THE BONNIFIELD AND KANTISHNA REGIONS.

By L. M. PRINDLE.

INTRODUCTION.

The northern foothills of the Alaska Range have been widely traversed by prospectors since the establishment of Fairbanks as a permanent supply point. In 1903 gold-placer mining commenced in the Bonnifield country, about 60 miles south of Fairbanks, and during 1906 the Kantishna region, about 150 miles southwest of Fairbanks and 30 miles north of Mount McKinley, was an area of considerable activity. These regions had produced, respectively, about $30,000 and $175,000 in placer gold. The writer and C. S. Blair, field assistant, were detailed to investigate the placers and also the deposits of lignitic coal of Cantwell River, which were visited by the Brooks party in 1902.

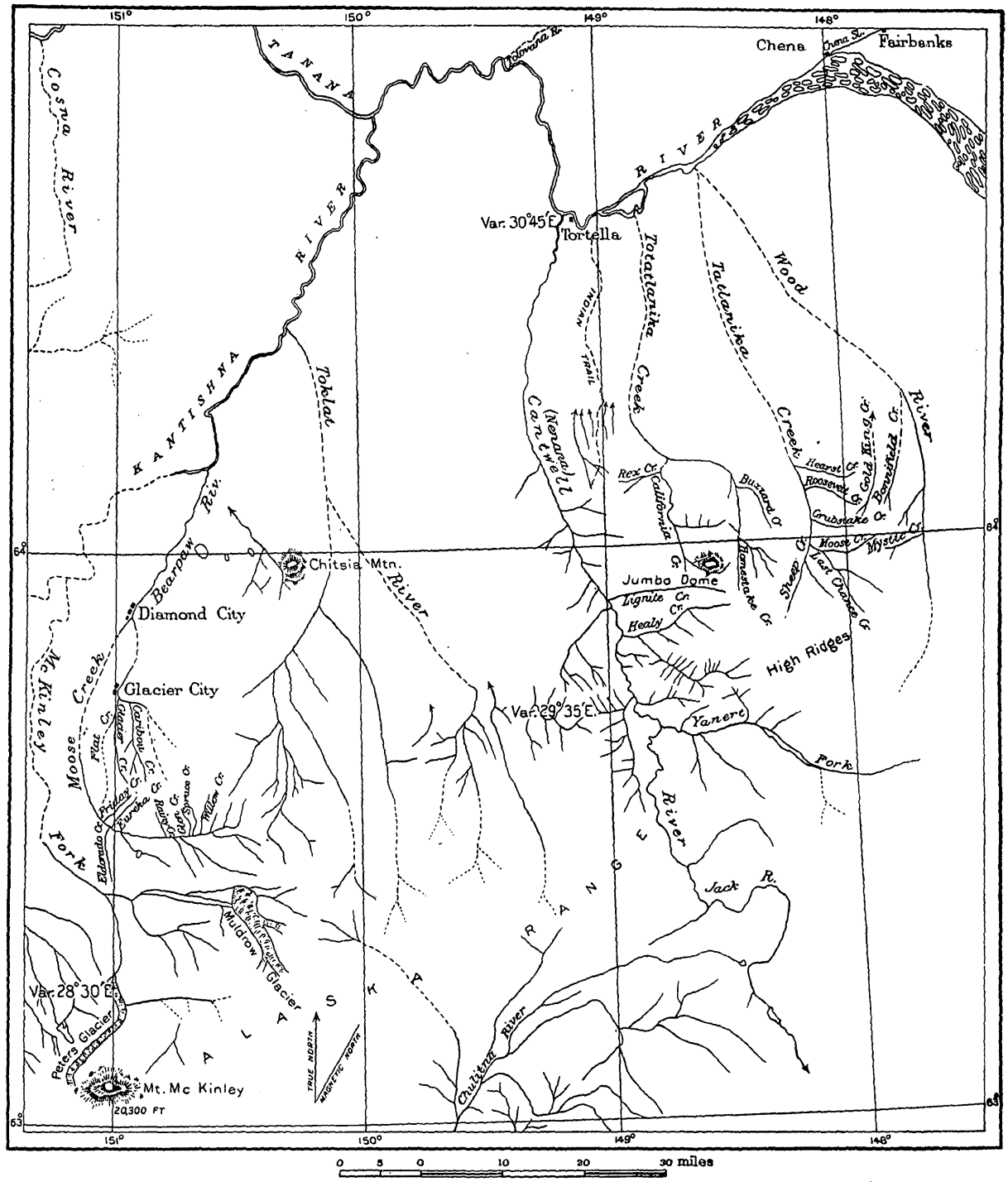
The sketch map (Pl. IV), with the foot traverses of the party in the two regions added to the topographic map made by the Brooks party in 1902, shows the geographic relations. The two most prominent geographic features of the entire area are the Alaska Range and the Tanana Flats.

The Alaska Range in this part of Alaska trends round from the northeast toward the east and is composed of lofty alpine ridges, surmounted here and there by beautiful peaks. Minor ridges flank the main range on the north and their outer members descend with more or less abruptness to the level of the Tanana Flats. All the drainage is to the Tanana. The main drainage lines are northward, transverse to the ridges. Many of the upper valleys are gorged with glaciers and the lower valleys are a succession of narrow canyons interrupted by east-west valleys parallel to the ridges.

The Tanana Flats extend northward from the base of the foothills to Tanana River. They have a width in the area under consideration of about 30 miles. They widen rapidly toward the west, as the river flows northwest and the mountains recede to the southwest, and form an impressive foreground to the mountains. The flats absorb small streams from the foothills and the surface is drained by swampy creeks, which cross them irregularly. The larger streams, a

few miles after leaving the hills, meander sluggishly in no well-defined valleys and enter the Tanana with sloughlike inconspicuity. The surface is sparsely timbered with small spruce, tamarack, birch, and aspen, with a larger growth near the major streams and along the base of the foothills. Swampy areas flecked with lakes are interspersed with patches of birch where the ground is bare and dry, and the traveling therefore fairly good. Feed is good along the watercourses but during the long hot days of summer there is scant relief for the pack animals from the horseflies and mosquitoes, which render an otherwise friendly area a place of almost constant torment.

