

# THE KOUGAROK REGION.

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## INTRODUCTION.

"Kougarok district" is the name<sup>a</sup> generally given to an auriferous gravel region lying in the central part of Seward Peninsula and drained, for the most part, by Kougarok River. This paper will describe, besides the drainage basin of the Kougarok, the other gold-bearing streams tributary to Kuzitrin River. Investigations were begun in this field in 1900 by the writer,<sup>b</sup> assisted by A. J. Collier, soon after the first actual discovery of workable placers, and were extended by Mr. Collier<sup>c</sup> in the following year. In 1903 the district was reexamined by Messrs. Collier and Hess, who prepared a statement for a report not yet in print.<sup>d</sup> The writer was again in this field in 1906, spending about ten days in visiting some of the more important localities. The notes of Messrs. Collier and Hess have been freely drawn upon, but for the conclusions here advanced the writer is alone responsible. All of the surveys thus far made have been preliminary, and the data obtained leave much to be desired, both as to the details of the geology and the distribution of the placer gold.

## TOPOGRAPHY.

The northwestern front of the Bendeleben Mountains slopes off to a lowland basin, 20 miles long and 10 miles wide. On the southwest the basin walls gradually approach each other and finally constrict the valley to a width of about 3 miles, but 10 miles below it opens out again to the low ground encircling the east end of Imuruk Basin, or Salt Lake, as it is popularly called. The north wall of the lowland basin slopes up gently to an upland, whose flat summits stand at altitudes of 800 to 1,600 feet. Here broad, flat-topped interstream areas, diversified by some higher domes reaching altitudes of 2,500 feet, are separated by wide valleys. As elsewhere in the peninsula, the upland summits mark a former stage of erosion. After the entire

<sup>a</sup> The "Kougarok precinct" includes the entire drainage basin of Kuzitrin and Kruzgamepa rivers.

<sup>b</sup> Brooks, A. H., assisted by G. B. Richardson and A. J. Collier: A reconnaissance of the Cape Nome and adjacent gold fields of Seward Peninsula (in Reconnaissances in the Cape Nome and Norton Bay region, Alaska, in 1900, a special publication of the U. S. Geol. Survey, 1901).

<sup>c</sup> Collier, A. J., A reconnaissance of the northwestern portion of Seward Peninsula: Prof. Paper U. S. Geol. Survey No. 2, 1902.

<sup>d</sup> Collier, A. J., Hess, F. L., and Brooks, A. H., The gold placers of a part of Seward Peninsula (in preparation).

region was planated, uplift formed a plateau, which is deeply dissected by the present watercourses.

Kuzitrin River carries the drainage of the district southwestward to Imuruk Basin, a tidal inlet connected with the sea at Port Clarence.

