Bulletin No. 295

Series { A, Economic Geology, 82
B, Descriptive Geology, 101

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

THE

YUKON-TANANA REGION, ALASKA

DESCRIPTION OF CIRCLE QUADRANGLE

BY

L. M. PRINDLE

WASHINGTON

GOVERNMENT PRINTING OFFICE

1906

CONTENTS.

ILLUSTRATIONS.

PREFACE.

By ALFRED H. BROOKS.

In planning the surveys and investigations of Alaska, the attempt was made to cover first those regions which were of the greatest economic importance. As a result of this, many of the mapped areas are very irregular in outline, and it now seems desirable to introduce greater uniformity into the published maps as rapidly as the data available for their preparation will permit. With this end in view a system of maps has been projected covering quadrangular areas outlined by parallels of latitude and meridians of longitude, this being in conformity with practice in surveys made within the United States proper. But the Alaska surveys being for the most part of a reconnaissance character and the region being very thinly populated, it has seemed best to adopt a map unit larger than that used in the States. This unit will include 4 degrees of longitude and 2 degrees of latitude, making a map about as large as can be conveniently handled. It is hoped eventually that these published reconnaissance topographic maps can be accompanied by sheets showing the geology and the economic resources, but in view of the great demand for the topographic maps it has been deemed advisable to give them immediate publication, with such accounts of the geology and mineral resources as may be available. Nor is it deemed desirable to delay the issuing of the maps until the complete areas have been covered.

The following report and the accompanying map (Pl. I) is the first of this series to be issued, and it will be followed by others as fast as the accumulation of the field notes will permit. The topographic surveys upon which the map is based were made under direction of Mr. T. G. Gerdine in 1903 and Mr. D. C. Witherspoon in 1904 and 1905; the geology is by Mr. L. M. Prindle, who has worked in this general field in 1903, 1904, and 1905. Mr. Prindle has presented the salient features of the geology so far as known in simple language devoid of technicalities. A more elaborate discussion of the scientific results is in preparation.

THE YUKON-TANANA REGION, ALASKA.

DESCRIPTION OF CIRCLE QUADRANGLE.

By L. M. PRINDLE.

INTRODUCTION.

The Yukon-Tanana region includes that part of the interior of Alaska delimited by Yukon and Tanana rivers and the international boundary. It is 300 miles west from the boundary to the junction of the two rivers, and the greatest distance in a north-south direction between them is about 175 miles. The area is approximately 40,000 square miles, or more than half that of the State of Washington.

Some of the earliest prospecting in the interior was done in this area. The discovery of placer gold on Fortymile Creek in 1886, and later discoveries in the Birch Creek and Rampart regions, in 1893, led to a rapid development of mining on streams tributary to the Yukon. The gold discoveries in 1902, about 260 miles above the mouth of the Tanana, have resulted in the development of the Fairbanks region, one of the most important gold placer camps in Alaska. Besides these four widely separated regions producing placer gold—the Fortymile, Birch Creek, Rampart, and Fairbanks regions—there are in this area several others of less present importance, which illustrate the wide distribution of gold through the area.

Gold has been found at a few localities in the bed rock, but as yet in insufficient quantities to afford a basis for the development of quartz mining.

Coal occurs at several points along the Yukon and on small tributaries of the Yukon from the south, and has been mined to a small extent.

The Yukon and Tanana are the main routes of travel, and from these rivers the productive areas are reached either by overland trails, by tributaries navigable for small boats, or, in the case of the Fairbanks region, by railroad and wagon road.

Governmental investigation by the Geological Survey has, so far as possible, kept pace with the rapid development of the area and responded to the increasing demand for information by the publication of topographic and geologic maps and reports on conditions in the gold-producing regions. The accompanying map (Pl. I) is framed by the one hundred and forty-second and one hundred and forty-sixth meridians and the sixty-fourth and sixty-sixth parallels, and includes about 17,000 square miles. Its relation to the larger area is shown in fig. 1. The part of this area mapped by the topographic parties extends west from the limits of the Fortymile quadrangle [a] as far as the headwaters of Birch Creek, reaches to the Yukon on the northeast, and includes the greater part of the Goodpaster Valley to the south.

[a] A map of the Fortymile quadrangle was issued by the U. S. Geological Survey in 1899.

The divergence between the true north as indicated on the map and the magnetic north as indicated by the compass needle is so great in Alaska (34° 25′ at Circle in 1902), and so many cases are known to the writer where this fact has been neglected, that too much emphasis can not be laid on the importance of bearing it in mind when using maps in connection with a compass, especially in a country like that under consideration, where the ridges and valleys often present great similarity of appearance.

The gold placers of the Birch Creek region and the numerous widely scattered areas tributary to the Yukon, Seventymile, Fortymile, Tanana, and Salcha that have been found somewhat productive of placer gold are included in the area covered by this

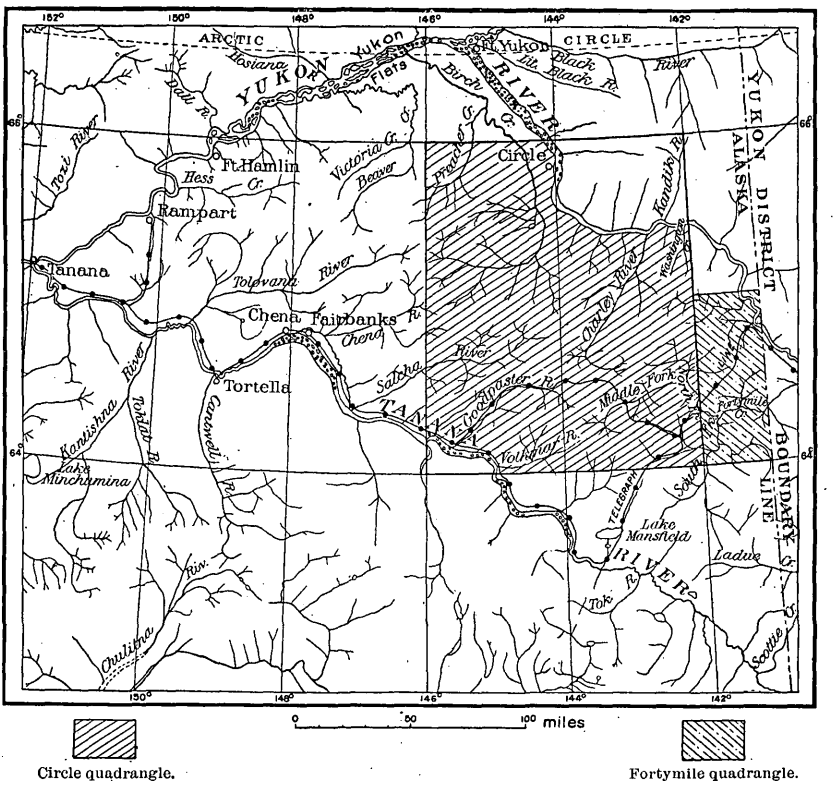

FIG. 1.—Index map, showing location of Circle quadrangle.

map, as are also a few coal-bearing localities along the Yukon. From the fact that Circle, the supply point of the Birch Creek region, is the only town within it, the map has been called the Circle sheet. The map of the Fortymile quadrangle has already been published, and those of the Fairbanks and Rampart regions will follow:

In the preparation of the following description free use has been made of the reports already published by the Survey bearing on the region under consideration.[a]

[a] Spurr, J. E., Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 87-392. Collier, Arthur J., The coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, 1903. Prindle, Louis M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: Bull. U. S. Geol. Survey No. 251, 1905. Purington, C. W., Methods and costs of gravel and placer mining in Alaska: Bull. U. S. Geol. Survey No. 263, 1905.

GEOGRAPHY.

RELIEF.

The Yukon-Tanana area is a part of the great interior dissected plateau-like region extending from the northern base of the Pacific mountain system to the Rocky Mountains far north of the Yukon and east and west throughout Alaska. The feature most prominently developed is that of ridges and valleys. There is a constant repetition of ridges undulating in outline and more or less uniform in height, separated by valleys of uniform depth. The prevailing sameness of the outlook is varied by occasional ridges which are sharply accentuated and attain altitudes of over 6,000 feet, and in one case of 6,540 feet. On the other hand, this ridge and valley feature gives place along parts of the courses of the two great rivers to lowlands of vast extent, which lie about 800 feet above sea level.