The bed rock of the Bonnifield and Kantishna regions includes highly metamorphosed ancient rocks and loosely consolidated deposits of comparatively recent origin. The most common distinction made by the miners is that between hard and soft bed rock, and this distinction is warranted by the conditions. The ridges are formed for the most part of metamorphic schists and igneous rocks; the intervening longitudinal valleys, of deposits in the main unconsolidated but older than those of the present streams. The most important fact from an economic view point is the distinction between the two groups of hard and soft bed rock. The hard bed rock from south to north includes a belt of highly metamorphosed schists, predominantly quartzitic schists with a small amount of interbedded crystalline limestone, and some carbonaceous schists; a belt of black slates with quartzite and cherty beds; and a belt of metamorphosed porphyritic feldspathic rocks. The belt of quartzite schists forms most of the bed rock in the Kantishna region, crosses Cantwell River just south of Healy Creek, and extends northeastward to the south of the Bonnifield region; the slates occur in the high ridges at the head of the Totatlanika and the porphyritic feldspathic schists form the several ridges to the north. These porphyritic schists occupy large areas in the northern foothills of the Alaska Range. They were observed throughout the area between Cantwell and Wood rivers. To the south they are interrelated with the black slates containing quartzite beds that succeed the quartzite schists. To the north they form the outermost ridges overlooking the Tanana Flats. Throughout this area are several prominent east-west ridges of these rocks rising 1,500 to 2,000 feet above the valleys that separate them. The color ranges from dark-gray to white. The prevailing tone is whitish, from the weathering of the large amount of feldspar that the rock contains, and much kaolinic material has been contributed by this rock to the deposits that occupy large areas in the longitudinal valleys between the ridges. The rock ranges in character from a coarsely porphyritic sericitic variety with feldspars 4 dm. or more in diameter to a fine, evenly grained white or gray sericite schist with no grains visible to the eye. These rocks are of igneous origin



SKETCH MAP OF BONNIFIELD AND KANTISHNA REGIONS.

and comprise highly metamorphosed rhyolitic rocks with probably some associated tuffs.

The soft bed rock includes thick beds of slightly consolidated sands, clays, fine gravels, and many beds of lignite, all overlain by thick deposits of gravel. Some of these deposits, at least, are of Tertiary age, and a more detailed description of them will be found in the section on the coal deposits (pp. 221–226).

BONNIFIELD PLACER REGION.

GENERAL DESCRIPTION.

The region known as the "Bonnifield country" is named for John E. Bonnifield, who was one of the first men to locate in this part of Alaska. The name referred originally to the region immediately west of Wood River, but as prospectors explored valleys farther west the name came to be used in a broader sense, and for the purposes of this report includes all areas of placer mining between Wood River and the Cantwell, 50 miles farther west.

The region is difficult of access in summer. The waterways are not easily navigable, even for small boats, yet supplies are sometimes brought in them about 40 miles upstream to points a dozen miles or more from the hills, whence they are transported overland by man or horse power about 20 miles to the creeks where they are to be used. Pack trains are occasionally taken over the flats along the west side of Wood River, but this method is expensive. Most of the supplies are transported during the winter, when streams afford good traveling for dog or horse sleds and the time consumed from Fairbanks to the creeks where mining is in progress is but a few days.

The region is delimited on the south about 20 miles south of the flats by prominent eastward-trending ridges which overlook it. The area between these ridges and the flats contains several ridges approximately parallel, with altitudes of 4,000 feet and intervening spaces a few miles in width at a level 2,000 feet below that of the ridges. Isolated prominences like Jumbo Dome form important landmarks and the area is one of diversity.

THE CREEKS.

The most striking characteristic of the drainage and one that finds explanation in the different conditions that once prevailed is the fact that the streams in general have cut canyons in ridge after ridge in their northward progress toward the flats. These canyons are for the most part narrow, and talus from the overtowering cliffs obstructs the streams. The intervening parts of the valleys are in general open, and gravel plains up to 1,000 feet or more in width have been developed.

The gravels include angular bowlders from the hard bed rock, finer material of the same nature, and a large proportion of well-washed gravels, in the main rather fine, which have been derived from the unconsolidated deposits that occupy large areas in the longitudinal valleys.

The creeks on which most work has been done are Totatlanika with its tributary Homestake; Grubstake, Roosevelt, and Hearst creeks, tributaries of the Tatlanika; and Gold King Creek, which flows independently out of the hills into the flats.

TOTATLANIKA CREEK.

Totatlanika Creek is comparable in size to streams of the Yukon-Tanana country like the Chatanika. It is formed by the union of several tributaries which originate in a high schist ridge to the south. It flows northward toward the flats, cutting canyons in several ridges of the igneous schist, and has developed in the intervening spaces tributaries that drain large areas in which the hard rocks are largely covered with coal-bearing deposits.

Mining was being done at scattered localities on the main creek along a distance of about 6 miles and on Homestake Creek, a small tributary. The conditions on the main creeks at all the localities are similar. The stream flat attains a width in the more open parts of the valley of several hundred feet, and the grade of the valley is approximately 100 feet to the mile. The quantity of water varies greatly. At ordinary stages on a rough estimate there are perhaps a dozen sluice heads available, and for the most successful working, by the methods employed, a low stage of water is desirable. The gravel bars at low water are mostly bare, and it is there and in the stream bed that the mining is being done. The bed rock includes hard, blocky porphyritic feldspathic schist with some associated carbonaceous schist and abundant quartz veins. A belt of andesitic rocks crosses above the mouth of Homestake Creek. The gravels are derived from these varieties of bed rock and from the unconsolidated coal-bearing deposits, which supply many vein-quartz and chert pebbles, pieces of lignitic coal, and a few large bowlders of the granite and greenstone that occur in the uppermost beds of these deposits. The thickness of the stream gravels where work is being done ranges from 3 to 6 feet.

The gold is found in most places scattered through the gravels, but in others is confined to the surface of the bed rock, and where this is blocky is generally found to a depth of 3 feet or more within it. The gold is mainly flat and most of the pieces are less than a quarter inch in diameter. Occasionally pieces are found worth 25 cents, and a $2 piece was the largest noted. It is all well worn. Pay has been found over widths of 50 to 100 feet, with values up to 1½ ounces per day to

the man, but too little work has been done to give definite information regarding the average dimensions, values, or persistence of the pay streak.

