." This is of considerable importance as probably showing a recurrence of coal-bearing rocks not far north of the Matanuska Valley.

There appears to be a considerable area of coal or lignite in the Sushitna Valley, in the vicinity of the mouth of the Talkeetna. Some of the exposures were seen by Eldridge,[a] who describes them as follows:

The third coal field along the main river, 4 to 10 miles above the Chulitna, appears in outcrops for a distance of 6 or 7 miles and is perhaps the exposed portion of an extensive area. The strata form bluffs 100 to 300 feet high, and consist of clays and sandstones—the former predominating—with coal seams from 6 inches to 6 feet thick. There are perhaps ten or fifteen coal beds exposed in the entire length of the outcrop. Their general dip is 5° to 10° SSE., with undulations. The thickness of the series exposed is perhaps 500 feet.

Other exposures in the same general district were described by Lieutenant Learned, who said:[b]

As the party under my charge proceeded up the Sushitna River specimens of coal were found on the sand bars from time to time, but more plentifully as the forks were approached. On the way down the river an outcropping of coal was seen on the east fork of the Sushitna River, about 2 miles south of the fork. The vein could not be measured, but as near as could be determined it was about 6 feet thick and of a poor quality.

Upon entering the Talkeetna River coal was seen on the bars and banks, and the same coal was found in the Chinaldna River. It was the main fuel used at the camp on the Chinaldna River for about two months. The coal found there was a brown lignite of about the same grade as the best found in the vicinity of Tyoonok. The vein was located first by Sergeant Yanert, and is noted on his map. It is about 6 miles above the mouth of the Chinaldna, at the base of a cut gravel bank about 100 feet high. When seen by Sergeant Yanert the water was clear and the vein could be traced across the river to the east bank. When I visited the vein the river was flooded and therefore very muddy. As near as could be determined by me the vein was 6 feet out of and fully as much more under the water, making it 12 feet thick, but Private Gamble, who had seen it in clear water, said it was at least 15 feet thick and perhaps much more, as it extended across the river, forming its bed, and there was no way of determining the thickness of that part forming the bed of the river. The vein is only slightly tilted, and comparatively easy to work if occasion should ever render it valuable. * * * All of the coal found, when consumed, gave a fair amount of heat, but left a large amount of ashes. * * * Sergeant Yanert reported that he found another large coal vein on the Chulitna River of about the same grade as the Tyoonok coal. It is doubtful if the coal found will ever have any commercial value, except such value as it possesses for fuel in the vicinity, and even that will be small, because of the timber found in the same localities. Enough was ascertained to show that there is plenty of coal of an inferior grade along the Sushitna River.

The Cook Inlet coal fields have already been described by various authors. All existing information was summarized in 1902 by Brooks,[c] who gave complete references to the earlier publications.

## ANALYSES AND TESTS.

*Chemical and calorimetric tests.*—The samples collected by the writer were (with the exception of No. 3) all taken in a uniform manner. They were obtained by making a cut across a fresh face of the coal from roof to floor, cutting down only the coal which would probably be loaded and leaving out such impurities as could be separated in the ordinary practices of actual mining. They are thus supposed to represent the quality of the coal which would be mined from these seams. The parts of each seam which went into the sample are indicated in the local sections. No. 3 was taken from only the best parts of the seam (see p. 21) and impurities were rejected which could be separated in practice only by very careful treatment, such as in "screened and hand picked" coal, or possibly by some mechanical process or by washing. The object of this selection was to show, by a comparison of analyses Nos. 2 and 3, what could probably be gained in practice by such careful separation of impurities.

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[a] Eldridge, G. H., A reconnaissance in the Sushitna basin and adjacent territory in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, p. 22.

[b] Learned, Lieut. H. G., Reports of explorations in the Territory of Alaska, War Dept., Adjutant-General's Office, No. 25, 1899, pp. 162-163.

[c] Brooks, A. H., The coal resources of Alaska: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, pp. 543-546.