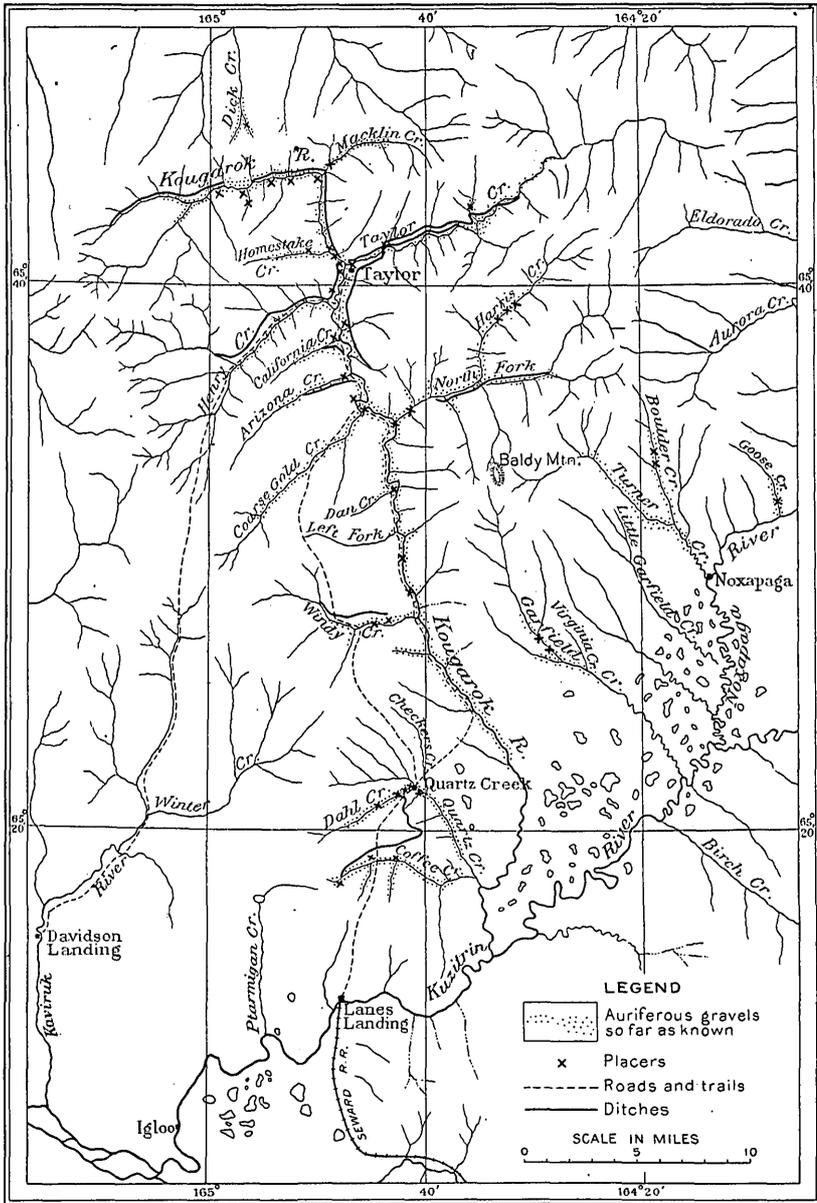


FIG. 9.—Sketch map of Kougarok region.

This river meanders with sluggish current across the lowland basin already described, receiving numerous large tributaries from the

north, the longest being Noxapaga and Kougarok rivers and Garfield Creek. (See fig. 9.) A number of smaller streams heading in the Bendeleben Mountains are confluent from the south, but these are outside of the province here discussed. The northern tributaries find their sources in the upland region, through which they meander in valleys which have tortuous courses and whose walls are in many places broken by well-defined benches, many of them covered with gravel. Though the topographic features described show no great variety in character of the relief, there is abundant evidence that the physiographic history of the region was far more complex than this simple analysis would indicate. There were no doubt at least two and probably more epochs of planation. Moreover, the benches along the valley walls bear evidence that the uplift which brought about the incision of the present valleys was intermittent.

As elsewhere in the peninsula, the dominant vegetation is moss. Timber is entirely absent, but thick growths of alder and willow are found along the watercourses. Grass, though not abundant, occurs in favored localities along the valley floors. The hill slopes are usually moss covered, with here and there some grass. Only on the highest summits and in sharply cut valleys is bed rock exposed, a feature of the region which makes it exceedingly difficult to decipher its geology.

#### GEOLOGY.

The stratigraphic units described in the reports referred to—the Kigluaik and the Nome series, including a subordinate member of the latter, known as the Port Clarence limestone—are represented in the Kougarok region. The limestone, schists, and granites of the Kigluaik series go to make up the Bendeleben Mountains, which stretch along the southern margin of the field here described. So far as known, these rocks have not been found to be gold bearing and need no further mention here.

This older series is separated by a broad belt of alluvium, flooring the Kuzitrin Valley, from the schists and limestones of the Nome series, which form the country rock of the uplands and are also the source of the placer gold. Here the Nome series is clearly divisible into two groups—(1) limestone and (2) a succession of graphitic phyllites and mica and greenstone schists, with some beds of semi-crystalline limestone. The schist series is closely folded and faulted, and its stratigraphic relation to the massive limestone has not been definitely established. Collier's interpretation of the known facts leads him to the opinion that the limestone is the younger formation, while, on the other hand, the writer is inclined to the belief that the schists overlie the limestone. The latter view finds support in the

fact that Moffit,<sup>a</sup> in the adjacent region to the northeast, found a schist series resting on a massive limestone formation.

Be the stratigraphic relations what they may, the fact of the occurrence of two series, one essentially schistose and the other a massive limestone, is well established. The limestone occurs in one area with oval outline lying between Kougarok and Noxapaga rivers, and in another of more irregular contour between Kougarok and American rivers. Between these two limestone belts lie the schists, which here exhibit great irregularity of dip, being closely folded and faulted.

Besides the sediments above described, several types of igneous rocks occur in this region or immediately adjacent to it. Greenstone schists, which are probably altered intrusives, occur with the schistose rocks. Dioritic rocks, some of them massive, others more or less schistose, are not uncommon among the schists as dikes and small stocks. A large stock of granite occurs a few miles northeast of the Kougarok-Arctic divide. There is a noteworthy hot spring near the margin of this granite mass. In the upper Kuzitrin Valley a large area is occupied by a basalt lava stream of recent age.

As in the other placer districts of the peninsula, the schistose rocks appear to be the source of the placer gold. Quartz seams and small veins are common in the schists and many of them are iron stained. Reports from prospectors indicate that some of these veins carry gold, but, so far as known to the writer, no lodes of commercial value have yet been found. It is said that a copper-bearing lode has been found in this district.

There appears to have been two generations of quartz intrusives. The earlier of these was injected previous to the extensive deformation of the schists, for its veins are crushed and sheared. The later intrusion, which cuts the first system of veins and is comparatively little deformed, appears to be more commonly mineralized than the first. The presence of the recent granite intrusion at a near-by locality suggests a genetic relation between the second generation of quartz and the granite, but of this there is no proof.

This district lends additional support to the view elsewhere set forth (pp. 25, 130-132), that the locus of mineralization lies at or near the contact between the schists and the limestones. There appears to be a close correspondence between the limestone and schist contacts and the distribution of the placer gold, so far as determined.

The alluvial deposits fall into three groups—(1) stream and river gravels; (2) the gravels, sands, and clays which floor the basin lowlands; and (3) bench sands and gravels. Glaciation has taken place in the Bendeleben Mountains, but there is no evidence that these ice masses ever crossed the Kuzitrin Valley to the upland on the north.