Mining is done by open cuts in combination with wing dams. The ground is for the most part free from frost, and the only trouble from this source has been experienced in constructing bed-rock drains. Wing dams are used to deflect the water from the ground that is being worked, and water for sluicing is carried from the dam a distance of a few hundred feet to the sluice boxes. These are given a grade preferably of 9 inches to the box. There is but little sediment in the gravels and no dump boxes are used.

The timber available for sluice-box lumber in this part of the valley is limited, and lumber is packed 5 to 25 miles from the lower canyon in the winter. About a dozen men were working on the creek during the summer of 1906.

HOMESTAKE CREEK.

Homestake Creek is a small stream, about 4 miles long, which enters Totatlanika Creek in the uppermost canyon. The valley consists of two parts of different character. The upper part is open and flat—hardly more than a depression in an undulating, well-nigh timberless area several miles wide—that extends east and west between the ridges. The lower part is a deep canyon with vertical walls of andesite that crowd the stream to a narrow, crooked course and burden it with great fragments. The grade of the upper valley is approximately 100 feet to the mile; that through the canyon is over 200 feet to the mile. The amount of water carried by the stream is, during a dry season, insufficient for mining purposes. The bed rock of the upper valley is composed of unconsolidated clay and sand of the coal-bearing formation; that of the lower valley is the igneous rock of the canyon.

Most of the mining has been done at the upper end of the canyon and in the open part of the valley half a mile farther upstream. The deposits that are worked range from 2 to 6 feet thick. Gold has been found in 2 to 3 feet of gravel, and part of it is coarser than that of Totatlanika Creek, one piece worth $15 having been found. All of the gold apparently is well worn. The stream heads in gravels and above the canyon has not yet cut down to hard bed rock, and it would seem that the gold has been derived from the gravels.

There are but few trees in the upper valley. Sluice-box lumber and even firewood are packed from the main stream. Some of the ground prospects well, but so little work had been done that the possibilities of the creek were not definitely known. Unlike those on the main stream, successful operations on Homestake Creek are dependent on abundant rainfall.

TATLANIKA DRAINAGE.

About 10 miles east of Totatlanika Creek is the Tatlanika, formed by the union of Sheep and Last Chance creeks. This is a somewhat larger stream and has developed for itself in the section of the valley under consideration a gravel plain several hundred feet wide, with a grade of about 90 feet to the mile. A finely preserved bench 40 feet high and half a mile or more wide limits the stream on the west, and 3 miles to the west high gravel hills separate the Tatlanika drainage from the headwaters of Buzzard Creek; on the east are blunt terminations of low, broad ridges that separate the small tributaries entering from that side—Grubstake, Roosevelt, and Hearst creeks, on which most of the mining is being done. These enter in the downstream order given, the mouths being separated by distances of 3 miles and 1 mile, respectively. The creeks are similar in size and character, and gold occurs on all of them under about the same conditions and with apparently the same origin. The Tatlanika in this area has not yet cut down to hard bed rock and these minor streams have cut narrow valleys for themselves in the unconsolidated gravels, clays, and sands of the coal-bearing deposits. Grubstake Creek heads along the contact of the schistose bed rock and the soft deposits and is the only one of the three that has the hard bed rock within its drainage basin.

GRUBSTAKE CREEK.

Mining on Grubstake Creek is confined to a mile of the lower valley. The stream is 200 to 300 feet below the steep inclosing slopes of soft material and the stream flat is 150 to 300 feet wide. The grade is approximately 100 feet to the mile. At the lowest stage the creek carries approximately a sluice head of water. The bed rock is sticky clay, sand, and coal, all three distinct from the stream deposits. The thickness of the gravels that are being mined ranges from a few inches to 6 feet. These gravels include both fine and coarse material, with a small proportion of bowlders. They are made up of schist, vitreous quartzite, compact conglomerate composed largely of chert pebbles, vein quartz, chert, granite, and diabase; the amount of sediment in them is small.

Gold is found scattered through about 2 feet of gravel or confined mostly to the surface of the clay bed rock. The pay streak has a width of 25 to 75 feet, but outside of 25 feet is reported to be patchy. The coarsest piece found was worth $1.43 and the gold is valued at $17.35 an ounce. The common variety is composed of small flat pieces, all well worn. Mining is done by open cuts. In some places a few feet of the top gravel are stripped off, but generally all the material from surface to bed rock is shoveled in and the character of gravel and bed rock is such that 6 cubic yards a day per man can be handled.

The black sticky clay which forms the bed rock, after being cleared of the stream gravels, contains considerable gold which has settled into its surface or been trodden into it in the progress of the work, and experience has shown that the best way of saving this is to strip off a thin layer one-fourth inch or more thick, leave it in the sluice boxes over night with a small amount of water running over it, and in the morning stir it with a sluice fork. The loosened mass then easily yields up its gold. The boxes are set on a grade of 8 or 9 inches to the box. The lumber for mining purposes is brought from the lower canyon of the Tatlanika, a distance of 14 miles. Some mining was done during 1905 and half a dozen men were at work during 1906.

ROOSEVELT CREEK.

The lower part of the valley of Roosevelt Creek is rather open and is covered with a light growth of small spruce. The mining area is about 2½ miles above the mouth, where the valley is narrow. The bed rock is sticky clay and yellowish sand that belong to the coal-bearing formation. The stream gravels are similar to those of Grubstake Creek and are derived from the thick bed of gravels that caps the sands and clays. They are shallow and gold occurs in 1 to 1½ feet of gravel over a width of 20 to 60 feet. The gold is small, flat, and well worn, the coarsest piece found being worth about 45 cents. At the time the creek was visited there was insufficient water for sluicing. The gold has most probably been concentrated together with the stream gravels out of the thick gravel deposits in which the creek originates. A point to be emphasized is that the soft clays and sands which form the bed rock are just as truly bed rock to the stream gravels that overlie them and carry the gold as if they were hard rock. A thickness of several hundred feet of these unconsolidated deposits may overlie the hard bed rock and any attempt to sink through them to the solid formation would be not only a most difficult task, but, inasmuch as the only run of gold known overlies them, would be in all probability useless.

HEARST CREEK.