The reconnaissance map (Pl. I) indicates the character of the surface. The areas where contour lines are most closely spaced indicate areas of greatest steepness; where contour lines are far apart the surface of the region most closely approaches horizontality. At a glance, then, the map is seen to clearly reproduce the face of the country—the numerous ridges (like the Crazy Mountains), the intermingled drainage systems, and on the north, in the space so free from contour lines, a part of the Yukon Flats. An inspection of the map shows, further, the absence of a well-defined divide separating the waters tributary to the two rivers, and the great irregularity of the courses of the minor streams before they become identified with their respective drainage systems.

The northern edge of the hill country, where the ridges break off abruptly to Yukon River or to the level of the Yukon Flats, has a more pronounced relief than that along Tanana River, where the ridges become gradually lower toward its valley or those of its tributaries. The valleys of the north-flowing streams are consequently narrow and deeply incised within the inclosing ridges, while those of the streams in the vicinity of the Tanana widen and flatten gradually to that of Tanana River.

The part of the Yukon Flats occupying the northwest corner of the map is a sparsely timbered surface, somewhat uneven and broken where minor ridges run out into it from the base of the hills. It is dotted with a few small lakes, and the streams which furrow deeply the northern slopes of the hills run irregularly across it in no well-defined valleys of their own.

DRAINAGE.

General statement.—A study of the map shows the close relation of all the drainage systems. The headwaters of the Salcha, for example, are seen to extend within 25 miles of the Yukon and to be separated from Birch Creek waters by only a narrow ridge with numerous side spurs, which may easily be mistaken for the main divide by the traveler without a map, and which, if followed, will lead him finally to waters the ultimate direction of which may be entirely opposite to that in which he desired to travel.

The most important streams tributary to the Yukon are Birch Creek, Charley River, Seventymile Creek, and the North and Middle Forks of Fortymile; those tributary to the Tanana are the Volkmar, Goodpaster, and the upper part of the Salcha and Chena rivers. Besides these major streams are many small tributaries of both Yukon and Tanana rivers, some of which, like Woodchopper and Coal creeks below Charley River, are of importance from the fact that some mining is being done upon them.

Birch Creek system.—The creeks of importance draining the northwestern part of the region all belong to the Birch Creek system. The many active tributaries ramify far within the hills to the east, south, and west and finally unite to form the forks

of Birch Creek, which flows northward through a narrow canyon cut within the outermost ridge of the hill country. Crooked Creek, with its tributaries of economic importance, and Preacher Creek, which joins it far out in Yukon Flats, are the most important tributaries. Birch Creek is fordable for horses at low water, but at high water is a turbulent flood.

The valleys of the two main forks are unsymmetrical in cross section. They are limited on the north by a steep ridge which rises 1,000 feet or more above the stream flowing close along its base. The other side of the valley is characterized by a bench which starts near the stream at a level of 100 feet above it and extends with a gradually rising slope to the base of the ridges limiting it on the south.

Charley River system.—Charley River is formed by several long tributaries. It occupies, for a large part of its course, a valley 500 feet or more below the limiting sides, which in places crowd closely against the meandering stream and in places withdraw some distance from it. Benches are prominently developed. The river can be easily forded on foot at low water in the upper part of its course and is said to be navigable for small boats for a distance of 100 miles above its mouth.

Seventymile system.—Only a small part of the Seventymile drainage extends into this area and the two creeks which have attracted the attention of miners are Flume and Nugget.

Fortymile system.—The Fortymile sends an elaborate system of tributaries to the south and west. Some of these are well known for their gold placers, but in the area covered by this map there are only a few which up to the present have proved productive. The valleys have the same character as those already described. Benching is very marked in the main valleys. From the higher elevations a few miles back, long spurs descend with gradual slopes toward the streams, and at an elevation of about 500 feet above the stream and in places as far as a mile back from it, are conspicuously benched.

Volkmar River system.—Volkmar River heads in a high ridge opposite the Fortymile drainage, and, while outside of the area covered by the topographic work, a part of its valley was traversed during the season of 1905 by a geologic party from the Survey. The stream, where crossed by the party at a point about 20 miles above the mouth, was narrow, swift, and tortuous, and the channel was obstructed by great log jams. It was easily fordable on foot. This part of the valley was open and a mile wide. The stream, as seen from the surrounding hills, forked about 2 miles above this point. The valley narrowed toward the northeast and widened toward the mouth, where its surface was flecked with many lakes.

About 6 miles west of Volkmar River is a parallel stream perhaps 30 miles long, which, so far as could be seen, pursues an independent course. If it is a tributary of the Volkmar, it apparently does not enter it within the hill country but far out in the Tanana Flats. The valley is rather narrow, and the stream meanders over a flat a few hundred feet wide. The ridge separating it from the Volkmar has a height of 2,000 feet above the valleys. A rather even-topped ridge on the northwest separates this valley from those of streams which finally enter a large west-flowing tributary of the Goodpaster.

Goodpaster system.—The south side of the high ridge at the head of Charley River is drained by Goodpaster waters. The source is a small stream starting from a saddle in the divide which contains also within a small space Charley River and Fortymile drainage. Steep-sided bare hills of high relief, which many winding trails proclaim a highway of caribou travel, tower above the stream and supply abundant water. The stream increases rapidly in size, and its waters, at first confined to one channel, become distributed in places over flats where ice fields 6 feet thick and many acres in extent linger till late in summer. There are stretches lower down the valley where the stream flows inconspicuously within the surface of low benches covered with grass and other vegetation and presenting the appearance of meadows.

Sometimes it flows close against the base of overshadowing ridges where there are long reaches of quiet water separated by shallow riffles, and sometimes, bordered on one side by gray crescentic gravel bars, it meanders broadly in an open-timbered valley with the rugged hills far in the background. Finally the hills recede, the valley widens to a broad flat, limited by low even-topped ridges, and a narrow line of timber indicates the course of the deepening stream where it passes sluggishly from its own valley into the timbered flats of the Tanana.

There is a large tributary of the Goodpaster within the southern limits of the quadrangle but outside the area mapped by the topographic parties. This drains the region between the prominent ridges extending westward south of Central Creek and the ridges overlooking Tanana Valley. It is 30 miles or more long and heads opposite Volkmar waters in deep narrow gulches which flare into meadow-like expansions at their heads. The lower valley is open, the stream meanders through a flat covered in places with grassy meadows, and enters the Goodpaster about 25 miles below Central Creek.

The Goodpaster is often traversed by small boats and rafts. The Government telegraph line follows the valley, and during 1905 there were stations at Summit, Central, and at the mouth, 34 miles below Central.

Shaw, Tenderfoot, and Banner creeks.—Shaw, Tenderfoot, and Banner creeks enter the Tanana between Goodpaster and Salcha rivers. Shaw creek is a stream 40 miles or more long, and the lower part of its valley is a wide flat, covered in places near the mouth with a scattering growth of tamarack. The stream enters the Tanana close to the limiting ridge on the west, the base of which at this point is swept by Tanana River. Tenderfoot and Banner are neighboring creeks only a few miles long, just off the western edge of the quadrangle.

Salcha and Chena drainage.—The western part of the area is drained by Salcha and Chena rivers, but within the area shown by the map the contributory area of the Salcha is much the larger. The stream formed by the gathering of the waters from many distant sources has become of considerable size before crossing the western limit of the quadrangle, and 50 miles farther to the southwest, where it enters the sloughs of the Tanana 60 miles below Goodpaster, it has become one of the largest streams in the Yukon-Tanana country. There are numerous riffles easily fordable by horses at ordinary stages of the water, and the long gravel bars at low water are often utilized for towing boat loads of supplies by horses as far as Butte and Caribou creeks, tributaries from the west 50 miles above the mouth.

The general character of the Chena drainage, so far as observed by the writer, is similar to that of the Salcha.

RELATIONS OF RELIEF AND DRAINAGE.