*Analyses and tests of Matanuska coals.*

| No. of sample. | Locality. | Thickness of coal seam in feet. | Moisture in air-dried sample.[a] | Total moisture. | Volatile matter. | Fixed carbon. | Ash. | Sulphur. | Calories[b] per pound of coal. | Recalculated. Fuel elements. Volatile matter. | Recalculated. Fuel elements. Fixed carbon. | Recalculated. Fuel ratio. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Between Boulder and Hicks creeks | 38.0 | (c) | 2.55 | 7.08 | 84.32 | 6.05 | 0.57 | 7,613 | 7.75 | 92.25 | 11.90 |
| 2 | Chickaloon Creek, tunnel No. 2 | 12.3 | 0.98 | 2.58 | 19.14 | 67.46 | 10.82 | .57 | ........ | 22.10 | 77.90 | 3.52 |
| 3 | Chickaloon Creek, tunnel No. 2 (selected) | 5.2 | (c) | .90 | 19.60 | 74.60 | 4.90 | .60 | 8,260 | 20.81 | 79.19 | 3.81 |
| 4 | .....do | ........ | (c) | 1.06 | 12.76 | 78.96 | 6.28 | .90 | ........ | 13.91 | 86.09 | 6.19 |
| 5 | Chickaloon Creek, tunnel No. 3 | 7.0 | 1.46 | 2.46 | 17.01 | 53.23 | 27.30 | .84 | ........ | 24.22 | 75.78 | 3.13 |
| 6 | Chickaloon Creek, tunnel No. 5 | 7.9 | 1.00 | 2.90 | 17.47 | 56.15 | 23.48 | .46 | ........ | 23.73 | 76.27 | 3.21 |
| | Average of analyses, 2–6 | ........ | ........ | 1.98 | 17.20 | 66.08 | 14.56 | .67 | ........ | 20.95 | 79.05 | 3.77 |
| 7 | Matanuska River, south side, 3 miles above Chickaloon Creek | 7.0 | 2.76 | 4.36 | 18.92 | 61.19 | 15.53 | .37 | ........ | 23.62 | 76.38 | 3.23 |
| 8 | .....do | 7.0 | (c) | 4.15 | 20.63 | 59.62 | 15.60 | .34 | ........ | 25.71 | 74.29 | 2.89 |
| 9 | Coal Creek, ¾ mile above mouth | 5.0 | 1.44 | 2.24 | 23.08 | 70.21 | 4.47 | .50 | ........ | 24.74 | 75.26 | 3.04 |
| 10 | .....do | 5.0 | (c) | 1.88 | 22.51 | 71.65 | 3.96 | .44 | ........ | 23.91 | 76.09 | 3.18 |
| 11 | Coal Creek, ⅜ mile above mouth | 8.6 | 2.64 | 6.74 | 14.96 | 65.83 | 12.47 | .44 | 6,649 | 18.52 | 81.48 | 4.40 |
| 12 | .....do | 8.6 | (c) | 5.83 | 18.24 | 63.03 | 12.90 | .47 | ........ | 22.44 | 77.56 | 3.46 |
| | Average of analyses, 7–12 | ........ | ........ | 4.20 | 19.72 | 65.26 | 10.82 | .42 | ........ | 23.14 | 76.86 | 3.32 |
| 13 | Kings Creek, west bank, upper bridge | 9.9 | 1.13 | 2.93 | 21.85 | 63.09 | 12.13 | .59 | 7,419 | 25.72 | 74.28 | 2.89 |
| 14 | .....do | 9.9 | (c) | 1.22 | 24.15 | 62.65 | 11.98 | .52 | ........ | 27.82 | 72.18 | 2.59 |
| 15 | Kings Creek | ........ | (c) | 1.15 | 23.09 | 69.34 | 6.42 | .89 | ........ | 24.98 | 75.02 | 3.00 |
| 16 | .....do | ........ | (c) | .50 | 22.00 | 70.50 | 7.00 | ........ | ........ | 23.78 | 76.22 | 3.20 |
| | Average of analyses, 13–16 | ........ | ........ | 1.45 | 22.77 | 66.40 | 9.38 | .67 | ........ | 25.57 | 74.43 | 2.91 |

[a] Determined by drying in the open air until weight becomes constant.
[b] A calorie is the amount of heat necessary to raise the temperature of 1 pound of water 1° C. It is equal to 1.8 British thermal units.
[c] Not determined.

*Analyses and tests of Matanuska coals*—Continued.