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<sup>a</sup> Moffit, F. H., *The Fairhaven gold placers*: Bull. U. S. Geol. Survey No. 247, 1905.

It is quite possible, however, that the basin of the Kuzitrin may have been in part covered by glacial ice at one time.

The stream and river gravels, which constitute the best-known type, vary in character according to their place of occurrence. The developed placers are nearly all in the stream and river gravels. So far as known they carry, as a rule, only material derived from the basins in which they are found. Much of the material is well rounded, but that of the pay streaks in the placers is in many places subangular. Quartz usually dominates as a constituent of the pebbles. In some streams, such as Kuzitrin River, the gravel bars are made up of iron-stained quartz, almost to the exclusion of all other material. Sands and some clay occur interbedded with the stream gravels, forming, however, but a small percentage of the bulk of the alluvium. In all the smaller streams and in parts of the larger ones a bed of clay or sandy clay, in which more or less vegetable matter is intermingled, forms the top-most layer. This surface bed, which varies in thickness from 2 to 30 feet and is called by the miners "tundra," appears to be a subaerial accumulation, due in part to the decay of vegetable matter and in part to the deposition of silts during the rainy season. Though sometimes explained as a lake deposit by the miners, its distribution and character seem to preclude lacustrine origin.

The gravels, sands, and clays of the basin lowlands, forming the second type of alluvium, are known only where exposed by river erosion. At such places they consist of material identical in every way with that of the first group except that the material is somewhat finer. Some fragmentary evidence furnished by drill records goes to indicate that much of the basin is filled by clay deposits whose genesis can probably be best explained by lacustrine action. The determination of the outline of this old lake and of the cause of its formation must await further investigation. It is worthy of mention, however, that the surface deposits of gravel and sand in the Kuzitrin basin probably as a rule do not exceed 20 or 30 feet in depth. This, however, applies only to the basin, for in the constricted part of the valley the gravel deposits probably have a much greater depth.

Bench gravels are of common occurrence in the district. The best known are those along the main Kougarok between Taylor and Windy creeks, and these have proved to be auriferous. Similar deposits occur on the upper Kougarok, but have been little prospected. These bench gravels are of the same character as the alluvium of the present streams. The sands and gravels which form the extensive bench at the mouth of Quartz Creek and continuing up that stream to Dahl Creek are described on page 173.

Another type of surficial deposit that deserves mention is the ground ice, which here occurs more extensively than in the Nome region. Along the southern slopes of the valleys it forms in many places almost

continuous beds for several miles. It varies in consistency from a frozen mud to almost pure ice. Fragments of beaver-gnawed wood have been found in this ice at a number of places. The ice beds usually slope with the valley wall, and some of them extend up the hillside to a height of 100 feet above the stream. This ice can probably best be explained by the accumulation and subsequent solidification of winter snow, which has become buried by the talus and alluvium. The thick coat of moss, once established, effectually prevents the thawing of the ice. Ground ice is a perpetual source of trouble and expense to the ditch builders.

#### DEVELOPMENT.

This district was probably visited by prospectors as early as the summer of 1899, though claims were first staked during the winter of 1899-1900, and it is unlikely that any actual discovery of gold was made until the following summer. A rush from Nome to the new field took place in March, 1900, and another in July of the same year. Harris Creek appears to have been the scene of the first claim staking in March, and in July gold was found on Quartz and Garfield creeks. In August and September considerable gold was taken out of the shallow placers of these two creeks. In the meantime gold had been found on the main Kougarok and many of its tributaries, but no claims were opened up. In 1901 there was a decrease in the gold output, for the shallow diggings were rapidly exhausted and no very rich gold had been found on other creeks. The remoteness of this field from transportation discouraged prospectors except those with good financial backing. There were no bonanzas to give an impetus to mining. Probably the most important discoveries were those of Kougarok River, but these could be exploited by the individual miners only during low stages of the water, and sudden freshets often destroyed the work of weeks of preparation. Thus the mining interests in the Kougarok district may be said to have lain dormant for several years, though some gold was produced every year, chiefly on Dahl Creek. With the successful construction of ditches at Nome came a renewed interest in this outlying placer field. In 1903 T. T. Lane constructed a ditch from the head of Coffee Creek to a bench at the mouth of Dahl Creek, and this was the first long ditch in the district. In the following years many more ditches were planned and surveyed. In 1905 and 1906 ditch construction went on with feverish activity, and by the end of last summer upward of a hundred miles of ditch were planned, about half being completed. The larger ditches can be enumerated as follows:

The North Star ditch extends from Arctic Creek, on the east side of the Kougarok, to the mouth of Taylor Creek and up that stream about 10 miles, with a total length of 15.2 miles. The Cascade ditch takes

water from Taylor Creek, about 6 miles up, and discharges at the mouth of the creek. Both these ditches were completed in 1906. The Kougarok Mining and Ditch Company had one ditch in operation in 1906 and two more partly constructed. Of these the Homestake ditch, which heads on the Kougarok  $3\frac{1}{2}$  miles above Macklin Creek and discharges at the mouth of Homestake Creek, with a head of 172 feet, was completed in 1905. Work has been begun on the Altoona ditch, which heads  $1\frac{1}{4}$  miles above the mouth of Washington Creek. A third ditch has been located, to be built up Macklin Creek, taking water from Schlitz and Reindeer creeks north of the Arctic divide. T. T. Lane has completed a ditch from Henry Creek, discharging at Homestake Creek. All the above-mentioned ditches discharge within a few miles of one another on Kougarok River and represent an aggregate outlay that hardly seems warranted by the developments in placer mining.