Reference has been made to the general uniformity of altitude prevailing in the Yukon-Tanana country, and also to the benches so prominently developed along some of the streams, especially those tributary to the Yukon. These benches occur at various levels and indicate changes that have taken place in the relative position of the land with reference to the sea level. One bench, at a level of about 500 feet above the streams, is especially well developed in parts of the valleys of Charley River and of Seventymile and Fortymile creeks, and can be easily traced on the map (Pl. I). These benches are suggestive as to what has taken place over the whole region. As these local areas have by elevation of the land been divided into separate areas by streams which cross them, so the whole region, a more or less uniform surface, formerly at a lower level, has been elevated and cut by the drainage systems into many similar ridges approximately conformable in height. With elevation of a surface so uniform in character, the streams had about the same start in life, and their valleys at corresponding points are consequently developed to about the same depth and have about the same grade. The grade of the smaller valleys, including

all those where mining is in progress, range from 70 to 100 feet per mile; that of the major valleys is in most cases probably less than 40 feet. A general characteristic is that the low grade is maintained nearly to the heads of the valleys, which are so deeply sunk that the grade to the inclosing ridges is very steep. From a study of the map the approximate grade of the valleys can be readily determined. The absence of commanding ridges and the low grade of the valleys have rendered difficult the application of the hydraulic method. Ditches must necessarily be long in order to reach a point of intake at a level sufficiently high to furnish an efficient head, and such a point is generally so near the headwaters that the water supply is liable to be low. There is particular need, therefore, in the interior of Alaska for the most experienced management in the conduct of hydraulic operations. From the fact that much of the ground is frozen throughout the year, the amount of water carried by the streams bears a close relation to the rainfall. The streams are liable to sudden floods, which, however, as suddenly subside. A drought, on the other hand, is fatal to a large production from the placers. The following measurements of stream volume in the Birch Creek region were made in July, 1904, with the Price current meter, and are taken from Purington's report.[a] There is included also a measurement of Birch Creek made in the same way by R. W. Stone, of the Survey, in June, 1905.

It should be clearly understood that these measurements were made at only one stage of the water in streams subject to wide and sudden variations, and are, therefore only rough approximations.

Stream measurements in Birch Creek region, July, 1904.

	Flow in miner's inches.
Deadwood Creek at Claim No. 9 above	582
Mastodon Creek	322
Junction of Eagle Creek and Mastodon Fork	255
Birch Creek	70,000
Birch Creek[b] at Twelvemile (low water)	63,160

CLIMATE AND VEGETATION.

The temperature has a wide range of variation. Temperatures below 80° F. below zero have been reported, and those 90° or more above zero are not uncommon. The extreme continued cold of winter leaves so deep an impress that the streams become covered with a layer of ice 6 feet thick, which in places lingers till late in summer, and the ground remains for the most part permanently frozen. The long days of summer, often very warm, soon mantle with green luxuriance much of the deeply frozen surface, and the shadows of the ice-scarred spruces along the river banks become enlivened with patches of grass or glow with brilliant fire weed and clumps of roses. This extreme differentiation of the seasons entails much change in mode of living and methods of transportation, and the times at which the gradual change takes place from summer to winter and winter to summer are therefore the most important climatic periods of the year. The Yukon at Circle closes about the middle of October, soon after the mush ice begins to run, and opens again about the middle of May, when the breaking of the ice emphasizes most dramatically the advent of the open season.

While the winters are in general similar in their essential characteristics, the summers vary greatly in temperature and rainfall. Some of them are characterized by long periods of beautiful weather with many days of great heat during June and July and the early part of August. The occasional thunderstorms or rainy days furnish insufficient water to meet the demands of mining, and work is thus frequently brought almost to a standstill. In other seasons thunderstorms may be of

[a] Purington, C. W., Methods and costs of gravel and placer mining in Alaska: Bull. U. S. Geol. Survey No. 263, 1905, p. 52.

[b] By Ralph W. Stone, June, 1905.

almost daily occurrence for several weeks. A third season may be unusually wet with frequent cold rains accompanied by snow in the higher hills.

The snowfall is generally light, and the total precipitation is much less than that of the southeast coast. At Eagle, according to data compiled by Cleveland Abbe for Purington's report, it approximates 11.4 inches,[a] while at Juneau it is 93.1 inches.

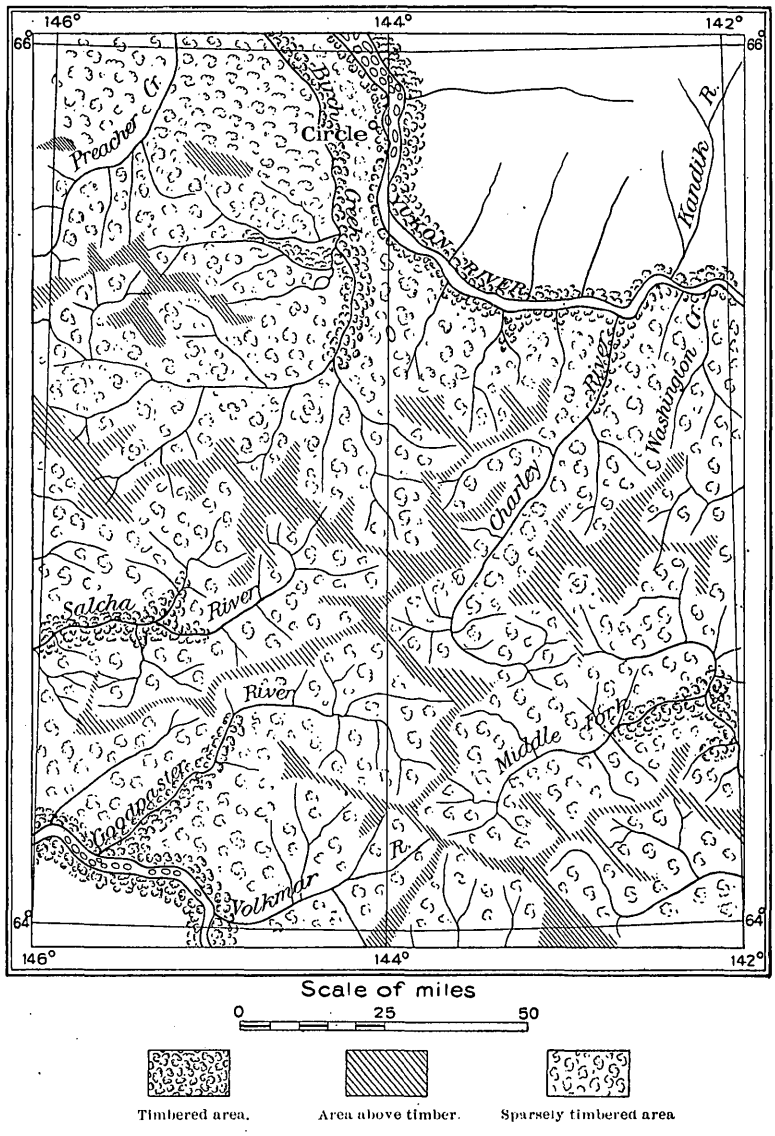

FIG. 2.—Map showing distribution of timber.

The lowlands are comparatively free from frost during the latter part of June and the months of July and August, and ordinarily mining can be carried on from the middle of June to the middle of September, and in a favorable season may be continued much longer.

[a] Bull. U. S. Geol. Survey No. 263, p. 48.

The distribution of timber is shown in fig. 2. The ridges (with the exception of the highest, which are rock and talus slopes) are covered mostly with moss or a sparse growth of dwarf birch and occasional clumps of alders. A light growth of small spruce covers the lower ridges and along with birch and poplar becomes abundant on their slopes. Spruce timber, 2 feet or more in diameter at the butt, is distributed in small areas along the lower valleys of the largest streams and more abundantly in the valleys of the two main rivers. Tamarack is common in the valley of the Tanana and in those of its most important tributaries. Timber for mining purposes is available to only a limited extent in the valleys of the gold-producing creeks, and in most cases must be transported a considerable distance. Small timber for fuel is abundant, but in the Birch Creek region is confined mostly to the lower parts of the valleys.

Feed for stock is found in the headwater valleys of the streams throughout most of the region, and in parts of the valleys of the larger streams is abundant. In the Crooked Creek Valley, near Central House, are natural meadows, where some of the grass is cut for winter use. Pack animals have in general but little difficulty in finding sufficient feed from the latter part of June to the first of September and cases are reported where horses have wintered in the open, dependent only on the natural resources. There are good gardens at the road houses in the Birch Creek region, and the rich soil produces all the common vegetables in abundance.

TRANSPORTATION.