| No. of sample. | Locality. | Thickness of coal seam in feet. | Moisture in air-dried sample. | Total moisture. | Volatile matter. | Fixed carbon. | Ash. | Sulphur. | Calories per pound of coal. | Recalculated. Fuel elements. Volatile matter. | Recalculated. Fuel elements. Fixed carbon. | Recalculated. Fuel ratio. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Young Creek, 3 miles above trail | 1.0 | (a) | 2.50 | 28.32 | 58.82 | 10.36 | 0.58 | ........ | 32.50 | 67.50 | 2.08 |
| | Average of analyses, 2-17 | ........ | ........ | 2.71 | 20.23 | 65.39 | 11.60 | .57 | ........ | 23.65 | 76.35 | 3.23 |
| 18 | Eska Creek, 3 miles above trail | 2.6 | (a) | 5.56 | 36.52 | 51.32 | 6.60 | .42 | ........ | 41.58 | 58.42 | 1.41 |
| 19 | ....do | 3.3 | (a) | 6.60 | 34.30 | 48.23 | 10.87 | .41 | 6,299 | 41.56 | 58.44 | 1.41 |
| | Average of analyses, 18-19 | ........ | ........ | 6.08 | 35.41 | 49.78 | 8.23 | .42 | ........ | 41.57 | 58.43 | 1.41 |
| 20 | Tsadaka Creek, 4 miles above trail | 6.0 | (a) | 4.03 | 34.84 | 49.31 | 11.82 | .38 | ........ | 41.40 | 58.60 | 1.42 |
| 21 | Tsadaka Creek 4½ miles above trail | 11.7 | 5.45 | 10.05 | 36.05 | 48.90 | 5.00 | .25 | ........ | 42.44 | 57.56 | 1.36 |
| | Average of analyses, 20-21 | ........ | ........ | 7.04 | 35.45 | 49.10 | 8.41 | .32 | ........ | 41.92 | 58.08 | 1.39 |
| | Average of analyses, 18-21 | ........ | ........ | 6.56 | 35.43 | 49.44 | 8.32 | .37 | ........ | 41.74 | 58.26 | 1.40 |

[a] Not determined.

1-3, 5-7, 9, 11, 13, 17-21. Sampled by G. C. Martin. Analyses by F. M. Stanton, U. S. Geol. Survey coal-testing plant, St. Louis, Mo.
8, 10, 12 and 14 Sampled by William Griffith and G. C. Martin. Analyses by A. S. McCreath, Harrisburg, Pa.
15. Sampled by George Jamme. Analysis by C. C. Borgardus Seattle, Wash. Published in Bull. U. S. Geol. Survey No. 259, 1905, p. 170
16. Sampled by Frank Watson. Analysis by William H. Stowell & Co., Seattle, Wash.

The samples which the writer collected were all analyzed by Mr. F. M. Stanton at the United States Geological Survey coal-testing plant at St. Louis, Mo. The methods of analysis are described in their reports.[a]

The other analyses were gathered from a variety of sources. Nos. 4, 8, 10, 12, and 14 are based on duplicates of samples taken by the writer. The others are of varied