The Irving Mining Company has constructed a ditch from Washington Creek along the north slope of the Kougarok Valley nearly to the mouth of Mascot Creek. Another ditch that has been built on North Fork by the Northwestern Mining Company heads at the junction of Alder and French creeks and is to be built to the Kougarok, about 7 miles being completed in 1906. The Lane ditch, from Coffee Creek to the mouth of Dahl Creek, has already been mentioned. Smaller ditches have been built or surveyed at various places, including Arizona, California, Coarse Gold, and Windy creeks. Besides these, there are many other schemes for ditch building which have not gone far enough to deserve individual mention.

The summer of 1906, being abnormally dry, was especially favorable for ditch construction, but worked havoc with those who were prepared to sluice. It is perhaps well, however, that the managers of the large companies should know what they may expect and be able to include an allowance for a dry season in their estimate of cost. The records show that in the last seven years there have been two notably dry summers (1900 and 1906) and that therefore the last season is not by any means as abnormal as some promoters would try to make the public believe.

Up to 1906 the Kougarok district could be reached from Nome only by an overland journey of about 100 miles or by a very circuitous water route via Teller, Imuruk Basin, and Kuzitrin River. From Lanes Landing, at the head of scow navigation on the Kuzitrin, freighting by wagon to the creeks cost from 6 to 15 cents a pound, the winter rates being much lower. J. M. Davidson and Andrew J. Stone, who are among the largest operators in the district, have established a transshipping point on Kaviruk River,<sup>a</sup> called Davidson Landing, and built a road from this place to the upper Kougarok region, a distance of 40 miles. Small lighters can be towed directly from the

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<sup>a</sup>Called locally Marys River.

ship's side at Port Clarence to Davidson Landing, so that at least one handling of freight is avoided.

In 1906 the Seward Peninsula Railway was extended northward to the head of Nome River and then down the Kruzgamepa to Lanes Landing. Surveys have been made looking to a further extension of this line up the Kougarok Valley. This railway will bring the district into close touch with Nome and will do much to accelerate its development. The recording office now at Igloo, 7 miles below Lanes Landing, will in all probability be moved to a more accessible point on the railway.

Mining operations in 1906 may be summarized as follows: One hydraulic plant was operated for a part of the season on a bench claim on Dahl Creek and two on the main Kougarok River above the mouth of Taylor Creek. The two latter utilized the plant to remove the overburden and part of the pay streak, bed rock being cleaned by hand. In both cases hydraulic lifts were operated. Considerable work was done on the lower four claims on Dahl Creek by shoveling into sluice boxes. Ground sluicing was done by a number of operators, notably on Windy Creek and on Solomon Creek, a tributary of Taylor Creek. Several claims were worked in a small way on Coffee Creek and on some of the tributaries of the Kougarok.

A dozen outfits were engaged in mining the river gravels and some of the tributary gulches of the Kougarok above Macklin Creek, but were handicapped during the earlier part of the season by lack of water and later by excess of water, which flooded them out. Below Taylor Creek, on the main Kougarok, attempts were made to exploit the bench gravels either by sinking shafts and drifting or by the aid of small hydraulic plants, but in most places the equipment was insufficient to produce anything more than meager results. Probably the most successful of these operations was the drifting on some benches on the west side of the Kougarok near the mouth of Taylor Creek. Harris, Garfield, and other creeks received some attention. Chiefly owing to the inadequacy of the water supply it is unlikely that there were, all told, over 150 or 200 men engaged in productive mining in this region.

It is thought that the amount expended in ditches and purchase of claims during the last two years (1905-6) probably exceeds a million dollars. Such an expenditure hardly seems justified by the placer ground actually proved. The total gold output, including that of 1905, is estimated at \$585,000, distributed probably about as follows:

*Gold production of Kougarok district, 1900-1905.*

1900.....	\$50,000	1904.....	\$150,000
1901.....	35,000	1905.....	200,000
1902.....	50,000		<hr/>
1903.....	100,000		585,000

This amount is, however, only an approximation. It should be noted that this does not include the output of the entire Kougarak precinct, but only that part of the precinct which is described in this paper. The production of 1906<sup>a</sup> was very small, owing to the lack of water.

#### DISTRIBUTION OF AURIFEROUS GRAVELS.

To speak broadly, the auriferous gravels thus far discovered in the district fall into two zones which converge from lower Kougarak River. (See map, fig. 9, p. 165.) The larger zone, here termed the "Kougarak belt," stretches northward and embraces much of the Kougarak basin; the smaller zone, which appears less well defined, extends eastward to the Noxapaga, embracing the streams tributary to Kuzitrin River. This second zone will here be called the "southern belt." The Kougarak belt lies in a zone of schistose rocks, bounded on either side by the massive limestones. It furnishes, therefore, further evidence for the general law that the gold has its source at or near the limestone and schist contacts. Nor does the southern belt, so far as known, offer an exception to this rule. Each of these two belts embraces placers of the various types to be described below.