The conditions on Hearst Creek are similar to those on the other two streams. In the lower part of the valley the creek meanders deeply in a narrow canyon, exposing sections 100 feet thick of the unconsolidated light-colored, cross-bedded sands and fine gravels of the coal-bearing formation. These deposits in places have been benched and capped with stream gravels. The upper part of the valley is more open and the stream heads in the thick gravel beds that overlie the sands and clays. The only work that has been done is at a point about 2 miles above the mouth, where in 1905 a few thousand dollars were reported to have been mined. In 1906 this locality was being prospected.

GOLD KING CREEK.

Gold King Creek is about 8 miles east of the Tatlanika. The stream heads in hard bed rock and flows through a V-shaped valley sunk to a depth of 1,200 feet below the inclosing gravel ridges. Long, flat, tonguelike spurs extend from these ridges into the narrow stream flat. The grade is about 100 feet to the mile, and the quantity of water at the lowest stage is approximately three sluice heads. The bed rock at points where mining is in progress is clay. The gravels include the same varieties as are found on the other creeks, and the proportion of bowlders 3 feet or more in diameter is large. They lie scattered through the gravel and have acted as efficient riffles in retaining the gold. The thickness of the gravels that are being mined ranges from 4 to 8 feet. In some places gold is found in 4 to 5 feet of gravel; in others it is mostly near the clay bed rock. Generally about 2 feet of overburden are ground sluiced off and from $1\frac{1}{2}$ to 4 feet shoveled into the boxes. The gold is flat; there are many pieces over one-fourth inch in diameter, and the coarsest piece was worth $1.25. This gold is said to assay $17.82 per ounce. Some of the ground is reported to yield about $1\frac{1}{2}$ ounces to the shovel. All the work is done by open cuts, and the presence of so many bowlders retards the work. Shoveling in can begin in some seasons about the first of June. During the season of 1906, however, on account of the extent of glaciers in the creek work did not begin until June 20. The gold, like that of the other creeks, probably originates in the high gravels, and these are reported to carry prospects in many places far above the creek and even on the surface of the high, flat ridges. About a dozen men were working on the creek, and wages were $6 and board per day.

SUMMARY.

The creeks of the Bonnifield region may be divided into two classes—those that have, in a part of their valleys at least, cut into hard bed rock, and those that are still cutting their valleys entirely in unconsolidated deposits, including gravels, sands, clays, and coal beds. The greatest part of the gold has in all probability been derived from the thick gravels. The form of its occurrence in these thick deposits is unknown. It may be regularly distributed through them, it may be confined to some particular stratum in which it is spread broadly, or it may occur as a more or less clearly defined pay streak. The material of the gravels is all found in the ranges to the south. The gravels were deposited under conditions much different from those of the present time and are probably mixed in their upper part with some glacial material.

The only general test of the values that these gravels may contain thus far available is that afforded by the gold found in the gravels of

the present streams. Although fair pay has been found in places on some of the creeks, it would seem that if the high gravels carried noteworthy values the placers derived from them would be much richer than they have yet proved. All the work has been accomplished on a small scale under adverse conditions. Most of the mining is being done above the timber line. The work is hampered and in some places brought to a standstill by lack of water. The soft nature of the bed rock in some of the creeks means a tremendous amount of material that clogs the work and complicates the situation caused by lack of water. In general it may be said that the quantity of gold is not such as to overshadow the economic factors of water supply, character of bed rock, presence or absence of bowlders in the gravels, timber resources, and transportation, but that in every case these are the determining factors in the situation.

KANTISHNA PLACER REGION.

GENERAL DESCRIPTION.

The rich shallow diggings discovered in the Kantishna region in 1905 were found to be more local than at first supposed, and the results of 1906 were unequal to expectation. During the fall of 1905 there was much travel by steamer from Fairbanks. Passengers and freight were carried at $40 a piece and $50 a ton, respectively, and landed at Roosevelt, on McKinley River, or at Diamond, 60 miles above the mouth of the Bearpaw. The town of Glacier also was established 12 miles from Diamond, at the mouth of Glacier Creek, about midway between the steamer landing at Diamond and the placers of Glacier Creek. During the winter of 1905–6 there was much travel between all of these places and the creeks, and the winter trail from Fairbanks up Cantwell River to the road house at the crossing and thence overland was also used extensively. The month of February found many already on the back trail. During the summer of 1906 the town of Roosevelt, situated as it was remote from the creeks across an 18-mile stretch of swampy tundra, became practically deserted, and in the fall the many empty cabins of Glacier and Diamond testified with depressing emphasis to the decadence from the activities of the previous year.

The Kantishna placers, about 30 miles directly north of Mount McKinley, are in an outlying ridge somewhat apart from the main range and separated from it by high bare hills, which form the foreground to this portion of the range. This ridge trends northeast and southwest, and its most prominent summits have altitudes of 4,000 to 4,700 feet. To the southwest it abuts against the foothills; to the northwest it descends abruptly to the level of long, flat slopes that extend for miles from the base of the hills into the extensive flats of the Kantishna Valley.

The slopes are deeply furrowed by narrow V-shaped valleys. The drainage on the south runs into Moose Creek, a stream that heads far back in the foreground of the mountains, flows close along the southern base of the ridge in a finely benched open valley, and finally cuts a canyon through the ridge to flow northward to the Bearpaw. The streams that drain the northern slopes have long lower valleys limited on either side by the edges of low tonguelike spurs.

The material of the ridge is for the most part a highly metamorphosed and closely folded quartzitic schist, with garnetiferous quartz-mica schist, carbonaceous schist, a small amount of interbedded crystalline limestone, and much greenstone, part of which at least is intrusive. This formation is like that at the canyon of Cantwell River, south of Healy Creek, and is the same in character as that of the Fairbanks region. The occurrence of gold also and the associated minerals are the same for the most part as in the Fairbanks region. The formation has in general a northeasterly strike. The foreground of the mountains to the east is formed of hornblende granite and granite porphyry and some dikes of granite porphyry occur in the schists. Small areas of the coal-bearing rock occur in the region and coal from a fork of Moose Creek is utilized to some extent for blacksmithing purposes. The extension of the schist area to the southwest has not been determined. Topographically it terminates apparently at McKinley River; to the northeast it is probably continuous with the schists of the Cantwell Canyon. The rocks of the Alaska Range to the east are in general black slates partly altered by contact metamorphism, greenstones, intrusive granitic rocks, and volcanics.