In 1905 transportation by steamer had reached considerable development, a score or more of boats, some of them using oil for fuel, plying on Yukon and Tanana rivers and carrying thousands of tons of freight. The upper Tanana is difficult of navigation and, although steamers carried supplies as far as the Goodpaster and, in one case during 1905, as far as the head of the Tanana, there was no regular transportation to these points. Improvements in transportation for the most part cease at the steamer landings, and the wagon roads so long in use on the Canadian side of the boundary give place to primitive pack trails which in wet weather are most difficult to travel. In the Dawson region the miner on a lonely gulch may be visited twice a week by the representative of a general store who delivers supplies at a rate but slightly above that paid in town, and with the advent of the railroad and improved wagon roads a similar condition is coming to prevail in the Fairbanks region. In the Birch Creek region, however, with conditions for road construction equally as favorable as in the Dawson region, where the Canadian government has constructed such excellent roads, the miner must either have all supplies for the year transported in the winter, or must pay 20 to 25 cents for every pound carried by pack train from the Yukon, a distance of 40 to 50 miles to the creeks. The production of the Birch Creek region, although not a large one, averaging about $200,000 a year, is yet sufficient even under unfavorable conditions to support a few hundred people, and the capacity of the region is such that it might be expected to respond to any improvements in transportation with increased production. It would seem highly desirable, therefore, that the Birch Creek region should be included in any general scheme of road construction for the placer regions in the interior of Alaska.

There is a station of the Government telegraph line at Kechumstuk near the southeast corner of the quadrangle but outside its area; another on North Fork of Fortymile, three at intervals of about 30 miles on the Goodpaster, and one at the mouth of the Salcha outside the quadrangle, but accessible to miners in the Salcha region. Trails have been constructed along the telegraph line and in places afford good traveling. Circle and the Birch Creek region are unfortunately without telegraphic communication.

GEOLOGY.

STRATIGRAPHY.

The area covered by the map is one of frequent changes in the kind of bed rock and one consequently where it is impossible to predict with any degree of certainty the existence of a formation in untraversed areas or, still less, to map its boundaries. The known facts, however, appear to justify provisional maps like fig. 3, which show the distribution of the formations so far as it is inferable from the facts obtained in the narrow areas traversed.

The rocks include representatives of the sedimentary and igneous classes—products of deposition through the agency of water-laid sandstone or conglomerate and products of solidification from a melted condition like granite or lava. The rocks of

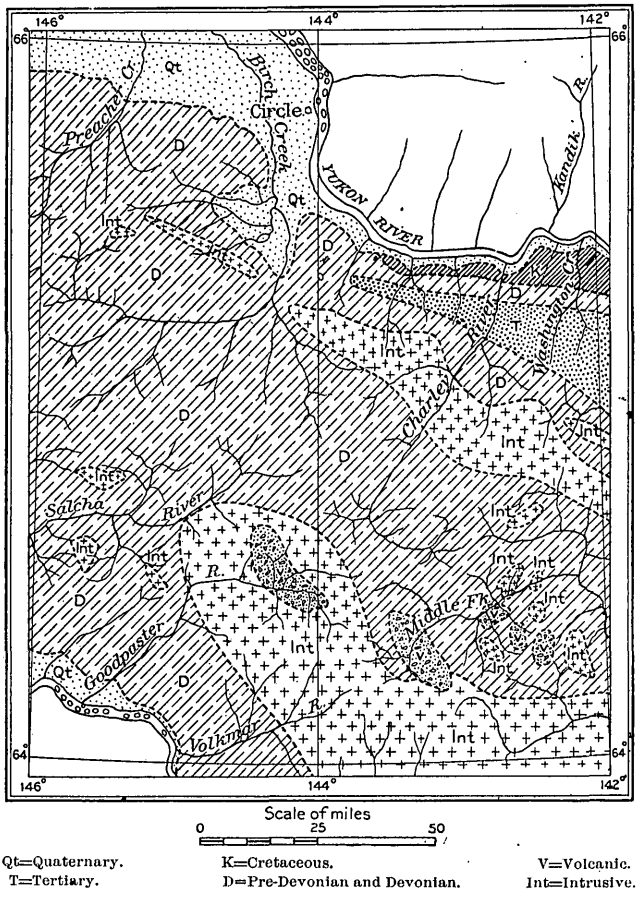

FIG. 3.—Geologic sketch map.

both classes have frequently been greatly changed or metamorphosed so that they have become in many cases very unlike what they were originally. For the purpose of this report they are divided into three groups, one composed predominantly of highly metamorphosed rocks, mostly schists of sedimentary origin, another of sedimentary rocks which have been but slightly metamorphosed, and a third of igneous rocks, some of which, like the sedimentary rocks, have also been metamorphosed.

The table shows the kinds of sedimentary rocks, their main subdivisions, and their sequence in time. Their distribution is shown in fig. 3,

The pre-Devonian rocks occupy much of the area and include most of the schists. The Devonian rocks are found mostly in the north, and are not so prominently developed as in the Rampart region; locally they have become schistose, and a grouping of all the schists would include some of these rocks. The majority of gold occurrences in the Fortymile, Birch Creek, and Fairbanks regions are in areas of pre-Devonian rocks; those of the Rampart region, and probably some of the occurrences in the Fortymile region, are in rocks regarded as Devonian. The two formations have therefore, for the practical purposes of this report, been grouped and differentiated from the succeeding rocks, which occupy only limited areas along the Yukon. These comprise slaty shales and limestones of Cretaceous age, forming conspicuous outcrops along the Yukon above Circle, and leaf-bearing shales, sandstones, and massive conglomerates of the Tertiary, which have been consolidated and closely folded, but otherwise slightly altered, and are prominently developed along the north side of Seventymile and the areas to the west. The Quaternary deposits have a wide distribution in the valleys of Yukon and Tanana rivers.

Provisional tabular statement of stratigraphy.

Age.	Formation name.	Lithologic character.
Quaternary		Silts, sands, and gravels.
Unconformity.		
Tertiary	Kenai	Shales, sandstones, conglomerates, and slightly consolidated clays.
Cretaceous		Slaty shales, sandstones, congloMerates, and thin-bedded limestones.
Devonian	Rampart	Slates, quartzites, conglomerate, limestone, chert, and greenstone (partly schistose).
Unconformity.		
Pre-Devonian	Fortymile and Birch creeks.	Schists, quartzites, crystalline limestone, and some intrusive gneisses.

The areas occupied by igneous rocks are roughly outlined in fig. 3, where no attempt has been made to separate the great variety further than to indicate the areas where the igneous rocks are mainly intrusives or extrusives.

SEDIMENTARY ROCKS.

METAMORPHIC ROCKS.

Pre-Devonian.—The pre-Devonian schists are the most widely distributed rocks within the area and have been so changed by complex processes of metamorphism that their origin is often doubtful. New minerals have been developed and new structures have been impressed upon them until their original characteristics are obscured or replaced by those of a secondary nature. Furthermore, they have been in places most intimately intruded by igneous rock and besides the natural results of such intrusion have undergone with the igneous rocks further metamorphism. Quartzite schists and quartz-mica schists are the common members, but there is much hornblende and carbonaceous schists, and also crystalline limestone, occurring either as thin beds found occasionally in the schists, or as massive beds becoming an important part of the formation. Greenstone schists are sometimes present. The schists are often garnetiferous, and garnets are sometimes abundant in the limestone.

These rocks have not only undergone changes in composition but have been folded upon themselves so closely that the structure is apparently simple, with the folds in some areas in a nearly horizontal position. The thickness of these rocks is therefore difficult to estimate. The strike, while in general northwest and southeast, is subject to much variation. The rocks contain numerous small quartz veins, some of

which have been folded with the schists, and locally the quartz veins or the rocks themselves have been more or less mineralized. Iron pyrite often occurs in the schists, and pieces of schist have been found containing gold-bearing quartz. There seems little doubt that the gold of the placers has been derived largely from these rocks, and the problem of their distribution is, therefore, one of economic importance.

A striking feature of the schists in the eastern part of the area is the large amount of granitic rock in the form of small dikes and sills with which they have been injected. Small dikes can be seen which have cut across the schistosity and sent along the planes sheets of granitic substance so thin that often several of them can be counted in the thickness of an inch. Frequently, too, these sheets of injected material have been folded with the schist. The injection by these acidic granites decreases in amount to the west and was not observed in either the Birch Creek or Fairbanks regions.