#### SOUTHERN BELT.

##### GENERAL DESCRIPTION.

The auriferous gravels forming a broken fringe along the southern margin of the highlands which bound the Kuzitrin basin on the north and west have certain features in common which justify the description of them as a unit. This belt includes the placers of Quartz and Garfield creeks, as well as those of the Noxapaga basin.

The bed-rock geology of this belt is obscured, both by the extensive alluvial deposits and by the products of deep rock decay. It appears however, that a belt of graphitic phyllites and schists, including some calcareous matter, stretches across the upland lying between Kaviruk and Kuzitrin rivers. In many places these rocks carry quartz veins, some of which are stained with mica and quartz. Schists occur north of the graphitic rocks, and still farther north these give way to a limestone. Though it is impossible to delineate these formations exactly because of the deeply weathered character of the rocks and the absence of outcrops, yet it appears that most of the gold-bearing creeks cross the contact of the limestone and schist.

The unconsolidated formations embrace (1) the present stream gravels, (2) the deposits flooring the Kuzitrin lowland, and (3) the bench gravels. Of the first group, which embraces most of the work-

<sup>a</sup> Not a single operator in the district responded to a request for information in reference to production.

ing placers of the district, little need be said, as they are fully described on page 168. Little can be added to the description of the second group already given. The terrace gravels merit some closer consideration.

It has already been indicated that the upland region falls off from an altitude of about 1,100 feet to the Kuzitrin Valley floor (100 feet above sea level) by a gentle slope, here and there broken by a more or less well-marked terrace. The best defined of these terraces lies about 100 feet above the present water level and is traceable from the mouth of Quartz Creek northward along the west side of Kougarok River to the point where the valley of the river emerges from the upland. A similar feature is found along the northern margin of the Kuzitrin lowland, and the lower part of Turner Creek and some of the tributaries of the Noxapaga are reported by Collier to be incised in deep gravel deposits, indicating an easterly extension of this same feature. Where exposed, the alluvium of which these terraces are made up is nearly everywhere seen to be composed of the same character of material—i. e., well-rounded and stratified brown sands and gravels. Certain exceptions to this will be noted below. There can be no doubt that these benches are the remnants of an extensive gravel sheet. In support of this view are the hillocks made up of stratified gravels which here and there stand above the floor of the Kuzitrin lowland.

Near the mouth of Quartz Creek the top of the terrace is about 125 feet above the water and the gravels rest on clay of unknown thickness about 15 feet below water level. The exposed material consists of well-rounded gravel and sand. On going up Quartz Creek the surface of the gravel is seen to dip with the grade of the stream, and a mile below Dahl Creek about 100 feet of gravel and sand is exposed in the valley wall. Above this point this bed was not definitely recognized, but it is believed to be represented by a white quartz gravel that is exposed on Quartz Creek just below the mouth of Dahl Creek. On the north side of Dahl Creek valley a shaft sunk to a depth of 180 feet was entirely in this white gravel and did not reach bed rock. It appears probable that these white gravels are a phase of the bench gravels of lower Quartz Creek and the Kougarok described above. The surface of these white gravels dips to the northwest under the trench occupied by Dahl Creek. In other words, the gravels underlying the pay streak at the Lane hydraulic mine and those of Dahl Creek are a part of the same bed. The surface of this same gravel deposit is believed to be exposed near the mouth of Joe Creek, a tributary of Quartz Creek. These relations are too complex to permit detailed analysis here, but they point to the following conclusions: (1) The auriferous gravels of the Lane hydraulic mine, Dahl Creek, and Joe Creek constitute the same horizon; (2) they are underlain by

alluvium, forming the white gravels of Dahl Creek and the bench gravels of the lower part of Quartz Creek and of the Kougarok, and these same gravels are found along the front of the upland near Garfield and Turner creeks; (3) this older gravel series is not believed to carry values, though it is known to be more or less auriferous.

This last conclusion is borne out both by the prospecting and by theoretical considerations. In general the rich placers of the peninsula occur in alluvium which is subangular and which was deposited under conditions of subaerial decay rather than during floods. These bench gravels are, however, well rounded and stratified and appear to have been laid down during periods of flood, which are not favorable to a concentration of values.

So far as known to the writer, the base of these gravels on bed rock has never been prospected. There is no reason to believe that the basement member may not be gold bearing, and in the opinion of the writer the chances of finding gold at depth is sufficiently good to warrant the outlay of the cost of prospecting them to bed rock.

Though it is not proposed to describe them in detail, a few notes on the different creeks will be appended.

#### COFFEE CREEK.

A peculiar auriferous deposit was opened up during the winter of 1906 on the upper part of Coffee Creek. Some rich placer ground was found in the angular talus of the valley slope, which appeared to be almost in place. The gold occurs in 4 to 7 feet of angular schist and quartz débris and weathered schist bed rock covered by 18 to 20 feet of muck. The quartz is iron stained, but does not appear to be auriferous, and the gold probably came from the schist. The gold is angular, spongy, and bright colored. These facts indicate that the material mined is the decomposed surface of a mineralized zone. The deposit has been traced about 1,000 feet, but being buried deeply its boundaries are not well known. It is indicative of the source of the gold and suggests at least the possibility of finding lode deposits which may carry values.