THE CREEKS.

The creeks head in open V-shaped areas formed by the convergence of two or more small tributaries. The lower parts of the valleys are narrow canyons. Where these join the main valleys benching becomes prominent and their deposits merge into the tremendous body of gravels that has been spread far and wide from the Alaska Range. This material is for the most part easily distinguishable from the schistose gravels of the creeks.

The creeks where mining has been done are located on both sides of the ridge. Named from east to west on the south side of the ridge, round the west end and eastward along the northern slope, they are as follows: Spruce, Glen, Eureka, Friday, Glacier, and Caribou.

SPRUCE CREEK.

Spruce Creek flows its last mile in the valley of Moose Creek. Above this part of its course for about 1½ miles the valley is narrowly V-shaped and then near the head becomes more open. The grade in the narrow

part is about 350 feet to the mile, and the amount of water carried at ordinary stages is about two sluice heads. The lower valley has a considerable growth of spruce in a narrow belt near the stream. The bed rock observed is predominantly quartzitic schist, with some carbonaceous and green schists. The only point where mining was being done is about 2½ miles upstream, above timber line and about 700 feet above the level of Moose Creek. The gravels at this point are about 3 feet thick and comprise quartzitic schists with a small proportion of green schist, carbonaceous schist, crystalline limestone, and vein quartz. Pay is found over a width of about 12 feet. The gold occurs mostly on bed rock and to a depth of 2 feet within it. Much of the gold is coarse, and the largest piece found was valued at $6.40. Some of it is rough and has quartz attached, and there is no reason to doubt its local origin. Three men were working at this locality. Their sluice boxes were made of lumber packed from Glen Creek and were set on a 10-inch grade.

GLEN CREEK.

Glen Creek is somewhat larger than Spruce Creek and is more deeply cut below the spurs that rise nearly 1,000 feet above it on either side. From the forks to the mouth, a distance of 3 miles, there is a grade of about 500 feet. The gravels are similar to those of Spruce Creek, being predominantly quartzitic schist, and where work is being done they range from a few inches to about 3 feet in thickness. In some places gold is found through 2 feet of gravel and at others it is all on or within bed rock. The width over which pay is found ranges from 30 to 150 feet and values have been reported of $20 to $100 to the box length, or approximately a maximum value of 65 cents to the square foot of bed rock, but their distribution is irregular. Much of the gold is coarse; several $8 to $10 nuggets have been found, and the largest piece discovered weighed over 3 ounces. A few garnets are found associated with the gold. At the time of visit most of the miners had left for the season, and it was reported that only about seven men would winter on the creek.

EUREKA CREEK.

Eureka Creek proved to be the best producer of the region. It is a small creek only about 5 miles long, flows southwestward in a deeply cut valley, and enters Moose Creek just below the point where the latter has turned northward through the ridge. The valley of Moose Creek at this point is a flat several hundred feet wide, and the creek itself, a powerful stream, swings round to the east and is cutting laterally into the bed rock just at the point where Eureka Creek enters. The valley of Eureka Creek has a grade of about 235 feet to the mile, and the smallest quantity of water flowing during the season of 1906

was reported to be two sluice heads. The bed rock is principally quartzitic schist, with some associated carbonaceous schist and greenstones. Small basaltic dikes were observed in a few places cutting the schists. Throughout most of the valley the stream gravels are composed of material derived from the bed rock, but in the lower part of the creek these rather fine subangular schist gravels become mixed with material derived from the heavy Moose Creek wash that rests on a bench over 150 feet vertically above Eureka Creek. In the process of downward cutting through which the drainage system has passed these bench gravels, comprising bowlders of granodiorite, greenstone, hard conglomerate containing chert pebbles, and metamorphic slates, all of these being materials mostly unlike those characteristic of the Eureka Valley, but entirely similar to those of the Alaska Range, have become intimately mingled with the local deposits.

Mining has been confined for the most part to 2 miles of the valley immediately above the mouth. The thickness of the deposits that are being worked ranges from 1 to 5 feet and the width is in most places that of the stream gravels, which is rarely more than 100 feet and in some places less than 20 feet. The gold is mostly on bed rock or within it to depths of 1 to 3 feet, but all the gravel from surface to bed rock is generally shoveled into the boxes. The richest ground was in the first half mile above the mouth, where many nuggets were found, the two largest of which were worth $186 and $678. Nuggets were not confined to this part of the creek, however, and some worth as high as $40 have been found 2 miles above the mouth. The nuggety gold is generally of a lighter color than the finer grade. The gold found in the upper part of the valley is mostly rough and gritty. Average assay values were reported ranging from $15 to $16 per ounce. The proportion of black sand accompanying the gold is small. Here and there pieces of stibnite occur in the gravels, and these have been derived, probably, like similar occurrences on Caribou Creek, from veins in the schists. The association in this respect is similar to that of the Fairbanks region.

The reason for the richness of the gravels near the mouth has often been a subject of inquiry and it might be supposed that a part of the gold at least was derived from the heavy Moose Creek bench gravels through which Eureka Creek has cut. So far as could be learned, however, these bench gravels are not known to carry payable values, and the explanation is rather to be found in the riffle efficiency of large bowlders in retaining gold that would otherwise be carried out from the smaller valley along with the finer wash. A decrease of grade of the smaller stream near the mouth may also be a factor.

All the gravels are worked by the open-cut method. Boxes are given grades ranging from 7 to 9 inches per box. There is but little

sediment in the gravels and no dump boxes were employed. The flats of Moose Creek opposite the mouth of Eureka Creek are covered with a light growth of small spruce and a few small spruce dot the steep slopes of the lower Eureka Valley, but lumber for mining purposes has to be brought from points 6 miles down the Moose Creek valley.

Gold was discovered on Eureka Creek in July, 1905. The richness of the gravels justified to a great degree the stampede that followed. The richest ground that has been discovered was mostly exhausted during July and August, 1906, when there were 50 or more miners on the creek. Wages during the busiest time of the season, when shifts were working night and day, were $1.25 per hour, paid in gold dust valued at $16 per ounce. There was a settlement of considerable size at that time on the flat of Moose Creek just above the mouth of Eureka Creek. A restaurant was in operation with rates for board alone of $4.50 per day, and there were small stores where supplies of various kinds were obtainable. About a dozen men were working in August, 1906. Various estimates of the output were reported, ranging from $150,000 to $160,000.