Devonian.—The rocks regarded as Devonian include a great variety. There are black, green, and purple slates, slaty shales, gray and blackish limestones, greenish quartzites, cherts, and a mass of igneous material, mostly serpentine and diabase. These rocks occur in the Crazy Mountains, in the valleys of creeks tributary to the Yukon above Circle, on Slate Creek, and on eastern tributaries of the Chena River. They are everywhere closely folded, and in places have become schistose. From the fact that the Rampart placers are in these rocks, and that part at least of the gold in the Chicken Creek area is believed to have been derived from these rocks, they deserve attention on the part of the miner wherever they have been made schistose by high metamorphism and are in close association with intrusive igneous rocks. The known occurrences of gold in these rocks are in such areas alone.

NONMETAMORPHIC ROCKS.

The succeeding formations—rocks of Cretaceous and Tertiary age—are limited in their distribution to the northern part of the area, the former occurring along the Yukon and the latter having considerable development north of the Seventymile.

Cretaceous.—The Cretaceous rocks are found along the Yukon, where they extend from the eastern boundary of the quadrangle to a point a short distance below Coal Creek, where the Devonian rocks commence. They consist of rather closely folded black slaty shale, limestone, and calcareous sandstone, and up to the present time have not been found of economic importance.

Tertiary.—The Kenai formation of Eocene age, which is of economic importance from the fact that it is coal bearing, has considerable development north of Seventymile Creek. Gold placers have been worked for several years on tributaries of the Seventymile flowing through Kenai rocks, whence it might be supposed that this formation is gold bearing. So far as could be learned, however, the gold is derived from the gravels overlying the Kenai. This formation, where studied by the writer on Seventymile Creek, is composed of shales, sandstone, and conglomerate. The shales are in places thin and papery and in places compact, preserving beautifully the great numbers of fossil leaves which they contain. The sandstone often contains chert pebbles in a sandstone cement resembling mortar. The pebbles of the massive conglomerate comprise black, gray, and green chert, quartzite, occasional pieces of schist, and vein quartz. The maximum diameter of pebbles observed was 5 inches. The cement contains much ferruginous matter, and the rock breaks down easily into its constituents, forming loose heaps of sand and gravel. The rocks are generally in a nearly vertical position.

Quaternary.—These deposits occur mostly in the Yukon Flats and along Yukon and Tanana rivers. They consist in general of silts, sands, and gravels of Pleistocene age and the alluvial deposits of the present streams. The Pleistocene sediments have a small distribution in the area under consideration, and the following descrip-

tion is narrowed to that of the alluvial deposits occurring in the valleys t roughout the area. These are roughly separable into bench gravels and stream gravels.

The constant weathering of the rocks produces a quantity of loose material which covers the fresher rock until removed. The streams forming their valleys have given opportuni y for removing this waste to lower levels, where it is worked and reworked by the running water until it becomes well-worn gravel. With elevation of the land the streams cut deeper, leaving these old accumulations on the floor of the abandoned older valleys and forming a new deposit of stream gravels at a lower level. This process has frequently taken place within this area, and along many of the streams there are gravels at different levels, some of them several hundred feet above the present stream. Many of these deposits, especially those of the valleys which are not well drained, are frozen throughout the year.

IGNEOUS ROCKS.

DISTRIBUTION.

The igneous rocks are present in such abundance as to render them an essential constituent of the area. A wide belt of them extends northwest from the international boundary as far, at least, as Goodpaster River. West of the river it has not been followed, but probably within a short distance breaks up into disconnected areas and finally gives place to schists, which are the predominant rocks along the trail from Circle to Fairbanks. There are many small areas throughout the region, a few of which are shown in fig. 3.

The prominent ridges are generally composed of igneous rock, which, from its superior hardness, withstands weathering and holds itself at a higher level while the rocks about it are being reduced. The ridge between the head of Seventymile Creek and Charley River is an example, as is also the one extending from Charley River east to Birch Creek. Glacier Mountain, to the east of the Circle quadrangle, is part of an igneous mass, which has its extension within this area at the head of Granite Creek. Mount Veta in the southeast and nearly all the points of highest relief in the main igneous belt are igneous rocks. There is a great variety of them and they occur both as intrusive rocks which have forced their way into the surrounding rocks at a considerable depth, and as extrusive rocks which have been poured out upon the surface like the lavas of the present day. The different conditions under which the same kind of molten material has consolidated have resulted in the production of coarse-grained, fine-grained, and glassy rocks entirely different in appearance. Furthermore, the igneous rocks, like the sedimentary, are subject to metamorphism and may thus depart far from their original characteristics.

INTRUSIVES.

The granular rocks include granite, rocks of intermediate composition, and gabbro. The granites vary greatly in composition and may be roughly divided into three varieties—alaskite, biotite granite, and hornblende granite. The alaskite is composed chiefly of quartz and feldspar, and occurs generally as small unaltered dikes and sills which have produced extensive granitization of the schists. The biotite granite has a darker color, due to the presence of a considerable proportion of biotite, and occurs sometimes in large areas. The largest mass observed is west of Charley River, where it forms a bare ridge, which attains an altitude of about 4,000 feet, and which was traversed by the Survey party for about 10 miles. It is an evenly granular, medium grained, biotite granite, with pegmatitic areas and a local development of gneissoid structure. Many of the granites contain considerable hornblende, distinguishable from the biotite by its greenish-black color and the fact that it does not cleave off in thin elastic plates like the biotite. Pyroxene is in some cases also present.

The rocks of intermediate composition contain, besides orthoclase, much plagioclase feldspar, biotite, and an abundance of hornblende. In a more detailed classification they could be differentiated into grano-diorites, quartz-monzonites, and quartz-diorites. Such rocks are especially abundant in the main mass of igneous rock, where also are many porphyritic varieties. At one locality on Mosquito Fork, just beyond the southeastern limit of the quadrangle, gold has been found in a mineralized zone in a rock of this character.

The most typical occurrence of gabbro is in the ridge that begins a short distance above the mouth of Flume Creek, on the north side of Seventymile Creek. As far as observed, this ridge is composed of gabbro and serpentine, cut by diabasic dikes. The rough ridges and precipitous peaks in which these rocks express themselves make this region one of wild beauty. The gabbro is a dark, greenish-gray, evenly granular rock, composed of irregular equidimensional grains of plagioclase and monoclinic pyroxene, with an average diameter of from 2 to 3 millimeters. Coarser varieties occur, and sometimes there is a parallel arrangement of minerals. The distribution of this rock has not been determined. The serpentine has been formed by the metamorphism of an intrusive igneous rock.

There are large areas of gneiss in the main mass of igneous rocks. These are in places rather fine, even-grained rocks and in places are coarse augen gneisses, with feldspar augen 2 inches or more in diameter. Through evidence obtained during the season's work of 1905, these are considered porphyritic granites intruded in the schists and afterward metamorphosed with them. The fresh porphyritic granites, which occur in a similar manner, have apparently only repeated what had already taken place so long before. Feldspathization of the schists has been an accompaniment of both the ancient and later intrusions.

VOLCANICS.

The extrusive rocks are found in about as great variety as the others and include rhyolitic rocks, andesitic rocks, and olivine basalt. They occur as dikes, or as small disconnected areas capping the hills of schist, or as areas of considerable size whose boundaries have not yet been defined. Along North Fork of Fortymile are several areas of coal-black, glassy volcanic rocks, and in the gravels of Slate Creek are fragments of the same rock. Basaltic dikes are common throughout the region, and some of the greenstones which form so characteristic a part of the Rampart formation are metamorphosed extrusive rocks.

SUMMARY.

The region is one of complex geology, being composed chiefly of metamorphic rocks. The oldest rocks are schists regarded as of pre-Devonian age. These have been highly metamorphosed, closely folded, and most intimately intruded by igneous rocks, which are composed partly of older rocks changed to gneisses by metamorphism and partly of younger, fresh intrusives. They are overlain unconformably by closely-folded Devonian rocks, which contain much volcanic material, and which, like the preceding, have undergone metamorphism, but have been rendered schistose only locally. Folding, intrusion, the formation of quartz veins, and mineralization have probably taken place at several periods. The material of later formations has been deposited on these older rocks, consolidated, folded, and worn with them by erosion to an undulating, more or less level surface. Recent changes in elevation have been many and are recorded on the terraced slopes of many valleys.

GOLD PLACERS.

DISTRIBUTION AND CHARACTER.