The other placers of the upper part of Coffee Creek are, as a rule, buried under an overburden of muck 10 to 20 feet thick. The gravels are chiefly schist and vary from 3 to 7 feet in thickness. Bench gravels similar to those of lower Quartz Creek occur near the mouth of Coffee Creek and are here said to carry some gold.

#### DAHL CREEK.

A bench at the mouth of Dahl Creek, 20 feet above the present stream bed, has been a large producer. A section at this point is as follows:

*Section at mouth of Dahl Creek.*

	Feet.
Muck.....	20
Ferruginous gold-bearing gravel.....	3-4
Sticky clay.....	½-1
Barren white quartz gravel.	

The section of the creek placers is practically the same, for as already stated the two horizons are believed to be identical. A mile and a half above the mouth the lower gravels give way to bed rock, and above this point but few values have been found.

## QUARTZ CREEK.

Quartz Creek for half a mile below the mouth of Dahl Creek appears to have been worked out, for no mining has been done there for several years. As yet no values have been found below this point. Some placer ground has been developed at the mouth of Joe Creek, but the pay streak does not appear to be extensive.

## TRIBUTARIES OF KUZITRIN RIVER ABOVE THE KOUGAROK.

This portion of the field, though the scene of profitable mining in the early days of the camp, has advanced but little in recent years. This is in part because the placers were found to be neither as extensive nor as rich as first believed and in part because of the high costs of mining due to the inaccessibility of the creeks.

Garfield Creek, from which \$25,000 in gold was taken out during the first two years after its discovery, has been almost abandoned, though one claim continues to yield a little. The pay streak on this creek was narrow and thin and rested on a clay bed rock. Benches, though present, have not been found to carry values. So far as known, hard bed rock has never been reached in any of the operations.

Boulder Creek, a tributary of Turner Creek, has had a history similar to that of Garfield Creek. Little work has been done on it during recent years. From 3 to 11 feet of gravels are reported, with no bed rock. Deeper prospecting would appear to be justified. Among the smaller creeks in this vicinity on which gold has been found, but which have not been developed, are Grouse, Black, and Goose creeks.

## NORTHERN BELT.

## GENERAL DESCRIPTION.

The auriferous gravels of the main Kougarok above the Kuzittrin flats and of its tributaries form the northern belt of placers. The bed rock of this area is chiefly schist, but most of the tributaries of the Kougarok have their courses in limestone areas. This belt embraces stream placers and bench placers, of which the former type, to the present time, has yielded most of the gold. There are two forms of

stream placers—(1) those of the smaller gulches and creeks and (2) those of the main river. The gulch and creek placers are usually of small extent, but are so situated that many of them have been profitably mined by pick and shovel. On the other hand, many of the placers of the main river are of considerable extent and are difficult to exploit except with equipment that permits the handling of a large amount of material and provides for both high-water and low-water conditions.

Bench gravels have been reported at various localities, but those of proved economic importance are confined to the main Kougarok River and some of its larger tributaries. These are chiefly within 25 feet of the present water level, but some higher benches are reported to be auriferous.

#### KOUGAROK RIVER.

The Kougarok is a swiftly flowing stream carrying at its mouth 10,000 to 15,000 inches of water and having an average gradient of about 20 feet per mile. Most of the material transported is coarse, varying from fine gravel to coarse cobblestone.

Undoubtedly the most extensive deposit of auriferous alluvium yet found in the district is that of the main Kougarok, occurring both in the present stream bed and on the benches. For at least 40 miles of its course the gravels of this stream have been found to be auriferous, though it is impossible to state at present what part of these carry commercial values. The valley of the Kougarok has a meandering course and varies greatly in its cross section. In some places it is steep walled, narrow, and without benches; in others it opens out into a broader basin, with gentle slopes or bounded by well-marked rock benches. A striking feature of its topography consists of the various levels of erosion, which are marked by benches both along the main river and along many of its tributaries. These clearly indicate a succession of uplifts that have brought about the incision of former valley floors, remnants of which are preserved as benches. Evidences were observed of at least three of these uplifts, of which naturally the last is best preserved, and consists of a rock bench covered by gravels standing 15 to 25 feet above the present water level. Where the Kougarok enters the Kuzitrin lowland both valley walls show well-marked benches. Two levels are here marked—one at 50 feet and one at 25 feet. These are traceable for about a mile and a half above Windy Creek; then the walls become steeper, and as far as Left Fork the river occupies a canyon-like valley. From this point to Washington Creek, 20 miles above, some evidence of benching can be observed at most places, though it is not intended to imply that the benches are continuous. The individual benches have not been traced, but in that part of the valley which lies below Taylor Creek there are at least two levels and possibly three.