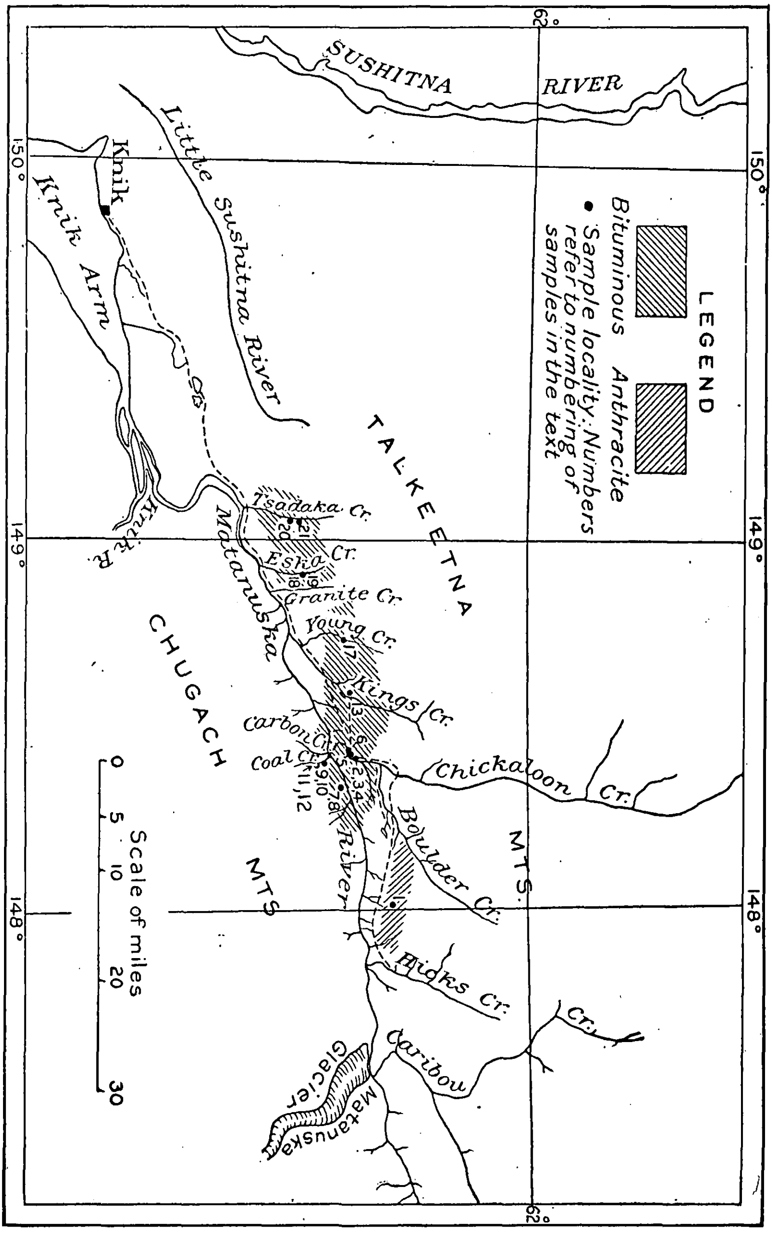


FIG. 4.—Sketch map of Matanuska Valley showing coal areas and localities from which coal samples were taken.

character, some being fair representations of the seams and some random selections of the best coal. The localities from which the samples came are indicated in fig. 4.

[a] Preliminary report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904: Bull. U. S. Geol. Survey No. 261, 1905, pp. 30-31. Report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904: Prof. Paper U. S. Geol. Survey No. 48, 1906, pp. 174-192.

The anthracite coal is represented by a single analysis (No. 1), which shows it (so far as this one outcrop is concerned) to compare not unfavorably with some of the Pennsylvania anthracite.

*Comparison of Matanuska and Pennsylvania anthracite.*

| Coal. | Moisture. | Volatile matter. | Fixed carbon. | Ash. | Sulphur. | Fuel ratio. |
|---|---|---|---|---|---|---|
| Matanuska | 2.55 | 7.08 | 84.32 | 6.05 | 0.57 | 11.91 |
| Pennsylvania (average of 9) [a] | 3.39 | 3.81 | 83.79 | 8.42 | .59 | 22.33 |

[a] Ashburner, C. A., Ann. Rept. Geol. Survey Pennsylvania, 1885, p. 313.

The coals represented by analyses 2 to 17 are near the border line between semi-bituminous steam coals (as the name is generally used in the trade, but not according to Frazer's definition) [a] and bituminous coking coals. They are rather high in ash, but are otherwise of good quality. Analyses 5 and 6 bring the average abnormally high, but even aside from these most of the seams are so impure that mechanical separators or washing should be used to remove part of the impurities. The purer of these coals correspond very closely to the Crows Nest Pass (British Columbia) coal, [b] which is the standard coking coal of western North America, and approximately to some of the coking coal of the East.

The lower-grade bituminous coal on Eska and Tsadaka creeks, which the analyses show to be intermediate between first-class bituminous coal and the lignite coals, should probably be called bituminous rather than lignite, as it is usually called in the region. It is of about the same composition as the Franklyn, Black Diamond, and Renton (Washington) coal. It will probably not make good coke, but should serve well under stationary boilers, and possibly as a locomotive fuel and for other local uses. It should be especially well adapted to the generation of power by the use of producer gas in a gas engine.

*Coking qualities.*—A rough test of the coking qualities of the coal from tunnel No. 2 on Chickaloon Creek (see p. 21) was made during the summer of 1905, by coking a large pile of coal under a covering of stones and dirt. The resulting coke was hard and firm and had a good ring and a good texture. The test showed conclusively that a satisfactory grade of coke can be produced.

### MINING CONDITIONS.

There are no serious difficulties in the way of mining these coals. The dips are so steep (10° to 60° on the anthracite, 18° to 85° in the east end of the bituminous area, and 20° to 44° in the west end of the bituminous area) that some method of stoping will have to be used. Miners who are accustomed to the steep dips in some of the coal mines of Washington and British Columbia will have no difficulty in this field. Drifts can be run from the level of some of the main streams and enough coal found above drainage to supply the mines for some time. It will ultimately be necessary to resort to slope or shaft mining. These methods (or tunnels across the measures from the upper floor of the Matanuska Valley) will probably have to be used on the anthracite very soon. But no operations should be undertaken in the anthracite area without thoroughly investigating the amount of workable coal, both by carefully exploring the surrounding country in search of outcrops and by testing the thickness and continuity of the seams by boring or other underground work. There is an abundant local supply of wood for building and mine timbering.