A small amount of work was done during the summer in the canyon of Moose Creek, about 5 miles below Eureka Creek, and some pay was reported.

FRIDAY CREEK.

Friday Creek is 2½ miles long and carries at the lowest stage about half a sluice head of water. The valley is cut to a depth of 1,500 feet below the inclosing ridges. The upper part where small streams unite is somewhat openly V-shaped; the lower part is very narrow and has a grade of over 400 feet to the mile.

Mining is confined to about a mile of the creek above the point where it emerges into the valley of Moose Creek. The bed rock includes quartzite schist, carbonaceous schist, greenstone, crystalline limestone, and dikes of granite porphyry. The gravels are formed mostly of these materials and are from 3 to 6 feet thick. Gold is found in 1½ to 2 feet of gravel and about the same thickness of bed rock. The gravels are in some places limited to the narrow space of 12 feet between the bed-rock walls; in others they reach 100 feet in width. Both nuggets and fine gold are found. The nuggets range in value up to $29. Many of them contain much quartz and are very rough, and some are rudely crystallized. Scattered pieces of galena several inches in diameter are found in the stream gravels, and one of these was assayed for the Survey and found to carry 184.76 ounces of silver and 0.20 ounce of gold to the ton. Only six men were working on the creek.

GLACIER CREEK.

It is about 8 miles round the base of the hills from Friday Creek to Glacier Creek. The latter is a larger stream than the other creeks that have been described, heads against them, and after emerging from its deep V-shaped canyon flows for several miles between broad, level-topped ridges before it joins the Bearpaw. Cabins were built at intervals along the entire length of the creek during the winter of 1905–6, but the area that up to the present time has proved most productive is a section of the valley about a mile long where the creek emerges from the hills into the area of long gravel-covered ridges. Near the end of the season of 1906 it was reported that pay was being found also on Yellow Creek, a small tributary near the head.

Glacier Creek, although considerably smaller than Moose Creek, is a powerful stream, and there has been no lack of water for mining purposes. The grade of the valley in the part that is being worked is approximately 130 feet to the mile. The bed rock observed comprised quartzite schists, greenstone schists, and garnetiferous mica schists, with abundant quartz seams and lenses. The gravels are coarse and the proportion of bowlders is large. The thickness of the deposits in the working area ranges from 2 to 5 feet, and the width in places is 250 feet. The gold is mostly on bed rock. The creek meanders sharply at its point of emergence from the hills, and the best pay is reported to have been found just above the points of the meanders. Values have been found ranging from $75 to $200 to the box length, and the gold is reported to be worth $16.40 per ounce. Many nuggets have been found, and the largest was valued at $365.

At the point where the stream leaves the hills there is a bench about 75 feet above the creek, capped by 3 to 5 feet of gravel underlying 6 to 8 feet of muck. Gold occurs in about 18 inches of the gravel and is yellower and flatter than the creek gold. Several areas of the bench gravels were reported to prospect, but insufficient work had been done to determine their values definitely. All the work was done by open cuts, and some of the lumber for sluice boxes was packed distances of 12 to 14 miles from Moose Creek. In the fall of 1906 there were approximately twenty men on the creek.

CARIBOU CREEK.

Caribou Creek is somewhat larger than Glacier Creek, but in other respects the conditions are similar. There is the same variety of bed rock and deposits, but up to the present time no well-developed pay streak has been found. In the early part of the season considerable work was done on Crevice Creek, a small tributary near the head. The gold was found to be rough and coarse, the largest piece being valued at $90. At the time Caribou Creek was visited by the Survey party but few men were working.

Stibnite (antimony sulphide) occurs in the wash of Caribou Creek, and a ledge containing this mineral has been located a short distance above the point where the creek emerges from the hills into the benched area of the lower valley. The creek forks at this locality, and on the southern fork, which has been named Last Chance, the ledge is exposed. The vein is about 4 feet thick, and the vein matter includes essentially quartz and stibnite. The quartz is partly massive and partly in the form of small crystals up to an inch in length. The antimony sulphide is in part a crystalline mass embedded in the spaces between the quartz crystals and in part a bluish-black, very fine-grained massive variety. The ledge strikes northeastward and dips 75° N. The country rock is hornblende schist, to the structure of which the vein conforms. A short distance upstream the hornblende schist is structurally conformable to the quartzitic schist. A small amount of work was being done here in the hope that the ledge material would be found to carry values. Of three specimens from this locality assayed for the Survey two contained silver at the rate of 4 and 2.76 ounces to the ton and the latter carried in addition 0.12 ounce of gold to the ton; the third specimen contained 0.12 ounce of gold, but no silver. Too little work had been done to give definite information regarding the proportion of the antimony sulphide in the vein, but pieces of nearly solid ore up to a foot in diameter were obtainable.

SUMMARY.

The Kantishna placers are in an area of crystalline schists. The gold-producing creeks head near each other. The bed rock of all the creeks comprises practically the same kinds of rock and the gravels are shallow. The bulk of the gold in every case has in all probability been derived from the valley in which it is found. The occurrence is not confined to any particular section of the valleys, but is such as to suggest a derivation from different points along them. The manner of its occurrence in the bed rock is indicated by the many pieces found in most intimate association with quartz, by a small flat nugget one-tenth of an inch thick attached to garnetiferous mica schist, and by the occurrence of silver- and gold-bearing galena and stibnite in the gravels of several creeks. Pieces of these sulphide ores a foot or more in diameter were observed in the gravels, and the fact that in one case high values in silver with some associated gold were carried by this material lends not only a qualitative interest to this occurrence but a quantitative one as well. The vein of stibnite on Caribou Creek, although carrying in the material tested no high values in silver or gold, illustrates the form of occurrence, and its interest is enhanced from the fact that the metal antimony, which forms about 70 per cent of the mineral stibnite, is at present (1907)

in considerable demand. Regarding the question whether there is sufficient high-grade silver ore or stibnite to pay for working, nothing definite can be said. It is probable that both the lead and antimony sulphides and the small amount of iron pyrites associated with them occur as small veins scattered through the schists. Although both stibnite and galena resemble each other to some extent, the former has often been determined by miners through its character of fusing readily in the candle flame. The coarser varieties can also be distinguished from galena by their lighter color and somewhat fibrous texture. The coarser varieties of galena break into little cubes.