Some of the placers of the present stream bed have been worked spasmodically since the discovery of the district. A little gold has been taken out of the river bed with shovel and rockers near Coarse Gold Creek and at various points as far as Taylor Creek. Much more work has been done at and above the big bend of the Kougarok, near the mouth of Macklin Creek, and as far as Washington Creek. Mining was necessarily confined to low-water stages. These placers are in no sense of the river-bar type, as they carry coarse gold mingled with gravels and concentrated to a large degree on bed rock.

The river gravels in their upper part are usually well rounded and stratified, but the pay streak near bed rock is in many places made up of subangular material. The largest pebbles are usually not over 1 or 2 feet in diameter, but a few boulders of greater size, which have been contributed by the talus of the valley slopes, are encountered. No general statement of the thickness of the gravels can be made, as it varies greatly in different parts of the river. In the canyon previously described bed rock is exposed throughout the river bed. In many places above the canyon gravels are almost entirely absent, while in other places the depth to bed rock is 6 to 20 feet.

The width of the alluvial floor also is variable, for in some parts of the river the entire valley floor is buried in gravels, and in others the stream has uncovered bed rock over a part of the floor. The actual flood plain of the river varies from 100 to 800 feet in width. Where the river enters the flat it is about 800 feet wide; in the canyon, about 100 feet; at the mouth of North Fork, about 300 or 400 feet; at the mouth of Taylor Creek and near the mouth of Trinity Creek, about 300 feet.

Below the flat at the mouth of Taylor Creek the alluvium is almost entirely made up of gravel; above that point the gravels are in places buried under considerable muck.

So far as known to the writer the gold found in the stream bed below Coarse Gold Creek is chiefly fine, but at the mouth of this creek and above it considerable coarse gold is reported. This fact is important, because it indicates that in the upper half of the river enrichment has taken place from local sources and that the gold has not all been brought in by the main stream from its headwaters. Coarse gold is, however, reported to occur at the mouth of North Fork.

The gold of the flood plain is usually of a dark color; that of the smaller tributaries is bright. Thus far the only placers of the flood plains that have been opened up on a commercial basis are those at the mouth of North Fork, where little has been done, at the mouths of Taylor and Homestake creeks, and between Macklin and Washington creeks.

The bench deposits of the Kougarok appear to afford an attractive field for the gold miner. Their position makes them easy of access, and no hydraulic lifts are required to dispose of the tailings. These benches can not be described in detail, because the facts are wanting. Between Coarse Gold and Taylor creeks the benches are particularly well defined, and there are at least two distinct levels about 25 and 50 feet above the water. So far as observed the gravels are from 8 to 10 feet in depth and are usually covered with muck. No determinations of values are known to the writer, but the fact that some gravels of the lower tier have been worked at a profit by crude methods makes it seem probable that their gold content is not inconsiderable.

Bench gravels have been reported at various places above Taylor Creek, and some are known to be auriferous, but they have not been developed on a commercial scale.

This rather fragmentary evidence points to a wide distribution of gold along the main Kougarok and to the presence of values at many places in both the bench and the flood-plain gravels. From the existing knowledge it appears that this valley contains the largest gold reserve of the district.

#### WINDY CREEK.

The developed placers on Windy Creek occur in a small tributary from the south called Anderson Gulch, which is a minor depression in the valley wall. The gravels exposed in the cuts are 2 to 3 feet thick. In addition to this  $1\frac{1}{2}$  to 2 feet of bed rock is put through the sluice boxes. The bed rock is a silvery mica schist with much iron-stained quartz. These placers have been traced for 1,600 feet along the slope of the valley of Windy Creek. The known area of workable deposits is not large, but as gold has been found in other parts of the basin other placers will probably be found.

#### NORTH FORK.

The basin of North Fork was the scene of the first gold discoveries in the Kougarok district, and some of the placers have yielded a considerable output of gold. A marked feature of its topography are the benches, of which three different tiers are known. The bed rock of the basin includes both schists and limestones.

Workable placers have been found on the main stream and on Harris Creek, and gold is reported from the gravels of Eureka Creek and a number of other small tributaries. The evidence at hand indicates that this basin will become an important producer.

## COARSE GOLD AND OTHER SMALL CREEKS.

The alluvium of Coarse Gold Creek is auriferous, but as yet only a small amount of gold has been extracted. A hard diorite forms the bed rock of a part of the creek and does not afford a favorable surface for the concentration of values. The lower part of the creek is in schist and deserves attention on the part of prospectors.

Arizona and California creeks are small streams, but they have considerable gravel deposits near their mouths. Both the flood-plain and bench deposits have yielded considerable gold.

Gold was discovered on Henry Creek about five years ago, but the values do not appear to be great. Little has been done on this stream since 1903.

Between Coarse Gold and Taylor creeks there are a number of small gulches which have yielded values, but these will probably be mined with the bench deposits already described and deserve no special mention here.

## TAYLOR, HOMESTAKE, AND OTHER CREEKS.

Taylor Creek is the largest tributary of the Kougarok. In its basin are exposed both limestone and schists. Some mining has been done near the mouth of the creek, where the placer deposits are similar to the flood-plain deposits of the Kougarok, of which they form an extension. Above this point the only mining attempted in this basin is on a small tributary called Solomon Creek. At the mouth of this stream there is a sloping bench on which lie 3 to 7 feet of gravels covered by 8 to 10 feet of muck. These gravels are auriferous and have been mined in a small way, as have also the stream gravels of Solomon Creek half a mile above.