[a] Rept. Geol. Survey Pennsylvania, vol. MM, 1879, pp. 144-145.
[b] Martin, G. C., Markets for Alaska coal: Bull. U. S. Geol. Survey No. 284, 1906, p. 29.

It will be necessary to wash or otherwise clean the coal from some of the seams. The percentage of ash can be reduced, by washing, from 10, 12, 15, 23, and 27 per cent to less than half and probably in some cases to a quarter of these figures. The tests at the coal-testing plant of the United States Geological Survey showed instances[a] where the percentage of ash was reduced as follows:

*Results of washing tests.*

| Percentage of ash in— | |
|---|---|
| Raw coal. | Washed coal. |
| 22.44 | 9.42 |
| 13.40 | 7.16 |
| 28.39 | 7.59 |
| 13.81 | 6.22 |
| 10.59 | 5.86 |
| 9.99 | 6.33 |
| 7.75 | 7.49 |
| 25.05 | 8.14 |
| 16.00 | 10.25 |
| 15.22 | 10.28 |

It is probable that with a plant adapted especially to some particular coal and with employees experienced in handling that coal even better results could be obtained.

### TRANSPORTATION AND MARKETS.

None of this coal can be used until a railroad is built to tide water. The Alaska Central Railway, now building from Seward to the interior, is expected to tap this coal field. The coal may then find a market for use as motive power on the railroad; for fuel in the towns and mines which may grow up along the line of the railroad and at its termini; for coke at the possible Alaska smelters; for bunker coal on the ocean and river steamers touching at the termini of the railroad, and for export. The question of markets and of competition with other fuels has been discussed in detail in another paper.[b]

## GOLD.

The terrace and stream gravels along the Matanuska are reported to carry small amounts of gold, but no locality has yet been found which is rich enough to be worked. It is entirely possible that placer deposits will be found in this region, but they will probably be on the tributaries rather than in the main Matanuska Valley or in the broad gravel sheet at its mouth. A placer deposit is now being worked in the mountains north of Little Sushitna River with considerable reputed success. The geologic conditions in the vicinity are not known. The Turnagain Arm placers[c], which have long been successfully worked, are not far south of the Matanuska Valley. It is quite possible that conditions similar to those at these localities will be found somewhere adjacent to the Matanuska.

[a] Preliminary report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904: Bull. U. S. Geol. Survey No. 261, 1905, pp. 60-73.

[b] Martin, G. C., Markets for Alaska coal: Bull. U. S. Geol. Survey No. 284, 1906, pp. 18-29.

[c] Moffit, F. H., The gold placers of Turnagain Arm: Bull. U. S. Geol. Survey No. 259, 1905, pp. 90-99; Mineral resources of the Kenai Peninsula, Alaska: Bull. U. S. Geol. Survey No. 277, 1906, pp. 7-52.

Metalliferous veins carrying both gold and copper are reported in the mountains bordering the Matanuska Valley. Very little is known regarding either these reputed discoveries or the geology of the localities in which they are supposed to have been made.

## IRON ORE.

The shales which contain the coal in the region between Tsadaka and Chickaloon creeks contain also numerous beds of iron-carbonate concretions. Several of these are shown in the sections on Chickaloon Creek recorded on pages 12 and 13. The concretions vary in diameter from a fraction of an inch to several feet. They are often so abundant as to make solid beds of the ore. These beds are from a few inches to 2 or 3 feet in thickness.

*Analysis of ferrous-carbonate concretion from Tsadaka Creek.*

| | |
|---|---|
| Total iron | 19.6 |
| Insoluble in HCl | 29.5 |

The bed from which this particular sample came is too poor in iron to be of value. It is possible that further search will bring to light beds which are thick enough and high enough in iron to be worked on a small scale.

Another specimen from Tsadaka Creek which had apparently been partially reduced from contact with a burning coal bed contained 70 per cent $Fe_3O_4$ and 20 per cent $Fe_2O_3$, or a total of 63.8 per cent iron. This sample of ore is of good quality, but the amount is far too small to be of value. Its chief interest is in its origin. One of the beds of iron carbonate had been brought in contact with a coal seam by faulting. In some way, probably from a forest fire, the coal caught fire, with not only the usual result of baking the overlying shales but also that of reducing the iron from the form of carbonate to that indicated in the analysis.

## APPENDIX.

The references given below will doubtless be useful to anyone who wishes to make comparisons of this coal with that in other parts of Alaska.

### LIST OF PAPERS, BY MEMBERS OF THE UNITED STATES GEOLOGICAL SURVEY, ON COAL, LIGNITE, AND PETROLEUM OF ALASKA.


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[a] Contains references to the Matanuska coal.

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