The greatest part of the gold produced in the area has come from a few small streams in the Birch Creek region, which have been worked continuously since 1893, and have produced, inclusive of 1905, approximately $4,000,000. The region still holds its own, and the amount of gold sent out during 1905 was approximately $300,000. The only other part of the area which has been notably productive during the past year is that of the smaller streams above Circle, tributary to the Tanana, which have contributed at least $15,000. Seventymile region was at one time the scene of much activity, and some of the small tributaries were very productive, but at the present time operations are confined mostly to investigation of the gravels with reference to working on an extensive scale. The widely scattered, richly productive areas of the Fortymile region were the means of distributing miners throughout the eastern part of the Yukon-Tanana country and of finding within the quadrangle a few localities which have produced a small amount of gold. The discoveries in the Fairbanks region caused similar investigation of streams tributary to the Tanana, and at a few localities within the quadrangle prospects have been found sufficiently encouraging to warrant considerable work.

The deposits that are mined are comparatively shallow, are mostly frozen, and are composed, in most cases at least, only of material derivable from the bed rock in the valleys where they are found. They are often divisible into three layers—muck, barren gravels, and pay dirt. The gravels contain few bowlders, and the gold content is found concentrated near the bed rock or to a depth of several feet within it. A large part of the ground, being less than 20 feet thick, is worked by open cut. The deeper ground is worked by steam drifting. The open-cut method is used most extensively in the Birch Creek region. The ground of streams tributary to the Tanana is generally deeper and necessitates steam drifting. The introduction of portable knock-down boilers, which can be packed on horses and are capable of operating one or two steam points, has greatly facilitated the work of prospecting.

Claims are recorded at Circle, Eagle, and Fairbanks, but the lack of accurate maps has hitherto rendered difficult the delimitation of recording precincts. The streams between the Yukon and Tanana rivers are so many, so similar in character, so little known, and pursue such irregular courses that many problems in recording have arisen. The accompanying map (pl. I) is expected to be of the greatest value both to the prospector and to the recording officer in furnishing the foundation for an accurate record.

BIRCH CREEK REGION.

General conditions.—The discovery of gold on the bars of Birch Creek attracted miners from the Fortymile, and later discoveries in the gravels of the gulches established the importance of the region and led to its rapid development.

Circle, about 140 miles below Eagle, on the west side of the Yukon, is the local supply point for the diggings in the Birch Creek region. The first-class passenger rates from Seattle to Circle by way of St. Michael are approximately $125; the freight rate on ordinary merchandise is $65 a ton. The corresponding rates by way of Skagway and Dawson are approximately $97 for passengers and $98 for freight. The mines are situated about 50 miles southwest of Circle, just within the edge of the hills. The trail between Circle and the gulches is direct and good during dry weather, but in long-continued rain becomes difficult to travel. Twelvemile House, Central House, and Miller House are good road houses, situated at convenient intervals along the trail. Pack trains make regular trips from Circle to the gulches, the freight rates being about 25 cents a pound during the summer season; but, as in all the other regions, the heavy freighting is done in winter.

The ramifying headwaters of Crooked Creek occupy a fan-shaped area within the edge of the hills to the south of its broad, flat valley. On its meandering way eastward to Birch Creek it receives also two tributaries, the Boulder and the Deadwood, which head a dozen miles or more to the south and flow northeast to the main stream in parallel courses about 3 miles apart. The south side of the divide in which these streams head is drained by North Fork of Birch Creek.

The creeks of economic importance on the north side of the divide where mining has been done are Deadwood, Mammoth, Mastodon, Independence, and Miller; on the south side, Eagle Creek and its tributary, Mastodon Fork.

Deadwood Creek.—This creek is about 20 miles long. It is divided into two parts, an upper about 12 miles long where it flows in a narrow valley bounded by ridges 1,200 feet above it, and a lower about 8 miles long where the individuality of the valley is lost in that of Crooked Creek. The fall in the upper part is about 150 feet to the mile. The stream flat is several hundred feet wide and is bounded on the east by a rather steep slope, near which the stream flows through most of its course. The west side of the valley has a more or less well-defined bench which rises gradually from a level about 20 feet above the stream toward the ridge separating Deadwood and Boulder creeks. Switch Creek is the most important tributary.

The bed rock in most of the valley is a rather massive, blocky quartzite schist, and quartz-mica schist. A structure observed at one locality showed a strike N. 60° E. and a dip of 20° to 25° to the southeast. The rocks show evidence of minor folding and contain numerous small quartz stringers. Intrusive granite is very prominent in the region farther east, especially in the valley of Ketchum Creek, only a few miles east of Deadwood Creek, where weathering has carved it into very striking pinnacled forms. On Deadwood Creek it is not so conspicuous, but forms the bed rock over a considerable part of the creek. Dark-colored dikes of diabase occasionally occur.

The gravels are composed of the varieties of rock outcropping in the drainage area and consist of subangular fragments, mostly under a foot in diameter, more or less irregularly arranged, containing much finely broken material of the same nature. The depth to bed rock varies in the creek from 3 to 12 feet, and on the bench to the west, so far as known, from 6 to 20 feet. The gravels in the creek vary in thickness up to about 8 feet, and there is generally but small overburden to be removed. The values are generally close to bed rock and are found also within it to a depth of 2 or more feet. When the bed rock is massive and is divided into blocks through jointing, values are found sometimes to a depth of 4 feet along the joint planes. The width over which pay is found varies from about 25 to 300 feet. The average width is said to be from 150 to 200 feet, and the average value of the ground for the entire creek to be about $50 to the box length of 12 by 16 feet, or 25 cents to the square foot. Some ground has averaged as high as $200 to the box length. Some work has been done on the bench on the west side of the valley, but little is known of the extent or values of the gravels found there. In a few cases, however, these gravels are being investigated and values have been found. The creek gold is generally flattened, and at the entrance of the valley is rather flaky; the bench gold is rougher and more lumpy. The coarsest piece found thus far on the creek was worth $122.

Ground is worked at various places throughout the narrow part of the valley, a distance of about 12 miles. The open-cut system has been employed on most of the ground and it has been found advantageous to work the cuts generally to a width of 16 feet. The season of 1905 was a prosperous one and new discoveries were made on Switch Creek. The bench trail, about 4 miles in length, from Central House across the flat to the entrance of the valley, is a good one, but in wet weather that along the creek is soft and difficult to travel.

Mammoth Creek.—Mammoth Creek, about a mile below Miller, flows through a flat which gradually widens toward the Porcupine.

The bed rock is quartzite schist and granite, and the gravels are made up mostly of these rocks, with a small proportion of vein quartz. The average depth to bed rock is about 10 feet, and the upper 2 or 3 feet are waste. The gold is rather fine, but the ground is probably rich enough to be worked at a profit on a large scale. An attempt made to work it by steam shovel in 1903 was not continued.

Mastodon Creek.—The headwaters of Mastodon Creek are gathered from an amphitheatral area on the north slope of Mastodon Dome. The creek flows through a picturesque valley limited by even-topped ridges which slope gradually in a direction parallel to the creek at an altitude of about 1,300 feet above it. The valley is unsymmetrical in section. The stream in its lower part approaches the steep ridge on the east, and is limited on the west by a bench which rises with a steep grade to the base of the spur. Farther upstream the valley becomes more open and the stream flat is several hundred feet wide.

Quartzite schist and quartz-mica schist are the most common varieties of bed rock and contain the usual proportion of quartz veins. The strike of the schistosity is usually across the stream and the dip is to the south. Near the mouth there is thin-bedded, impure, closely folded limestone. On some of the claims occurs a greenish feldspathic schist which weathers more easily than the usual bed rock, and may represent an intrusive rock metamorphosed along with the other rocks. There are also small granitic dikes.

The gravels are similar in character to those on Deadwood. They include subangular fragments of the bed rock, with fine material of the same nature and some sand and clay. The average depth to bed rock is 10 to 12 feet, with a maximum of about 20 feet. There is sometimes a layer of muck a few feet thick on top of the gravels, and the maximum of stripping required is about 7 feet. The gold is found sometimes scattered through the gravel and sometimes close to bed rock, or to a distance of a few feet within it. The pay streak has a variable width with a maximum of perhaps 200 feet. The gold is generally rather fine, the coarsest piece found weighing only 3 or 4 ounces. Some of the ground averages probably from $2 to $3 a cubic yard, and some of it is considerably richer. The gold brings $17 an ounce in trade.

Successful results were obtained in 1905 by working the rim to the west of Mastodon. The gold is somewhat coarser than the creek gold. Most of the creek has been worked by the open-cut method, but machinery has been introduced on a few claims. There is some winter work done by drifting in the upper part of the valley.