Auriferous gravels have been found throughout the length of Homestake Creek, and the claims near the mouth have produced some gold. The auriferous gravels are from 5 to 8 feet thick, and pay streaks to a width of 40 feet have been found.

Among the smaller tributaries above Homestake Creek which have yielded values are Macklin, Trinity, and Mascot creeks. These streams contain no extensive deposits, but include some workable gravels, whose occurrence is of significance in showing a wide distribution of the gold.

## CONCLUSIONS.

The investigations on which this report is based were entirely too inadequate to permit a final word on the value of the auriferous gravels of the district. That there are extensive alluvial deposits carrying sufficiently high values to yield adequate returns for economic mining no one can deny who has studied the matter carefully.

It is equally well known that as yet, with the exception of a few claims, no gravels of very high grade have been developed. Certain conditions already referred to are favorable to the probable extension of the placer-mining industry. One of these is the wide extent of the mineralization. If, as stated elsewhere in this report (pp. 25, 130-132), the zones of mineralization of the peninsula are most commonly found along or near the contacts of mica schist and limestone, the Kougarok is a region where placers should be expected. As in other mineral-bearing districts of the peninsula, the bed rock is closely folded, faulted, and fractured, and mineralized quartz stringers are not uncommon, but have not been tested as to their gold content. In at least two localities the gold has been traced to its bed-rock source in the schists. So far as the present studies can determine, the bed rock is no less favorable for the occurrence of gold here than in other districts of the peninsula.

The history of this province since it was last elevated above the sea, interpreted according to theories elsewhere presented, favors the concentration of gold in the alluvial deposits. The various epochs of erosion indicated by the bench deposits would promote the concentration of the heavier materials in the gravels. In several localities on Kougarok River the gold was probably derived by reconcentration from older elevated placers. Yet it must be said that, in spite of this reconcentration, the resulting placers have not been found to be as rich as those of similar origin in other parts of the peninsula. This fact points toward the conclusion that the bed-rock source is not as heavily mineralized as in some of the other districts. The lower bench gravels of the Kougarok and some of its tributaries are undoubtedly among the most important deposits of the district, if only because of their favorable position for cheap mining. The highest gravels (i. e., those above 50 or 60 feet) reported at various places have now little prospect of development unless they are far richer than any of the other deposits. Their topographic position makes it difficult, if not impossible, to hydraulic except at great cost. Experience has shown that the abundance of the ground ice, the limestone masses, and heavy talus all combine to make ditch construction and maintenance expensive.

The writer is unable to make a definite statement of the gold tenor of the gravels in this field, for the results of the little prospecting that has been done have not been available for the purposes of this report. When the meager evidence is carefully weighed, it seems probable that \$2 to the cubic yard must be considered high value for most of the placers of the district. Whether or not there are considerable bodies of gravel which carry such values, the writer is not prepared to state. While a gold tenor of \$2 would be considered very rich in most placer camps, it is low compared with that of some of the auriferous gravels

of Anvil and Ophir creeks. Nevertheless, there is no doubt that gravels can be profitably mined at but a fraction of this amount in many places in this district.

The two dry summers, 1900 and 1906, make it evident that such climatic conditions must be reckoned with in counting cost, especially where large investments of money are made. Though during a wet season there is an abundance of water, nevertheless the Kougarok has no such reservoirs to draw on as the Kigluaik Mountains, which are being tapped by the Nome ditches, and this fact is emphasized by a dry season like that of 1906. At the rate that ditch building is going on every possible source of water supply will soon have been utilized. Here, as elsewhere, more careful prospecting of the ground would probably have curtailed some of the ditch building. It appears that some operators have been too ready to believe without adequate prospecting that the values in the ground were sufficient to warrant large expenditures for ditch construction. This hit-or-miss style of mining has fewer odds against it in regions where the hope of finding bonanzas is better than in the Kougarok. It certainly can find no place in a region where the question of costs has to be carefully considered.

The Kougarok does not appear to be an inviting field for the miner without capital. Though considerable gold has been recovered by pick and shovel, on the whole the values thus far developed are not high enough to yield profits by such simple methods of mining. This is certainly true now; but conditions may alter with the reduction of costs of labor and supplies.

To recapitulate briefly, the following facts appear to be established: (1) Prospecting up to the present time, so far as known to the writer, has not established the existence of many bonanzas. (2) There are some extensive deposits of heavy auriferous gravels, yet it appears that but few of them have been sufficiently prospected to prove their values. (3) Water is far from abundant, but, in many localities during most seasons, is probably sufficient. (4) Mineralization, however, is widespread, as is also the gold in the alluvium. (5) Some of the bench deposits are very favorably located for profitable exploitation by hydraulic methods. (6) There is probably some ground which can be dredged, but as yet few facts in regard to it are available.

In the opinion of the writer the Kougarok district will become one of the important gold producers of the peninsula, though it is not to be expected that its output will ever be comparable to that of some of the older districts, such as Nome and Ophir Creek. It is a field where profits can be expected only by a careful counting of costs and conservative business management.