There is a great resemblance between the Kantishna and Fairbanks regions. The geologic environment and mineral associations are practically the same. The essential difference is apparently one of physiographic development. The Kantishna region is in a youthful stage. The valleys are narrow and have steep grades, and their deposits are consequently shallow and have undergone less shifting with the accompanying gravitative differentiation of the heavy constituents to the vicinity of bed rock.

The bulk of the production has come from Eureka Creek and most of the remainder from Glacier Creek. The conditions on Eureka Creek probably find an explanation in the fact that the heavy foreign wash derived from the bench near the mouth, working in combination with a decrease in grade, checked to a greater or less extent the removal of the gold that was being brought down the valley of Eureka Creek while the canyon was being cut, and thus brought about an enrichment at this particular point. There is the possibility, too, that the bench gravels contributed a part of the gold. It is noteworthy in this connection that the richest ground on Glacier Creek is at the point where the valley emerges from the hills into the benched area that surrounds their base.

There was no lack of water during the summer of 1906, but in a dry season the small creeks would shrink below the economic limit. The timber resources in the vicinity of the hills are scanty. There is some fair timber along parts of the valley of Moose Creek and this increases in quantity toward the mouth, but in general the localities where mining is done are above the limits of good timber, and lumber has to be packed for several miles. The town sites of Glacier and Diamond were well timbered, and the valleys of the Bearpaw and Kantishna contain many small areas of fine spruce.

Steamer transportation during the summer of 1906 was very irregular, and the accessibility of the placers to the points where it is possible to land supplies from steamers is rendered difficult on account of swampy areas that in places well-nigh block the approaches to the hills. Up to the present time but little attempt has been made

to construct summer trails, as most of the transportation between the creeks and the local supply points has been done in winter.

The auriferous gravels thus far discovered are adapted only for summer work when sluicing can be done from about the 1st of June to the early part of September, and the rich ground first discovered has been largely worked out. There is some ground still remaining that contains fair pay, and about 50 men intended to remain during the winter of 1906–7 to prospect.

COAL DEPOSITS.

GENERAL DESCRIPTION.

Deposits containing lignite coal have a wide distribution in the northern foothills of the Alaska Range, but the only section to be considered here is that extending east from Cantwell River to Wood River, a distance of about 50 miles, and northward to the flats. The low spaces within this area between the east-west ridges of old metamorphic rocks are occupied by these deposits. They are for the most part but slightly consolidated, and have been so deeply incised by the drainage systems that in places nearly complete sections are exposed. That the present areas are only a part of masses formerly much larger in extent is shown by small isolated patches of these deposits that lie slantingly on the upper slopes of ridges and by well-worn pebbles derived from them that lie scattered on the tops of the highest ridges, 1,500 to 2,000 feet above the occurrences of the valleys. These deposits have been folded, the flexures being for the most part broadly open, with dips of 30° to 35°, but locally closer, with resultant vertical dips attended in places by consolidation of the gravel beds to conglomerate; in addition, here and there parts of the deposits have been faulted.

The material comprises alternating beds of sands, clays, coal, and gravels that are divisible into three parts—an underlying white deposit composed of angular and some well-worn, subangular, fine quartz gravels, with a large admixture of kaolinic material where the bed rock is feldspathic, an intermediate member of yellowish cross-bedded sands and fine well-worn gravels, dark plastic clays, and coal beds, and an upper member composed almost entirely of gravels. The feldspathic schists produce by weathering a large amount of white clay and the quartz veins which in places in these rocks are very numerous furnish abundant quartz material, and these characteristics of the old bed rock have gone over into the basal members of the sediments. The transition from the decomposed products of the schists that still retain their structural position to the same materials in the overlying deposits is in some places strikingly exhibited. The

thickness of these underlying deposits was not determined, but one section was observed in which 100 feet of them was exposed. The sands and clays of the intermediate member are naturally less conspicuous than the underlying beds, but have in many places become indurated by the burning of the coal beds and baked to a conspicuous red color. The overlying gravels at the localities where their relations to the underlying deposits were observed, whether in horizontal or tilted strata, were found to be structurally conformable. They are characterized by a yellow color. They include both fine and coarse material, are well worn and well rounded, and the predominant constituents are white quartz and chert of various colors, principally black. There is a considerable proportion of metamorphic rocks and many pebbles of compact chert conglomerate. In the upper part of the gravels, in strong contrast with their medium- to fine-grained material, are locally many bowlders of granitic rocks and diabase and a few well-rounded bowlders of dense chert and quartzite conglomerates. The greatest observed thickness of these deposits was approximately 3,500 feet. The upper gravels constitute about half of the entire deposit.

Fossil leaves are observable nearly everywhere in the beds associated with the coal, but except where these beds have been baked by the burning of the coal the fossils are poorly preserved. The age of the coal-bearing member has been determined as Kenai. The age of the gravels has not been determined, nor is it definitely known that they are chronologically conformable with the underlying deposits, but they have been folded at every point where folding was observed, along with the underlying deposits. Where valleys have been extensively developed in these deposits bench gravels have in many places been laid down on the truncated edges of the older deposits, and where these older beds are horizontal the bench gravels are in apparent conformity with them, obscuring the relationship. It is probable that deposits of various ages since the Kenai, formed under varied conditions of sedimentation, occur in this area and that the coarse material in the uppermost part of the gravels owes its origin to glaciation.

Parts of the gravel members of these deposits are auriferous and have supplied the gold for the Bonnifield region. There is a marked resemblance between these coal-bearing deposits, with their thick beds of overlying gravels, and the Kenai beds of the Seventymile Creek area near Eagle, with their coal-bearing deposits and thick beds of conglomerate formed largely of the same kinds of material. These latter beds also, as was observed by Brooks in the Woodchopper Creek area during 1906, are auriferous.

LOCAL OCCURRENCES.

The most prominent exposures of coal are on Healy Creek and Lignite or Hosanna Creek. These localities have been described by Brooks.[a] In 1906 a large part of the coal-bearing area on Healy Creek had been staked as coal claims.