Independence Creek.—This creek has a valley similar to that of Mastodon, with a slightly flaring cirque-like expansion at the head in the northern slopes of Mastodon Dome. The deposits near the mouth where mining has been done are of the same character as those of the other creeks, consisting mostly of slightly worn fragments of schist and vein quartz embedded in a mass of fine material composed of finely comminuted particles of the more resistant rocks, products of rock decomposition, and resistant minerals released by such decomposition. The pay streak seems to have been of limited extent, and although the creek has been somewhat productive, there has been but little work upon it during recent years.

Miller Creek.—The conditions on Miller Creek are similar to those on Mastodon. The bed rock is quartzite and quartzite schist veined with quartz. Granitic dikes occur on the divide between Miller and Eagle creeks. The gravels are similar in character and arrangement to those on the Mastodon. The depth to bed rock varies from 8 to 16 feet, the average depth being about 12 feet, with 6 to 8 feet to strip. There is sometimes a layer of clay from 4 to 8 feet in thickness between the gravels and bed rock, which, when present, contains most of the pay. The gold is about the same as that of the Mastodon. Pieces weighing an ounce have been found, but the general run is rather fine. That near the head of the creek is rough. The gold is scattered through several feet of gravel over a maximum width of about 50 feet.

Some of the ground averages about $1.20 to the cubic yard. It is worked by open cuts.

Eagle Creek and tributaries.—Over the divide at the heads of Mastodon and Miller creeks are the headwaters of two small streams, Mastodon and Miller forks, which unite to form Eagle Creek, a tributary of Birch Creek. Gold was discovered on Eagle Creek in 1895, and much work has been done on this creek and on Mastodon Fork. The bed rock and gravels are similar to those already described. As on Miller Creek, clay is often found next to the bed rock of quartzite schist.

Eagle Creek is about 4 miles long. The valley widens rapidly below the junction of the forks until it becomes a half mile wide, limited by receding ridges which terminate in gentle slopes at Birch Creek. Work has been done for about 2 miles below the junction. The bed rock and gravels are similar to those on the other creeks; the depth to bed rock at the localities visited varies from 14 to 18 feet; about 6 feet is ground sluiced, and pay is found in about 6 feet. Values range from $125 to about $400 per box length of 13 by 18 feet. Some of the gold is coarse, one piece worth $74 having been found.

The depth to bed rock on Mastodon Fork ranges from 8 to 10 feet. In some cases there are 3 to 4 feet to strip and 4 to 5 feet of pay dirt. When clay occurs along with the gravels, the gold is often found in seams in the clay a few inches above bed rock. It is also found in the bed rock to a depth of 3 feet. Values are said to be irregularly distributed. Some ground has been good and has yielded $2 to $4 per cubic yard.

Summary.—The conditions of occurrence on all of the gold-producing creeks of the Birch Creek region are apparently the same. No foreign wash was anywhere observed, and there is no reason to believe that the gold has had other than a local origin. The quartzite schists contain numerous small quartz stringers, and pieces containing gold in the quartz seams have been found. The bed rock, so far as known, is about the same over a large area. Only a few of the streams within this area are gold producers. Whether the rocks have been uniformly mineralized over a considerable part of the drainage basin of a stream or only within certain zones or areas along its course which are relatively rich is a problem that can be solved only by detailed study. When gold has originated from local rich areas, it can often be traced to its source. The process of distribution, or decentration, as it might be called, of the gold from such local areas through the agency of gravity and local wash precedes that of concentration, and its results may be often obscured or removed by the stream action which brings about the later concentration. It seems probable, in view of what facts we possess, that the gold of the Birch Creek region has been derived from considerable areas of bed rock more or less uniformly mineralized; and that the distributed products from these areas have been concentrated mostly by stream action.

YUKON REGION.

A few small tributaries of the Yukon, notably Woodchopper, Coal, Washington, and Fourth-of-July creeks, have produced during 1905 at least $15,000, and according to some reports were expected to produce, before the close of the season, about $30,000.

The bed rock on these creeks, so far as known, includes Kenai sandstones and conglomerates, Cretaceous slates, and Rampart slates and greenstones. The gold is often coarse, and one nugget found on Washington Creek was worth $167.50. Most of the work in the Woodchopper Valley has been done on Mineral Creek, a small tributary entering from the east, about 7 miles above the mouth, and that in Coal Creek Valley, on Colorado Creek, also a tributary from the east, entering about 12 miles above the mouth.

SEVENTYMILE REGION.

General conditions.—The mining on Seventymile is confined mostly to tributaries east of the area covered by the map. Nugget and Flume creeks, however, come within the quadrangle. Supplies are obtained from Eagle. The Seventymile, except for a small portage at the Falls, is generally navigable for small boats nearly to Barney Creek, just off the eastern limit of the quadrangle, and supplies are sometimes carried by boat as far as possible and then packed overland; in other cases they are carried all the way from Eagle by pack train.

Nugget Creek.—Nugget Creek is small, entering the Seventymile about 10 miles above Barney Creek. The bed rock near the mouth is a gneissoid granite, and the gravels are mostly of the same material, their average thickness being about 4 feet. The gold occurs in plates up to one-fourth inch in diameter, and has garnets associated with it. The quantity of black sand is small. Pay is found over a width of 20 feet from rim to rim and for a length of about four claims.

Flume Creek.—Flume Creek enters Seventymile from the south about 45 miles by trail from Eagle. It heads several miles back in the hills and flows in a V-shaped valley, which, about a mile from the mouth, is a narrow canyon bounded by precipitous walls. About a half mile above the mouth the walls begin to recede from the stream, and at the mouth there is a flat about 300 feet wide. A quarter of a mile upstream this is bounded on the west by the face of a rock-cut bench, which lies about 20 feet higher than the creek, and has a very even surface mantled with a few feet of gravel.

The bed rock for about a mile above the mouth is greenstone and serpentine. Basic dikes are common. Above this formation are the metamorphic schists. The gravels at this point are mostly schists, but include a considerable proportion of large quartzite bowlders, greenstone, vein quartz, crystalline limestone, black-chert conglomerate, and granitic rocks. Granite is said to outcrop at the head of the stream. Flume Creek has been a favorite creek for prospecting. Some coarse gold has been found, and nuggets of considerable value have been reported. There are mineralized areas in the greenstone formation, one of which, hardly a mile above the mouth, has been somewhat prospected. At this place the rock contains many small quartz stringers, intersecting at various angles, and considerable pyrite. The oxidized zone, about 40 feet in width, can be traced across the creek to the opposite wall of the canyon, and strikes about N. 25° W.

Seventymile Creek.—The extensive benching which the valley of the Seventymile has undergone has been accompanied on the lower benches by the deposition of gravels. Large bodies of these gravels occur, and have been more or less prospected from time to time in the hope of finding extensive deposits sufficiently rich to pay for working on a large scale. Some work was in progress on them during 1903 and has been continued since that time. The prospecting requires much systematic work before the values of the gravel can be determined.

FORTYMILE REGION.

General conditions.—Considerable work has been done in the eastern part of the area on North Fork of Fortymile, on tributaries of Hutchinson Creek, and on Slate Creek, and during 1905 discoveries were made at other localities within the part of the Fortymile drainage included in the quadrangle. Up to the present time, however, gold has been found in limited quantities only.

The bed rock is mostly schist and crystalline limestone like that of producing creeks to the east. Igneous rocks are common, occurring as large masses of intrusive granitic rock like that of the high ridge east of Hutchinson Creek, or as the small dikes and sills so numerous in the schists, or as extrusives which cap many of the hills of schist in the area west of Hutchinson Creek.

North Fork.—North Fork occupies a meandering rock-cut canyon about 500 feet below the floor of an older valley. The necks of the meanders are frequently formed by only a narrow ridge of schist. A large meander known as the "Kink" is shown near the eastern edge of the map. The ridge forming the neck at its lowest point is 100 feet above the stream and the distance across the neck at the base is only 100 feet, while the distance around by stream is 2¾ miles. By blasting a channel through the rock barrier the waters were diverted from their former course and the stream bed was thus laid bare for mining. Work was soon suspended, however, probably from lack of gold in the gravels.

Montana Creek.—Gold has been found at several localities in the Hutchinson Valley, but chiefly on Montana Creek, where some mining was in progress during 1902.

Gold run.—Gold Run, a tributary of Slate Creek, about 4 miles long, located in the Fortymile basin about 75 miles southwest from Eagle and 30 miles northwest of the Kink, has been the scene of some activity for several years. The bed rock in this area includes pre-Devonian schists and Devonian slates and limestones; the depth of the gravels is about 12 feet. Open cuts are used, and the dump gate is the favorite method of ground sluicing the gravel. Some of the ground is reported to average $30 to the box length. Although no large values have been found, the discovery is of importance in showing the presence of gold in a remote part of the Yukon-Tanana country.

SALCHA REGION.

General conditions.—There has been considerable prospecting during 1905 in the country north of the Tanana and 50 to 100 miles east of Fairbanks on creeks within the quadrangle, and especially on Butte and Caribou creeks, tributaries of the Salcha. A few creeks north of the Butte, including Gold Run and its tributaries, were also being prospected. Tenderfoot Creek, where considerable work was in progress, lies off to the southwest outside the quadrangle.

The bed rock on these creeks consists chiefly of pre-Devonian schists like those of the Fairbanks and Birch Creek regions, gneisses intrusive in the schist, crystalline limestone in places garnetiferous, and slates, limestone, greenstone, and serpentine, regarded as Devonian. There are also fresh granitic intrusives, largely hornblende granite like that forming a large part of the Butte at the head of Butte Creek. It will be noticed from the map that, while the bed rock in the valleys of Chena and Salcha rivers is chiefly schist, the area of schist diminishes toward the southeast until in the Volkmar Valley it occupies only part of the valley below the forks, and still farther in the same direction outside the quadrangle, in the ridge west of Healy River, forms a belt only a few miles wide along the Tanana. The headwaters of Volkmar and Healy rivers are in areas of igneous rocks, chiefly granitic rocks and gneiss, with some areas of more basic rocks.

Butte and Caribou creeks are adjacent tributaries of Salcha River which enter from the west about 50 miles above the mouth. A combination road house and store is situated at the mouth of Salcha River and here also is a Government telegraph office. Supplies were transported from Fairbanks during the past season largely by poling boats, which ascend Fairbanks Slough to the point where it leaves the Tanana, traverse the main river for only about 1½ miles, and then enter Salcha Slough. This route at time of low water is an excellent one, as it is possible to use a horse in towing boats for the greatest part of the distance. The bars of Salcha River at low water are laid bare for considerable distances, and a horse can easily ford the river from the one side to the other. At high water, however, transportation of supplies is difficult. The time required from Fairbanks under the most favorable conditions is about seven days. A spur which starts at the head of Fairbanks Slough, near Mullowney's cabin, affords fair traveling for a pack train, the distance to Butte Creek being about 40 miles. The next spur, a few miles farther down the river, is recom-

mended by some as being somewhat drier; both lead to the same main ridge about a dozen miles north of the river.

A prominent ridge, extending west from the forks of Salcha River, about 60 miles above the mouth, divides the drainage of North Fork from that of the main river below the forks and then swerves southwest toward the Tanana, between the Chena and Salcha drainages. The ridge has an undulatory outline, with deep saddles and several points of prominence, the highest of which is known as the Butte. This has an altitude of about 4,200 feet and is prominently isolated from the main ridge by deep saddles at the base of either flank. The steep northern slope faces an open valley, drained by Gold Run, a tributary of North Fork of Salcha River, which receives several minor tributaries from the slopes of the inclosing ridges. The southern slope is steep and deeply cut by the headwaters of Butte Creek. The prevailing rocks are schists. Crystalline limestones are abundant in the hills east of the Butte, and these are in places thin bedded, alternating with schist, and, like the schist, are frequently garnetiferous. Carbonaceous slates occur in the hills west of the Butte, and here, too, greenstones and serpentine have a considerable distribution. The Butte itself is composed mostly of dark-colored intrusive granite, and owes its prominence largely to the superior hardness of this rock. The gravels, so far as was observed, are essentially the same in character and arrangement as those of creeks in the Fairbanks region.

Butte Creek.—Butte Creek is considerably larger than any of the productive streams in the Fairbanks region, carrying at the lowest stage during the past season 3 to 4 sluice heads of water. The valley has a grade of about 100 feet to the mile; its width in the middle of its course is about half a mile, becoming gradually narrower toward the head, where it is joined by steep, narrow gulches. The valley is limited on the west by massive wooded spurs, which descend from the main ridge 2,000 feet or more above the creek, and on the east by the lone, even-topped ridge, about 1,000 feet above the creek, which extends from the saddle at the eastern base of the Butte southeast toward the Salcha and separates the valleys of Butte and Caribou creeks. The creek flows for the greatest part of its course near the east side of the valley, leaving on the west a flat of considerable extent. Claims were not staked until the middle of May, 1905. The greatest part of the labor during the summer had necessarily been expended in providing shelter and supplies, and consequently at the time the creek was visited the last week in August but little development work had been accomplished. Only three holes had been sunk to bed rock, disclosing a thickness of 24 to 26 feet of deposits, consisting of about 6 feet of muck and 18 to 20 feet of gravel. The gravels consist of several varieties of schist, gneiss, granite, greenstone, and vein quartz. Live water was encountered in some of the ground, and rendered prospecting difficult. Prospects were reported, but insufficient work had been done to determine whether a pay streak was present.

Caribou Creek.—Caribou Creek is the neighboring creek to the east and is easily reached in an hour's walk over the ridge from Butte Creek. It is about 7 miles long, carries less water than Butte Creek, and flows southeast to the Salcha. The valley is narrow and deep. The position of the stream is close to the base of the high, steep ridge which forms the eastern limit of the valley. On the west side of the stream is a flat, in places a few hundred feet wide. The more gentle eastern slope of the valley is well timbered and the bottom of the valley is covered with small spruce. The stage of development was found to be about the same as on Butte Creek, and many of the men who had been working there during the summer had just left for Fairbanks to get supplies for the winter. So far as could be learned, gold was discovered in April, 1905. A few holes only had been sunk to bed rock in deposits ranging from 24 to 36 feet thick. The layer of muck was found generally to be but a few feet thick. Pay dirt and pieces of gold weighing as high as $4.75 have been reported. All that can be said regarding the future of the creek is that it is well worth prospecting.

COAL RESOURCES.

The coal which occurs in this area along the Yukon was investigated in 1902 by A. J. Collier,[a] of the Geological Survey, from whose report the following facts are taken:

Coal is found on Washington Creek, Bonanza Creek, and Coal Creek.

Washington Creek.—The rocks in the lower part of the Washington Creek Valley are Lower Cretaceous. They are succeeded by a belt of Rampart rocks about 2 miles wide, and these again by coal-bearing sandstones, shales, and conglomerates which belong probably to the Kenai; these last commence at a point about 9 miles from the Yukon where the valley broadens to a wide flat basin. The reports of prospectors indicate that the coal is interbedded with soft sandstone and shale. Mining has been done at points 2 miles or more apart. There are coal outcrops between, and there is probably a considerable area of coal-bearing sandstone containing beds of more or less pure coal. The greater part of the coal, however, lies below the level of the drainage. The coal is black and glossy, has a conchoidal fracture, and contains numerous grains and streaks of amber. It is lignitic in character. The following analyses were made by Dr. E. T. Allen, of the United States Geological Survey:

Analyses of coal from Washington Creek.

	No. 75.[a]	No. 313.[b]
Water	13.48	11.13
Volatile combustible matter	43.74	42.57
Fixed carbon	39.58	44.20
Ash	3.20	2.10
	100.00	100.00
Sulphur	.24	.26
Fuel ratio	.91	1.04

[a] Sample taken by the writer, 10 miles from Yukon River, from a 5-ton sample mined for steam test.

[b] Sample taken by Kasper Ellingen, of Alaska Coal and Coke Company, 12 miles from Yukon River.

Coal was discovered here in 1897, and up to 1902 about 5 tons had been mined. The localities are 10 to 12 miles from the Yukon, and should the quality of the coal and the demand justify it, a railroad could be easily built to connect the mines with the Yukon.

Bonanza Creek.—This creek, a tributary of Charley River from the east, is parallel with the Yukon about 6 miles to the south and is separated from the Yukon drainage by rough hills. The geologic relations are probably similar to those on Washington Creek. Extensive beds of coal are reported, but up to 1902, at least, had not been exploited.

Coal Creek.—The stream is about 30 miles long and coal is reported from a point about 6 miles from the Yukon. The coal is similar to that on Washington Creek, and the conditions of occurrence are probably the same.

[a] Collier, A. J., The coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, 1903, pp. 28-33.