Healy and Lignite creeks are about 5 miles apart. The valley of Healy Creek near its junction with the Cantwell is limited on the south by a high schist ridge. A similar ridge separates the valleys of Healy and Lignite creeks, but the schist part of this ridge terminates about 3 miles from the Cantwell and its continuation is composed of the thick body of gravels with the underlying coal deposits, which along the Cantwell becomes continuous with the deposits of Lignite Creek.

HEALY CREEK.

The deposits extend about 10 miles up Healy Creek, in places running parallel with the creek and in places crossing it. In the lower part of the valley they dip north from the schists, on which they rest unconformably, at angles ranging from 25° to 35°. Toward the upper limit of the deposit folding has been closer and there are vertical dips. The stream flat of Healy Creek is about 500 feet wide, and in parts of the valley coal beds form the banks for distances of a quarter of a mile or more close to the water. The thickness of these deposits from their base to the under surface of the overlying gravels, which are approximately 2,000 feet thick, is about 1,500 feet and the coal beds aggregate about 230 feet. The nature of the deposits and the relation to them of the coals are shown in the accompanying section of the deposits at a point about 2 miles above the mouth of the stream. The coal thicknesses were measured with the tape; the thicknesses of the intervening beds are in part only approximate. This section probably does not give the total thickness of coal, because some beds in almost every section have been destroyed by fire. In this section seven beds were observed 20 feet or more thick, aggregating 175 feet, and sixteen thin beds higher in the deposit aggregating 55 feet. The lower beds are of better quality than the upper ones, which are shaly and contain much woody material. While the thick seams contain some interbedded foreign material, the proportion is apparently small. The following analysis was made in the laboratory of the Geological Survey and is taken from Brooks's report, already cited:

[a] Brooks, A. H., note Collier, A. J., Coal resources of the Yukon, Alaska: Bull. U. S. Geol. Survey No. 218, 1903, pp. 44-46.

Analysis of coal from Healy Creek.

Moisture	13.02
Volatile matter	48.81
Fixed carbon	32.40
Ash	5.77
	100.00
Sulphur	.16

Section on Healy Creek 2 miles above mouth.

	Feet.
Overlying sands, clays, and gravels	2,500
Coal	14
Sands.	
Coal	7
Sands.	
Coal (shaly)	2
Sands.	
Coal	8
Sands and clays with two thin beds of coal	75
Coal	5
Sands.	
Coal	20
Sands	100
Coal	25
Sands	100
Coal	24½
Sands and clays	50
Coal	40
Sands and clays.	
Coal (two beds)	3
White sands and gravels	75
Brown earthy shales	60
Coal	21
Covered	50
Coal	5
Dark shales and red sandstone formed by burning of the coal	10
Reddish sands with fine white gravel	20
Coal	6
Covered	100
Coal	10
Fine sandstone, white sand, and clay	15
Coal	2
Clay and nodules of sandstone	12
Alternating beds of sand and gravel	30
Clay, sand, and sandstone	15
Well-rounded gravel mixed with sand and clay	20
Clay and sand	4
Well-rounded fine wash of quartz and chert	100

Total coal, 230 feet.

LIGNITE CREEK.

In the valley of Lignite Creek, where the space between the hard-rock ridges is wider than in Healy Valley, these deposits extend from the schist ridge that limits the valley on the south to the base of Jumbo Dome, a distance of about 3 miles, and eastward till limited by the schist ridge at the head of the creek. They have been cut to depths of 1,000 feet or more by the many tributaries of Lignite Creek, which have steep grades and form where crossing the resistant coal beds waterfalls up to about 30 feet in height. These narrow cuts are clogged with masses of material from the sandy beds that break away in great blocks from the steep bluff above to form sand heaps at the bottom, and contain blocks of coal 20 feet or more in diameter.

The following sections were observed. The first is at a point about 6 miles above the mouth; the other section is about 3 miles farther upstream, near the headwaters and near the eastern limit of the occurrence.

Section on Lignite Creek 6 miles above mouth.

	Feet.
Overlying gravel.	
Thin beds coal alternating with sands and clays	250
Coal	18
Sand	10
Coal	1
Clayey sand	10
Sand, cross-bedded	100
Coal	15
Sands	100
Coal	8
Sand	75
Coal	32
Sandy clay	40
Coal	10
Sand	12
Coal	20
Sand, clay, and small amount of fine subangular quartz gravel	25
Coal (only the top of a bed exposed).	

Total coal, 129 feet.

Section near head of Lignite Creek.

	Feet.
Overlying gravel.	
Coal (shaly)	8
Sandy clays	50
Coal	6
Clay	10
Coal	12
Sands.	
Coal	1
Gray sand and gravel, clayey toward top	40
Coal	1½
Friable clays	10

	Feet.
Clean sand	20
Coal	1
Sandy clays	2
Cross-bedded gray sands and fine gravels	50
Ferruginous sandstone	2
Coal	6
Thin-bedded sands	100
Coal	10
Sticky clay	25

Total coal, 45 feet.

The valleys of these two creeks contain a large amount of coal. The conditions for transportation in the absence of a railroad are bad. The Cantwell is an unnavigable stream and the locality is about 50 miles south of the Tanana. It would seem that if the developments in the Fairbanks region should justify it the energy of these coals might best be transported in the form of electricity. The distance across country to Fairbanks, about 75 miles, is well within the practicable limits of such an undertaking.

OTHER AREAS.

In the area to the east wherever these deposits are cut to a sufficient depth the coal-bearing beds are exposed. They occur on Coal Creek, a small tributary of Totatlanika Creek, where they are used to a slight extent by the miners, and on Mystic Creek, about 2 miles from Wood River, where two beds 20 feet and 12 feet thick were exposed in a section 80 feet high. They are reported to occur also east of Wood River. There are approximately 600 square miles of these younger deposits between Cantwell and Wood rivers. To what extent they are underlain by coal has of course not been determined. The coal-bearing beds, too, probably vary greatly in number and thickness and furthermore have been in many places burned. The continuations of the coal beds of Healy Creek outcrop on the west side of Cantwell River, and it is very probable that there is considerable coal between Cantwell and Toklat rivers. Coal occurs farther to the southwest in local disconnected areas, and in the Kantishna region is used to a small extent.

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